India

Groundnut

K Ganesamurthy, HL Nadaf, KP Vishwanatha, P Venkataramana, Somasekhar, M Vaithiyalingan, GS Shekar, Damodara Parida, Manoj Kumar, Ravi Gopal Singh, N Manivannan, P Janila, SN Nigam, HD Upadhyaya, P Parthasarathy Rao, D Kumara Charyulu, CG Goodrich and CL Laxmipathi Gowda

Economic importance of groundnut in India

Groundnut is the major oilseed, food and feed crop in India grown in an area of 4.93 million ha during 2010 with a production of 5.64 million tons and an average yield of 1140 kg ha^{-1} (Source: FAOSTAT 2012). It contributes about 15% to the edible oil basket of the country. India remains a major importer of edible oils. The South Asian region has more than 7 million ha (31% of world total) under groundnut; nearly 83% of this is in India. The country has lost 1.62 million ha of groundnut area to other crops like soybean, maize and Bt cotton during the period 2000 to 2010. Nevertheless, non-traditional area under groundnut is expanding and falls largely in Agroecological Zone 4.

Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra are major states (in Agroecological Zones 2, 3 and 5) that account for 90% of total groundnut production in India. About 85% of the total area under groundnut in the country is sown in the rainy season (Jun/Jul– Oct/Nov) and the remaining 15% is sown during postrainy season (Oct/Nov–Feb/Mar; Jan/Feb–May/Jun), either with irrigation or under residual soil moisture along the riverbanks in rice fallows. Being a rainfed crop, the yield variability across growing regions as well as years is high. Groundnut is grown as a sole crop (mostly in the postrainy season) or in intercropping system with pigeonpea, castor, cotton, etc (mostly in the rainy season). In India, 80% of the total produce is crushed for extraction of oil, 11% as seed, 8% for food uses and 1% is exported. India ranks fifth in export of groundnut with shell and 12th in export of shelled groundnut (FAOSTAT 2012). The oil-cake and haulms are used as cattle feed. Groundnut production and demand in the country are given below.

National production: 6.3 million tons in 2002 and 5.64 million tons in 2010

National demand: 6.4 million tons (2002) as there are no imports of groundnut

Expected growth in demand: 2.41% (2000–15)

The estimated production during 2015–17 is 8.3 million tons, while the estimated demand is 9 million tons as per projections of IMPACT model. The expected demand/production growth rate is 1.86% (2000–15).

Agroecology

The 3-year average of 2005–07 district level data has been used to derive the zonal data. In the district data, break up of rainy and postrainy seasons is not available, so the data reported is for all groundnuts.

Zone 1

This zone includes Rajasthan, Haryana, Punjab and Uttar Pradesh for rainy season and Punjab, Rajasthan and Uttar Pradesh for spring season.

Area: 0.4 million ha (2005–07)

Average production: 0.53 million tons (2005–07)

Proportion of production sold commercially: 85%

Dominant varieties: M 522, Pratap Mungphali 2 (ICGV 92195), RG 382 and HNG 10 in rainy season and SG 99 (ICGV 89280), SG 84 (ICGS 1), Avtar (ICGV 93468) and Dh 86 in spring season

Key constraints: In rainy season, drought, low input usage, insect pests and foliar diseases are important, while high temperature is a major constraint in spring season. Lack of quality seed production and supply of improved varieties are constraints in both the seasons. The average yield in this zone (1.25 t ha^{-1}) is close to national average; however, the average yield in spring season (>2 t ha^{-1}) is higher than in rainy season.

Target yield by 2015: 1.5 t ha^{-1} in rainy season and 2.5 t ha^{-1} in spring season

Zone 2

This zone includes Gujarat and Southern Rajasthan for rainy season and Gujarat, Maharashtra and Chhattisgarh for summer season.

Area: 1.89 million ha (2005–07)

Average production: 2.84 million tons (2005–07)

Proportion of production sold commercially: 85%

Dominant varieties: GG 6, Girnar 2, AK 159, TAG 24 and GG 20 in rainy season and ICGS 76 and TG 37 A in summer season

Key constraints: In rainy season, erratic distribution of rainfall leading to drought/waterlogging, foliar diseases, soilborne diseases like stem rot, and insect pests are important, while in summer season, high temperature and insect pests are important. Although there is variety replacement, quality seed production and supply still remains a constraint. Farm mechanization can help in reducing production costs.

The average yield in this zone (1.5 t ha^{-1}) is higher than the national average.

Target yield by 2015: 1.8 t ha^{-1} in rainy season and 2.2 t ha^{-1} in summer season

Zone 3

This zones includes Northern Maharashtra and Madhya Pradesh for rainy season, Karnataka and Southern Maharashtra for summer season and Andhra Pradesh, Tamil Nadu and Kerala for postrainy season

Area: 0.37 million ha (2005–07)

Average production: 0.36 million tons (2005–07)

Proportion of production sold commercially: 85%

Dominant varieties: TG 37 A, J 11, AK 159 and TPG 41 in rainy season and TMV 2 and JL 24 in postrainy season

Key constraints: In rainy season, drought, low input use, foliar diseases and insect pests are important, while in postrainy season bud necrosis in Andhra Pradesh and Tamil Nadu and rust and leaf spots in

Tamil Nadu are important. Lack of quality seed production and supply of improved varieties and lack of farm mechanization and adoption of integrated crop management (ICM) practices are constraints in both the seasons.

The average yield in this zone is less than 1 t ha^{-1}, lower than national average, but in this zone too postrainy season yields are far better than rainy season yields.

Target yield by 2015: 1.2 t ha^{-1} in rainy season and 2 t ha^{-1} in postrainy season

Zone 4

This zone includes Jharkhand, West Bengal, Orissa and North Eastern Region for rainy season and West Bengal, Jharkhand and Northeastern states for postrainy/summer non-traditional areas.

Area: 0.33 million ha (2005–07)

Average production: 0.48 million tons (2005–07)

Dominant varieties: AK 12-24, Smruti (OG 52-1), ICGS 44, ICGV 91114, ICGS 76, TG 37 A, TAG 24, Kaushal

Key constraints: Low soil fertility and micronutrient deficiencies and lack of quality seed production and supply of improved varieties are common. Erratic distribution of rainfall leading to drought/water stagnation, insect pests and foliar diseases are constraints in rainy season, while in summer season high temperature and insect pests are key constraints.

The average yield of the zone (1.45 t ha^{-1}) is higher than national average.

Target yield by 2015: 1.5 t ha^{-1} in rainy and 1.9 t ha^{-1} in postrainy season

Zone 5

This zone includes Southern Maharashtra, Andhra Pradesh, Karnataka, Kerala and Tamil Nadu for rainy season

Area: 3.31 million ha (2005–07)

Average production: 3.35 million tons (2005–07)

Proportion of production sold commercially: 85%

Dominant varieties: JL 24, TMV 2, TAG 24, Vikas (GPBD 4), Prutha (Dh 86, Kadiri 6, ICGV 91114, VRI 2, Narayani (TCGS 29), TG 37 A, TMV (Gn) 13

Key constraints: Drought, eroded soils with poor soil fertility, cultivation of obsolete varieties, low input use, lack of quality seed production and supply of improved varieties, foliar fungal diseases, aflatoxin contamination, seed and seedling diseases, bud and stem necrosis, and insect pests like leaf miner and *Spodoptera* are important. Labor intensive cultivation and lack of mechanization is another important constraint. The average yield in the zone is about 1 t ha^{-1}, but within this zone the average yield is less than 1 t ha^{-1} in Andhra Pradesh and Karnataka, while it is higher in Tamil Nadu. In large areas of Andhra Pradesh and Karnataka, TMV 2, an obsolete variety with poor performance, is still under cultivation. In Karnataka, groundnut area has decreased from 908,000 ha in 2007–08 to 659,000 ha in 2010–11 as groundnut is less competitive than crops like maize and Bt cotton and the productivity remained low at 900 kg ha^{-1}.

Target yield by 2015: 1.4 t ha^{-1}

Strategic partners

The strategic partners and their role in the seed system are given in Table 1.

Table 1. Strategic partners and their role.

Strategic partner	Role
ICRISAT	Project implementation, monitoring, coordination and reporting, NARES capacity enhancement [scientists, technicians, Department of Agriculture (DoA) and NGO staff and farmers]; generation and supply of genetic resources and breeding materials to NARES; preparation and distribution of farmer-friendly generic literature on farmer-preferred varieties (FPVs); integrated crop management (ICM) and basic seed production
All India Coordinated Research Project on Groundnut (AICRP-G), ICAR	Evaluation of FPVs in national testing system; facilitation of release of FPVs at national level; organization of breeder seed production for formal seed sector
State Agricultural Universities (TNAU, Coimbatore in Tamil Nadu; UAS-Bengaluru, UAS-Dharwad and UAS-Raichur in Karnataka; BAU, Sabour in Bihar and OUAT, Bhubaneswar in Odisha)	Development of new varieties with farmer- and market-preferred traits using conventional and molecular breeding tools; conducting farmer participatory variety selection (FPVS) trials; evaluation of FPVs in the state testing system; facilitation of release of FPVs at state level; organization of breeder and foundation seed production for formal and informal seed sector; training of farmers and staff of DoA and NGOs in seed production and ICM; preparation and distribution of farmer-friendly literature in vernacular languages on FPVs, ICM and seed production
State Farm Corporation of India (SFCI), State Seeds Development Corporations, State Departments of Agriculture, Oilseeds Growers' Federations, ABI, various NGOs operating in different states	Production and marketing of certified/truthfully labeled seed of FPVs
Farmers	Conducting FPVS trials; evaluation of FPVS; participation in formal and informal seed production and marketing

Capacity building needs (staff, infrastructure)

Training in groundnut breeding methodologies, seed production and molecular breeding (MAS and bioinformatics) is needed for national partners in which women scientists are to be included and the number to be increased along the years. Basic infrastructure to facilitate seed production activities and phenotyping in new states (Bihar and Odisha) is needed and in old locations (Tamil Nadu and Karnataka) further strengthening of the existing facilities for phenotyping and facilities for integration of MAS in breeding programs are needed.

Special cultural/gender considerations

- Promotion of groundnut cultivation will enhance employment opportunities particularly for rural women by engaging them in local markets like selling roasted/slated groundnut and other local preparations.
- Increase in groundnut production would also increase the drudgery of women and hence there is a need for varieties suitable for mechanical harvesting. Similar interventions are required at various stages of production, like weeding and harvesting that reduce drudgery for women, offering more time to pursue productive activities.

- Trading for confectionery varieties also increases participation and employment opportunities to women through their involvement in hand-sorting to remove *Aspergillus flavus* infected kernels and hand-picked kernels for bold size (for export purpose).
- In terms of seed storage options, women are in the forefront of adaptive research and they often make the hard decision of what to use for seed, and what to use as food to feed their children. This may be important especially for decentralized seed enterprises. Seed production and delivery approaches and tools that capture priorities from both male and female participants as well as giving them equal opportunities for participation, will be emphasized. A gender considerate skills and knowledge enhancement program in areas of seed systems will facilitate an equitable participation of men and women.
- Women are often engaged in livestock rearing and are involved in sale of milk to chilling units and local markets. The earning from this is the only regular income to a farm family used to meet family food and other requirements. Groundnut haulms supplement cereal fodder with proteins and minerals and enhance livestock productivity and thus increase women's earning from livestock.
- The participatory monitoring and evaluation system will be guided by a performance measurement framework that integrates local and gender disaggregated data and gender specific indicators for monitoring project outcomes.

Processing and storage requirements and market opportunities

- Majority of groundnut produced is crushed for oil and meets 15% of edible oil requirement of the country. Oil-cake, by-product obtained after oil extraction, is used as animal feed. The utilization pattern indicates that 80% of the total produce is used for oil extraction, 11% as seed, 8% for direct food uses and 1% is exported. The food uses are showing an increasing trend in the country. The exports are not taking-off from the country due to stringent regime on permissible levels of aflatoxin on imports in developed countries.
- Dried pods after harvest are sold in the market and the farmers generally do not store the produce except for seed purpose. When not appropriately stored, storage pests cause serious losses. Due to lack of seed storage facilities at village level farmers end up buying seed from market, Department of Agriculture or public seed agencies that escalates the cost of production. Moreover, variety replacement is also lagging despite release of several improved varieties for cultivation as seed of obsolete varieties is supplied by these agencies. Improper storage of produce by traders/exporters/farmers can also result in aflatoxin contamination that has trade implications.
- Due to the price premium for groundnut oil in the domestic market, oil extraction remains the dominant market for groundnut. However, the groundnut marketing chain comprises numerous market intermediaries who get the lion share of the profit. With growing demand for edible groundnut, mainly for exports, a price premium is attached in the groundnut confectionery trade. Thus many traders in Mahabubnagar district of Andhra Pradesh and neighboring districts now prefer selling their decorticated produce to the Maharashtra market/traders. This has resulted in increase of the prices at the farmers' end. On the other hand, the oil millers have not been able to buy high quality produce since the prevailing prices are well above the parity prices for breaking even. Consequently, oil millers are shifting towards trading for confectionery markets or to crushing of other crops like sunflower and soybean and most of the local oil milling units were shut down in the last four years. Thus an increase in market opportunities for confectionery trade is observed in recent years. Driven by rapid increase in demand for animal products, India's demand for oil-cake meal as feed too has increased considerably and is likely to increase further. Limiting and monitoring aflatoxin contamination levels in export consignments can fillip export markets.

Key policies

Policies recently implemented

- India provides price support to major oilseeds in the form of a Minimum Support Price (MSP). The MSP for groundnut has been increased steadily since 2004–05 when it was ₹ 15,000 to ₹ 27,00 per ton. However, MSP was not really operational since market prices were higher than MSP.
- Import duties for oilseeds have been lifted in order to increase domestic availability. The current duty difference between crude and refined oils stands at 7.5%, which provides some measure of protection to domestic refiners against competition from imported refined oils. Imports of edible oils to India increased from 1.3 million tons in 1997/98 to 8.8 million tons in 2010, constituting nearly 40% of its total consumption.
- Export of edible oils was banned in 2007 and the ban was extended till 2010 –11. The export ban has particularly affected groundnut oil since India exports around 30,000 tons of groundnut oil annually.
- Under the small-scale industry reservation policy, expelling of groundnut, rapeseed, sesame and safflower oils is restricted to units with investment of ₹ 0.5 million to ₹ 7.5 million (US$ 10,000 to 170,000), effectively restricting their processing capacities to units much smaller by international standards. Firms that manufacture oilseed processing equipment are subject to the same-scale limits, restricting use of modern technology.
- Restrictions on inter-state movement of agricultural products however, have been lifted recently. The legalization of future trading was allowed for soybean and groundnut products, palm and rapeseed in 2003/04.

Policies needed

- Recognition of farmer-participatory varietal selection and evaluation in formal release of a variety at state level
- Innovative seed systems to increase the uptake and dissemination of improved varieties
- Enhancement in MSP of groundnut
- De-reservation of groundnut oil extraction to small-scale industries (which use obsolete technologies)
- Market-price determination based on oil content, aflatoxin contamination and confectionery value
- In case of delayed onset of monsoon, buy-back seed of improved varieties from farmers by the state governments to avoid distress sale of seed as commodity in the market
- Enhanced subsidy on agricultural machinery required for groundnut cultivation
- Enforcement of quality checking and certification at various stages of groundnut marketing chain to facilitate exports to EU and other developed countries with stringent aflatoxin screening mechanisms
- Easy access to credit for small-scale farmers, particularly women farmers
- Farm machinery made available at affordable and subsidized prices

Key issues for competitiveness (ie, reducing production costs, increase market value)

The key issues for enhancing competitiveness of groundnut vis-à-vis other oilseed crops are:

- Enhancing groundnut productivity to lower the cost of per unit production (through integrated use of FPVs and ICM)
- Quality seed production and supply of improved varieties
- Mechanization in groundnut cultivation to reduce labor cost
- Promotion of dual-purpose groundnut varieties for systems sustainability through enhanced livestock productivity
- Promoting aflatoxin-free groundnut production (cultivation of aflatoxin tolerant varieties and adoption of management practices)
- Monitoring aflatoxin contamination levels in groundnut produce/products
- Promoting groundnut cultivation in non-traditional areas that have an opportunity and potential (for instance, spring–summer groundnut cultivation in Uttar Pradesh, India)
- Promotion of groundnut and its products for health and nutrition
- Agronomy needs to be defined appropriately for area expansion in non-traditional areas like Bihar state and paddy fallow areas of command and coastal regions in Karnataka
- Promoting contract farming by involving groundnut processing industries and farmers in Tamil Nadu
- Storage infrastructure development
- Promotion of seed supply chain between seasons in Odisha wherein seed for postrainy season is produced in the preceding rainy season and vise-versa

Mechanization as it relates to timely planting/harvesting and processing

Groundnut cultivation is labor intensive, but with labor being non-available and/or expensive for agricultural operations, moving toward farm mechanization is urgently needed to reduce the production cost of groundnut. Moreover, it also reduces drudgery to women often engaged in laborious activities such as, sowing, weeding, harvesting, stripping and shelling. Suitable women friendly machinery for various small-scale field operations in groundnut for tasks performed by women is needed. Groundnut digger suitable for dryland conditions and other available farm machinery (seed drill, thresher and decorticators) need to be made available to the farmers at subsidized prices. The possibility of training women in use of farm machinery can also be explored.

Environmental/sustainability issues

No negative environmental/sustainability issues are associated with groundnut cultivation. Being an energy rich crop (high oil content), it harvests more carbondioxide (CO_2) from the environment for the same level of economic yield than non-oil crops. Groundnut ensures systems sustainability by supporting livestock. Groundnut haulms provide nutritious fodder thus improving livestock productivity. It ensures sustainability of rainfed cropping system by fixing biological nitrogen. Diseases and insect pest tolerant varieties require minimum pesticide use.

Monitoring and evaluation

It includes annual in-country review and planning meeting, visits to partner locations during the cropping season, farmer–scientist interaction meeting to assess impact, gender disaggregated focus group discussion with all value chain stakeholders to gauge preliminary impacts/constraints of the project and will include gender sensitive indicators and gender disaggregated data, and conducting workshop with partners to share findings of reports, field-level interactions, etc.

Seed production plan

Groundnut seed production plan for India is given in Table 2.

Table 2. Groundnut seed roadmap for India[1].

Ecology	Demand (ha)	Variety characteristics: Productivity traits	Variety characteristics: Market traits	Promising varieties	Seed available in 2012 (Breeder/ foundation) (t)	Seed production (t): Breeder seed (BS)	Seed production (t): Foundation seed (FS) + Certified seed (CS)	Seed to reach 20% adoption (t)	Seed production goal (t) Year 3	Key partners
Zone 5 (Karnataka)	680,000	Drought tolerant, foliar fungal disease resistant, short duration, high yield	High oil content, medium bold seed	ICGV 91114 Chintamani 2 ICGV 00350 R 2001-2 GPBD 5 GPBD 4[2]	10.0 (BS) 0.5 (BS) 0 0.95 (BS) 1.5 (BS) 80.0 (BS)	320	2550 FS	20,400	20,400	Production: BS by UAS-D, UAS-R, UAS-B; FS and CS by UAS-B, UAS-R, UAS-D, State Seed Corp., SFCI, State Department of Agriculture (DOA), Oilseed Growers Fed, Agribusiness Incubator (ABI), NGOs Distribution: State Seed Corp., SFCI, State DOA, Oilseed Growers Fed, NGOs
Zone 5 (Tamil Nadu)	320,000	High pod and haulm yield, drought and foliar fungal disease tolerant	High oil content, medium bold seed	ICGV 87846 ICGV 00351 TMV 7[2] TMV 13[2] VRI 2[2] VRI 3[2] Co G 4[2]	0 0 245.8 41.5 329.6 56.4 28.7	150	1200 FS	9, 600	9, 600	Production: BS by TNAU; FS and CS by State Seed Corp., SFCI, State DOA, Oilseed Growers Fed, Agribusiness Incubator (ABI), NGOs Distribution: State Seed Corp., SFCI, State DOA, Oilseed Growers Fed, NGOs
Zone 4 (Odisha, for both rainy and postrainy seasons)[4]	243, 000	High pod yield, drought and foliar fungal disease tolerant	High oil content	ICGV 91114 [3] TAG 24[2] Smruthi[2]	20.0 (BS) 15.0 (BS)	7	90	4, 860	730	Production: BS by OUAT; FS and CS by State Seed Corp., SFCI, State DOA, Oilseed Growers Fed, NGOs Distribution: State Seed Corp., SFCI, State DOA, Oilseed Growers Fed, NGOs
Bihar[5]	1650	High pod yield, drought and heat tolerant	Medium bold seed, high oil content	Yet to be identified although R 20 is popular locally	0	1	7	50	50	Production: BS by BAU; FS and CS by BAU, State Seed Corp., DOA Distribution: BAU, State Seed Corp.

1. Seed rate 150 kg pods per ha.
2. Improved variety released before inception of TL-II project.
3. FPV identified in a previous project supported by IFAD and released for cultivation as Devi.
4. More than 65% groundnut cultivated is in postrainy season.
5. Non-traditional area with potential for spring and rainy season cultivation similar to Zone 4.

Chickpea

Veera Jayalakshmi, Y Satish, DM Mannur, AG Vijayakumar, Rakesh D Ranjan, Dayanidhi Mishra, P Parthasarathy Rao, Pooran Gaur and CL Laxmipathi Gowda

Introduction

Chickpea is the most important pulse crop of India contributing to 40% of the country's pulse production. India is the largest producer (67% of the world production) and consumer of chickpea in the world. During 2007–09, annual average import of chickpea by India was 227,400 tons (valued at US$ 121.8 million) and export was 128,000 tons (valued at US$ 107.6 million). Chickpea is grown mainly in six states namely Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh, and together they account for more than 90% of the crop's area.

Chickpea is an important source of protein for millions of people who are vegetarian because of choice or economic reasons. The per capita availability of chickpea is 12 g per day (32 g per day for all pulses). Expansion of irrigation and wheat cultivation in northern India led to large shift in chickpea area from northern states (cooler long-season environments) to central and southern states (warmer short-season environments). Chickpea has higher levels of drought and heat tolerance as compared to several other cool season food legumes. It is largely grown under rainfed conditions; only one-third of the chickpea area is irrigated. It plays an important role in preventing soil degradation and improving soil fertility and enhancing system productivity.

Chickpea production and demand in India are given below.

National production: 6.76 million tons (average of 2007/08 to 2009/10)

National demand: 8 million tons

Area: 7.87 million ha (average of 2007/08 to 2009/10)

Average yield: 857 kg ha^{-1}

Proportion of production sold commercially: 20–50% by marginal to small farmers; 50 to 90% by medium to large farmers

Production target by 2015: 30% increase in production in the target regions

Agroecology

North Hill Zone (NHZ)

It includes western Himalayan regions of Jammu and Kashmir, Himachal Pradesh, Uttaranchal (except Tarai area), Sikkim and hills of West Bengal and Northeast states. The chickpea area (<5,000 ha) is negligible in this zone.

North West Plain Zone (NWPZ)

It includes Punjab, Haryana, Delhi, Rajasthan (except Kota and Udaipur divisions), Western Uttar Pradesh (except Jhansi division) and Tarai region of Uttaranchal. The major chickpea growing state in this zone is Rajasthan (0.88 million ha). Chickpea area in other states (Punjab, Haryana and Uttar Pradesh) has been largely replaced by wheat. Chickpea area in this zone is 0.98 million ha.

North East Plain Zone (NEPZ)

It includes Eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal, Orissa, Assam, Sikkim and the northeastern states. There is vast area of rice fallows in this zone that offers opportunity for expansion of chickpea area. Chickpea area in this zone is 0.29 million ha.

Central Zone (CZ)

It includes Madhya Pradesh, Maharashtra, Chhattisgarh, Gujarat, Jhansi division of Uttar Pradesh and Kota and Udaipur divisions of Rajasthan. This is the largest chickpea growing zone with an area of 5.28 million ha.

South Zone (SZ)

It includes Andhra Pradesh, Karnataka, Tamil Nadu and Kerala. Chickpea area is rapidly increasing in this zone and is currently 1.62 million ha.

Potential for expansion

Chickpea area and production in India are given in Table 1. The additional area will mainly come from expansion of chickpea area in rice fallows, other fallow lands mainly in NEPZ and SZ, and increasing awareness of crop diversification in all zones.

Table 1. Area and production of chickpea in 2009/10[1].

				Potential for expansion by 2020		
Zone	Area (million ha)	Production (million t)	Yield (kg ha^{-1})	Area (million ha)	Production (million t)	Yield (kg ha^{-1})
NWPZ	0.98	0.63	643	1.4	1.12	800
NEPZ	0.29	0.24	833	0.6	0.54	900
CZ	5.28	5.17	979	5.5	6.05	1100
SZ	1.62	1.42	877	2.0	2.4	1200
All India	8.17	7.46	913	9.5	10.11	1100

1. Source: Agricultural statistics at a glance 2011, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India (http://eands.dacnet.nic.in/latest_2006.htm).

Dominant chickpea varieties

The dominant varieties of chickpea are given in Table 2.

Table 2. Dominant chickpea in different agroecological zones of India.

Zone	Dominant varieties
NWPZ	Avrodhi, C 235, KPG 59, Radhey, RSG 888, Pratap Chana 1
NEPZ	JG 16, DCP 92-3
CZ	JG 74, JG 315, JG 130, JG 11, KAK 2, Vijay, Vardan, Vishal, Samrat,
SZ	JG 11, KAK 2, JAKI 9218, Vihar, Annigeri

Key constraints

Abiotic and biotic constraints

The abiotic and biotic constraints to chickpea production in India are given in Table 3.

Table 3. Abiotic and biotic constraints to chickpea production in different agroecological zones of India[1].

Constraint	NWPZ	NEPZ	CZ	SZ
Abiotic				
Terminal drought	***	***	***	***
High temperatures at reproductive stage	**	***	***	***
Low temperatures at reproductive stage	***	**		
Soil salinity	**			
Poor soils		**		
Biotic				
Fusarium wilt	***	***	***	***
Pod borer (*Helicoverpa armigera*)	***	***	***	***
Dry root rot	*	**	***	***
Collar rot	**	**	**	**
Ascochyta blight	**			
Botrytis gray mold	**			
Nematodes		**		
Weeds	**	**	*	*

1. Degree of severity: * = Low; ** = Medium; and *** = High.

Socioeconomic constraints

Farmers generally give high priority to staple cereals and vegetables as compared to food legumes. Chickpea is generally grown rainfed and largely on marginal lands. Use of low inputs by farmers, poor adoption of improved cultivars and production technologies are other reasons of low productivity of chickpea.

Organizational constraints

- Inadequate availability of quality seed
- Uncertainty in the quality and timely availability of fertilizers, fungicides and pesticides
- Difficulty in accessing credits by farmers
- Lack of policies to reduce fluctuations in market price and gaps between the farm-gate price and price paid by the consumers

Strategies for TL-II target states

Andhra Pradesh

Chickpea is the most important pulse crop of Andhra Pradesh occupying an area of 614,000 ha with a production of 708,000 tons and a productivity of 1298 kg ha^{-1}. There was dramatic increase in chickpea area in Andhra Pradesh since 1997/98 (147,000 ha with production of 59,000 tons and 398 kg ha^{-1}) and the area touched 647,000 ha during 2009/10. The typical growing environment of Andhra Pradesh is characterized by short growing season and mild winter. The most important chickpea growing districts in Andhra Pradesh are Kurnool, Prakasam, Kadapa and Ananthapur. The realized productivity in Andhra Pradesh is the highest in India. This could be achieved through the adoption of improved cultivars and production technologies and mechanization of agricultural operations. The most important varieties grown by the farmers are JG 11, JAKI 9218, KAK 2 and Vihar. The current major constraints to chickpea production include frequent dry spells, dry root rot, *Helicoverpa* pod borer and *Spodoptera exigua.*

Suggested strategies for increasing chickpea production

- Promotion of varieties with higher and stable yields under drought situations.
- Development of tall and upright growing varieties which can be harvested mechanically.
- Management of *Helicoverpa* pod borer by improving host-plant resistance and integrated pest management (IPM) technologies.
- Promotion of kabuli varieties like Vihar and extra-large-seeded kabuli varieties like MNK 1 which help farmers to realize higher net returns.
- Creating awareness among farmers about improved varieties and increasing the efficiency of seed systems for promoting the adoption of improved varieties.
- Promoting the spread of improved varieties and production technologies by involving public agencies, NGOs, women self-help groups (SHGs) and farmer groups.
- Promotion of improved cultivars and production technologies in Guntur, Adilabad, Medak, Rangareddy and other potential districts.
- Promotion of chickpea under rice fallows.
- Study of value chain to realize profitable price for the farmers.

Karnataka

The area under chickpea is steadily increasing in Karnataka since 2007/08. During postrainy season 2010 the area under chickpea was 960,000 ha with a production of 640,000 tons. The average productivity is 723 kg ha^{-1}. The districts of north Karnataka occupy 85% of area and contribute to approximately 90% of the production of chickpea in the state. The popular varieties of the region are JG 11, JAKI 9218, BGD 103, MNK 1 and the local variety Annigeri.

Suggested strategies for increasing chickpea production

- Development of extra-early genotypes for cultivation in shallow and poor soils.
- Development of varieties tolerant to terminal drought and heat stresses.
- Development of varieties responsive to high management practices.

- Development of tall, semi-erect and non-lodging varieties suitable for mechanical harvesting.
- Expansion of chickpea area under rice fallows.
- Popularization of new and improved varieties identified in different ecological niches.
- Strengthening of informal seed system by establishing seed banks at community level by involving progressive farmer groups, NGOs and women SHGs.

Odisha

Chickpea is an important postrainy season pulse crop of the state occupying an area of 45,000 ha in the cropping system of rice–chickpea. Though chickpea is grown in about 30 districts, large areas are in remote and tribal dominated districts like Kalahandi, Mayurbhanj, Keonjhar, Nawapara and Nawarangpur. The productivity of the state is 748 kg ha^{-1} (2009/10). The trend analysis for five years (2005/06 to 2009/10) indicates that there is an increase in area by 5% from 2005/06 to 2008/09 and record growth during 2009/10 (20%) over its previous year. Similarly, the productivity has increased by 1% from 2005/06 to 2008/09 with a record growth of 13% during 2009/10 over the previous year.

The current major constraints to chickpea production include non-availability of quality seeds, small and marginal farmers with scattered landholdings, lack of knowledge on improved package of practices, poor market linkages and lack of life saving irrigation facilities during stress periods.

Suggested strategies for increasing chickpea production

- Generate awareness among the farmers by different activities [farmer participatory variety selection (FPVS) trials, demonstrations, field days, farmers' fairs, etc] on improved cultivars and production technologies.
- Strengthening of formal and informal seed systems with emphasis on seed production at the village level.
- Development of proper sowing technologies for rainfed conditions with emphasis on biotic stresses.
- Development of heat tolerant varieties suitable for different agroclimatic zones of the state.
- Development of high-yielding farmer- and consumer-preferred varieties.
- Capacity building of the tribal farmers.
- Supportive policies for price and marketing.

Bihar

Chickpea is an important pulse crop of Bihar, cultivated on an area of 65,000 ha with a total production of 77,000 tons and productivity of 1182 kg ha^{-1}. Chickpea area is mainly concentrated in South Gangetic Plains, which has sandy loam to clay loam soils and an average annual rainfall of 1100 mm. The top 10 chickpea growing districts of Bihar are Patna, Aurangabad, Bhojpur, Bhabhua, Rohtas, Nalanda, Banka, Gaya, Lakhisarai and Bhagalpur. All these districts are under South Gangetic Plains. The most common cropping systems in this zone include rice/maize (rainy season)–wheat/maize (postrainy season)–onion/mungbean (summer) in the irrigated conditions and rice/maize (rainy season)–chickpea/lentil/groundnut/pigeonpea/oilseeds (postrainy season) in the rainfed conditions.

The constraints to chickpea production include drought and heat stresses, pod borer, low and unstable yields as compared to wheat in irrigated conditions, lack of suitable technologies for good crop establishment in rice fallows, and inadequate availability of quality seed.

Suggested strategies for increasing chickpea production

- Development of drought and heat tolerant cultivars.
- Development of high input responsive cultivars.
- Incorporation of resistance to biotic stresses.
- Development of extra-large-seeded kabuli varieties.
- Refinement of crop production practices for growing chickpea in rice fallows.
- Enhancing adoption of improved cultivars and production technologies.
- Ensuring availability of quality seed at the local level.
- Bringing additional area under chickpea cultivation by promotion of short-duration, heat tolerant varieties under rice fallows and new niches.

Key partners

The key partners along the value chain and their role are given below.

- ICRISAT: Generation and supply of improved germplasm to NARS partners; development and application of molecular tools in crop improvement; development and promotion of integrated crop management (ICM) technologies; capacity enhancement of NARS; international networking in research and development; facilitating NARS in dissemination of improved cultivars and production technologies.
- Indian Council of Agricultural Research (ICAR) and its institutes, such as Indian Institute of Pulses Research (IIPR), Indian Agricultural Research Institute (IARI), and All India Coordinated Research Project (AICRP) on Chickpea: Development of regionally adapted cultivars and production technologies; coordinating research and evaluation of cultivars and technologies in India; transfer of technology.
- State Agricultural Universities: Development of regionally adapted cultivars and production technologies; transfer of technology.
- State Agriculture Departments and NGOs: Transfer of technology
- National and State Seed Corporations: Seed production

Capacity building needs

Training of NARS partners is needed on hybridization, selection, and novel breeding methods, such as marker-assisted backcrossing (MABC) and marker-assisted recurrent selection (MARS) and use of electronic field books, pedigree and data management system. Attention will be given to include women scientists/staff.

Special cultural/gender considerations

Women farmers play an important role in chickpea cultivation in India. Efforts will be made to ensure involvement of women farmers in participatory varietal selection (PVS), field days, farmers' fairs and various training programs. Roles of men and women in cultivation, processing and marketing will be identified. Constraints faced by and needs of women in relation to the tasks/roles they perform will be considered. Training programs will be tailored to cater the needs of women.

Processing and storage requirements and market opportunities

Seed processing and storage facilities are needed to be strengthened for farmers or farmers' groups/ societies involved in seed production. Attention will be given to women's groups.

Over 60% of chickpea is consumed as splits (dal) and flour (*besan*). Consequently the processing of chickpea is an important step in the marketing chain. The marketing channel for chickpea and its processed products is marked by a few important bottlenecks.

- A majority of the harvested produce is sold to the village traders owing to prior input-credit contracts. The market price that the farmers get in this situation is typically lower than the price in the market yard. Grading facilities are typically absent or not implemented depriving the farmers of a fair price.
- There are additional links in the value chain between chickpea farmers and dal processors that further erode the farmer's share in the consumers' rupee. Dal processors prefer to buy whole grain in bulk in order to cut down on their transaction costs. However, since a lot of the chickpea farmers are small-scale farmers with small marketable surpluses, a commission agent who collects all the grains from the farmers, and sells it to the dal millers in bulk quantity becomes an important actor in the value chain.

Key policies

Policies recently implemented

The Ministry of Agriculture, Government of India (GOI) made efforts on enhancing production of pulses in India through Integrated Scheme of Oilseeds, Pulses, Oil palm and Maize (ISOPOM). Under this scheme, new technologies, timely supply of inputs, extension support, remunerative price, marketing infrastructure and postharvest technologies were provided for increasing pulses production including chickpeas. In 2008, the Project was implemented in 437 districts in 14 states spread across the country.

In 2007, under the nationally sponsored National Food Security Mission, sustainable production for pulses (chickpeas) were being targeted in 168 districts in 14 major pulse producing states as part of a special project called the Accelerated Pulse Production Program (A3P). The program includes quality seed production, integrated nutrient management, IPM, distribution of sprinkler sets, strengthening infrastructure, and training and extension services.

The GOI announces Minimum Support Price (MSP) for several crops including pulses as a floor price for procurement by government agencies. In a bid to improve acreage under pulses, the MSP for chickpea has been hiked steadily over the years with a big push in 2010/11 when the MSP increased by 20% over 2009/10 from ₹17,600 to 21,000 per ton. Despite this, by and large during the last several years the MSP for pulses (chickpea) has remained lower than the market prices.

Pulses imports were placed under Open General License (OGL) in 1979, allowing any public or private sector player to import into India without approval or restriction. With the elimination of import duties since 2000, imports of pulses to India have risen from 350,000 tons in 2000/01 to 1.7 million tons in 2005/06. In 2009/10 India imported 3.6 million tons of pulses of which chickpeas constituted around 10%.

In 2008 the GOI had launched the sale of subsidized pulses in Fair Price Shops (FPS) after a steep rise in prices caused consumer distress. The scheme required state governments to import pulses through state-run agencies and sell them through FPS and state cooperative dairies. The Government gave a fixed subsidy of ₹10 per kg, which enabled eligible consumers to buy pulses at a price lower than those prevailing in the market.

Policies needed

The following policies are needed: for recognition of FPVS data for release of varieties; to support seed production of legumes by informal seed systems; to promote inclusion of legumes for crop diversification in cereal dominated cropping systems (eg, rice–wheat in northern India); for better targeted food subsidy that increases access to chickpea through sale in FPS to below poverty line (BPL) families thus enhancing their nutritional security.

Key issues for competitiveness

- Varieties with higher and stable yields for increased production
- Varieties suitable for mechanical harvesting for reducing production cost
- Varieties with market-preferred seed traits (size, shape and color) to ensure higher market value
- IPM for management of pod borer to reduce use of pesticides
- Increasing the availability of quality seed at the local level and at affordable price

Mechanization needs

- Promote tall and erect varieties which can be harvested mechanically
- Organize marginal and small farmers in farmers' groups/societies/communities and provide them tractors, cultivators, seed drills, harvesters and other farm equipment at community level
- Develop pod shellers to meet the potential need of green immature seeds in supermarkets
- Develop/identify women friendly equipment and herbicide tolerant cultivars to decrease drudgery (eg, hand weeding)
- Explore avenues where possible to train women on use of other equipment

Environmental/sustainability issues

- Promote IPM practices which are eco-friendly and affordable by the farmers
- Enhance crop diversification for ensuring sustainability of the cropping system

Possible interventions to increase production and productivity

These are: development of improved germplasm with enhanced resistance/tolerance to abiotic and biotic stresses, phenology and plant type required for existing and evolving cropping systems, and seed quality preferred by the enhancement market using conventional and modern breeding approaches; and enhancement of adoption of improved varieties and improved management practices by conducting PVS trials, through various activities for knowledge empowerment of farmers and by strengthening informal and formal seed systems.

Institutional and technical innovations required

- Establishing linkages between informal and formal seed systems.

- Evaluation of improved lines developed through MABC and MARS for developing drought tolerant varieties.

Monitoring and evaluation

These will include annual in-country review and planning meeting, monitoring visits during the cropping season and farmer–scientist interaction meeting to assess impact. Gender disaggregated data and gender sensitive indicators will be included.

Seed production plan

Chickpea seed production plan is given in Table 4.

Table 4. Chickpea seed roadmap for India[1].

Ecology	Demand (ha)	Variety characteristics: Productivity (t ha^{-1})	Variety characteristics: Type	Promising varieties	Seed currently available (Breeder + Foundation) (t)	Seed production (t): Breeder seed	Seed production (t): Foundation + Certified seed	Seed to reach 30% adoption (t)	Seed production goal (t): Year 1 (2012)	Seed production goal (t): Year 2 (2013)	Seed production goal (t): Year 3 (2014)	Key partners (Seed production and distribution)
Rainfed	960,000	2.5	Desi	JG 11	3000	201.6	19958.4	20160.0	4032.0	6048.0	10080.0	RARS-Nandyal, ARS-Gulbarga, UAS-Raichur, UAS-Dharwad, BAU-Sabour, NSC, SFCI, APSSDC and KSSC
Rainfed	400,000	2.5	Desi	JAKI 9218	1540	94.1	9313.9	9408.0	1881.6	2520.0	4200.0	
Rainfed	160,000	2.0	Kabuli	KAK 2	800	48.0	4752.0	4800.0	960.0	1440.0	2400.0	
Rainfed	48,000	1.5	Kabuli	MNK 1	68	5.8	570.2	576.0	115.2	302.4	504.0	
Rainfed	30,000	2.0	Desi	BGD 103	15	3.4	332.6	336.0	67.2	324.0	540.0	
Rainfed	15,000	2.0	Desi	Pusa 256	2.8	31.5	283.5	315.0	63.0	94.5	157.5	BAU-Sabour, NSC, SFCI and BSSC
Rainfed	10,000	2.0	Desi	Pusa 362	2.2	21.0	189.0	210.0	42.0	63.0	105.0	BAU-Sabour, NSC, SFCI and BSSC
Rainfed	12,000	2.0	Desi	Pant G 186	2	25.2	226.8	252.0	50.4	75.6	126.0	BAU-Sabour, NSC, SFCI and BSSC

1. Seeding rate 70 to 120 kg ha^{-1} (depending on seed size).

Pigeonpea

C Sudhakar, Ravi Gopal Singh, PK Sahu, KB Saxena, MG Mula and CV Sameer Kumar

Economic importance of pigeonpea in India

India is the largest producer of pigeonpea in the world and contributes around 80% of the world's total production. In 2009/10, pigeonpea consumption for urban areas was 0.26 kg per month while it was 0.16 kg per month in rural areas. Production in India is not sufficient to support the domestic needs and resulted in the rising prices to nearly 250% in the last couple of years and the need to import about 500,000 tons of pigeonpea yearly from Myanmar and Southeastern Africa.

Pigeonpea is mainly consumed as dry split seed (dhal) and to a lesser extent as green vegetable in certain areas. It is an excellent source of protein (20–22%), supplementing energy rich cereal diets in a mainly vegetarian population. Pigeonpea is a multi-purpose crop that fits very well in the context of sustainable agriculture. In addition to food, it is used as fodder, feed, fuel, functional utility (for making baskets, huts, fences, etc), fertilizer (fixes atmospheric nitrogen and releases phosphorus), forest use (re-forestation, lac production), and even for pharmaceutical purposes.

Pigeonpea is often planted in marginal environments and under rainfed (96%) conditions. It is drought tolerant; its root system allows optimum utilization of soil moisture and nutrients. Pigeonpea is known to improve the soil structure and fertility, and consequently, ensures better growth of the succeeding crops. It is estimated that pigeonpea has a beneficial effect on subsequent crops equivalent to about 40 kg N ha^{-1}. The traditional pigeonpea cultivars are medium to long duration, with maturity ranging from 150 to 280 days, and are typically grown as an intercrop with relatively shorter duration crops including sorghum, maize, millets, cotton, groundnut, soybean, etc.

Development of high-yielding disease resistant varieties has helped in increasing pigeonpea area and thereby production from 1.7 million tons in 1950/51 to over 3.19 million tons in 2009/10. However, productivity has remained at around 700 kg ha^{-1} and increase in productivity is yet to be witnessed. Recently, attempts have been made to increase pigeonpea productivity through breeding high-yielding disease resistant varieties and hybrids.

Seed production target

National production: 2.63 million tons (average of 2007/09)

National demand: 3.13 million tons

Area: 3.55 million ha (average of 2007/09)

Proportion of production sold commercially: 60–75%

Average yield: 742.48 kg ha^{-1}

National projected demand for 2020: 5 million tons

Expected growth of production: 2%

Target average yield for 2015: Andhra Pradesh and Odisha – 1,000 kg ha^{-1}; Bihar – 1,300 kg ha^{-1}

Agroecology

Data on pigeonpea production is given in Table 1.

North Hill Zone (NHZ)

This includes western Himalayan regions of Jammu and Kashmir, Himachal Pradesh, Uttaranchal (except Tarai area), Sikkim and hills of West Bengal and North East States. The pigeonpea area is negligible (<5,000 ha) in this zone.

North West Plain Zone (NWPZ)

This includes Punjab, Haryana, Delhi, Rajasthan (except Kota and Udaipur divisions), Western Uttar Pradesh (except Jhansi division), and Tarai region of Uttaranchal.

North East Plain Zone (NEPZ)

This includes Eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal, Odisha, Assam, Sikkim and plains of far eastern states.

Central Zone (CZ)

This includes Madhya Pradesh, Maharashtra, Chhattisgarh, Gujarat, Jhansi division of Uttar Pradesh and Kota and Udaipur divisions of Rajasthan.

South Zone (SZ)

This includes Andhra Pradesh, Karnataka, Tamil Nadu and Kerala.

Table 1. Area and production of pigeonpea in different agroecological zones of India during 2005 to 2007[1].

Zone	State/District	Area ('000 ha)	Production ('000 t)	Yield (kg ha^{-1})
NEPZ		480	440	917
	Bihar	35	40	1125
	Bhagalpur	0.8	1.375	1758
	Banka	0.6	1.071	1859
	Odisha	133	111	841
	Dhenkanal	3.07	2.69	875
	Angul	9.65	8.59	890
	Naupada	5.5	4.12	750
CZ		1800	1400	778
SZ		1100	650	591
	Andhra Pradesh	450	207	460
	Ranga Reddy	35	35	1000
	Mahaboobnagar	80	36	450
NWPZ		160	160	1000
All India		3540	2700	750

1. Source: DES (Directorate of Economics and Statistics), Department of Agriculture and Cooperation, Ministry of Agriculture, various years. Government of India, New Delhi.

Dominant varieties by ecology

NEPZ: UPAS 120 (early maturity); Bihar – Bahar, Bada, Pusa-9, Patam; Odisha – Kandula

CZ: Asha, Maruti, Laksmi, BSMR-736, LRG-30, PRG-100, BDN-2, PRG 158 (medium maturity)

SZ: Asha, Maruti, Laksmi, BSMR-736, LRG-30, PRG-100, BDN-2, PRG 158 (medium maturity); Andhra Pradesh – Asha, Maruti, Laksmi, LRG 30, LRG 41, PRG 100, PRG 158

NWPZ: Manak

Key constraints

Abiotic and biotic constraints

The abiotic and biotic constraints to pigeonpea production are given in Tables 2 and 3.

Table 2. Abiotic and biotic constraints to pigeonpea production in different agroecological zones in India[1].

Constraint	NWPZ	NEPZ	CZ	SZ
Abiotic				
Terminal drought	**	**	***	***
Soil salinity	**	*		
Waterlogging	**	**		
Biotic				
Fusarium wilt		***	***	***
Sterility mosaic		***	***	***
Pod borers (*Helicoverpa* and *Maruca*)	***	***	***	***
Dry root rot			*	*
Pod fly/pod bugs	**	***	*	*
Nematodes			*	*
Phytophthora blight	**	**	*	*
Storage pests	**	**	**	**
Alternaria leaf spot		**		
Weeds	**	**	**	**

1. Degree of severity: * = Low; ** = Medium; and *** = High.

Socioeconomic constraints

India continues to struggle with the problem of poverty that is largely dependent on low productivity of rainfed agriculture. Constraints to pigeonpea production are not solely biophysical, but also influenced by various socioeconomic factors such as efficient markets and their links with producers, availability of quality seeds, timely availability of inputs, small farm holdings, value addition, credit and availability of labor.

Organizational constraints

Land shortage and land tenure (government owned) restricts private investment in land management (such as soil and water conservation), leading to land degradation. Some organizational constraints are listed.

Table 3. Abiotic and biotic constraints to pigeonpea production in three states of India[1].

	NEPZ		SZ
Constraint	Bihar	Odisha	Andhra Pradesh
Abiotic			
Terminal drought	*	***	***
Waterlogging	*		
Biotic			
Fusarium wilt	***	***	***
Sterility mosaic	***	***	***
Pod borers (*Helicoverpa* and *Maruca*)	***	***	***
Dry root rot		*	*
Pod fly/pod bugs	***	*	*
Nematodes		*	*
Phytophthora blight	**	*	*
Storage pests	**	**	**
Alternaria leaf spot	**		
Weeds	**	**	**

1. Degree of severity: * = Low; ** = Medium; and *** = High.

- High poverty level
  - Poor investment in labor and inputs such as quality seed, fertilizers and insecticides
  - Difficulty to access medium- and long-term credit and poor loan recovery
- Marketing in domestic and international markets
  - Limited volume of domestic production and huge domestic demand
  - Lack of value addition facilities
  - Lack of infrastructure facilities (ie, postharvest facilities, improved farm to market roads)
  - Lack of market information and grading facilities
  - High commission of brokers and middlemen
  - High transportation cost

Key partners along the value chain (across zones)

Partners from the public and private sector play key roles in research and development efforts (Table 4). They cooperate in joint evaluation and selection programs, promotion, production and distribution of breeder and certified seeds of promising varieties and hybrids. They also contribute knowledge and skills to educate and train farmers, technicians, scientists and students in theoretical and practical aspects of breeding, genetics, seed systems, etc. They also assist in monitoring, evaluation and impact assessment of the technologies developed and shared (CMS hybrid system, new varieties, improved seed systems).

Table 4. Key partners and their role in the seed system.

Partner	Role
ICAR (Indian Council of Agricultural Research), State Agricultural Universities	Variety development, evaluation and release; production of breeder and foundation seeds
ICRISAT	Provide improved germplasm/breeding populations; capacity building through training; research on effective methods for technology dissemination
NSC (National Seed Corporation) and SSC (State Seed Corporations)	Seed systems support; production of certified seed and distribution of quality seed
Department of Agriculture	Seed systems support and distribution of quality seeds and technology transfer
NGO/CSO initiatives	Production and distribution of quality seeds and technology transfer
Private sector (market intermediaries and emerging small-scale seed enterprises and processors)	Processing and commercialization of seed and products
Farmers	End-users of technologies in terms of high-yielding varieties, management practices

Capacity building needs

- Training programs for NARS in pigeonpea breeding, genetics, seed production, integrated pest management (IPM) and crop production technologies. Attention will be given to include women.
- Create farmer friendly literature.
- Promotion of hybrid technology.
- Improvement of seed system at farmers' level. Women's seed systems and networks will be targeted.
- Training in data management to include women.
- Modernization of field equipment and identifying friendly technology for women to reduce drudgery in milling and harvesting.

Processing and storage requirements and market opportunities

For pigeonpea, the traditional private marketing channel is the most prevalent. Typically, the farmers sell grain directly to the traders in the agriculture produce market yards or to village traders who are also popular. Imported pigeonpea is channeled through agencies, such as the State Trading Corporation (STC), Minerals and Metals Trading Corporation (MMTC) and Project and Equipment Corporation (PEC), to private wholesalers or processors. Importers who are licensed to import pulses sell the consignment directly to secondary wholesalers or processors through middlemen. The major portion of the processed pulses from processors goes to secondary wholesalers, and is then sold to consumers through retailers. The processing and storage requirements and market opportunities are:

- At present processing and storage at village level are lacking and it needs to be established with the help of NARS/NGOs.
- Enhance yield levels through hybrids.
- Availability of varieties with farmer and market preferred traits such as color, uniformity of grain size, recovery rate, cooking time, taste, storability, etc.

- Diversification of crop to non-traditional areas both under limited as well as high input conditions. This can be achieved through development of varieties and hybrids belonging to short-, medium- and long-duration groups.
- Linkages with markets are essential.

Key policies (recently implemented/needed)

In order to improve pulses production, the Government of India (GoI) launched a program called the Integrated Scheme of Oilseeds, Pulses, Oil palm, and Maize (ISOPOM). Under this scheme, new technologies, timely supply of inputs, extension support, remunerative price, marketing infrastructure and postharvest technologies were provided for increasing pulses (pigeonpea) production. In 2008, the Project was implemented in 437 districts in 14 states spread across the country. In 2007, under the nationally sponsored National Food Security Mission, sustainable production for pulses was being targeted in 168 districts in 14 major pulse producing states as part of a special project called A3P (Accelerated Pulse Production Program). The program includes quality seed production, integrated nutrient management, IPM, distribution of sprinkler sets, strengthening infrastructure, and training and extension services.

The GoI announces Minimum Support Price (MSP) for several crops including pulses as a floor price for procurement by government agencies. In a bid to improve acreage under pigeonpea, its MSP has been hiked steadily over the years with a big push in 2010/11 when the MSP was increased to ₹30,000 per ton, ie, 30% increase over 2009/10 prices. Despite this, by and large during the last several years the MSP for pigeonpea has remained lower than its market prices.

Pulses imports were placed under Open General License (OGL) in 1979, allowing any public or private sector player to import into India without approval or restriction. With the elimination of import duties since 2000, imports of pulses to India have raised from 350,000 tons in 2000/01 to 3.6 million tons in 2009/10. Pigeonpea imports constitute about 10–15% of total pulse imports.

In 2008 the GOI had launched the sale of subsidized pulses in Fair Price Shops (FPS) after a steep rise in prices caused consumer distress. The scheme required state governments to import pulses through state-run agencies like STC, PEC, MMTC and NAFED and sell them through FPS and state cooperative dairies. The Government gave a fixed subsidy of ₹10 per kg, which enabled eligible consumers to buy pulses at a price lower than those prevailing in the market. The scheme was discontinued from March 2012 after a report from the Comptroller and Auditor General's office pointed out that importing agencies suffered a loss of ₹1,201 crore on import and sale of pulses between 2006 and 2011 without succeeding in price stabilization in the market.

Key issues for competitiveness

- Introduction of integrated pest and disease management to reduce input costs; efficient and effective seed system; organized marketing to demand good prices; widespread introduction of farmer- and market-preferred varieties; product delivery as per domestic, regional and international market demands to fetch high prices.
- The lack of competitiveness of pigeonpea relative to competing crops or companion crops in the intercropping system is an important constraint, especially under irrigated conditions. Joshi et al. (2000) estimated that if pigeonpea were to replace rice, farmers would have to sacrifice 49% profit and 76% rice production. However, under rainfed conditions, pigeonpea can grow on low moisture with minimal or no fertilizer application. Therefore promoting pigeonpea in rainfed growing domains would increase production.

- Increased adoption of high-yielding varieties that are suited to the agroecologies where pigeonpea is grown with special reference to drought tolerance to reduce the unit cost of production.
- Better management practices (pre- and postharvest) to reduce pest and disease incidence.
- Improvement in efficiency of seed system to ensure that high-yielding varieties of pigeonpea are available and of good quality.
- Stringent seed certification requirements and accompanying bureaucratic hassles discourage farmers' participation in the formal seed system.

Mechanization as it relates to timely planting/harvesting and processing

Indian farmers use mechanical as well as traditional plow for land preparation; it depends on the landholding of farmers. Transportation is done using bullock carts, while threshing is done manually. Sometimes harvested produce is placed on the main road for vehicles to pass over it – but this is detrimental to the quality of the grain. The majority of Indian farmers still use bullocks for sowing because of lack of affordable tractor-drawn implements for small-scale farmers. To enhance commercialization of pigeonpea, it is important to introduce pre- and postharvest machineries such as irrigation pumps, light tractors, planters, tractor-mounted sprayers, harvesters and threshers.

Gender considerations

Women represent 80% of the workforce involved in agriculture in India. Men tend to move into higher income jobs and thus women have the responsibility of handling farm labor from planting to harvesting. Feminization of agriculture in India is a reality. Despite this, women only receive 2–10% of extension support (Source: FAO). Women have been traditionally discriminated in terms of access to inputs such as land, credit and agricultural technologies. Thus efforts, both political and socioeconomical are needed to empower women in India.

Grain legumes (pigeonpea included) are 'pro-gender crops'. Women and children (the most vulnerable groups nutritionally) will be the primary clients of nutritionally improved legumes. Women play a critical role in any nutrition education component, both for their own health, and their role as 'care givers' and homemakers.

In terms of seed storage options, women are in the forefront of adaptive research and they often make the hard decision of what to use for seed, and what to use as food to feed their children. This may be important especially for decentralized seed enterprises. Seed production and delivery approaches and tools that capture priorities, from both male and female participants, as well as giving them equal opportunities for participation, will be emphasized.

Women are also more involved in small-scale processing and food preparation for home use or local sale, so the introduction of simple processing technologies can directly benefit them and the households. It is expected that the increased and focused participation of women in the value chain could increase their involvement in higher level economic activities like marketing, managing end-product enterprises and decision-making.

It is also proposed that the participatory monitoring and evaluation system in each center be guided by a performance measurement framework that integrates local and gender specific indicators for monitoring project outcomes.

Environmental/sustainability issues

- To overcome the problem of early season drought, the varieties should have flexible adaptation.
- Crop protection options to suit variable climatic conditions.
- Quality seeds are of primary importance and high priority should be given by public/private sector.
- Losses due to drought and waterlogging are significant in some areas; therefore research has to be initiated in these areas.
- Awareness program should be strengthened.
- Capacity building for diffusion of improved crop production technologies is needed to improve livelihood through increased yields from the crop.

Monitoring and evaluation

- Monitoring visits during the cropping season
- Farmer–scientist interactions during project monitoring
- Annual in-country review and planning meetings
- Regional planning and reporting workshops
- Early adoption and diffusion studies
- Gender disaggregated focus group discussions
- Feeding the yearly monitoring and evaluation findings back into the research cycle

Strategies for the target states

Andhra Pradesh

- The productivity of pigeonpea has been static and low over decades.
- Enhance production and productivity through promotion of hybrids and improved seed systems.
- Expansion in non-traditional areas.

Bihar and Odisha

- Identification of varieties for different agroecologies
- Identification of variety/hybrid for new ecological niches (rice bunds, rice fallows)
- Relevant backup research for enhancement of productivity, quality and adaptation
- Refinement and genetic improvement of local variety *Patam*
- Developing a weed management module for rainy and postrainy seasons

Seed production plan

Pigeonpea seed production plan is given in Table 5.

Table 5. Seed roadmap for pigeonpea in India[1].

Ecology	Demand (ha)	Variety characteristics: Yield (t ha^{-1})	Variety characteristics: Special traits	Promising varieties	Seed currently available (Breeder + Foundation) (kg)	Seed production: Breeder seed (kg)	Seed production: Foundation + Certified seed (t)	Seed to reach 30% adoption (t)	Seed production goal (t): Year 1 (2012)	Seed production goal (t): Year 2 (2013)	Seed production goal (t): Year 3 (2014)	Key partners (Seed production and distribution)
Rainfed North Eastern Plain Zone (Odisha and Bihar)	170,000	2.5	Drought tolerant, early and medium duration and disease resistant	Asha, Maruti, Kamica, ICPL 88039, ICPH 2671	50	200	10	510	300	400	550	ICRISAT, SAUs, SSDC, Farmer seed growers, NGOs, private seed companies
Rainfed Southern Zone (Andhra Pradesh)	500,000	2.5 to 3	Drought tolerant, early and medium duration and disease resistant	Asha, Maruti, PRG 158, ICPH 2740	200	600	30	1500	1100	1300	1500	

1. Seeding rate: 10 kg ha^{-1}.

Partners

BILL & MELINDA GATES foundation

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

IITA
Research to Nourish Africa

About ICRISAT

ICRISAT
Science with a human face

International Crops Research Institute for the Semi-Arid Tropics

CGIAR
ICRISAT is a member of the CGIAR Consortium

The **International Crops Research Institute for the Semi-Arid Tropics** (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics have over 2 billion people, of whom 644 million are the poorest of the poor. ICRISAT innovations help the dryland poor move from poverty to prosperity by harnessing markets while managing risks – a strategy called Inclusive Market-Oriented Development (IMOD).

ICRISAT is headquartered in Patancheru near Hyderabad, Andhra Pradesh, India, with two regional hubs and five country offices in sub-Saharan Africa. It is a member of the CGIAR Consortium. CGIAR is a global research partnership for a food secure future.

ICRISAT-Patancheru (Headquarters)
Patancheru 502 324
Andhra Pradesh, India
Tel +91 40 30713071
Fax +91 40 30713074
icrisat@cgiar.org

ICRISAT-Liaison Office
CG Centers Block, NASC Complex,
Dev Prakash Shastri Marg, New Delhi 110 012, India
Tel +91 11 32472306 to 08
Fax +91 11 25841294

ICRISAT-Addis Ababa
C/o ILRI Campus, PO Box 5689
Addis Ababa, Ethiopia
Tel: +251-11 617 2541
Fax: +251-11 646 1252/646 4645

ICRISAT-Bamako (Regional hub WCA)
BP 320, Bamako, Mali
Tel +223 20 709200, Fax+223 20 709201
icrisat-w-mali@cgiar.org

ICRISAT-Bulawayo
Matopos Research Station
PO Box 776, Bulawayo, Zimbabwe
Tel +263 383 311 to 15, Fax +263 383 307
icrisatzw@cgiar.org

ICRISAT- Kano
PMB 3491
Sabo Bakin Zuwo Road, Tarauni, Kano, Nigeria
Tel: +234 7034889836; +234 8054320384,
+234 8033556795
icrisat-kano@cgiar.org

ICRISAT-Lilongwe
Chitedze Agricultural Research Station
PO Box 1096, Lilongwe, Malawi
Tel +265 1 707297, 071, 067, 057, Fax +265 1 707298
icrisat-malawi@cgiar.org

ICRISAT-Maputo
C/o IIAM, Av. das FPLM No 2698
Caixa Postal 1906, Maputo, Mozambique
Tel +258 21 461657, Fax+258 21 461581
icrisatmoz@panintra.com

ICRISAT-Nairobi (Regional hub ESA)
PO Box 39063, Nairobi, Kenya
Tel +254 20 7224550, Fax +254 20 7224001
icrisat-nairobi@cgiar.org

ICRISAT-Niamey
BP 12404, Niamey, Niger (Via Paris)
Tel +227 20722529, 20722725
Fax +227 20734329
icrisatsc@cgiar.org

About ICRISAT: **www.icrisat.org** ICRISAT's scientific information: **http://EXPLOREit.icrisat.org**

ISBN 978-92-9066-559-5 Order code: BOE 062 401-2013