Suggested Reading

Saxena KB. 2006a. Hybrid pigeonpea seed production manual, Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. ICRISAT. Pp 24.

Saxena KB. 2006b. Seed production systems in pigeonpea, Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. ICRISAT. Pp 70.

Saxena KB and **Kumar RV.** 2006. Hybrid Pigeonpea Research and Development. Pages 167-207 *in* Hybrid Parents Research at ICRISAT. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Saxena KB, Kumar RV, Srivastava N and **Shiying B.** 2005. A cytoplasmic-nuclear male-sterility system derived from a cross between *Cajanus cajanifolius* and *C. cajan.* Euphytica 145: 291-296.

About ICRISAT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a nonprofit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Future Harvest Centers of the Consultative Group on International Agricultural Research (CGIAR).

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ICRISAT

Hybrid Pigeonpea

.....seeds of excellence

- Pigeonpea is a drought tolerant legume crop of tropical and sub-tropical regions of Asia, Africa, Latin America and the Caribbean. It plays an important role in subsistence agriculture because it produces protein-rich food with fewer inputs.
- India has the largest pigeonpea growing area (3.5 m ha) with an estimated annual production of 2.5 m tons. The major pigeonpea growing Indian states are Maharashtra, Karnataka, Andhra Pradesh, Uttar Pradesh, Bihar and Madhya Pradesh.
- Pigeonpea is cultivated in the rainy season in diverse cropping systems. The early maturing (120-140 d) types are grown as a pure crop, while the medium (160-180 d) and long (>200 d) duration varieties are cultivated as an intercrop with sorghum, pearl millet, cotton, groundnut etc.

Why Hybrids

- 25-30% higher yield than varieties
- Greater drought tolerance
- Greater disease resistance
- Greater stability

- India is the major consumer of pigeonpea and about 500,000 tons of grains are imported annually from Myanmar and Africa to meet the demand, which exceeds the production.
- To meet the protein needs of the growing population in India, it is essential to increase the production of pulses. A number of pigeonpea varieties have been released for cultivation. The area has increased to a certain extent but to date the yield has remained unacceptably low (Fig.1).

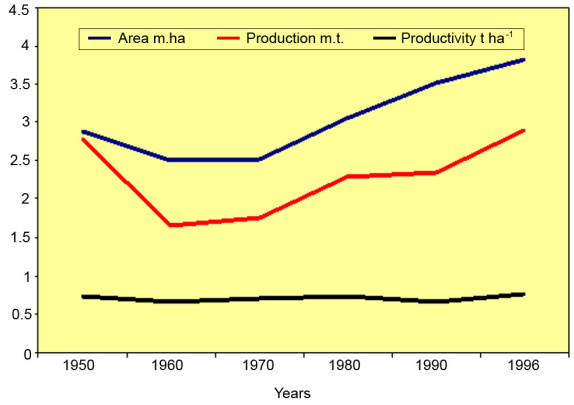

Fig. 1 Pigeonpea area, production, and productivity in India.

- ICRISAT along with its partners, has developed a new hybrid breeding technology, which is expected to enhance the production in farmers' fields by a margin of 30% or more. This is expected to break the yield barrier in pigeonpea.

The Technology

- The research on hybrid pigeonpea technology began with the discovery of a genetic male-sterility (GMS) system, leading to the release of the world's first pigeonpea hybrid, ICPH 8, in 1991.
- ICPH 8 recorded 25-30% higher yield over the best available variety, in farmers' fields. This was followed by the release of five more GMS-based hybrids with a similar yield advantage. These hybrids, however, never became popular due to seed production problems.
- To further improve the hybrid seed production technology, ICRISAT and partners developed the cytoplasmic-nuclear male-sterility (CMS) systems using the cytoplasm of wild relatives of pigeonpea (Table 1).

Table 1. Pigeonpea CMS Systems

CMS System	Cytoplasm donor
A_1	*Cajanus sericeus*
A_2	*C. scarabaeoides*
A_3	*C. volubilis*
A_4	*C. cajanifolius*
A_5	*C. cajan (cultivated)*

managers from various (Fig 8) public and private seed sector institutions. We also assist our partners by providing need-based breeding materials to strengthen their research programs. The feedback we receive from our partners always guides us in revamping our research agenda.

Present Research and Development Activities

- Genetic diversification of parental lines
- Search for new cytoplasm donors
- Trait based parental line development
- Molecular characterization of parental lines
- Human resource development
- Sharing technology with public and private sector

Our Research Partners

- Ankur Seeds
- Biogene Agri-tech
- Bioseed Research
- Indian Council of Agricultural Research
- JK Agri Genetics
- Krishidhan Seeds
- MAHYCO
- Nath Seeds
- Nimbkar Seeds
- Nuziveedu Seeds
- Pradham-Biotech
- SM Sehgal Foundation
- Zuari Seeds
- CAAS,Beijing, China
- GxAAS, Guangxi, China
- YAAS & IRI, Kunming, China

Technology Transfer

ICRISAT believes in partnership-based targeted research and development activities. To achieve this we conduct both formal and informal training programs on various aspects of hybrid pigeonpea technology. In the last three years we have trained over 50 scientists, technicians, and research

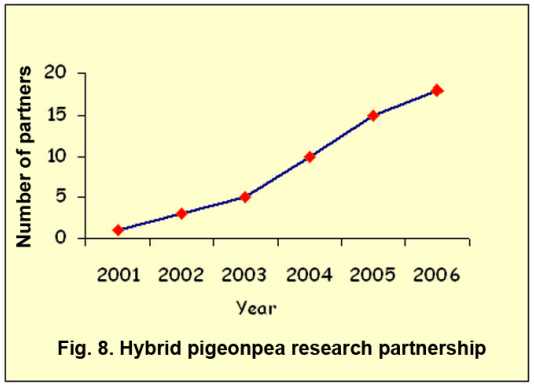

Fig. 8. Hybrid pigeonpea research partnership

Fig. 2. Cajanus cajanifolius, source of A_4 CMS system

Fig. 3. Stable CMS line- ICPA 2039

- Among the five CMS systems developed, the one with A_4 cytoplasm derived from *Cajanus cajanifolius* (Fig.2) is the best.
- ICPA 2039 (Fig.3), is a stable A_4 CMS line, with no pollen shedders and a high frequency of stable fertility restorers.

Table 2. Variation for important agronomic traits among A-lines

Character	Range
Days to flower	55 - 135
Days to maturity	100 - 198
Plant height (cm)	74 - 245
100- seed mass (g)	8.6 - 13.8
Seeds pod^{-1}	3.2 - 5.6

- A strong pigeonpea breeding program at ICRISAT is diversifying the genetic base of the male-steriles and fertility restorers with increased emphasis on disease and insect resistance, stability, and yield.
- At present we have 31 A_4 CMS lines with a large variation for important agronomic traits (Table 2). Seven of these A-lines also have a high level of resistance to wilt and sterility mosaic diseases.

Table 3. Fertility restorers of A_4 cytoplasm

Maturity group	Lines	Days to flower	Seed pod^{-1}	100-seed mass (g)
Extra short	15	< 70	3.0 – 4.1	6.2 – 12.7
Short	17	71 – 80	3.0 – 4.1	6.7 – 12.1
Medium	45	81 – 130	3.4 – 4.5	7.5 – 14.7
Long	14	> 130	3.3 – 4.9	7.7 – 14.0

- So far we have identified 91 fertility restorers of A_4 cytoplasm in different maturity groups (Table 3). Of these, 37 restorers are resistant to wilt and sterility mosaic diseases.
- Large-scale seed production of A-lines is undertaken in isolation (300-400 m distance) using a row ratio of 1 male (B-line) : 4 female (A-line). Seed on the male-sterile plants is produced by cross-pollination carried out by a variety of insects (Fig.4). About 800-1000 kg ha^{-1} seed of A-lines can be harvested under good management.

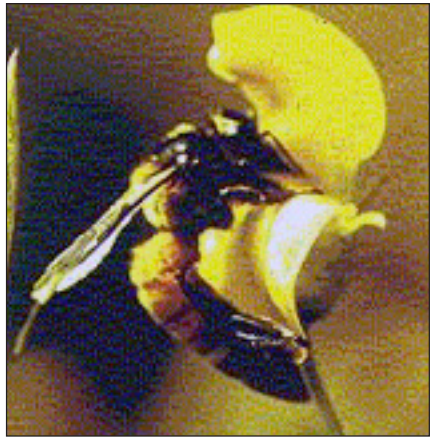

Fig. 4. Honeybee mediated out-crossing.

- For hybrid seed production also, a row ratio of 4 A-lines : 1 R-line is used. At ICRISAT we harvested > 1000 kg ha^{-1} of hybrid seed of ICPH 2671 (Fig.5).
- To maximize the yield of A-line and hybrid, the male : female row ratio could be modified for different environments.

Fig. 5. Pigeonpea hybrid seed production block.

Performance of Hybrids

- Among the experimental hybrids tested at Patancheru in 2005, ICPH 2438, 3310, 3308, 3496, and 3446 were found outstanding with standard heterosis of 20 to 207% (Fig.6).

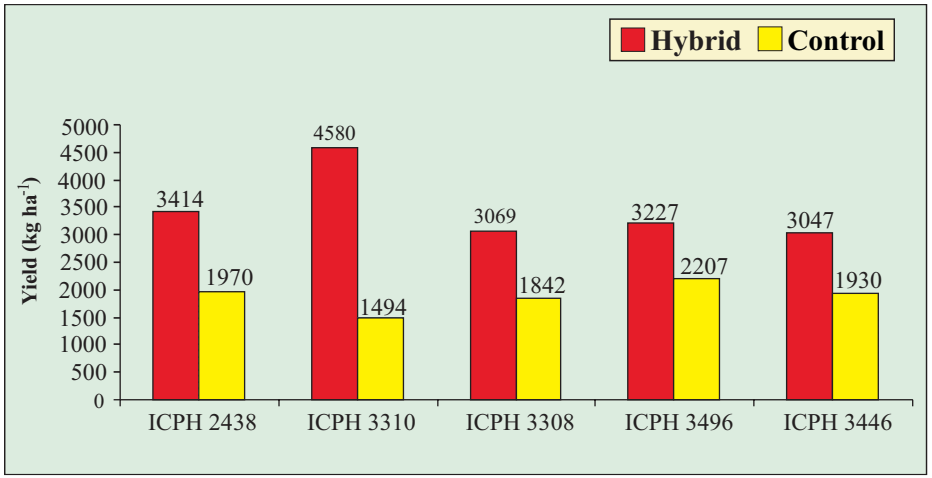

Fig 6: Yield (kg ha^{-1}) of promising hybrids and controls at Patancheru, 2005.

- In multilocation (five locations) trials, hybrids ICPH 2438, 2363, 2788, 2740, and 3331 were promising with 11 to 106 % superiority over the control (Fig.7) in 2005.

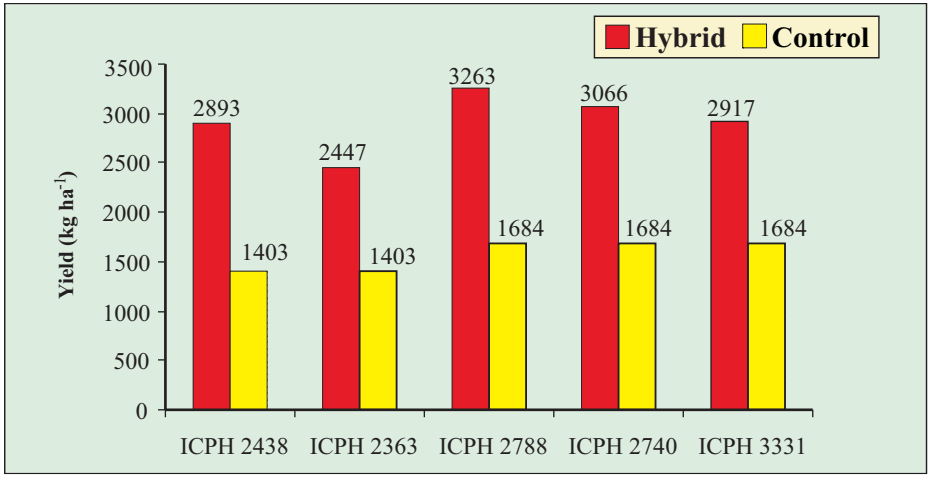

Fig 7: Yield (kg ha^{-1}) of promising hyrbids and controls in multilocation trials, 2005.