# UGANDA

## Can Cotton Yields be Doubled?

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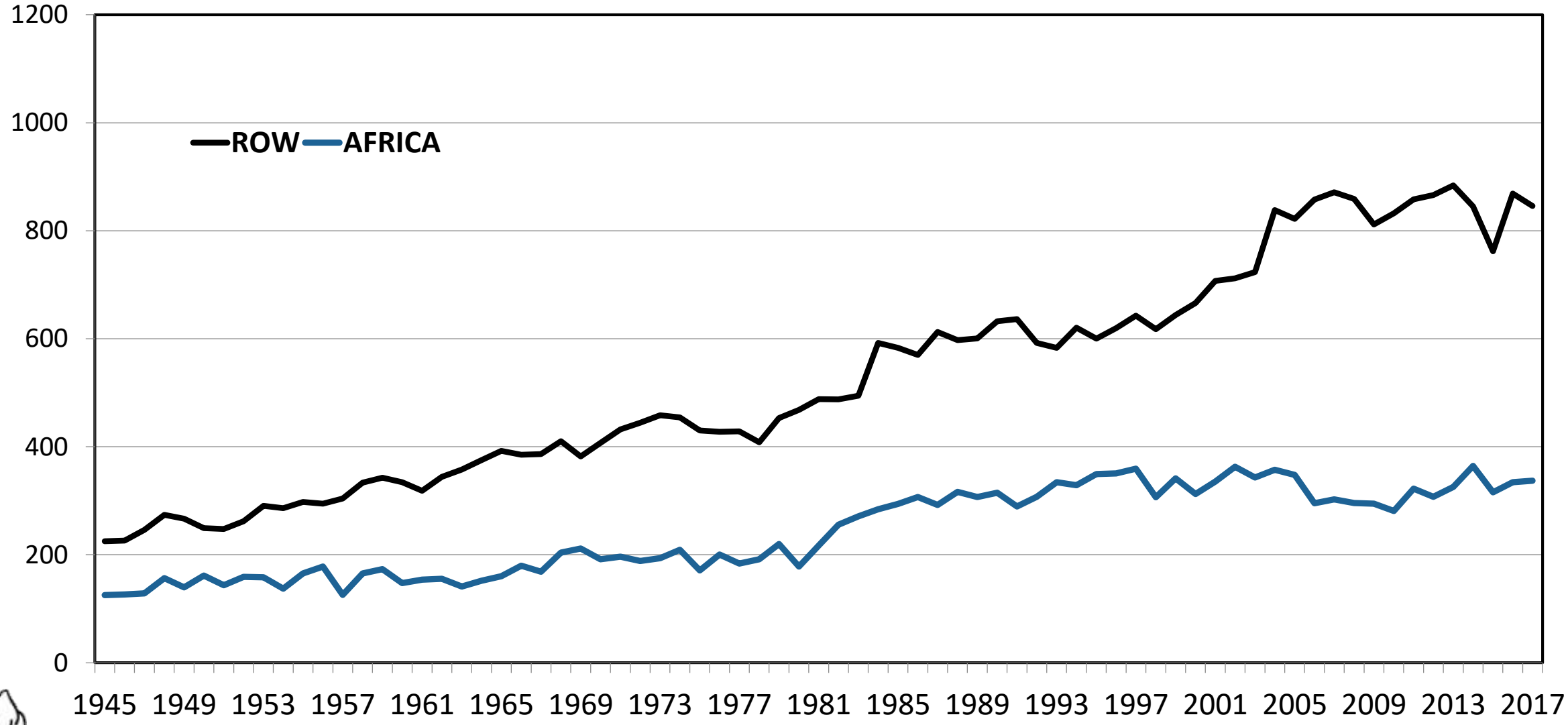
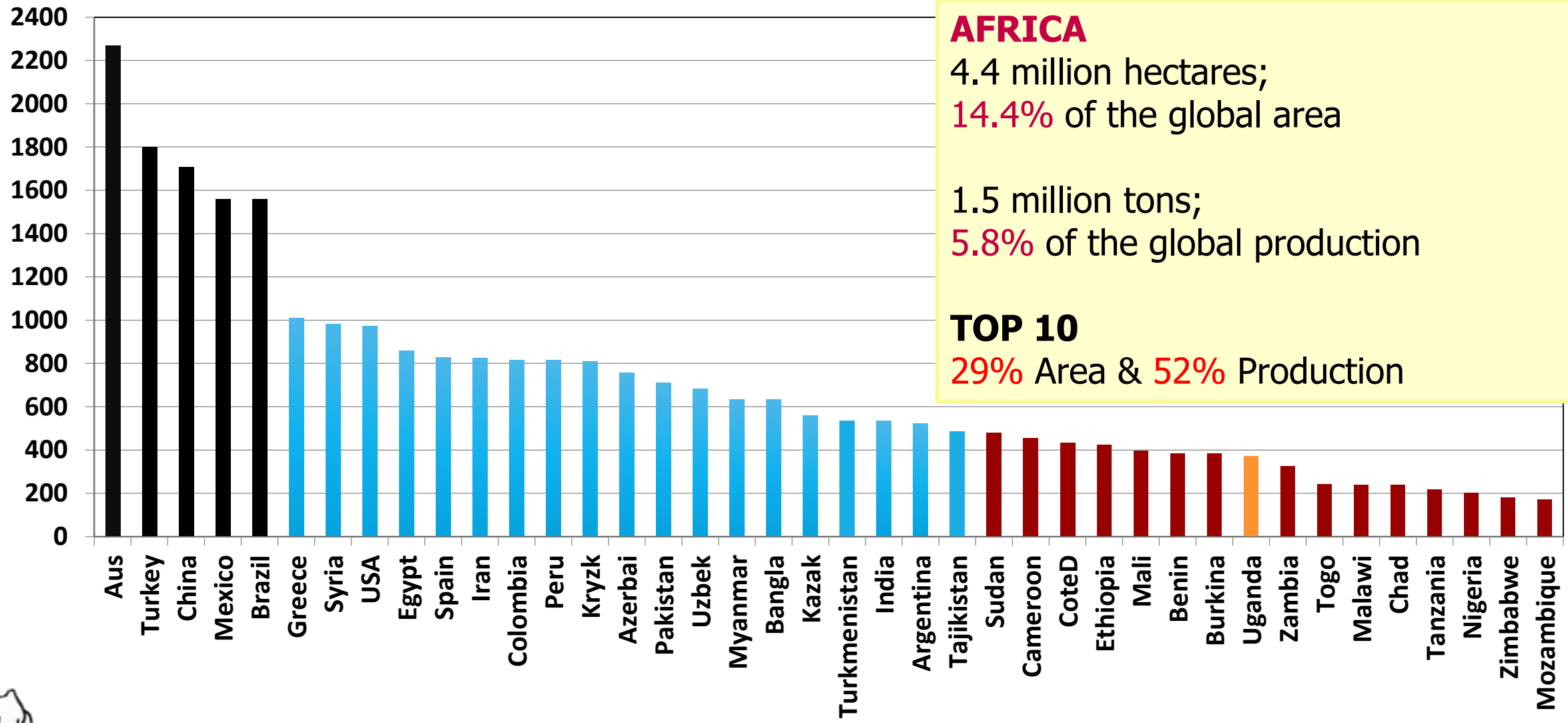
International Cotton
Advisory Committee

# YIELDS (Kg/ha) 1945-2017



# YIELD (Kg/ha) 2017




**AFRICA**

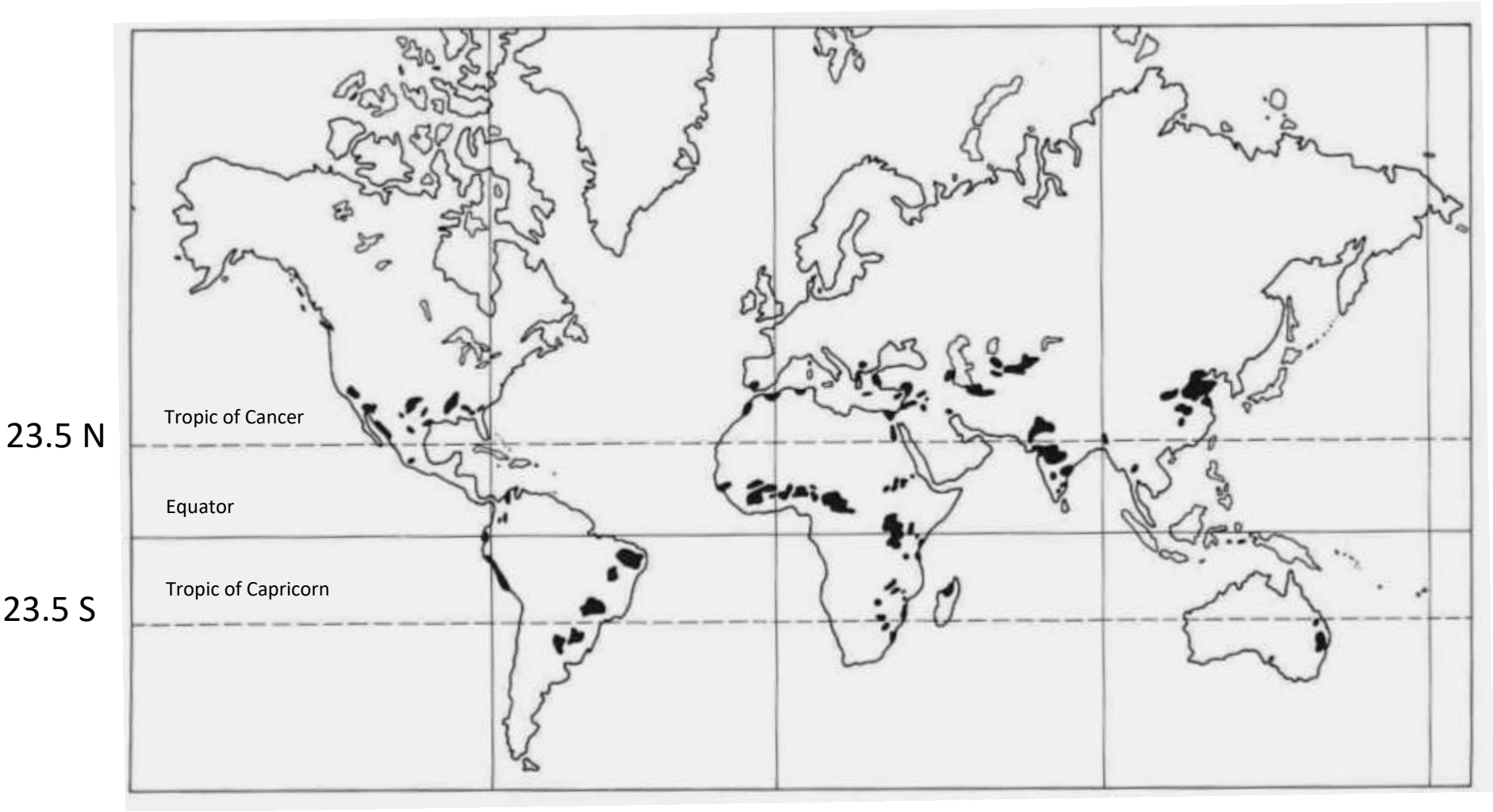
4.4 million hectares;
14.4% of the global area

1.5 million tons;
5.8% of the global production

**TOP 10**

29% Area & 52% Production

# ARE YIELDS RELATED TO THE LATITUDE?



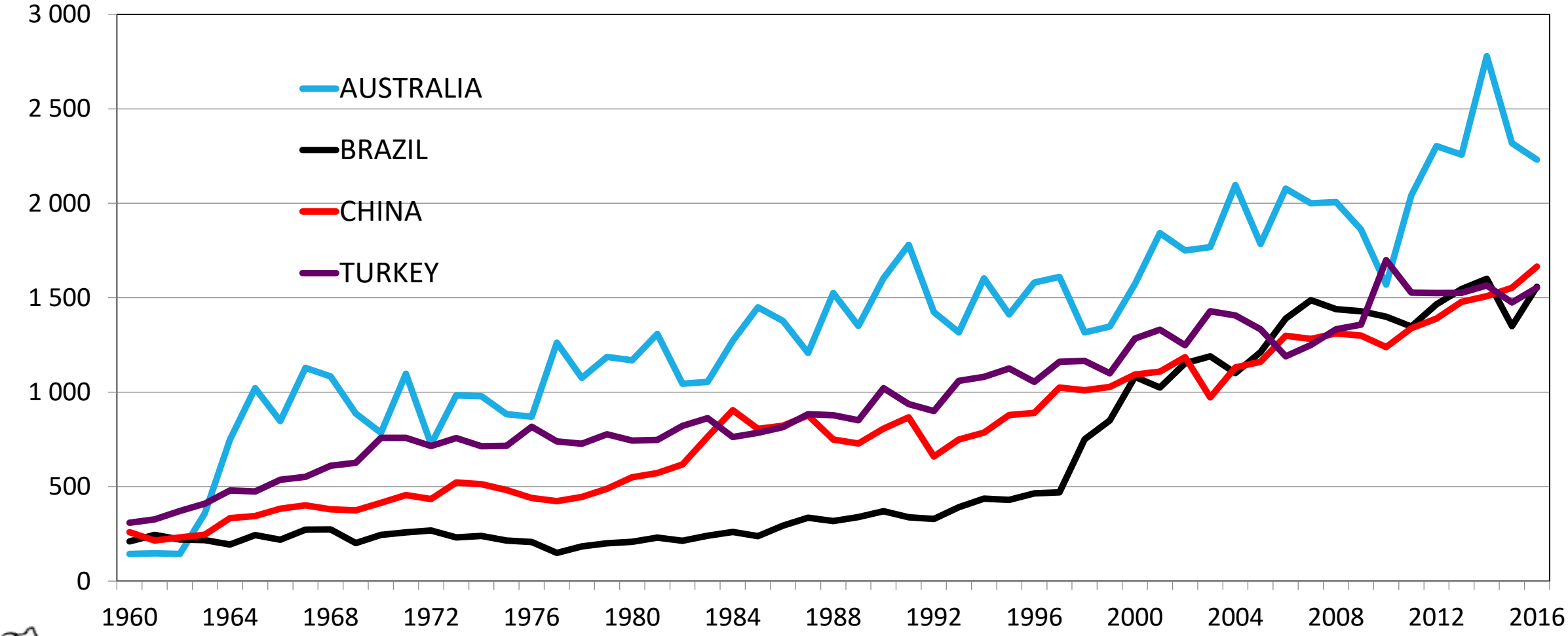
# Yields: Top 20 countries (SUB-TROPICS)

| Rank | Country | Yield (Kg/ha) | Latitude |
|---|---|---|---|
| 1 | Australia | 2,268.00 | -29.575682 |
| 2 | Israel | 1,905.00 | 31.81419373 |
| 3 | Turkey | 1,799.00 | 39.05101013 |
| 4 | China | 1,707.00 | 36.55308533 |
| 5 | Mexico | 1,619.00 | 28.63 |
| 6 | Brazil | 1,544.00 | 20.77 |
| 7 | Bulgaria | 1,089.00 | 42.73 |
| 8 | Greece | 1,045.00 | 39.07 |
| 9 | United States | 996 | 39.443256 |
| 10 | Syrian Arab Republic | 995 | 34.8 |
| 11 | Spain | 964 | 40.46 |
| 12 | South Africa | 762 | -29.50849915 |
| 13 | Pakistan | 711 | 28.83160019 |
| 14 | Egypt | 693 | 26.75610352 |
| 15 | Uzbekistan | 683 | 40.72639316 |
| 16 | Kyrgyzstan | 653 | 41.46435547 |
| 17 | Iran, Islamic Republic Of | 610 | 39.0618491 |
| 18 | Turkmenistan | 559 | 39.09596294 |
| 19 | Kazakhstan | 554 | 48.14600372 |
| 20 | Argentina | 550 | 27.42 |

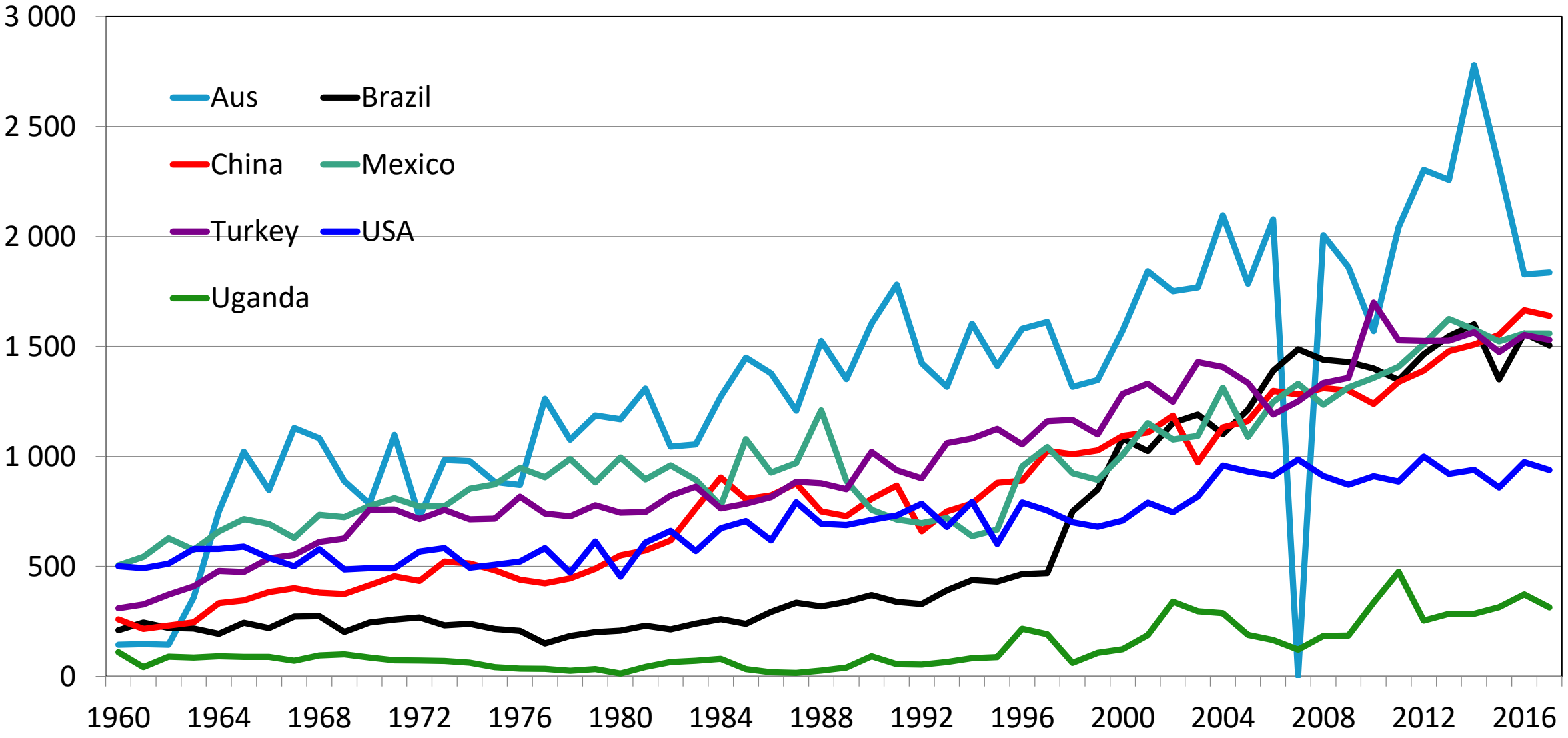
# Low yields:  countries ranking 21-45 (TROPICS)

| Rank | Country | Yield (Kg/ha) | Latitude |
|---|---|---|---|
| 21 | India | 535 | 20.63278425 |
| 20 | Ethiopia | 530 | 9.14 |
| 22 | Sudan | 529 | 16.08578491 |
| 25 | Cameroon | 484 | 5.68547678 |
| 26 | Benin | 423 | 9.31 |
| 27 | Côte D'ivoire | 421 | 9.465248949 |
| 28 | Paraguay | 416 | -23.24028969 |
| 29 | Mali | 404 | 17.35776711 |
| 30 | Burkina Faso | 404 | 11.58222024 |
| 31 | Niger | 392 | 9.08 |
| 32 | Ghana | 381 | 7.94 |
| 33 | Uganda | 363 | 1.277328014 |
| 34 | Zambia | 352 | -13.45884514 |
| 35 | Yemen | 339 | 15.55 |
| 36 | Senegal | 327 | 14.49 |
| 37 | Togo | 323 | 8.513226509 |
| 38 | Malawi | 280 | 13.25 |
| 39 | Zimbabwe | 245 | -17.77168083 |
| 40 | Chad | 203 | 15.45 |
| 41 | Kenya | 196 | 0.576503 |
| 42 | Nigeria | 190 | 9.08 |
| 43 | Mozambique | 176 | -17.55586433 |
| 44 | Tanzania, United | 156 | -6.306897163 |
| 45 | Somalia | 127 | 5.15 |

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



# UGANDA AND THE GOLIATHS: LINT YIELDS Kg/ha



*Note: Image source credit to National Cotton Council of America*

**Potential Yield (Aus) = 3,500 Kg lint/ha**

**Theoretical Yield = 5,034 Kg lint/ha**

**Reported Yield (China) = 5,005 Kg lint/ha**

-Ref, www.nzweek.com (2013)

Uptake, distribution and redistribution of NPK is crucial

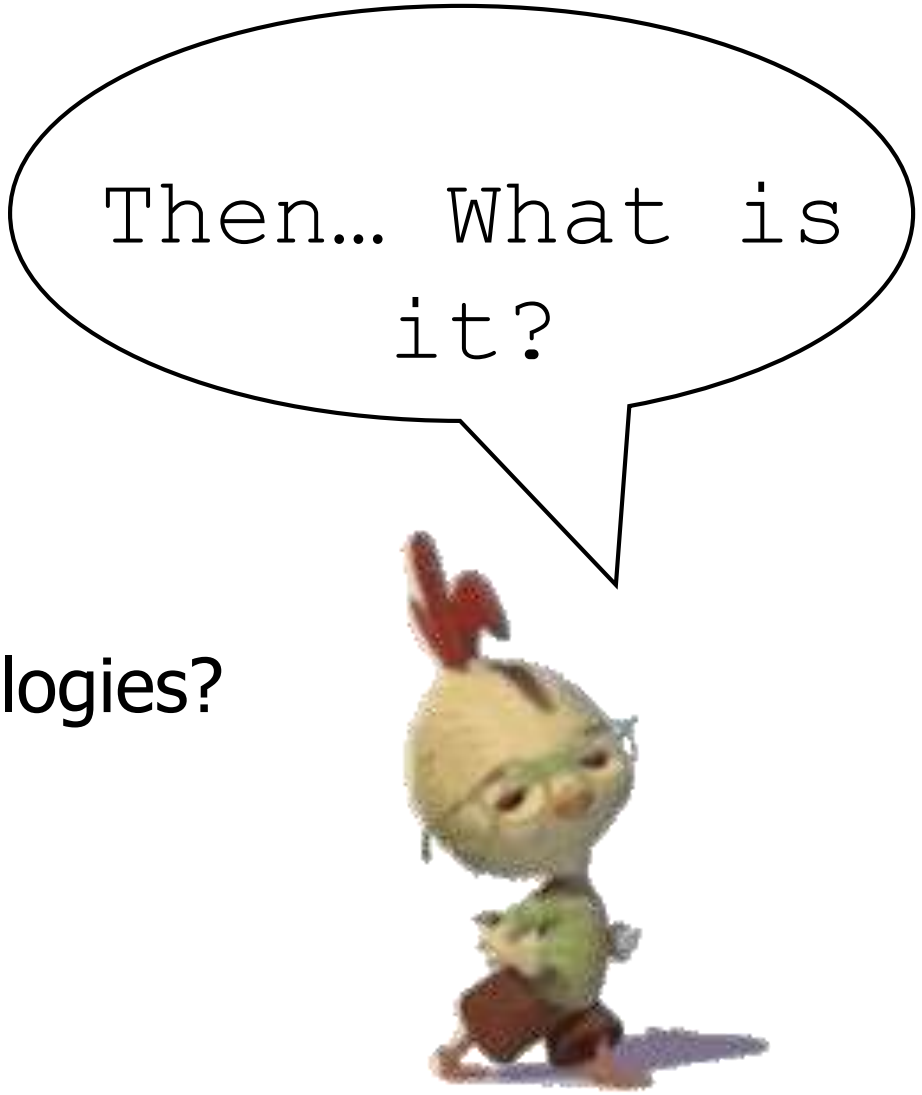
Constable and Bange, 2015

**What is the secret of high yields?**

**What did these countries do which India & Africa haven't done?**

# The Secret……

Better management?
More fertilizers?
More water?
Better pesticides?
More investment?
Bt cotton?
Advanced sophisticated complicated technologies?



# 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

Image: Oosterhuis, 1990

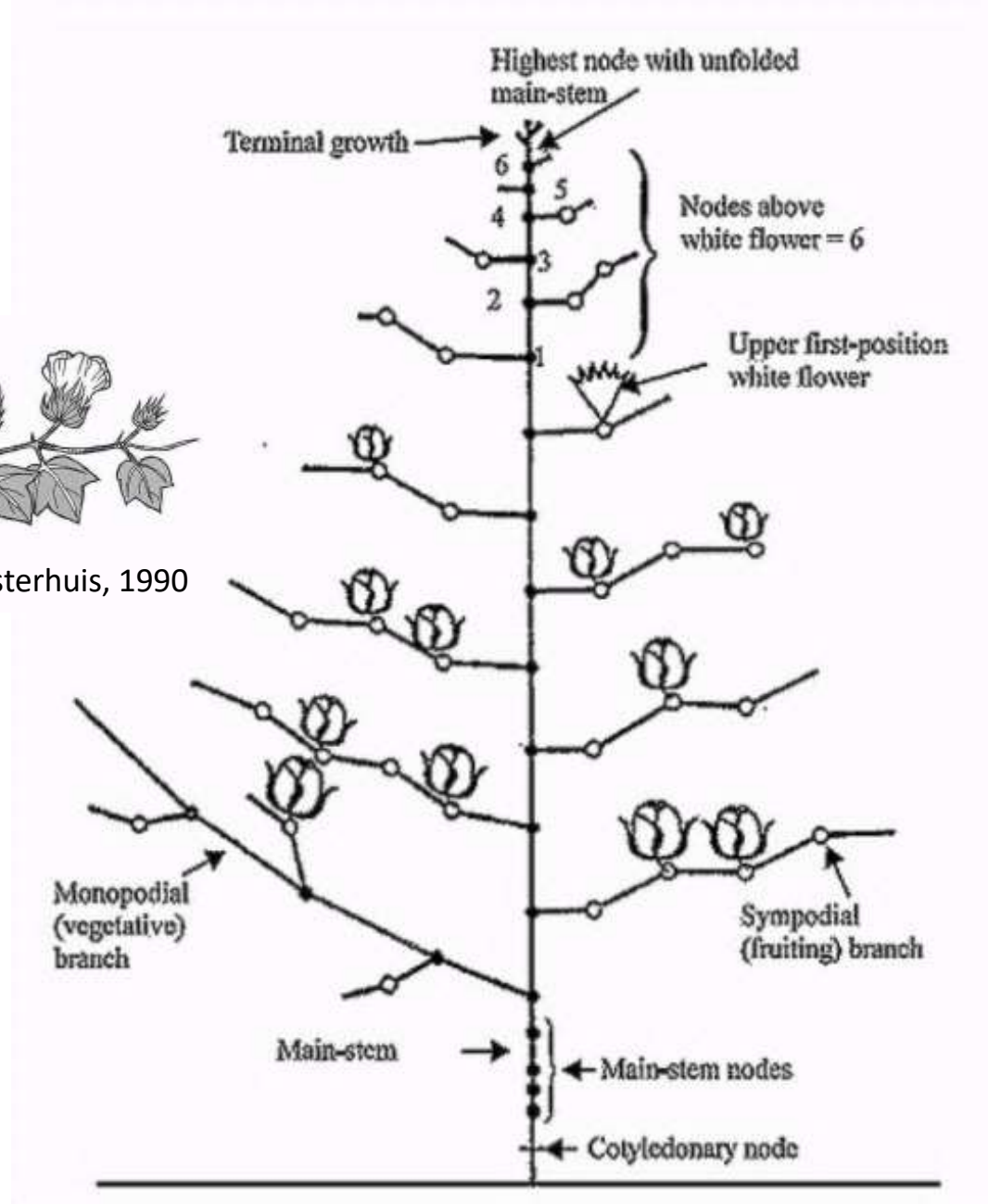



Image: Romain Loison, 2015

# 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

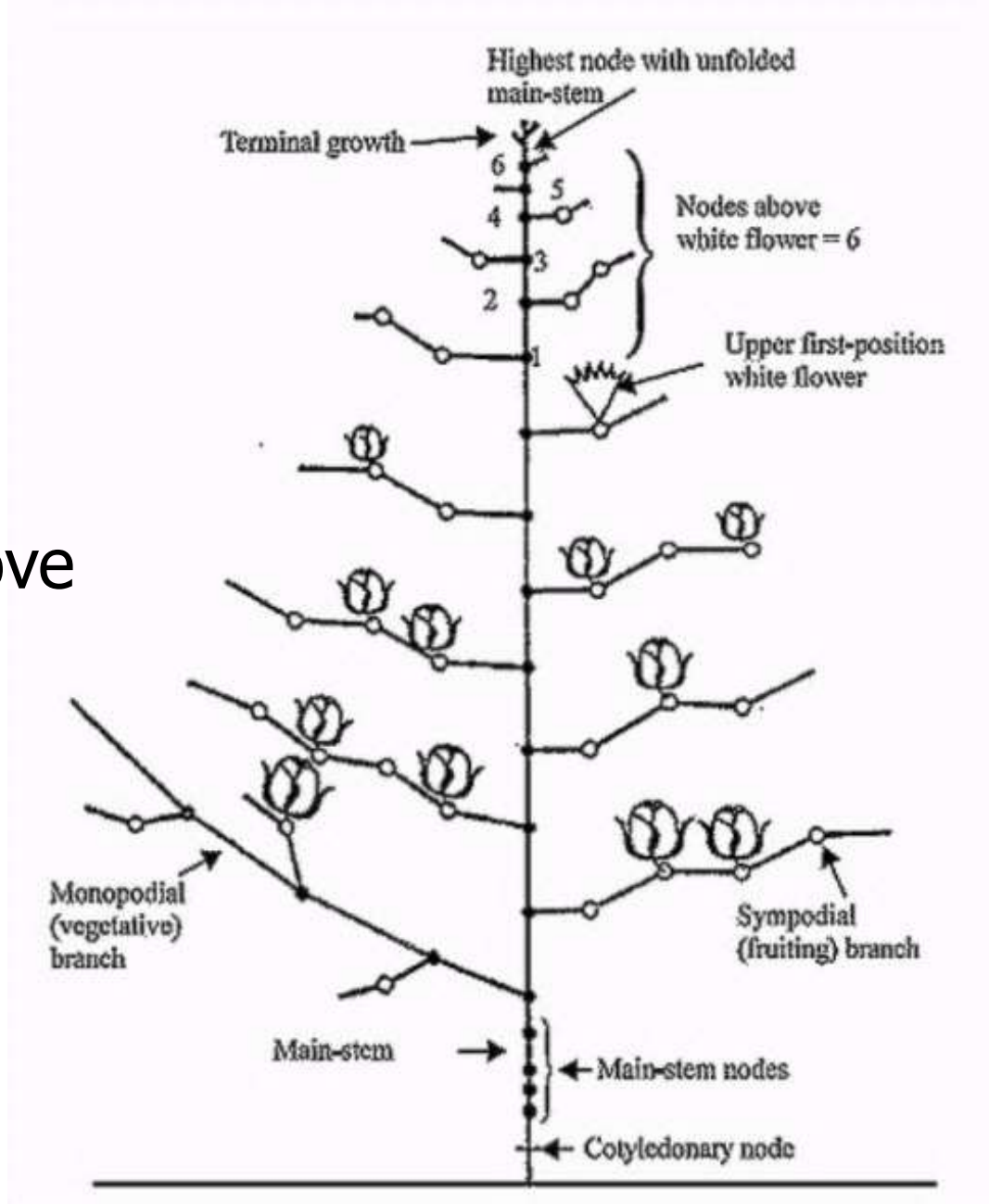



Image: Romain Loison, 2015

# 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

# THE BASIC DIFFERENCES

| | Top 10 countries | Africa & India |
|---|---|---|
| Varietal architecture | Compact | Bushy |
| Duration (days) | 150 | 160-200 |
| Harvest Index | 0.4-0.5 | 0.2-0.25 |
| Planting geometry | 76 x 10 | 90 x 60 |
| Density (plants/ha) | >111,000 | <16,000 |
| Water, nutrients & pesticides | Precise | Indiscriminate |
| **Canopy Management** | **YES** | **NO** |

## 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

# 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

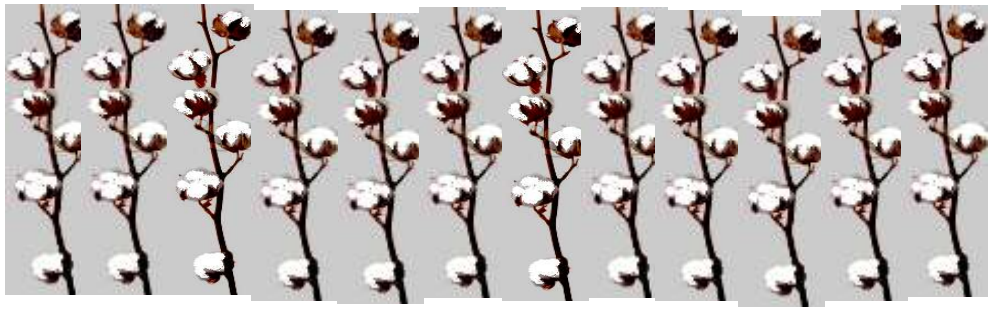
**111,000** PLANTS/Ha

# VARIETAL ARCHITECTURE

**Spacing**

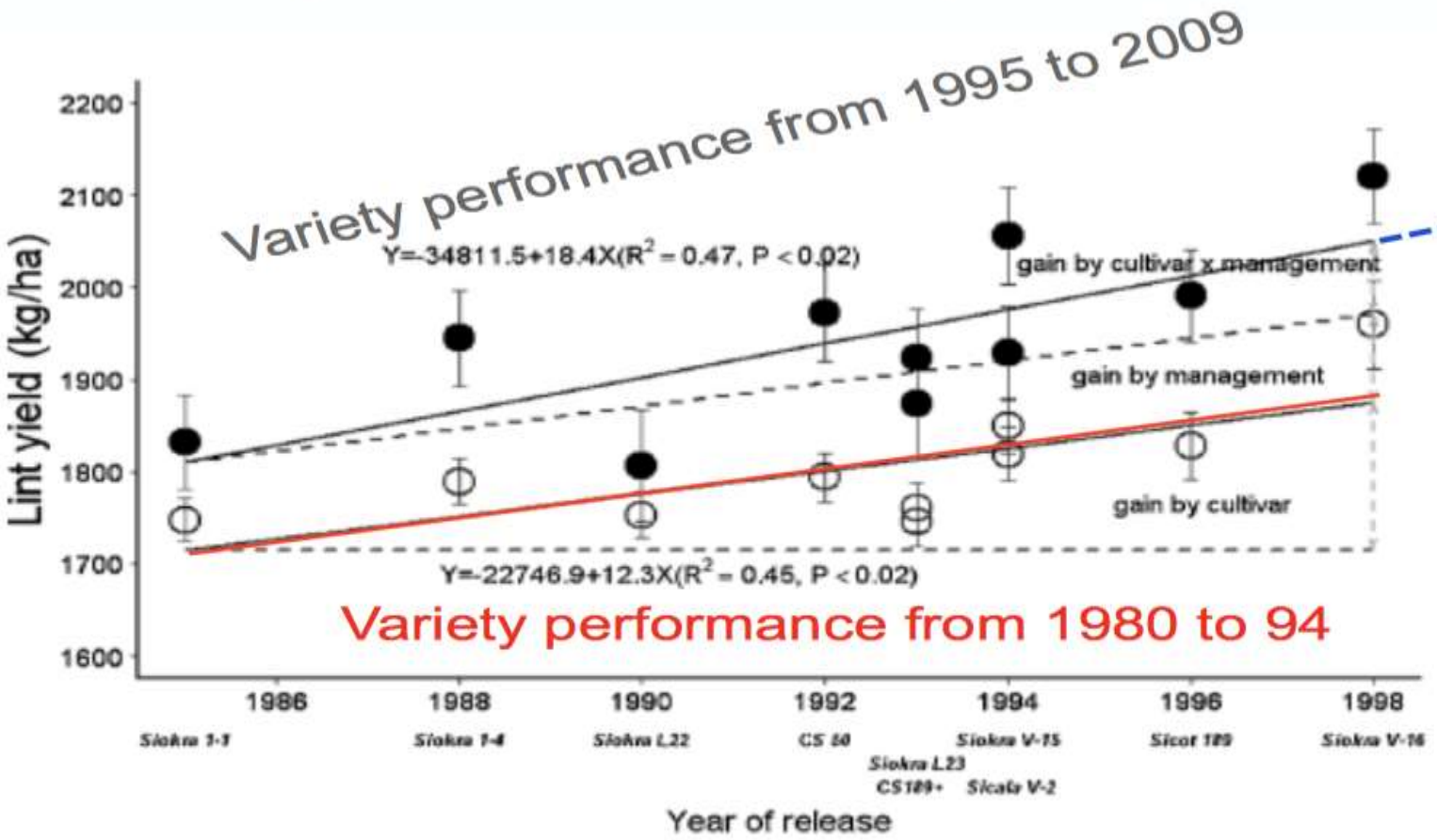
90 x 60 cm (India & Africa)

76.5 x 8 cm (Australia)



# Yield gain due to variety, management & their interaction 325 CSIRO experiments over 30 years.

*Liu et al FCR 2013*



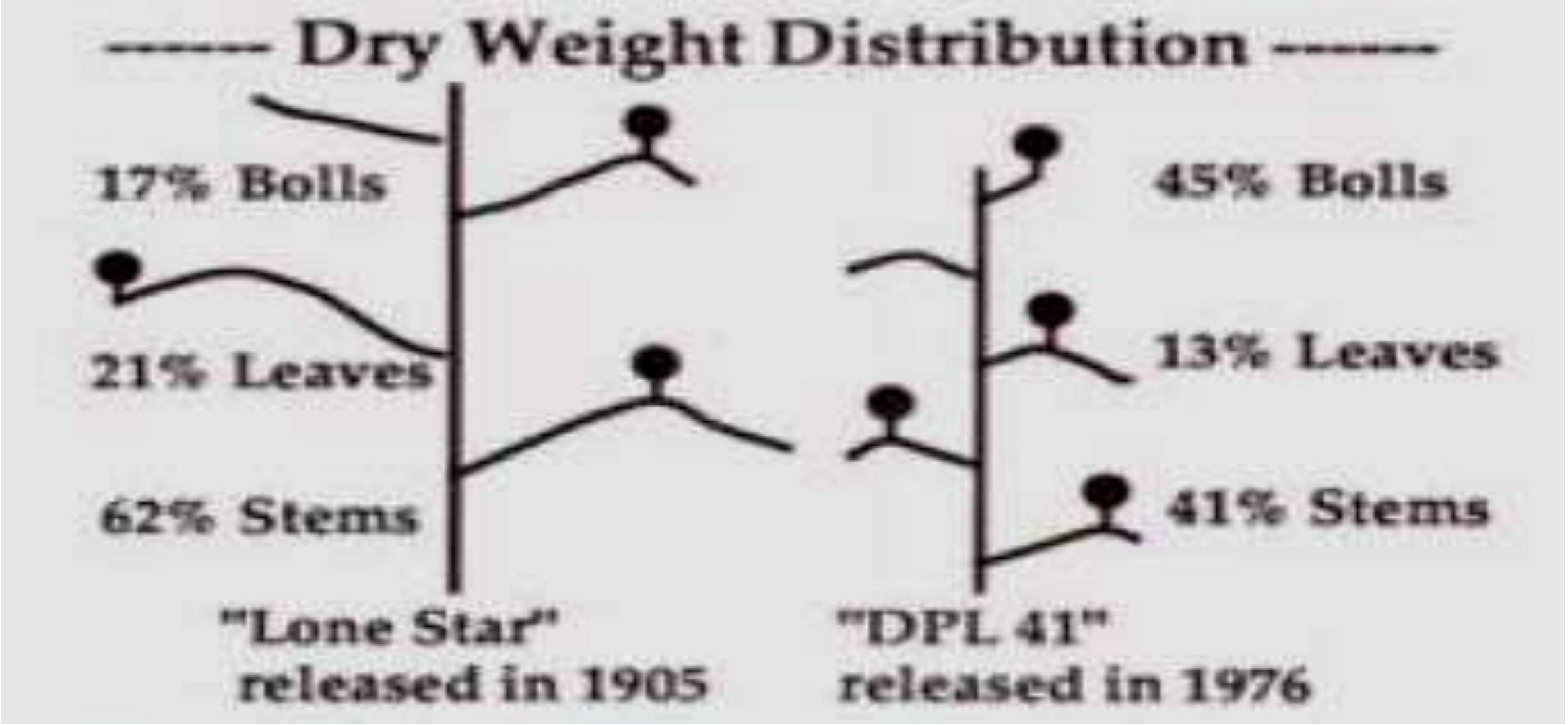

Sicot 71

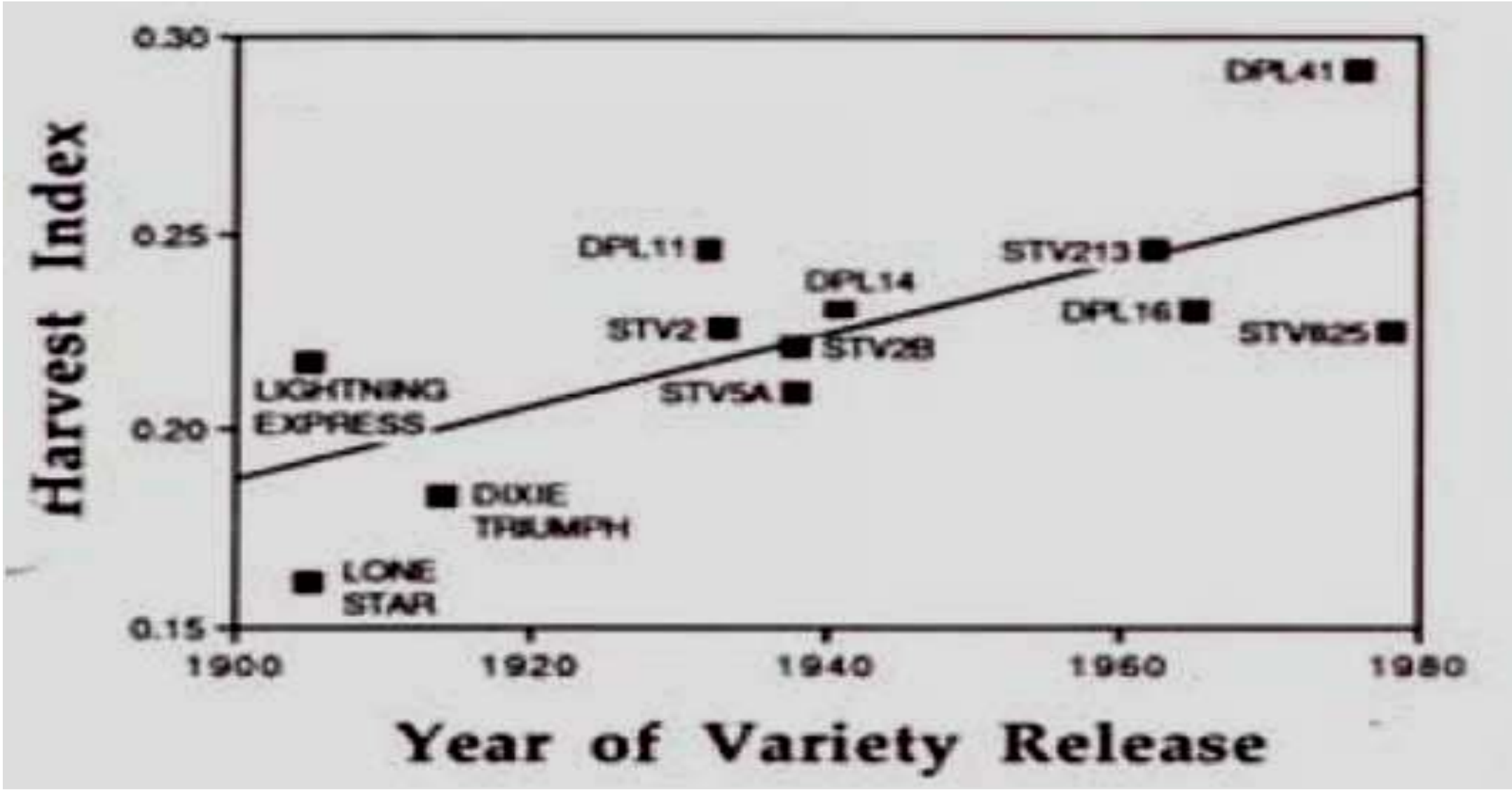
24% Variety x Management

28% Management

48% Variety

# HARVEST INDEX – CANOPY MANAGEMENT - BREEDING






**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

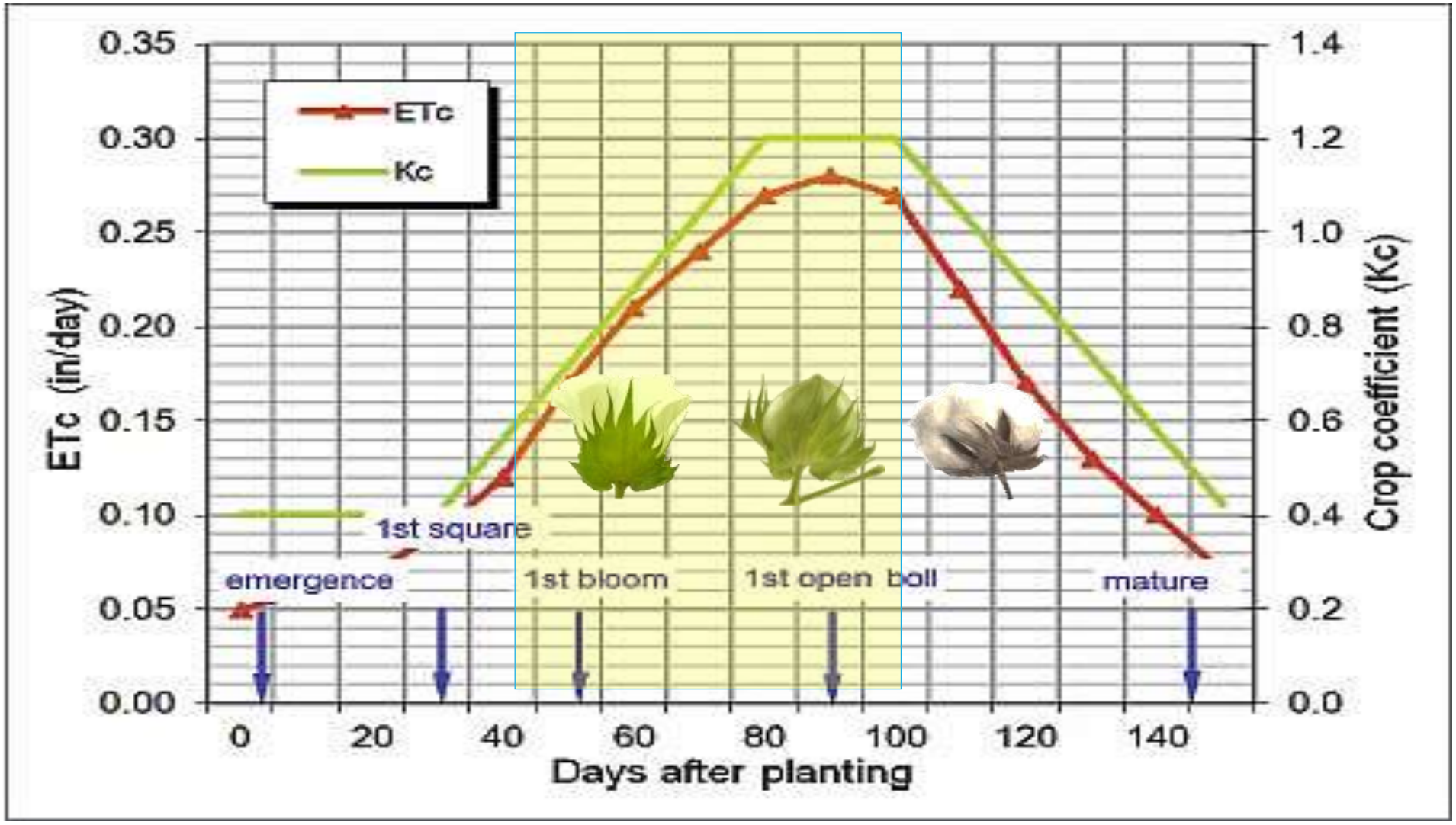
**2-3 mm/day**

**6-8 mm/day**

**Cotton needs 600-700 mm Water** (6-7 million litres per hectare)

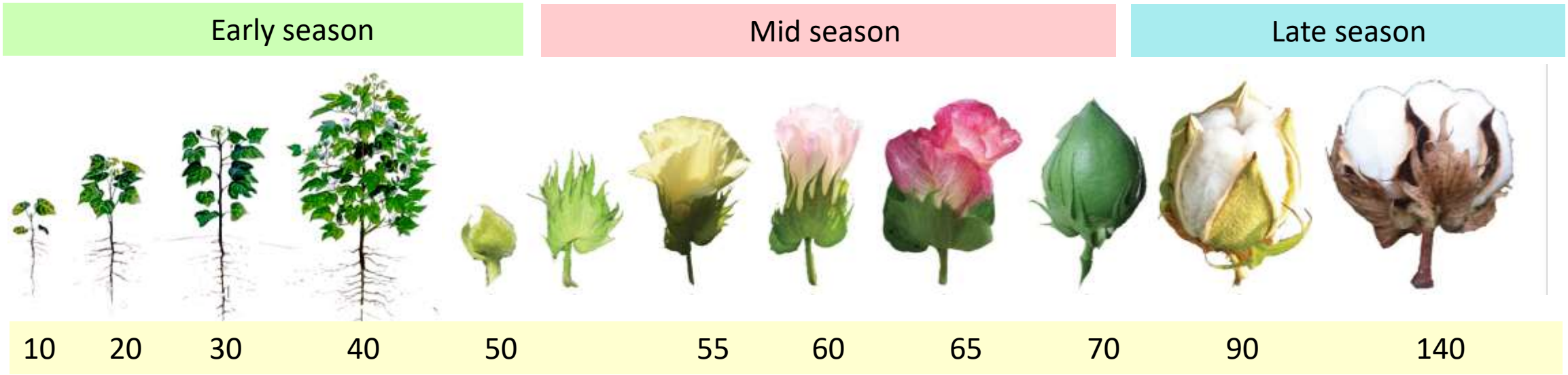
# Critical Stages: Flowering + Green boll stage

Water stress at critical stage causes 30-70% yield loss




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

# WATER REQUIREMENT



**2-3 mm/day**

**6-8 mm/day**

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

Early season | Mid season | Late season

10 20 30 40 50 55 60 65 70 90 140

Days after planting

**2-3 mm/day**

**6-8 mm/day**

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

Early season | Mid season | Late season

10 20 30 40 50 55 60 65 70 90 140

Days after planting

**Kg/day/ha Nitrogen** 0.5 **4.0** **0.5**

CRITICAL WINDOW

NUTRIENTS
20% at early season
80% at mid season

# Nitrogen Audit (Kg/ha)

**100** for 2200 Kg lint

**100** for plant residues

**150** as fertilizer

**100** from soil

**25** leaching + denitrification

**200** Uptake

**25** as soil residues

# THE CRITICAL WINDOW ATTRACTS BOLLWORMS

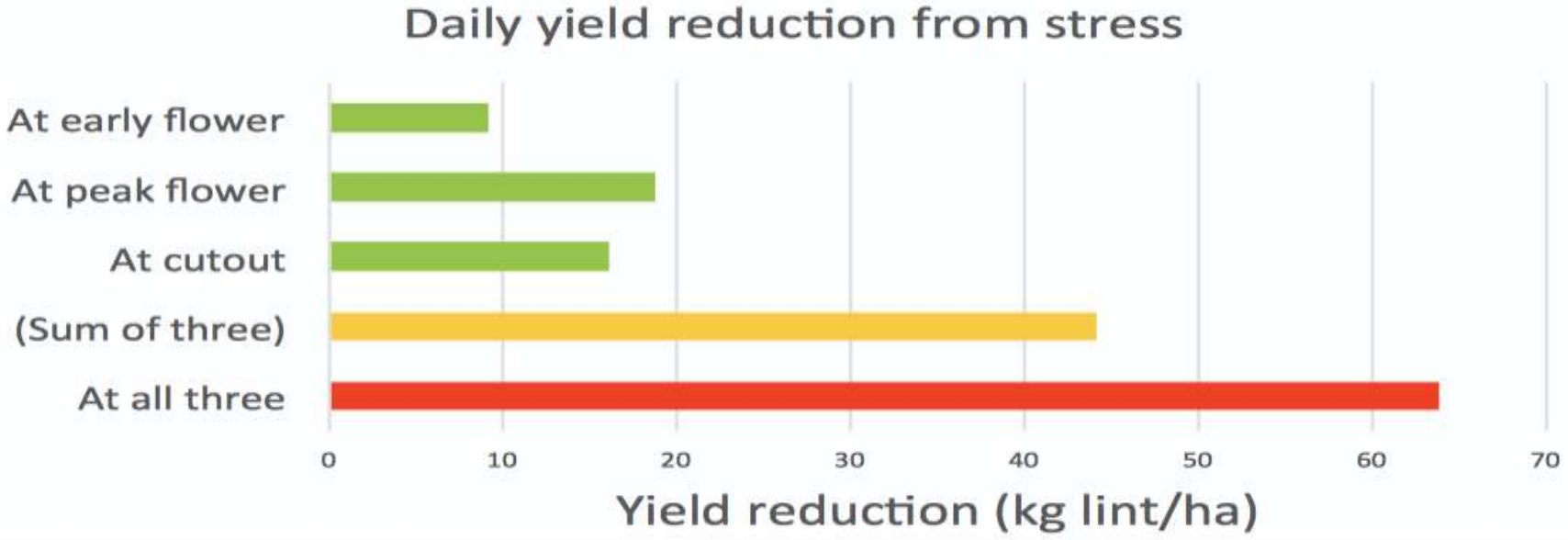
1. India and Africa have a longer 90-120 days critical window
2. Management is a nightmare
3. Water & nutrients usage is indiscriminate and soil degradation is high

# 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.

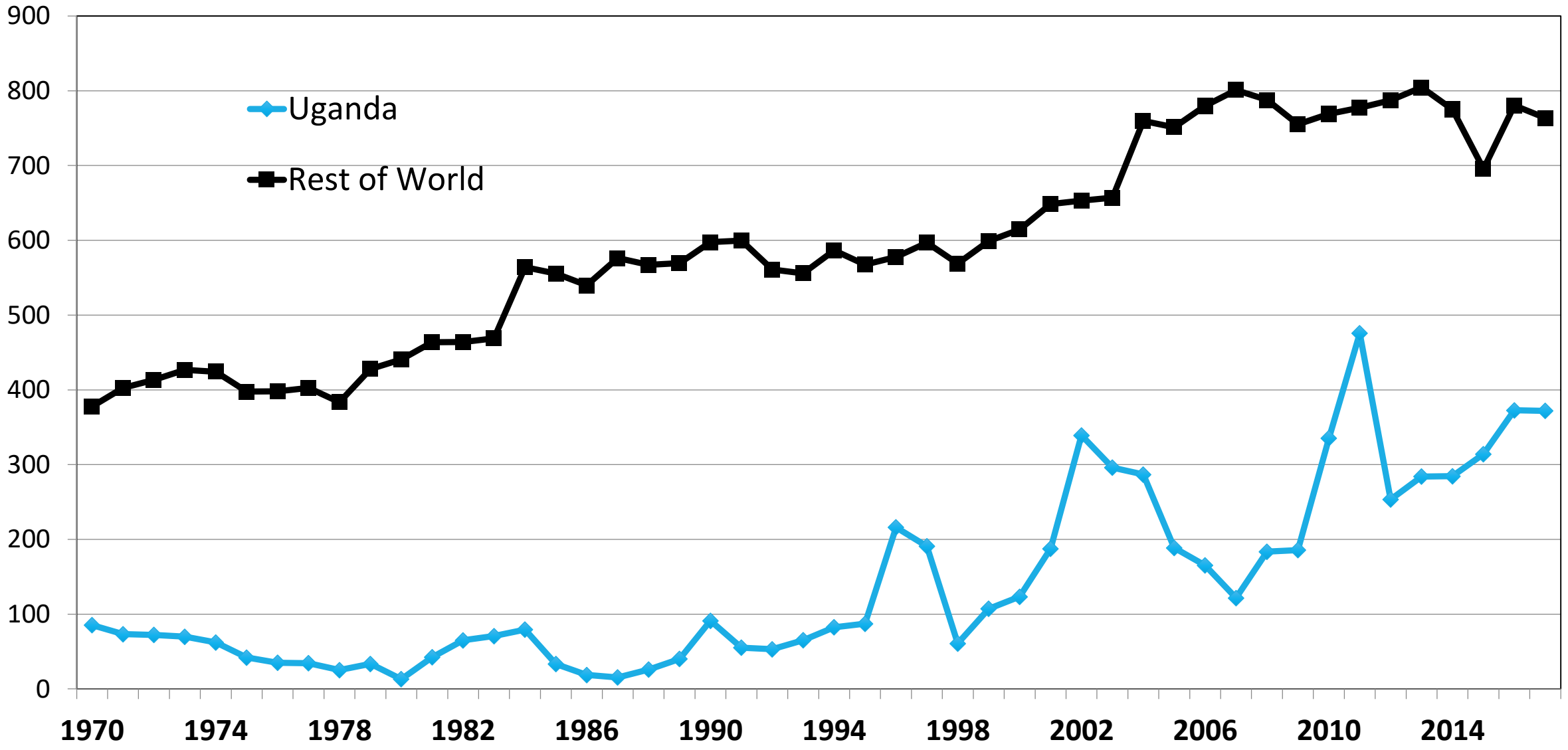



Combinations of stresses can accumulate to result in low yields

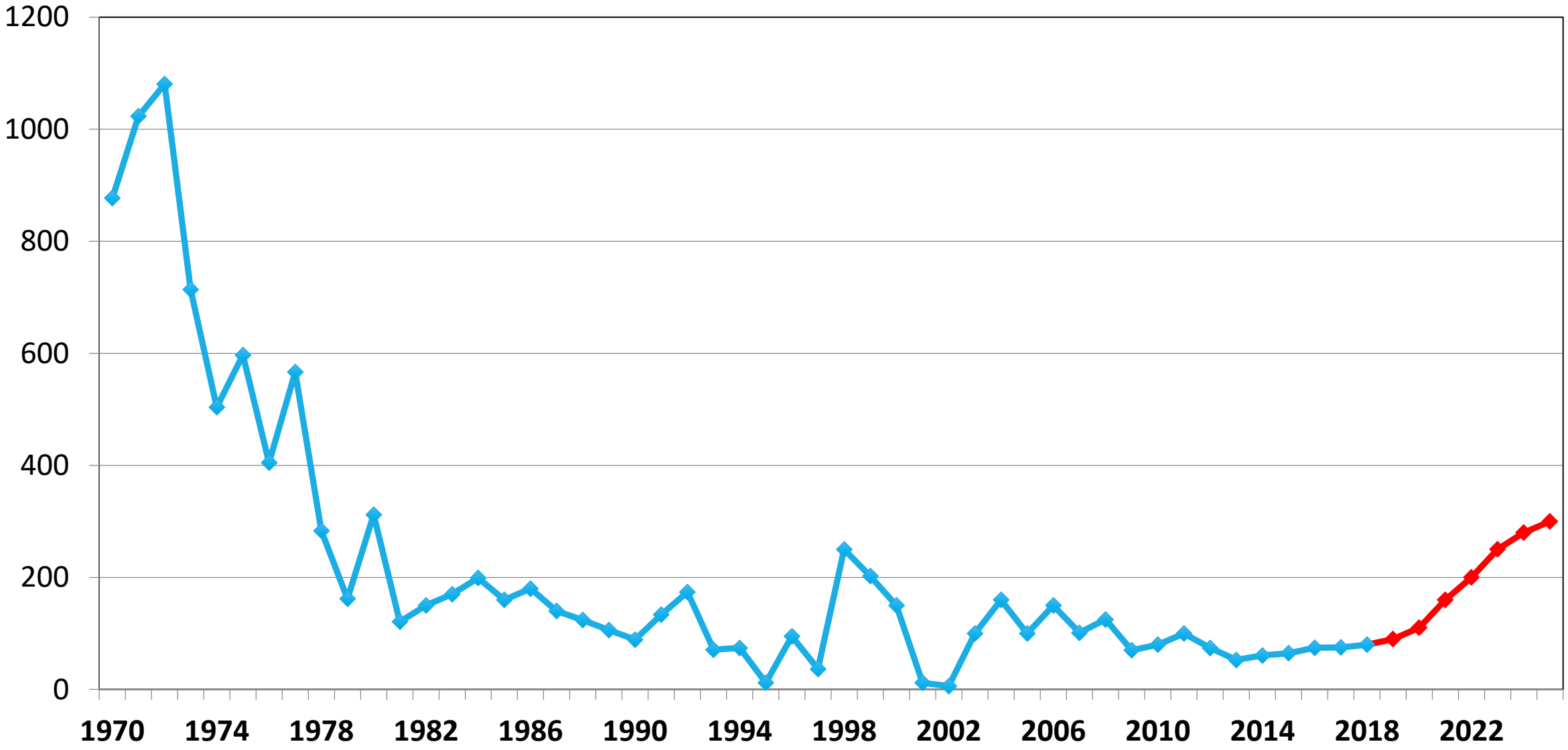
# UGANDA

## Can Cotton Yields be Doubled?

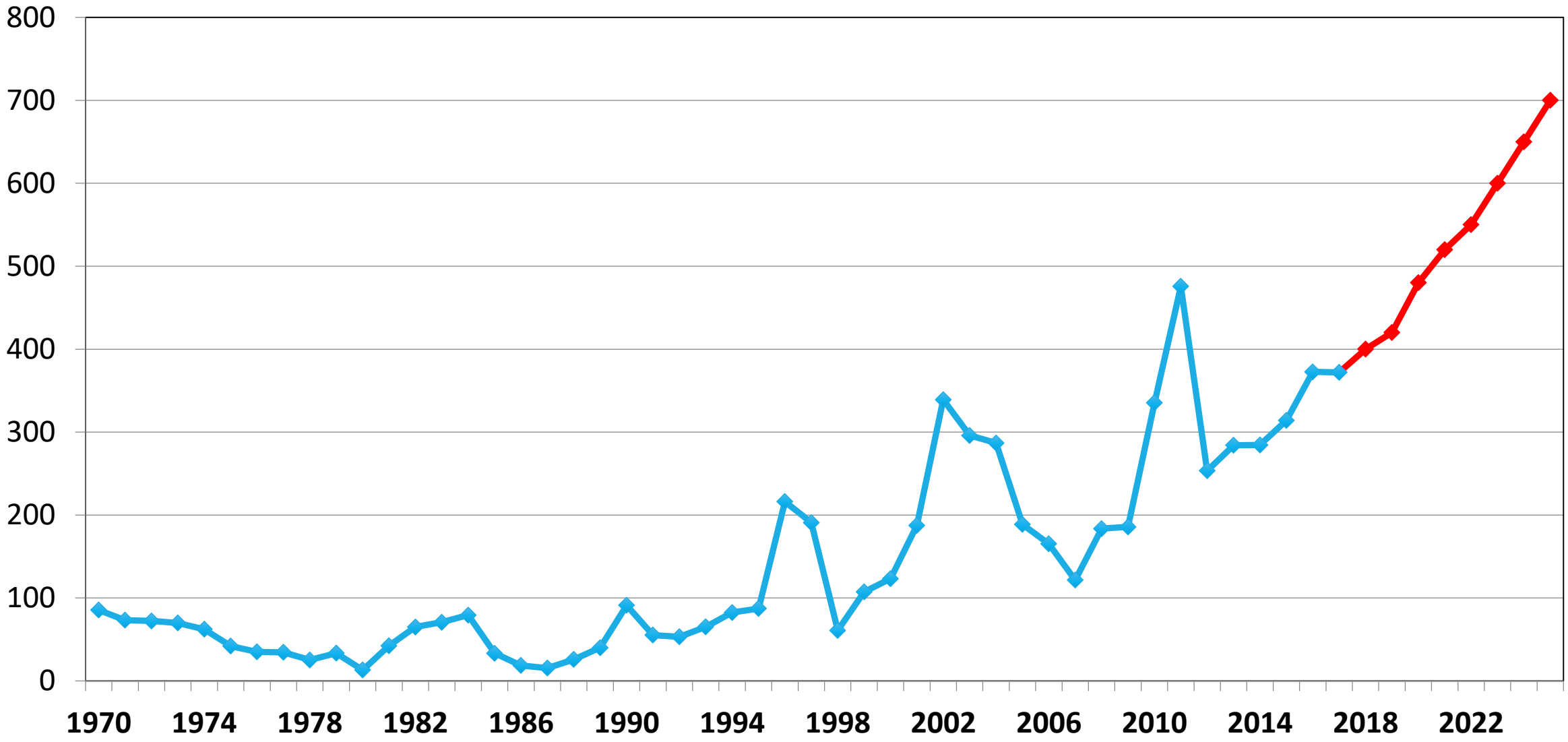
# Uganda v/s Rest of World Yields Kg/ha



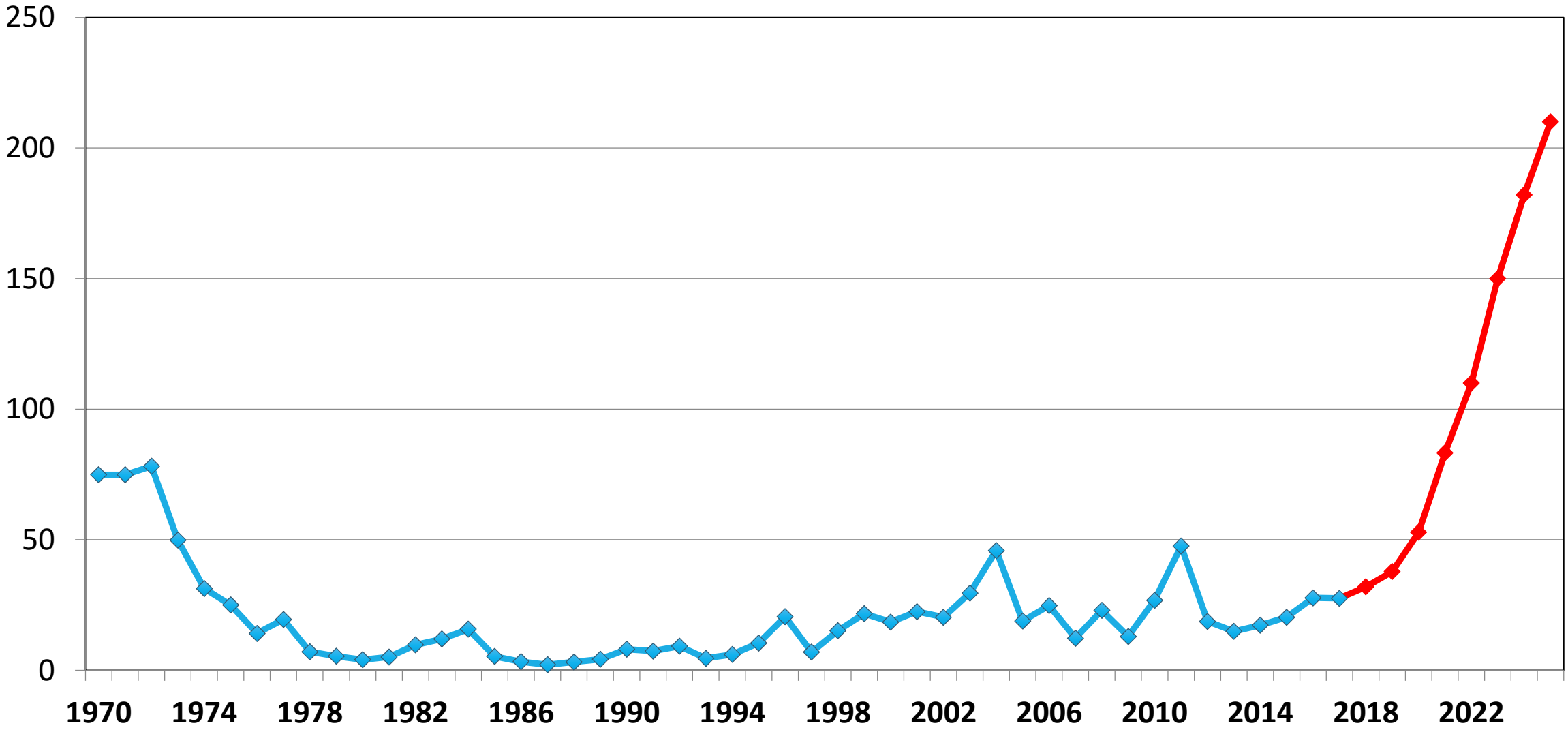
# Uganda Area '000 Hectares



# Uganda Lint Yield Kg/ha



# Uganda Lint Production '000 tonnes



# 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
- Mycorryhizae + 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

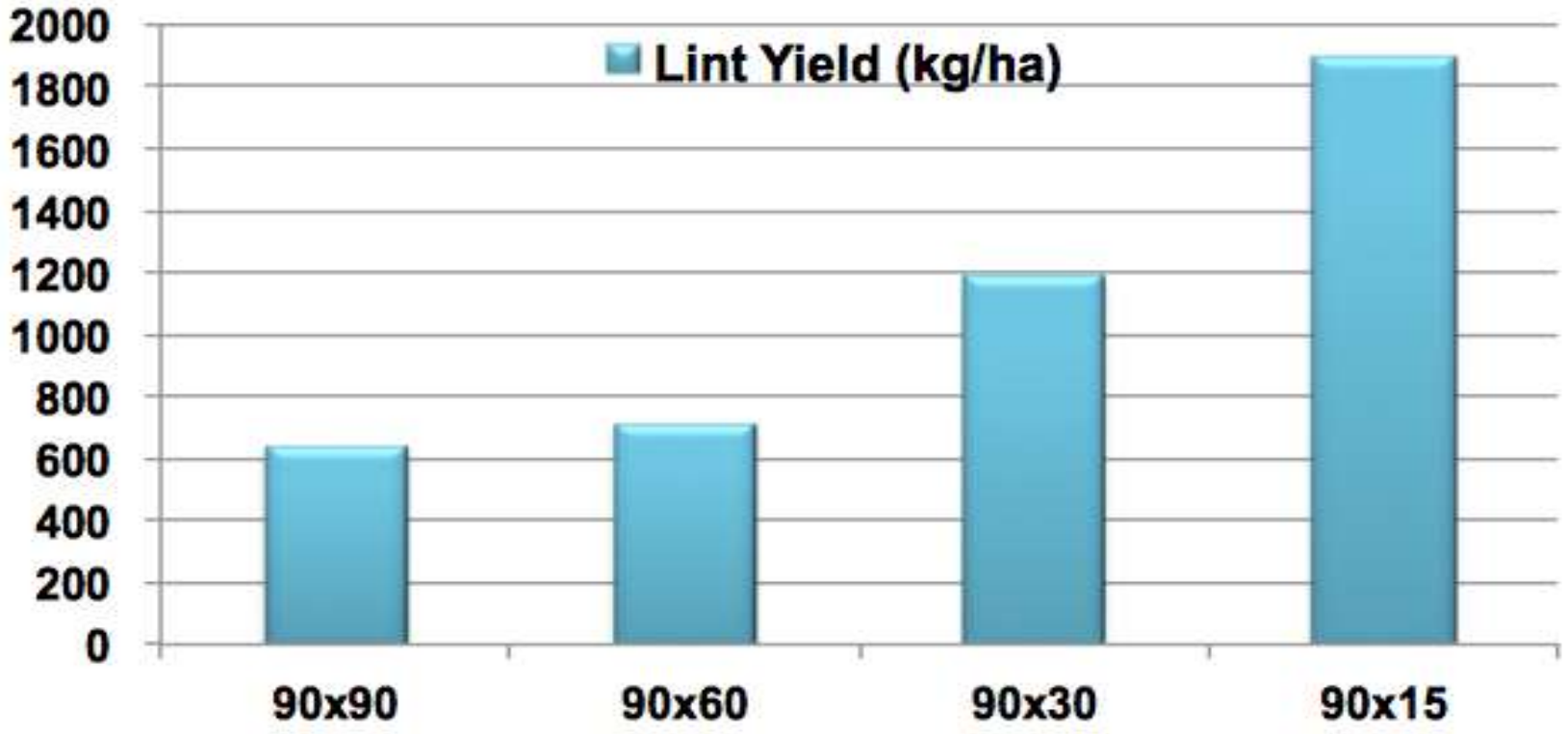
**WATER:** Fit in a short season crop into monsoon for critical window + ridge planting + mulch

**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**




Ref: Rao, M. P. 2014. Asian Seed Congress.

# Thank You