Participatory Cotton Breeding and Cultivar Evaluation for Organic Smallholders in India

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bioRe
Organic cotton cooperation in Madhya Pradesh

Chetna Organic
Organic cotton producer cooperation in Orisha

University of Agricultural Science (UAS)
Dharwad in Karnataka
Organic Cotton Production on global level


footnote:
1. Data rounded to the nearest whole number
Challenges of Organic Cotton in India

- Organic cotton in India is less than 2%, while genetically modified Bt cotton reached 95% in less than 10 years.
- Seed market for non GM seed completely eroded.
- High cost for certification / tracing system (Tracenet) and for testing GM contamination of seeds and harvest.
- Reduced interest of farmers to grow organic cotton:
  - Reduced yield & longer picking periods compared to Bt cotton.
  - Improvement of organic cotton cultivation (composting, irrigation, systemic plant protection, resilient cultivars).
  - Market development for other crops in cotton rotation.
  - Other labels like BCI are more attractive, easier to achieve.
  - Other crops become more attractive (market price, time till sale, risk of contamination, availability of seed in time).
Area under GMO cotton of main producing countries

Reference: www.transgen.de
Competition with other labels like BCI (Better Cotton Initiative) introduced in 2010

Figure 1: Sales of different sustainable cotton labels, source Warrik (2013)
Cultivated cotton species in India

- **Gossypium hirsutum**
  - Upland cotton tetraploid

- **Gossypium barbadense**
  - Pima / Egyptian cotton tetraploid

- **Gossypium arboreum**
  - Desi cotton diploid

- **Gossypium herbaceum**
  - Desi cotton diploid
Change of cultivation area in different cotton species in the last decades in India

Prof. Dr. R. W. Bharud, Mahatma Phuke Agricultural University Rahuri, MA
All Indian Cotton Improvement Project
How can organic cotton be safeguarded in India?

短期行动：确保种子供应

- 建立与公共和私营棉花利益相关者建立网络，他们有相同的兴趣（Dharwad 声明）
- **培训与能力建设**（Training & Capacity building）对有机棉花种植者进行农场上的品种测试和种子乘积
- **田间和实地品种测试**（On-Station and On-Farm Cultivar Testing）与农民一起，为适应当地小农户有机种植条件的品种适合性

中长期行动：改进适应有机种植的棉花品种

- 收集和利用棉花种质资源的全多样性，尤其是更**强壮的本地Desi棉花**（G. arboreum）和适应的G. hirsutum自交系和公共杂交品种
- 建立分散的参与式棉花育种项目，专注于有机棉花生产者的种植条件

→ 获得**种子主权**（Seed Sovereignty）的高质量棉花种质
Networking, Collaboration, Awareness rising

On National Level

- National Workshop on Safeguarding non-GM cotton in Dharwad 2011 → Dharwad Declaration (Press release)
- National Workshop on Breeding and Seed supply of non-GM cotton in Kasrawad in March 2013 (exchange among stakeholder)
- Indian Round Table of Organic Cotton co-organized by CottonConnect and C&A Foundation in Indore in March 2014

On International level

- Pre-Conferences on organic cotton of OWC in Oct. 2014 organized by Textile Exchange and Helvetas

www.organiccotton.org; http://farmhub.textileexchange.org
www.greencotton.org
Capacity building
Involve farmers in selection criteria, cultivar testing & selection, breeding activity

Cultivar selection

Single plant selection

![Graph showing priority of traits for farmers]

- Height
- Many Branches
- Boll size
- 4-5 compartments
- Deep root
- Boll opening
- Easy picking
- Easy cotton release
- Continuous flowering
- Hairy leaves
- Earliness
- No Wilting
- Germination
- Fiber quality
- Disease tolerant

Male (%) | Female (%)
New crosses of *G. arboreum*

- Collection of desi cotton *G. arboreum* 2013
- Intra (interspecific) crosses 2013/14
- Multiplication of offspring 2014/15
- Single plant selection 2015/16
- Decentralized single plant selection 2016/17
Selection of locally adapted advanced lines

- Observation trials of advanced breeding lines of G. hirsutum, G. arboreum at Kasrawad by BioRe
- Observation trials of advanced breeding lines of G. hirsutum, G. arboreum and G. barbadense at Orissa by Chetna organic
- Selection of best lines for further evaluation in the following years
- On station trails at several locations managed by breeder at each region
- On farm trials managed by instructed farmers
- Pilot cultivation of best selections
Field trials 2013/14

- Two sites at Madhya Pradesh
  - Heavy soil with drip irrigation
  - Light soil with limited irrigation

- Two sites at Odhisa
  - Shallow soil rainfed
  - Black soil rainfed

- 24 on farm trials in neighbouring villages
Distribution of On-Farm Trials in Madhya Pradesh

- Chhoti Kasrawad
- Pipalzopa
- Chichlai-2
- Balkhad
- Aashapur-2
- Choli
- Bada-3
- Devziri
- Ajandi
- Bhilav
- Nimrani
- Badi
- Balakwada
- Amlatha
- Jowd
- Katary
- Bhaklai
- Choli
- Choli-3
Madhya Pradesh Light Soil Trial rainfed 2013/14

GCP LST Hirsutum 2013/14 (Rep. I&II)  Cotton yield (kg) / Acre

Hirsutum varieties

GCP LST (R-I&II) Cotton yield (kg) / Acre

Arboreum varieties
Conclusions

- Organic Sector has to take responsibility for its own seed supply otherwise organic cotton is lost in India.

- Priorities for optimal traits are quite different between breeders, farmers, also between female vs. male farmers, and the textile industry, to be successful ALL aspects must be considered.

- Under low fertility and rainfed conditions traditional *G. arboreum* have much higher yield than *G. hirsutum*. Introgression lines of *G. arboreum* can meet good fiber quality, but picking time is increased. Inbreds lines can outyield hybrids under less favorable conditions.

- A broad range of genotypes is needed to cover the different growing systems and pedoclimatic conditions & demands of textile industry. Breeding is indispensable to cope with climate change and new pest & diseases evolving.

- Cultivation (e.g. plant density) need to be adjusted to each cultivar, therefore breeding must go hand in hand with improvement of plant management and anticipated future trends like mechanical harvest. A global marketing strategy of organic cotton is needed!!!!
Thanks a lot to your attention and to all who have supported the cotton seed projects so far.

Normal people just see a seed:

Gardeners see the dreams within.

Joseph Tychonievich
First Steps: The Dharwad Declaration

- National Workshop June 21st 2011: «Disappearing non-GM cotton - ways forward to maintain diversity, increase availability and ensure quality of non-GM cotton seed» Dharwar Declaration

- Jointly organized by bioRe India Ltd., FiBL Switzerland, University of Agricultural Sciences Dharwad including main stakeholders

- To combine forces for immediate action and support of:
  - Collaboration & Exchange, e.g. private public partnership
  - Desired Policy Changes, e.g. establishing GM-free zones
  - Evaluation and multiplication of existing cotton cultivars under
Goals and Objectives of Green Cotton

- Safeguarding the future seed supply of non-GM cotton crucial for the organic cotton production and textile industry
  - Improving yield stability & fibre quality and adaptation to local growing conditions by decentralized selection on non-GM cotton in the target environment

- Promoting genetic diversity in the field with special focus on the utilization of tradition Desi cotton germplasm to get prepared for climate change
  - Performaning specific crosses with desi cotton for organic and marginal growing conditions

- Enabling farmers and farmer organisations to retain seed sovereignty to become more independent from high input costs
  - Initiation of participatory breeding involving farmers in selection
  - Training of farmers → certified farmer breeders for selection & seed propagation
Influence of GM cotton on Organic Cotton

Fast spread of GM cotton in the last 10 years
- Globally 24.7 million hectares GM cotton (86%)
- Bt cotton: India, China, Pakistan, Myanmar, Burkina Faso, Brazil, USA, Argentina, Australia, Colombia, Costa Rica
- Bt & Herbicide resistant cotton: USA, Argentina, Australia, Brazil, Mexico, Colombia, South Africa

Co-existence of organic and GM cotton extremely difficult
- Risk of physical contamination during storage, ginning, transport etc.
- Risk of genetic contamination due to outcrossing of pollen from neighboring GM cotton plants and by seed mixtures
- Severe economic losses due to rejection of contaminated cotton as well as high costs for installation of respective monitoring systems, which has to be paid by the organic sector
Participatory technology development (PTD)

Technology improvement for organic farmers

Mother trial (on-station)

Baby trial (on-farm)

Baby trials (on-farm)

Baby trial (on-farm)
On Farm Trial 2013/14

On Farm Trials Set 1 and Set 2

Seed cotton yield kg/acre

- On farm trial Heavy Soil
- On farm trial Light Soil

Varieties:
- RAAS
- 320-5
- DV-8
- DV-106
- M-9632
- DAS
- Suraj
- DV-101
- DV-114
- M-9632
- Across all

www.fibl.org
## Important traits identified by farmers at workshop in November 2013

<table>
<thead>
<tr>
<th>TRAIT</th>
<th>21 male farmers</th>
<th>12 female farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium height 4 feet</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Lot of branches</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Less space between 2 bolls</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><strong>Big boll Size</strong></td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>4-5 compartment</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Deep root</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td><strong>Boll opening fully</strong></td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td><strong>Easy picking</strong></td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Easily cotton release from bolls</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td><strong>Cont. flowering and flush</strong></td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Hairy leaf less pest attack</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Strong stem and no banding</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Early variety</strong></td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Proportionate batter for flower</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td><strong>No wilting problem</strong></td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>Good germination</strong></td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Good quality cotton</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td><strong>Less diseases</strong></td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
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