



A chickpea revolution in southern India

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Key messages

- The introduction of short-duration improved chickpea varieties in the southern Indian state of Andhra Pradesh has led to what is now known as the *Andhra Pradesh chickpea silent revolution*, with more than six-fold increase in the area cultivated with the crop and a ten-fold increase in production.
- Productivity has surged, 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.
- Nearly 90% of land in the state given over to chickpea production was under improved cultivars by 2011. The progression of adoption reflects the release of varieties that closely match both the needs of the farmers and prevailing environmental conditions.
- The new improved varieties in Andhra Pradesh have produced yields 37% higher than those of the best cultivar previously available.
- Adoption of the improved varieties has resulted in direct welfare gains of US\$358.9 million in Andhra Pradesh. Of this, 68% is attributable to the increased incomes of farmers who switched to chickpea production from other crops.
- The total research benefits generated were US\$543.9 million, accrued at the all India level. Research investment produced an internal rate of return of 28%.
- Evidence suggests that, given an enabling environment, the success in southern India could be replicated in other regions of South Asia and sub-Saharan Africa.

This brief is based on the paper: Bantilan, M.C.S. et al. 2014. Short duration chickpea technology: enabling legumes revolution in Andhra Pradesh, India. Research Report No. 23, Patancheru, India, ICRISAT (available at <http://www.icrisat.org/what-we-do/mip/SPIA.pdf>). This paper was commissioned by the Standing Panel on Impact Assessment (SPIA), CGIAR Independent Science and Partnership Council (ISPC), Rome, Italy.

Background

This study was part of a global initiative to assess the impacts of legume research in CGIAR. Specifically, it documents the success story of the adoption and diffusion of improved chickpea varieties in the southern Indian state of Andhra Pradesh.

Chickpea production in India has undergone a major shift over the past five decades. Cultivation has declined in the crop's traditional stronghold of the cooler, long-season north, where it has been largely displaced by wheat and other cash crops. By contrast, chickpea production has increased substantially in the warmer, short-season south of the country.

Traditional chickpea varieties are ill-suited to the environmental conditions of the south. A major challenge for International Crops Research Institute for the Semi-arid Tropics (ICRISAT), in collaboration with the Indian national agricultural research system (NARS) has been developing chickpea varieties that would thrive in the environmental conditions of southern India. Problems include short winters, terminal moisture stress and heat stress, as well as a higher prevalence of pests and diseases, such as pod borer and wilt.

Following more than 30 years of research to produce varieties of chickpea suited to local conditions, ICRISAT has developed several varieties that mature quickly (short-duration) and are resistant to wilt. The most successful of these have been trialed and released to farmers.

A key objective of the study was to assess the uptake and impacts of improved agricultural technologies – specifically improved chickpea – by using new approaches that enable disaggregation of impacts by farmer type.

This Brief summarizes the adoption and diffusion of improved chickpea short-duration varieties in Andhra Pradesh, a low latitude

region with a dry hot climate and vertisol soils. It presents a detailed assessment, applying advances in methodologies, of the impacts of these new varieties on farmers' livelihoods and the potential for replication in other semi-arid tropical regions of the world.

Chickpea cultivation in India

Chickpea (*Cicer arietinum* L.) is the most important pulse crop in India and the second most important worldwide (FAOSTAT, 2012). India is both the world's leading producer and consumer of chickpea.

Chickpea is a post-rainy season crop. Its productivity is strongly influenced by both the volume and distribution of rainfall. Another crucial biophysical parameter is the length of the growing period (LGP), which determines crop choices in a particular region/district. In common with other pulse crops, chickpea makes an important contribution to soil fertility management, particularly in drylands (Sharma and Jodha, 1984).

Photo: ICRISAT



Overall, South and Southeast Asia contribute approximately 86% of the world's production, but productivity per hectare is relatively low, at around 878.8 kilogram/hectare (kg/ha), compared with the global average of 911.2 kg/ha (FAOSTAT, 2012). While chickpea is a relatively new crop in Andhra Pradesh with most farmers only starting to grow it in the past 10 years, productivity has increased significantly, outstripping that of any other state in India. It rose from 853 kg/ha in 1996/97 to 1,308 kg/ha by 2009/10 because of the widespread adoption of improved high yielding short-duration cultivars.

Methodology

This study explored the reasons behind the farmers' current preference for chickpea cultivation over other crops in Andhra Pradesh and the impact on producers and their households. It also set out to examine the pattern of chickpea varietal adoption and replacement, the productivity gains at the farm level, and unit cost reductions. To this end, the study built on previously developed models and established field data gathering techniques, in the form of surveys and focus group discussions. A partial equilibrium model based on the principle of economic surplus was used to explore factors that have fostered the widespread adoption of chickpea technology throughout the region, identifying the welfare effects from farm to national level.

Data collection

A systematic tracking approach was developed using a representative sample survey conducted in Andhra Pradesh. This was complemented by an analysis of available secondary district and sub-district level data on area, production and yield, and seed sector information to assure a robust sampling frame. The adoption and impact survey of 810

households¹, as well as in-depth understanding from the temporal changes in area, production and yield, revealed the fast changing patterns as a result of the key drivers of technology adoption and other sources of growth. The analysis harnessed both time series data from 1966–2012 and the spatial analysis, using GIS tools, of geo-referenced parameters which related to chickpea-homogenous research domains. Farm-level reconnaissance was extremely useful in gaining an understanding of the underlying qualitative factors not covered in the formal representative survey.

Faster uptake of newer chickpea varieties

As stated earlier, most farmers in Andhra Pradesh started growing chickpea only in the past 10 years. But by the 2011/12 growing season for the sample surveyed, it accounted for 67% of the total cultivated area and 88% of the post-rainy season cropped area, replacing crops such as sorghum, sunflower, black gram, safflower, coriander, maize and tobacco.

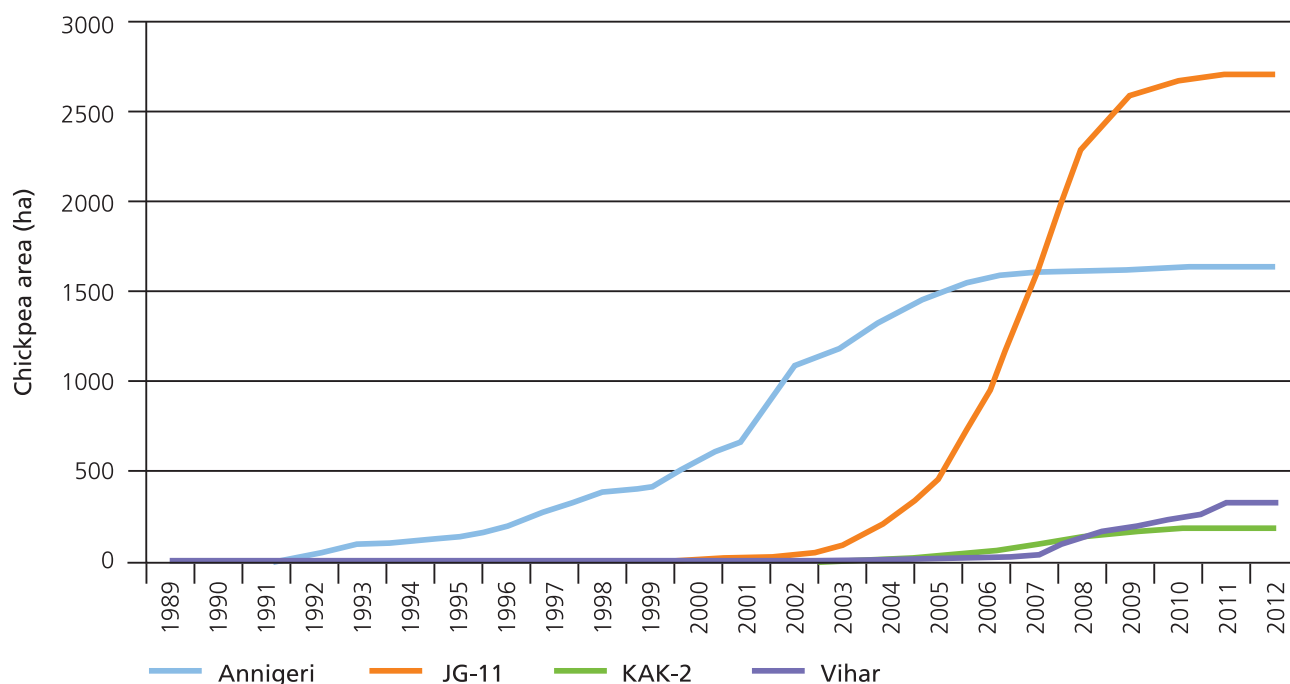
Annigeri, a medium-duration improved landrace selection², was the single dominant cultivar in the state until 2005. Among the sample households, the time lapse between its initial release and its peak adoption was almost 17 years (Figure 1). An obstacle to its adoption and further spread was the limited availability of seed and its susceptibility to wilt disease. However, between the early 1990s and 2000s it paved the way for chickpea penetration of the districts of Andhra Pradesh being studied.

The short-duration variety JG 11, released in 1999, reached its peak adoption rate in just nine years (Figure 1). The high and rapid uptake patterns of the newer variety were partly the result of a concerted effort by ICRISAT, the Indian NARS, and the state seed sector to make

1. These chickpea growing households were spread across 90 villages and 30 mandals in seven districts of Andhra Pradesh representing over 70% of the chickpea area of the state.

2. Annigeri was released in 1978 from the state of Karnataka (adjacent to Andhra Pradesh).

Figure 1. Cumulative first adoption areas (ha) of improved cultivars by sample



seed readily available to farmers. Based on lessons learned from the Annigeri experience, higher volumes of seeds were produced and a subsidy offered to encourage adoption. Of the sample survey area of 4028 ha under chickpea cultivation in 2009/12, 3392 ha (84%) were sown with JG 11. Other varieties showed lower uptake levels (Figure 1).

This lag in adoption reflects that most farmers (83%) reported learning about the new varieties (JG 11) by word of mouth – only 12% received this information from government agencies. Similarly, 72% of the JG 11 first seed requirements were met by purchases from other villagers while 11% of the first seed was purchased from local traders.

Large welfare benefits

An important feature of this study was the disaggregation of data to provide a more detailed analysis of the welfare gains and losses of different groups of farmers. These groups included traditional chickpea producers, those who started cultivating

chickpea in preference to other crops, farmers who retained the old varieties, and those who adopted the improved short-duration varieties.

To calculate the welfare benefits, researchers considered the following as parameters in the model: production, consumption, farm-gate price, research lag (years), adoption parameters, unit cost reduction, elasticity of supply and demand, discount rate, and research costs.

In the business as usual scenario in Table 1, the direct welfare benefit accruing to Andhra Pradesh as a result of adopting short-duration varieties was US\$359 million. The new short-duration cultivars produced yields about 37% higher than the next best cultivar available. Their introduction reduced unit cost for farmers by 22%, an average of US\$144 per ton. Under all scenarios, it is clear that producers receive a higher share of the benefits than consumers, partly explained by Andhra Pradesh being an exporter of the crop. Further, farmers who switched from another

Table 1. Direct welfare gains resulting from the adoption of short-duration improved cultivars in Andhra Pradesh (US\$ million)

Type	S1: Conservative scenario (UCR=117 US\$/ton)	S2: Business as usual scenario (UCR=144 US\$/ton)	S3: Optimistic scenario (UCR=169 US\$/ton)
Total chickpea production (‘000’ tons)	810	810	810
Total chickpea consumption (‘000’ tons)	112	112	112
Total welfare change #	284	359	430
Producer surplus #	279	353	424
Consumer surplus #	5	6	6
Adopters benefits #	284	359	430
Non-adopters #	-5	-5	-6

UCR – Unit cost reduction; # – US\$ million

crop to chickpea received a higher proportion (68%) of this gain compared to existing chickpea growers who adopted new varieties.

For the country as a whole, the study estimated the benefit to be around US\$543 million, with consumers gaining more than producers³ because of the increased supply and consequently lower price of chickpea.

Greater productivity, high returns on research investments

From a relatively small area under chickpea cultivation during the early 1990s, Andhra Pradesh has grown to be a major producer, largely due to the introduction of short-duration and *Fusarium* wilt resistant cultivars, and high uptake by local farmers.

In recent years, Andhra Pradesh has seen a significant improvement in productivity (on average 38 kg/ha per annum), as a consequence of the adoption of new varieties. This is significantly higher than the 5 kg/ha average annual increase for the country as a whole (GOI, 2012). Chickpea production in the state has increased tenfold and overall, nearly 90% of chickpea area was under improved cultivars by 2011.

Focus group discussions with farmers together with survey data and discussions with research groups revealed that, in combination with changed (favorable) market conditions, the short-duration varieties were so profitable to the farmers that many who had not previously produced chickpea started cultivating them instead of other crops.

3. The total gain to producers in India is US\$67 million, but this is overwhelmed by a significant loss to non-adopters (US\$336 million). Thus, producer gain for India as whole, including the producer gain for AP (US\$359 million) is only US\$84 million.

Favored by farmers

Among the reasons for high adoption of chickpea and the displacement of other crops in the post-rainy season in Andhra Pradesh, especially after new improved varieties were introduced:

- The new chickpea cultivars provide a short-duration crop
- There are fewer pest problems – new varieties are resistant to Fusarium wilt disease
- Cultivation (of chickpea) is less labor intensive. Some of this is attributable to the shorter growing season trait of new varieties
- Relatively low investment per hectare is needed
- Farmers view chickpea as a less risky crop
- Assured yields, market, and good remunerative price
- Well suited to mechanical operations, potentially enabling expansion of the cultivation area
- Chickpea (being leguminous) improves soil fertility

The comprehensive report estimated the discounted total flow of welfare benefits to India at US\$543 million. The discounted total flow of costs for developing this technology (research, development, and extension) was US\$3 million. About 80% of the total costs was incurred by ICRISAT, with the NARS partners sharing the remaining 20%. The return on total (ICRISAT + NARS) research investment was 28%.

Summary and conclusions

Chickpea is a relatively new post-rainy season crop for farmers in Andhra Pradesh. Following significant investment in research by the ICRISAT-Indian NARS partnership, short-duration, disease resistant varieties of chickpea, which are suited to warmer, short-season environments and which directly farmer needs, have been taken up on a massive scale in this southern Indian state. Many producers have switched to chickpea from other crops.

This shift has resulted in what is sometimes referred to as the *Andhra Pradesh chickpea silent revolution*, with a more than six-fold increase in the area cultivated, a ten-fold increase in production, and a surge in productivity. Currently, over 90% of the

chickpea-growing area of Andhra Pradesh—some 548,000 ha – is sown with short-duration chickpea cultivars. Most producers have moved from subsistence to commercial chickpea farming by mechanizing their operations, with the exception of harvesting.

Significant welfare benefits have been achieved by the wide adoption of improved chickpea cultivars in Andhra Pradesh. As well as the increases in average household incomes reported in surveys, focus group meetings revealed that adoption of the varieties has led to improved nutrition and greater investment in children's education and health.

The many advantages to farmers have been the major drivers of the adoption of short-duration chickpea varieties, including higher yields, remunerative market prices due to strong demand, ease of cultivation and low investment requirements.

Strong partnerships between ICRISAT and NARS, coupled with policy support from local government, a concerted effort to make seed available, and the willingness of local farmers to innovate, were pivotal in reducing the release to peak adoption time lag.

The short-duration chickpea cultivar is slowly spreading beyond Andhra Pradesh to the neighboring states of Karnataka and southern Maharashtra. Institutional capacity and policy support/environment will play a significant role in determining the extent of research benefits in those states.

Further research is planned to examine other dimensions not considered in the current study. These include the possibility of sustainable intensification to further optimize land use, and the effects of land ownership and leasing on the benefits realized. The welfare impact on women of the adoption of new varieties will also receive attention, as will the nutritional value to consumers.

The success of the Andhra Pradesh experience suggests that there may be scope for using improved varieties to increase chickpea production and productivity in countries with similar agro-ecological profiles, such as Bangladesh, Myanmar, Ethiopia, and Tanzania. This option is now being explored by researchers.

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