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

Girish N Kulkarni, N Nagaraj, D Kumara Charyulu, D Moses Shyam and A G Vijayakumar

UNIVERSITY OF AGRICLTURAL SCIENCES, DHARWAD

AND

INTERNATIONAL CROPS RESEARCH INSTITUTE FOR SEMI-ARID TROPICS, PATANCHERU, ANDHRA PRADESH-502 324

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1. Background

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

1.1 Major chickpea growing states

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

1.2 Study on tracking of varietal diffusion

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

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

Particulars	Area			Productivity			Production		
	Growth rate(%)	Mean ('000/ha)	Instability index(%)	Growth rate(%)	Mean (kg/ha)	Instability index(%)	Growth rate(%)	Mean ('000 tone)	Instability index (%)
Madhya Pradesh	1.14 (0.007)	2504.85	3.44	0.72** (0.013)	902.818	11.14	2.26** (0.018)	2535.1	3.69
Andhra Pradesh	14.47*** (0.021)	455.70	16.52	2.10** (0.017)	1248.1	14.7	21.18*** (0.19)	553.7	24.8
Karnataka	6.96*** (0.020)	573.50	19.47	3.98*** (0.013)	666	0.11	10.72***	298.1	0.24
Maharashtra	7.34*** (0.012)	1073.00	10.51	5.25*** (0.010)	653.1	0.094	10.64*** (0.026)	525	0.12
Rajasthan	7.92** (0.027)	950.50	19.73	-1.85*** (0.025)	674.7	19.74	1.61 (0.035)	667.4	25.56
Uttar Pradesh	0.08** (0.010)	737.90	8.13	-7.12*** (0.016)	650.8	0.13	-0.68 (0.014)	880.6	0.12
India	1.60 (0.007)	7324.10	4.46	0.89** (0.006)	836.1	5.90	5.58*** (0.011)	6207.01	9.72

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

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

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

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

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

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

Objectives of tracking survey:

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

2. Sampling frame and methodology

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

I. Seed beneficiaries: This sample category includes;

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

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

II. Non-seed beneficiaries: This category includes;

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

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

2.1 Sampling strategy for real-time tracking survey in Karnataka

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

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

Table-2.1: Sampling frame for real time tracking survey

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

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

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

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

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

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

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

2.2 Analytical techniques

The data collected from primary sources were computerized for analysis. The data were checked for consistency and completeness and analyzed using different descriptive statistical procedures. The descriptive statistics viz., sample mean, frequency distribution, cross tabulation were used. Tabular analysis was adopted to compile the general characteristics of the sample farmers, determine the resource structure, cost structure, returns, profits and opinion of farmers regarding the problems in production and marketing. Simple statistical tools like averages and percentages were used to compare, contrast and interpret results properly. In order to know the performance of chickpea crop over time, compound growth rates (CGR) were computed to comprehend the annual growth in the area, production, and productivity of chickpea in the country for major chickpea growing states and for the selected districts for the period from 2000-01 to 2010-11.The instability indices were also worked out to know the extent of instability in respect of chickpea area, production, and productivity during the study period.

3. Results and discussions

3.1 Socio-economic, natural and institutional factors

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

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

Table-3.1: Caste composition of sample chickpea farmers

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Note: Figures in parentheses indicates percentages to the total

3.2 Nature and extent of benefits and technology adoption

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

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

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

Note: Figures in parentheses indicates percentage to the total

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

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

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

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

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

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

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

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

3.3 Sources of seed

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

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

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

Note: Figures in parentheses indicates percentages to the total

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

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

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

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

Note: Figures in parentheses indicates percentages to the total

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

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

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

3.4 Economic performance of chickpea cultivars

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.5 Role of institutions in technology diffusion

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

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

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

4. Summary and conclusions

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

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

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

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