CROP PROTECTION PROGRAMME

Building on strengths towards sustainable management of sterility mosaic disease for enhanced pigeonpea production in the Indian Subcontinent

R8481 (ZA0692)

FINAL TECHNICAL REPORT

1 April 2005 – 31 January 2006

Farid Waliyar

International Crops Research Institute for the Semi-Arid Tropics
Patancheru 502 324, Andhra Pradesh, India

Date FTR completed: 24 February 2006

"This publication is an output from a research project funded by the United Kingdom Department for International Development for the benefit of developing countries. The views expressed are not necessarily those of DFID."
R8481, Crop Protection Programme

Executive Summary

Pigeonpea (*Cajanus cajan*) is a major pulse crop mainly cultivated in the Indian subcontinent. It plays an important role in the livelihoods of resource poor smallholder farmers. Sterility mosaic disease (SMD), caused by Pigeonpea sterility mosaic virus (PPSMV) transmitted by an eriophyid mite, *Aceria cajani*, is a major disease limiting pigeonpea production in the subcontinent. SMD aborts flower production and renders plants sterile. The disease is responsible for annual grain loss of worth >US$ 300 million in the subcontinent. Through CPP-DFID funded projects (R6407(H), R7452 and R8205), vital breakthroughs were made which led to the understanding of SMD etiology and paved a way to select suitable resistant sources. This phase promoted strategies derived from previous CPP projects to alleviate pigeonpea losses due to SMD for attaining yield stability and increased productivity in the semi-arid cropping systems of the Indian subcontinent.

The project outputs contributed to the identification of 12 new sources of SMD resistance (ICP14404, 16166, 11719, 16169, 14478, 16165, 14834, 11632, 95029, 14399, 16294, 16293) in 100-140 days maturity. Early maturing varieties escape terminal drought stress, a frequent problem in central India. Evaluation of pigeonpea core collection led to the identification of 13 new SMD resistant sources (ICP 7869, 14120, 14155, 14368, 11910, 14229, 14569, 14147, 14545, 11833, 14471, 6123 and 15185). These genotypes will be further evaluated and utilized in breeding and will also be released for farmer cultivation. SMD resistant variety ICP 7035 was released in Zone-5 region of Karnataka state; and ICP 7035 and ICPL 96058 were released by a private seed company for marketing in South India.

Promising SMD resistant varieties were promoted for farmer cultivation in SMD endemic areas of Andhra Pradesh and Karnataka states, through frontline demonstration trials in over 25 locations through NGOs, Agricultural Universities, Agriculture Research Stations, and ICAR Centres. Twenty-five on-farm and on-station training courses were conducted for farmers on Integrated Pest Management (IPM) to control SMD, fusarium wilt and pod borer. Five field days were organized to demonstrate the performance of the SMD resistant varieties. About three hundred on-farm trials (0.1 to 2 ha field size) were organized under the aegis of NGOs and state extension units, to promote SMD resistant varieties (ICPL 96058, ICP 7035 and ICPL 87051) and IPM technologies. Ten community-based seed village programmes was established to assure sustainable seed production of ICP 7035, ICPL 96058 and ICPL 87051, under the aegis of local NGOs and State Extension Education Units. Each seed village can produce up to 100 - 200 kg of seed per season. A “mini-dhal mill” facility established for making pigeonpea *Dhal* [decorticated split seeds of pigeonpea]. Decortication prevents seed damage by storage pests, and permits direct sale of *Dhal* to consumer, thereby fetches higher remuneration (up to 50% increase over normal value).

SMD resistant varieties are being adopted by farmers, and as resistance donors in the development of hybrid pigeonpea programmes. Capacity building at village-level for seed production and IPM under the aegis of local NGOs, state extension units and progressive farmers would ensure the sustainability of seed production of improved varieties. All these steps are contributing to enhanced pigeonpea yields and increased incomes to farmers.

Background

Pigeonpea (*Cajanus cajan*) is a very important pulse crop grown under low input conditions in marginal farming systems adopted by smallholder farmers in the Indian subcontinent. Pigeonpea seed is the dietary protein source for an estimated 1.1 billion people, most of whom are poor and vegetarian. Pigeonpea is currently cultivated on 5.25 mha globally, with nearly 90% of it being grown in the Subcontinent. Pigeonpea plays an important role in livelihoods, because every part of the plant provides economic returns to the subsistence farmer. This crop is a major source of income where surpluses are traded in both local and commercial markets.

Sterility mosaic disease (SMD), first described in 1931, is a major disease limiting the pigeonpea production in the Indian subcontinent. The SMD causal agent is spread by the arthropod mite vector, *Aceria cajani* (Acari: Eriophyidae). The disease is characterized by sterility (complete or partial cessation of flower production), mosaic symptoms on leaves, excessive vegetative growth, severe stunting and reduction in leaf size. This disease occurs with regularity, with an annual incidence range between 10-100%. SMD alone is responsible for annual grain loss valued over US$ 300 million. Yield losses caused in most genotypes by SMD occurrence during early in the season can lead to >90% crop loss. The causal agent of the disease remained unidentified for several decades. Consequently efforts to manage SMD were not effective. Resistance to SMD is scarce in the germplasm. Additionally, several SMD pathogen isolates with various degrees of virulence occur in different geographic regions. Through CPP-DFID funded projects (R6407(H), R7452 and R8205), vital breakthroughs were made which led to the understanding of SMD etiology and paved a way to select suitable resistant sources. The key outputs of the previous projects (R6407(H), R7452 and R8205) are listed below and pictorially depicted in Figures B1, B2 and B3. *(For more details please refer to progress reports and publications for respective projects)*.

- The variability in resistance at different locations was due to the occurrence of different SMD pathogen strains and their interaction with the host.
- SMD causal agent identified as a virus, named *Pigeonpea sterility mosaic virus* (PPSMV). PPSMV has novel properties unrelated to any characterized virus. Isolates of this virus with various properties were determined. This enabled the development of sensitive methods for its detection in plants; allowed the development of technologies for the selection of durable SMD resistant sources; the determination of the transmission characteristics by its mite vector; and virus host range.
- The diagnostic tools and improved screening methods facilitated the precise screening of pigeonpea accessions. This identified several genotypes possessing resistance to PPSMV strain at Patancheru (P) and a few genotypes possessing resistance to PPSMV isolates at Coimbatore (C) and Bangalore (B).
- A pigeonpea cv. ICP 7035, with broad-based SMD resistance to PPSMV was selected for release in Karnataka State. A few promising lines were tested on-station for their suitability for release.
- Evaluated several pigeonpea genotypes (45 cultivated and 115 wild species) that are resistant to PPSMV isolates. Five new varieties (ICPL 96058, 96053; 87051, 99050 and 96061) resistant to SMD were selected and are being evaluated on-farm for release. Sixteen broad-based durable resistant wild *Cajanus* accessions identified.
- Characterized three PPSMV isolates (P, B, C). This has given the possibility of differentiating them based on nucleic acid sequence variation for a more rapid means of identifying the regional distribution of virus strains within the peninsular India.
- Surveys were conducted to understand the SMD epidemiology and its effect on crop.
- Cultivar ICP7035 is evaluated fully and it has been provisionally approved for release in Zone-5 of Karnataka state in the year 2005.

- Seed of promising sources multiplied and supplied to farmers and NARES. Extension programmes were implemented at village-level through local NGOs and government extension agencies. Training was provided to the farmers in integrated crop management practices and in utilizing locally available natural ingredients to combat pests.

The current project seeks to further build on the successful outcomes through following three activities.

1. Development of short to medium duration (100-150 days maturity) SMD resistant varieties necessary to overcome terminal drought stress

2. Evaluation of pigeonpea core collection for SMD resistance to identify new sources of SMD resistance in pigeonpea germplasm collection.

3. Up-scaling on-farm SMD-mitigating technologies by increasing the number of seed-village programmes; on-farm trials and training in IPM to extension workers, NGOs and farmers to manage SMD, wilt and pod borer; for enhancing farmers' capacity in sustainable management of diseases and pests of pigeonpea.

Project activities were conducted in primary pigeonpea production zones of Andhra Pradesh and Karnataka states (Figure B3). These two states are major producers of pigeonpea and represents geographically diverse regions for evaluation of various genotypes. Moreover, two diverse PPSMV isolates are endemic in these regions [PPSMV-P (Patancheru isolate) in northern parts of Andhra Pradesh and Karnataka state; and PPSMV-B (Bangalore isolate), in southern parts of the Karnataka state]. Technologies and inputs for these activities were from previous CPP-DFID projects.

Figure B1: Pictorial representation of SMD pathosystem. The PPSMV can infect only pigeonpea and few of its wild relatives. It is spread by the vector, *Aceria cajani*, an obligate dependent on the pigeonpea. Affected plants produce mosaic symptoms on leaves and do not produce flowers (sterility).

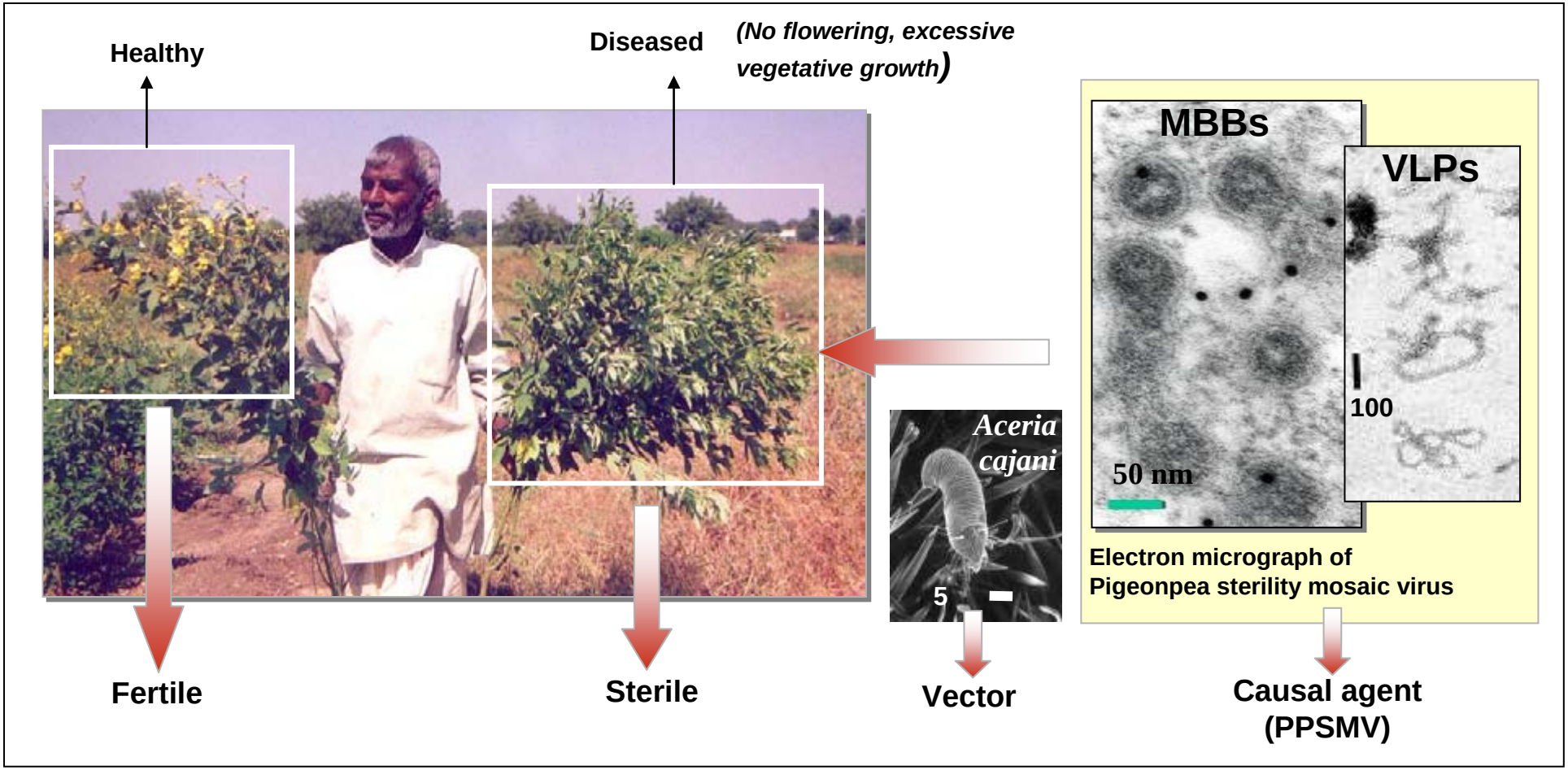


Figure B2: Effect of SMD infection of pigeonpea yield. Maximum yield loss results when infection takes place when crop <45 days old.

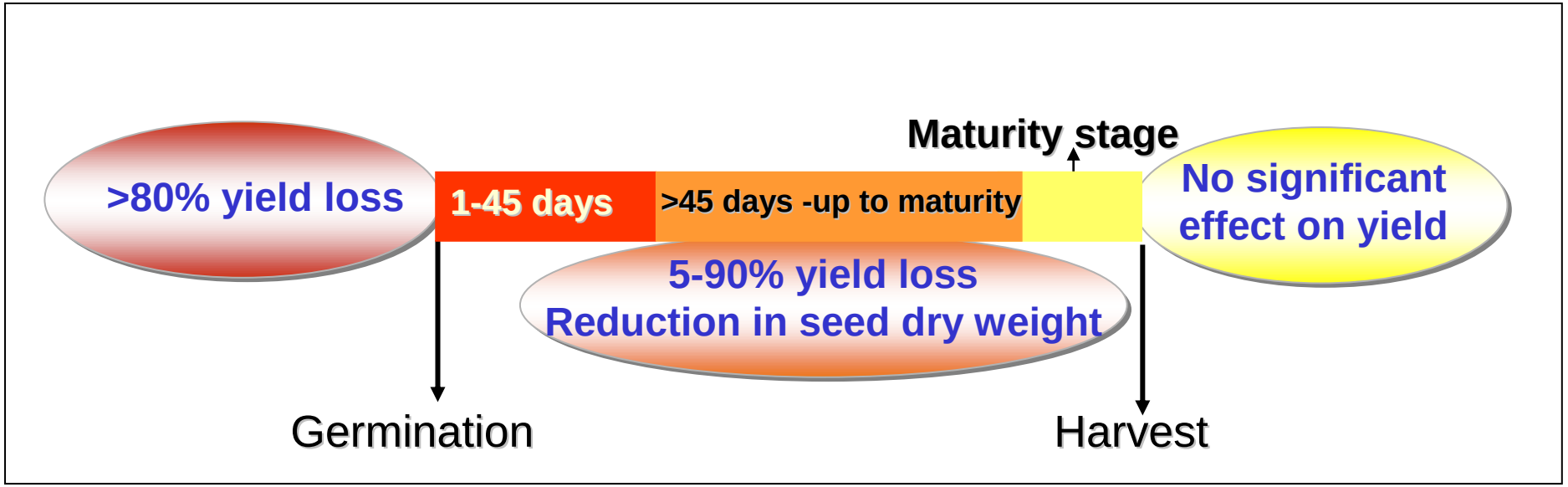
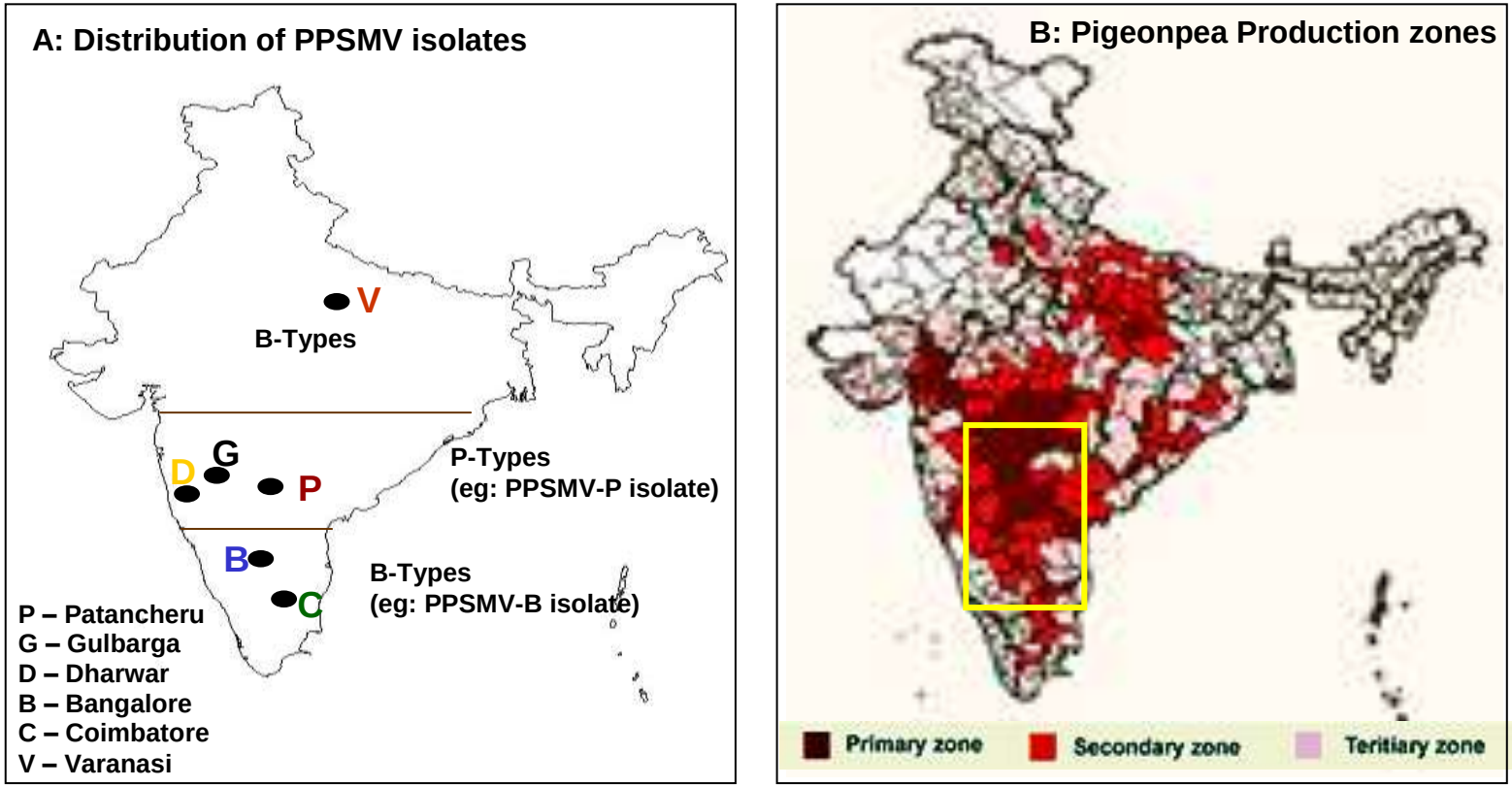


Figure B3:

(A) Geographic distribution of PPSMV isolates. Based on virulence PPSMV isolates are broadly categorized into two types, P and B types. B isolates have ability to overcome resistance selected against P isolates. P types appear to be localized in central and northern peninsular India. B types appear to be localized in southern peninsular and northern India.

(B) Pigeonpea production zones in India. Based on the cropping area, regions were divided into primary, secondary and tertiary zones – with highest cropping in primary zone. All the project activities, on-station and on-farm trials were in primary and secondary production zones confining in Andhra Pradesh and Karnataka states (boxed area).



Project Purpose

Promote sustainable strategies to alleviate pigeonpea losses due to sterility mosaic disease (SMD) for attaining yield stability and increased productivity in the RNRS of the semi-arid cropping systems in the Indian subcontinent, for the benefit of marginal farmers who primarily cultivate pigeonpea under low-input rainfed conditions.

The following three activities were undertaken to achieve the project goal:

1. *Development of short to medium duration SMD resistant varieties*: Pigeonpea cultivated in rainfed regions and shallow soils are severely affected by the terminal drought. Varieties with maturity period of 100-150 days (short to medium duration) are necessary to escape terminal drought. SMD resistance in short to medium duration maturity (100-160 days) is lacking in pigeonpea. Breeding programmes were undertaken to transfer resistance to short duration varieties.

2. *Evaluation of pigeonpea core collection:* Resistance to SMD, especially against severe PPSMV isolates (such as B) is limited. Search for resistance in the global pigeonpea germplasm collection comprising over 13,000 accessions is extremely difficult and expensive. Recently core collection of pigeonpea comprising around 1,250 accessions was established that represents the genetic diversity of entire global germplasm collection. From this, a mini-core collection (core of core collection) comprising 146 accessions was identified. The mini-core is the representative sample of the global germplasm collection. Evaluation of mini-core accession against two PPSMV isolates (B and P) would result in identification of new sources of resistance and also provides insights about genetic diversity of SMD resistance in the global germplasm. The promising genotypes will be further promoted for farmer cultivation by on-farm testing and through state and national varietal programmes.

3. *Up-scaling on-farm SMD-mitigating technologies:* Increase the number of seed-village programmes for sustainability of seed production of disease resistant varieties; organize training programmes to extension workers, NGOs and farmers in IPM to manage SMD, wilt and pod borer; and train farmers in dehulling (dehusked, split seeds) to protect from the storage pests.

Project outputs contributes to the development of new SMD resistant pigeonpea varieties in short to medium duration maturity, and genotypes with diverse genetic backgrounds that will be promoted for farmers and further advanced for breeding programmes. Varieties with durable resistance to SMD, combined with integrated management of fusarium wilt and pod borer would stabilize pigeonpea production and enhance yield potential at no extra cost to the farmers. This benefits resource poor farmers living in marginal areas in the subcontinent, where pigeonpea is a major subsistence crop and women are involved in post-harvest processing and marketing. Scientists in NARES and NGOs, benefit from new sources of resistance, and to develop high-yielding pigeonpea cultivars thereby continuing the development of improved varieties.

Research Activities & Outputs

Experimental methods (inoculum maintenance, sowings, inoculation techniques, virus detection) were as detailed in FTR of R8205 and were not repeated in this report. Pigeonpea genotypes were regarded as resistant, tolerant or susceptible based on symptom type and percent incidence (Table below).

	% SMD incidence	***Symptom type***
Resistant	0-30	Mild mosaic to severe mosaic
Tolerant lines	>80	Chlorotic ringspots
Susceptible	>30	Severe mosaic

Activity 1. Development of short to medium duration SMD resistant varieties:

- Thirty-eight pigeonpea breeding lines developed at ICRISAT using broad-based SMD resistant variety, ICP7035, as one of the parents, were evaluated for resistance against P and B isolates during 2003-2005 (please see Tables O1.4 – O1.6 in FTR of R8205). All these lines have short to medium duration maturity (100-160 days).

- From the 38 breeding lines, 12 promising lines (ICP14404, 16166, 11719, 16169, 14478, 16165, 14834, 11632, 95029, 14399, 16294 and 16293) were selected for evaluation in 2005-06 on-station trials at Bangalore and Gulbarga against PPSMV-P and PPSMV-B isolates, respectively, to assess the maturity and resistance to SMD (Figure 1). Test plants were grown in SMD sick plots to allow infection to take place at young stage (12-15 days old plants). Local cultivars ICP8863 and TTB7 were used as susceptible controls, and these plants showed >80% infection.

- At Bidar and Gulbarga, all the 12 genotypes attained 80% maturity in 140 days and showed good resistance to PPSMV-P isolate endemic in this region (Table 1). Seven of 12 accessions showed no infection. Remaining genotypes showed SMD incidence between 7.5 to 33% (Table 1). All the 12 genotypes were adopted by the local NARES for further validation and adoption. The 7 seven genotypes (ICP16166, 11719, 16169, 16293, 14834, 11632 and 95029) that showed no infection will be evaluated in the coordinated trials and on-farm.

- Evaluation of these genotypes against PPSMV-B isolate at Bangalore revealed that all the 12 accessions were infected with SMD with incidence between 30 to 90% (Table 2). Although all the genotypes were infected, most of the genotypes produced flowers, in particular, ICP 14834, 16165, 11719, 14478, 11632 and 14399 (incidence between 30 – 40%) showed apparently normal flowering (Figure 2). Six accessions, ICP 11719, 14834, 11632, 14399, 14478 and 16165, performed well against both PPSMV-P and PPSMV-B isolates.

Outputs:

- Twelve short to medium-duration SMD resistant lines [ICP 14404, 16166, 11719, 16169, 14478, 16165, 14834, 11632, 95029, 14399, 16294 and 16293] were identified that is suitable for cultivation in PPSMV-P endemic regions. These genotypes are ideally suited to overcome the terminal drought.

- Absolute resistance to PPSMV-B (severe isolate) was not available in breeding lines. Six lines, ICP 11719, 14834, 11632, 14399, 14478 and 16165, have tolerance <40% incidence and delayed expression of symptoms) to PPSMV-B isolate.

Table 1. On-station evaluation of short to medium duration SMD resistant lines at Gulbarga and Bidar, Karnataka during 2005 rainy season

Sl No	Accession number	Days to 50 % flowering	Days to 80 % Maturity	Plant Height (cm)	No. of Primary Branches	No. of Secondary Branches	%SMD
1	ICP 16166	106	139	113	9	6	0.00
2	ICP 11719	106	139	95	11	0	0.00
3	ICP 16169	106	139	105	14	2	0.00
4	ICP 16293	106	137	85	11	13	0.00
5	ICP 14834	106	139	130	6	0	0.00
6	ICP 11632	106	139	100	13	11	0.00
7	ICP 95029	104	137	120	11	4	0.00
8	ICP 14399	106	137	90	9	3	7.50*
9	ICP 16294	106	137	150	11	2	10.0*
10	ICP 14478	106	139	110	10	2	25.0**
11	ICP 16165	104	137	80	9	5	25.0**
12	ICP 14404	106	139	95	1	0	33.33**
Local checks							
ICP 8863 susceptible control		*115*	*158*	*180*	*11*	*5*	*85*

**Mild mosaic symptoms*
***Infected accessions showed mild mosaic to sever mosaic symptoms, delayed symptom expression*

Table 2. On-station evaluation of short to medium duration SMD resistant breeding lines at Bangalore, Karnataka during 2005 rainy season

	Accession number	Days to maturity	%SMD	Symptom type
1	ICP 14834	108	30.74*	SM
2	ICP 16165	115	33.33*	SM
3	ICP 11719	135	33.33*	SM
4	ICP 14478	160	34.04*	SM
5	ICP 11632	130	35.3*	SM
6	ICP 14399	152	40.0*	SM
7	ICP 95029	130	48.07	SM
8	ICP 14404	140	55.0	SM
9	ICP 16166	125	66.6	SM
10	ICP 16293	108	70.0	SM
11	ICP 16924	120	80.0	SM
12	ICP 16169	123	90.32	SM
TTB7 Susceptible control		-	100	SM

SM = Sterility mosaic; *accessions with apparently normal flowering

Figure 1: On-station validation of short to medium duration pigeonpea lines at Bangalore (A) and Gulbarga (B).

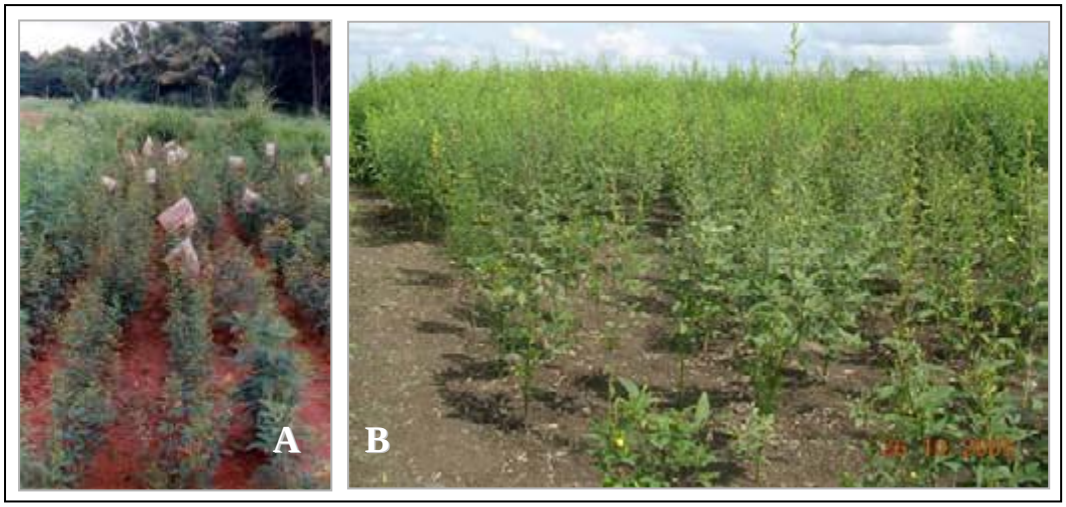


Figure 2: Normal flowering pattern showed by PPSMV-B infected short to medium duration pigeonpea line at Bangalore location.

Activity 2. Evaluation of pigeonpea core collection

- Pigeonpea (*Cajanus cajan*) mini-core collection, comprising 146 accessions (Table 3) were evaluated against PPSMV-P and PPSMV-B at Patancheru and Bangalore, respectively. Each accession was sown in plastic pots in three replications and maintained in greenhouse at Patancheru. In Bangalore, sowings were done in experimental station. Plants were inoculated with respective PPSMV isolates at 2-leaf stage (Figure 3). Observations (symptom time and percent infection) were taken at 2 weekly intervals and scoring was based on visual symptoms and plants were tested for virus by ELISA using PPSMV-P polyclonal antibodies. ICP 8863 was used as susceptible control.

- Out of 146 accessions, 3 accessions (ICP 7869, 14120 and 14155) showed no infection; 8 accessions (ICP 14368, 11910, 14229, 14569, 14147, 14545, 11833 and 14471) showed 1-10% infection; and 11 accessions (ICP 14701, 14722, 15049, 1444, 14801, 14638, 14976, 13304, 14294, 11015 and 4317) showed infection between 11-30%. Rest of the accessions showed >30% infection (Tables 3 and 4; Figure 4). Five accessions (ICP 12123, 10654, 11015, 11059 and 3046) although showed >80% infection, the genotypes expressed chlorotic ringspot symptoms, and no sterility observed in these genotypes, and they can be regarded as tolerant to SMD.

- At Bangalore 143 accessions were tested (no germination in case of ICP 12105, 10559 and 12596). Only 4 of 143 accessions had <30% infection against PPSMV-B isolate (ICP 6123, 15185, 14569 and 14976) (Tables 3 and 4). Symptoms appeared late in all the four genotypes. This experiment is still on going and final data with complete agronomic features will be presented at later date.

- Evaluation of pigeonpea mini-core indicates narrow base of resistance to SMD in the pigeonpea germplasm (Figure 4). Resistant sources to B-type of isolates are much scarce. The resistant accessions provide entry point for further evaluation of genotypes for SMD resistance. All the promising lines identified in this activity will be further validated. This work will be continued as part of the *Generation Challenge Programme* funded by CGIAR. Resistant lines are being propagated for seed multiplication and supply to NARS for utilization in downstream research.

Outputs: Screening of pigeonpea mini-core resulted in identification of 13 new sources of SMD resistance [ICP 7869, 14120, 14155 14368, 11910, 14229, 14569, 14147, 14545, 11833, 14471, 6123 and 15185] that had <20% infection. ICP 6123 and 15185 were resistant to PPSMV-B isolate and rest of the accessions was resistant to PPSMV-P isolate. The selected accessions provide an entry point for further evaluation of pigeonpea germplasm for broad-based SMD resistance.

Table 3: List of pigeonpea mini-core accession evaluated against PPSMV-P and B isolates

Sl. No	**Acc. no**	Sl. No	**Acc. no**	Sl. No	**Acc. no**	Sl. No	**Acc. no**
1	**7**	38	**6929**	75	**10447**	112	**13577**
2	**348**	39	**6992**	76	**10503**	113	**13579**
3	**655**	40	**7057**	77	**10559**	114	**13633**
4	**772**	41	**7076**	78	**10654**	115	**13662**
5	**939**	42	**7148**	79	**11015**	116	**13884**
6	**995**	43	**7223**	80	**11059**	117	**14094**
7	**1071**	44	**7260**	81	**11230**	118	**14116**
8	**1126**	45	**7314**	82	**11281**	119	**14120**
9	**1156**	46	**7366**	83	**11320**	120	**14147**
10	**1273**	47	**7375**	84	**11321**	121	**14155**
11	**1279**	48	**7426**	85	**11477**	122	**14229**
12	**2577**	49	**7507**	86	**11627**	123	**14294**
13	**2698**	50	**7803**	87	**11690**	124	**14368**
14	**2746**	51	**7869**	88	**11823**	125	**14444**
15	**3046**	52	**8012**	89	**11833**	126	**14471**
16	**3049**	53	**8152**	90	**11910**	127	**14545**
17	**3451**	54	**8227**	91	**11946**	128	**14569***
18	**3576**	55	**8255**	92	**12105**	129	**14638**
19	**4029**	56	**8266**	93	**12123**	130	**14701**
20	**4167**	57	**8384**	94	**12142**	131	**14722**
21	**4307**	58	**8602**	95	**12298**	132	**14801**
22	**4317**	59	**8700**	96	**12410**	133	**14819**
23	**4392**	60	**8757**	97	**12515**	134	**14832**
24	**4575**	61	**8793**	98	**12596**	135	**14900**
25	**4715**	62	**8840**	99	**12654**	136	**14903**
26	**4903**	63	**8860**	100	**12680**	137	**14976***
27	**5142**	64	**8921**	101	**13011**	138	**15049**
28	**5863**	65	**8949**	102	**13139**	139	**15068**
29	**6049**	66	**9045**	103	**13167**	140	**15109**
30	**6123**	67	**9336**	104	**13191**	141	**15161**
31	**6128**	68	**9414**	105	**13244**	142	**15185**
32	**6370**	69	**9655**	106	**13270**	143	**15382**
33	**6668**	70	**9691**	107	**13304**	144	**15493**
34	**6739**	71	**9750**	108	**13359**	145	**16294**
35	**6815**	72	**10094**	109	**13431**	146	**16309**
36	**6845**	73	**10228**	110	**13571**		
37	**6859**	74	**10397**	111	**13575**		

Accessions with 0-30% infection are underlined. Accessions that were resistant against P and B isolates are indicated with *

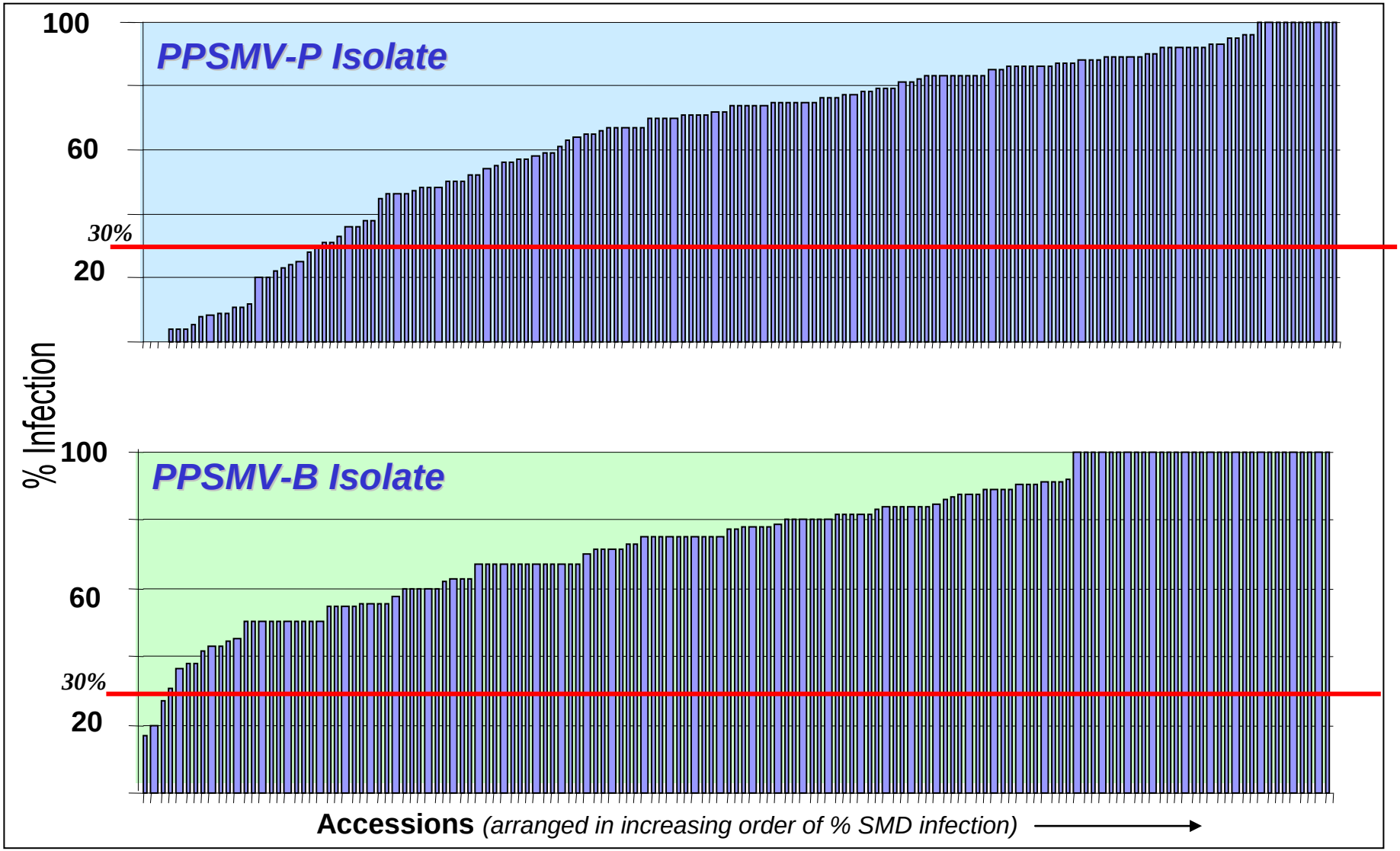
Table 4: Summary pigeonpea mini-core evaluation. Promising accession that was resistant to PPSMV against P and/or B is given below.

% SMD infection	PPSMV-P Isolate	PPSMV-B Isolate
0	7869, 14120, 14155	None
1-10	14368, 11910, 14229, **14569,** 14147, 14545, 11833, 14471	None
11-20	14444, 14801, 14638	6123, 15185
21-30	14701, 14722, 15049, **14976**, 13304, 14294, 11015, 4317	**14569, 14976**

Remaining accessions of pigeonpea mini-core showed >30% infection;
Common sources underlined and in bold

Figure 3: Testing of mini-core accessions at ICRISAT against PPSMV-P isolate

Figure 4: Reaction of pigeonpea mini-core accessions to PPSMV-P and B isolates. [Accessions with <30% infection were regarded as promising sources. Note that percent infection was high in PPSMV-B isolate and very few accessions showed resistance to this isolate].



Activity 3: Up-scaling on-farm SMD-mitigating technologies

- ***Working group meeting with collaborators and other stakeholders:*** The 4th Working Group Meeting on '*Combating pigeonpea sterility mosaic disease*' was organized on 23 May 2005, at ICRISAT, Patancheru, India. All project partners [from ICRISAT; University of Agriculture Sciences, Bangalore; Center for Sustainable Agriculture, Hyderabad; REEDS, Hyderabad; Agriculture Research Station, Gulbarga; University of Agriculture Sciences, Dharwad; Central Research Institute for Dry Land Agriculture (CRIDA)] participated in this workshop and finalized work plans for the on-farm activities, viz., evaluating pigeonpea lines, organizing on-farm trials, seed multiplication and training (Figure 5).

- ***Release of SMD resistant varieties:*** Broad-based SMD resistant variety ICP 7035 was released for farmer cultivation by ICRISAT and University of Agriculture Sciences, Bangalore. Final approval was given in the month of May 2005. Pigeonpea varieties ICP 7035 and ICPL 96058 (resistant to PPSMV-P isolate and wilt) was released by JK Seeds Pvt. Ltd., for cultivation in Karnataka, Andhra Pradesh and other south India states (Figure 6).

- ***Organization of demonstration and on-farm trials to promote SMD resistant varieties:*** A total of about 300 on-farm trials were being organized with three medium duration pigeonpea varieties, ICP 7035 (broad-based SMD and wilt resistant), ICP 87051 and ICPL 96058 (resistant to PPSMV-P isolate and wilt for central India), and seed was provided to the farmers. On-farm managed trials were conducted as per the farmers methods. During the course of the trials, visits were made to monitor the farms, for evaluating performance, to obtain farmers opinion and to monitor SMD incidence. On-farm training courses were conducted to introduce farmers to good agriculture practices to maximize the yields. List of various trials conducted were detailed here. Yield data and final evaluation data will be submitted at later date.

    - Ten on-farm trials were conducted in three taluks (Chincholi, Aland and Gulbarga) in Gulbarga District of Karnataka (1 acre for test genotype and 0.5 acre for local check). Test varieties ICP 7035 (3 farmers) ICPL 96058 (7 farmers) (Table 5). Local checks, ICP 8863 and Asha. Sowings were done in second week of July. Genotypes are performing well and yield data is awaited. All these trials were conducted with inputs.

    - 200 on-farm trials of ICPL 96058 in 15 villages of Mahaboonagar district in Andhra Pradesh were conducted (Table 6). Sowings were done in third week of July. No local checks were included in these trials. These trials were managed as per the traditional farmers practice, with minimum inputs to maintain the pest problem. All the farmers in these trials are smallholders. Seeds were treated to prevent wilt infection. IPM methods were followed for pest control. Yield data is awaited.

    - 25 on-farm trials of ICPL 96058, ICP 7035 and ICP 87051 were organized in 8 districts (Medak, Ranga Reddy, Khammam, Adilabad, Nizamabad, Nellore, Nalgond and Warangal) of Andhra Pradesh (Table 7). Three varieties were supplied to farmers. ICP8863 and other local varieties were included as checks. Yield data is awaited.

    - Thirty-two frontline demonstrations of ICP 7035 were organized in 4 districts of southern Karnataka. These demonstrations were conducted in association with the State Extension Education Unit for the promotion of variety in diverse

regions (Table 8). Forty-eight on-farm trials of ICP7035 conducted in the SMD epidemic areas in 3 districts of Karnataka (Table 9). Yield data from these trials are awaited.

- All trial locations received good rainfall and varieties are performing well. No SMD incidence observed on disease resistant varieties. Yield data will be provided later.

- ***Organization of training courses, fields days and seed-villages*:**

- ***Training to farmers and field days***: Training courses were conducted for farmers on IPM to manage SMD, wilt and pod borer. Selected farmers were given training in preparation of plant extracts for pest control (Table 10). Emphasis was placed on IPM of SMD, fusarium wilt (endemic in the subcontinent) and pod borer (*Helicoverpa armigera*). Rationale for this approach was that, in the field these three biotic problems occur regularly. To sustain the yield gains attained through management of SMD, it is essential to manage other two problems. IPM emphasis on management of SMD and wilt through cultivation of resistant genotypes; and pod borer management is through a combination of traditional methods and judicious application of chemical sprays. The IPM package is listed in Figure 7. Training was given to farmers in IPM modules during field days, on-farm training courses conducted at village level, scientist-farmer interaction meetings and on-station training courses (Table 10). Farmers were given training in preparation of plant-based extracts, such as chilli-garlic paste, neem seed kernel extracts, preparation of NPV solutions, to control pod borer. Farmers selected for seed village programme were given training in pigeonpea crop management to ensure quality seed production.

- Training courses were organized as one-day events, at Agriculture Research Stations, NGO training halls, and on-farm during field demonstration visits. In these events farmers were given lectures in local language.

- Farmer field days were organized to demonstrate on-farm performance of pigeonpea varieties to the farmers (Table 11). All the farmers training programmes and field days were organized in collaboration with NGOs and State Extension Education Units. For such events information bulletins were prepared in local language and supplied to the farmers.

- ***Seed village system:*** Seed villages were established at 12 locations for the multiplication of ICPL 96058 and ICP 7035 (Table 12). These were established in association with local NGOs. In this, designated farmers multiply the pigeonpea genotypes for seed purpose. Standard crop management practices were followed, external inputs such as fertilizer, one time irrigation given at flowering, and isolation distance was maintained. The seed produced was collected and sold on par with the market price to the local farmers. The money generated will be used to continue the seed production next year. This system ensures timely availability of quality pigeonpea seed to the farmers at right time. At present each seed village has the capacity to produce 100 to 200 kg seed for season. Assured supply of quality seed at right time is encouraging farmers to participate in this programme. This system is designed to be self-sustainable, as in-charge farmer would get the returns and profit.

- ***Preparation of pigeonpea Dhal (Decorticated split seeds):*** A mini-dhal mill (designed at Tamil Nadu Agriculture University) was established at Achampet, Andhra Pradesh, under the aegis of CONARE-CSA NGO (Figure 8). The mill will allow local farmers to dehusk the seed, which can be sold to consumer directly as opposed to traders – and this fetches farmers' higher remuneration. Dehusking the

seed averts damage by storage pests, a major problem for farmers. To ensure collective ownership and maintenance, 50% of the mill cost was borne by the local farmers, and 50% was paid by the project. Mill operators will recover cost of seed processing, and this fund will be used to cover cost of power, and equipment maintenance. NGOs are linking farmer-produced dhal to traditional markets. Depending on the success of this system, this will be up-scaled to few more villages.

Outputs:

- SMD resistant variety ICP 7035 was released in Zone-5 region of Karnataka state through state Agriculture University and two varieties, ICP 7035 and ICPL 96058 through a private seed company [JK Seeds Company Pvt. Ltd]
- SMD resistant varieties promoted through several frontline demonstration trials on-farm trials and farmer field days in Andhra Pradesh and Karnataka states through NGOs, Agriculture Universities, Agriculture Research Stations, and ICAR Centres, led to well adoption of disease resistant varieties in the farmers fields.
- Farmers knowledge enhanced through training in eco-friendly management of SMD, wilt and pod borer, and these methods are well adopted.
- Community-based seed village programmes was established for sustainable seed production of ICP 7035, ICPL 96058 and ICPL 87051, under the aegis of local NGOs and State Extension Education Units. Each seed village will produce up to 200 kg of seed per season to cater the local needs.
- Established “mini-dhal mill” thereby enabling farmers to prepare pigeonpea *Dhal* (decorticated split seeds), which averts seed damage by storage pests, and adds value to the produce thereby fetching higher remuneration (up to 50% increase over normal value).

- **Figure 5: Participants of 4th SMD Working Group Meeting held at ICRISAT**

Figure 6: ICP 7035 and ICPL 96058 release for cultivation through public and private sectors

ICP 7035: Released by the University of Agriculture Sciences, and JK Seeds Pvt. Ltd., India.

ICPL 96058: SMD and fusarium wilt resistant medium duration high yielding variety released by JK Seeds Pvt. Ltd., India.

Figure 7. Scheme for integrated management of SMD, wilt and pod borer promoted through on-farm training courses

Management of SMD and Wilt

- Cultivation of common SMD and wilt disease resistant varieties [*Asha ICPL87119; ICPL96058; ICPL96053; ICP7035]*
- Removal of volunteer SMD inoculum sources
- Five kg *Trichoderma viridie* mixed with 125 kg farm-yard manure ha^{-1} to control wilt (*Fusarium udum)*

Management of pod borer

- Deep summer ploughing to control pest and to conserve soil moisture
- Random planting of maize and sorghum to attract insectivorous birds
- Mechanical shaking of plants to dislodge *Helicoverpa* larvae
- Spraying with:
  - Neem seed kernal (NSKE) @ 5% (w/v) to control insect pests
  - Nuclearpolyhedrosis virus (NPV) @ 500 $L.E.ha^{-1}$ to control *Helicoverpa*
  - Neem oil @ 3% (v/v) to control *Helicoverpa*
- Pheromone traps [10 per ha] for monitoring *Helicoverpa* population
- Bird Perches @ 50 ha^{-1} to attract insectivorous birds
- Seed dehuling to prevent damage by storage pests.

Figure 8: **(A, B) Pigeonpea mini-dhal at Achampet, Andhra Pradesh**
(C) Dhal of ICP 7035 prepared using mini-dhall mil

Table 5: Details of on-farm trials on ICPL 96058 Vs local cultivars conducted during 2005-06 in Gulbarga District.

(Yield data is awaited and will be submitted later)

	1	2	3	4	5	6	7	8	9	10
Vilalge Taluk (Tq)	Pattan Tq: Gulbarga	Bommanahalli Tq: Gulbarga	Kapnoor Tq: Gulbarga	Melakunda Tq: Gulbarga	Mudbool Tq: Chitapur	Kotaga Tq: Chincholi	Degalmadagi Tq: Afzalpur	Garmpali, Tq : Chincholi	Nandikur Tq: Gulbarga	Lengte Tq: Aland
Farmers Name	Basavaraj Jeevanagi	Shivakumar.B. Patil	Shambuling Tengli	A.G.Hagargi	Shamraya Hosmani	Ramanna Y.K	Chitrashekar D	Shamrao Bheema	Somanna Nadakartti	Shivanand Gudge
Field Size	1 Ac-ICPL-96058 ½ Ac-Maruti ½ Ac-Asha	1 Ac-ICPL-96058 ½ Ac-Maruti ½ Ac-Asha	1 Ac-ICPL-96058 ½ Ac-Maruti ½ Ac-Asha	1Ac-ICPL-96058 ½ Ac-Maruti ½ Ac-Asha	1 Ac - ICPL-96058 1/2 Ac - Maruti 1/2 Ac - Asha	1 Ac - ICPL-96058 1/2 Ac-Maruti 1/2 Ac - Asha	1 Ac - ICPL-96058 1/2 Ac-Maruti 1/2 Ac - Asha	1 Ac - ICPL-96058 1/2 Ac-Maruti 1/2 Ac - Asha	1 Ac - ICPL-96058 1/2 Ac-Maruti 1/2 Ac - Asha	1 Ac - ICPL-96058 1/2 Ac-Maruti 1/2 Ac - Asha
Soil Type	Medium Black	Medium Black	Medium Black	Medium Black	Medium Black	Medium Black	Medium Black	Medium Black	Medium Black	Medium Black
Variety	ICPL-96058/Asha / Maruti / BSMR – 736 / Mico Hybrids	ICPL-96058 /Asha / Maruti / 7035/ BSMR – 736 / Mico Hybrids	ICPL-96058 /Asha / Maruti / BSMR – 736 / Mico Hybrids	ICPL-96058 /Asha / Maruti / BSMR – 736 / Mico Hybrids	ICPL-96058 /Asha / Maruti BSMR – 736 / Mico Hybrids	ICPL-96058/Asha / Maruti / BSMR – 736 / Mico Hybrids	ICPL-96058/Asha / Maruti / BSMR – 736 / Mico Hybrids	ICPL-96058/Asha / Maruti / BSMR – 736 / Mico Hybrids	ICPL-96058/Asha / Maruti / BSMR – 736 / Mico Hybrids	ICPL-96058/Asha / Maruti / BSMR – 736 / Mico Hybrids
Date of Sowing	15-07-05	23-07-05	16-07-05	24-07-05	15-07-05	20-07-05	14-07-05	16-07-05	16-07-05	18-07-05
FYM	10 ton/Ac	1 ton/Ac	1 ton/Ac	1 ton/Ac	1 ton/Ac	1 ton/Ac	1 ton/Ac	1 ton/Ac	3 ton/Ac	1 ton/Ac
Inorganic (N:P:K)	------	10:20:00	10:20:00	10:20:00	10:20:00	10:20:00	10:20:00	10:20:00	10:20:00 3 ton/Ac Top dressing with Urea ome spraying 2% 19:19:19	10:20:00
Seed treatment	2% Cacl2, Rhizobium, PSB & Tricoderma	2% Cacl2, Rhizobium, PSB & Tricoderma	2% Cacl2, Rhizobium, PSB & Tricoderma	2% Cacl2, Rhizobium, PSB & Tricoderma	2% Cacl2, Rhizobium, PSB & Tricoderma	2% Cacl2, Rhizobium, PSB & Tricoderma	2% Cacl2, Rhizobium, PSB & Tricoderma	2% Cacl2, Rhizobium, PSB & Tricoderma	2% Cacl2, Rhizobium, PSB & Tricoderma	2% Cacl2, Rhizobium, PSB & Tricoderma

Rain (mm)	752.8	628.7	752.8	752.8	1022.5	808.9	633.7	808.9	752.8	628.7
Insecticides:Chem / Bio Chem or Comb. Chem names. No.Of appln & date of Appln.	Biological	both Chemicals & Biologicals	both Chemicals & Biologicals	both Chemicals & Biologicals	both Chemicals & Biologicals	both Chemicals & Biologicals	both Chemicals & Biologicals	both Chemicals & Biologicals	both Chemicals & Biologicals	both Chemicals & Biologicals
Irrigated / rain fed	Rain fed	One Irrigation at pod formation	One Irrigation at pod formation	One irrigation at flower initiation & Second irrigation at pod formation stage	One irrigation at flower initiation & Second irrigation at pod formation stage	One irrigation at flower initiation & Second irrigation at pod formation stage	One Irrigation at pod formation	One Irrigation at pod formation	One irrigation at flower initiation & Second irrigation at pod formation stage	One irrigation at flower initiation & Second irrigation at pod formation stage

Table 6: On-farm trials of SMD resistant variety ICPL 96058 in Mahboonagar District of Andhra Pradesh

Sl. No.	Village	No. of farmer managed trials*
1	Pyalamaddi	60
2	Kasturipalli	10
3	Indanur	5
4	Boyapalli Thanda	5
5	Dunkudu Thanda	2
6	Hasnabad	5
7	Udimeswaram	3
8	Bulkapuram	15
9	Chettupalli Thanda	15
10	Bollibavi Thanda	10
11	Hamsanipalli	10
12	Linganpalli	25
13	Burahanpur	15
14	Salianderpur	10
15	Madanpalli Thanda	10
	Total number of trials	**200**

*Two kg seed per 0.5 acres. Sowings undertaken in 3rd week of July

Table 7: Front line demonstrations in eight districts of Andhra Pradesh

S.No	NGOs	Trial Location	Pigeonpea varieties	Trial Area (Acres)
1	CROPS	Jangaon, Warangal Dist.	ICPL-7035 ICPL-96058 ICPL-87051	2.25
2	MARI	Hanmakonda, Warangal Dist.	ICPL-7035 ICPL-96058 ICPL-87051	2.25
3	NAVAJYOTHI	Ramayampet, Medak Dist.	ICPL-7035 ICPL-96058 ICPL-87051	2.25
4	CEAD	Nirmal, Adilabad Dist.	ICPL-7035 ICPL-96058 ICPL-87051	2.25
5	SECURE	Palvoncha, Khammam Dist.	ICPL-7035 ICPL-96058 ICPL-87051	2.25
6	GMM	Solipet, Nalgonda Dist.	ICPL-7035 ICPL-96058 ICPL-87051	2.25
7	PEACE	Bhongir, Nalgonda Dist.	ICPL-7035 ICPL-96058 ICPL-87051	2.25
8	SPEAK INDIA	Puligilapadu, Nellore Dist.	ICPL-7035 ICPL-96058	1.5
9	RADS	Vikarabad, Ranga reddy Dist.	ICPL-7035 ICPL-96058	3.0
10	DDS	Zaheerabad, Medak dist.	ICPL-7035 ICPL-96058 ICPL-87051	2.25
11	CONARE	Achampet, Mahaboobnagar Dist.	ICPL-7035 ICPL-96058 ICPL-87051	3.0
12	SEVA	Desaipet, Warangal Dist.	ICPL-7035 ICPL-96058	2.00

*9 kg seed of each variety supplied to NGOs

Table 8: Locations of front line demonstration trials of ICP 7035 conducted during 2005-06 in four districts of Karnataka

	Farmer name and address	Area
	Tumkur district	
1	Umesh , Aralikatte, Tumkur (tq)	1.0 acre
2	Gnagaiah , Ajjigondanahalli, Tumkur (tq)	2.0 acres
3	Mahadevaiah, Ajjigondanahalli, Tumkur (tq)	2.0 acres
4	Nagaraj, Balya, Tumkur (tq)	10 guntas
5	Prabakar, Bellavi, Tumkur (tq)	0.5 acre
6	Rangaiah, Doddaveeranahalli, Tumkur (tq)	0.5 acre
7	Nandisha, Bommenahalli, Tumkur (tq)	0.5 acre
8	Siddalingaiah, Bellavi, Tumkur (tq)	0.5 acre
9	Shekar, Karalapalya, Tumkur (tq)	0.5 acre
10	Hanumanthaiah, Chikkanagavara, Tumkur (tq)	0.5 acre
11	Gangaraju, Kuchangi, Tumkur (tq)	1.0 Acre
12	Prasad, Kuchangi, Tumkur (tq)	30 guntas
13	D. Rangaswamy, Kuchangi, Tumkur (tq)	30 guntas
14	D. Suresh, Karalapalya, Tumkur (tq)	2.5 acres
15	Udaya Banu, Yellapura, Tumkur (tq)	2.5 acres
16	Basavaraju, Bommenahalli, Tumkur (tq)	2.5 acres
17	Nataraj, Bellavi, Tumkur (tq)	1.0 acre
18	Prakash, Kalikere, Tumkur (tq)	1.0 acre
19	Mangalamma, Chigondanahalli, Tumkur (tq)	1.0 acre
20	Uchanna, T. G. Halli, Tumkur (tq)	0.5 acre
21	Jagadish, Bellavi, Tumkur (tq)	25.0 guntas
22	Ragunath, Gowdihalli, Tumkur (tq)	10.0 guntas
23	Shiva Kumar, Dodderi, Tumkur (tq)	25.0 guntas
24	Mahesh, Aralikatte, Tumkur (tq)	25.0 guntas
25	Thimmanna, Gowdihalli, Tumkur (tq)	10.0 guntas
	Bangalore (Dist)	
1	Venkatesh, Magadi (Tq)	10.0 guntas
2	Venkatesh, Belagumba, Magadi (Tq)	10.0 guntas
3	Jayaram, Mutharayanagudi, Magadi (Tq)	10.0 guntas
4	Chikkarangaiah, Mutharayanagudi, Magadi (Tq)	10.0 guntas
5	Nagaraju, Kodarayanapalya, Magadi (Tq)	10.0 guntas
	Shimoga district	
1	Umesh, Yellapura, Channagiri (tq)	1.0 acre
	Kolar district	
1	Subbana, Kodegandlu, Chintamani (Tq)	10.0guntas

Tq = taluk

Table 9: On-farm trials of ICP 7035 in Southern Karnataka

Sl. No.	Farmer name and address	Area
1	Gangaih, Aralokatte, Tumkur (tq), Tumkur (Dist)	1.0acre
2.	Beere Gowda , Aralikatte, Tumkur (tq), Tumkur (Dist)	1.0 acre
3.	Shivanna, Aralikatte, Tumkur (tq), Tumkur (Dist)	1.0 acre
4.	Mudlagiriyappa, Aralikatte, Tumkur (tq), Tumkur (Dist)	1.0 acre
5.	Krishnappa, D, Aralikatte, Tumkur (tq), Tumkur (Dist)	0.5 acre
6.	Shivaramaiah, Channigaiah, Tumkur (tq), Tumkur (Dist)	0.5 acre
7	Umesh, T. M. Halli, Tumkur (tq), Tumkur (Dist)	0.5 acre
8.	Doddaiah, Doddaveeranahalli, Tumkur (tq), Tumkur (Dist)	0.5 acre
9	Shivanna, Aralikatte, Tumkur (tq), Tumkur (Dist)	0.5 acre
10	Jayanna, Lingadahalli, Tumkur (tq), Tumkur (Dist)	0.5 acre
11	Thimmegowda, Kuchangi, Tumkur (tq), Tumkur (Dist)	0.5 acre
12.	Prakash, Kuchangi, Tumkur (tq), Tumkur (Dist)	0.5 acre
13.	Vanaraju, Kuchangi, Tumkur (tq), Tumkur (Dist)	10guntas
14.	Lingaraju, Karalapalya,, Tumkur (tq), Tumkur (Dist)	10 guntas
15.	Venkatesh, Karalapalya, Tumkur (tq), Tumkur (Dist)	1.0 acre
16.	Hanumantharaju, Karalapalya, Tumkur (tq), Tumkur (Dist)	0.5 acre
17.	Ananda, Karalapalya, Tumkur (tq), Tumkur (Dist)	0.5 acre
18.	Hutchaiah, Karalapalya, Tumkur (tq), Tumkur (Dist)	0.5 acre
19.	Bhimaraj, Karalapalya, Tumkur (tq), Tumkur (Dist)	0.5 acre
20.	Nagaraj, Karalapalya, Tumkur (tq), Tumkur (Dist)	0.5 acre
21.	Siddalingappa, Karalapalya, Tumkur (tq), Tumkur (Dist)	10 guntas
22.	Krishnappa, Karalapalya, Tumkur (tq), Tumkur (Dist)	10 guntas
23.	Shiva Kumar, Karalapalya, Tumkur (tq), Tumkur (Dist)	0.5 acre
24.	Badrish, Ajjigondanahalli, Tumkur (tq), Tumkur (Dist)	2.5 acres
25.	Ganganna, Ajjigondanahalli, Tumkur (tq), Tumkur (Dist)	2.5 acres
26.	Prabakar, Bellavi, Tumkur (tq), Tumkur (Dist)	1.0 acre
27.	Renukaprasanna, C. T. Kere, Tumkur (tq), Tumkur (Dist)	0.5 acre
28.	Chitra Shekar, C. T. Kere, Tumkur (tq), Tumkur (Dist)	0.5 acre
29.	Ramaiah, Chigondanahalli, Tumkur (tq), Tumkur (Dist)	0.5 acre
30.	Siddappa, Soregunte, Tumkur (tq), Tumkur (Dist)	0.5 acre
31.	Parameshewaraiah, Seegehalli, Tumkur (tq), Tumkur (Dist)	0.5 acre
32.	Kempanna, Bellavi, Tumkur (tq), Tumkur (Dist)	0.5 acre
33.	C.S. Lingaraj, Bellavi, Tumkur (tq), Tumkur (Dist)	0.5 acre
34.	Shiva Kumar, Avalagunte, Tumkur (tq), Tumkur (Dist)	10.0 guntas
35.	Pandurangaiah, Bellavi, Tumkur (tq), Tumkur (Dist)	10.0 guntas
36.	Thimmanna, Gowdihalli, Tumkur (tq), Tumkur (Dist)	10.0 guntas
37	Rama Chandrappa, Soregunte, Tumkur (tq), Tumkur (Dist)	0.5 acre
38.	Umesh, Chelur, Gubbi (tq), Tumkur (Dist)	3.0 acres
39.	Bhaskar, Venkatapura, Magadi (Tq), Bangalore (Dist)	10.0 guntas
40.	Venkataswamy, Bettadasarapura, Magadi (Tq), Bangalore (Dist)	10.0 guntas
41.	Shivalingaiah, KVK, Tiptur, Tumkur (Dist)	1.0 acre
42.	Kempahonnaiah, Kuchangi, Tumkur (Tq), Tumkur (Dist)	0.5 acre
43.	Somashekara, Ballapura,	0.5 acre
44.	Sarojamma, Doddalu	0.5 acre
45.	Siddananjappa, Nagarjunahalli	0.5 acre
46.	Nagaraju, Chikkanavangala, Tumkur (tq), Tumkur (Dist)	0.5 acre
47.	Rangappa, T. Gollarahalli, Tumkur (tq), Tumkur (Dist)	0.5 acre
48	Shiva Kumar, Bellavi, Tumkur (tq), Tumkur (Dist)	0.5 acre

Tq = Taluk; Dist = District

Table 10: Village-level training courses to farmers on SMD management with emphasis on IPM conducted in Andhra Pradesh State, India

S.No	Item	Date	Location	Partner NGOs
1	Training on NPM (non pesticidal management) of pest and diseases on pigeonpea, castor and cotton	1/4/2005	Kesaram	PEACE, Bhuvangiri, Nalgonda
2	Seed village training, NPM options, Vermicomposting.	6/5/2005	Chowdarpally	PEACE,
3	NPM training in pigeonpea SM disease management	1/6/2005	Nagainepally	Bhuvangiri, Nalgonda
4	Training in IPM and management of SMD	1-5/6/2005	Chettupalli Thanda	REEDS, Achampet
5	Training on sustainable pigeonpea production and NPM	4/7/2005	Chowdarpally	PEACE,
6	Training on NPM of pest and diseases on pigeonpea, castor and cotton	10/4/2005	C.P. Tanda	CONARE, Achampet Mahaboobnagar
7	Usage of Neeem seed, NPM methods	5/5/2005	C.P. Tanda	CONARE,
8	Training on NPM on pigeonpea, castor and cotton	10/6/2005	Todellagadda	Achampet Mahaboobnagar
9	Training on NPM on pigeonpea, castor and cotton	20/6/2005	Todellagadda	CONARE,
10	Green manure, NPM option and compost making for pigeonpea farmers	10/7/2005	C.P. Tanda	Achampet Mahaboobnagar
11	Sustainable Agriculture Practices, seed village, NPM options.	19/9/2005	Todellagadda	CONARE,
12	Sustainable Agriculture Practices	5/9/2005	Sajjaraopet	DDS, Zaheerabad, Medak
13	NPM methods to manage SM, Wilt and pod borer in Pigeonpea	12/9/2005	Yedakulapally	DDS, Zaheerabad, Medak
14	Shaking method to dislodge pod borers and preparation of nucleopolyhedro virus (NPV) solution at village level	29/11/2005	Sajjaraopet	DDS, Zaheerabad, Medak
15	Training on Seed village concept	14/12/2005	Sajjaraopet	DDS, Zaheerabad, Medak
16	Training on neem seed collection and summer ploughing	7/6/2005	Enabai	CROPS, Jangoan Warangal
17	Management of SM, Wilt and pod borer in pigeonpea	11/8/2005	Enabai	CROPS, Jangoan Warangal
18	training on preparations of neem seed solution, Tobacco decoction, Chilli-garlic extraction and cow-dung-urine solution	30/7/2005	Field office-Parvatagiri	Mari, Hanmakonda Warangal
19	Health hazards of pesticides, and awareness on NPM was conducted	5/8/2005	Field office-Parvatagiri	Mari, Hanmakonda Warangal
20	Making better profit from pigeonpea	4/11/2005	Payalamaddi village	REEDS, Achampet
22	Making better profit from pigeonpea	8/1/2006	Kasturipalli village	REEDS, Achampet

Table 11: Farmer field days and exposure visits organized in Andhra Pradesh and Karnataka during 2005-06

S.No	Item	Date	Location/Village	Partners
1	Farmers exposure visit to ICPL 96058 demonstration field [100 farmers]	28/9/2005	Linganpall, MBNR, Andhra Pradesh	REEDS, Achampet
2	Awareness programme on pigeonpea biotic constrains and farmer-scientist interaction [45 farmers]	26/10/2005	Agriculture Research station, Gulbarga, Karnataka stae	ARS-Gulbarga
3	Awareness campaign for management of pest & disease	5/10/2005	Gowdanahalli, Sedam district, Karnataka state	ARS-Gulbarga
4	Farmers exposure visit to ICPL 96058 demonstration field [100 farmers]	4/11/2005	Pyalamaddi villages. MBNR, Andhra Pradesh	REEDS, Achampet
5	District level farmers day to demonstrate performance of ICPL 96058 along with local varieties [250 farmers]	12/12/2005	Pattan village, Gulbarga taluk, Gulbarga, Karnataka state	ARS-Gulbarga
6	Performance of ICP 7035 and farmers scientist interaction [200 farmers]	20/12/2005	Yellapur village, Tumkur, Karnataka	University of Agriculture Sciences, Bangalore and Extension Education Unit, Tumkur, Karnataka
7	A field day at Agricultural Research Station, Gulbarga to demonstrate advanced pigeonpea breeding lines and also ICPL 96058 [200 farmers]	2/1/2006	Gulbarga, Karnataka state	ARS-Gulbarga

**Fields days were officiated by local Agriculture and Extension Officers, Districts Agriculture Commissioners, scientists from ICRISAT and local NARS.*

Table 12: Seed villages for the multiplication of two SMD resistant varieties, ICP 7035 and ICPL 96058 established in Andhra Pradesh and Karnataka sate

S. No.	Village	Overseeing Organization	Pigeonpea variety	Seed quantity per season (kg)
1	Solipet, Nalgonda, Andhra Pradesh	GMM, Nalgonda, Andhra Pradesh	ICP 7035	100
2	Achampet, MBNR, Andhra Pradesh	CONARE, MBNR, Andhra Pradesh	ICP 7035	200
3	Jangoan, Warangal, Andhra Pradesh	CROPS, Warangal, Andhra Pradesh	ICP 7035	100
4	Buvangir, Nalgonda, Andhra Pradesh	PEACE, Nalgonda, Andhra Pradesh	ICP 7035 ICPL 87051	100
5	Pyalamaddi, MBNR, Andhra Pradesh	REEDS, MBNR, Andhra Pradesh	ICPL 96058	200
6	CP Thanda, MBNR, Andhra Pradesh	REEDS, MBNR, Andhra Pradesh	ICPL 96058	200
7	Linganpalli, MBNR, Andhra Pradesh	REEDS, MBNR, Andhra Pradesh	ICPL 96058	200
8	Buranpur, MBNR, Andhra Pradesh	REEDS, MBNR, Andhra Pradesh	ICPL 96058	200
9	Bommanhalli, Gulbarga District, Karnataka	Agriculture Research station, Gulbarga	ICPL 96058	300
10	Pattan, Gulbarga District, Karnataka	Agriculture Research station, Gulbarga	ICPL 96058	300
11	Lengte, Gulbarga District, Karnataka	Agriculture Research station, Gulbarga	ICPL 96058	300
University of Agriculture Sciences, Bangalore Seed Production:				
1	Yellapur village, Tumkur taluk. Karnataka	University of Agriculture Sciences, Bangalore	ICP 7035	1200

Figure 9: Various on-farm activities for the management of SMD


Awareness camp and Group discussion with farmers at Tadola village


Training to women farmers on SMD management and Seed village at CONARE

Farmers, Scientists interaction meet held at Gulbarga


Farmers observing different varieties of SMD resistant varieties in demonstration trials resistance


ICPL-96058 in farmers fields at, Jangoan, Warangal


Board Director, Vice Chancellor and other dignitaries of UAS Dharwad in the demonstration field of SMD resistant varieties

Contribution of Outputs to developmental impact

The project promoted technologies to mitigate the impact of SMD on pigeonpea productivity. The project outputs contribute to the identification of 12 new sources of SMD resistance in 100-140 days maturity that are needed to cope with terminal drought, a frequent problem in rainfed regions in India. Evaluation of core collection led to the identification of 13 new SMD resistant sources for further evaluation, and utilization in breeding / release for farmer cultivation. Both these outputs are seed-based, which are sustainable and needs no extra investment from farmers/NARS for adoption. Promising SMD resistant sources were widely promoted for farmer cultivation in SMD endemic areas of Andhra Pradesh and Karnataka states, through varietal release programmes (2 varieties released), establishment of seed villages for sustainable seed production at local level (10 seed villages), promotion of IPM technologies, post-harvest processing of pigeonpea for protection against storage pests, which also fetching higher price to farmers through sale of *Dhal* directly in the markets. All these steps are contributing to enhanced pigeonpea yields and increased incomes to farmers.

IPM training for the management of SMD, wilt and pod borer strengthened the local capacity and led to promotion of improved disease resistant cultivars and crop management technologies. Local NGOs and extension units of NARES, have substantial capacity and experience to backstop and further promote these aspects. Capacity building at village-level for seed production under the aegis of local NGOs and progressive farmers would ensure the sustainability of seed production of improved varieties. Greater access and awareness on improved cultivars and technologies through on-farm trials, plus training in pest management and seed-processing, led to higher revenues to the farmers. Since these are profitable to farmers, increasing number of farmers are adopting.

ICRISAT and NARES will continue to support research, and solicit additional funding to continue research on SMD, especially on characterization of isolates and selection of resistant varieties. Through CGIAR GCP funded projects, pigeonpea genotypes selected from the mini-core collection will be further evaluated and promoted for use in breeding programmes and farmers cultivation. Recent breakthrough in development of ‘pigeonpea hybrids’ at ICRISAT has attracted enormous response from private seed corporations, who are funding pigeonpea hybrid research. Developing SMD resistant parents is a key component of this research. Technology and promising cultivars selected from this work are fundamental inputs to this work that creates a good impact.

This project addressed a priority constraint on pigeonpea production in the subcontinent. Research institutes, especially ICRISAT and the Indian Council of Agriculture Research (ICAR), have pigeonpea in their mandate with a research agenda supported from core and external agencies for the application of the technologies developed from CPP projects to continue research for sustainable management of SMD and other biotic problems. These institutes have extensive networks for dissemination to various stakeholders in the subcontinent.

Biometricians Signature: Not applicable