FUNCTIONS OF COTTON SA

• Quality analyses and quality control
• Research; development & cultivar development
• Farmer development; transformation & production
• Training
• Information transfer
Cotton Production in SA

COTTON PRODUCTION AREAS

GINS

& SPINNERS

A - Lower Orange River
B - Marydale/Prieska
C - Hopetown/Douglas
D - Vaalharts
E - Taung
F - Weibe
G - Thabazimbi/Dwaalboom
H - North & South Springbok Flats
I - Marble Hall/Grobiersdal
J - Bushbuckridge/Barberton
K - Makhathini
L - Stella/Setlagoli
M - Lichtenburg/Delareyville/Schweizer-Reneke
N - Hoopstad/Hertzogville
O - Winterton
P - Pongola/Mkuze
Q - Jacobsdal
R - Luckhoff
S - Nkomazi/Komatipoort

COTTON GINS

1 - Weipe
2 - Loskop
3 - Vaalharts
4 - Northern Cape
5 - GWK
6 - Swaziland Gin
7 - Ubongwa
8 - Koedoeskop

COTTON SPINNERS

1 - Prilla Mills
2 - Tai Yuen Textiles
3 - Standerton Mills
4 - Tradelink

Current Cotton Areas

Traditional Cotton Production Areas

New Commercial Areas

New Smallholder Areas
Smallholder production in actual bales* in relation to the National Crop.

![Bar chart showing production years from 2019 to 2023 with data points for total lint bales, DP 1240, PM 3225, and proportion of national crop (%).](chart.png)

- **2019**: Total lint bales = 202,076, DP 1240 = 3,950, PM 3225 = 122,360, Proportion of national crop = 4.25%
- **2020**: Total lint bales = 74,094, DP 1240 = 2,837, PM 3225 = 69,000
- **2021**: Total lint bales = 556, DP 1240 = 4.25%
- **2022**: Total lint bales = 1,244, DP 1240 = 1,994
- **2023**: Total lint bales = 987, DP 1240 = 4.25%

*Smallholder production in actual bales in relation to the National Crop.*
SOUTH AFRICA: Research, Development & Technology

- **GMO technology:** - have 2\textsuperscript{nd} generation technology
- **Harvesting technology:** spindle pickers and new stripper technology & smallholder baler machine

- **Production research** – cultivar trials & agronomic research (plant densities/growth regulator trials)
- **Pesticides:** Insecticides & biological products & defoliators & boll openers

- **Breeding programme** – Agricultural Research Council (ARC) – no research/very limited
WHY COTTON.
• Better suited for dryland production than other crops – like maize, sunflower, sorghum etc.
• It rotates well with other glyphosate-tolerant crops, maize and soya - to increase sustainable farming
• Rotational crop with Sugarcane
• Dryland and irrigated production
• Water efficient (55% of the national crop - dryland)
• Alleviating poverty – job creation per hectare (1,35/ha) – extended benefit, 5,3 persons per family unit.
Challenges

- Weed control technology

- Increase production - Short-season cultivars for dryland farming (approx. 140-145 days post-planting)

- Environmental – commercial & smallholders (rain/floods/drought)

- Job creation – (33% of population- jobless)

- Natural resources: electricity (load-shedding) & water (water –scheduling)
Why South Africa need access to germplasm?

To make use of the available soil moisture.

Maturity of fibre - season too short; limited access to cultivars.

Commercial farmers:
Two cultivars: DP 1240 BG2RF and Candia BG(2)RF (< 0,1%, DP 1541 BG2RF); refugia DP18RF
Smallholders: PM3225 BG2RF.
- technology has become stagnant

Access to other germplasm will depend on the presence of traits in the chosen varieties.

No conventional cotton (non-GMO), - will not revert to conventional cultivars, realising the impact of the current technology; no resistance.
Technology elsewhere - how it limits access to genetic diversity.

South Africa: present technology restricts access to germplasm:
Bollgard II (Cry1Ac & Cry2Ab) & Roundup Ready Flex, provide farmers with limited access to four (3?) cultivars (bollworm resistance and glyphosate tolerance.

De-regulated in 2007 in stack gene combination
- current cultivars introduced in 2016/2017, seven years
- no new varieties with the same or alternative technology

No introduction of cultivars with the same traits - permission and in full agreement with the patentee.
- Can not revert to previous single gene trait – Bollgard I,
  Stewardship of technology

Egan et al. (2022): mention a slowing in genetic gain over time in isolated programmes (or countries in this instance), leading to the overall genetic variability being reduced.
The exchange of germplasm to support breeding programmes should be easy.

Cultivar development is hampered by multinational companies who restrict access to their germplasm through intellectual property protection rights - patents and licensing agreements on specific cultivars.

This results in an overall reduction in the movement of germplasm between germplasm resources, resulting in the limited exchange of genetic resources.

**Germplasm exchange must be facilitated**
Drivers for breeding/factors limiting production increase

Variable climates within any country (variable soil conditions & resources):

- total available water - plant
- day degrees
- economic affordability of input costs (such as fertilisers and pesticides)
- access to mechanical harvesters/manual labour for handpicking (minimum wage)

Transportation costs & accessibility (fuel)

Electricity and diesel costs and demand

Other available resources: access to information

Access to finance
Some of the latest published work on germplasm in the global environment
Australia (Warwick N. Stiller and Iain W. Wilson)

China (Yinghua Jia, Junling Sun and Xiongming Du)
China (Upland varieties) Hongxian Mei, Xiefei Zhu, Wangzhen Guo, Caiping Cai and Tianzhen Zhang

India (S.S. Narayanan, Parchuri Vidyasagar and K. Srinivasu Babu &
Utilization of Indian varieties (N. Manikanda Boopathi, S. Sathish, P. Dachinamoorthy, P. Kavitha and R. Ravikesavan)

Pakistan (Mehboob ur-Rahman, Zainab Rahmat, Abid Mahmood, Khalid Abdullah and Yusuf Zafar)

USA (Richard G. Percy, James E. Frelichowski, Mark D. Arnold, Todd B. Campbell, Jane K. Dever, David D. Fang, Lori L. Hinze, Dorrie Main, Jodi Scheffler, Monica A. Sheehan, Mauricio Ulloa, Jing Yu and John Yu) & New World (Mauricio Ulloa) Upland cotton (Linghe Zeng).

Uzbekistan (Ibrokhim Y. Abdurakhmonov, Alisher Abdullaev, Zabardast Buriev, Shukhrat Shermatov, Fahridin N. Kushanov, Abdusalom Makamov, Umid Shapulatov, Sharof S. Egamberdiev, Ilkhom B. Salakhudtinov, Mirzakamol Ayubov, Mukhtor Darmanov, Azoda T. Adylova, Sofiya
https://doi.org/10.2135/cropsci2009.09.0551


To address future challenges:
Plant germplasm collections or “germbanks are collections of seeds or breeding material, aimed at preserving a source of genetic diversity.

Kinds of germplasm collections:
- have evolved over the years in response to research needs:
  * base collections
  * backup collections
  * active collections
  * breeders' or working collections.
  * core collection (represent diversity in germplasm & wild relatives with limited resources)
Core collection:

- Accession: be ecologically and geographically distinct from each other to maximise diversity – Allopatric species
- Be comprehensive, multi-organizational and international. (Accessions that did not make it into the core collection can be considered as a reserve collection).

Many other crops like chickpeas, mung beans, peanuts, apples, eggplant, barley etc. have core collections.

- 8 countries present most of the germplasm resources.
- Smaller collections (sub-selections or mini-core collections) can be created
  - to serve a certain objective like a source of resistance lines for a breeding purpose, being a subsample of the core collection (representing 10% of the germplasm).

- In cotton, currently few core collections globally (pp. Egan et al, 2022) - in Australia, there are yet no core collections.
Genetic diversity of germplasms—presents a “bouquet” of characters

For South Africa:

- A compact short statured plant framework
- Bolls closer to the stem, 110 000 plants/ha (irrigation) & 44 000 – 66 000 plants/ha, (dryland), no monopodial branches
- A short season of 140-150 days; short reproductive window (50-60 day critical window of squaring, flowering and early boll set)
- Resistance to sap-sucking insects (secondary pests) & nematodes
- High initial shoot and vigour
- A high gin out turn and good quality fibre
To unlock potential dryland areas in Schweizer-Reneke (North-West) – water table fields.
Possibilities to look into for South Africa?

- Early-maturing cotton cultivars/varieties has been a goal for Central Asian and European countries - with germplasm from Bulgaria, Greece, Yugoslavia, Romania, Albania, and other EU countries to provide adaptation to Northern climatic zones.

- *G. hirsutum punctatum* accessions from Mexico – early maturing varieties with improved fibre quality) - in Univ. of Florida herbarium.

- Campbell *et al.* (2010) id. early maturing varieties to avoid boll weevil in the US.
ARC - Germplasm Conservation and Reproductive Biotechnologies (GCRB), Roodeplaat, Pretoria, Contributions by researchers: former Tobacco and Cotton Research Institute, - The Institute for Industrial Crops, - Vegetable, Industrial - and Medicinal Plants Institute (VIMP)

Accessions from 1960 to the late 1990s. Total: >1700 accessions.

MTA must be in place before the exchange of seed. Seed = conventional varieties; mainly G. hirsutum.

Other species represented, i.e., G. barbadense, G. harknessii, G. herbaceum subsp africanum.

Total species list - unknown.

The Treaty on Plant Genetic Resources for Food and Agriculture (2009) by the FAO, emphasizes the importance of genetic exchange.

The Convention on Biological Diversity (CBD) in 1992 by the UN focuses on conservation of biological diversity.

The Cartagena Protocol on biosafety, - 2000 (limit movement of living organisms) by the UN Convention on Biological Diversity, limits the movement of living organisms.

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits (2014) by the FAO focuses on access to genetic resources and benefits.

Germplasm and Genetic Stocks Work Group – in Cotton Gen Database (2024-2025, by the International Cotton Genome Initiative (ICGI: http://icgi.tamu.edu/)
What influence the advancement of production/breeding programmes?

- **Funding** is a limitation in most countries.

- Research institutions have an added handicap if patent holders have introduced traits with *registered patents*.

- **The cost of research** that goes into providing alternative plant material.

- The **cost** of introducing traits into foundation seed, from which seed can be evaluated, multiplied, certified and released commercially, limits access to alternative plant genetics; it influences the seed price in the form of royalty payments for the licensee.

- Cost of using molecular tools
Availability of Molecular Tools: to determine genetic variation within germplasm

- Short snippets (SNP’s) Nucleotide combinations?
- RNAi interference
- Crisper technology
- Mutagenesis techniques
- Molecular markers
- Gene editing

Voit et al. (2015) suggested:

- Focusing on agronomic and phenotypic characteristics.
- Using common DNA markers to identify genetic diversity across germplasm collections to form linkages of databases across the world.
- DNA-based studies: confirmed a high degree of genetic uniformity across cultivated *G. hirsutum* which impairs adaptation to stress; emerging pests, environmental change, or competition.
Molecular tool: Example:

Hize et al. (2017): molecular markers e.g. Cotton SNP 63K array, relates to the nutritional value of the seed.

Molecular techniques used for:
- savings in cost, time and opportunities for visual observations.
- to distinguish between differences or homologies between accessions
- to correlate polymorphisms with variations in phenotypic traits
To facilitate exchange: FAO Treaty on Genetic resources - 2009: Stipulates: germplasm is: “common heritage of mankind” which should be made available without restriction.

- Material Transfer Agreement (MTA) must be in place. Optional: a free-trade agreement could be facilitated to promote the use of germplasm in other countries.
- Collaboration between patent holders and Institutions employing breeding programmes.
- Establishing a core collection ensures cultivar diversity (Egan et al., 2022; Campbell et al. (2010).
- Preservation of wild species is difficult.
- Characterizing gene bank entries – by production specialists, i.e., entomologists, pathologists, breeders, nematologists etc. to ensure comprehensive/inclusive and more accurate characterization.
Conclusion

To facilitate germplasm exchange and promote cotton breeding:

- Long-term **financial** support.
- **Storage guidelines** for seed in a germplasm bank.
- Guidelines to **collect descriptive and molecular data** and the establishment of multinational collaboration.
- Greater emphasis is placed on the **identification and dissemination** of germplasm to overcome challenges.
- A **desire to maintain patented technology** can be a hindrance in developing small markets –this is in itself the first obstacle to alternative germplasm.
- **Close collaboration** with seed companies & private industry to improve trust relationships in search of alternative plant genetics.
Cotton can be “THE” crop that makes a difference in many developed - and developing countries.

If more emphasis is placed on the identification and dissemination of germplasm, it will lead to the overcoming of major challenges in a region.

Cotton itself – is healthy at its core!
Thank You