UGANDA
Can Cotton Yields be Doubled?

Keshav Kranthi
Head, Technical information Section
YIELD (Kg/ha) 2017

AFRICA
4.4 million hectares;
14.4% of the global area
1.5 million tons;
5.8% of the global production

TOP 10
29% Area & 52% Production

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ARE YIELDS RELATED TO THE LATITUDE?
<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Yield (Kg/ha)</th>
<th>Latitude</th>
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<td>Argentina</td>
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Low yields: countries ranking 21-45 (TROPICS)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Yield (Kg/ha)</th>
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<td>Yemen</td>
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<td>Senegal</td>
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<td>Togo</td>
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<td>38</td>
<td>Malawi</td>
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<td>39</td>
<td>Zimbabwe</td>
<td>245</td>
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<td>40</td>
<td>Chad</td>
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<td>15.45</td>
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<td>45</td>
<td>Somalia</td>
<td>127</td>
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</table>

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AUSTRALIA, BRAZIL, CHINA & TURKEY LINT YIELDS Kg/ha

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UGANDA AND THE GOLIATHS: LINT YIELDS Kg/ha

- Aus
- Brazil
- China
- Mexico
- Turkey
- USA
- Uganda

Graph showing lint yields in kg/ha from 1960 to 2016 for different countries.
Potential Yield (Aus) = 3,500 Kg lint/ha
Theoretical Yield = 5,034 Kg lint/ha
Reported Yield (China) = 5,005 Kg lint/ha

Uptake, distribution and redistribution of NPK is crucial


Constable and Bange, 2015
What is the secret of high yields?

What did these countries do which India & Africa haven’t done?
Better management?
More fertilizers?
More water?
Better pesticides?
More investment?
Bt cotton?
Advanced sophisticated complicated technologies?

Then... What is it?
The Secret

CANOPY MANAGEMENT

• Restrict height to 60-90 cm
• Short season (150 days)
• 15-20 bolls per plant
• Fruiting branches (9-10)
• Remove non-productive branches
The Secret......

CANOPY MANAGEMENT

• Use PGR chemicals or manual clipping

• To cut-out at 4-5 fruiting branches above white flower using PGRs

• Restrict internode length 4-5 cm

• Retain 80% squares & 60-70% bolls
Canopy in Africa

• Tall & bushy. No canopy control
• 25-30 fruiting branches + many unproductive branches
• 45-60 bolls/plant. Long duration
• Long internodes + outer bolls
• Square and boll shedding
• Delayed maturity
<table>
<thead>
<tr>
<th></th>
<th>Top 10 countries</th>
<th>Africa &amp; India</th>
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</thead>
<tbody>
<tr>
<td>Varietal architecture</td>
<td>Compact</td>
<td>Bushy</td>
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<tr>
<td>Duration (days)</td>
<td>150</td>
<td>160-200</td>
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<tr>
<td>Harvest Index</td>
<td>0.4-0.5</td>
<td>0.2-0.25</td>
</tr>
<tr>
<td>Planting geometry</td>
<td>76 x 10</td>
<td>90 x 60</td>
</tr>
<tr>
<td>Density (plants/ha)</td>
<td>&gt;111,000</td>
<td>&lt;16,000</td>
</tr>
<tr>
<td>Water, nutrients &amp; pesticides</td>
<td>Precise</td>
<td>Indiscriminate</td>
</tr>
<tr>
<td>Canopy Management</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>
Canopy  **Best practices**

- >110,000 to 220,000 plants/ha
- CROP DURATION: 140-160 days
  40 days vegetative +
  70 days fruiting phase +
  40 days maturation stage
- Short critical window
- Efficient management
- High yields

Practices in Africa

- 11,000 to 40,000 plants/ha
- CROP DURATION: 180-240 days
  50 days vegetative +
  120 days fruiting phase +
  40 days maturation stage
- Long critical window
- Complicated management
- Low yields

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Canopy management: China

- Restricting plant height to 65-70 cm: 100% compliance
- Topping: 100% compliance
- Removal of vegetative branches: 50-70% compliance
- Removal of unproductive plant parts: 100% compliance
- Removal of early fruiting branches: 100% compliance
VARIETYAL ARCHITECTURE

INDIA & AFRICA

BUSHY LONG DURATION
11,000 PLANTS /Ha

AUS, BRAZIL, TURKEY

COMPACT – SHORT DURATION
111,000 PLANTS/Ha

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VARIE TAL ARCHITECTURE

Spacing
90 x 60 cm (India & Africa)
76.5 x 8 cm (Australia)
Yield gain due to variety, management & their interaction 325 CSIRO experiments over 30 years.

Variety performance from 1995 to 2009

\[ Y = 34811.5 + 18.4X \quad (R^2 = 0.47, \ P < 0.02) \]

- Gain by cultivar x management
- Gain by management
- Gain by cultivar

Variety performance from 1980 to 94

- Sicot 71
- 24% Variety x Management
- 28% Management
- 48% Variety
HARVEST INDEX – CANOPY MANAGEMENT - BREEDING

Dry Weight Distribution

17% Bolls
21% Leaves
62% Stems

"Lone Star" released in 1905

45% Bolls
13% Leaves
41% Stems

"DPL 41" released in 1976
40% INCREASE IN HARVEST INDEX IN 80 YRS
THE POSSIBLE ANSWERS FOR AFRICA AND INDIA

VARIETIES
COMPACT ARCHITECTURE
SUITABLE FOR HIGH DENSITY PLANTING
HIGH HARVEST INDEX
EARLY MATURING & SHORT DURATION
Importance of Water and Nutrient Management at Critical Window
Cotton is basically a Desert Crop (Xerophyte)

It needs water at a critical stage for good yields
Water Requirement of Cotton

Cotton needs 600-700 mm Water (6-7 million litres per hectare)
Critical Stages: Flowering + Green boll stage
Water stress at critical stage causes 30-70% yield loss

http://www.cottoninc.com/fiber/agriculturaldisciplines/engineering/irrigation-management/cotton-water-requirements/
WATER REQUIREMENT

Early season

Mid season

Late season

Days after planting

10 20 30 40 50 55 60 65 70 90 140

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Early season

2-3 mm/day

Mid season

6-8 mm/day

Late season

WATER REQUIREMENT
15% at early season
85% at mid season

Days after planting

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Nitrogen Audit (Kg/ha)

- **200** Uptake
- **100** for 2200 Kg lint
- **100** for plant residues
- **150** as fertilizer
- **100** from soil
- **25** leaching + denitrification
- **25** as soil residues

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THE CRITICAL WINDOW ATTRACTS BOLLWORMS

1. India and Africa have a longer 90-120 days critical window
2. Management is a nightmare
3. Water & nutrients usage is indiscriminate and soil degradation is high
Interaction between stresses

Interaction between stress at different stages can be substantial. In this example, one day of water stress at all three growth stages caused ~50% greater loss in yield than the sum of one day of stress at each stage. This is because early stress reduces plant size and number of fruiting positions, and later stress prevents compensation as well as growth of surviving fruit.

**Daily yield reduction from stress**

- At early flower
- At peak flower
- At cutout
- (Sum of three)
- At all three

**Yield reduction (kg lint/ha)**

Combinations of stresses can accumulate to result in low yields.
UGANDA
Can Cotton Yields be Doubled?
Uganda is Poised for High Yields

• Excellent rainfall
• Ideal weather for cotton
• Ideal heat units
• Good soil fertility
• Very good quality
• Short duration + wilt resistant
• Big bolls (4.5 to 6.0 g)
• High ginning%
• Good legume crops
• *Glycine max, Phaseolus vulgaris, Tithonia diversifolia*
• Good natural control of pests

**THREATS**
• Bollworm, Bacterial blight & Wilts
• Burning of stalks
• Bushy crop: No canopy management
BEST PRACTICE

Canopy management

1. Plant architecture management
2. Square & boll retention management
3. Timely termination for source-sink
4. Crop residue management
5. Closed season
BEST PRACTICES

- Fit the rainfed crop into monsoon
- Compact architecture + Short season (150-160 days)
- 76x10 cm spacing: High density population

- Conservation tillage
- Ridge sowing for soil moisture management
- Stale seed bed (prevents weeds)
BEST PRACTICES

• Shred crop residues: incorporate or mulch
• Legume cover crops to add 70-80 Kg N/ha
• Mycorrhizae + Organic manure
• Harvest and conserve water
BEST PRACTICES

Pest management

- Variety resistant to sucking pests/diseases + treated seed
- No sprays for two months for sucking pests
- Precise Nitrogen (to avoid sucking pests + delayed maturity)
- Ecosystems: use biofertilizers, biopesticides initially
- Use spinosad & Emamectin for bollworms
- Strictly avoid pesticide mixtures and other sprays
SIMPLE PRACTICAL TECHNOLOGIES

FERTILIZERS: Legume cover crops + crop residues: 70-80 Kg N/ha + other nutrients. Canopy management for nutrient channeling into fruiting parts

WATER: Fit in a short season crop into monsoon for critical window + ridge planting + mulch

WEED CONTROL: Stale seed bed + hand weeding: inexpensive

PEST MANAGEMENT: IPM (Variety resistant to sucking pests + Biocontrol + 2 insecticides for bollworm control)
AN EXPERIMENT IN INDIA – PROOF OF CONCEPT

Erect plant types, PGR (Mepiquat chloride, mepiquat pentaborate), defoliant (Thidiazuron, Thidiazuron+Diuron), Boll openers (Ethepon, paraquat) and machine picking

Thank You