Diversity, germplasm information and exchange

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Outline

- Germplasm exchange is good
- Diversity: big potential for progress in collections
  - But beware of the bias by exclusive focus on genetics
- Collections: where and what?
- Exchange: low level, why?
- Information on germplasms: impediment to exchange
- ICRA's initiative to improve germplasm information
- Take-away messages

Germplasm exchange ⇒ Desired variety

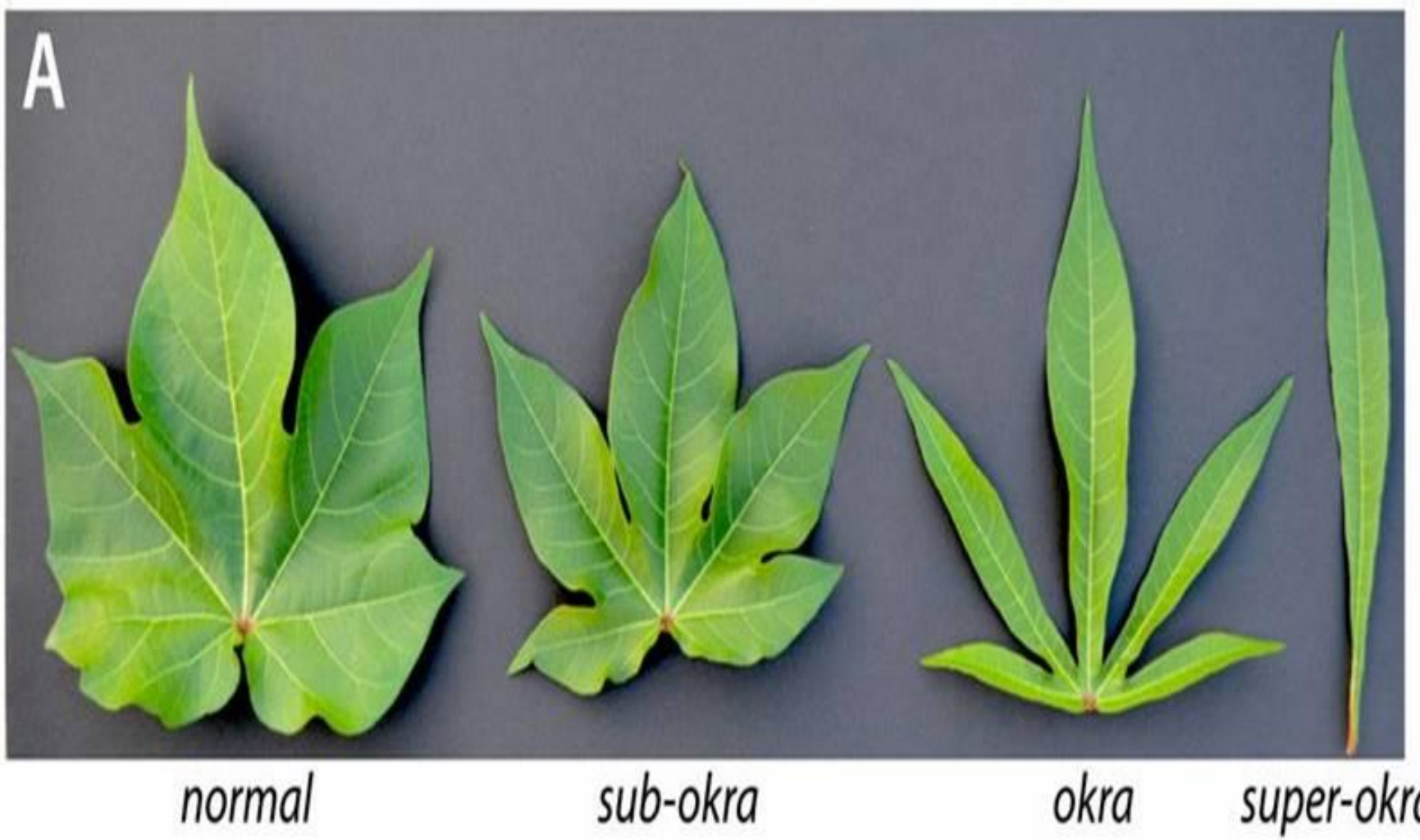
- Case of a new variety resistant to Leaf Curl Virus in Pakistan
  - ⇐ a set of 74 accessions obtained from CIRAD
    - Request made formally
    - Accessions provided in 2006
  - Variety CIM-620 approved for commercial release in 2016, in Punjab province
    - Tolerance against CLCuV
    - Light brown color of lint
    - Ginning outturn = 40.2%
    - …

Germplasm exchange ⇒ basis to relaunch breeding program

- Cote d'Ivoire: cotton research station destroyed at the beginning of a 10-year political crisis
  - Restart ⇐ material by CIRAD

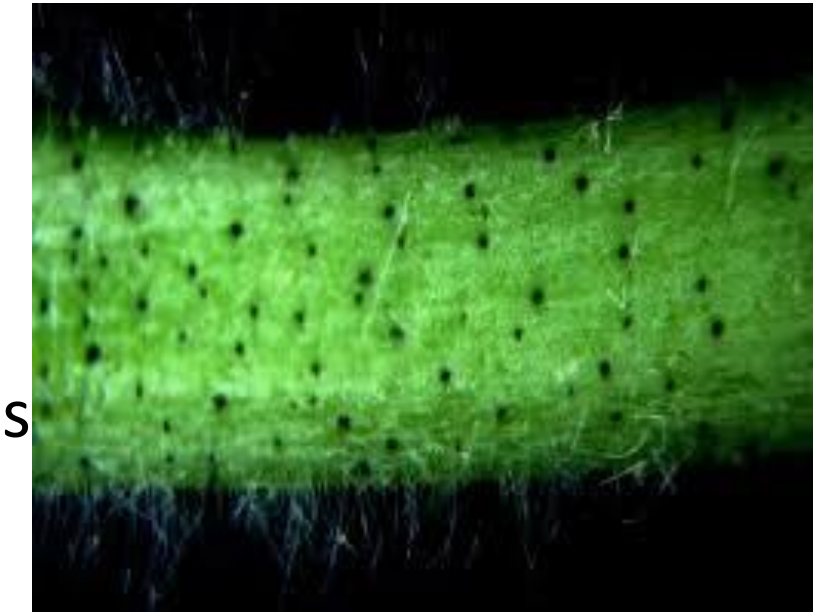
Diversity = big reservoir for progress

- Case of potentially interesting morphological traits
  - Okra leaves for better light penetration
    - Trait exploited, but far from all countries



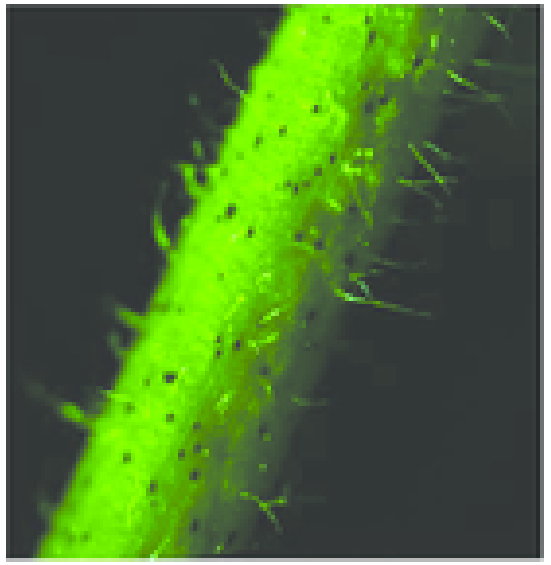
Diversity = big reservoir for progress

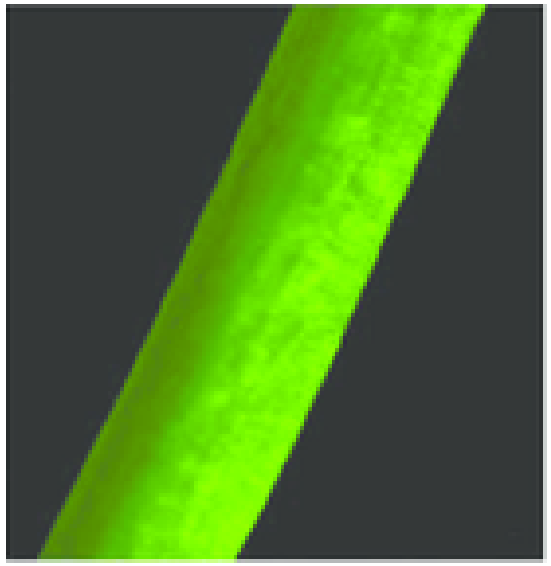
- Case of potentially interesting morphological traits
  - High density of gossypol
    - Exploitation contemplated (China?)



Diversity = big reservoir but beware of the bias on genetics

- Exploitation of an interesting morphological trait: Glandless cotton
  - ± 250,000 ha in West Africa in mid-1990
  - Experience little known
  - Experience: not lasting
    - Adaptation of pest control was overlooked
- Lessons learnt
  - Variety or genetics cannot suffice by itself
  - Better to breed varieties along with cultivation techniques
    - Case seldom encountered





Cotton germplasms, collections : gene banks

Cotton germplasms: where

- All breeding teams have germplasms
  - Size frequently small
- Countries with large public cotton collections
  - USA: several collections, > 10,000 accessions
  - China: a central collection, ± 9,000 accessions
  - India: a central collection + secondary collections
    - ?? accessions
  - Pakistan: a central collection of 5,202 accessions
    - 1,923 accessions of G. hirsutum
    - 3,279 accessions of various Gossypium species
  - Uzbekistan: a central collection, 6000?? accessions
  - France: CIRAD collection, 3069 accessions

24,830 accessions in the US (Public) Cotton germplasms

USDA-ARS Beltville Cotton Branch Archive	1,053
National Centre for genetic Resource preservation, cotton collection	2,685
Pedigrees of Upland and Pima cultivars	661
National Plant Germplasm System (NPGS), Crop Science registration	1,082
NPGS Cotton Plant variety protection	661
National Chemical Genomics Centre (NCGC) G. barbadense collection	1,549
NCGC Cotton Wild Species collection	486
NCGC Panel	10
NCGC Cotton race collection	2,088
NCGC Cotton obsolete variety collection	2,850
NCGC Asiatic cotton collection	1,844
Germplasm Resource Information Network (GRIN) Cotton collection	9,861

Number of distinct accessions: hard to know

- Redundancy of accessions in collections
  - Within a country
    - Clear case with the USA
- Furthermore redundancy between countries

	Accessions common to French and Pakistanis collections	
	Number	% of French total
G. hirsutum	322	11,8
G. barbadense	6	0,8
G. arboreum	0	0
G. herbaceum	2	3,6

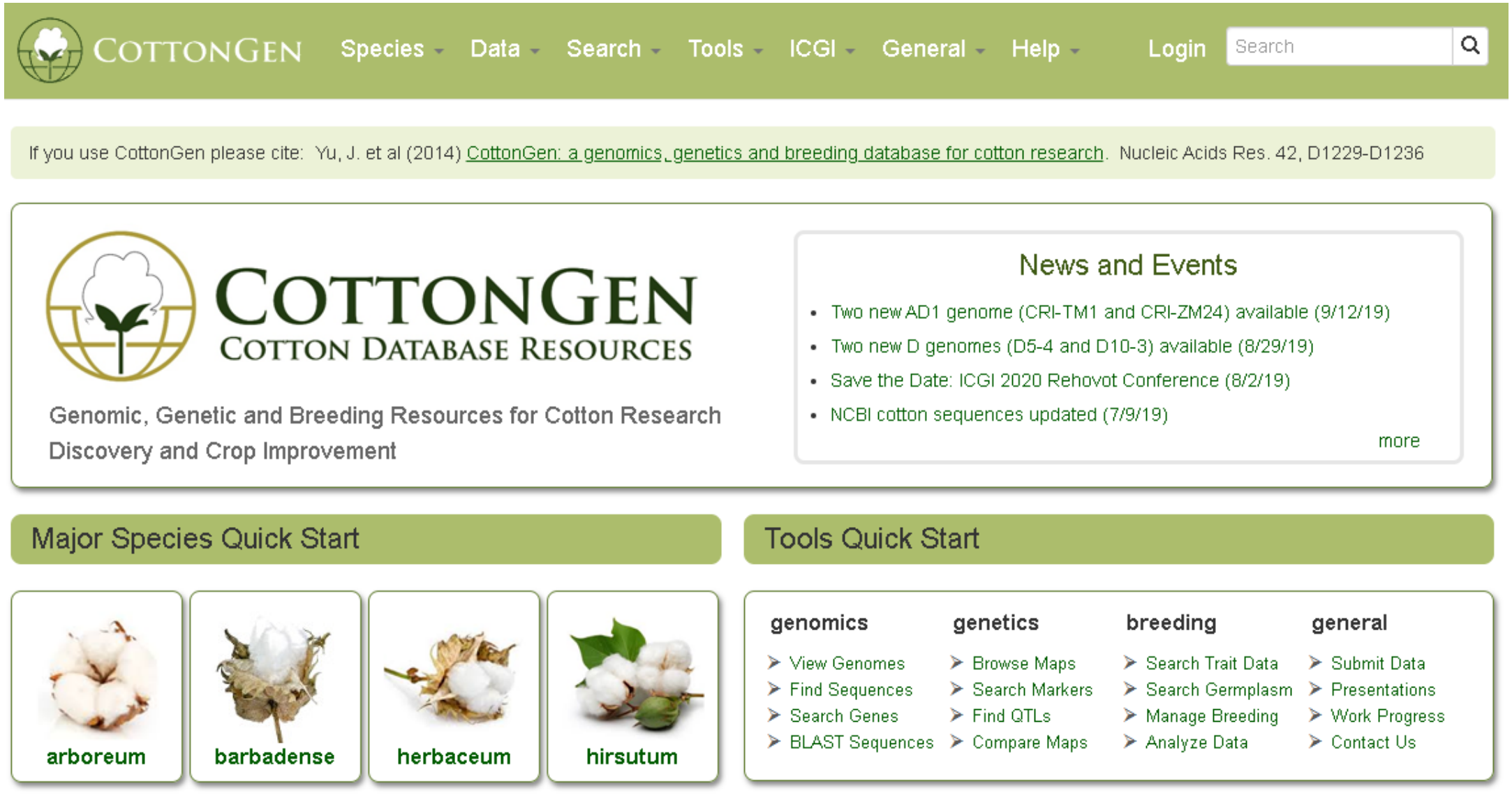
Reduncdancy in collections is an advantage

- a same accession could have been evaluated in several countries
  - Under various biotic and abiotic stresses
- But advantage not really exploited so far
- Between countries, collections not that much reduncdant
  - Relevance to increase the reduncdancy
    - A new wave of exchange between collections is needed

Cotton germplasms: what?

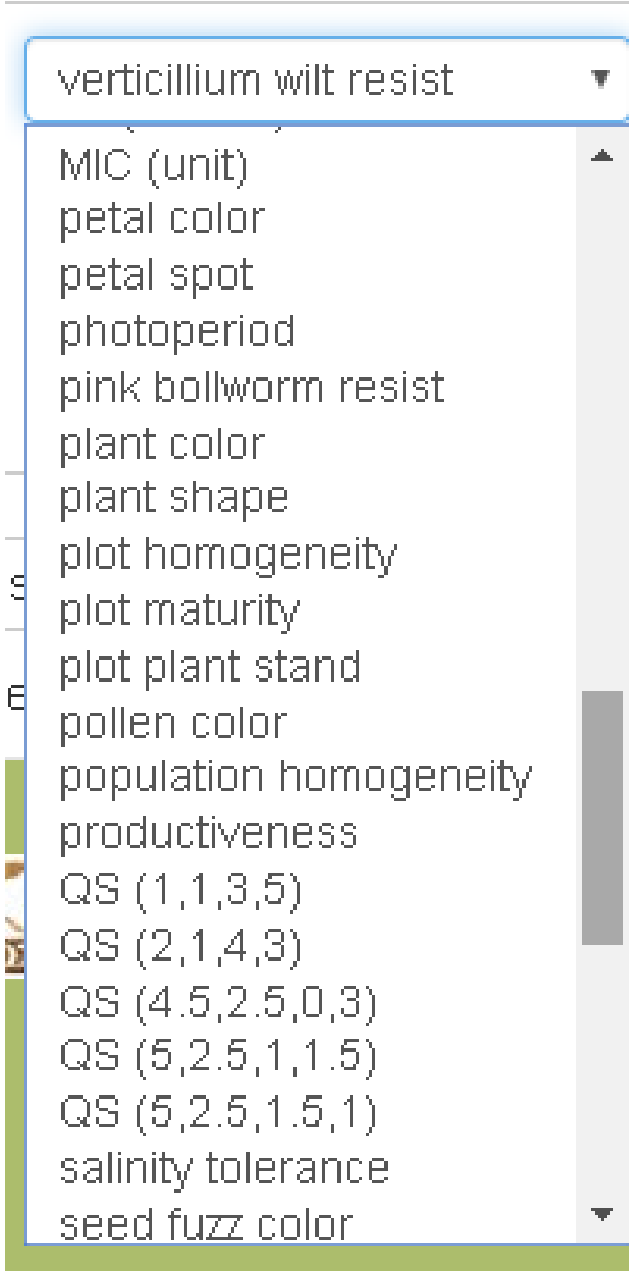
- Little information available, hardly accessible
  - ⇐ Management of most cotton collections
    - No cooperation obtained from several countries for this presentation
- CottonGen: A single and remarkable initiative
  - https://www.cottongen.org/
  - Possible information on 28,735 accessions
    - 24,830 accessions from US collections
    - 16,880 accessions in 4 major species
      - 12,414 Gossypium hirsutum
      - 2,047 G. barbadense
      - 2,158 G. arboreum
      - 261 G. herbaceum
  - Albeit not yet perfect

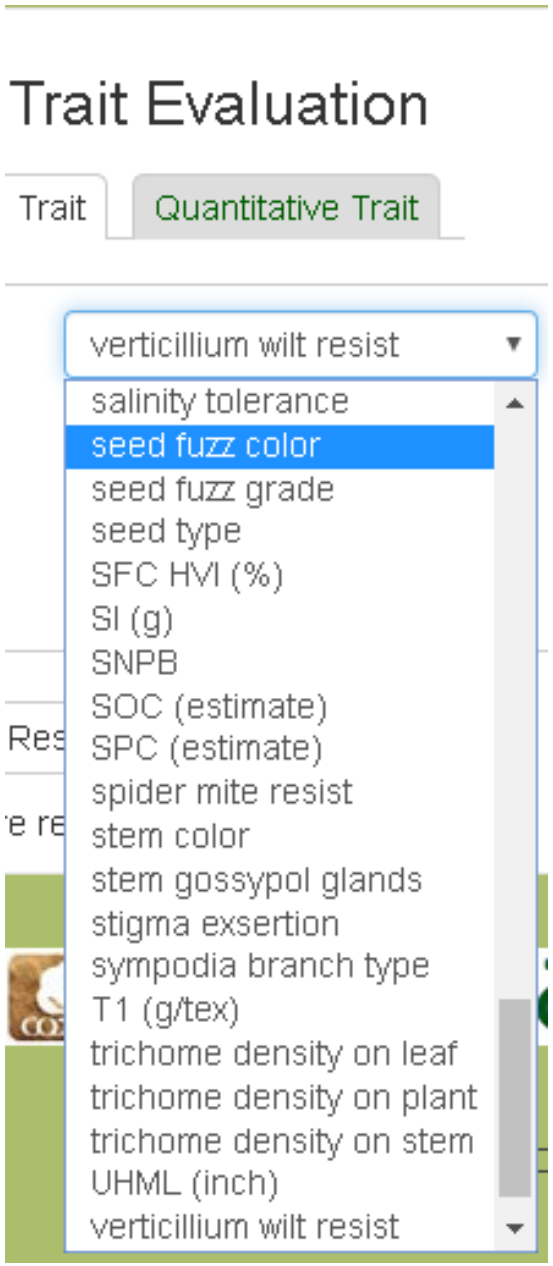
Homepage of CottonGen



Cotton collections integrated into CottonGen

- Several collections involved…
  - China
  - Uzbekistan
  - Public collections in the USA
- …but only partially except for the USA
  - China: 2,980 accesions out of ±9,000
  - Uzbekistan: 913 accessions out of ±6,000?





Limitations

- Already 78 traits searchable
- But important traits still missing
  - Blue disease
  - Leaf curl virus
  - …

Low level of exchanges based on CIRAD's recent experience

- 217 accessions supplied on request over 7 years
  - 42% were for CIRAD's own use
- 5 countries have benefitted

	Out of CIRAD	CIRAD		
		For rejuvenation	For studies	Total
2012	1			
2014	10			
2015	38	25		25
2016	25		2	2
2017	2	39		39
2018	16		23	23
2019	34	1	1	2
Total	126	65	26	91

Influential factors of low exchanges

- Attitude of routine from breeders?
  - Need not felt for breeding from enlarged genetic diversity

Influential factors of low exchanges

- Great difficulty to deal with wild species of Gossypium

- Steps followed to achieve variety CIM-620 in Punjab
  - Accession AS-0349 is photo period sensitive
    - no flower formation in Punjab
  - AS-0349 plants maintained by ratooning during 3 years
    - Till flowers were obtained in December 23, 2009
  - Crossings made possible in Breeding Program
    - 3-4 years after access to the original accession and perseverance efforts

Influential factors of low exchanges

Greater difficulty to deal with large genetic diversity

Means and capabilities may lack

- $\Rightarrow$ rational for a regional/international program to create/manage diversity
  - and pass more stabilized material to national teams to finalize country-adapted varieties

Influential factors of low exchanges

- Main factor = lack of information for breeders
  - Where potentially genetic materials are?
  - How interesting materials are?
  - To whom address one's request?
  - (would my request positively responded?)
- Organized, comprehensive and accessible information is yet to come
  - Despite CottonGen initiative
    - Not all collections are covered
    - Accessions are seldom comprehensively described/evaluated

Germplasm information: impediment to exchanges

- Difficult issue of describing accessions
  - A lot of "descriptors" are required
  - Sets of "descriptors" vary between collections or countries
    - In terms of composition, definition, measurement
      - 78 descriptors identified by CottonGen
      - 22 descriptors informed in Pakistan
        - 20 in CIRAD, France
  - All existing sets of descriptors are not complete
    - No way and no rationale to evaluate comprehensively
    - Missing descriptors pertain e.g. to important region or country-specific diseases or trait (like ginning outturn)
    - $\Rightarrow$ lack of interest for existing germplasms to countries with emphasis on specific trait
  - A global set of descriptors, desirable, is yet to come

ICRA's idea/initiative: promote information on germplasms

- 'Germplasm Information Sharing Initiative' = GIFI
- Initiative open to organizations/countries willing to join in
  - Pakistan (PCCC)
  - France (CIRAD)
  - Others are expected
    - USA? India? Australia? Uzbekistan? China?
- Objective = sharing information
  - Ownership not shared, remains with existing collections
  - $\Rightarrow$ address to collections for requests of accessions

2-phase initiative

- Phase 1: Limited fund requirement
  - Towards a harmonized and comprehensive set of descriptors
    - Task of a group of focus scientists from each participating organization
    - Task inspired by CottonGen achievements

2-phase initiative

- Phase 2: More substantial fund requirement
  - Development of an adapted online tool to enable
    - Sharing and consolidating information on accessions managed in various collections
    - Searching on multiple traits
    - Knowing availability and accessibility of accessions
  - References to inspire from
    - CottonGen
    - Florilege in France
      - http://florilege.arcad-project.org/fr/collections

Take-away messages

- Genetic variability in collection: potential for progress to be exploited
- There are collections available for request/exchange
- But request/exchange of low level
  - $\Rightarrow$Rationale for regional/international program of variability creation combined with national breeding activities
  - $\Rightarrow$ Rationale for international initiatives (e.g. ICRA's proposal)
- Germplasm exchange advocated…
  - = Relevant public good to promote…
  - …but where funding support is?