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**Seeding the
Green Future**



Seeding the Green Future

Participatory breeding for Securing Organic Cotton and Genetic Diversity

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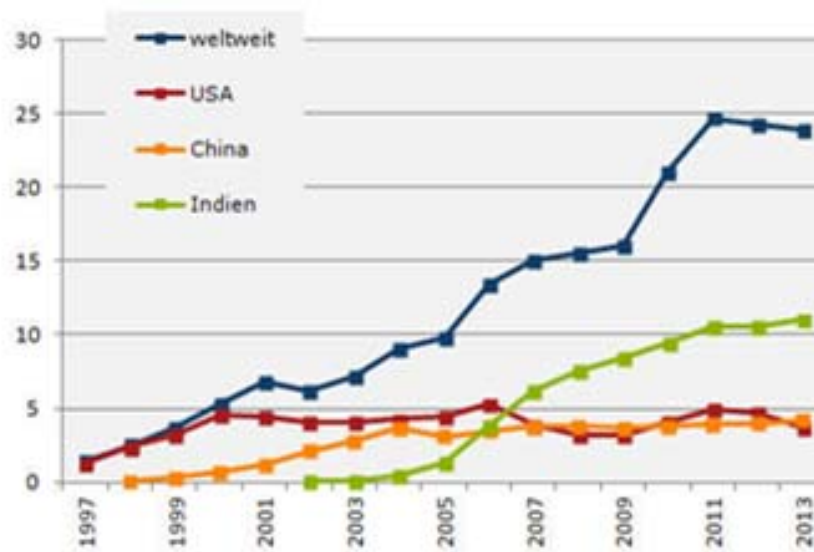
Meeting Point Organic right from the start! biofach Messe Nürnberg organic breeding exhibition

Nürnberg, 15th February 2019

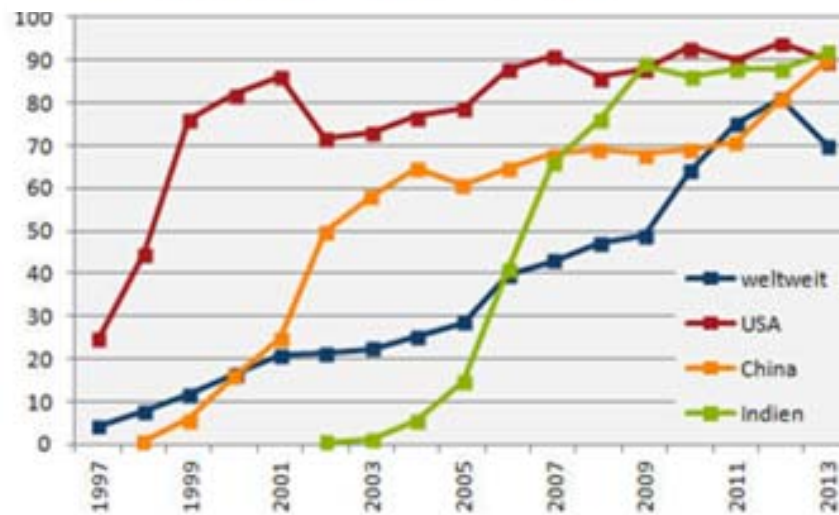
Challenges of organic cotton in India

- India has been the largest organic cotton producer, 10 years ago India supplied 80% but dropped now to 56%, with a decrease of 20% from 2014/15 to 2015/16!!!
- Organic cotton in India is less than 2%, while genetically modified Bt cotton reached 95% in less than 10 years
- Public breeding and seed multiplication were neglected
- Local non-GM seed supply were eroded
- Commercial seed companies have limited interest in non GM cotton (higher production risks, risk of Bt contamination, small demand)
- High dependency on global seed company holding Bt licence resulting in high seed price and concentration on high input agriculture (high level of fertilizer, pesticide, irrigation)
- Breeder's seed is already contaminated with Bt, causing Bt contamination throughout the cotton value chain

Area under GMO cotton of main producing countries



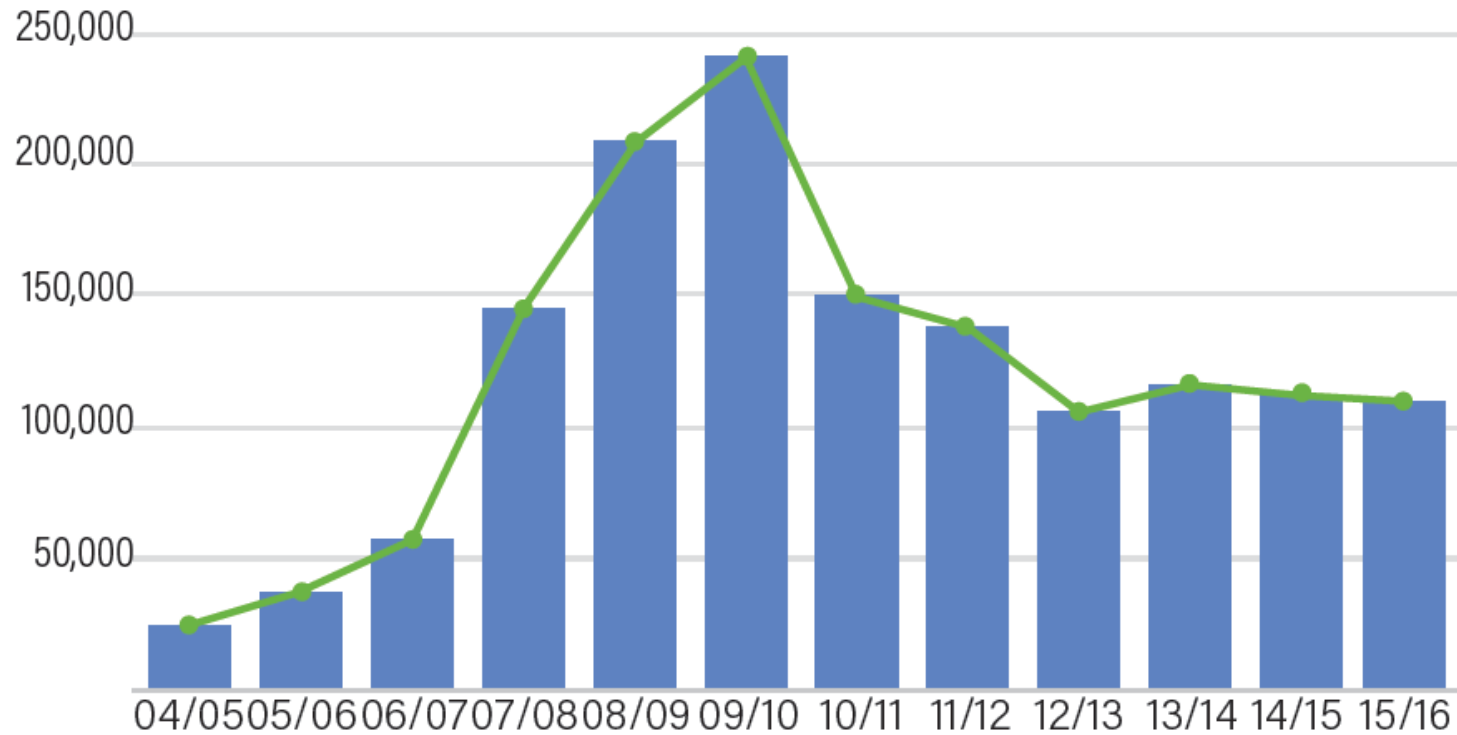
Anbauflächen gv-Baumwolle in Millionen Hektar



Anteil gv-Baumwolle an der Anbaufläche eines Landes in Prozent

Organic Cotton Production on global level

Global Fiber Production Trend (MT)



Textile Exchange: Organic Cotton Market Report 2017

Challenges and Research Gaps of Organic Cotton

- Limited genetic improvement of non-GM cotton after introduction of Bt-cotton
- Missing public breeding programs for organic and low input conditions and nationwide cultivar testing under organic conditions
- Loss of genetic diversity: the more resilient traditional desi cotton (*G. arboreum*) disappeared from production

Cultivated cotton species in India

***Gossypium
hirsutum***

Upland cotton
tetraploid



***Gossypium
barbadense***

Pima /
Egyptian cotton
tetraploid



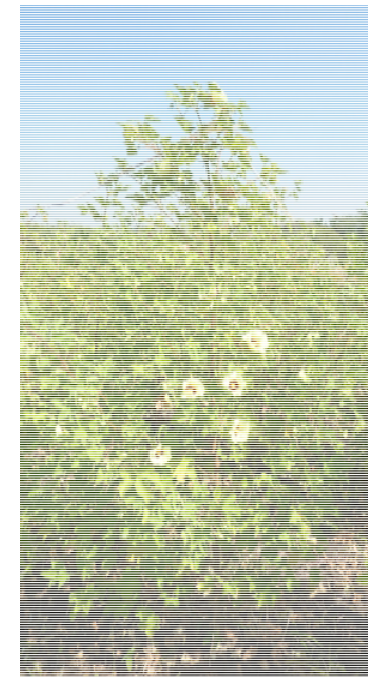
***Gossypium
arboreum***

Desi cotton
diploid

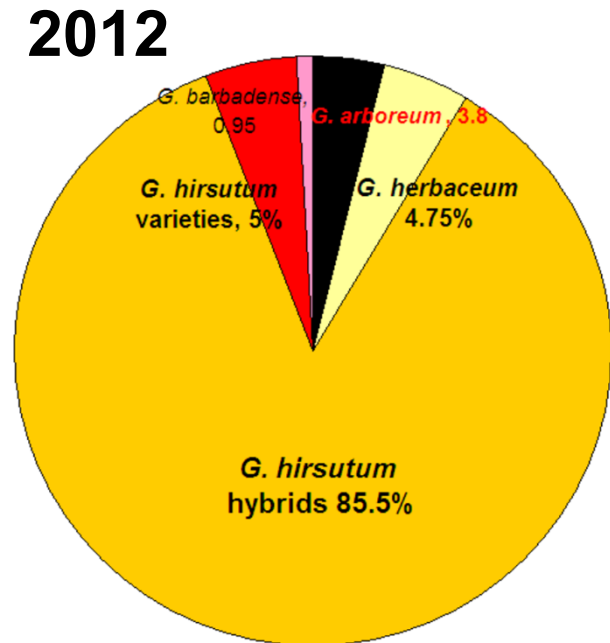
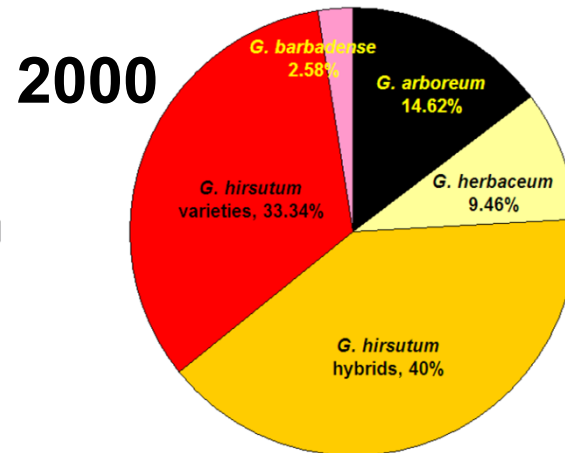
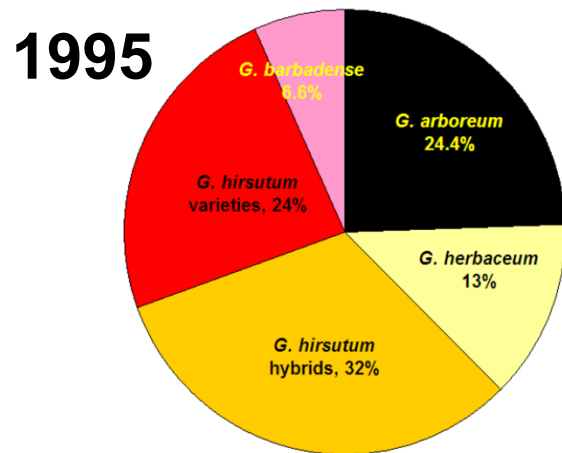
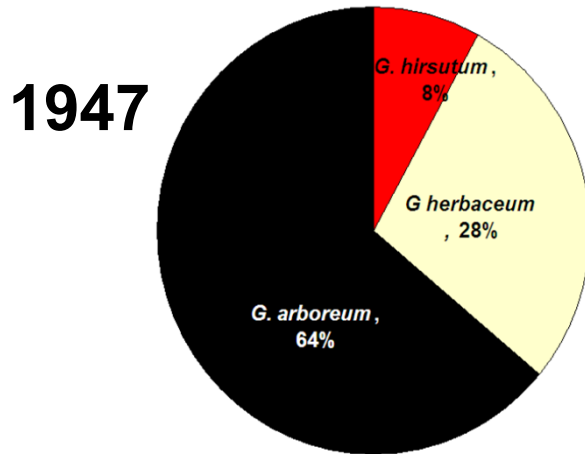


***Gossypium
herbaceum***

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

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 organic and low-input conditions
- Establishing and optimizing the non-GM seed chain
- Continuous improvement of non-GM cultivars





GREEN COTTON

Decentralized Participatory Cotton Breeding for Organic and Marginal Growing Conditions in India

In collaboration with Partner Organisations:

- bioRe Association
- Chetna Organic
- University of Agricultural Science Dharwad

Timeframe: 2013 – 2016 (option for prolongation)

Supported by Mercator Foundation Switzerland



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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**
 - › Performing 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



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Phase II of Green Cotton 2017 - 2022

Team



Partners



Pratibha



Supporters:



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15 February 2019

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Objectives:

- **Continuation of participator breeding initiatives and upscaling of the activities in different States in India**
- Secure non GM seed supply chain of adapted cultivars for organic cotton farmers
- Develop a broad portfolio of new cotton cultivars of American and traditional Desi cotton with
- Improve integrity of organic cotton by capacity building and close collaboration of actors among the supply chain
- Improve livelihood of small holder cotton farmers
- Empower female and male farmers to manage their own seed supply free of GMO and adjusted to local conditions and climate change

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Local partners

Organic cotton growers organisations:

- **Chetna Organic**: involved in Green Cotton participatory breeding since 2013
- **Pratibha Synthex**: started with on station organic breeding
- **Cotton Connect**: link to many organic growers associations on farm trials
- **Action for Social Advancement (ASA)**: on farm trials
- **Center for Sustainable Agriculture (CSA)**: on farm trials

Public institutions and universities:

- **RVSKV Gwalior university – Khandwa College**: testing for truthfully labeled seed under organic conditions, seed multiplication, crosses
- **JN Agric. University Jabalpur**: interested to support organic cotton farmers
- **Akola university**: running breeding programs of *G. hirsutum* and *G. arboreum* cotton
- **MKV Parbhani University**: breeding of long fibre arboreum cotton

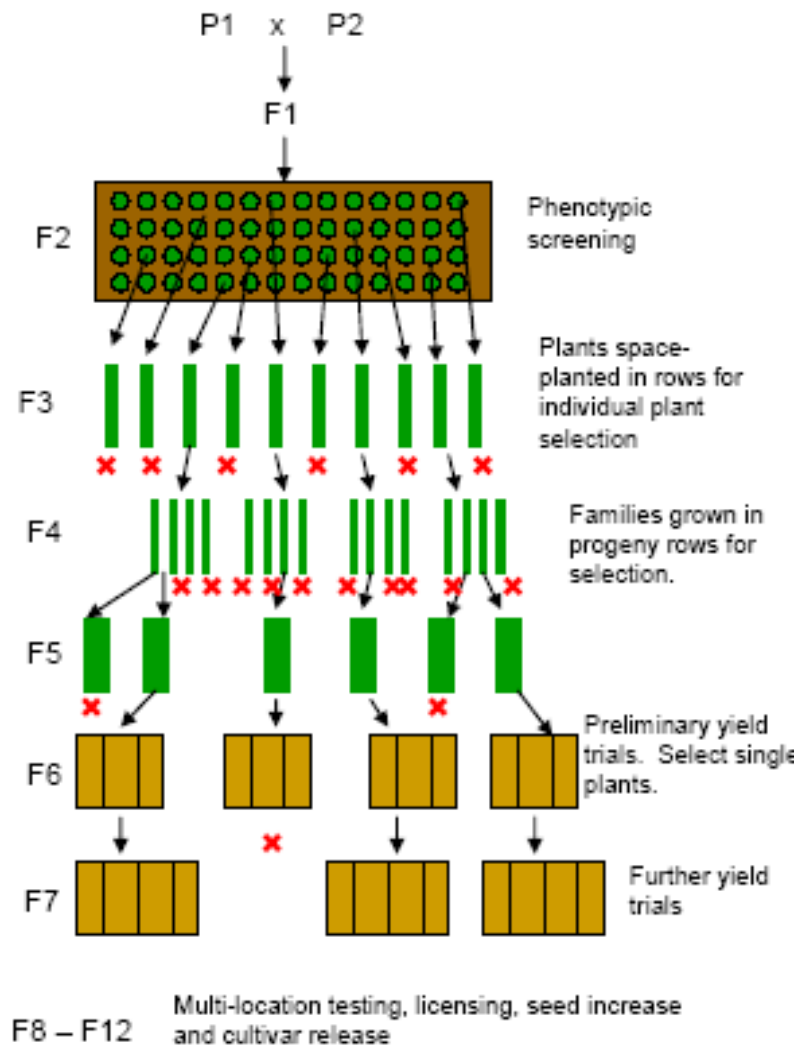
Commercial seed companies providing non GM seed on contract basis: Dafthari seeds, Green Gold Seeds, JK Seeds, Nirmal Seeds, Bloom biotech, Krishidhan seeds, Nuziveedu seeds, Ankur Seeds Ltd

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Methodology:

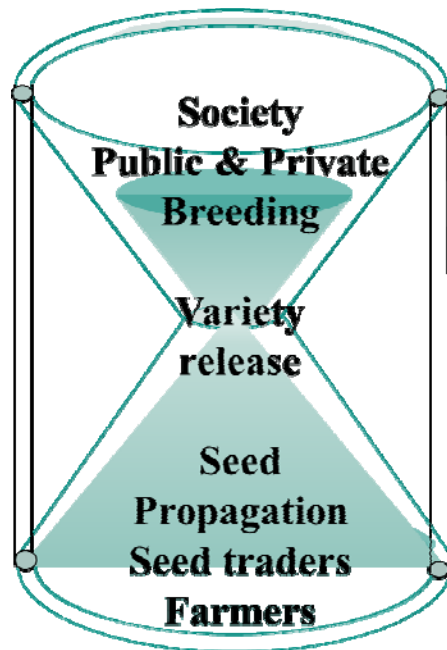
- Scale up participatory cotton breeding by empowering farmers through collaboration with researchers, breeders, seed companies, advisors, textile industry
- Utilizing full potential of genetic cotton resources in India
 - Explore potential of traditional diploid desi cotton (*G. arboreum*) in order to combine drought resistance, tolerance to sucking pest, nutrient use efficiency with fiber quality (>28mm)
 - Explore the potential of tetraploid *G. hirsutum* cotton varietal lines bred and selected under organic condition
- Training of trainers & farmers and implementation of
 - organic on-station and on-farm trials for cultivar testing and selection
 - cross breeding and single plant selection
 - Maintenance breeding, seed multiplication, seed quality and GMO testing

Breeding Scheme



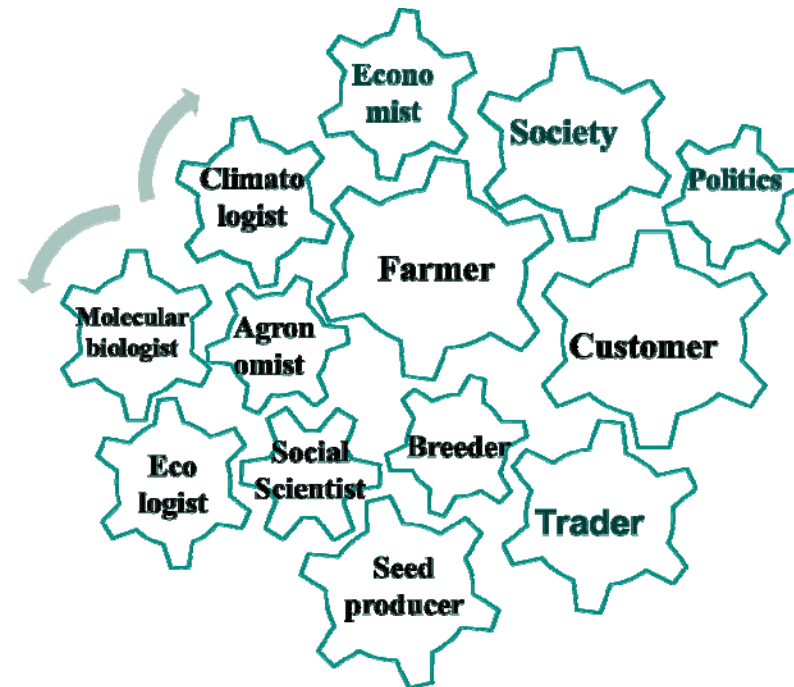
Participatory Cultivar Evaluation and Participatory Breeding as a viable Alternative to Seed Monopoly

Formal plant breeding and seed supply



**One Way
Information:
Scientist**
↓
**Extension
Service**
↓
Farmer

Participatory plant breeding and seed multiplication

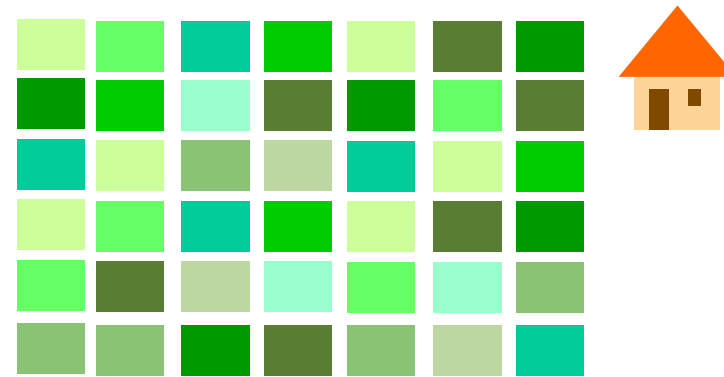


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Methodologies and Tools for Participatory Research

- Participatory rapid appraisal
- Mother - Baby Trial
- Farmer field schools
- Farmer research committees
- Participatory technology development
- Action research

Mother trial (on-station)

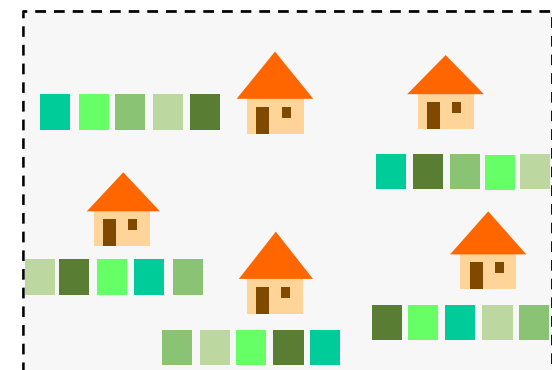
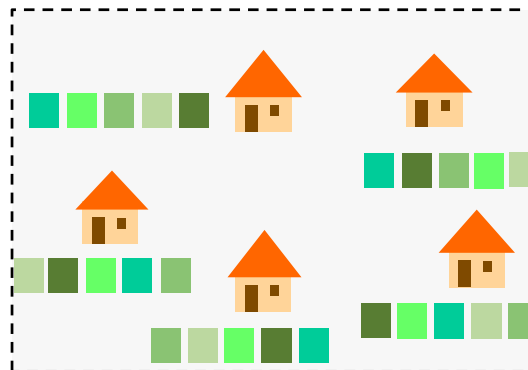


21 cultivars x 2 replication

Best 5 cultivars tested in 10 on-farm trials

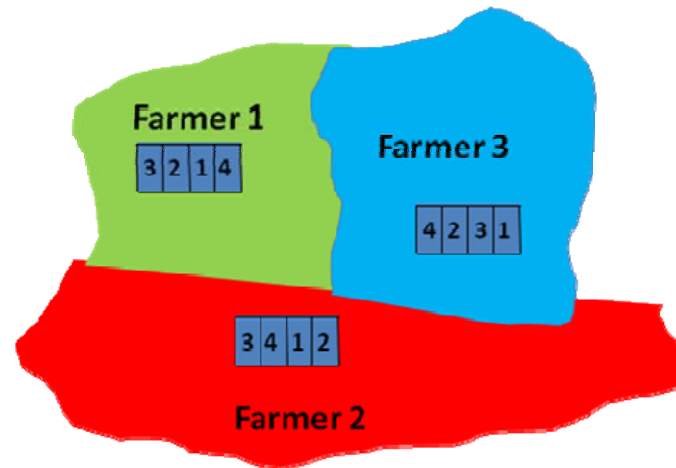
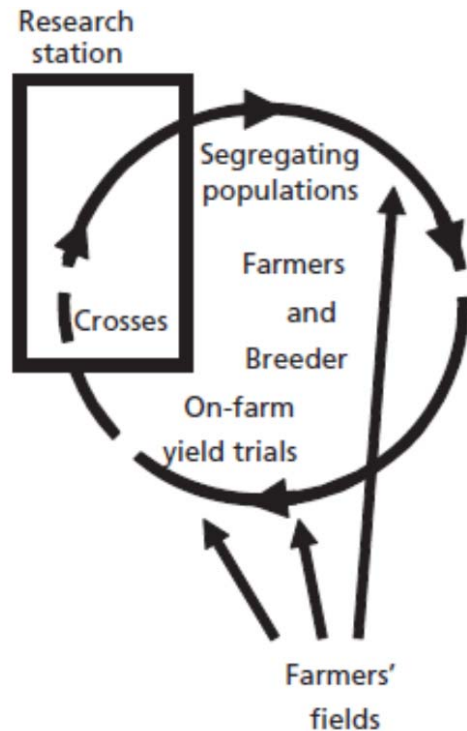
Baby trials (on-farm)

Baby trials (on-farm)



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Start of on farm trial and training



Capacity building in

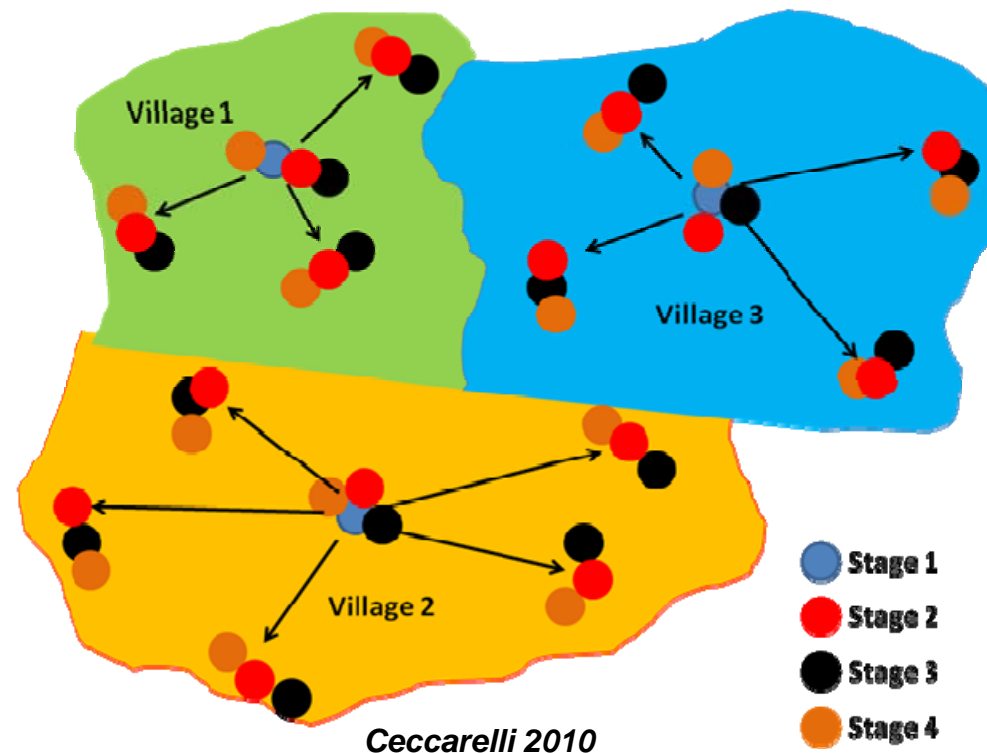
- › Varietal Testing
- › Seed multiplication
- › Seed processing & cleaning
- › Germination Testing
- › Seed Health
- › Storage
- › Crossing techniques
- › Selection techniques

Ceccarelli 2010

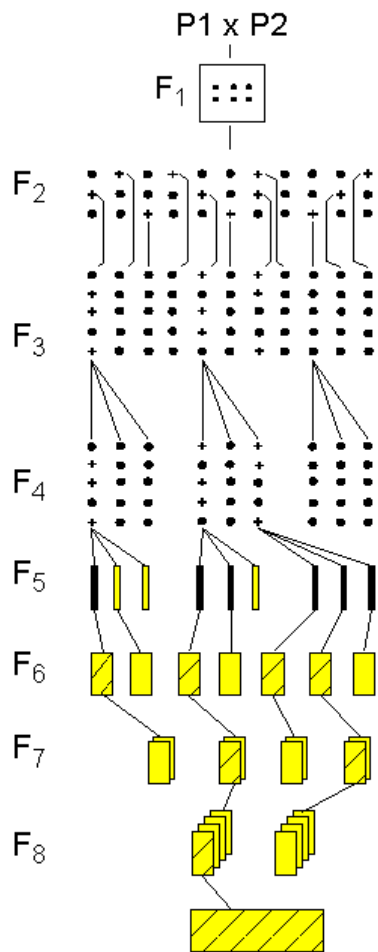
Regular Workshops with all Stakeholders
Farmers Field Days and Demo Trials

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Spreading of on farm trials



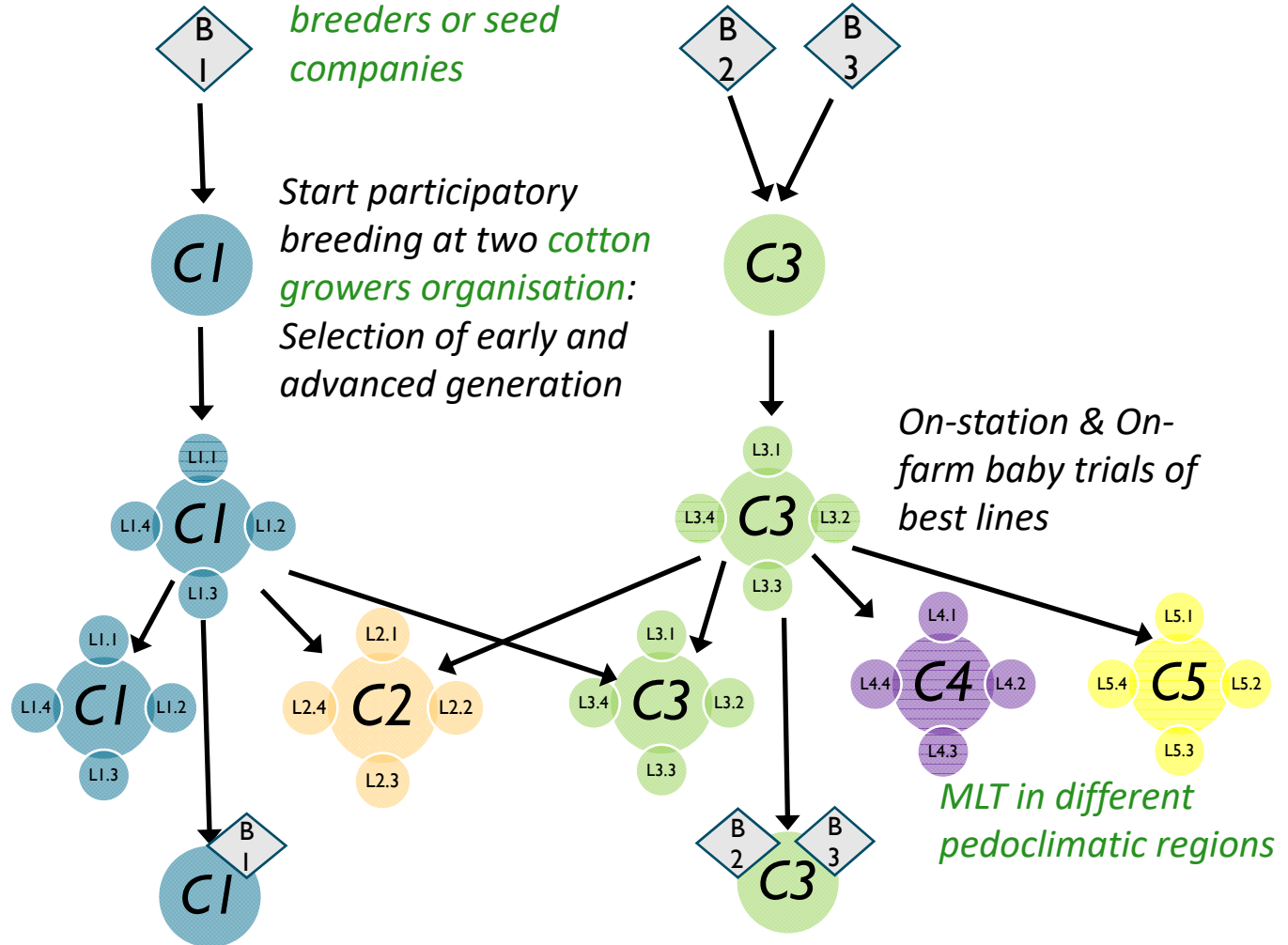
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Breeding material from different breeders or seed companies

Start participatory breeding at two cotton growers organisation: Selection of early and advanced generation

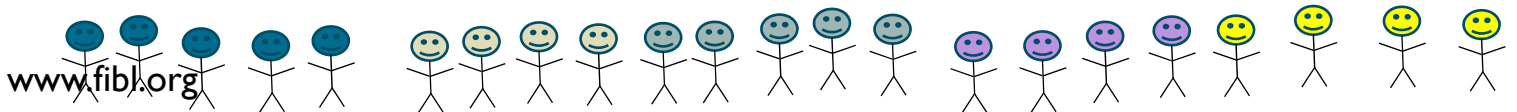
On-station & On-farm baby trials of best lines



Two seed producer provide organic non-GM cotton seed for ALL organic farmers



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Capacity buiding



Involve farmers in selection criteria, cultivar testing & selection, breeding activity

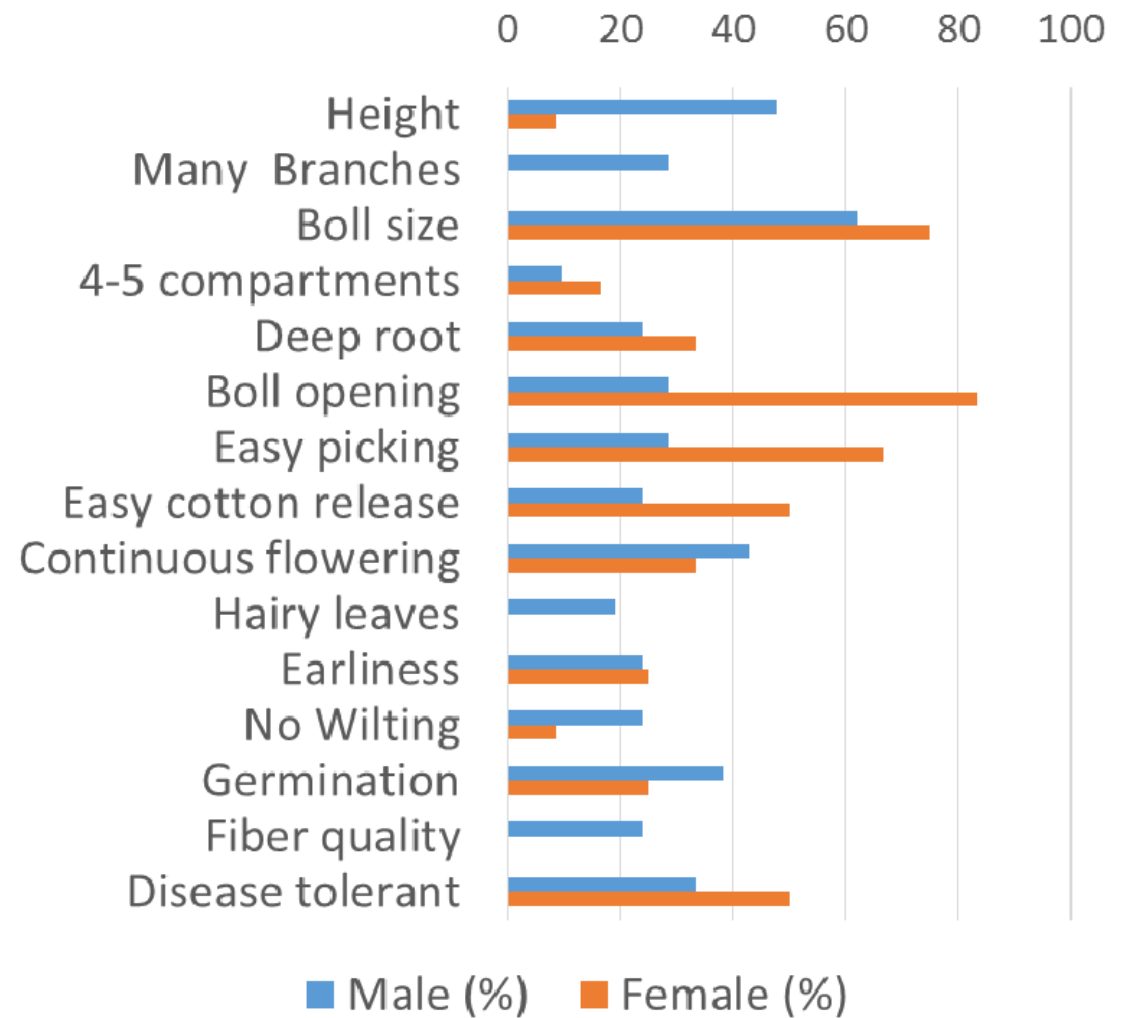
Cultivar selection



Single plant selection



Priority of Traits for Farmers



Creating new diversity of traditional cotton

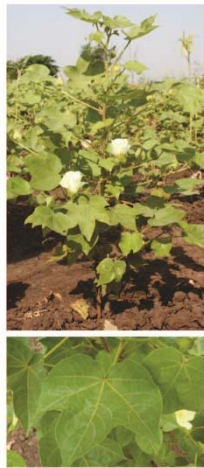


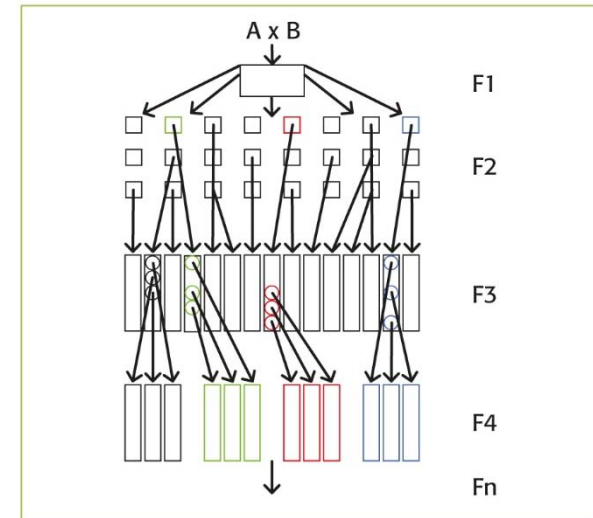
Fig. 1 *G. hirsutum*
4x hybrid



Fig. 2 *G. hirsutum* x
barbadense 4x hybrid



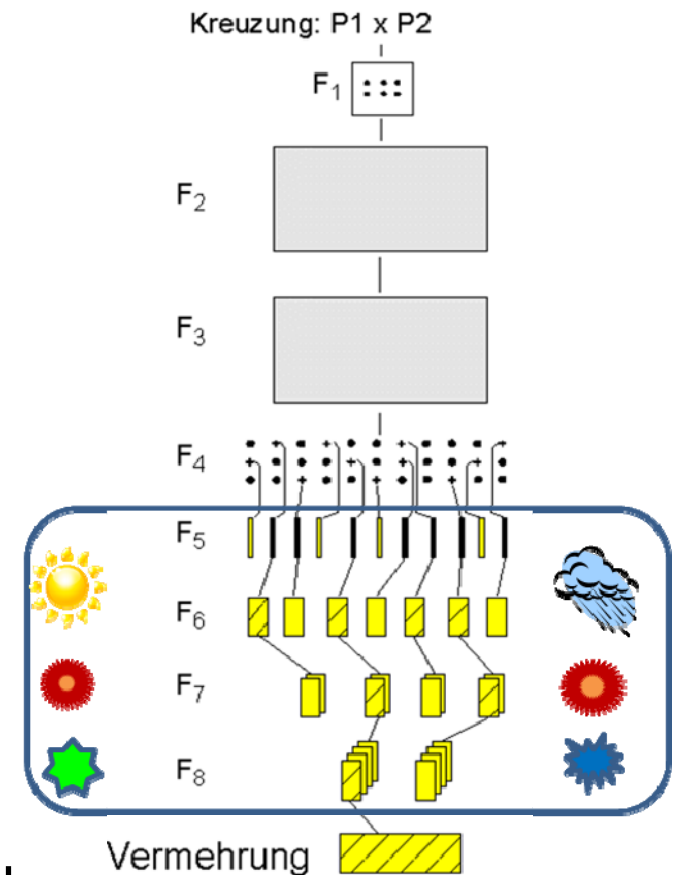
Fig. 3 *G. arboreum*
2x varietal line



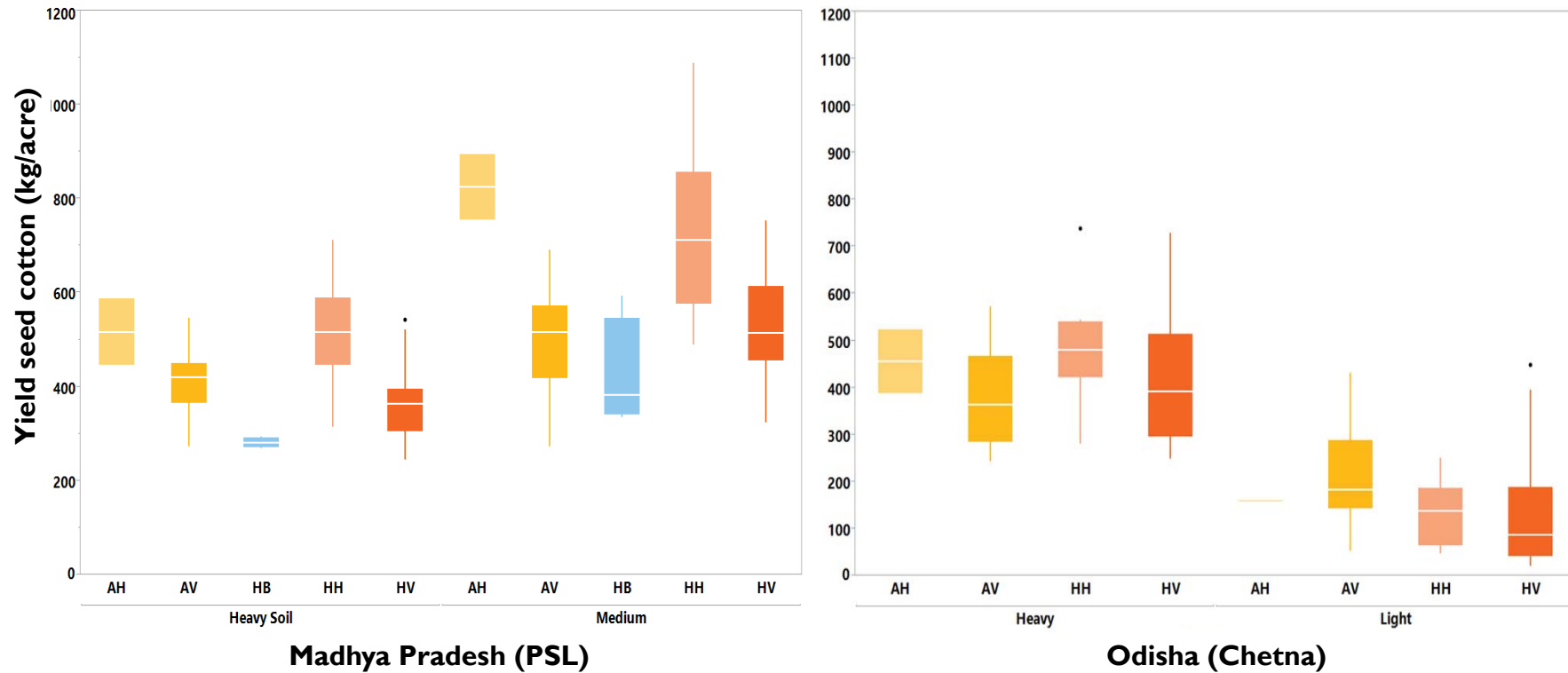
- Collection of traditional Indian cotton *G. arboreum*
- Crosses of traditional Indian cotton and modern cotton species
- Multiplication of offspring
- Single plant selection in early generations (F2 - F5)
- Testing advanced generations (F6-F9)

Development and implementation of new cultivars

- **Multilocation trials of 20 to 50 lines with replication in organic farms** for yield stability, resistance, fiber quality in 3 different States under irrigated fertile soil and rainfed under sandy soil
- **150 on farm baby trials of best candidates** including traditional cotton and open pollinated cotton in 6 States and growing conditions
- **18 pilot trials** in farmers field to compare with hybrid cultivars
- **Seed multiplication** of best candidates in isolated areas
- Registration of cultivars
- Commercialization of truthfully labelled seed



Results highlight the need for agro-ecological zone specific cultivar development for different soil and water dynamics



Legend



***G. arboreum* (desi)**

AH: arboreum hybrid
AV: arboreum variety



***G. hirsutum* (upland)**

HH: hirsutum hybrid
HV: hirsutum variety



***G. barbadense* (egyptian)**

HB: hirsutum X
barbadense hybrid

SGF Trial Sites (2018-19)

150 on farm trials

1 **Madhya Pradesh**

2 **Maharashtra**

3 **Rajasthan**

4 **Odisha**

5 **Gujarat**

6 **Andhra Pradesh**





Plan for conservation - multiplication

Village : Bhimdonga

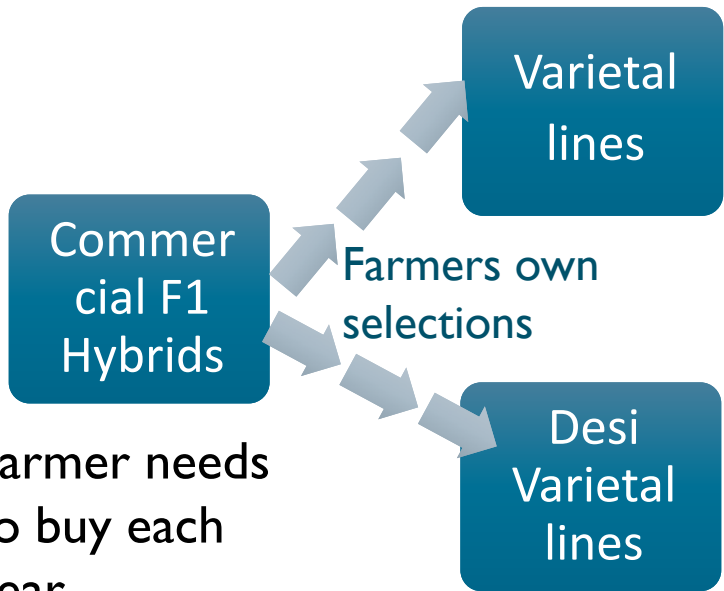
Manikeswari group

Ma lakmi seed bank

Farmer name	Low land	Low land conservation	Multipli cation	Up land	Upland conservation	Multipli cation
Deepu	1	2 rows 5 var paddy	0.1 acr 2 var paddy	2	10 var millets	0.2 acre 2 var redgram
Dhano	2	2 rows 10 var paddy	1 acr 5var paddy	2	1 Var of upland crops like oils seeds, cotton	1 var cotton seed multipl



Farmers own seed



Farmer needs to buy each year

Farmers can use their farm saved seed

Chetna Cooperatives & Seed banks
Procure 400 kg of varietal seed cotton & gin

200 kg of locally suitable varieties stocked for 100 certified organic farmers.



Example for cross-sector promotion of organic cotton breeding

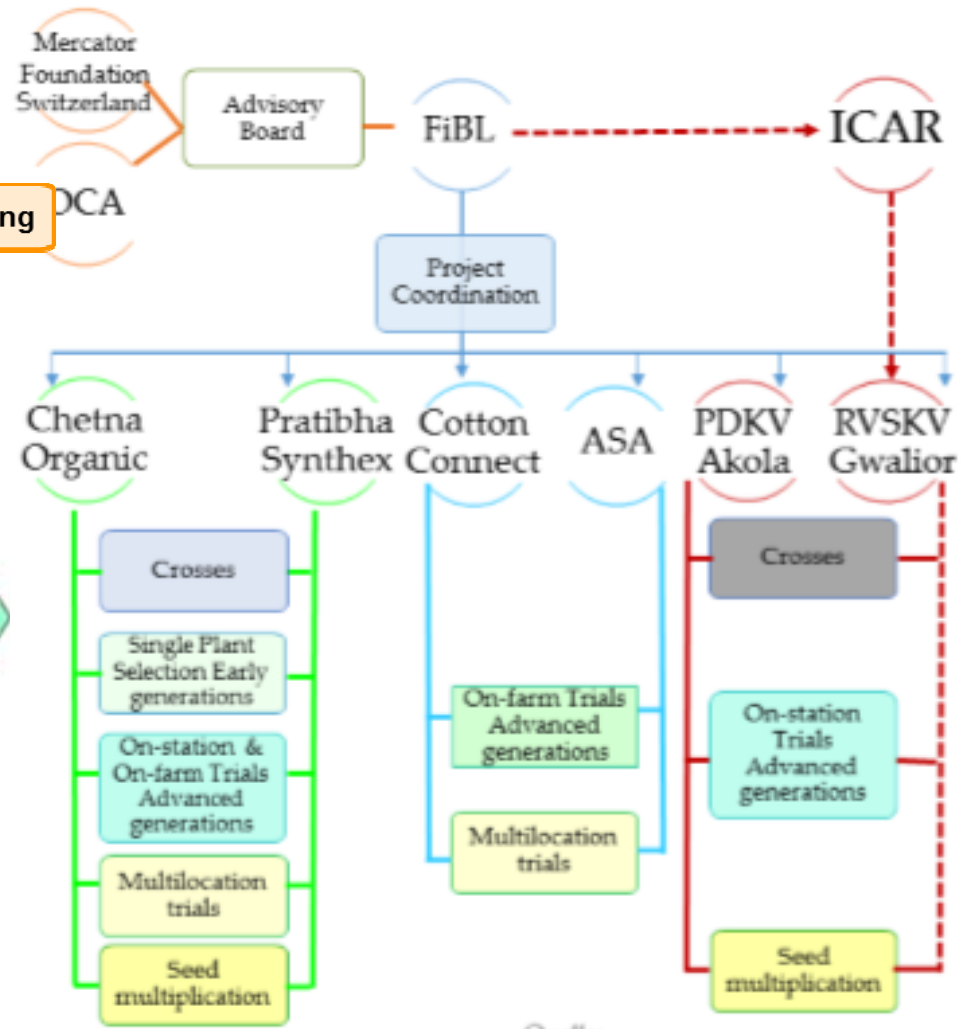


Poolfunding of organic breeding:
50% Foundation Mercator Switzerland
50% Organic Cotton Accelerator



Fund raising

Project Governance, Activities & Partners



Importance of International Cooperation

Textile Exchange:

- annual Organic Cotton Market Report
- established 2012 Organic Cotton Round Table
- with annual meetings the task force Seed & Soils



Organic Cotton Accelerator:

Pooling resources of international textile brands to support

- cotton breeding projects in India
- develop business models and sourcing practices that secure the integrity of organic cotton supply chain



First Results on Participatory Breeding and Conclusion

- Engagement of all actors of the value chain allow a targeted selection of cultivars that are best suited for their growing conditions and meet demand of market.
- Traditional desi cotton are more tolerant against sucking pest, more tolerant towards drought and flooding and morphological distinct from GM-cotton, and do not cross with them
- Empowerment of female farmer and involvement in breeding improves adoption of new cultivar types
- Training, capacity building, farmers organisations and shared decision power is important as well as a neutral facilitator fostering collaboration between cooperations
- Linking farmers with textile industry is needed to develop a supply chain partnership with mutual benefit and secure supply of high quality organic cotton fiber
- Breeding is part of the value chain and needs support from the textile industry

Outlook

Linking Seed & Breeding Initiatives on global scale

- Capacity building to empower organic farmer organisations
- Sharing of information, knowledge, practices, testing protocols
- common R&D projects
- Status quo analysis of available species and cultivars
- Focus on biodiversity and adaptation to climate change
- Exchange of seeds: among partners, between countries? Open source seeds, farmer owned seeds
- Maintenance breeding with quality system to avoid GMO contamination
- Scholarship, Training, institutional exchange
- Political lobbying for organic cultivar testing
- Linking stakeholders, partner recruitment
- Develop business plan for breeding and seed production
- Common fundraising to approach different brands, Crowd funding

Outlook for 2019

Organic Cotton Exhibition and sustainable textile consumption

Botanical garden Univ. Zürich 10th August – 29th September 2019



Conference on participatory Research 28. -29. August 2019

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**Thanks to all partners,
supporters and
for your attention**

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