This book summarizes the Tropical Legumes (TL-II) project interventions in South Asia across three major legumes crops (chickpea, pigeonpea and groundnut) between 2007 and 2014. The key findings and various lessons learnt across project activities such as baseline surveys, farmer participatory varietal selection, early adoption surveys and real-time tracking surveys etc. were discussed and systematically presented for the benefit of researchers, academicians and policy makers. The study outcomes are highly valuable for future legume research investments in South Asia.

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978-620-0-46579-5

Targeting of Grain Legumes for Income and Nutritional Security

Kumara Charyulu Deevi
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In South Asia

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Imprint

Cover image: www.ingimage.com

Publisher:
LAP LAMBERT Academic Publishing
is a trademark of
International Book Market Service Ltd., member of OmniScriptum Publishing Group
17 Meldrum Street, Beau Bassin 71504, Mauritius

Printed at: see last page
ISBN: 978-620-0-46579-5

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

D Kumara Charyulu and D Moses Shyam

Abstract

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

A number of research initiatives have been completed in five major states (Andhra Pradesh, Bihar, Karnataka, Odisha and Tamil Nadu) in India and Barind region of Bangladesh during last eight years (2007-2014) of project phase 1 and phase 2 implementation. These studies have examined and documented the existing situation of legumes cultivation, constraints faced by the farmers, market linkages, potential opportunities for their expansion etc. In close association with the crop improvement scientists, agricultural economists have also assessed the farmers preferred traits for chickpea, pigeonpea and groundnut varieties expressed during the 'Farmer Preferred Varietal Selection (FPVS)' demonstrations. Subsequently, the farmer preferred varieties were identified, released formally, multiplied and supplied as seed samples to legume growers in the project 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 brought out location specific suggestions to accelerate the food legumes productivity and profitability in India and Bangladesh. The summary outcomes of these studies will immensely help the researcher, academicians and policy makers for future designing of legume interventions and developing location specific technologies.

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Chapter 1

Current Trends and Plausible Future Outlook of Food Legumes in Asia

S Nedumaran[1], D Kumara Charyulu and P Jyosthnaa

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 which are 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 and grown as rotation crops, helping in enhancing nitrogen fixation. Integration of legume cover crops in 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 (Parthasarathy 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 are 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 1.1) and produces about 85%, 64% and 82% of global chickpea, groundnuts and pigeonpea respectively.

Table 1.1: 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

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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 legume 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, raise in incomes, changes in markets, consumption patterns and biophysical conditions on the future of food legumes around the world particularly in Asia. The important questions are: 1) what are the alternative futures and outlooks for the food legumes under changing population and income growth scenarios? 2) what are the potential impacts of changing consumption pattern and growing preferences for rice, wheat, maize and livestock products and how it affect production, demand, and trade opportunities for food legume crops? 3) 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

[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).

function of prices, income, and population growth. The IMPACT model incorporates climate effects from the DSSAT modelling results as a shifter in the supply functions. 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 2009a).

Socio-economic scenarios

Three socio-economic pathway scenarios[4] were developed using combinations of economic and demographic drivers. Table 1.2 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 1.2: GDP and population data for the three socio-economic scenarios

Item	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).

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

[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.

[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

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 (Robertson et al 2012).

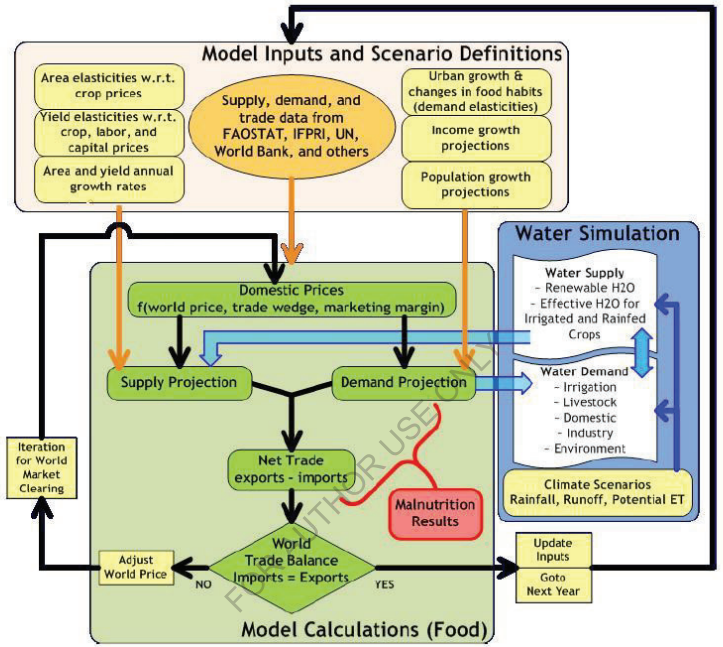

Figure 1.1: The IMPACT modeling framework
Source: Nelson et al (2010)

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 1.3) at an

population that peaks midcentury, but with rapid changes towards a service and information economy and introduction of clean and resource efficient technologies.

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 –2.2% during 1991-2013 (Table 1.4). 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 B_t 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 1.3). 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 1.3), at an annual rate of 1.6% (Table 1.4). Yao (2004) reported that the rapid expansion of groundnut in China was due to its comparative advantage over other crops 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 was very high compare to other major groundnut growing countries in Asia.

Table 1.3: Area, yield and production of groundnut in different regions

Country/ Region	Area ('000 ha)			Yield(kg/ha)			Production ('000 tons)		
	91-93	01-03	11-13	91-93	01-03	11-13	91-93	01-03	11-13
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

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 1.4). 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 1.3 and 1.4) 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 1.4). 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 1.4). 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 is Myanmar. The groundnut production tripled during 1991-2013 with an annual rate of 6.54% (Table 1.4).

Table 1.4: 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 the 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 1.5 and 1.6). 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 post-rainy season.

Global chickpea yield increased at an annual rate of 1.31% during 1991-2013, from 699 kg/ha to 931 kg/ha (Tables 1.5 and 1.6). Chickpea yield is lower in traditional chickpea growing areas such as Asia compared to that of non-traditional areas like Africa and developed countries such as 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 better crop management practices used by the farmers.

Table 1.5: Area, yield and production of chickpea in different regions

Country/ Region	Area ('000 ha)			Yield (kg/ha)			Production ('000 tons)		
	91-93	01-03	11-13	91-93	01-03	11-13	91-93	01-03	11-13
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**

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 1.5 and 1.6). 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 1.6). 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 1.6) which is mainly due to doubling of area and yield during 1991-2013.

Table 1.6: 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 sub-tropics 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 1.7 and 1.8). Its area grew rapidly in Africa and developed world at an annual rate of 2.7% and 5.4% respectively 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 1.8). 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 1.8). The increase in pigeonpea area can be attributed to availability of medium duration wilt-resistant varieties and increase in pigeonpea prices in relation to its competing crops as well as substitution of 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 1.8). 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 significantly higher in Myanmar with an annual increase of 4.4% between 1991 and 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 1.7 and 1.8). 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 1.8). The rapid production in Myanmar is driven by area expansion and considerably by the improvement in yield.

Table 1.7: Area, yield and production of pigeonpea in different regions

Country/Region	Area ('000 ha)			Yield (kg/ha)			Production ('000 tons)		
	91-93	01-03	11-13	91-93	01-03	11-13	91-93	01-03	11-13
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 1.8: 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 1.9). 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 1.9: Demand and supply projections ('000 tons) of groundnut

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 1.10. 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 1.10: Demand and supply projections ('000 tons) of chickpea

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

* includes demand for food, feed and others

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 1.11). 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 1.11: Demand and supply projections ('000 tons) of pigeonpea

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

* includes demand for food, feed and others

Climate change scenario analysis

Groundnut: The simulations carried out by the both climate models projected a decline in groundnut yield in most of the countries. The decline is much higher in the CSIRO scenario than MIROC scenario. 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 1.12). The yields reduce by 17% in Pakistan 4% in Myanmar and 1% in India. The yields in China 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 yield, the reductions in production are higher in the CSIRO scenario than MIROC scenario. 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, the CSIRO scenarios in 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 and Myanmar, it increases in the CSIRO B1 scenario, it increases by 3% in 2050 relative to baseline (Table 1.12).

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 1.12).

Chickpea: The projections for chickpea are mixed. Just as the case of groundnut, Pakistan is the worst hit country in both the scenarios and predicts significant 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 scenario. In case of Pakistan, it declines by 17% and 21% by 2050 in the CSIRO B1 and A1B scenarios respectively and 14% and 6 % in the MIROC scenarios. In Iran, the chickpea 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 it is seen to decrease by 4% in MIROC and 2% in CSIRO A1B scenarios respectively (Table 1.13).

The changes in production did 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 1.13).

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 1.13).

Pigeonpea: Pigeon pea yield is projected to decline by around 1% and 2 % each in India in CSIRO B1 and A1B scenarios 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 1.14).

Conclusion and policy implications

The sustained increase in per capita incomes, growing population, changing lifestyles and dietary consumption, the demand for 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% per 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.

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 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 (MSP). Both the environmental benefits as well as nutritional value of the legumes have 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 the demand for these legumes in future. The policies at the national and international levels need to create a conducive policy environment to incentivize and sustain such efforts.

Table 1.12: Deviation (%) in groundnut area, yield and production over baseline (climate change scenario)

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 1.13: Deviation (%) in chickpea area, yield and production over baseline (climate change scenario)

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 1.14: Deviation (%) in pigeonpea area, yield and production over baseline (climate change scenario)

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

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Chapter 2

Targeting and Diffusion of Chickpea Improved Cultivars in Andhra Pradesh, India

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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 - small in size, light to brown seed in colour with a rough coat, cultivated mostly in the India and much of the Indian sub-continent as well as in Ethiopia, Mexico and Iran; and *kabuli type* - associated with Kabul in Afghanistan are lighter colored also whitish, with larger seeds and a smoother coat, mainly grown in Southern Europe, Northern Africa, South America and Indian sub-continent, having been introduced during 18th century to India.

In the world, major chickpea growing areas are Mediterranean, western Asia, the Indian sub-continent, Australia and the Great Plains. Major countries producing chickpeas are India, Australia, Pakistan, Turkey, Burma, Ethiopia and Iran. Among all of them, 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 pulse produced in the country.

In Andhra Pradesh, Kurnool and Prakasam were the major districts occupying first and second positions in chickpea production. During 2007-08, a baseline survey was conducted in these districts for establishing a bench mark before any intervention. Besides this mother baby trials were organized during 2007-08 to facilitate participatory varietal trials for selection (PVS) of suitable varieties involving the farmers. Before the intervention there were certain chickpea varieties cultivated by the farmers, but those existing varieties were released 30 years back. These cultivars virtually yielding like local varieties because the seed has lost its purity over years. Intermittently, several other varieties were tried but did not like by farmers. The present chapter attempts to provide a holistic view of TL-II interventions (chickpea) in the state and the key findings emanated from both baseline and real-time tracking survey.

Baseline survey – lessons learnt

In Kurnool and Prakasam districts, baseline surveys were conducted to serve as a bench mark for the study and to assess the impact of TL-II interventions at a later point of time. Stratified random sampling technique was adopted to cover all the categories of farmers by drawing a sample of 135 from each district. In Kurnool district - Balapanur, Mitnala and Pulimaddi (3 adopted) Munagala, Rasulpet and Brahmanapally (3 control) and in Prakasam district – three adopted (Cherukurapadu, Chirvanauppalapadu, Kollavaripalem) and three control villages (Paidipadu, Maddiralapadu and Bodavada) were selected. Both adopted (being the villages where mother baby trials were conducted in 2007) and control (villages where there was no deliberate intervention made) slightly differ in project treatments, but they are having similar agro-climatic conditions.

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Baseline survey found that food crops such as jowar and bajra, non-food crops like cotton, chillies and tobacco in Prakasam and sunflower and jowar in Kurnool were major traditional crops cultivated and these were replaced by chickpea. Chickpea gained prominence as it is a short duration crop, suitable to black soils, less labor intensive, suitable for mechanization and realized stable prices from market. Baseline revealed a striking fact that the old variety Annigeri popularly referred by farmers as gulabi was the ruling variety. The respondents of the survey were ready to buy new seed even at higher price if it yields better than Annigeri.

Lessons learnt

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

Cultivars identified during FPVS trials 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 continued interventions moved away from the treated villages and brought awareness among farmers in neighboring villages within a span of two years. Ruling variety (Annigeri) started declining and project introduced new cultivars were expanded significantly. This led to the initiation of early adoption surveys during 2009-10 to ascertain whether there is uptake of the chickpea improved technology and cultivars. All the 270 baseline survey respondents were revisited to track the early adoption information. The trends in adoption of improved cultivars was similar in all the project villages surveyed. The old cultivars almost disappeared in the project locations.

Early adoption survey – lessons learnt

Chickpea cropped area increased as a percentage of total cropped area of the respondents as well as in the district. The predominant varieties preferred by farmers were: JG 11 and JAKI 9218 in Kurnool while JG 11 and KAK 2 in Prakasam district.

- JG 11 was adopted by 157 farmers in both districts
- KAK 2 was sown by 89 farmers and the price for KAK 2 was greater than of JG 11. Yield levels were significantly improved compared to Annigeri.

The adoption of new cultivars has greater impact on farmers' income and they realized a benefit cost ratio of 2.39. The net returns from chickpea ranged from Rs. 28,514 to Rs. 35,153 per ha. The project continued the seed multiplication and the farmer trials could outreach into new areas.

Real time tracking survey

A real time tracking survey was taken-up to oversee the process of adoption, diffusion, technology dissemination and innovations involved in the spread of improved cultivars introduced under TL-II looking at its sustainability. This survey was taken up with specific objectives:

1. To understand the adoption and diffusion process and identification of drivers of adoption
2. Track the seed source, delivery process and role of various agencies in spread of the technology

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, a real time tracking survey was conducted. A total sample of 487 farmers including seed beneficiary households (2008, 2009 and 2010) and non-seed beneficiaries from baseline surveys were included (Table 2.1). About 70% of sample covered from Kurnool district covering 19 mandals while remaining from Prakasam district (covering about 13 mandals). A semi-structured questionnaire was designed and all the 487 farmers were interviewed to get the desired information.

Table 2.1: Sampling framework

District	Seed beneficiaries		Non-seed beneficiaries		Total
	Baseline	Non-baseline	Baseline control	Non-baseline	
Prakasam	0	99	17	30	146
Kurnool	14	217	33	77	341
Total	14	316	50	107	487

Note: Figure in the parenthesis indicates percentage to column totals

Key findings from real time tracking survey

The real-time tracking survey was conducted by contacting 330 seed beneficiary farmers and 157 non-seed beneficiary farmers from both Kurnool and Prakasam districts**.** The survey has widely covered in 65 villages representing 32 mandals. The data collected was classified and presented in two major categories - seed beneficiary and non-beneficiary. In Kurnool district, the total seed beneficiaries are 231 and non-seed beneficiaries are 110. Similarly, the seed beneficiaries in Prakasam were 99 while non-seed beneficiaries were 47 (see details in Table Appendix 1).

The mixed profile of sample farmers is presented in Table 2.2 highlighting education, caste category, experience in chickpea cultivation etc. for seed beneficiaries and non-beneficiaries. Among the 330 seed and 157 non-seed beneficiaries, seed beneficiaries are found to be more educated than non-seed beneficiaries with their mean schooling years being at 8.4 years compared with 6.9 years respectively. Among the sample, open category farmers were higher (62%) followed by backward caste (32%) and scheduled caste (4%). About 2% of sample did not share their caste groups. The mean experience of chickpea cultivation by seed and non-seed beneficiary farmers was almost the same i.e., 10.98 and 10.25 years confirming that chickpea introduced as a new crop only a decade ago. The extent of own land holding was 14.1 acres for entire sample and the mean operational holding was 16 acres. It was noteworthy that 98.76% of the sample farmers cultivated chickpea in deep black soils reinforcing the soil suitability for crop cultivation is mandatory. Chickpea expansion took place in the adjacent areas of black soils in neighboring villages.

Table 2.2: 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.)*			
Scheduled Caste (SC)	15	2	17
Backward Caste (BC)	120	36	156
Open Category (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:	-	-	-
**11 respondents have not disclosed their caste*			

Area expansion under chickpea

Table 2.3: Expansion of chickpea in project locations

Item	Seed beneficiaries (N=330)	Non Seed beneficiaries (N=157)	Sample Average/ Sample Total (N=487)
Area under chickpea (acres in 2013-14):	5381.5	2766.5	8148
Area under chickpea in 2012 -13 *(acres)*	3346	1544.5	4890.5
Trends in area allocation 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	-
Distance to Research station *(km)*	21.49	12.28	-
Distance to Agricultural Office *(km)*	10.07	9.25	-
Distance to Storage facility *(km)*	12.75	12.46	-
Are you member of any organization/society (No.) **			
Yes:	19	9	28
No:	309	148	457

Total area cultivated by sample farmers was 8148 acres in 2013-14, while it was 4890 acres in 2012-13, indicating doubling of chickpea cropped area establishes the tremendous potential for crop expansion in the target area (Table 2.3). 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 9% want to expand the area further under chickpea. The decline in area is because of harvest prices are being stagnant even after waiting for six to seven months. The major competing crops were tobacco and jowar. As new areas are already gaining (Medak and Guntur), definitely there is huge scope for expansion in the area but it depends upon import and export policies. The average distance from the seed beneficiary villages to the regulated markets is about 16.3 km and to the research stations is 21 km when compared to 12.3 km for the non-seed beneficiaries households to the regulated markets and research stations. Storage facilities such as warehouses/cold storage units were in a vicinity of 12 km for all the villages. All these storage facilities are owned by private people only.

Seed distribution

The variety-wise seed distribution over the past four years (2008-09 to 2011-12) under project are summarized in Table 2.4. Seed beneficiaries were about 150 during 2008-09, 76 of them 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 another 22 farmers with JG 130 seed. These trials were taken up in an aggressive way with wide and deep coverage. Once the farmers are aware of the yield potential of new cultivars, they are willing to try the new seeds in their fields. Only 20 kg of seed pockets were given to each farmer and thus bringing many farmers into the purview of seed distribution program. Slowly the withdrawal of the intervention started, thereby creating necessity to farmers to meet the seed demand. This has resulted in development of both public and private partnerships as well as farmer to farmer seed networks for establishing 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 success rate in sowing the seeds of new cultivars was about 95%. The middle men/commission agents also were helping the farmers to store their seed and try for loans on the basis of warehouse receipt. Thus the no. of warehouses have tremendously increased. Storage function also used to mitigate the price risk.

Table 2.4: TL-II seed beneficiary details (N =330)

Details	2008-09	2009-10	2010-11	2011-12
Variety wise HH benefited from TL-II project seed (no.)				
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
Total	170	127	29	6
Avg. quantity of seed received (kg)				
JAKI 9218	20.4	19.3	22.3	17.5
JG 11	20.0	18.0	18.3	-
JG 130	18.9	21.4	25.3	25.0
KAK 2	19.0	20.9	21.2	-
Vihar	18.7	21.2	18.7	18.3
Did the household sown this variety (no.)				
Yes:	156	121	28	5
No:	11	6	1	1

Seed Sources and varietal adoption

All the varieties were primarily obtained from PVS trials only (69% 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

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 in Figure 2.1. It 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.

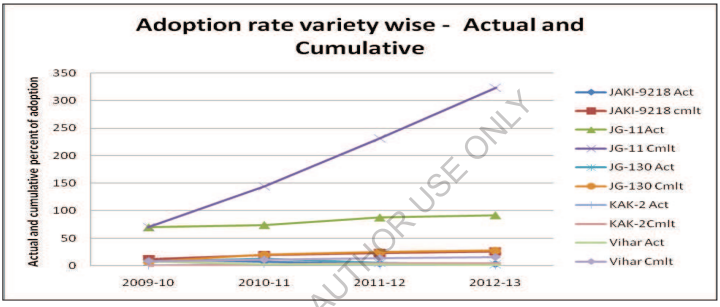


Figure 2.1: Variety wise adoption rate

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 2.2 which showed JG 11 was occupying 96% of the output produced.

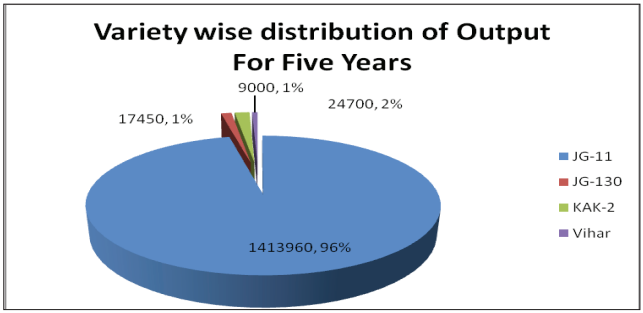
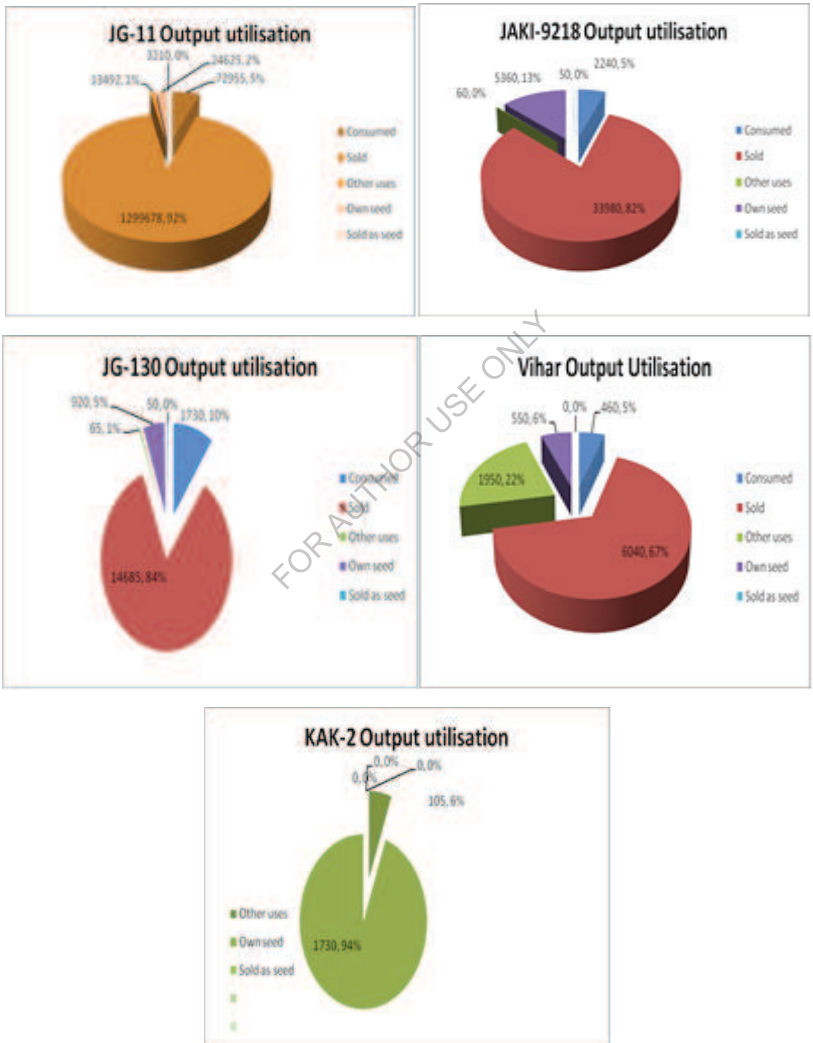


Figure 2.2: Variety wise seed output

Output utilization – 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 utilization pattern was depicted in the following Figures 2.3 to 2.7. When the output sold was assessed by variety wise - the quantity ranged from 67 to 96%. Household consumption was around 5% of the output which was used for day to day consumption.



Figures 2.3 to 2.7: Variety-wise output utilization pattern

Costs and returns from chickpea cultivation

A year before the seed distribution, there were about 225 farmers growing Annigeri variety in 1953 acres. Costs and returns were obtained from new cultivars (JAKI 9218, JG 11, JG 130, KAK 2 and Vihar) and old cultivars (Annigeri) pertaining to 2012-13 is summarized in Table 2.5.

Table 2.5: Variety-wise costs and returns from chickpea, 2012-13

Operation	Cost of Cultivation (Rs/acre)						
	Annigeri	JG 11	JAKI 9218	JG 130	KAK 2	Vihar	Pooled average
Land preparation	1094	1905	2006	1957	2269	2307	1923
FYM/Compost	0	480	805	450	0	195	322
Seed costs	1000	1864	1839	1750	2123	2073	1941
Sowing costs	719	1145	1121	997	840	893	953
Fertilizer costs	856	2339	2470	2094	3092	2667	2253
Micro-nutrient costs	-	10	29	-	-	-	7
Inter-culture costs	94	254	543	540	-	32	244
Weeding costs	406	725	792	728	1350	891	815
Plant protection costs	1250	1828	1711	1592	2619	2127	1855
Watching expenses	56	17	55	4	-	-	22
Harvesting costs	963	1003	1120	1097	1004	1142	1055
Threshing costs	688	799	900	878	1831	1138	1039
Marketing costs	83	223	238	214	148	213	186
Rental value of land	6000	6116	6346	6896	6192	6773	6387
Others costs if any	-	-	127	-	-	-	21
Total costs	13207	18753	20103	19195	21468	20451	19029
Grain-pod yield (kg)	425	763	641	696	671	700	633
% increase in grain yield over Annigeri	0	79	51	64	58	65	49
Grain-pod price/kg	34	37	34	33	39	38	36
Gross returns	14450	27959	21614	23136	26216	26915	22710
BCR	1.09	1.49	1.07	1.20	1.22	1.31	1.19

Among all the cultivars, the costs of cultivation per acre was the lowest for Annigeri variety. All the project introduced improved cultivars showed significant higher (40%) costs of cultivation per acre. The reason could be due to high seed costs and towards land preparation. However, the perceived gross returns per acre were the highest in case of JG 11 followed by Vihar and KAK2 varieties. The estimated BC ratio was higher for JG 11 (1.49) and Vihar (1.31). The old cultivar (Annigeri) could able to realize the BC ratio of about 1.09. This clearly establishes the farmers' preferences towards the JG 11 and KAK2 cultivars when compared with other improved varieties. Among all the cultivars, the yield potential was recorded much higher in case of JG 11 (763 kg/acre) and Vihar (700 kg/acre). The local variety (Annigeri) yielded only about 425 kg/acre.

Seed exchange

Among sample farmers (487), only 35 farmers have shared their seed with neighboring farmers while the rest did not (Table 2.6). The quantity of JG 11 seed shared was 21332 kg to 71 farmers in the same village (SV) and another 50 farmers were outside village (OV). 5210 kg of JG 130 was also shared with 11 farmers in the same village and 26 farmers from outside villages. Similarly, 2500 kg of KAK 2 was shared by 3 farmers in the same village and 11 farmers in other villages. Overall, a total of 31792 kg of chickpea was shared with 112 farmers from same village and about 99 farmers from other villages. This data clearly reveals that informal (farmer to farmer) seed exchange was the key for rapid diffusion of chickpea improved cultivars in the study area. Approximately, on an average, each farmer distributed to a minimum of three farmers.

Table 2.6: Informal seed exchange among sample 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)	Same Village Farmers (No.)	Outside Village Farmers (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	-
Total	31792	112	99

Drivers of technology adoption and diffusion

Logit model was employed to examine the drivers of chickpea improved cultivars in the state. 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; otherwise $Y_i = 0$;

Whereby:

Y = Adoption of improved chickpea variety

β = Parameters to be estimated

X =Vector of explanatory variables

E_i and μ_i= random error

Further, to model the adoption of chickpea improved cultivars, the following specific equation was used:

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) otherwise= 0
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

The Logit model was used to investigate factors affecting the adoption of improved chickpea varieties as shown in Table 2.7. The adoption of improved chickpea varieties was increased by 96 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 68 percent. The access to information pathways has intensified the adoption of different technologies. Indeed, studies of innovation adoption and diffusion have recognized that information and its availability have enhanced the technology adoption significantly (de Harrera and Sain 1999). Information becomes especially important as the degree of complexity of the technology increases and when the farmers were at trial and decision confirmation stage

(Nowak, 1987). Information sources that positively influence the adoption of technologies can include: other farmers; media; meetings and extension officers etc.

Table 2.7: Logit model estimates for adopted chickpea growers

Variables	Parameter estimate β	S. E
No of working family members	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%		

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 27 per cent respectively. While an increase in acre of irrigated land decreased the chickpea adoption by 14 per cent. It implies that farmer may go for irrigated crops when they get access to irrigation.

The Logit model 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 etc. increases the likelihood of adoption. It is therefore important that appropriate seed delivery mechanism should be put in place after an introduction of improved cultivars. 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/market intelligence also encourages adoption of chickpea.

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Chapter 3

Targeting and Diffusion of Groundnut Improved Cultivars in Tamil Nadu, India

K R Karunakaran, Madhu Sudan Battarai, D Kumara Charyulu and D Moses Shyam

Introduction

India is a major 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 from 18 million tons in 1989-90 to 26 mt of oilseeds and produce 8 mt of vegetable oil by 2000 A.D. 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, 5.81 mt and 795 kg per ha respectively. About 85% of groundnut production in the country is under rainfed situation. 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/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%, 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.

Performance of groundnut in target sites

Groundnut is an important oilseed in Tamil Nadu, which constituting 7.51% of area and 13.67% 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 compared with the performance of state during last two decades. This will help in understanding the trends and also helps to formulate necessary strategy for its improvement. The results are presented in Table 3.1 to 3.3.

Table 3.1: Performance of groundnut area in study districts

District	Area (lakh ha)			Decadal change (%)			Growth rate (%)		
	TE 1992 -93	TE 2002 -03	TE 2011 -12	TE 1992 to 02	TE 2002 to 11	TE 1992 to 11	TE 1992 to 01	TE 2002 to 11	TE 1992 to11
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 lakh 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 lakh ha has been recorded a sharp fall to 1.91 lakh ha in TE2002-03 hand further declined to 1.11 lakh ha in TE 2011-12. Overall, the TL II targeted districts lost half of its area under groundnut in last two decades.

Table 3.2: Performance of groundnut production in study districts

District	Production (lakh tons)			Decadal change (%)			Compound growth rate (%)		
	TE 1992 -93	TE 2002-03	TE 2011 -12	TE 1992 to 02	TE 2002 to 11	TE 1992 to 11	TE 1992 to 01	TE 2002 to 11	TE 1992 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

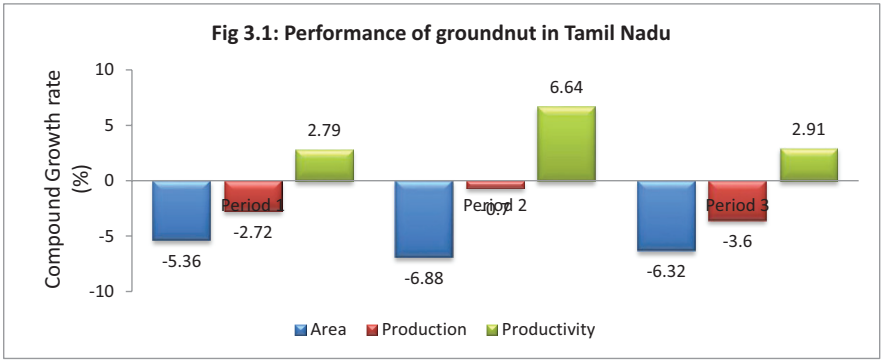
Similar declining trend has been also noticed in production. Tamil Nadu recorded the groundnut pod production of 14.88 lakh tons in TE1992-93, which has shrunk to 9.51 in TE2011-12. Similar sharp declining trend also noticed in Erode and Namakkal from 1.35 and 1.21 lakh tons to 0.32 and 0.62 lakh tons 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 3.3: Performance of groundnut productivity in study districts

Districts	Productivity (ton/ha)			Decadal change%			Compound growth rate (%)		
	TE 1992 -93	TE 2002-03	TE 2011 -12	TE 1992 to 02	TE 2002 to 11	TE 1992 to 11	TE 1992 to 01	TE 2002 to 11	TE 1992 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 are analyzed and the results are presented in Table 3.3. In general, the productivity of groundnut has been improved in all the study districts as well as in Tamil Nadu. Particularly, the groundnut productivity has improved from 1.37 tons/ha in TE 1992-93 to 2.41 tons/ha in TE 2011-12, registering 75% increase in the state, while 90% 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 (Fig 3.1).



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 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. 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 for socio-economic studies under phase I and II of the project.

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. The details of the farmers participated or surveyed in the TL II intervention are presented in Table 3.4. During last 5 years, the project has covered 16 mandals in 229 villages benefiting 2394 farmers through FPVS and PCT activities. More number of farmers (964 from 105 villages) were benefitted from Namakkal followed by Erode (720 farmers from 55 villages) and Thiruvannamalai (710 farmers from 69 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 3.4: FPVS interventions in groundnut, 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	27	296
2009	9	87	8	237	9	81	26	405
2010	8	103	12	196	18	90	38	389
2011	21	202	58	281	18	150	97	633
2012	8	221	18	160	15	290	41	671
Total	55	720	105	964	69	710	229	2394

*numbers

The details of baseline and PCT farmers who participated in 2009, 2010 and 2011 were summarized in Table 3.5. 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. From all sample farmers, crop specific information were collected, data were computerized and analyzed to track the diffusion of new groundnut cultivars. The results were presented in the subsequent sections.

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 farmers in villages of selected districts. The distribution of targeted villages for the paired comparison trial conducted in 2009-11 were shown along with the sample village selected for RTT. 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.

Table 3.5: Distribution of sample farmers in real time tracking survey

District	Block	Baseline farmers		Paired comparison trials (PCT)			Total Samples in RTT
		Total BL farmers	sample in RTT	No village	Total (exc BL farmers)	Actual sample in RTT	
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

Further analysis on farm characteristics, varietal distribution, adoption, 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 treated and 25 control) farmers.

Analytical techniques

Simple 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. Standard statistical analysis were used to compare, contrast and interpret results in an appropriate way. To analyze and study the traits preferred by the farmers, weighted average ranking method was used.

Results and discussions

The distribution of sample among selected blocks are shown in Table 3.6. Among 500 sample farmers surveyed in RTT, it was observed that 96.4% 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 (19.2 per cent) 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 3.6: 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	120	93.8	8	3.9
Ammapettai	48	7	3		5	63	60	95.2	3	4.8
Nambiyur	50	10		5		65	60	92.3	5	7.7
2.Thiruvannamalai	51	30		10	5	96	86	89.6	10	10.4
Keelpenathur	20	10			5	35	35	100	0	0.0
Thandrampet	16	10		5		31	26	83.9	5	16.1
Thiruvanamalai	15	10		5		30	25	83.3	5	16.7
3. Namakkal	276					276	276	100	0	0.0
Elachipalayam	83					83	83	100	0	0.0
Paramathy	80					80	80	100	0	0.0
Thiruchengodu	113					113	113	100	0	0.0
Total	425	47	3	15	10	500	482	96.4	18	3.6
%	85	9.4	0.6	3	2	100				

Socio-economic characteristics of sample households

Age, education, community, experience and training attended etc. are the farmer's basic characteristics which were much influencing factors in adoption of new technology. The farm characteristics of the SBFs and NBFs were analyzed and the result are presented in Table 3.7. It could be inferred from the table there is no much difference in (year of schooling) level of education among two farmers' groups. However, NBFs had 8.4 years schooling compared to 8.1 years of schooling by SBFs. The results indicated that 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.

When comparing the allocation of area under groundnut cultivation for all samples (500 samples) during last three years, 67.2% of farmers inferred that the area had been decreasing while only for 6.4% of them opinioned that there was an increase in groundnut area. Among

seed beneficiary farmers 67% of the farmers concluded that area under groundnut has been decreasing while 25% of the beneficiary sample farmers said that the groundnut cropped area was neither increasing nor decreasing, it left constant and for remaining 8% 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% 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.

Table 3.7: Socio-economic characteristics of sample

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 groundnut 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 groundnut 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

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.

The study results revealed that 51.8% of total sample farmers were not a member in any organization/society while remaining were the members. Similarly, in case of non-seed beneficiary farmers about 56% of the farmers were not members in any organization. Few groundnut production organizations such as self helps groups and effective function of PACS are village level organization in which most of the sample farmers are members.

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 3.8. 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 3.8: Project beneficiary details (Seed beneficiary N =482)

Details	2009-10	2010-11	2011-12
Is this HH 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	8.9	10.0	10.0
2. CO 7	5.0	8.0	7.3
3 TMV 13*	-	5.0	5.0
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 paired 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 packs. 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 farmers 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.

Extent of adoption of improved cultivars

The diffusion of new varieties would be traced by tracking the area expansion by newly distributed groundnut varieties over years among sample farmers. In order 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 SBFs and NBFs and the results are presented in Table 3.9. 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 TNAU GnCo6 occupied 3.4 per cent and Co7 by 2.2 per cent of the total groundnut area 446.96 ha in the sample.

Table 3.9: Extent of adoption of improved cultivars (in ha)

Seed beneficiaries (N= 482)							Non seed beneficiaries (N= 18)		
Previous year of benefitted			Seed benefitted year				Previous year of benefitted year		
Variety	Area (ha)	%	Beneficiary variety	Benefitted year	Area (ha)	%	Variety	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			
Total	607.9	100			473.8	100		36	100

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.

Major sources of seed

The varieties are categorized into 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% 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% of the sample farmers received seeds from these sources and the second highest seed source was other farmers who supplied to 14% 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 third of 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.

Table 3.10: Sources 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

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 3.11 and 3.12 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 12 and the under new varieties occupied 3.7 per cent in 2011-12.

Table 3.11: 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 3.12: Groundnut area under different cultivars (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 3.12 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.

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 3.13. Among the SBF, the major ruling varieties are: TMV1, VRI2, TMV7 and CO2. They altogether produced more than 80 per cent of 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 3.13: Output utilization pattern of seed benefited farmers (N=482)

Variety	Grain output		Output utilization (%)					
	Output (kg)	%	Consumed (kg)	other use (kg)	Own seed (kg)	Seed sold (kg)	Output sold	Total output
Seed benefited farmers(N=482)								
Co2	242580	17.30	11.07	0.12	11.37	0.91	76.53	100
POL2	37140	2.65	4.79	1.91	16.91	1.35	75.04	100
TMV1	318640	22.72	1.11	0.16	15.54	0.25	82.94	100
TMV2	7900	0.56	1.27	2.53	20.25	2.53	73.42	100
TMV7	261295	18.63	3.77	2.45	13.20	0.19	80.39	100
VRI2	296620	21.15	0.78	0.69	14.40	0.88	83.25	100
Mixed	63380	4.52	3.39	1.03	17.54	1.10	76.93	100
TMV13	2410	0.17	0.00	0.00	0.00	0.00	100.00	100
VRI6	12440	0.89	0.00	0.00	6.43	0.00	93.57	100
VRI7	56520	4.03	0.00	0.00	5.98	0.00	94.02	100
Co6	76705	5.47	9.55	0.09	17.09	1.07	72.20	100
Co7	26962	1.92	0.00	0.09	16.55	18.58	64.78	100
All	1402592	100.00	3.84	0.78	13.91	0.95	80.52	100
Non Seed benefited farmers(N=18)								
CO2	4600	7.89	0.00	0.00	8.70	0.00	91.30	100
Local	3640	6.24	0.00	0.00	10.99	0.00	89.01	100
TMV7	39550	67.85	5.18	4.42	7.23	0.00	83.16	100
VRI2	10500	18.01	0.00	0.00	11.14	0.00	88.86	100
All	58290	100.00	3.52	3.00	8.29	0.00	85.19	100

Among the newly introduced varieties Co 6 and Co 7, output retained for seed purpose was more (17%) 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.

Profitability of improved groundnut 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 3.14).

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% 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/acre. Whereas in Erode and Thiruvannamalai, the new variety Co7 realized an average 774 kg/acre, which is five per cent higher than the ruling varieties (POL 2, TMV 7 and VR I2).

Table 3.14: 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	%
Land preparation	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 cultivation	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
Total Cost	**20850**	**100.0**	**20986**	**100.0**	**20363**	**100.0**	**20976**	**100.0**
Pod yield (kg)	941		823		774		738	
Haulm yield (kg)	1344		686		1218		794	
Pod value	26284	93.0	24048	92.5	25141	92.6	25911	93.2
Haulm value	1983	7.0	1949	7.5	1995	7.4	1899	6.8
Total Value (pod & haulm)	**28267**	**100.0**	**25997**	**100.0**	**27136**	**100.0**	**27811**	**100.0**
Net Income (Rs/ac)	7418		5011		6773		6835	
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% 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. 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.

Summary and conclusions

Regardless of the considerable area share, productivity advantage and various development programs, the Tamil Nadu faced unfavorable negative trend in area (-6.88 annual growth) during last decade resulting 50% 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 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) 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.
3) 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.
4) 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.
5) 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.
6) 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.
7) 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
8) 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.
9) 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.
10) 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 programs 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' program. 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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Chapter 4

Targeting and Diffusion of Chickpea improved cultivars in Karnataka, India

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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. 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.

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 4.1. Among the states, Madhya Pradesh is the largest chickpea producing state in the country with mean annual area of 2504,850 ha and showed a positive (1.14%) growth. Maharashtra state occupied second position with average annual area of 1073,000 ha (7.34% growth rate). Karnataka occupied fifth place in respect of chickpea area (573,500 ha) followed by Andhra Pradesh (455,700ha). Both states witnessed a significant annual growth (6.96% and 14.47% respectively) in area. 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 4.2.

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. 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.

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 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
- To analyze specific constraints in the chickpea cultivars

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; a) **Non-baseline households:** 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

b) **Baseline beneficiary households:** 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

Table 4.1: Growth (%) in area, production and productivity of chickpea and their instability, 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 4.2: Growth (%) in area, production and productivity of chickpea and their instability in 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

II. Non-seed beneficiaries: This category includes:

Baseline households: These are the non-seed beneficiaries of baseline households that were selected from adopted villages. Since these farmers 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: These are 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.

Sampling strategy for real-time tracking survey

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. The sample was distributed based on the probability proportion to total number of seed beneficiaries across two intervention districts of Karnataka (Table 4.3).

Table 4.3: Sampling framework 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 from the both districts. Another 15 farmers from each district were selected from baseline control villages comprising a total of 30 control households from both the 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 Appendix Table 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.

Results and discussions

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 etc. Table 4.4 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. In Dharwad district majority (64.86%) of them belonged to backward caste. Similarly, in case of Gulbarga district backward caste dominated (77.55%) followed by scheduled caste (10 to 12%) and scheduled tribes (6 to 9%). Rest is occupied the forward caste communities in both the districts.

Table 4.4: Caste composition of sample chickpea farmers

Caste category	Seed beneficiaries	Non-seed beneficiaries	Grand total	Mean
Dharwad				
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

The experience in chickpea cultivation by farmers was observed to be 13 years for both districts together and it was almost on par among 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. The extent of owned land by chickpea farmers is presented in Table 4.5 and the results across districts and sample categories (seed beneficiaries and non-beneficiaries) indicated almost similar trend. The overall average owned area was 13.13 acres in Dharwad and 12.13 acres in case of Gulbarga district. The

study also showed that a large proportion of land area was operated under cultivation. Land leasing and share cropping practices were not very popular in the study area. The average operational holding was almost on par across study districts.

Table 4.5: Landholding particulars of chickpea farmers (in acres)

District	Seed beneficiaries	Non-seed beneficiaries	Sample average
Own land particulars			
Dharwad	12.53	13.20	13.13
Gulbarga	12.80	12.10	12.13
Total	12.67	12.41	12.42
Operational landholding			
Dharwad	12.30	13.06	12.98
Gulbarga	12.77	12.02	12.05
Total	12.53	12.31	12.33

The major soil types where chickpea are cultivated in the study districts is presented in Table 4.6. The overall indication across districts showed that 83.1% of farmers in Dharwad cultivated chickpea in medium black soils followed by 16.9% in deep black soils. But, in case of Gulbarga, about 48.6% of sample household cultivate in deep black soils while the rest in medium black soils.

Table 4.6: Major soil types in study districts

Soil type	Seed beneficiaries	Non seed beneficiaries	Mean
Dharwad			
Deep black soils	15 (11.3)	10 (66.7)	25 (16.9)
Medium black soils	118 (88.7)	5 (33.3)	123 (83.1)
Total	133 (100.0)	15 (100.0)	148 (100.0)
Gulbarga			
Deep black soils	166 (49.3)	5 (33.3)	171 (48.6)
Medium black soils	171 (50.7)	10 (66.7)	181 (51.4)
Total	337 (100.0)	15 (100.0)	352 (100.0)

The allocation of area under chickpea cultivation during last three years is summarized in Table 4.7. 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 in non-seed beneficiaries (73.33% and 66.67%, respectively). Overall, mean area under chickpea for both sample categories together showed an increase trend (72.97%) in Dharwad district. Similar trend of increase (73.58%) in area was observed in case of Gulbarga district. Thus, it implied that the importance of the chickpea crop in post-rainy season in both the districts were significant. This was mainly attributed to high yielding cultivars, resistant to pests and diseases and their relative drought tolerance capacity etc. High output prices in the market is the major driving force for rapid expansion of cropped area in the state. The chickpea cultivation was primarily (85% in Dharward and 94% in Gulbarga) under rainfed situation in both the study districts.

Table 4.7: Allocation of area under chickpea cultivation

District	Seed beneficiaries*	Non-seed beneficiaries*	Grand total
Dharwad			
Constant	20 (15.0)	2 (13.3)	22 (14.8)
Decreasing	16 (12.0)	2 (13.3)	18 (12.2)
Increasing	97 (72.9)	11 (73.3)	108 (72.9)
Total	133 (100.0)	15 (100.0)	148 (100.0)
Gulbarga			
Constant	74 (21.9)	3 (20.0)	77 (21.8)
Decreasing	14 (4.1)	2 (13.3)	16 (4.5)
Increasing	249 (73.9)	10 (66.7)	259 (73.6)
Total	**337 (100.0)**	**15 (100.0)**	**352 (100.0)**
Note: Figures in parentheses indicates percentage to the total			

Project beneficiary details

The break-up of project seed beneficiary details for which seeds were received over the project time (2008-09 to 2011-12) are summarized in Table 4.8. Out of 470 seed beneficiaries chosen for real time tracking survey, 18.9% of them were given improved seed during 2008-09 followed by 263 (55.9%) farmers during 2009-10 and 21.0% farmers during 2010-11. The remaining 4% beneficiaries during 2011-12. About 87.6% of seed beneficiaries received JG-11 seed while 11.4% were provided with BGD-103 varieties during 2008-09. During 2009-10, all the (263) seed beneficiaries farmers found to adopted with JG-11 variety for which seed material was distributed. It is very interesting to note that over the last four years, number of seed beneficiaries who cultivated JG-11 increased over time than the other variety. This clearly indicated the farmer's preference towards JG-11.

Table 4.8: 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 average area under traditional and improved chickpea cultivars over the years from 2009-10 to 2012-13 is presented in Table 4.9. The average area allocated per farm under traditional variety (Annegiri-1) declined substantially among seed beneficiary (5.30

to 2.35 acres) farmers in Dharwad and Gulbarga (5.2 to 3.0 acres). In case of non-seed beneficiary group, there was a marginal reduction in area under Annegiri-1 in Dharwad (from 6.0 to 4.6 acres) and 7.7 to 7.6 acres in Gulbarga after project intervention. The average area allocated per farm increased under JG-11 variety across sample categories and districts.

Table 4.9: Area allocation under different chickpea cultivars (acre/farm)

District	Sample category	Variety	Year-1 (2009)	Year-2 (2010)	Year-3 (2011)	Year-4 (2012)
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

Sources of seed

It could be implied that in Dharwad district, almost all farmers depended upon Government agency as a source of seed supply w.r.t to JG-11. However, the project intervention for popularizing improved chickpea varieties was in force in the selected areas/villages from 2008-09 onwards. Limited (6.7% farmers) scale depended on farmer to farmer exchange as a source for seed for improved cultivars. In case of Gulbarga district, majority (96.74%) of farmers also depended on Government agency. Thus, it could be inferred that majority of the farmers highly depended on Government source for supply of seeds. Table 4.10 furnishes the 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 (31.5%), followed by farmer to farmer. Similar the trend in case of Gulbarga district as well. It could be inferred that both the district farmers depend on own/inherited sources of seed for Annegiri-1.

Table 4.10: Seed sources for 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**

Economic performance of chickpea improved cultivars

Table 4.11: Cost and returns from 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
BC ratio	1.63	1.74	1.68

The cost and returns from old cultivar (Annigeri-1) is presented in Table 4.11. 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. Grain yield was relatively more at 602.02 kg/acre in Dharwad while it was 535.78 kg/acre in Gulbarga. Relatively, the gross returns/acre were found to be higher (16266.53 Rs/acre) in Dharwad when compared with Gulbarga (14766.06 Rs/acre). 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 districts.

The results on cost and returns of improved chickpea cultivar, BGD-103 revealed that cost of different operations among two study districts was almost on per (Table 4.12). 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 cultivation in Dharwad district was found to be marginally higher at Rs.11250/acre when compared to Gulbarga (Rs.10521/acre). The benefit cost ratio for BGD-103 across districts ranged between 2.26 to 2.32 indicated higher returns for every rupee invested in its production.

Table 4.12: Cost and returns of 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 and returns of JG-11 (Table 4.13), 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. It was preferred by farmers as a major substitute for Annigeri-1 (most extensively adopted variety prior to project intervention). Among the costs there was a marginal variations in both the study districts. 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 4.13: Cost and returns of 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 due to improved chickpea cultivars (JG-11 and BGD-103) proved the hypothesis made while designing the study. The improved variety particularly JG-11 has expanded in its area over the traditional variety. 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, JG-11 and BGD-103 is furnished in Table 4.14.

Table 4.14: 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
	BC ratio	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 4.14 showed that the cost and returns per acre in the production of chickpea using different cultivars. Among them, 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.

Role of institutions in technology diffusion

It could be seen that University of Agricultural Sciences, Dharwad played important role along with ICRISAT, Hyderabad in taking-up improved high yielding varieties to farmer doorsteps on mission mode for promoting their adoption in the state. 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 etc. 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.

Summary and conclusions

Chickpea was a major crop during *rabi* season as it occupied a considerable proportion (over 56 to 60%) of the operational land and predominantly cultivated in black soils of both the districts. Average operational farm size per household was 12.9 acres in Dharwad and 12.0 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). The chickpea was largely cultivated under rainfed condition in both the districts. Seed beneficiary farmers were provided with improved and preferred chickpea cultivar 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 majority of seed beneficiary farmers were provided with the seed material during the project period. 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 popular old 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 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% of seed beneficiary farmers shared seed material of improved cultivars with other fellow farmers. There was a tendency of farmers to share seed material (38.7%) within the same village and only 17.2% farmers shared with farmers of outside villages. Majority of (79%) farmers were disinterested to share seed with other farmers as they needed more time for validation on the true benefits. Government sources comprising of Department of Agriculture, Seeds Corporations constituted as the major sources of seed supply at lesser cost to (about 80%) farmers followed by the University of UAS, Dharward.

Overall, the Tropical legumes-II project could make greater impacts 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 rainfed conditions. There is need to use existing communication channels for the dissemination of market information.

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Chapter 5

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

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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 such as rice, wheat and maize. There is increasing concern about the sustainability of high input, intensive cereal-dominated cropping systems expansion in Bangladesh. Crop diversification with legumes not only help in improving soil fertility but also the system productivity. Chickpea (*Cicerarietinum L.*) is one of the most preferred pulse crop grown in Bangladesh by considering consumers' choice. It has been traditionally cultivated in the country under rainfed condition. About 85% of chickpea was grown in Jessore, Faridpur, Rajshahi, Kustia, Pabna, ChapaiNawabgonj and Dinajpur distircts. 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 summarized in Table 5.1. The average area under chickpea for the period from 1980-2012 was 49 thousand hectares. The coefficient of variation (CV) of area during the same period was 76 per cent. Similarly the mean production during the period was 35 thousand tons indicating a CV of 75%. However, the productivity was increased marginally from 723.5 to 742.6 kg/ha during the same period.

Table 5.1: Area, production and productivity of chickpea, 1980-12

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 8,000 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. The information on economics of chickpea cultivation, marketing opportunities, marketable surplus etc. were also captured. 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 program and also make possible market interventions in order to enhance the remuneration to the farmers. 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
2. To track the preferred traits along the value chain
3. To provide preliminary feed back to the crop improvement

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 planned to cover small, medium and large chickpea growers from each location.

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 analyze and study the traits preferred in chickpea, a weighted average ranking method was applied.

Results and discussions

Socio-economic profile of sample farmers in the study areas were presented in Table 5.2. More than ninety percent of sample farmers were male headed households. 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 46 years. 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 completed was around 7.

Majority of the sample farmers were not participating in the nominated/elected bodies. Ninety six to ninety seven per cent 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 per cent of the sample farmers had two wheeler/bicycles and television sets indicating that use of these goods had increased in the recent times.

Table 5.2: Socio-economic profile of sample farmers, 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)	4	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

Land ownership and operational holding pattern

Table 5.3: Average land holding size across different farm categories (ha)

	Particulars	Irrig/dry	Marginal	Small	Large	Pooled
Rajshahi	Own land	*Irrigated*	0.30	0.90	3.50	1.10
		Dry	-	0.10	1.00	0.20
	Leased-in land	*Irrigated*	0.40	0.30	-	0.30
		Dry	-	-	-	-
	Leased-out land	*Irrigated*	-	-	-	-
		Dry	-	-	-	-
	Operated land	*Irrigated*	0.70	1.20	3.50	1.40
		Dry	-	0.10	1.00	0.20
ChapaiNawabgonj	Own land	*Irrigated*	0.20	0.70	2.40	0.75
		Dry	-	0.10	0.20	0.07
	Leased-in land	*Irrigated*	0.20	0.10	0.60	0.20
		Dry	-	-	-	-
	Leased-out land	*Irrigated*	-	-	-	-
		Dry	-	-	-	-
	Operated land	*Irrigated*	0.40	0.80	3.0	0.95
		Dry	-	0.10	0.20	0.07

Land ownership pattern and operational farm size in the study area was presented in Table 5.3. 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 of dryland in ChapaiNawabgonj sample farmers.

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 5.4).

Table 5.4: Value of land owned by sample farmers, 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 5.5).

Table 5.5: Value of livestock owned by sample farmers, 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	-	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 5.6).

Table 5.6: Value of farm implements owned by sample, 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 5.7).

Table 5.7: Value of consumer durables owned by sample, 2011-12 (Tk per Hh)

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 of Rajshahi 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.

Table 5.8: Financial assets and liabilities of sample farmers, 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

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 5.8).

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 5.9).

Table 5.9: Source of finance across sample districts (% Hh)

Source of laons	Rajshahi		Interest	ChapaiNababgonj		Interest
	A	C	rate (%)	A	C	rate (%)
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 5.10).

Table 5.10: Net worth of sample farmers, 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

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 5.11a, 5.11b and 5.11c. 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 5.11a: Kharif cropping patterns in study districts (ha/Hh)*

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 5.11b).

Table 5.11b: Rabi cropping patterns in study districts (ha/Hh)*

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 5.11c).

Table 5.11c: Summer cropping patterns in study districts (ha/Hh)*

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 5.12). Proportion of chickpea area was 49 ha to the total cropped areas for adopted farmers.

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 5.13).

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 5.14. 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 respectively and BINA-

4 was 0. 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 5.12: Relative importance of chickpea in sample, 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

Table 5.13: 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

Table 5.14: Allocation of area under different cultivars, 2009-2012 (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 5.15).

Table 5.15: Composition of chickpea varieties, 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 rainfed situation (Table 5.16). In good years, the average yield was to the tune of 1081.06 kg/ha and 1117.68 kg/ha in rainfed 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 5.16: Productivity levels of chickpea (kg/ha) perceived by farmers, 2011-12

Perceived Yield	Rajshahi		ChapaiNawabgonj		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
Rainfed						
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 5.17).

Table 5.17: Productivity of chickpea varieties, 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						

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 5.18).

Table 5.18: Cost and returns from different competing crops, 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						

The input-output analysis of ruling chickpea cultivars and utilization patterns of inputs in the study areas is depicted in Table 5.19a and 5.19b. 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 1145 kg/ha for adopted and 1040 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 958 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.

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). The estimated 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 these locations (Table 5.20).

Table 5.19a: Economics of chickpea in Rajshahi district, 2011-12 (Tk per ha)

Operations	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	995	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				

Table 5.19b: Economics of chickpea in ChapaiNawabgonj, 2011-12 (Tk per ha)

Operations	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				

Table 5.20: Economics of BARI Chola-3 and BARI Chola-5 in rainfed 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 5.21: Net household income of sample farmers, 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, 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**

Income and expenditure of sample farmers

The analysis of the results on annual net household income by sources is presented Table 5.21. 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 5.22: 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 5.22) 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.

Crop utilization

The proportion of utilization pattern of output (specifically in case of BARI Chola 5) to the total production by households across districts and areas (adopted and control) are presented in Table 5.23. 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 5.23: 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 centre from the study areas were 2.5 to 3.0 km and 35 to 40 km respectively (Table 5.24).

Table 5.24: 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
ChapaiNababgonj	A	Manikara, Bahoroil and laxmipur	2.5	35
	C	Amnura, Dheenagor and Kanpara	3.5	40

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 5.25. 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 5.25: Sources of information, 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)

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 5.26a. 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 5.26a: Preferred traits for chickpea production (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 color		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 5.26b).

Table 5.26b: Preferred traits for chickpea consumption (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 5.26c).

Table 5.26c: Preferred traits for chickpea marketing (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 5.27).

Table 5.27: 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	-	-	-	-

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**	**% market coverage**
	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 (8 years) of schooling followed by adopted farmers of ChapaiNawabgonj district (6 years). Ninety six to ninety seven per cent of the sample farmers of both adopted and control villages in both the districts reported that agriculture as their main occupation. Overall, data showed that majority of the sample

farmers had two wheeler/bicycles and television sets indicating that use of this type of goods had increased. Average operational land holding of Rajshahi sample farmers were 1.40 ha (irrigated) whereas it was 0.95 ha in ChapaiNawabgonj sample. During *rabi season*, 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 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 other crops. 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.

Chapter 6

Targeting and Introduction of Chickpea Improved Cultivars in Bihar, India

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Introduction

Chickpea is one of the major pulse in Bihar, with crop yield of 1000 kg/ha, which is higher than the national average 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. The current study assessed the existing socio-economic condition of chickpea cultivars in the state. It also focused on identifying the major constraints as well as opportunities in production & marketing of chickpeas in the state. The conclusions drawn are based on primary surveys conducted at eight villages of two districts in Bihar. One district each from both the southern and eastern Bihar (Bhagalpur and Banka) were chosen for project interventions. Chickpea area and production are 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 a total of 8.75 million ha during 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 conspicuous in states such as Maharashtra, Madhya Pradesh, Rajasthan, Andhra Pradesh, Karnataka and Gujarat (Table 6.1).

Table 6.1: Trends in chickpeas acreage among states

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

Note: States presented in Table 1 are denoted as losing states with respect to area and production (Fertilizer News 2012, Govt. of India).The assessment data by each state suggest that Gujarat followed by Maharashtra recorded highest growth in crop yield. Similarly, 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 such as 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 ascertain the socio-economic status of chickpeas growers in Bihar state in relation to adoption and dissemination of chickpea improved cultivars in targeted locations of Bihar. Keeping in the view of this context, the study has following specific objectives:

1) To carry out socio-economic assessment of chickpea cultivation in the state
2) To identify farmer level constraints and opportunities in chickpea cultivation
3) To document the farmers' preferred traits of chickpea
4) Suggest policy implications for chickpea expansion in the state

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 2.5% 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 got major setback, the total pulse crop acreage has declined from 1.63 million ha in 1970-71 to 0.53million ha by 2011-12. Some part of this decline is also due to bifurcation of state in early 2002. However, there has been continues declining on crop acreage under pulses. Area under pulses have experienced not only a declining trend, but also unstable during the last two and half decades. However, chickpea has highest variability in area and production; whereas productivity of lentil showed 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 (Table 6.2). The chickpea area has been in declining trend in the new state of Bihar due to profitability and growing popularity (and public policy emphases) of rice-wheat system and other competing crops. It has been noticed that as irrigation facilities developed, chickpea crop area in the state gradually has been converted to rice and wheat system. 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 6.2: Performance of chickpeas in Bihar

Period	Average crop area (in 000 ha)	Average production (in 000 tons)	Average productivity (in 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	7.80
1990-2009	35.06	37.52	12.23

Chickpeas production in the selected districts of Bihar

Two leading chickpea producing districts of Bihar were selected for farmer's level survey. In Bhagalpur district, the average area under chickpea in triennium ending 2000 was 5,042 ha producing 4,416 tons with mean productivity level of 872 kg per ha. The district is endowed with congenial climate condition for cultivation of wide range of crops. However, the periodic distribution of rainfall during the season is not uniform. Dry and wet spells are commonly experienced resulting in water stress. Rice is still a dominant crop, which covered 41 to 46 % of gross cropped area. Recently, the area under maize has increased due to adoption of winter maize at large scale especially in Bihpur subdivision of Bhagalpur district. Wheat is the main competing crop during the post-rainy season followed by chickpea and oilseed crops. Pulses occupies 23% of total gross cropped area in the district. Among pulses, chickpea accounts for 60% of total pulse area. The mean productivity levels of chickpea during recent time (2000-2009) is hovering between 872 and 744 kg/ha (Table 6.3).

Banka is also located in Zone-3A and having similar climatic condition & rainfall. But, irrigation access is different from Bhagalpur. Chickpea is one of the major pulse crop in Banka district with an area of 3873 ha during 2000 after that it has declined to 2477 ha until 2009. However, average production has been stagnated over the same period. But, the productivity level has shown an increasing trend from 716 to 1057 kg/ha. Wheat is the main competing crop during the post-rainy season followed by chickpea. More than 90% of farmers continues to grow local varieties of chickpea. Among selected sample districts, the variability in area and production was found to be more in Bhagalpur than Banka. Productivity was found to be less stable in Banka as indicated by having higher CV value.

Table 6.3: Performance of chickpeas in study districts, 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

Results and discussion

Major crops grown in the study districts are summarized in Table 6.4. 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. In contrary, chickpea was the major rabi crop followed by wheat (0.06 ha/hh) in control

villages. At Banka, the major rabi crop was chickpea (0.50 ha/hh) followed by wheat and mustard.

Table 6.4: Avg. cropping patterns across study districts, 2011-12 (ha/Hh)

Crops	Bhagalpur		Banka		Pooled	
	Adopted	Control	Adopted	Control	Adopted	Control
Rainy season						
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 season						
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						
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

The relative importance of chickpea crop in total cropped area is shown in Table 6.5. Chickpea was accounted nearly about 20% in adopted village and up to 36% in control villages respectively.

Table 6.5: Allocation of area under chickpeas in the study districts

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	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 6.6). Average yield of chickpea in adopted villages were comparatively higher (754.5 kg/ha) than control village (689 kg/ha). Crop yield of other crops such as paddy, mung and lentil were also higher in control villages than that of the adopted.

Table 6.6: Average productivity levels across major crops (kg/ha)

Crops	Season (K/R/S)	Bhagalpur		Banka		Pooled	
		Adopted	Control	Adopted	Control	Adopted	Control
Chickpea	R	711	616	798	762	755	689
Mustard	R	630	NA	NA	NA	315	NA
Wheat	R	2408	2250	3440	2503	2914	2376
Paddy	K	2238	4006	3210	1979	2724	2992
Maize	K	NA	4183	3593	NA	1796	2091
Maize	S	2499	3618	3624	2118	3061	2868
Mung	S	624	1206	840	1666	792	1436
Lentil	R	NA	1000	704	1000	352	1000

The data pertaining to composition of different varieties indicated that traditional varieties are still playing a dominant role in chickpea cultivation. Local varieties accounted for nearly 90-95% of total chickpea area (Table 6.7). Among traditional verities, *Desla Plain* was accounting for 69% in adopted villages while 47% in control villages respectively. It was 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%). *Deshla plain* is the most popular variety which is generally used by many of the farmers in both adopted villages of Bhagalpur and Banka. However, its share was relatively less in control villages of Banka than other places.

Table 6.7: Chickpea area under different cultivars (% area)

Variety	Bhagalpur		Banka		Pooled Sample	
	Adopted	Control	Adopted	Control	Adopted	Control
Desla Plain	81.7	96.9	51.8	9.7	68.8	47.1
Deshla Roon	6.9	1.2	32.5	68.2	17.9	39.5
JG 14	0.1	0.0	5.2	0.0	2.3	0.0
KAK 2	0.7	0.0	4.0	0.0	2.1	0.0
Radha	1.0	1.9	6.3	14.7	3.3	9.2
Subhara	1.5	0.0	0.2	7.4	1.0	4.2
Vaibhav	8.1	0.0	0.0	0.0	4.6	0.0
Total	100	100	100	100	100	100

Study framework and methodology

Two districts namely, Bhagalpur and Banka of Bihar were purposively selected for undertaking the baseline survey. These two districts are major project target sites where breeders and other scientists have initiated the project interventions. Improved chickpea cultivar seed samples were distributed among farmers in the adopted villages. 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 villages would enable the team

to do a comparable counter factual analysis in the future impact evaluations. 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. In Bhagalpur district - Khankitta, Rajpur and Pipra were selected as adopted; and the control villages 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. The three control villages were Gurudwara, Padampur and Babura.

Stratified random sampling technique based on probability proportion to size method to farm size was used for selection of farmers from study villages. From each of the adopted villages, a sample of 30 farmers were interviewed and from each control village 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 Table 6.8.

Table 6.8: Sample coverage in the study districts

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
Total	6	180	6	90	270

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.

$$Y_T = ab^t u^t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

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

U^t = 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 ascending order of the mean scores.

Characteristics of chickpea growing farmers

Post stratification of sample farmers (Table 6.9) indicated that about 40% of sample farmers were of large category followed by small (32.7%) and (27.7 %) marginal farmers in adopted villages. However, in control villages, 43% were having large size of holdings followed by marginal farmer (37.7%) and only 18.8% were having small size of holdings respectively.

Table 6.9: Distribution of sample across categories, 2011-12

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 use and categorized as cultivable land (irrigated, dry) fallow land, leased-in land and leased-out land etc. It may further be categorized as marginal, small and large farms according to size of holding.

Table 6.10: Average land holding size across farm categories (ha/Hh)

	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 different categories for Banka was about 1.88 ha/hh. Out of that 1.71 ha was irrigated and remain were dry land. Where as in Bhagalpur it was estimated about 2.98 ha/ hh, in which 2.22 ha was irrigated. Apart from these, on an average, 0.11 ha/hh area was leased-in land and no area was leased out to the other farmers in Banka. In Bhagalpur, it was estimated approximately about 0.04 ha of land was leased-in and leased-out to the others (Table 6.10).

Socio-economic profile of sample farmers indicated that 100% households of sample headed by male (Table 6.11). On an average, the proportion of male and female in sample households were found to be nearly 52.5% and 47.5% respectively. Further, it was observed from the table that out of total population nearly 53% of population had agriculture as main occupation in adopted villages. However, for control villages it was 54.4%, 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. But, 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. Levels of education for selected household head were lagged much behind as indicated by having only middle level i.e., 9.8 and 8.5 respectively for both of the districts. All the sample farmers had (nearly 100%) mobile phones followed by two wheelers and television sets.

Table 6.11: Socio-economic profile of sample farmers, 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						

Total household income was derived by summing-up of total farm income as well as 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 the selected districts during 2011-12 by source in Rs./Year/Household has been presented in Table 6.12.

Table 6.12: Net household income of sample, 2011-12 (Rs/year)

Source of income	Bhagalpur		Banka		Pooled	
	A	C	A	C	A	C
Income from crops	92717	27544	49250	26267	70983	26905
Farm work (labor earnings)	28367	11156	15744	12311	22055	11733
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
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
Total	250,782	113,407	169,839	130,629	210,310	112,518

It may be observed that total household income on an average was worked out to be Rs.250,782 for adopted villages of Bhagalpur. It was found to be the highest followed by adopted village of Banka district (Rs.169, 839). Among control villages, it was comparatively higher for Banka district (Rs.130, 629) than that of Bhagalpur (Rs.113,407). Regular salaried jobs figured the second major source of income in both the districts i.e. contribution of non-farm income was about 82,061 for adopted villages of Bhagalpur and Rs.82,167 for adopted villages of Banka. Earnings from business figured out to be the third most important source of income.

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) and adopted villages (55478). Whereas data pertaining to expenditure on total non-food items by samples of Banka districts were comparatively higher in both adopted (88688) and control villages (58609). Among food items, expenditure on cereals was found to be the 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 (Table 6.13).

Table 6.13: Consumption expenditure of sample farmers, 2011-12 (Rs/year)

	Bhagalpur		Banka		pooled	
Food item	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 new pulse technology

Study tried to analyze the sources of information for adoption of new seed, fertilizer management, pest management and disease management etc. in case of pulse crops because it involves different kinds of operation to be performed for obtaining optimum yield (Table 6.14). However, the farmers do not carry out the operations uniformly because farmers have different levels of technical knowledge as well as resources in possession. Therefore adopting these practices may invariably be different from farmer to farmer and location to location. Deeper understanding about these issues will be help in better targeting of new interventions in the project areas.

Table 6.14: Sources of information to sample farmers, 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	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.

As shown in Table 6.14, despite of the KVK research station being located nearby from the farmers' settlement, surveyed farmers have not given top priority to that research station. But, they have given top priority to fellow farmers (highest rank), followed by friends and relatives (2nd highest rank) and then to input dealers (3rdrank).

Table 6.15: Sources of information in Banka, 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 (Table 6.15). 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.

Productivity of chickpea

Productivity of chickpea by variety in sample districts during the year 2011-12 kg/ha has been presented in the following Table 6.16.

Table 6.16: Productivity of chickpea by variety, 2011-12 (kg/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' intension 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 6.17.

Table 6.17: Economic costs of chickpea cultivation, 2011-12 (Rs/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

The net return obtained from chickpea was estimated at Rs. 6,000 to 20,000/ha in the sample surveyed among farmers. This indicates that the comparative advantage from chickpea was better than many of the competing crop like wheat. Especially with the environment of inadequate soil moisture, chickpea performed extremely well. By and large, pulses are more remunerative crops for Banka rather than Bhagalpur. However, there is no distinct difference across the sample farmers. Overall, the estimated benefit-cost ratio for chickpea in the study district was 1.64. This is fairly higher than many of other crops cultivated in this area.

Constrains and prospects of chickpea cultivation

Many problems or constraints were observed on sample farms, which were collected and pooled into the following categories namely, low yield, pest and disease, long duration, small grain size, lack of technical knowledge, lower market prices 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 (Table 6.18).

Table 6.18: Major constraints in chickpea cultivation (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 lack of access to improved cultivars was a major constraint. The productivity levels of local cultivars was low. The other major constraints were - high incidence of pod borer, lower market prices, not attractive color and small grain size etc. These limitations were quite common in both Bhagalpur and Banka districts.

Conclusions and policy implications

Chickpea is one of the major pulse crop in Bihar. The area under chickpea has declined from 2.45 lakh ha in 1975-76 to 0.56 lakh ha by 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 access to improved varieties etc. Among improved cultivars distributed to the farmers - JG 14, KAK 2 and Subhra were most acceptable in the state. However, poor germination, non-suitability into cropping pattern, post-harvest losses due to rat attack etc., are some of the major farmer's level problems which hindering further expansion of crop in the target districts.

The productivity of improved cultivars ranged between 850 to 1000 kg/ha in the selected districts. However, the cost of cultivation per ha has been estimated at Rs. 18280 to 19200. Profitability of chickpea is comparatively higher than others rabi crops cultivated in the region. Sample farmers have been repeatedly using the chickpea local cultivars over the past 25 years. The most preferred traits for consumption and marketing of chickpea in Bihar are high yielding followed by fetching higher market price. Better taste with good keeping quality ranked third in priority. Major constraints for growing chickpea in Bihar are unavailability of suitable high yielding cultivars, erratic rainfall, moisture stress, increasing incidence of disease & pests etc. Recently, the per capita consumption of chickpeas has gone up but this has not been reflected in the wholesale prices in the state. To increase area and production of chickpea in Bihar, region specific approaches and prioritization exercises

needs to be carried out. Chickpea adoption needs to be considered within the existing farming systems and crop choices of the farmers. Further, the access to irrigation motivated the farmers to take-up wheat crop instead of chickpea crop.

Policy implications

The following policy recommendations have emerged out of the empirical analyses carried out:

(i) Replacement of traditionally cultivars with high yielding improved cultivars
(ii) Introduction of short duration cultivars to better fit in the existing cropping systems
(iii) Improving market information system and infrastructure
(iv) Linking MSP to market price can bridge the gap between demand and supply
(v) Farmer's participatory research should encouraged along with extension

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Chapter 7

Targeting and Introduction of Groundnut Improved Cultivars in Odisha, India

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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 seasons 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 7.1).

Table 7.1: 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

Status of groundnut in major producing states

Andhra Pradesh, Karnataka and Maharashtra states together produce more than 75% of the total groundnut output in the country. Gujarat ranks first as far as area under groundnut is concerned. Though productivity of groundnut in Gujarat increased from 750 kg/ha during 1980-89 to 1219 kg/ha in 2000-09, but the area remained stagnant (Table 7.2). In Andhra Pradesh, groundnut area fluctuated during the study period. However, productivity remained almost stagnant over the three decades 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 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 7.2: performance of groundnut in major states (1980-2009)

(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

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 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% while about 66% of area under post-rainy season. Overall, major share of cropped area is under rainfed cultivation.

Table 7.3: 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 by 2000-12 (Table 7.3). Production, however, declines

only by 7% from 398.31 to 368.75 thousand tons during the period mainly because of increase in yield from 1318 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. Late nineties and the last decade experienced 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 huge scope for further expansion. The climate of Orissa is conducive for groundnut. The availability of seed during rabi (post-rainy season) is the major hindrance for cultivation of groundnut in the state.

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 with backed-up by 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; and 3. To investigate the level of adoption of modern varieties, productivity and profitability levels, preferred traits of groundnut crop etc.

Sampling 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 case of Dhenkanal, the similar observation was made. Area under groundnut in Jajpur is hovering around 32 thousand ha (Table 7.4). Production increase was observed mainly because of significant yield increase (1078 to 1758 kg/ha). In contrast to Jajpur, area under groundnut in Dhenkanal declined sharply from 20.55 thousand ha during the triennium ending 1998 to 11.63 thousand ha by the last triennium ending 2012. The production remains same around 20 thousand tons because of increased productivity from 974 to 1725 kg/ha. 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 7.5 furnishes 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 7.4: Performance of groundnut in sample districts

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

Table 7.5: 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	
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 about 71%. In case of control villages, 84% of the farmers are from the marginal and small categories in Jajpur. While these categories together represented about 87% in case of Dhenkanal district (Table 7.6).

Table 7.6: Distribution of 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)

Analytical techniques

Simple 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 of groundnut in the state. Simple statistics tools such as average and percentages were used to compare, contrast and interpret results in an appropriate way. To analyse and study the traits preferred in chickpea cultivars, weighted average ranking method was used.

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 etc.

Table 7.7: Socio-economic profile of sample farmers, 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 mobile phones (%)	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 (Table 7.7). 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 6th level. Among the respondent farmers, poor participation in the local bodies was observed. About 42 and 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.

Land holding particulars of the sample

Average land holding was found to be higher among Dhenkanal farmers than that of Jajpur district (Table 7.8). 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 7.8: 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

Assets and liabilities of sample farmers

Land owned by the respondent farmers in Jajpur was comparatively lower than that of Dhenkanal district (Table 7.9). 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.

Overall, value of livestock owned by respondent farmers were found to be Rs 23,900 and Rs 30,100 per Hh respectively for adopted villages of Jajpur and Dhenkanal and were Rs 26,200 and Rs 27,900 respectively for the control villages of these districts as depicted in Table 7.10.

Table 7.9: 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

Table 7.10: Value of livestock owned by sample, 2011-12 ('000 Rs/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 26,820 and Rs 31,170 per Hh respectively for the farmers belonging to adopted villages of Jajpur and Dhenkanal while for the control villages, the values were Rs 25,860 and Rs 26,180 per Hh respectively for two categories of villages (Table 7.11). Ownership of mechanized implements was found to be low among the respondent groundnut farmers irrespective of the districts.

Table 7.11: Value of farm implements owned by sample, 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

Financial assets and liabilities

Overall it is observed from Table 7.12 that net liabilities were higher in case of Dhenkanal than that of Jajpur district. It was found to be Rs 26,000 and Rs 43,540 respectively for adopted villages of Jajpur and Dhenkanal districts whereas, for control villages the values were Rs 34,000 and Rs 41,000 respectively for the two districts. Though savings was found to be much more in case of farmers of the adopted villages of Dhenkanal district, but borrowings were much higher at Rs 54,000 per Hh.

Table 7.12: Financial liabilities and assets of sample, 2011-12 (Rs '000 per Hh)

Financial Liabilities and Assets	Jajpur		Dhenkanal	
	Adopted	Control	Adopted	Control
Borrowings (-)	29.01	38.13	54.07	46.82
Lending's (+)	0	0	0	0
Savings (+)	2.99	4.11	10.53	5.71
Net Liabilities	26.03	34.02	43.54	41.18

Net worth of sample 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. But in case of Dhenkanal, the net worth per household was on par among two category of farmers (Table 7.13).

Table 7.13 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

Income and expenditure of sample farmers

In case of adopted villages of Jajpur district, bulk of the income came from farming which stood at Rs. 48,580 per Hh (Table 7.14) followed by salaried job (Rs. 28,160), non-farm labour income (Rs.10,220), remittances (Rs. 10,000), business (Rs. 8,400) and farm labour income (Rs.6,010). However, in case of adopted villages of Dhenkanal, though still farming contributed the major chunk of the income which stood at Rs. 44,320, nonfarm farm labour income was the second most important source of income at Rs. 20,600 followed by salaried job (Rs.13,270), business (Rs.7,940) and farm labour income (Rs.5,340). Among all the categories of respondent farmers, highest net household income of Rs 166,160 was observed to be with the farmers of control villages in Jajpur district.

Table 7.14 Net household income of sample, 2011-12 (Rs '000 per Hh/annum)

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

Consumption expenditure of sample 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 (Table 7.15). However, in case of control villages of Jajpur, food item expenses surpassed than that of Dhenkanal because of higher household size. As in case of food item expenses, non-food item expenditure was also on higher side in the adopted villages of Dhenkanal than that of Jajpur. Overall, the total consumption expenditure for adopted villages was Rs. 71,583 and Rs. 85,910 respectively for Jajpur and Dhenkanal and Rs. 100,240 and Rs. 92,345 respectively for the control villages of the two districts.

Table 7.15: 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

Cropping pattern and importance of groundnut

The relative importance of groundnut in the cropping pattern among the sample farms is presented in Tables 7.16. 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.

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 such as black gram, horse gram, vegetables etc. were minor crops in Jajpur. In Dhenkanal, though groundnut is the main crop among the sample, 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 7.16: 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.

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 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 7.17).

Table 7.17: Relative importance of groundnut, 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

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 (Table 7.18). Its yield ranged between 73889 kg/ha (control villages) in Dhenkanal district to 87284 kg/ha in 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 261 kg/ha and 576 kg/ha respectively for adopted and control villages. However, yield of rice varied from 2673 kg/ha in case of control villages to 2895 kg/ha for adopted villages in Dhenkanal. 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 control villages. Pigeonpea is grown in uplands of Dhenkanal district both in the adopted villages as well as in 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 (Table 7.18). Jajpur and Dhenkanal district average yields outweighed the state average. Other major pulses grown in the studied villages were horsegram, mung bean, black gram and gram. These crops are not

competing crops with groundnut. The yields were also found to be very low excepting in case of horse gram. Rabi season vegetables yield was comparatively higher than that of kharif season.

Table 7.18: Average 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
Horse gram	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	-	-	-

Area allocation under different ground varieties during post-rainy season

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 such as Gujarat, Karnataka, Andhra Pradesh, Maharashtra and even from the Baragarh district of Odisha (Table 7.19). However, farmers have no 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. So typical groundnut varieties were found to be Gujarati, Amravati, Padmapuri etc. as is seen in Table 7.19. During 2009-10, in the adopted villages of Jajpur district, area under Amravati variety was 48.4% which reduced to 38.0% during 2011-12. 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 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 villages. Area under Gujarati slightly increased from 33.2 to 35.7% during the period. Other varieties like Amravati, TMV-2, Smruti were found to be of little significance. In control villages of Dhenkanal, AK 12-24 was found to be most dominant variety which occupied more than 90% of the area. 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. But in case of control villages, though percentage area under Gujarati variety is increasing, 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 7.19: Allocation of area under different cultivars (%)

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 7.20: 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
Gujarati	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
Baragarh		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 (Table 7.20). 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).

Perceptions on productivity of groundnut

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 district (Table 7.21). 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 at around 24 qt/ha among both adopted and control farmers of pooled sample.

Table 7.21: Perceived productivity levels of groundnut (Qtl/ha), 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

Productivity of groundnut by major varieties

Productivity of groundnut by variety-wise is presented in Table 7.22. It is evinced that among all the major groundnut varieties being cultivated by the farmers, Gujarati variety performed better and its yield was recorded at 2482 kg/ha (adopted) and 2597 kg/ha (control) villages respectively. Few isolated varieties such as Rajasthani also outperformed other varieties and its mean yield was observed at 2717 kg/ha in control villages. Padmapuri also did pretty well at 2580 kg/ha among the adopted villages. The yield of Amravati variety recorded at 2357 kg/ha and 1894 kg/ha respectively for adopted and control villages of Jajpur district.

Table 7.22: Productivity of groundnut by varieties, 2011-12 (kg/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.

Economics of groundnut and other competing crops

The gross returns from the crops normally grown in the sample villages are furnished in Table 7.23. 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 subjected to flood. Over the years, groundnut has emerged as the most lucrative crop enterprise because they are putting sand to heavier clay and clay loam soil is good to raise groundnut crop. The gross return per ha in Jajpur was found to be Rs 101,083 and Rs 96,357 respectively for adopted and control villages, whereas, for Dhenkanal it was observed to be quite lower at Rs 76,211 and Rs 74,636 respectively. Lower return was observed in Dhenkanal mainly because of low yield of the old and degenerated seeds used by the farmers. 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 as both seed and output merchants. Higher seed price 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 7.23: Gross returns from different crops, 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
Horse gram	5459	29057	8898	11490	7866	17037
Sugarcane	165931	-	152792	148410	156077	148410

The gross returns 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. Pigeonpea is mainly grown in the uplands during kharif season in Dhenkanal district and the gross return was Rs 17811 and Rs 27788 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 156,077 and Rs 148,410 per ha respectively for adopted and control villages.

Cost of cultivation of groundnut crop by variety (rabi season)

Costs of cultivation of groundnut for different varieties have been placed in Table 7.24a and Table 7.24b 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 land followed by seed cost constituting 21 to 26% of the total costs. Seed, threshing and harvesting together occupy 20 to 21% of the total costs. The productivity levels of different varieties were recorded at 2339, 2597 and 2561 kg/ha respectively for Amravati, Gujarati and Padmapuri for adopted villages of Jajpur district.

Table 7.24a: Economics of rabi groundnut 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/season	13025 (25.5)	14110 (25.4)	15088 (27.2)	12350 (29.5)	19760 (31.9)	19765 (32.7)	12283 (36.4)
Total costs	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

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 was noticed in TMV 2 mainly attributed to the fact that as it was promoted with the support extended by agricultural department. Seed cost of Gujarati variety was found to be Rs 14726 per ha followed by Rs 12319 for Smruti. 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 7.24b: Economics of rabi groundnut cultivation 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 (29.0)	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 (Table 7.24b). Total cost per ha varied between Rs 45,747 in case Gujarati to Rs 54,017 for Amravati in case of adopted villages, whereas, for control villages, it ranged between Rs 41,845 in case of TMV 2 to Rs 45,975 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, costed much less than the other varieties. Smruti variety having attractive peal colour is costlier at Rs 12,844 per ha. Harvesting and threshing cost together accounted for 13 to 20% of the total costs. In case of TMV 2, since it was irrigated, yield was comparatively higher at 2449 kg per ha. The mean yield per ha of other groundnut varieties in the adopted villages varied from 2152 to 2258 kg/ha and for control villages, it ranged between 2014 to 2216 kg/ha.

Economics of groundnut cultivation

Average yield of groundnut per ha in Jajpur district was 2484 kg and 2402 kg respectively for adopted and control villages (Table 7.25). It was comparatively lower in Dhenkanal at

2155 kg/ha and 2017 kg/ha respectively for adopted and control villages. Costs of cultivation per ha was quite high at Rs 53,541 and Rs 58,410 respectively for adopted and control villages in Jajpur as compared to Rs 46,226 and Rs 42,486 respectively for adopted and control villages of Dhenkanal district. Though gross return was quite higher in case of Jajpur district, it has got lower BC ratio, because of higher cost of cultivation. 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 of Dhenkanal district.

Table 7.25 Cost and returns in groundnut cultivation, 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	

Groundnut utilization among sample farmers

Table 7.26: 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

Groundnut utilization pattern in sample villages is summarized in Table 7.26. Groundnut output per household was highest in case of adopted villages of Jajpur. Of the total grain output of 2256.6 kg per Hh in adopted villages of Jajpur, more than 86% was sold, whereas, for control villages, about 89.5 % was sold. In Dhenkanal, grain output per Hh was 1407 kg and 609 kg per Hh respectively for adopted and control villages. It is obvious that when the crop output is low, highly commercial crop like groundnut, higher percentage of the output was sold in market. 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.

Preferred traits of Groundnut

Irrespective of the adopted or control villages, productivity remains the highly preferred trait among farmers (Table 7.27). In adopted villages of Jajpur district, the second most important trait being the determinate type. Since groundnut is cultivated during post-rainy season under rainfed situation, indeterminate type is subject to drought and subsequently results in poor yield. In general, groundnut is priced as per shelling percentage. Shelling percentage >70 fetches a remunerative price. Sample farmers are heavily relied on seed traders for seed and other monetized inputs. Seed traders brought seed from kharif growing states such as Gujarat, Maharashtra, Karnataka, Andhra Pradesh etc. which significantly raises the cost of seeds. Majority of the farmers are unable to procure seeds at that level which is in excess of Rs 60/kg. 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 etc. 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. Hence, strong peg has become one of the preferred trait in selection of new cultivars. Recurrent droughts are quite common and short duration cultivars highly preferred. In adopted villages of Dhenkanal, drought resistance was found to be preferred variety as the soil is mostly sandy besides the river embankment as well as with poor moisture retaining capacity. Short duration cultivars with determinate type are highly preferred.

Table 7.27: 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
Highest shelling (%)	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	

Summary and policy implications

During 2nd phase of TL-II Project, two districts namely, Jajpur and Dhenkanal of Odisha were purposively chosen for implementation of interventions under groundnut crop. A baseline survey was conducted during 2011-12, immediately after the cropping season, to assess the socio-economic status of groundnut farmers, adoption of improved cultivars, yield levels and benefit/cost ratio of groundnut crop.

The inferences taken from baseline study suggest that groundnut is the dominant crop during the post-rainy season in both the study districts. In Jajpur, groundnut is the leading crop which sustains the livelihoods of farming community. However, it was found that farmers are largely constrained in getting quality seeds at the appropriate time. In Jajpur, farmers entirely depended on seed traders for the seed sources. 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 provide any incentive to quality seed management of designated varieties. They are also in hurry to arrange for seeds and are mostly lifted from APMC mandis from respective states. In Dhenkanal, decades old AK 12-24 is still the dominant variety. Though government is supplying TMV-2, farmers hardly find any difference between these two varieties and still go with AK 12-24. However, it has become now susceptible to pests and diseases. During 2011-12, Jajpur experienced severe flooding during October. It suited well for groundnut crop during the post-rainy season and the crop growth was exceptionally good resulting in very high yield which was not realized for over a decade. Similar was the situation in case of Dhenkanal as well. However, due to traditional varieties being grown in the district and poor soil quality than that of Jajpur, yield was comparatively low in Dhenkanal.

Benefit-cost ratio for groundnut crop was found to be low in Jajpur as compared to Dhenkanal mainly because of higher cost of cultivation in Jajpur. Fellow farmers are the major sources of information for new cultivars and fertilizer management. Input dealers also play significant role in providing information related to pest and disease management. 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 etc.

Introduction of cultivars having with above desirable traits suitable to different agro-climatic conditions of the state is of outmost importance in the project interventions. Releasing of improved cultivars is not enough. Development of efficient seed delivery system for making available desired seeds at appropriate time is the key. Further, it has to be strengthened with certain incentives in form of subsidies and market interventions to encourage farmers to increase the area under the crop. 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 also to protect the crop from unseasonal rains.

Chapter 8

Productivity and Profitability in Legumes Cultivation: Opportunities, Challenges and Lessons Learnt

D Kumara Charyulu[7], D Moses Shyam, Cynthia Bantilan and GD Nageswara Rao

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) from targeted countries. 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 implemented in two phases: Phase-1 (2007-2010) and Phase-2 (2011-2014) across the three regions and crops. However, the project has been planned to fund for three phases with totalling of 10 years[8].

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 studies and 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.

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

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

modernization to take advantage of the advances in molecular breeding sweeping across the disciplines.

Table 8.1 summarizes the major crop-country combinations for targeting the research and project interventions over the last eight years period. However, the present chapter confines to South Asia region (India and Bangladesh) and three targeted crops (chickpea, pigeonpea and groundnut) only. The subsequent sections of this chapter document the initial impacts on project interventions in South Asia and those legumes. Among several interventions, the present chapter focuses and highlights on four major activities carried out across regions. Overall, the project targeting and scaling-out efforts are summarized in Fig 8.1.

Table 8.1: 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	

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.

Seed production and delivery systems[9]

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 legume seed production because of lower 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 and from crop to crop.

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 8.2). 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 8.2: Different classes of seed distribution (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
Total	92,891	57289.4	88099.0	238,280

Capacity building

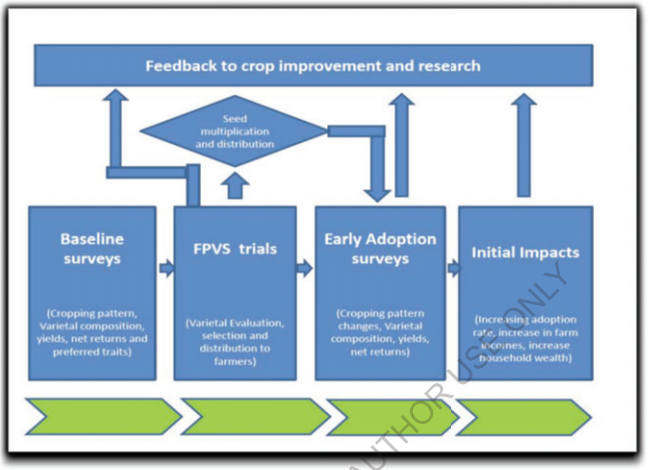
Good progress has been made in terms of both physical and human capacity building in the NARS of target countries. Laboratory and office equipment has been purchased and submitted to the NARS; irrigation facilities for conducting research on drought tolerance have been installed or upgraded in all countries. 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.

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

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 etc. The project has been able to reach approximately 5 million farmers during its first and second phases.

Fig 8.1: Targeting and diffusion interventions under TL II project



Impact on adoption, productivity and profitability in South Asia

As mentioned earlier, the present chapter confines more to South Asia and on 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 of improved cultivars, constraints faced by the farmers, market linkages, potential opportunities for their expansion etc. Few studies also conducted on monitoring the early adoption behavior of newly introduced improved cultivars and their performance in the targeted locations. However, the present section highlights the initial impacts of those TL II project interventions on extent of adoption, productivity and profitability by crop wise in the targeted sites.

Chickpea[10]

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

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

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:

Chickpea in Andhra Pradesh

Table 8.3 & 8.4 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 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 8.3: Performance of chickpea in 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 8.4: Performance of chickpea in 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 8.5 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 8.5: Profitability of chickpea cultivation in AP, 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: Cynthia Bantilan et al. 2015.

Chickpea in 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 supplied small quantities of 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 8.6: Performance of chickpea in 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 8.6 & 8.7). 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 8.7: Performance of chickpea in 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 8.8: 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 8.8 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).

Chickpea real-time tracking survey

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.

Groundnut[11]

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 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 real-time 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:

Groundnut in Karnataka

Table 8.9: Performance of groundnut in 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								

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

Table 8.9 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 8.10: Profitability of 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 (Table 8.10). 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).

Groundnut in Tamil Nadu

Table 8.11 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 8.12 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.

Table 8.11: Performance of groundnut cultivars in Tamil Nadu

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 8.12: 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

Groundnut 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.

Pigeonpea[12]

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 baseline surveys 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

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

of free seed samples were distributed between 2007 and 2010 in project intervention sites across two study states. Partial penetration of project introduced cultivars was observed in both the targeted states due to some constraints.

Pigeonpea in Andhra Pradesh

Table 8.13 furnishes the details of pigeonpea improved cultivars adoption in Andhra Pradesh during 2007-2009. Old cultivars such as 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 and on par with superior variety 'Asha'.

Table 8.13: Varietal composition of pigeonpea 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 8.14). 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 8.14: Profitability of pigeonpea 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

Pigeonpea in 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 8.15). 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 8.16. 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 8.15: Varietal composition of pigeonpea in 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 8.16: Profitability of pigeonpea 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

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.

Chickpea

Challenges and lessons learnt

The previous session 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 Deshla Roon 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.

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 have been 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.

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.

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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Appendix Table 1: Chickpea RTT survey particulars in AP, 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	
KURNOOL	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**
PRAKASAM	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

Appendix Table 2: Chickpea RTT survey particulars in Karnataka, 2013 (no.)

District	Village	Treated / Control	Seed beneficiaries		Non-seed beneficiaries		Total sample
			Non-baseline HH	Baseline beneficiary HH**	Baseline HH*	Baseline Control HH#	
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**