



Participatory breeding for Securing Organic Cotton and Genetic Diversity

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www.greencotton.org, www.sgf-cotton.org

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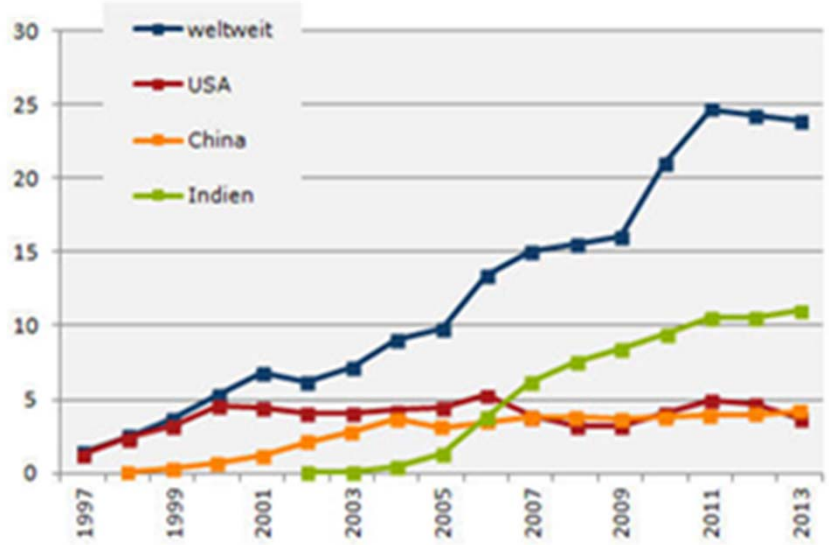
Why we get engaged in organic cotton breeding in India?

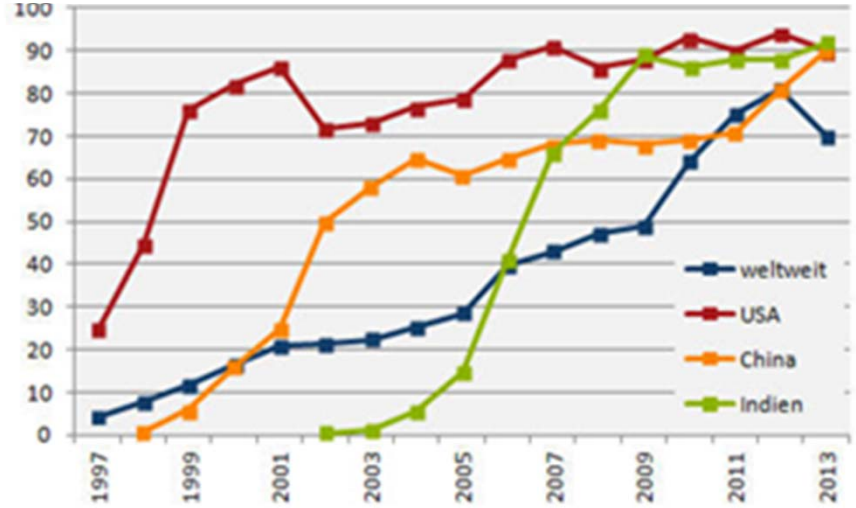
Challenges of organic cotton in India

- India has been the largest organic cotton producer, 10 years ago India supplied 80% but dropped now to 56%, with a ecrease 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 (higer 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, pestizide, irrigation)
- Breeder's seed is already contaminated with Bt, causing Bt contamination throughout the cotton value chain

India fastest adopter of Bt cotton



Anbauflächen gv-Baumwolle in Millionen Hektar



Anteil gv-Baumwolle an der Anbaufläche eines Landes in Prozent

Reference:
www.transgen.de

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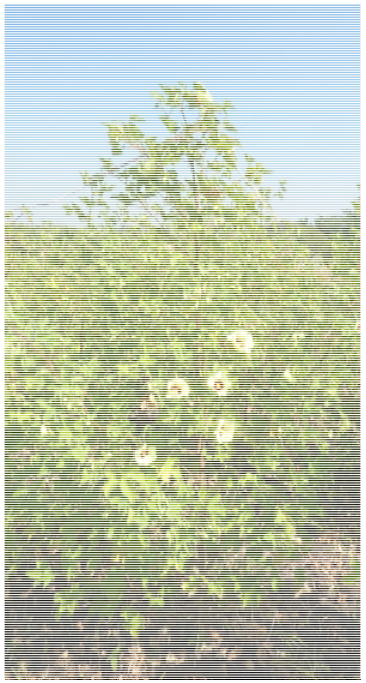
Cultivated cotton species in India

Gossypium hirsutum	*Gossypium barbadense*	*Gossypium arboreum*	*Gossypium herbaceum*
Upland cotton tetraploid	Pima / Egyptian cotton tetraploid	Desi cotton diploid	Desi cotton diploid



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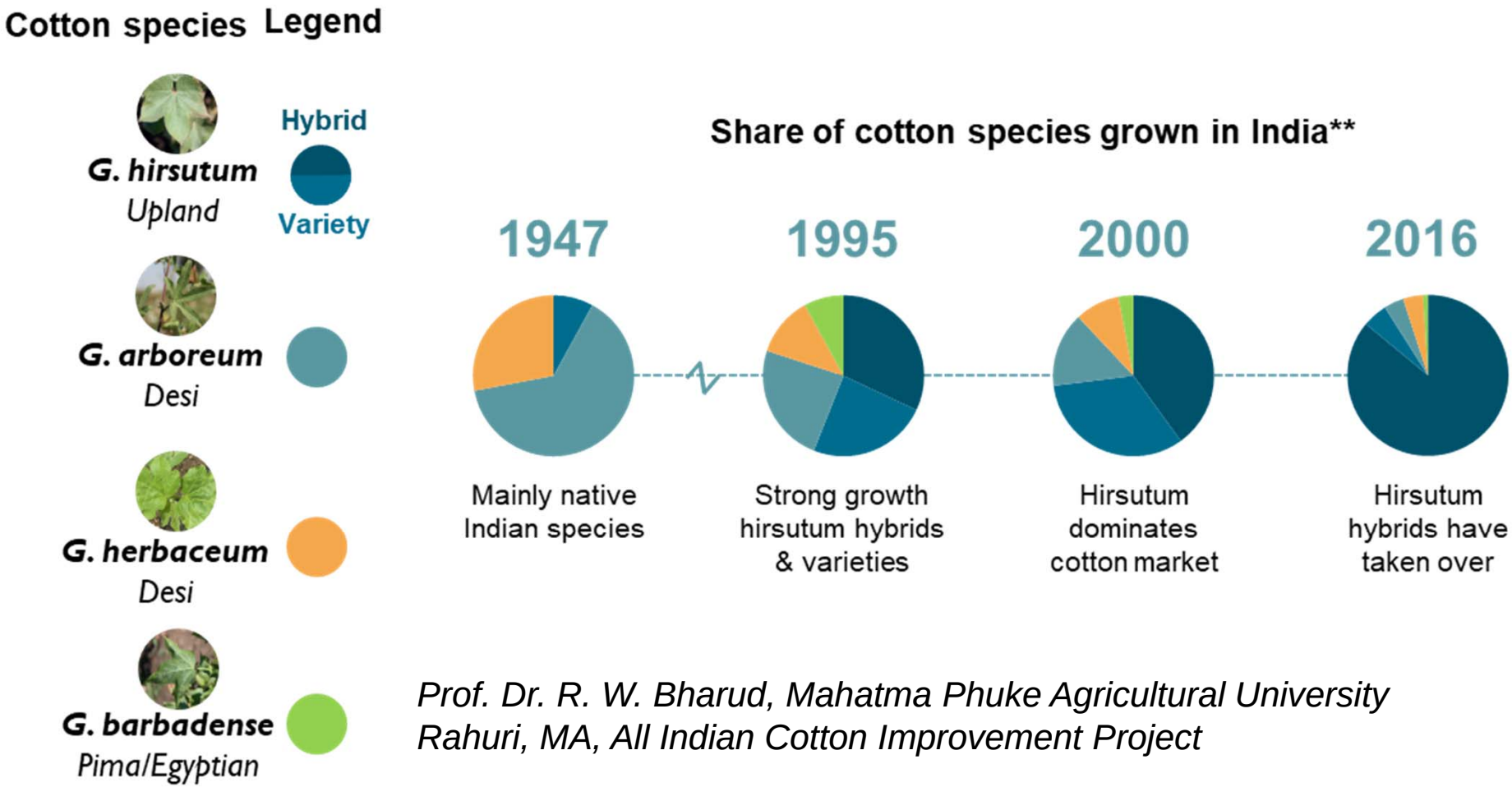
Historic development of cotton species in India



Prof. Dr. R. W. Bharud, Mahatma Phuke Agricultural University Rahuri, MA, All Indian Cotton Improvement Project

→ 95% F1 hybrids of Bt hirsutum cotton
→ loss of genetic diversity
→ loss of farmers' choice for GMO-free seed
→ endangered organic cotton production in India

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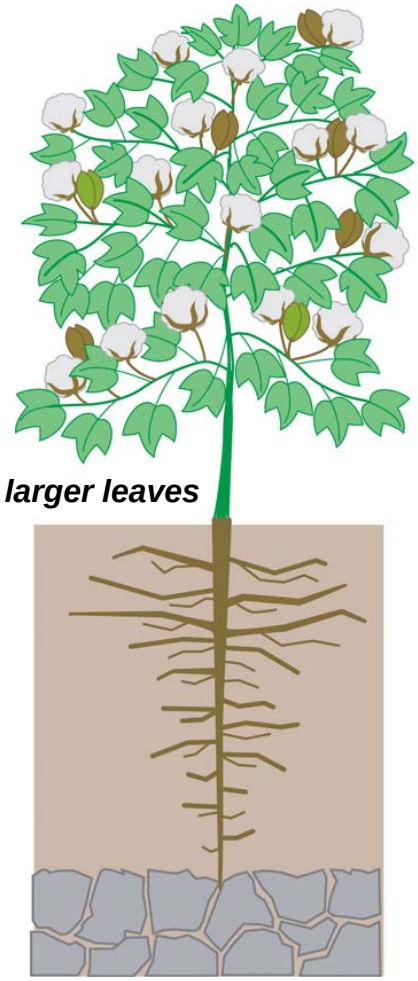
Challenges and Research Gaps of Organic Cotton

- 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

Selecting the right cotton varieties

American Upland cotton *(G. hirsutum)*



Advantages:

- High yields
- Longer staple (higher price)

Disadvantages:

- Needs more water
- Needs more manure
- More prone to pests

Suitable for:

- Deep soils
- Heavy soils
- Good irrigation

Indian 'desi' varieties *(G. arboreum, G. herbaceum)*

Advantages:

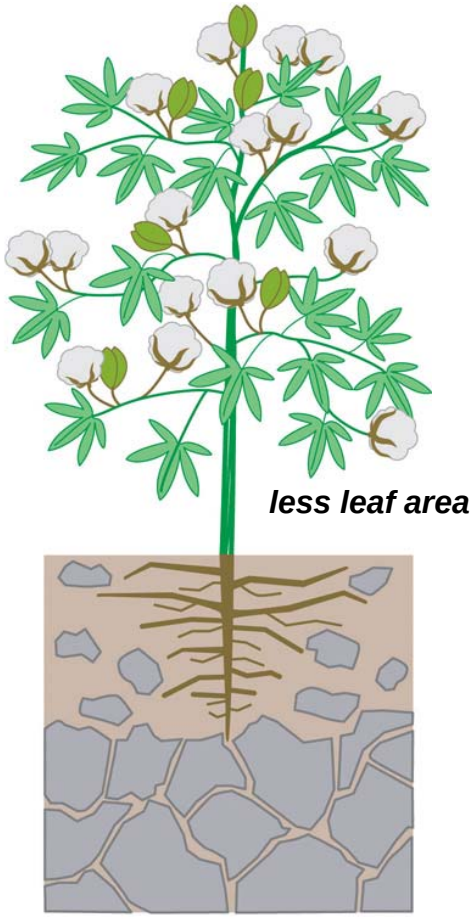
- Better drought resistance
- More tolerant to succing pests

Disadvantages:

- Longer vegetation period
- More difficult to pick
- Mostly shorter staple (lower price)

Suitable for:

- Shallow soils
- Sandy soils
- Little/no irrigation



Seeding the Green Future – Participatory organic cotton breeding

Objectives

- Re-establish non-GM cotton seed chain in India
- Develop new cotton cultivars adapted to organic farming
- Foster varietal lines and traditional cotton species
- Seed sovereignty
- Empowerment of farmers

Methods

- Participatory cotton cultivar trials
- Initiate decentralized participatory cotton breeding
- Capacity building with focus on female and tribal farmers
- Advocacy on international level

First Steps: The Dharwad Declaration

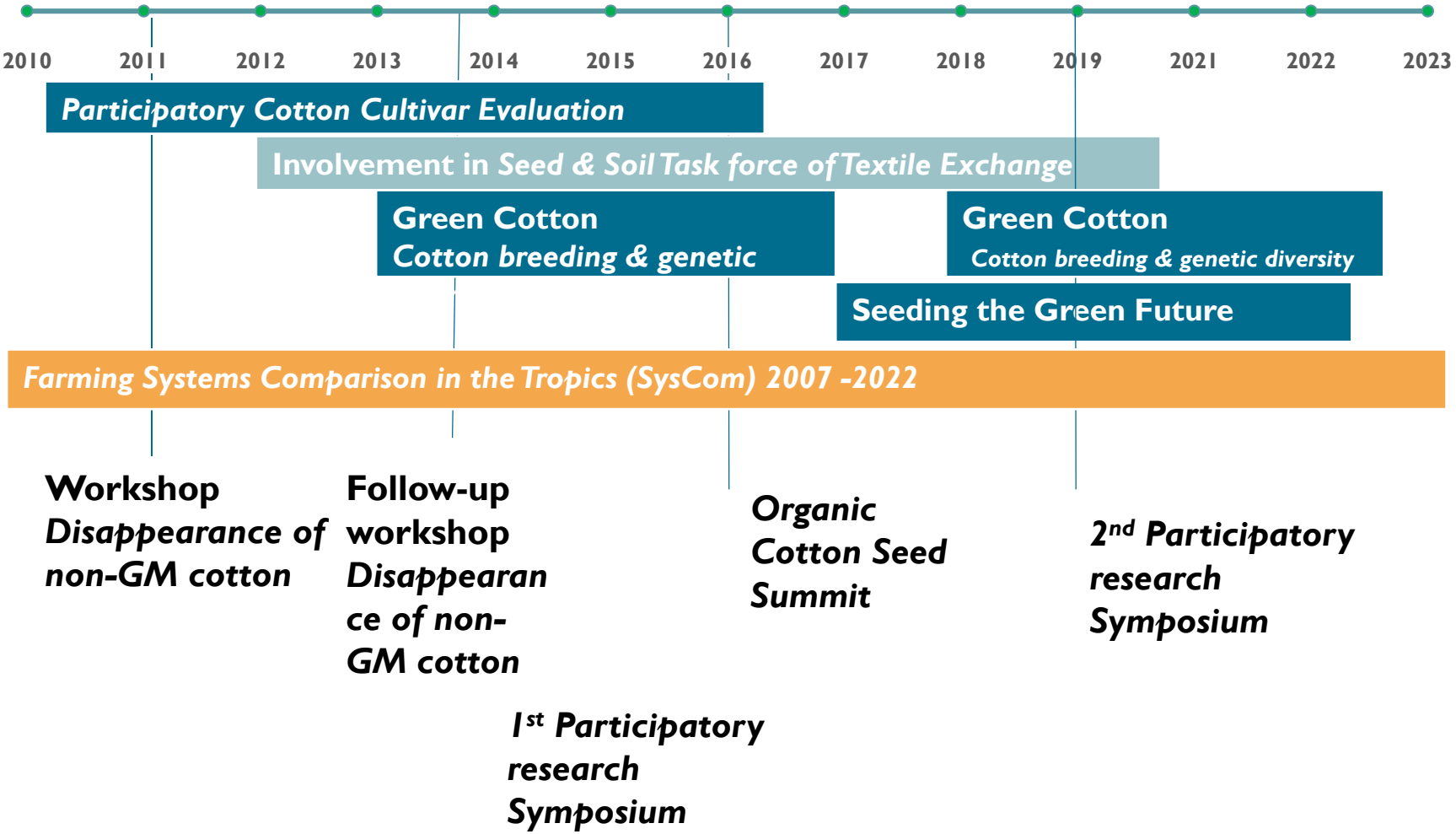
National Workshop June 21st 2011: «Disappearing non-GM cotton - ways forward to maintain diversity, increase availability and ensure quality of non-GM cotton seed» Dharwar Declaration

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

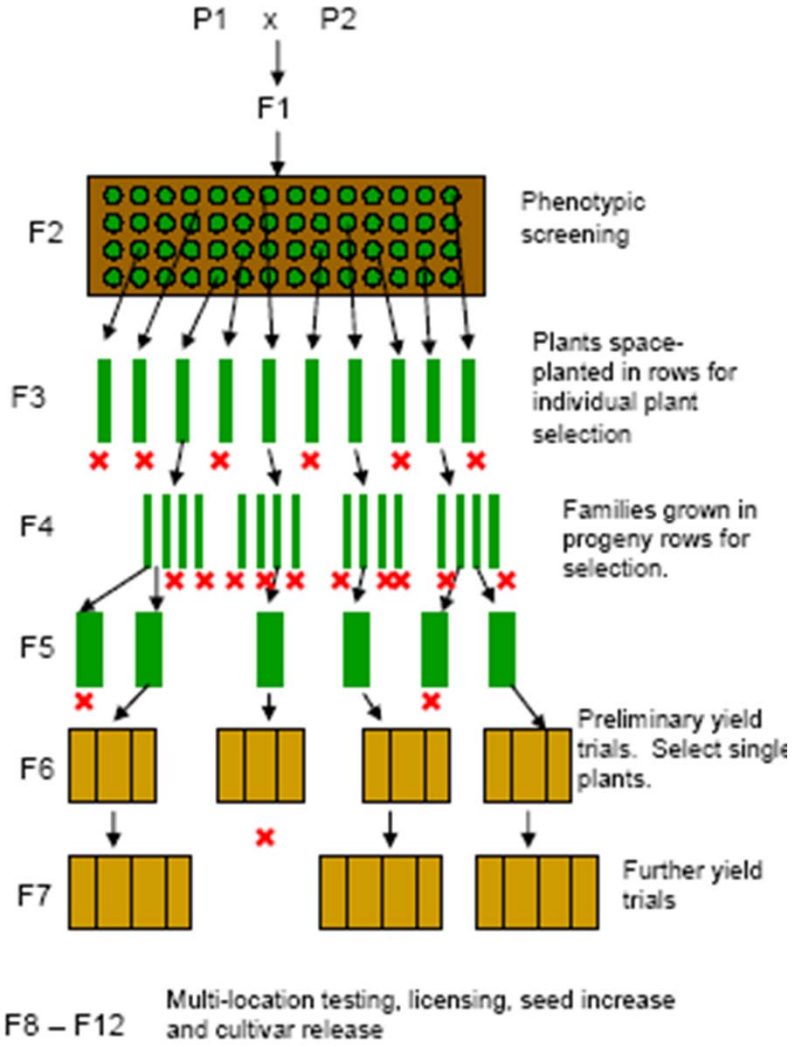
To combine forces for immediate action and support of:

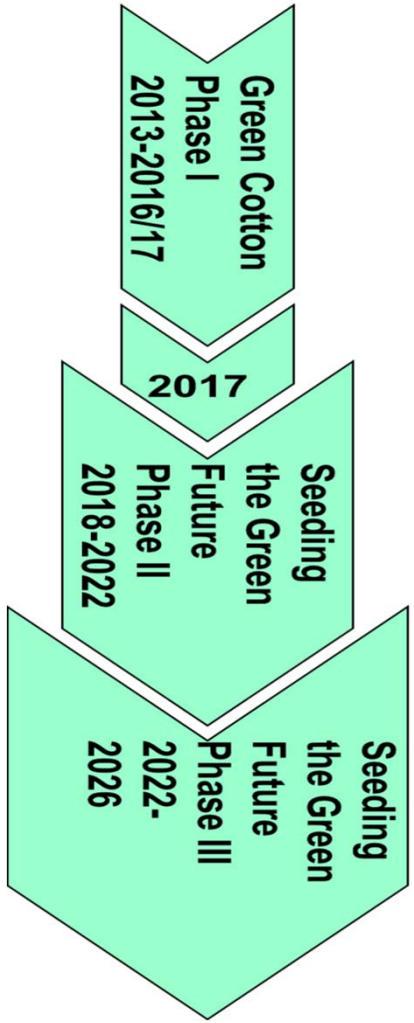
- Collaboration & Exchange, e.g. private public partnership
- Desired Policy Changes, e.g. establishing GM-free zones
- Evaluation and multiplication of existing cotton cultivars under organic and low-input conditions
- Establishing and optimizing the non-GM seed chain
- Continuous improvement of non-GM cultivars

Organic cotton research in India and advocacy



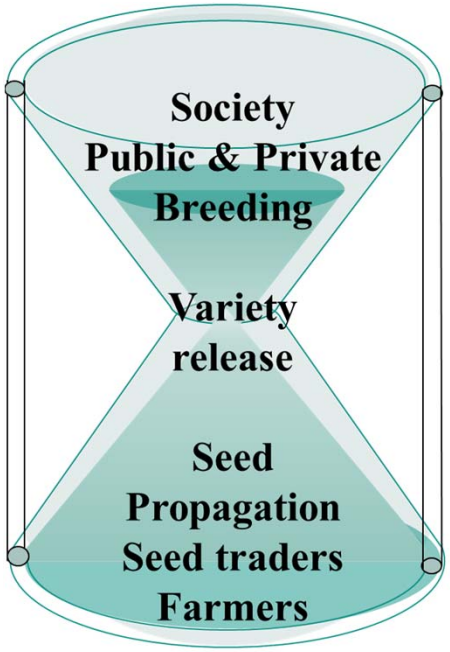
Breeding Scheme





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

Formal plant breeding and seed supply



One Way Information:
Scientist

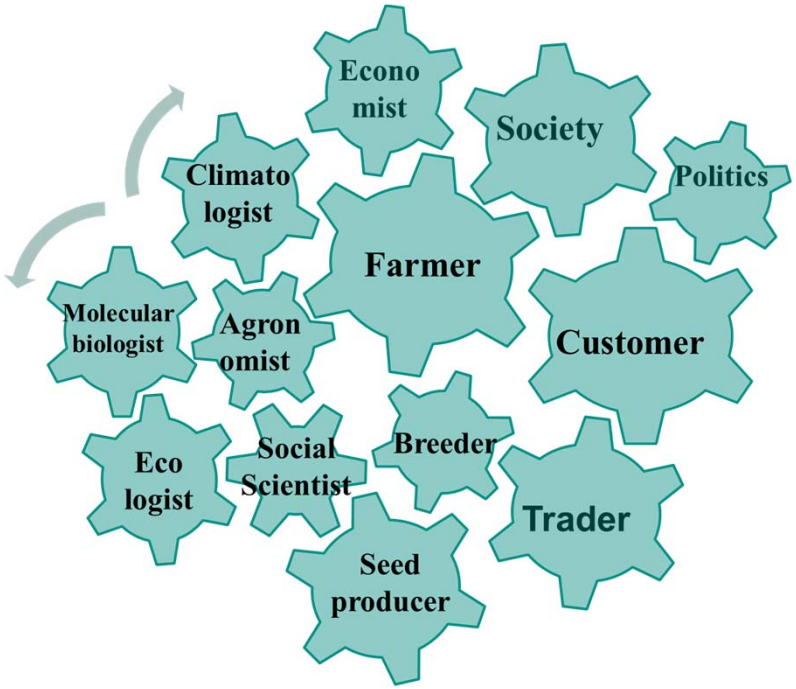
↓

Extension Service

↓

Farmer

Participatory plant breeding and seed multiplication



Seeding the Green Future

Methodologies and Tools for Participatory Research

Participatory rapid appraisal

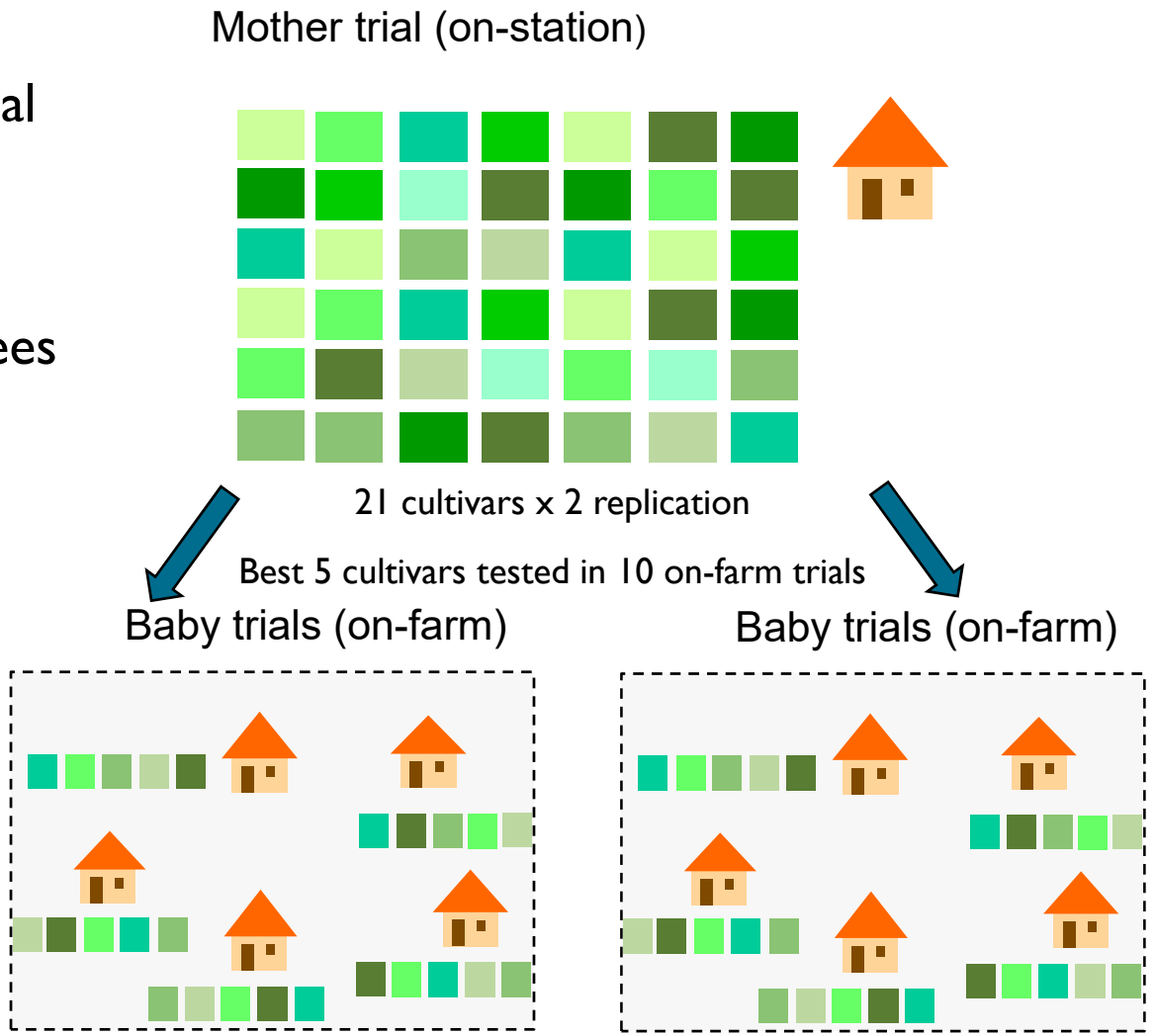
Mother - Baby Trial

Farmer field schools

Farmer research committees

Participatory technology development

Action research



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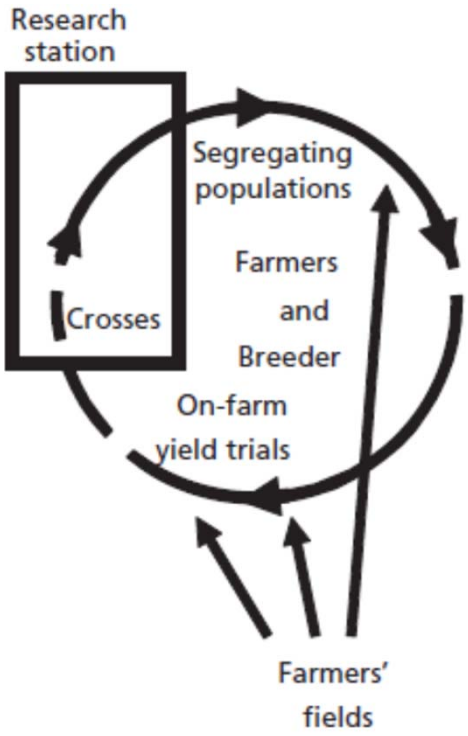
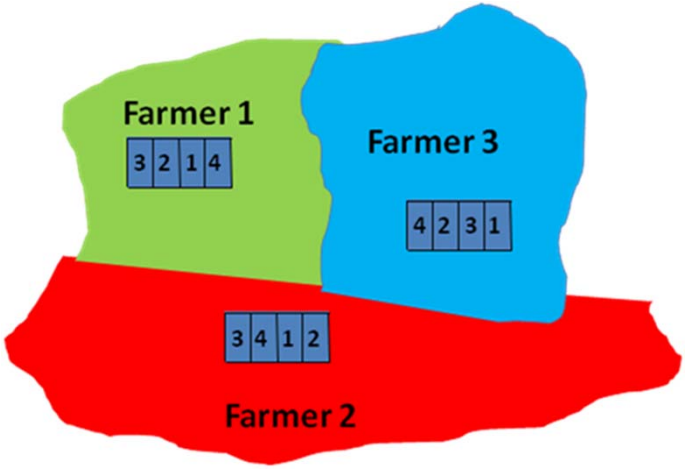
Start of on farm trial and training



Ceccarelli 2010



Capacity building in

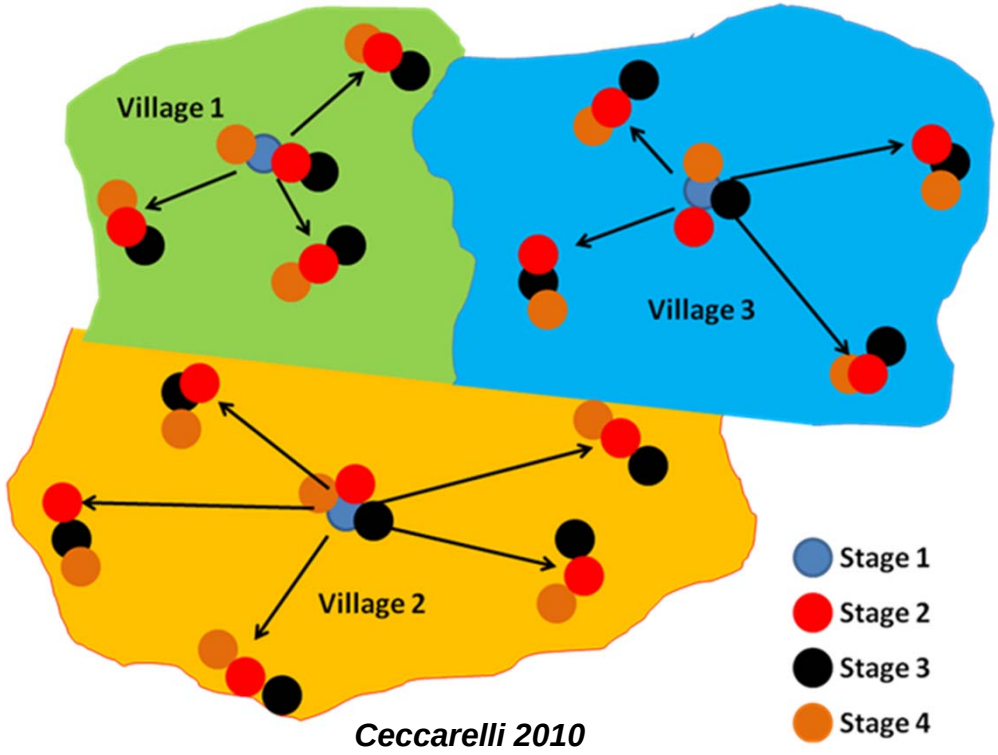
- Varietal Testing
- Seed multiplication
- Seed processing & cleaning
- Germination Testing
- Seed Health
- Storage
- Crossing techniques
- Selection techniques

Regular Workshops with all Stakeholders

Farmers Field Days and Demo Trials

Seeding the Green Future

Spreading of on farm trials



Ceccarelli 2010

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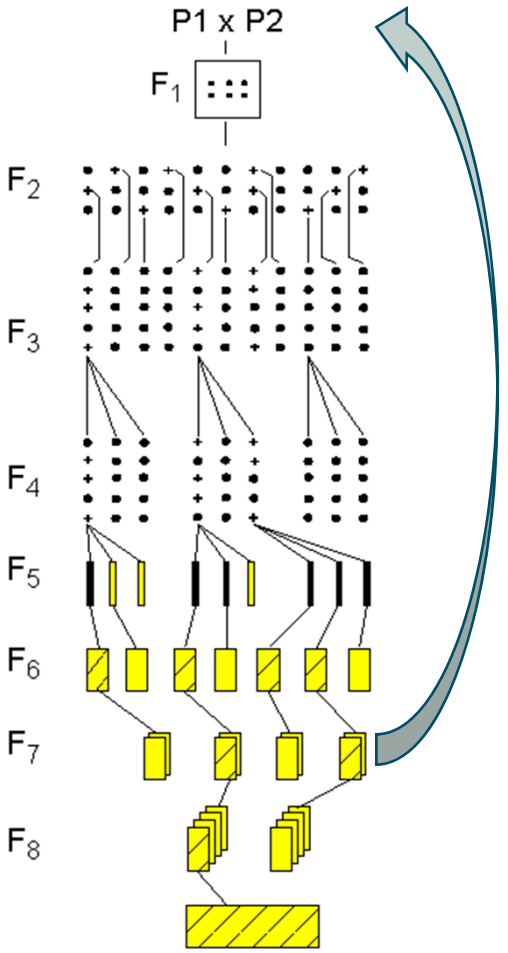
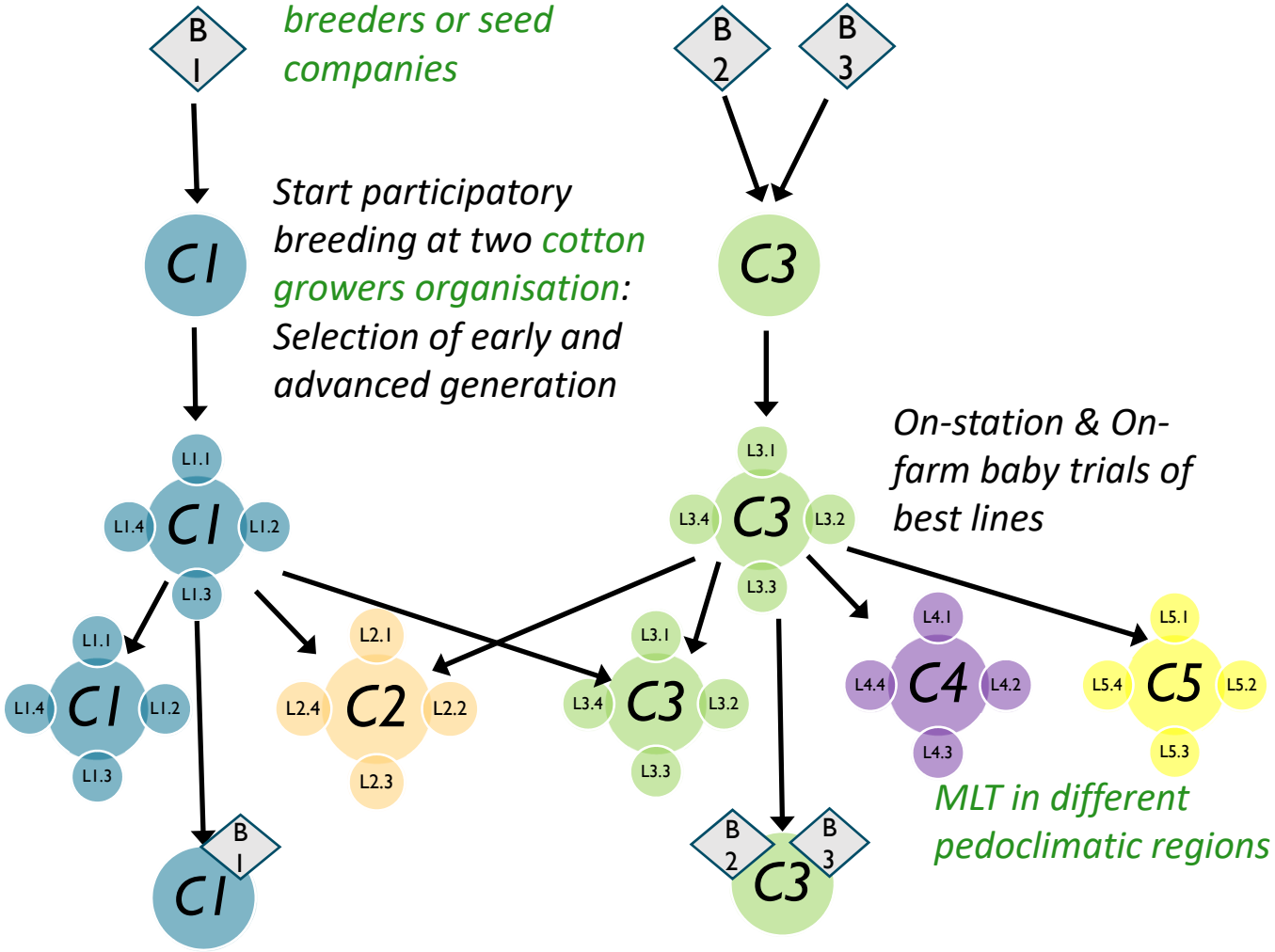


Breeding material from different breeders or seed companies

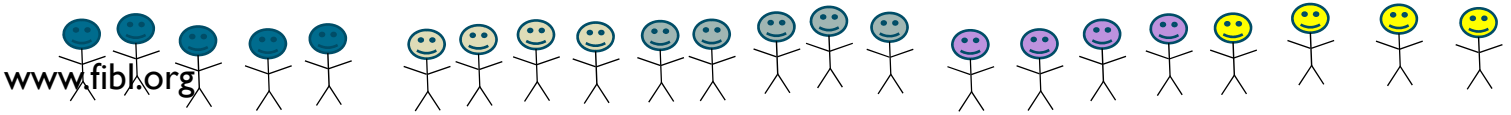
Start participatory breeding at two cotton growers organisation: Selection of early and advanced generation

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

MLT in different pedoclimatic regions



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



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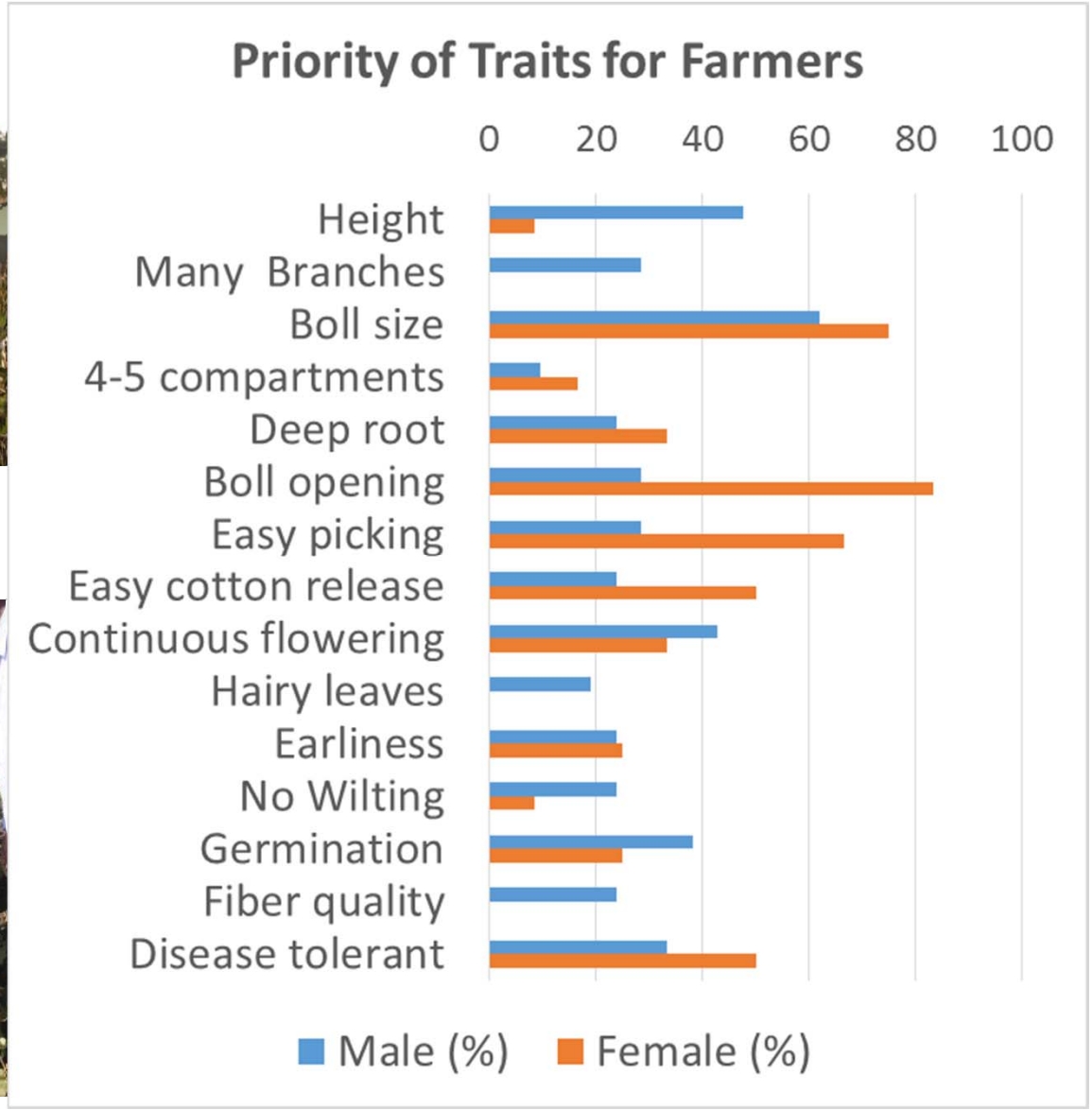
Capacity buiding

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

Cultivar selection

Single plant selection



Creating new diversity of tradtional cotton

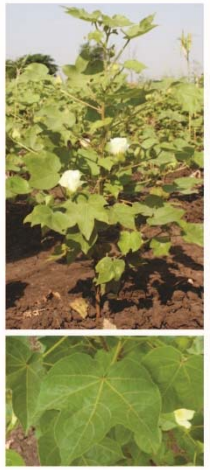
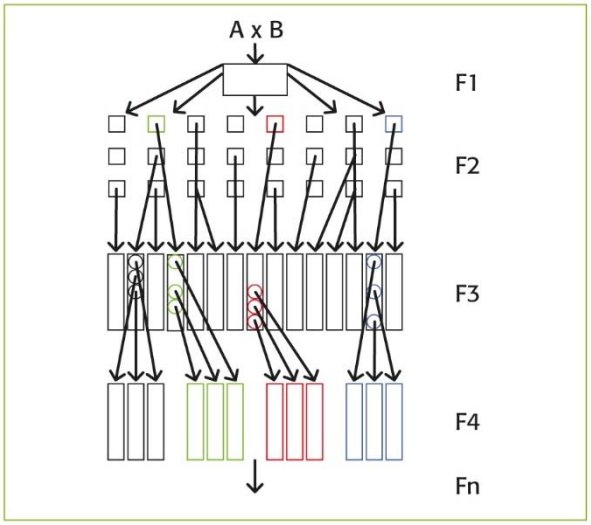


Fig. 1 *G. hirsutum* 4x hybrid

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

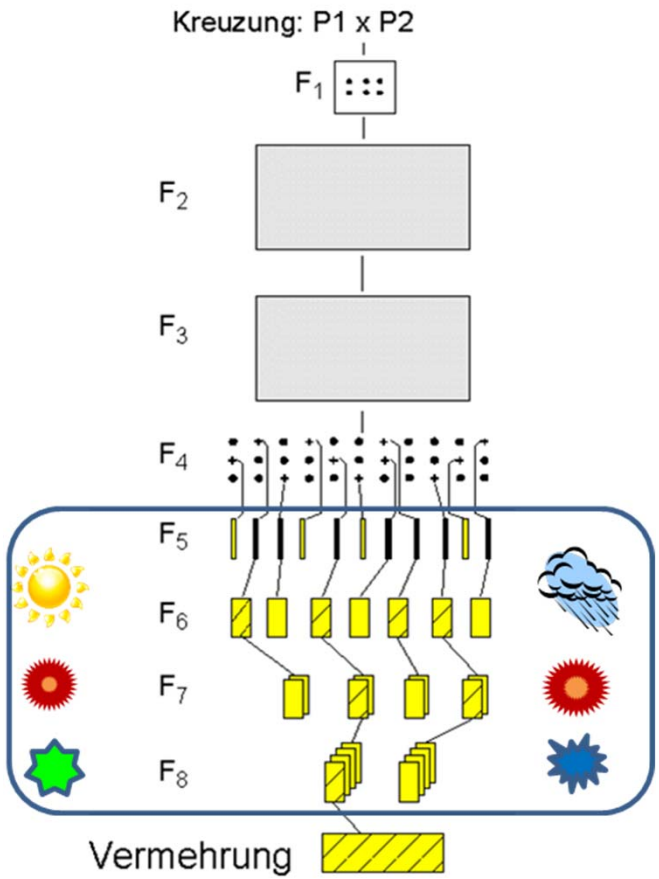
Fig. 3 *G.arboreum* 2x varietal line



- Collection of traditional Indian cotton *G. arboreum*
- Crosses of traditional Indian cotton and modern cotton species
- Multiplication of offspring
- Single plant selection in early geneartions (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 candidated in isolated areas
- Registration of cultivars
- Commercialization of truthfully labelled seed



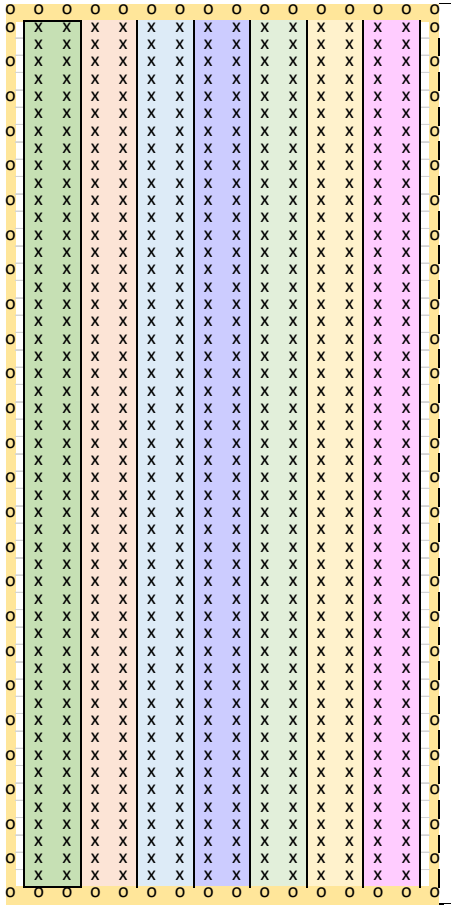
SGF Trial Sites (2018-19)
150 on farm trials

1. **Madhya Pradesh**
2. **Maharashtra**
3. Rajasthan
4. **Odisha**
5. Gujarat
6. Andhra Pradesh

Seeding the Green Future On-farm Trials

On-Farm Baby Trial with colour code

Cultivar		Cultivar Type	colour
Suraj 1		**HV**	**green**
PA-255		AV	orange
Shankar-178		HV	blue
Mallika 207		HH	purple
Suraj 2		**HV**	**green**
Chetna_J1		HV	yellow
Namaskar 81		HH	pink



Farmers field with his commercial cotton cultivar

- Farmer can choose 5 from a set of 5 to10 pretested cultivars where sufficient seed is available
- In addition he needs to use always the same check which is replicated to allow for Bayestion statistics

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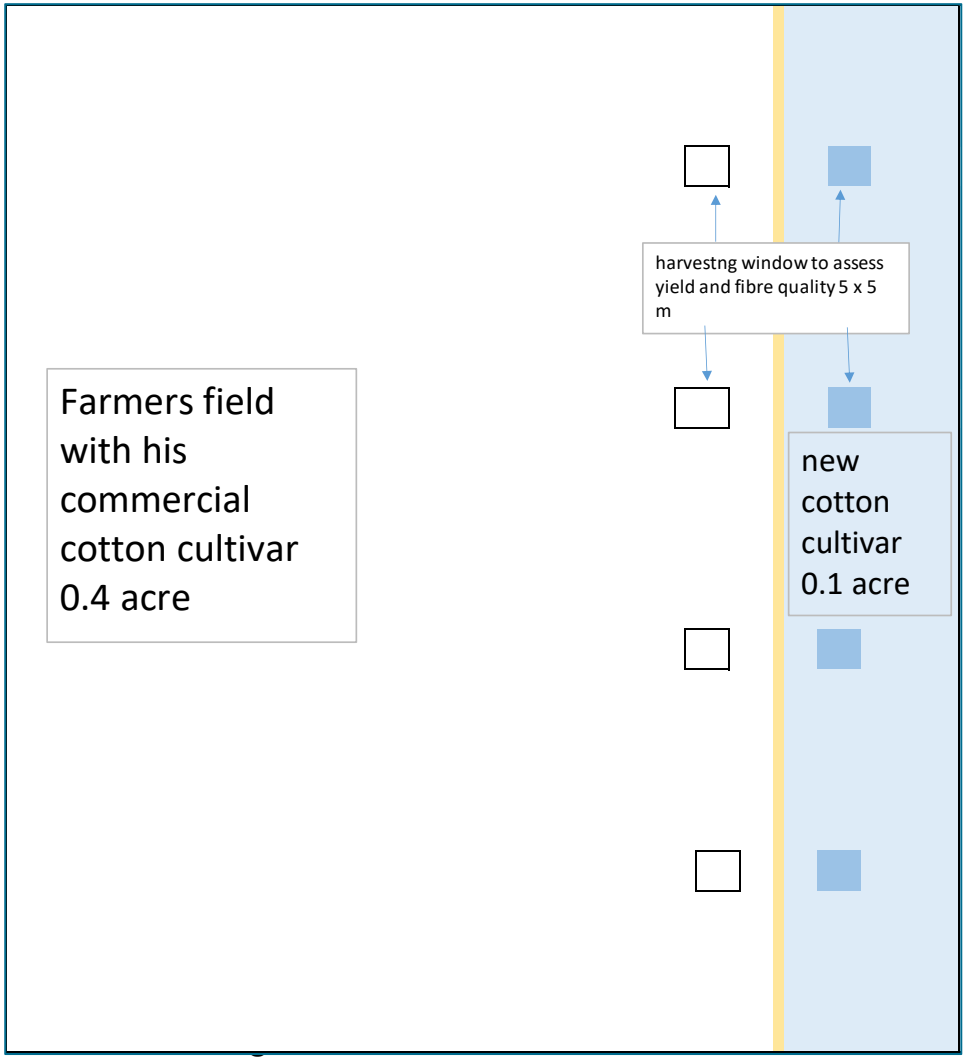
See **DIVERSIFOOD homepage and R-package**
https://priviere.github.io/PPBstats_book/family-1.html#model-1

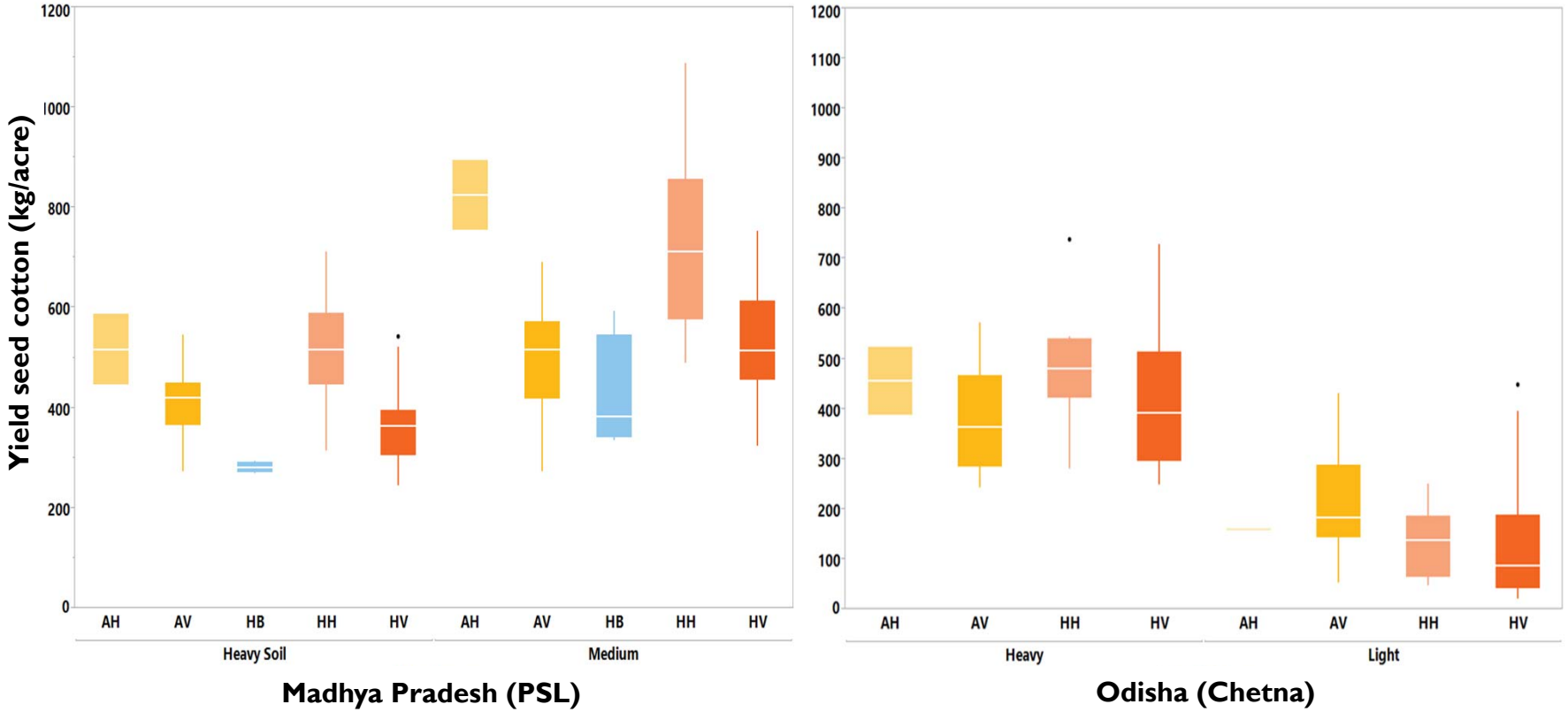
DIVERSIFOOD

Seeding the Green Future On-farm Trials

On-Farm Pilot trials accoring to choice of farmer



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

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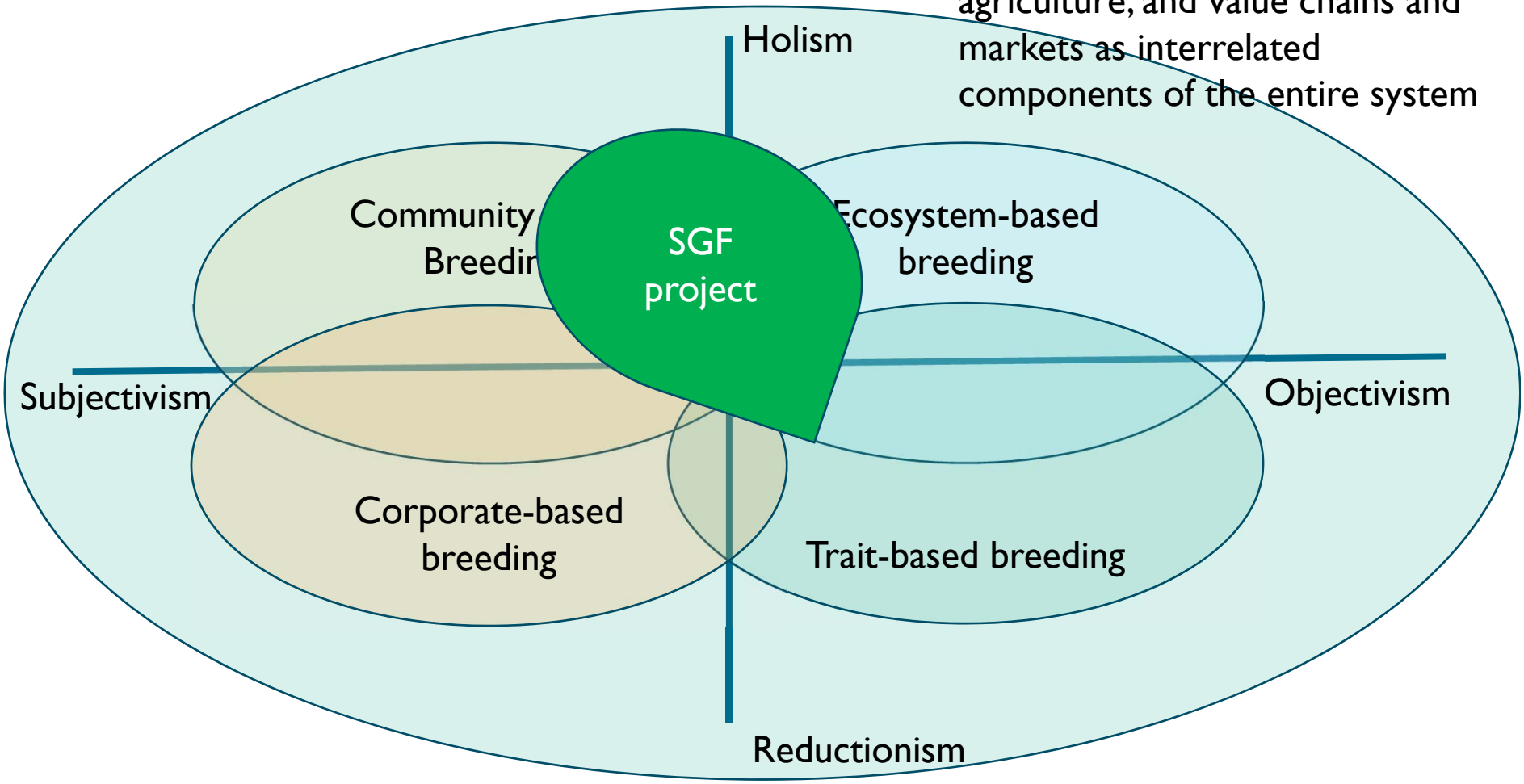
Systems-based breeding concept

Systems-based breeding including civil society, policy, nature, agriculture, and value chains and markets as interrelated components of the entire system



Lammerts van Bueren, E.T., P.C. Struik, N. van Eekeren and E. Nuijten. 2018. Towards resilience through systems-based plant breeding. A review. Agronomy for Sustainable Development 38: 42.

Example for cross-sector promotion of organic cotton breeding

Seeding the Green Future

Poolfunding of organic breeding:

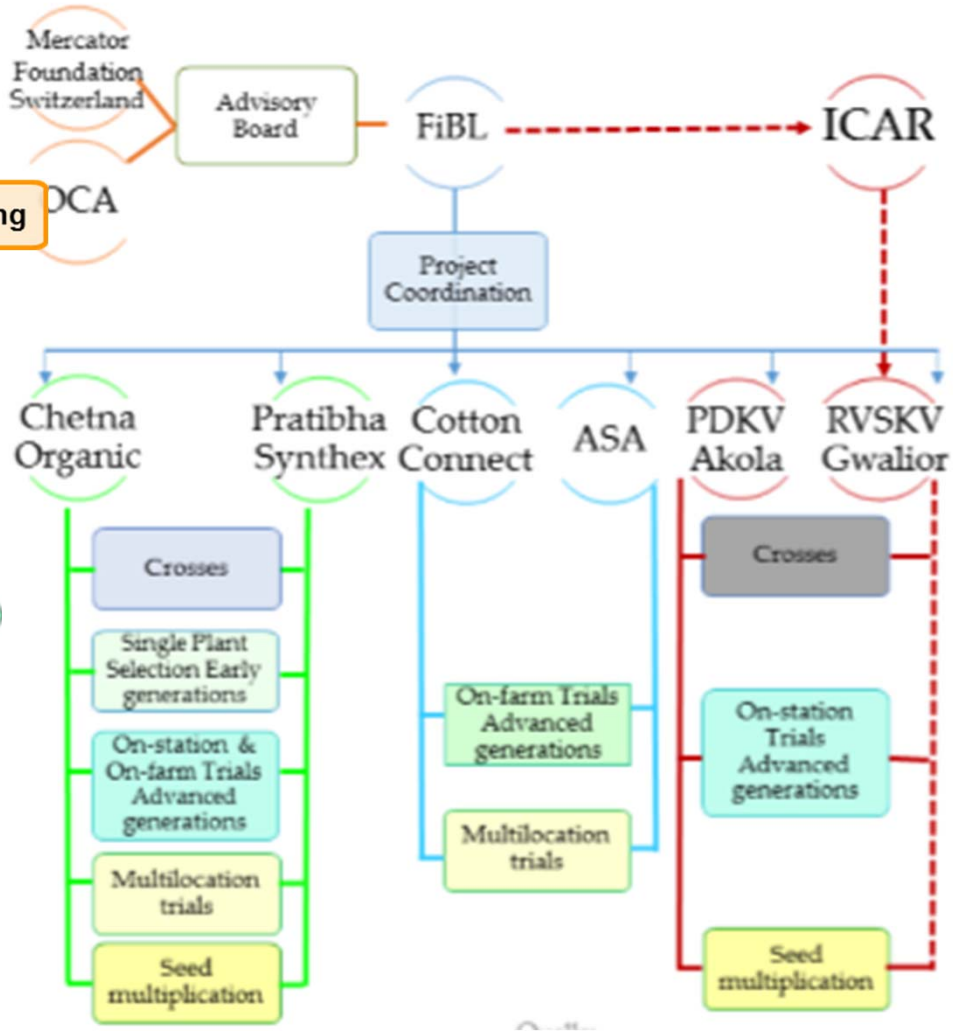
50% Foundation Mercator Switzerland

50% Organic Cotton Accelerator

C&A, Tchibo, H&M, EILEEN FISHER, INDITEX, KERING, CottonConnect, TextileExchange, KappAhl, PESTICIDE ACTION NETWORK UK, Pratibha, C&A Foundation

Fund raising

Project Governance, Activities & Partners



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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

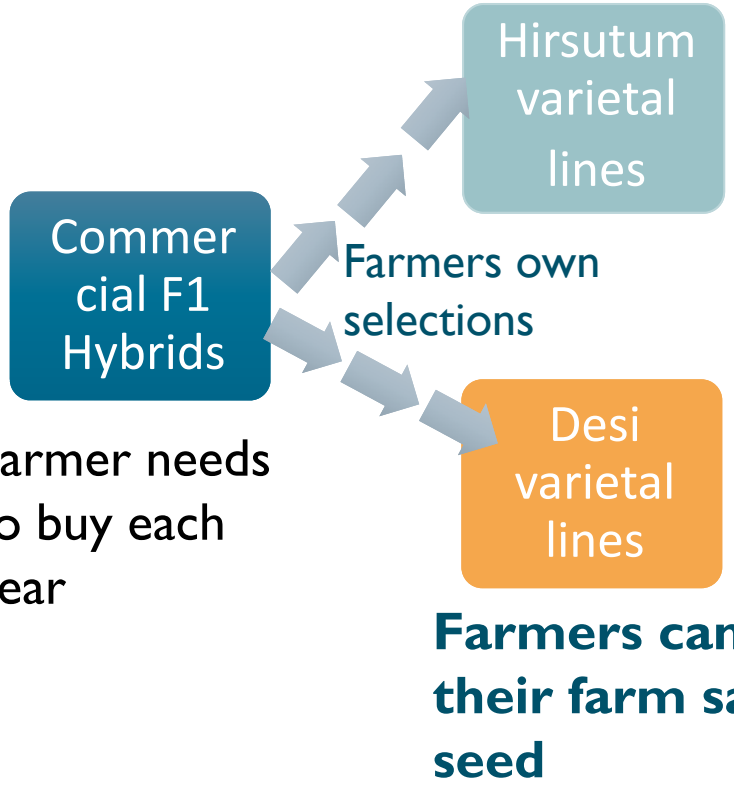
First Results on Participatory Breeding and Conclusion

- 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 distinkt from GM-cotton, and do not cross with them
- Empowerment of female farmer and involvemment 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 collabotation 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 recruitement
- Develop business plan for breeding and seed production
- Common fundraising to approach different brands, Crowd funding

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.

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Roadmap of Seeding the Green Future

	Phase I: 2017-2018	Phase II: 2018-2022	Phase III: 2022-2026
Clusters & FOs	2 clusters 5 FOs	5 clusters 20 FOs	10 clusters 40 FOs
Regions	Central India	Central and Southern India	Central, Southern and Nothern India
New cotton lines		10	30

Success factors to scale:

- Successful fundraising from donors, foundations, industry

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SGF Seeding the Green Future

ASA आसा

Chetna Organic™ Environment..Ethics..Equilibrium

COTTON CONNECT TRANSFORMING THE WORLD'S COTTON FOR GOOD.

CSA

Pratibha

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Monika.Messmer@fibl.org
Amritbir.Riar@fibl.org

www.greencotton.org
www.sgf-cotton.org
www.fibl.org/en/themes/organic-cotton.html

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