



Bulletin of Tropical Legumes

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About the bulletin

The Bulletin of Tropical Legumes is a quarterly publication of the Tropical Legumes III (TL III) project, funded by the Bill & Melinda Gates Foundation, and jointly implemented by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the International Center for Tropical Agriculture (CIAT) and the International Institute of Tropical Agriculture (IITA) in close collaboration with partners in the national agricultural research systems of target countries in sub-Saharan Africa and South Asia. TL III aims to improve the livelihoods of smallholder farmers in drought-prone areas of the two regions through enhanced productivity and production of grain legumes.

The Tropical Legumes II project accelerated Chickpea Revolution in southern India

Chickpea has always been the most important pulse crop of India, well recognized for its benefits to soil fertility in crop rotation with cereals and its nutritive value in vegetarian diets when consumed with cereals. Since the known history of chickpea cultivation, India has continued to remain the largest producer and consumer of chickpea. During early 1960s, chickpea area in India was over 9 million ha and Indian contribution to global chickpea production was over 75%. The expansion of irrigation and high input agriculture during the era of the Green Revolution brought substantial changes in cropping patterns in India. The area of rainfed crops like chickpea and other pulses declined, while the area of wheat, rice and other input responsive crops increased substantially.

The chickpea area continued to decline in India and reached the lowest level of 5.2 million ha during 2001. As a result, Indian share in global chickpea production declined to 55% and Indian chickpea import reached the highest level of 0.5 million ton in that year.

There has been an impressive growth in area, productivity and production of chickpea in India since 2001 (Figure 1). There are several factors contributing to this progress including strong policy support and various developmental schemes of the Government of India, availability of better varieties and technologies and increased market price of chickpea. Despite a good growth in chickpea production, the gap in demand and supply of chickpea continued and India remained the largest importer of chickpea in most of the years during 2001 to 2009. However, in recent years, Indian export of chickpea has increased considerably and it exceeded Indian import of chickpea during 2010 and 2011. During 2012-13, India had a record high production (8.8 million tons) and a record high yield (1020 kg ha⁻¹) of chickpea.

As chickpea is a cool season crop, the general perception is that it requires cooler and longer winter season and is more suited to northern India. It was probably true for the earlier varieties which were bred for cooler and long-season environments. Thus, the major chickpea area was earlier confined to northern and central India. However, the scenario of chickpea cultivation has drastically changed in India during the past five decades, primarily because of two factors - (1) the Green Revolution that intensified wheat cultivation in northern India replacing post-rainy season pulses, particularly chickpea, and (2) development of short duration chickpea varieties that are better adapted to warmer, short-season environments, like central and southern India. There has been a major shift (about 4.0 million ha) in chickpea area from northern India (cooler, long-season environments) to central and southern India (warm, short-season environments). During the triennium 1965-67 and 2011-13, the chickpea area declined from 4.7 to 0.7 million ha in northern states (Punjab, Haryana and Uttar Pradesh), while it increased

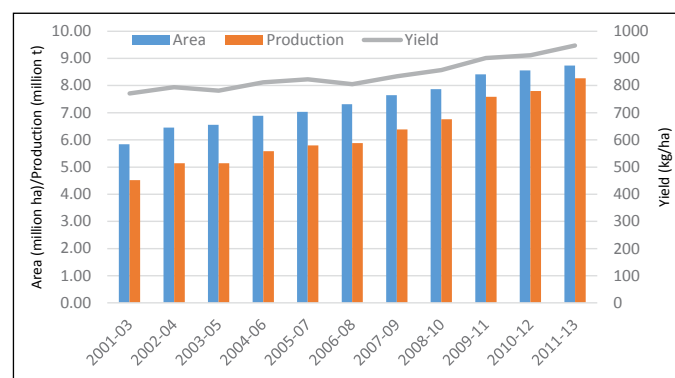


Figure 1. Trend in area, production and yield of chickpea in India during triennium 2001-03 to 2011-13.

Project:
Tropical Legumes III
(TL III)

This work has
been undertaken
as part of the



RESEARCH
PROGRAM ON
Grain Legumes

Investor:
Bill & Melinda
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Partners:



from 2.1 to 6.1 million ha in central and southern states (Madhya Pradesh, Chhattisgarh, Maharashtra, Andhra Pradesh and Karnataka) (Figure 2).

ICRISAT has a global mandate for chickpea improvement and its headquarters is based in Patancheru, near Hyderabad in Telangana state of southern India. The genebank of ICRISAT has the largest global collection (>20,000 accessions) of chickpea germplasm. ICRISAT supplies germplasm and breeding materials to the researchers globally. The breeding material supplied by ICRISAT has led to release of 90 cultivars in 11 countries. ICRISAT being hosted in India has had strong collaboration with Indian chickpea research programs of ICAR institutions (Indian Institute of Pulses Research and Indian Agricultural Research Institute) and state agricultural universities (SAUs) working under the umbrella of All India Coordinated Research Project (AICRP) on chickpea. The major emphasis of ICRISAT's chickpea breeding program has been on development of early maturing varieties with high resistance to Fusarium wilt and high yield potential. Short duration cultivars escape terminal drought and heat stresses and enhance adaptation of chickpea to warmer, short-season environments. Forty high yielding chickpea varieties with early to medium maturity and high resistance to Fusarium wilt have been developed and released in India from the breeding materials supplied by ICRISAT. The most popular varieties developed through ICRISAT-India partnership include JG 11, JAKI 9218, JG 130, JG 14, JG 16, KAK 2, Pratap Chana 1, Vishal, JGK 2, ICC 37, Virat, JGK 1, JG 6, JGK 3, Vaibhav, IPCK 2004-29, GG 4, GG 2, ICCV 10, Himachal Chana - 2, ICCV 2, Vihar and CO 4. These varieties have shown high adoptions, particularly in central and southern India, and accounted for about 49% of the indent of chickpea breeder seed in India during 2013-14.

Southern India has warmer and shorter winter season and was earlier not considered suitable for chickpea production. But a chickpea revolution has taken place in Andhra Pradesh and Karnataka states of southern India during the recent years. During the triennium 1999-2001 to 2008-10, the chickpea production in

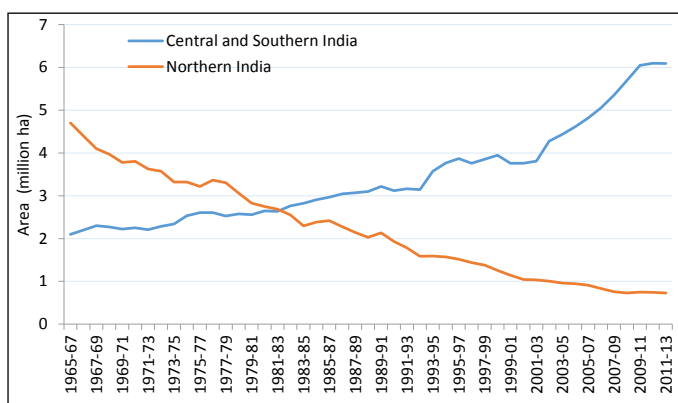


Figure 2. Shift in chickpea area from northern India to central and southern India.

Andhra Pradesh increased 5.8-fold (from 151,000 to 872,000 tons) due to 3.7-fold increase in area (from 170,000 to 628,000 ha) and 60% increase in productivity (870 to 1389 kg/ha) (Figure 3). However, the drought during the triennium 2011-13, reduced the productivity to 1091 kg/ha and production to 667,000 tons. In Karnataka state, the chickpea production increased 2.9-fold (197,000 tons to 574,000 tons) due to 2.7-fold increase in area (336,000 ha to 911,000 ha) and 8% increase in productivity (582 kg to 627 kg/ha) during the triennium 1999-2001 to 2011-13 (Figure 4).

Andhra Pradesh and Karnataka have been the target states for chickpea research for development (R4D) activities of TL II project in India during Phase I and Phase II (Figure 5). Kurnool and Prakasam in Andhra Pradesh, and Dharwad and Gulbarga in Karnataka were the target districts included in Phase I. The districts added in Phase II included Anantpur in Andhra Pradesh and Raichur and Bijapur in Karnataka. The partners involved in the project included ICRISAT, Acharya NG Ranga Agricultural University (ANGRAU) – Hyderabad, University of Agricultural Sciences (UAS) – Raichur, UAS – Dharwad, Andhra Pradesh State Seed Development Corporation (APSSDC), Karnataka State Seed Corporation



Figure 3. Trend in area, production and yield of chickpea in Andhra Pradesh state of India during triennium 1999-2001 to 2011-13.

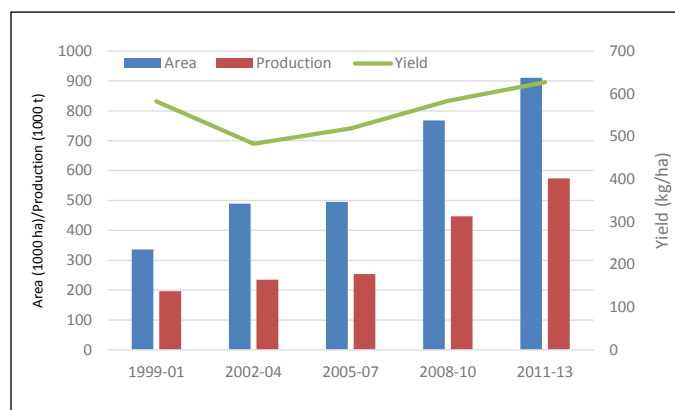


Figure 4. Trend in area, production and yield of chickpea in Karnataka state of India during triennium 1999-2001 to 2011-13.



Figure 5: Target TL II states for chickpea R4D activities in southern India.

(KSSC), National Seed Corporation (NSC), State Farms Corporation of India Limited (SFCL), Department of Agriculture – Government of Andhra Pradesh, and Department of Agriculture – Government of Karnataka.

The major achievements of TL II project activities in Andhra Pradesh and Karnataka are described below:

1. Identification of farmer and market preferred chickpea cultivars

The current status of adoption of improved varieties and traits preferred by the farmers were assessed at the beginning of the project. Taking into account farmer and market preferred traits, eight improved cultivars/



Figure 6. Women field workers harvesting chickpea crop in Andhra Pradesh.

breeding lines (4 desi + 4 kabuli) were selected for farmer-participatory varietal selection (FPVS) trials at each of the four project locations (Kurnool and Prakasam districts in Andhra Pradesh, and Dharwad and Gulbarga districts in Karnataka). Twenty mother trials and 217 baby trials were conducted in 23 villages (5 to 8 villages in each district) during 2007-08 to expose farmers to improved cultivars and allow them to select cultivars of their preference. The crop in Prakasam district of Andhra Pradesh was destroyed in the first year by heavy rains at maturity, so FPVS trials were repeated in the second year (2008-09). A total of 1181 farmers (1052 men + 129 women) were involved in ranking of varieties in FPVS trials. The desi chickpea cultivars JG 11 and JAKI 9218 were preferred in all four districts. In addition to these, desi chickpea cultivar JG 130 was preferred in both the districts of Andhra Pradesh, while desi chickpea cultivar BGD 103 and kabuli variety MNK 1 were preferred in both the districts of Karnataka. Farmers in Prakasam district of Andhra Pradesh also preferred kabuli chickpea cultivar KAK 2. The traits for which these cultivars were preferred included profuse podding, high productivity, early maturity, resistance to Fusarium wilt, and market-preferred seed traits (eg, medium seed size in desi type and large seed size in kabuli type).

2. Release of cultivars

The results of FPVS trials strengthened release proposals of varieties. A desi chickpea variety BGD 103 was released and notified for cultivation in Karnataka state of India in 2009. This is a high yielding, large-seeded variety with early maturity and resistance to fusarium wilt. A kabuli chickpea variety MNK 1 was later released by the Central Variety Release Committee for South Zone of India. This variety has extra-large (52 g/100-seed) seed. One desi variety Nandyal Sanaga 1 (NBeG 3) was released in 2012 in Andhra Pradesh. This is an early maturing, drought and heat tolerant, Fusarium wilt resistant and high yielding variety.

3. Enhancing seed availability of improved cultivars

Excellent progress was made in chickpea seed production and distribution in Andhra Pradesh and Karnataka. The research partners were mainly engaged in production of breeder seed, but also produced limited quantities of certified seed and truthfully-labeled seed. They together produced 2,093 tons of seed in Phase I, which included

1,207 tons breeder seed, 205 tons certified seed and 681 tons truthfully-labeled seed. The seed was produced both at the research stations and the farmers' fields under direct supervision of scientists. The share of JG 11 was 84% in breeder seed and 71% in other classes of seed. In Phase II (2011 and 12), research partners in these states produced 7,453 tons of breeder seed.

A strong partnership between research partners and public seed corporations was established, where research partners produced breeder seed and the public seed corporations produced foundation and certified seed. The four seed corporations (NSC, SFCI, APSSDC and KSSC) together produced 74,531 tons seed in Phase I and 76,215 tons seed in Phase II. JG 11 had the highest share in chickpea seed production.

During Phase II, because of policy support from the state government in Karnataka, 48 small private seed companies came forward to undertake seed production of popular chickpea cultivars. These companies produced 12,752 tons foundation seed and 91,707 tons certified seed during 2013.

4. Distributing seed samples to farmers

Seed samples of different sizes (2-20 kg) of farmer-preferred varieties were distributed to farmers for enhancing their awareness about improved varieties and making available initial quantity of high quality seed for further multiplication. In Phase I, a total of 4,979 seed samples were distributed in four target districts. The total quantity of seed distributed was 47.5 tons. In Phase II (2011 & 12), 75 tons of small seed samples of chickpea (4-25 kg each) were distributed to 11,851 farmers.

5. Knowledge empowerment of farmers, extension personnel and seed traders

Training of farmers in improved chickpea production technology, seed production and storage was given high priority. Over 200 training programs were organized by NARS partners in Phase I and Phase II in which 14,699 farmers (13,364 men + 1,335 women) participated. The various topics covered in the training programs included FPVS trials, improved chickpea varieties, improved chickpea production technologies, integrated pest management; seed production, processing and storage; and post-harvest value addition.

A total of 86 field days/farmers' fairs were organized in Phase I and Phase II, in which 28,534 farmers (25,729 men + 2,805 women) participated. These events exposed farmers to improved cultivars and production technologies and gave them opportunities of interacting with researchers, extension personnel and development agencies.

Efforts were made to reach large number of farmers through electronic and print media to disseminate information on improved cultivars and crop production technologies of chickpea. During Phase I and Phase II, the project partners organized 84 activities (TV and radio programs, news and articles in newspapers, leaflets, booklets, etc) during crop growth period to enhance farmers' awareness on integrated chickpea production practices. A chickpea seed production manual was published in English, Telugu (for Andhra Pradesh) and Kannada (for Karnataka) languages. The English version is available online (www.icrisat.org/tropicallegumesII/pdfs/ChickpeaManual_full.pdf).

Training on improved chickpea production technology was provided to extension personnel from research organizations, Department of Agriculture (Agricultural Officers, Assistant Directors of Agriculture) and NGOs. A total of 2,449 extension personnel (2,073 men + 376 women) were given training at research stations located in the district.

In addition to the public seed sector, the local seed traders play an important role in making seed available to farmers. Training programs were organized for improving knowledge and skill of local seed traders in proper handling of seed. In Phases I and II, a total of 290 seed traders from Andhra Pradesh and Karnataka



Figure 7. Farmers threshing a bumper crop of chickpea in Andhra Pradesh.

states were provided training on seed processing and safe storage.

Baseline and early adoption studies

A desi chickpea cultivar “Annigeri-1” developed in 1940 (officially notified in 1978) has been the ruling chickpea variety in Andhra Pradesh and Karnataka for over six decades. Annigeri-1 is a short-duration cultivar well adapted to short chickpea growing season of Andhra Pradesh and Karnataka. The traders also preferred seed quality of Annigeri-1 and offered 5-10% less price to other desi varieties, which discouraged farmers from adopting new varieties. It is estimated that Annigeri-1 covered over 90% of the chickpea area in Andhra Pradesh and Karnataka up to the 2003-04 crop season. A need was felt to replace Annigeri-1 because of increasing incidence of Fusarium wilt. ICRISAT and ANGRAU started promoting improved chickpea cultivars ICC37, ICCV 2, JG 11 and KAK 2 in Andhra Pradesh prior to start of the TL II project. As a result, area of Annigeri-1 reduced to 45% in Kurnool district and 24% in Prakasam district by 2007 (Table 1). However, in Karnataka, Annigeri-1 occupied 92% area in Dharwad and 94% area in Gulbarga in 2007 (Table 2).

Concerted efforts made under the TL II project on knowledge empowerment of farmers on improved cultivars and production technologies, and enhancing seed availability accelerated adoption of improved cultivars by farmers. An early adoption survey was conducted in 2009-10, which indicated that the area under improved cultivars (JG 11, KAK 2, JAKI 9218) promoted under the TL II project increased from 55 to 90% in Kurnool and 67 to 97% in Prakasam district during 2007 to 2009-10 (Table 1). Similarly, in Karnataka, the area under improved cultivars (JG 11, KAK 2, BGD 103, JAKI 9218 and MNK 1) promoted under TL II project increased from 5 to 55% in Dharwad and 2 to 55% in Gulbarga (Table 2).

The chickpea farmers have significantly benefited through enhanced yields, improved soil fertility and

Table 1. Adoption of improved chickpea cultivars in the sample villages of Kurnool and Prakasam districts of Andhra Pradesh.

Varieties	Varietal composition (%) in Kurnool		Varietal composition (%) in Prakasam	
	BL-2007	EA-2009	BL-2007	EA-2009
Annigeri	45.35	10.13	24.48	2.62
ICCV 2	0	0	9.87	0
KAK 2*	1.43	0	26.37	78.5
JG 11*	53.22	89.45	39.28	18.88
JAKI 9218*	0	0.42	0	0
Overall	100.0	100.0	100.0	100.0

*Promoted under TL II project; BL: Baseline in 2007; EA: Early Adoption survey in 2009-10.

Table 2. Adoption of improved chickpea cultivars in the sample villages of Dharwad and Gulbarga districts of Karnataka.

Varieties	Varietal composition (%) in Dharwad		Varietal composition (%) in Gulbarga	
	BL-2007	EA-2009	BL-2007	EA-2009
Annigeri	91.5	41	94.2	42
Bhima	2.4	2	0	0
Local or others	1.2	2	4.2	3
KAK 2*	4.9	2	1.6	5
JG 11*	0	23	0	22
BGD 103*	0	18	0	18
JAKI 9218*	0	12	0	0
MNK 1*	0	0	0	10
Overall	100.0	100.0	100.0	100.0

*Promoted under TL II project; BL: Baseline in 2007; EA: Early Adoption survey in 2009-10.

increased household nutrition and fodder availability. As part of a global initiative to assess the impacts of legumes research in the CGIAR, a study supported by the Standing Panel on Impact Assessment (SPIA) was conducted in Andhra Pradesh on adoption and impact of improved chickpea cultivars during 2012-13. The complete report can be accessed at <http://www.icrisat.org/what-we-do/mip/SPIA.pdf>. The salient findings of this report are as follows:

- The improved chickpea varieties developed through ICRISAT-NARS partnerships were spread to about 98% of the chickpea area in Andhra Pradesh by 2011.
- Improved chickpea varieties led to a more than six-fold increase in area cultivated with the crop. Productivity has doubled, rising by an average 38 kg/ha per year between 1996-97 and 2009-10 in Andhra Pradesh, compared with an average annual increase of 5 kg/ha for the country as a whole.
- The direct welfare benefits accrued to Andhra Pradesh due to adoption of short duration chickpea cultivars were estimated at \$358.9 million.

Important Lessons for Tropical Legumes III in India and Africa

Project planning was based on the assumption that all TL III activities will be built upon the achievements and outputs of TL II and elements of TL I. The program will specifically support the breeding pipelines of the Africa based breeding programs and chickpea varietal development in Uttar Pradesh. These efforts will result in the release of varieties that exhibit significantly higher yields and yield stability in their target production environments, as well as strong resistances to an array of key pests of each crop, with taste, cooking and nutritional qualities and market preference that

are equal to or possibly far better than the dominant varieties now grown in target countries.

Responding to the Bill & Melinda Gates Foundation's call for increased focus, TL III will concentrate its efforts on groundnut, cowpea, common bean and chickpea. Geographic targets include seven African countries: Burkina Faso, Nigeria, Mali, Ghana, Tanzania, Ethiopia and Uganda and the Indian State of Uttar Pradesh. To leverage the Bill & Melinda Gates Foundation's earlier investments in soybean and pigeonpea, which are not included in TL III, the partners will pursue other opportunities to build upon and sustain the significant accomplishments made previously with these crops.

Three complementary research and delivery pillars are proposed within TL III:

- Support for the development and release of farmer-preferred varieties of cowpea and groundnut in four of the Bill & Melinda Gates Foundation's focus countries (Burkina Faso, Ghana, Mali, Nigeria); common bean and chickpea in Ethiopia; common bean and groundnut in Tanzania and Uganda; and chickpea in Uttar Pradesh, India;
- The strengthening of the legume breeding capabilities of national partners in all target countries with support from three CGIAR Centers – ICRISAT, IITA and CIAT to promote genetically-driven yield increases, and
- The production and delivery of improved seed to smallholder farmers, particularly female farmers who often are ignored or overlooked by development workers.

The successes in the TL II Indian partner states as documented above were taken as signal that they no

longer need support for breeding and seed delivery and that TL III should focus its seed work entirely on the African target geographies, except for the case of the Indian State of Uttar Pradesh, that was not included in TL II, but which has significant chickpea hectareage (>600,000 ha).

There were several lessons learned from the TL II activities on chickpea in Andhra Pradesh and Karnataka states of southern India. It was evident that the farmers' awareness of the improved varieties and availability of the seed of improved varieties are the key factors in spread of improved chickpea cultivars. FPVS trials and distribution of seed samples are very effective in enhancing awareness of farmers to improved varieties and rapidly spreading the new varieties. These key lessons learned from success stories of Andhra Pradesh and Karnataka will help in improving adoption of chickpea cultivars in other regions of India and other countries especially in sub-Saharan Africa.

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