



*Seeding the
Green Future*

Participatory breeding for securing genetic diversity and organic cotton production in India

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

Postgraduate Course Participatory Plant Breeding & Resilient Seed Systems Online, 30th Nov till 4th Dec 2020



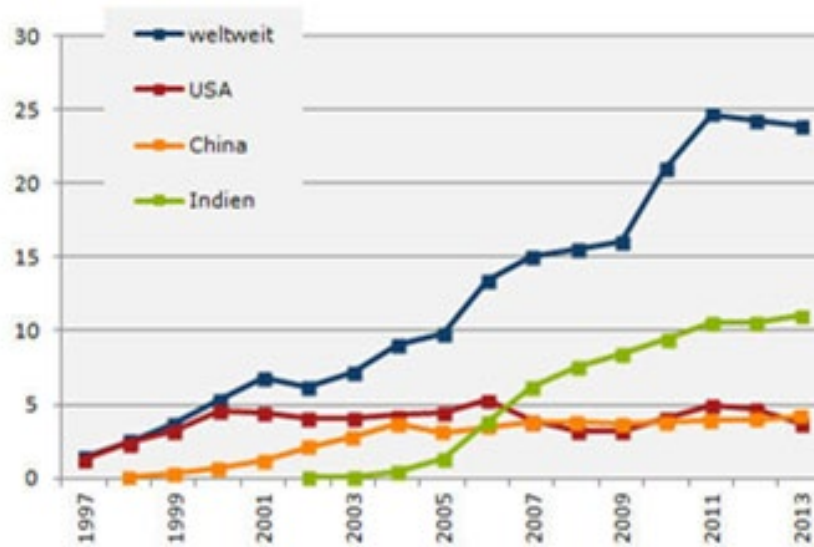
Why we get engaged in organic cotton breeding in India?



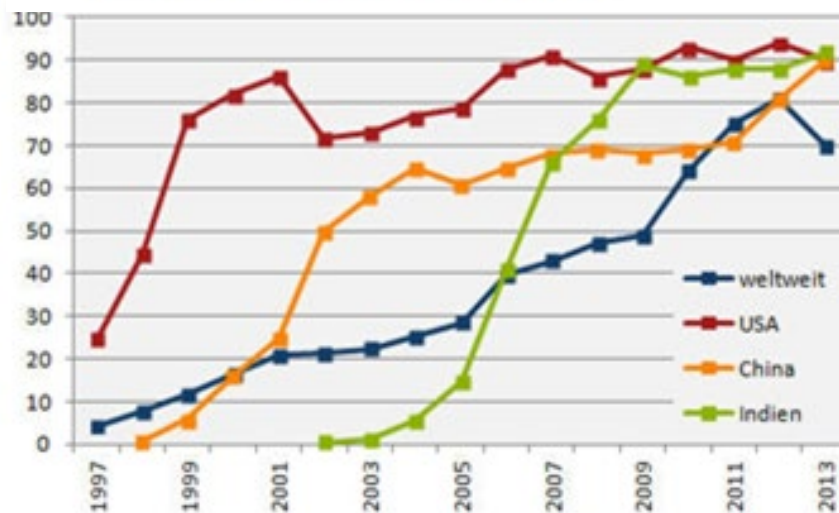
Challenges of organic cotton in India

- India has been the largest organic cotton producer, 10 years ago India supplied 80% but dropped now to 56%
- 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

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

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

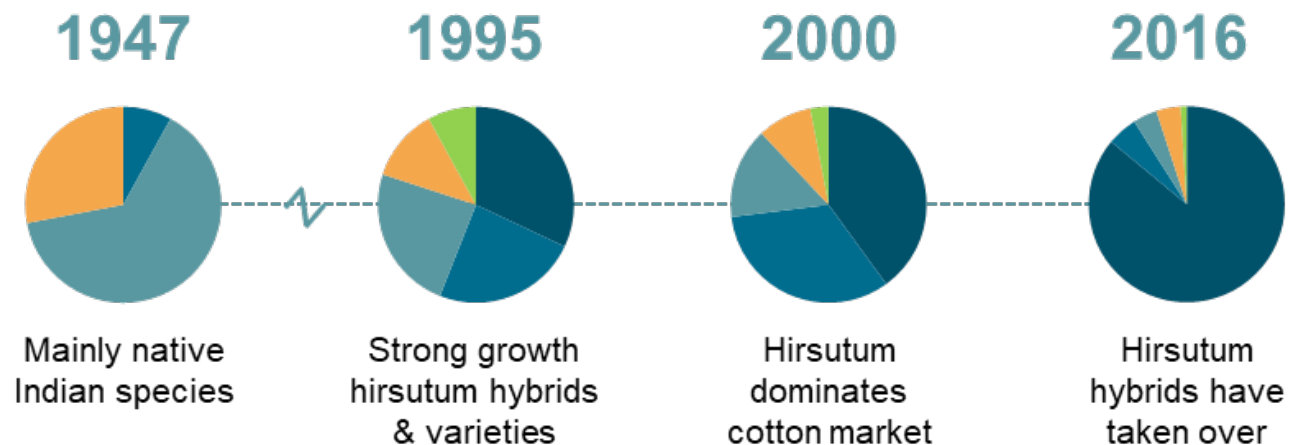


Historic development of cotton species in India

Cotton species Legend



Share of cotton species grown in India**

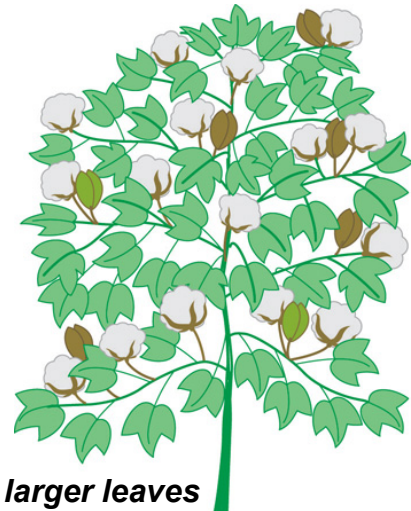


*Prof. Dr. R. W. Bharud, Mahatma Phuke Agricultural University
Rahuri, MA, All Indian Cotton Improvement Project*

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

Selecting the right cotton varieties

American Upland cotton (*G. hirsutum*)



Advantages:

- High yields
- Longer staple (higher price)

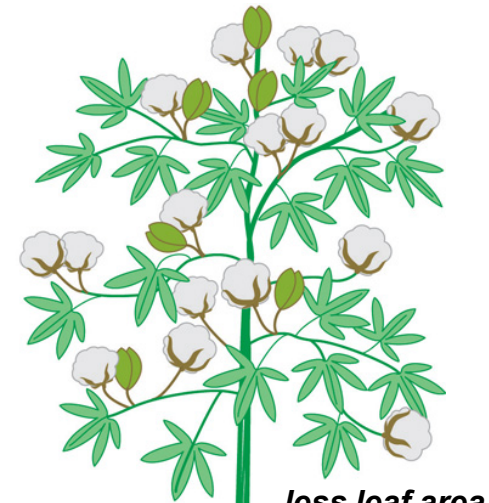
Disadvantages:

- 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 sucking pests

Disadvantages:

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

Suitable for:

- Shallow soils
- Sandy soils
- Little/no irrigation

Green Cotton – 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
- Train the trainers
- 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» Dharwad Declaration

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

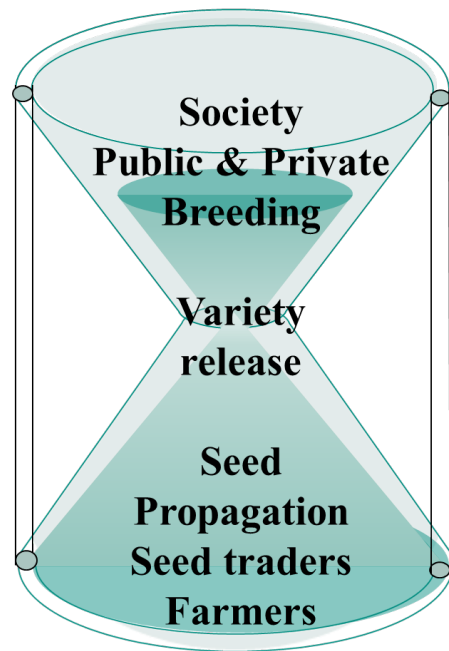
To combine forces for immediate action and support of:

- 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



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

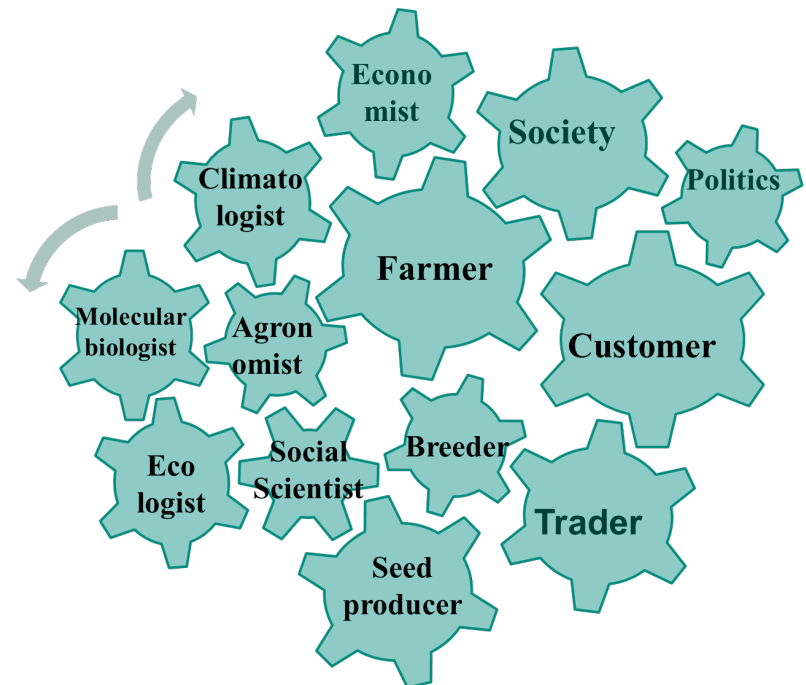
Formal plant breeding and seed supply



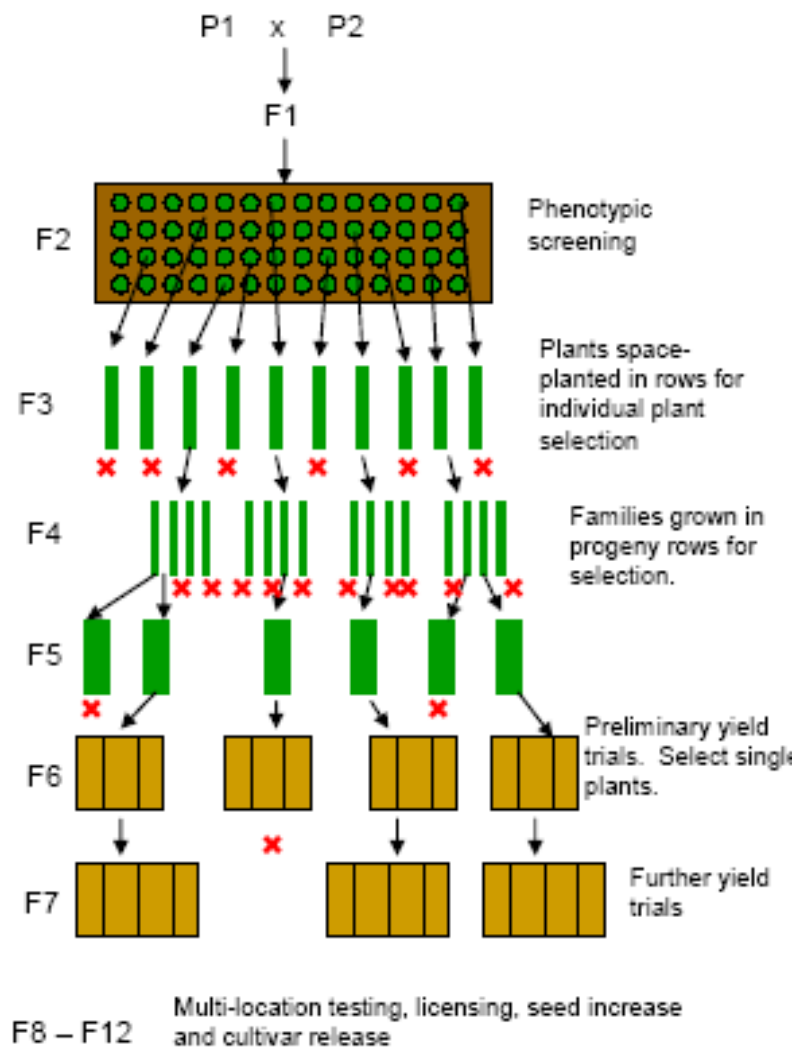
**One Way
Information:
Scientist**



Participatory plant breeding and seed multiplication



Breeding Scheme



Year	Breeding generation	Homozygous
1	Cross of 2 lines	99%
2	F1 progeny or F1 hybrid	0%
3	F2 plant selection	50%
4	F3 plant to row selection	75%
5	F4 plant to row selection	87.5%
6	F5 replicated plots (yield trials)	93.7%
7	F6 multi location trials (MLT)	96.8%
8	F7 MLT, purification & seed multiplication	98.4%
9 - 11	F8 –F12 testing for truthfully labelled seed or official variety release	99.2%

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Methodologies and Tools for Participatory Research

Participatory rapid appraisal

Mother - Baby Trial

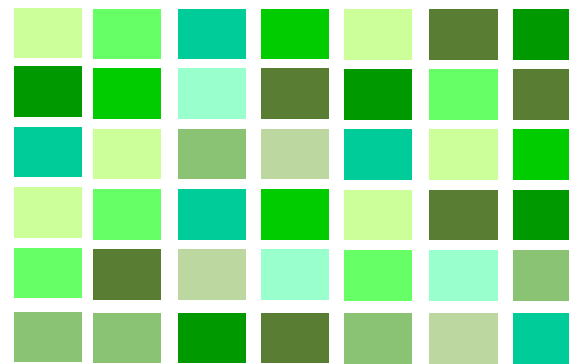
Farmer field schools

Farmer research committees

Participatory technology development

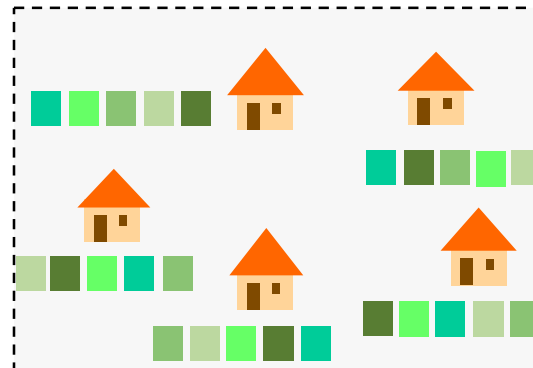
Action research

Mother trial (on-station)



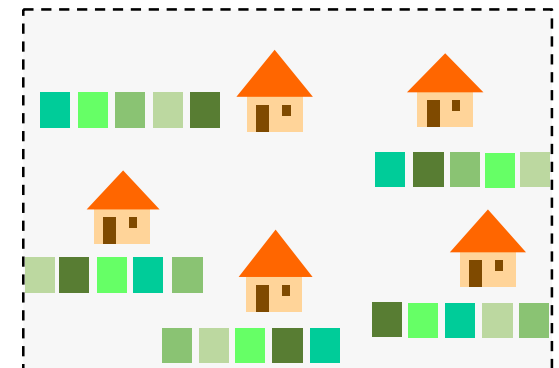
21 cultivars x 2 replication

Baby trials (on-farm)



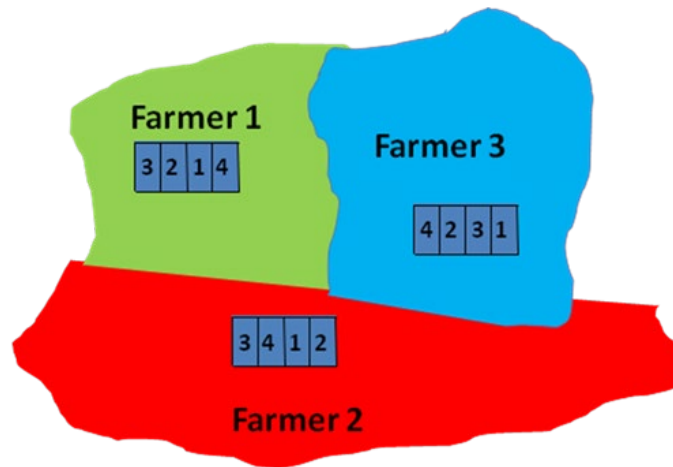
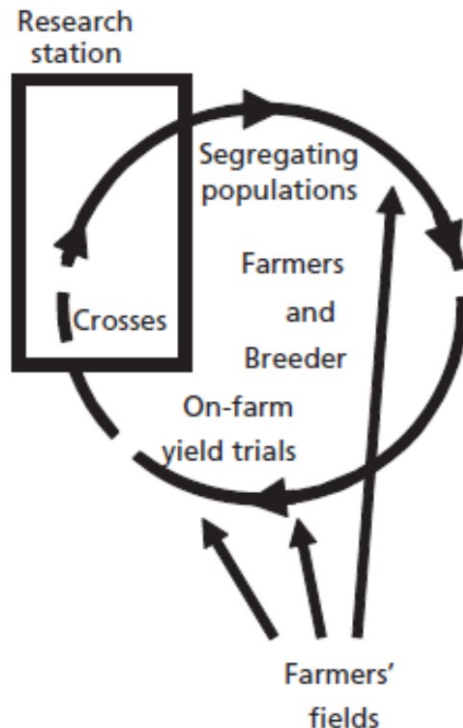
Best 5 cultivars tested in 10 on-farm trials

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**

Capacity buiding



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

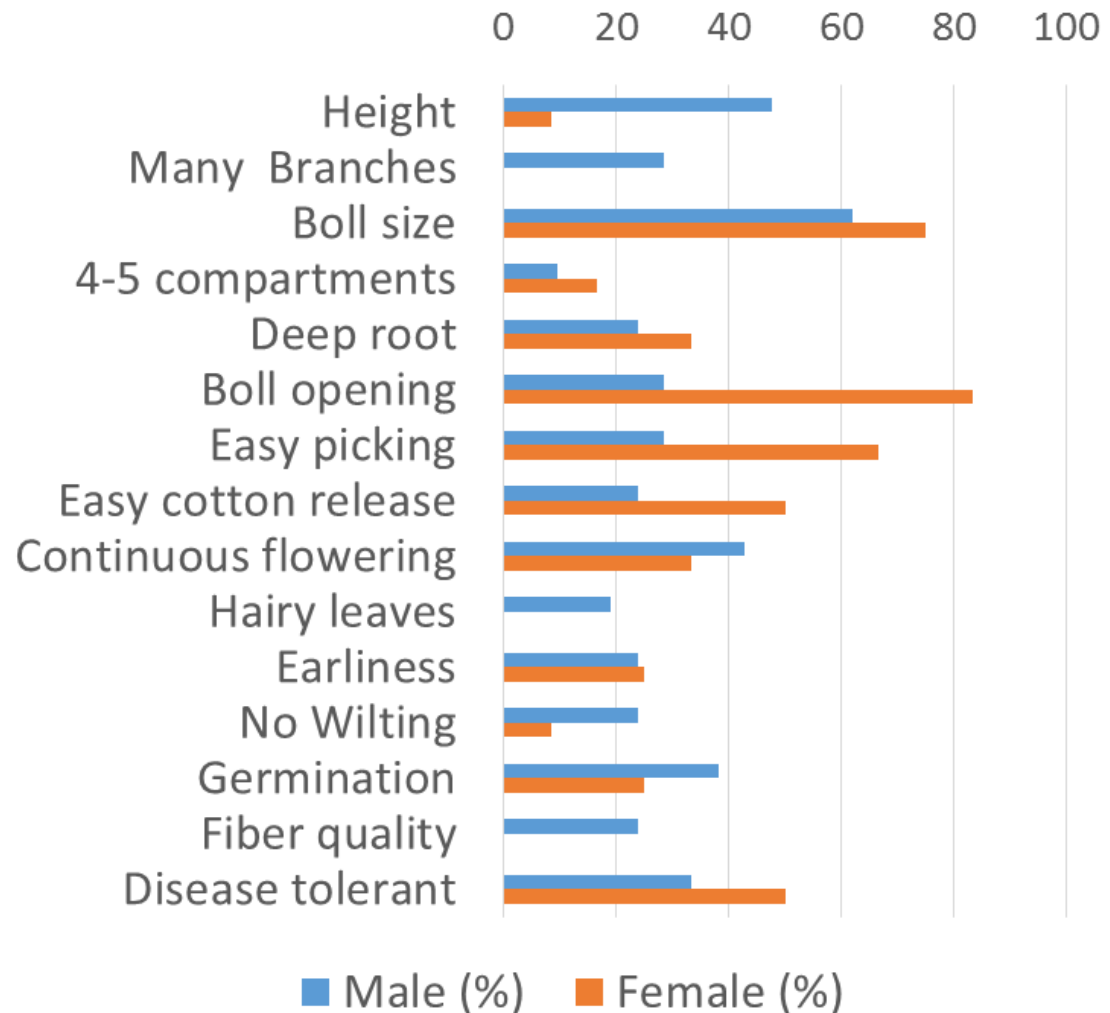
Cultivar selection



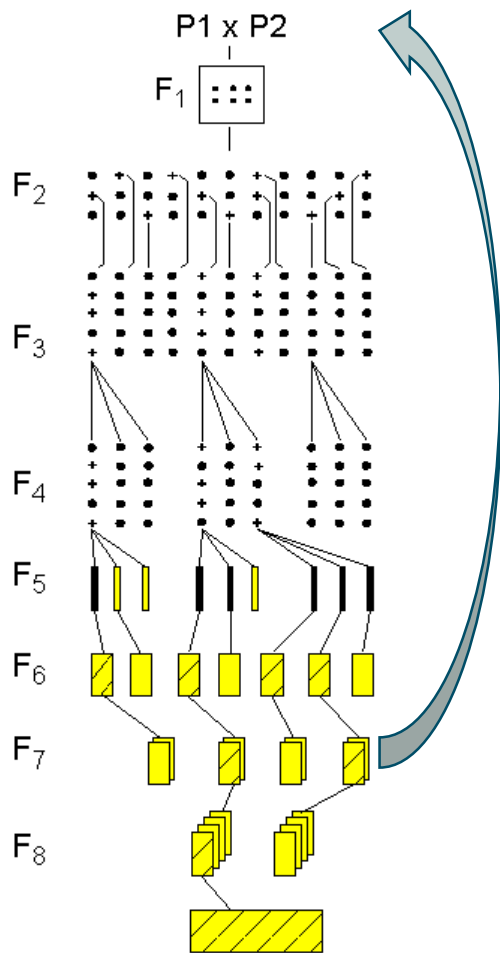
Single plant selection



Priority of Traits for Farmers



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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

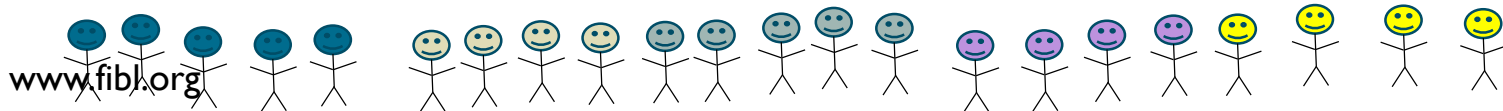
On-station & On-
farm baby trials of
best lines

MLT in different
pedoclimatic regions

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

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SGF Trial Sites (2018-19)

150 on farm trials

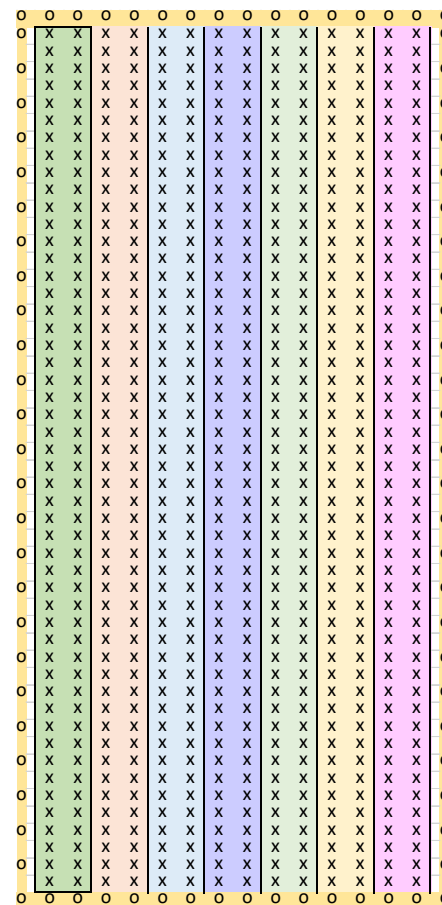
- 1 **Madhya Pradesh**
- 2 **Maharashtra**
- 3 **Rajasthan**
- 4 **Odisha**
- 5 **Gujarat**
- 6 **Andhra Pradesh**



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

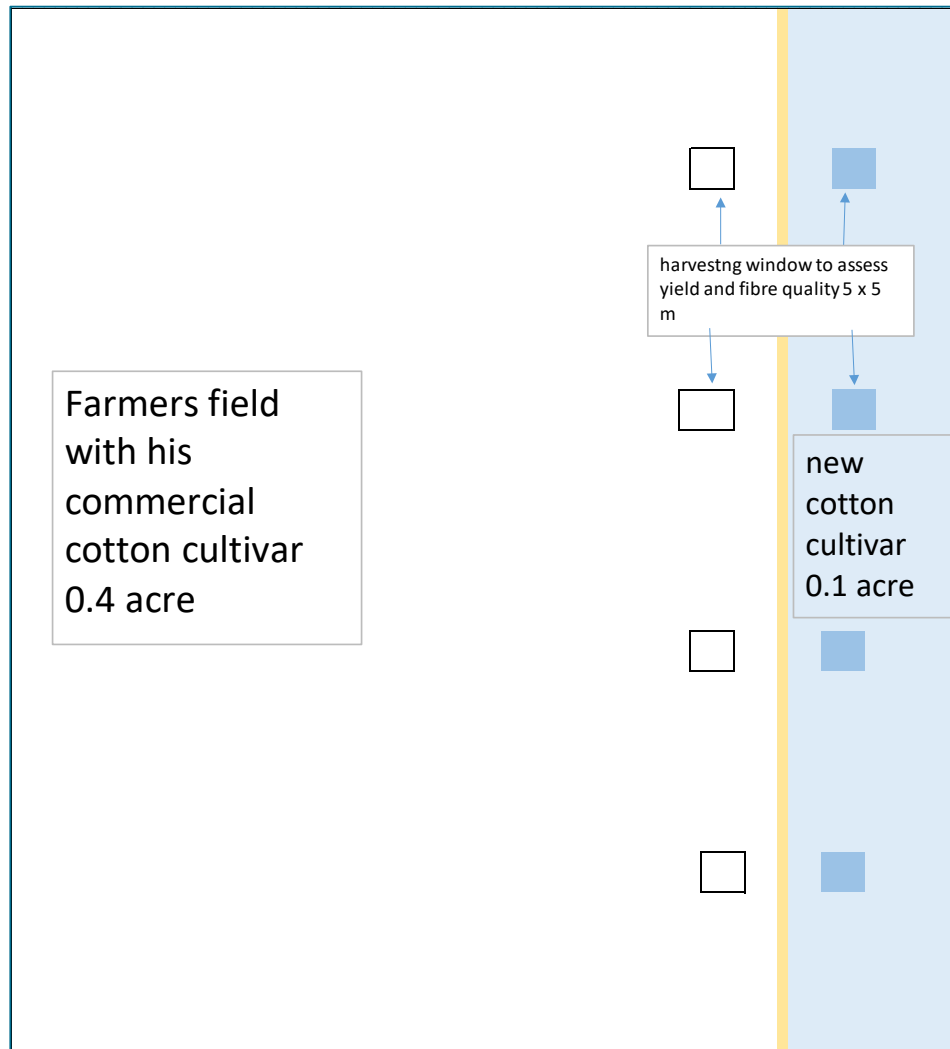


Farmers field
with his
commercial
cotton cultivar

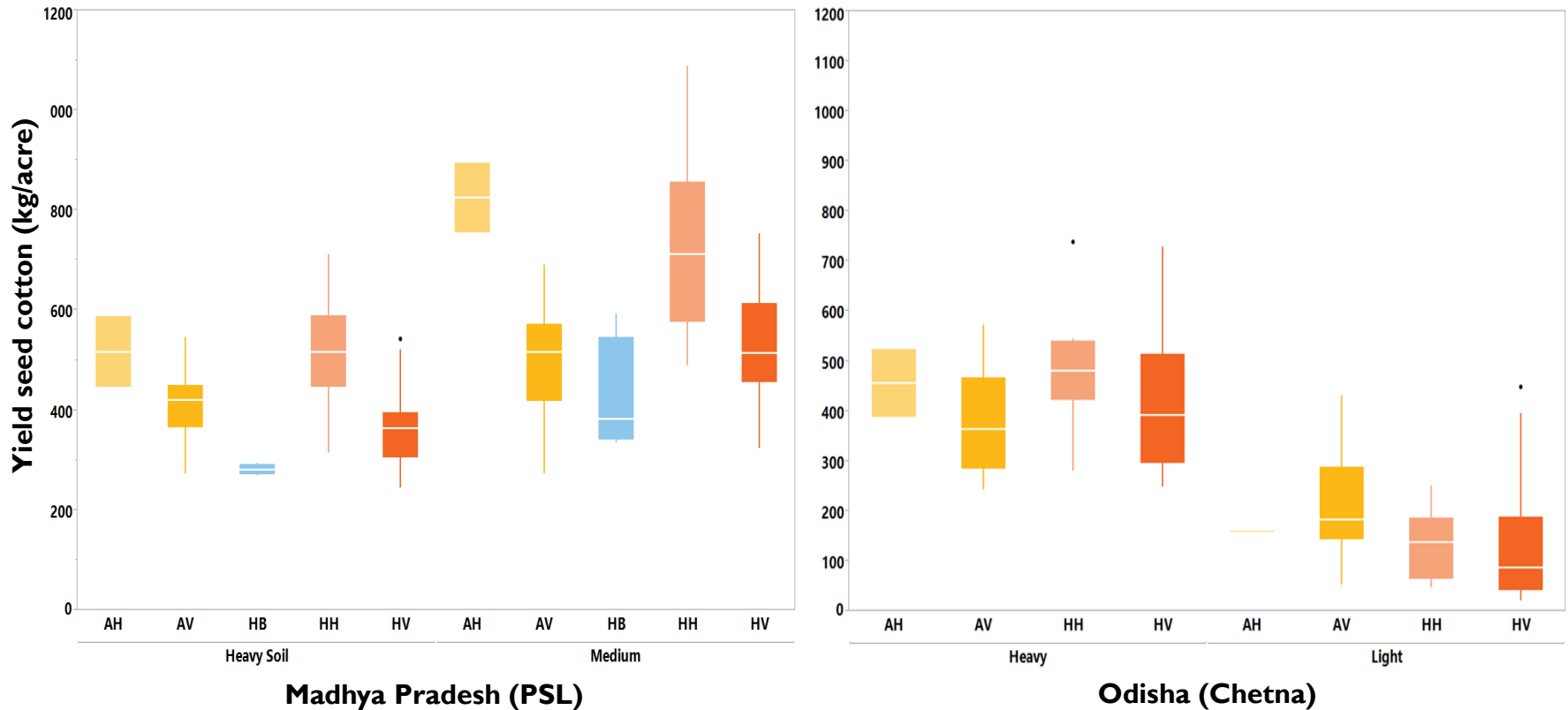
- Farmer can choose 5 from a set of 5 to 10 pretested cultivars where sufficient seed is available
- In addition he needs to use always the same check which is replicated to allow for Bayestion statistics

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*)

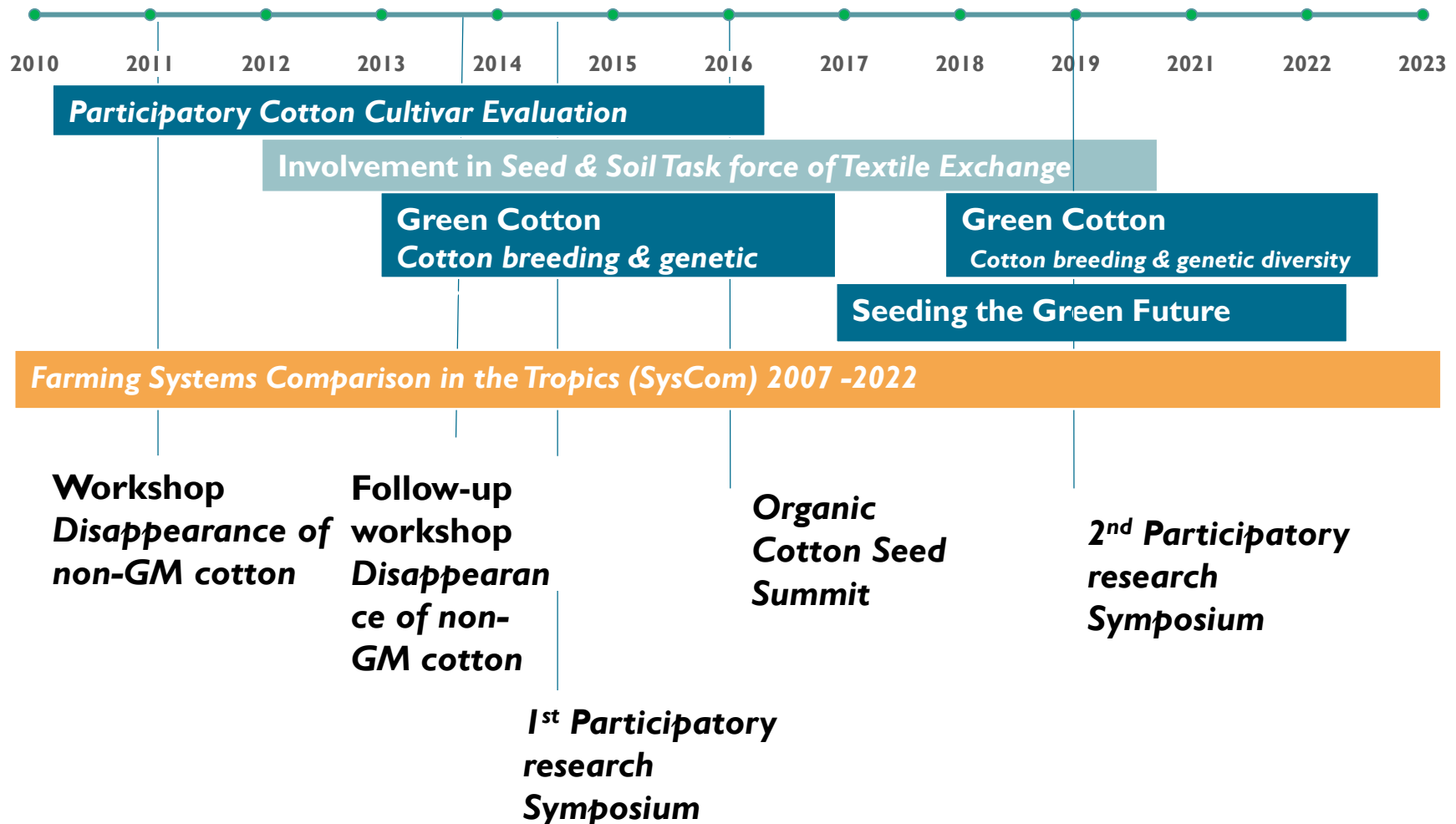
- HH: hirsutum hybrid
- HV: hirsutum variety



G. barbadense (*egyptian*)

- HB: hirsutum X barbadense hybrid

Organic cotton research in India and advocacy



Example for cross-sector promotion of organic cotton breeding

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



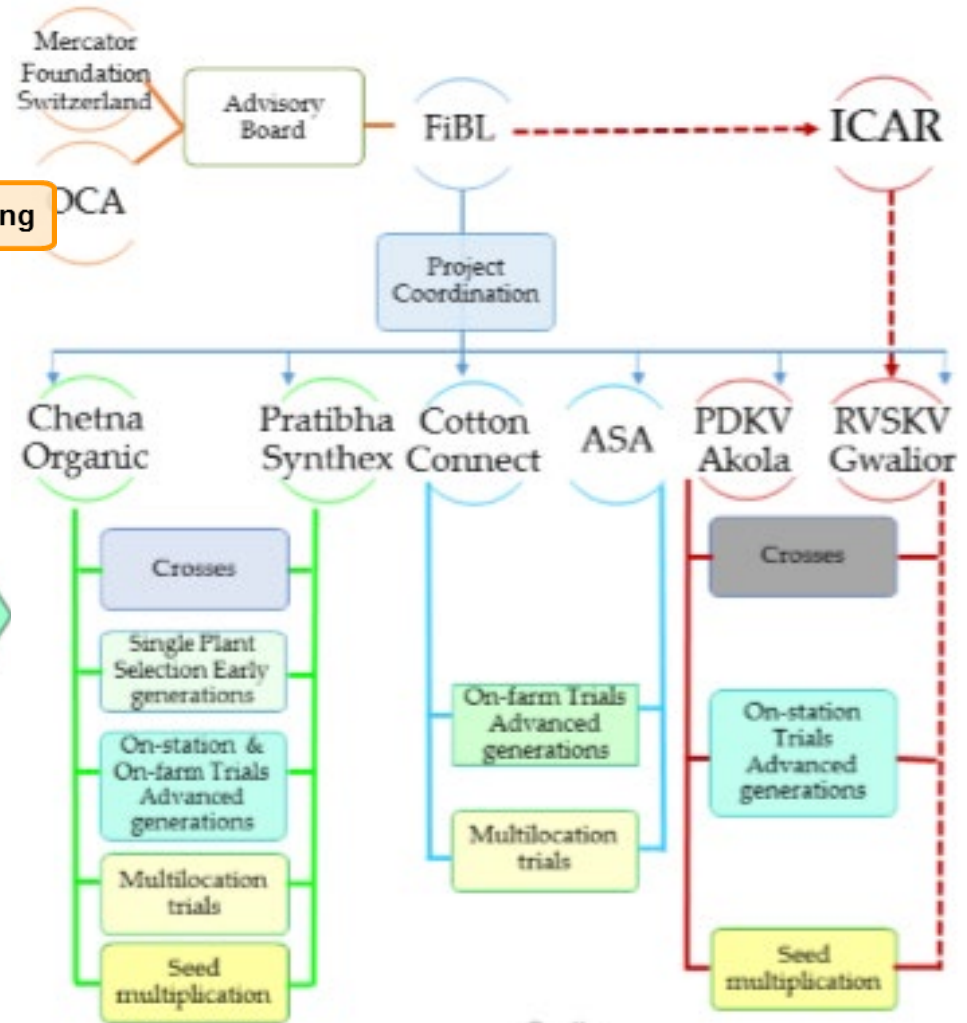
Fund raising



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Project Governance, Activities & Partners



Key figures at the end of the 2019/20 cotton season



✓ **Performance evaluation results** of over **49** different cultivars, incl both SGF and commercial cultivars

✓ **6 own breeding lines** introduced to farm trials, selected from a total of 12 candidates



✓ **Over 300 trials** set up in research stations and farmer's fields

✓ **Training** of **5446** farmers and **148** trainers



✓ **Manual** For Participatory On-Farm Breeding of Organic Cotton



✓ **Cultivar Evaluation Trial** data will be analysed for peer reviewed publication and public domain until spring/ summer 2021

SGF: Best Performing Lines (6) and Cultivars Contributed (12) to Seed Framework Group

S. No	SGF_Code	Generation	Variety/ Hybrid	Contributor	Yield_kg_ha		Average Yield_kg_ha	Fibre_Length_2.5 _span_length_ mm	Fibre: Fineness_ Micronaire_value
					Min	Max			
*1	SGF_324	F-8	<i>G. hirsutum</i> (Variety)	SGF-PSL	595	2140	976	32.00	3.96
*2	SGF_325	F-8	<i>G. hirsutum</i> (Variety)	SGF-PSL	462	2330	825	29.00	4.12
3	SGF_010	F-11	<i>G. arboreum</i> (Variety)	SGF-PSL	288	1555	674	29.67	4.54
*4	SGF_013	F-8	<i>G. arboreum</i> (Variety)	SGF-PSL	338	1325	712	30.00	3.90
5	SGF_014	F-8	<i>G. arboreum</i> (Variety)	SGF-PSL	450	1390	704	32.00	4.25
*6	SGF_303	F7	<i>G. hirsutum</i> (Variety)	SGF-FFID	160	1705	670	29.82	3.94
*7	SGF_306	F7	<i>G. hirsutum</i> (Variety)	SGF-FFID	172	2535	749	28.66	4.12
8	SGF_321	F7	<i>G. hirsutum</i> (Variety)	SGF-FFID	99	1934	569	28.91	4.37
9	SGF_305	F7	<i>G. hirsutum</i> (Variety)	SGF-FFID	191	1358	774	29.90	4.03
*10	SGF_008	F7	<i>G. arboreum</i> (Variety)	SGF-FFID	160	1320	673	28.92	4.28
11	SGF_002	F7	<i>G. arboreum</i> (Variety)	SGF-FFID	261	1394	789	26.92	4.71
12	SGF_003	F7	<i>G. arboreum</i> (Variety)	SGF-FFID	145	1723	730	28.32	5.00

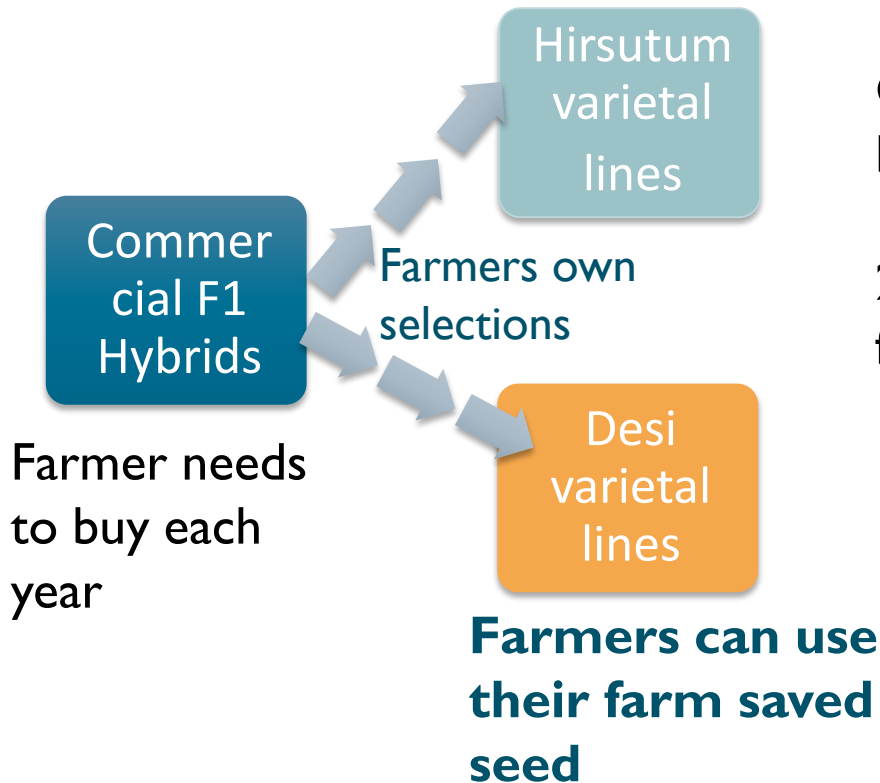
* Top 6 performing cultivars in advance generations

Farmers' own 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.



SGF Process Explainer Videos:

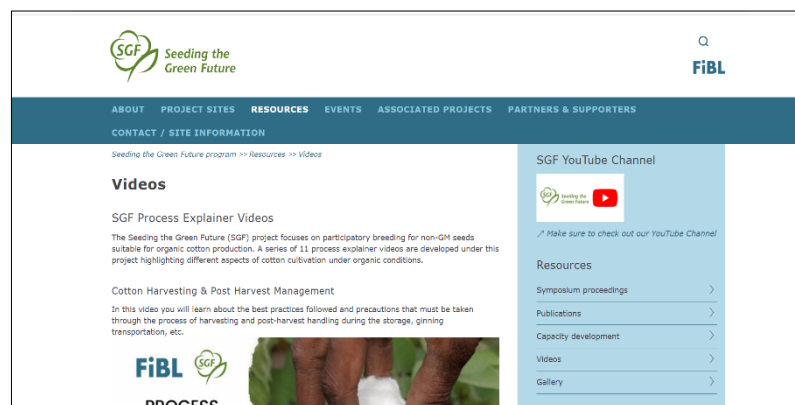
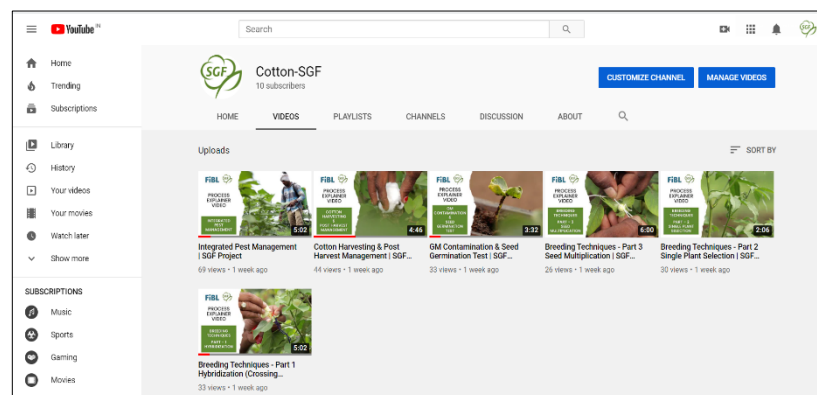
A major initiative to mitigate challenges posed by COVID 19 to SGF activities

Core Idea:

To draw the attention of the target audience towards the life cycle of the cotton crop by creating a series of 11 (eleven) process explainer videos, showcasing best practices of cultivating cotton organically

Target Audience: Farmer, trainers, students, extensionist, field experts, etc.

Behind the scene



<https://www.youtube.com/channel/UCNDsrOhblqw2R2LA9aI8VIQ/videos>

<https://www.sgf-cotton.org/resources/videos/>

SGF Uploads: Look and Learn



Coming soon....



<https://www.youtube.com/channel/UCNDsrOhblqw2R2LA9aI8VIQ/videos>

Technical Guide: Manual for Participatory On-Farm Breeding of Organic Cotton

Technical Guide

2020 | No. 2222

Manual For Participatory On-Farm
Breeding of Organic Cotton



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- ☐ A reference manual for training of farmers
- ☐ Support trainers in conducting instructional and practical training courses on participatory plant breeding (PPB)
- ☐ Already gone through several rounds of edits
- ☐ Final draft and design of manual will be ready soon
- ☐ To be released in coming months

30 November 2020

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Outcome 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
- A **strong and independent facilitator** is most important to keep cooperation going

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CONNECT**
TRANSFORMING THE WORLD'S COTTON FOR GOOD.



Supporters

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Boosting Organic Seed and Plant Breeding across Europe 2017-2021

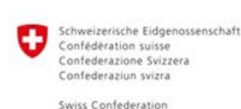


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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727230 and by the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 17.00090. The information contained in this communication only reflects the author's view. Neither the Research Executive Agency nor SERI is responsible for any use that may be made of the information provided.

