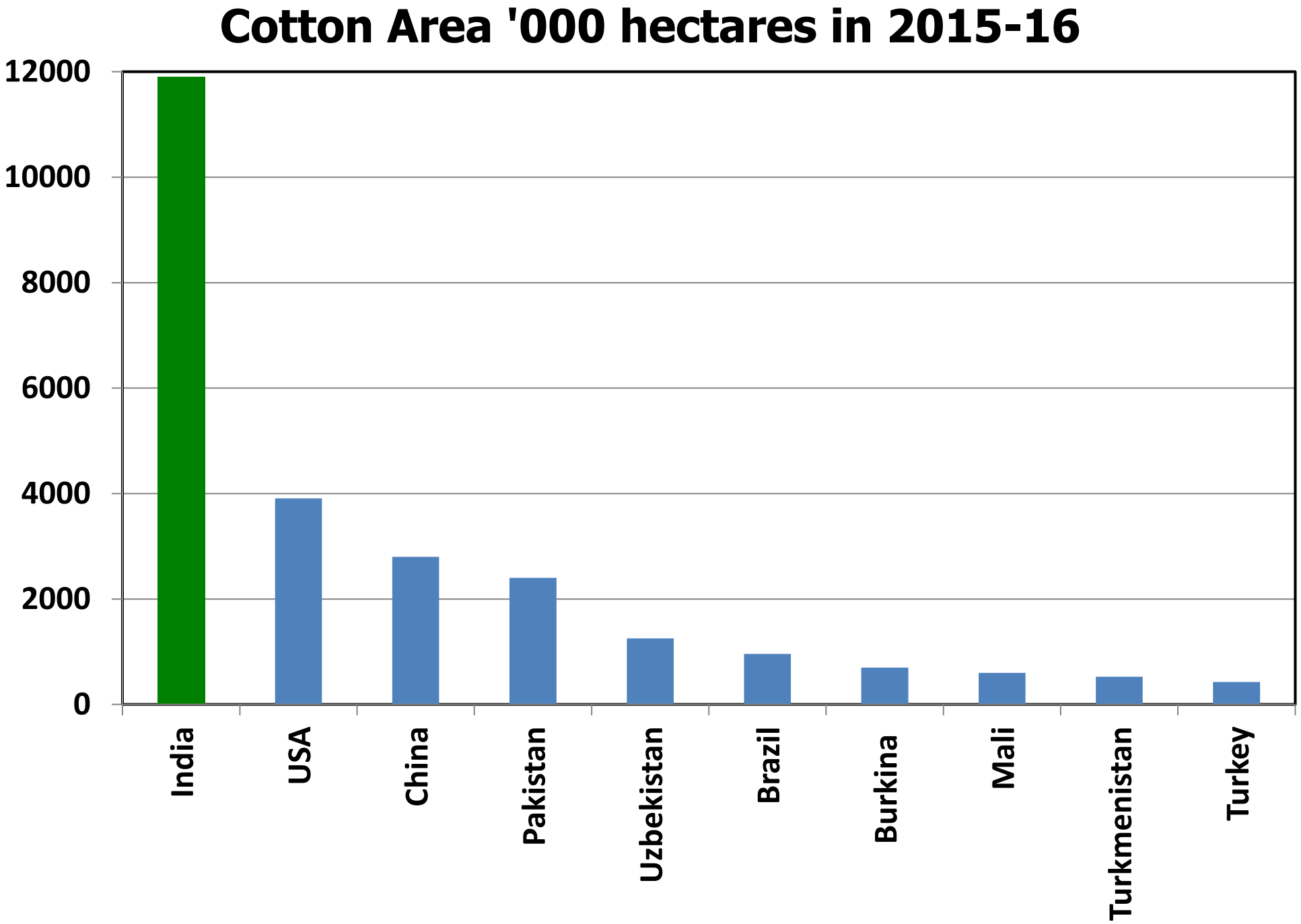
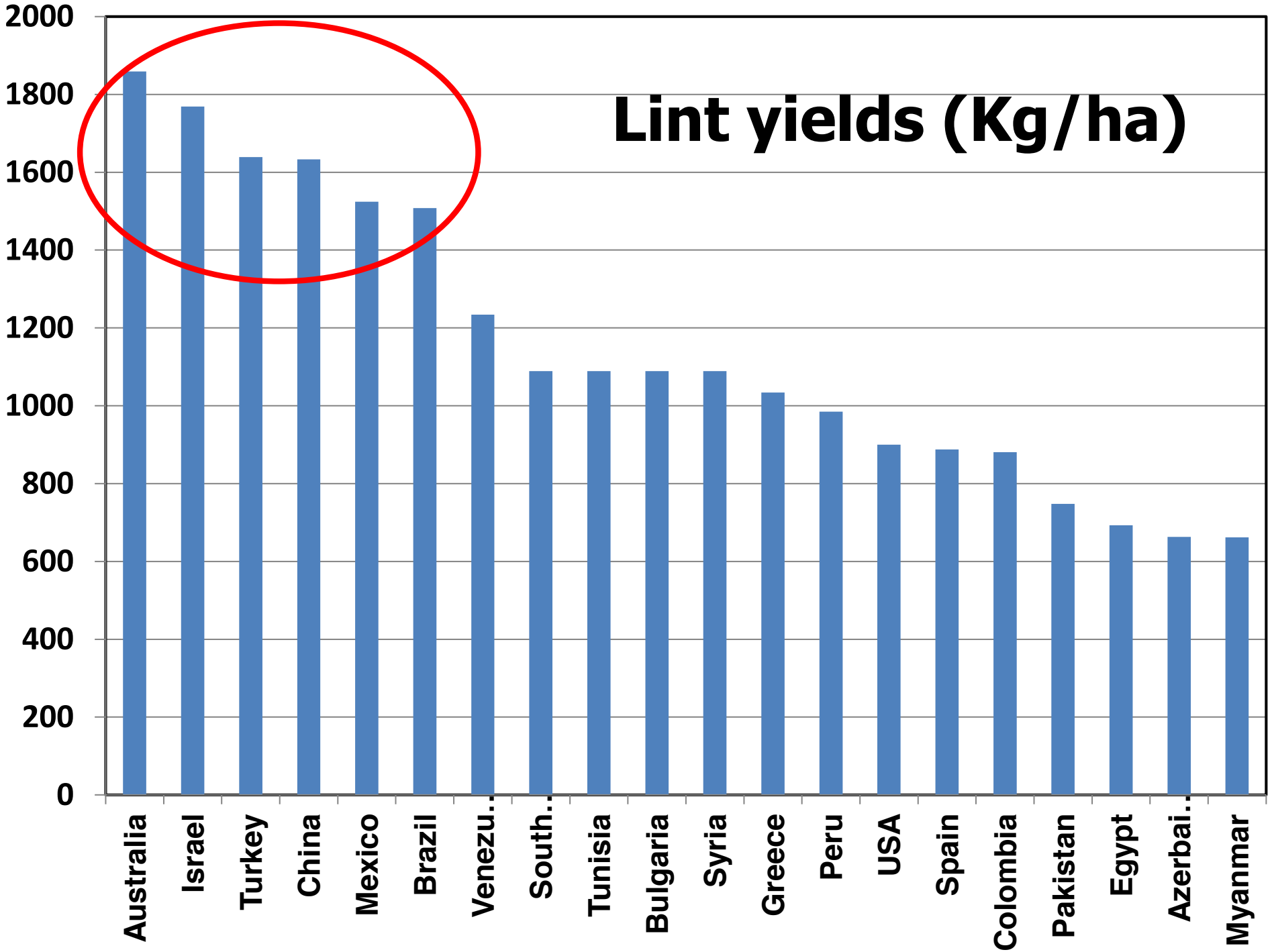
Technologies for the 21st Century

K. R. Kranthi
Head Technical Information Section, ICAC


Cotton Area '000 hectares in 2015-16
12000
10000
8000
6000
4000
2000
0
India
USA
China
Pakistan
Uzbekistan
Brazil
Burkina
Mali
Turkmenistan
Turkey


Lint yields (Kg/ha)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Australia
Israel
Turkey
China
Mexico
Brazil
Venezu..
South..
Tunisia
Bulgaria
Syria
Greece
Peru
USA
Spain
Colombia
Pakistan
Egypt
Azerbai..
Myanmar

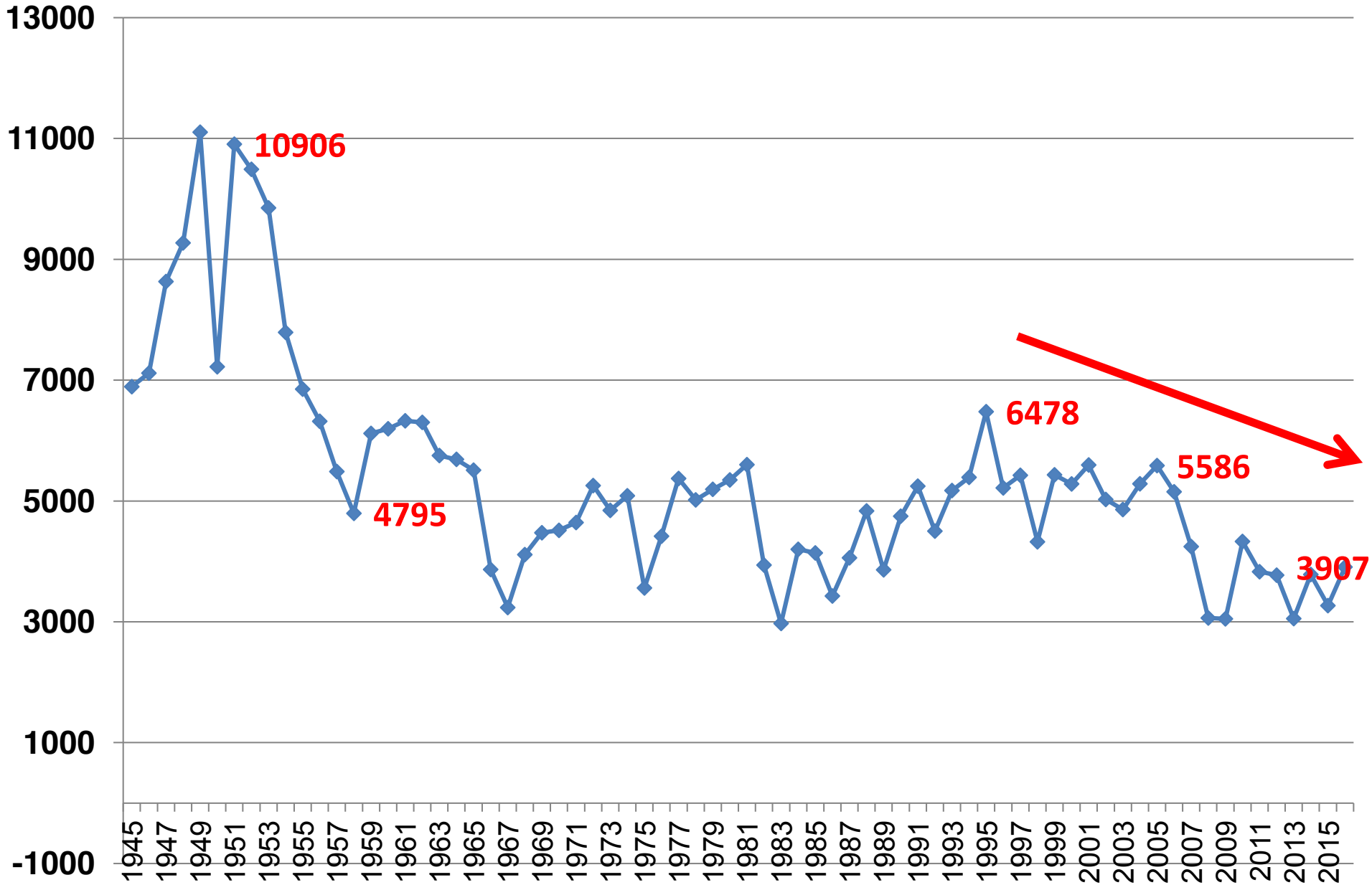
Yield >1500 kg/ha Club

	Kg lint/ha	Area ha
Australia	2443	400,000
China	1633	3,400,000
Brazil	1508	1,000,000
Turkey	1639	500,000
Mexico	1600	90,000
Israel	1800	24,000

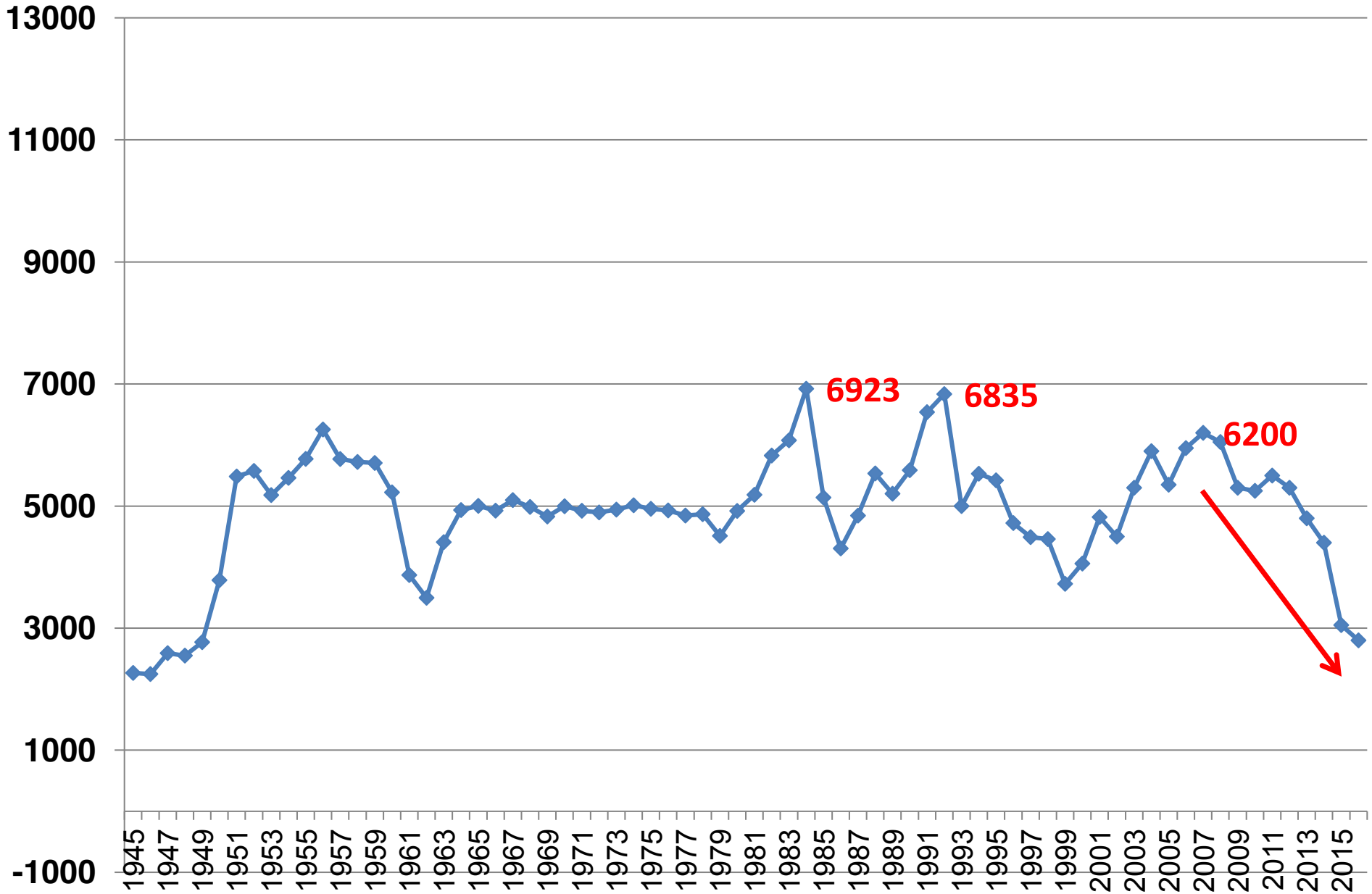
Challenges

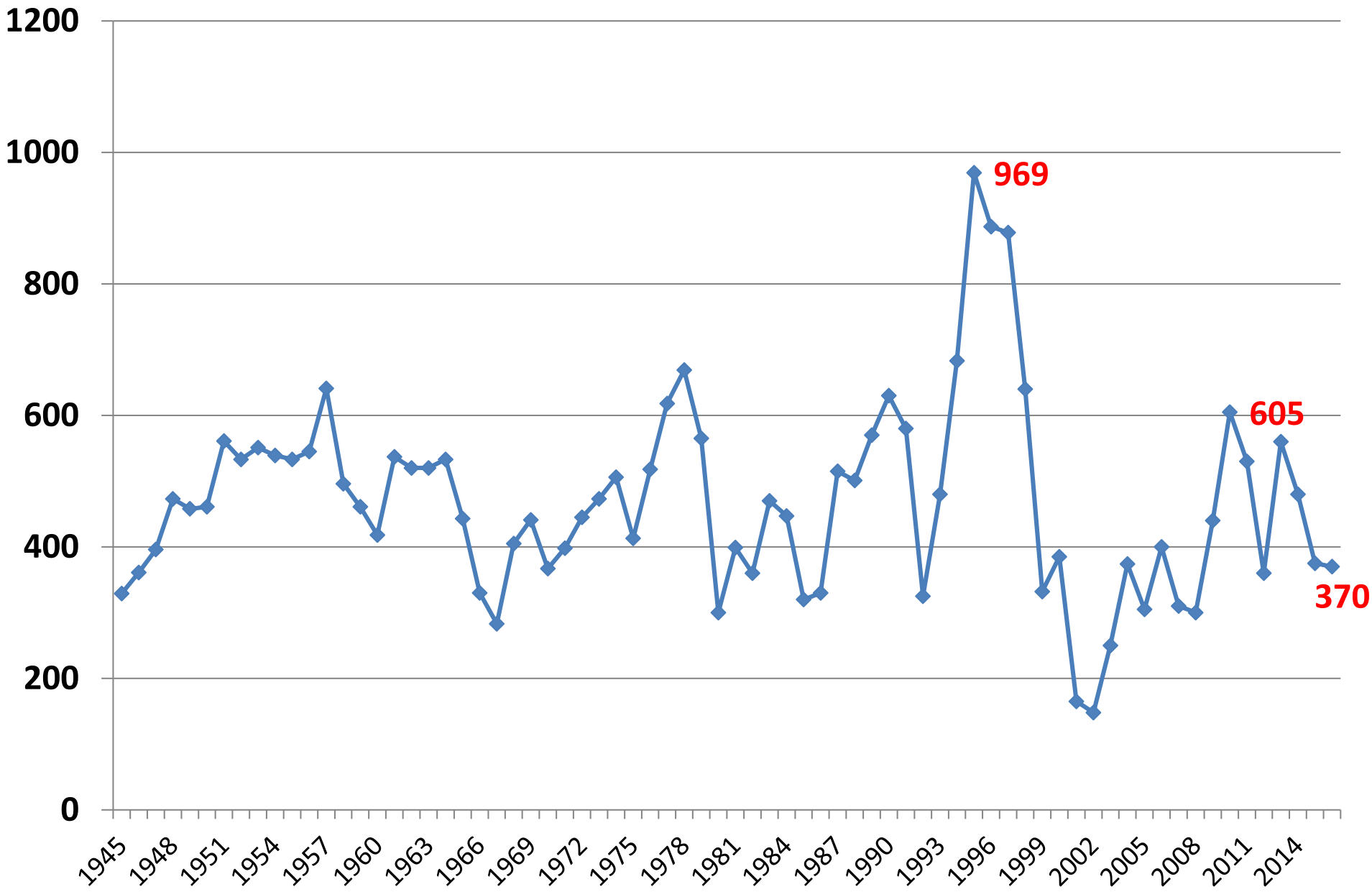
Area in some countries is declining
Production costs are increasing
Chemicals are increasing
Yields are stagnating
Integrity, Traceability?

USA area '000 hectares

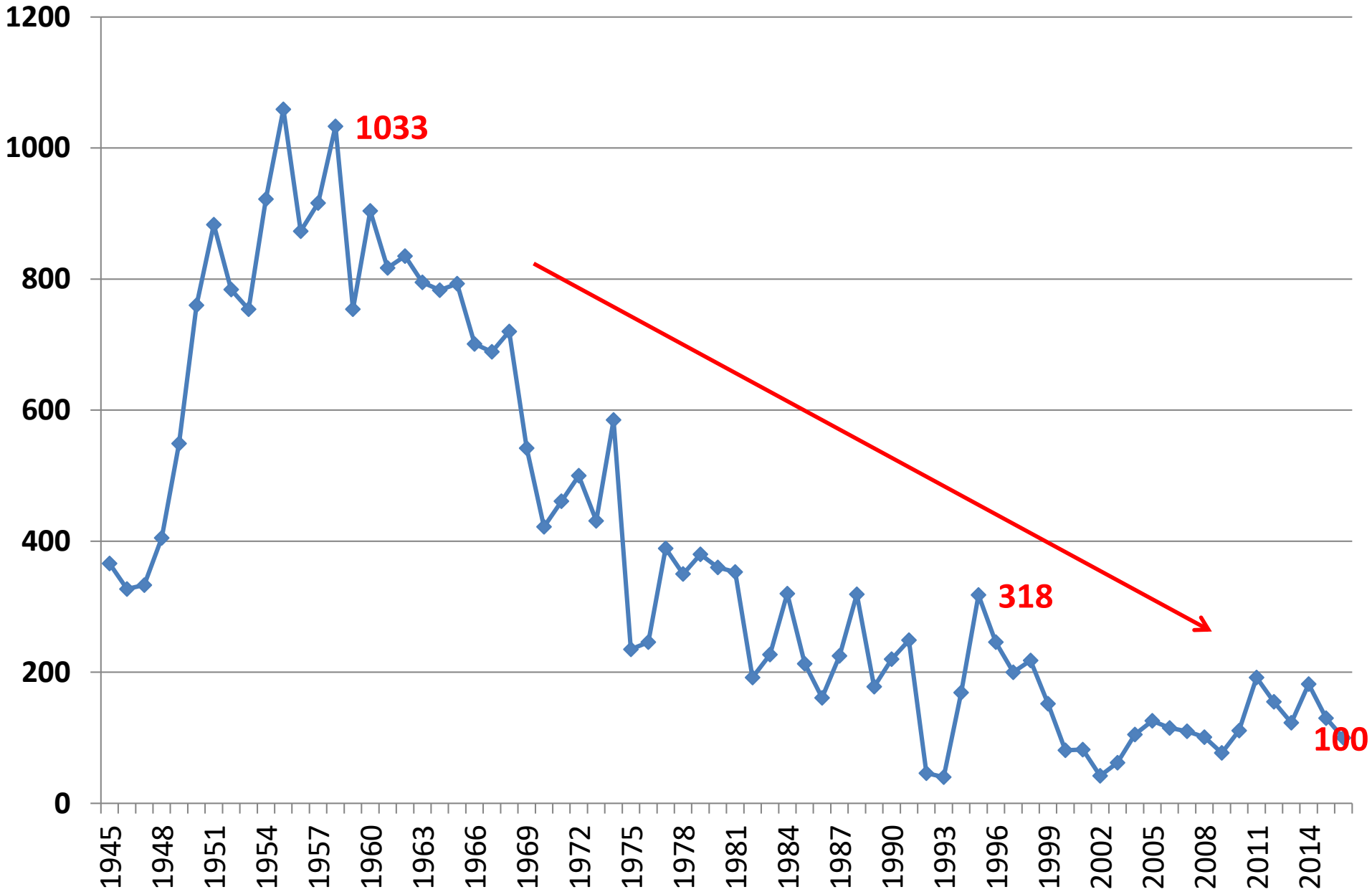


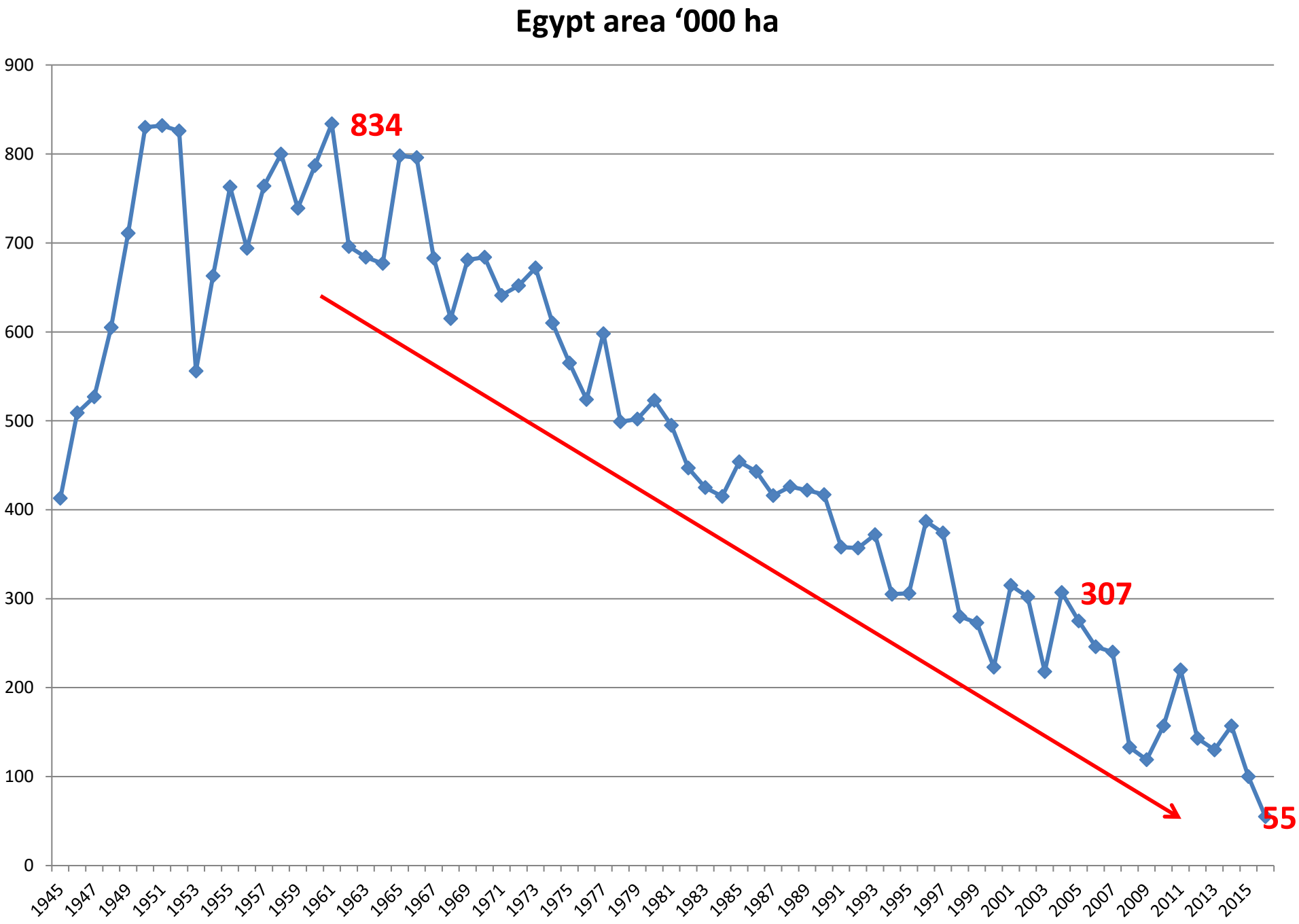
China area '000 ha



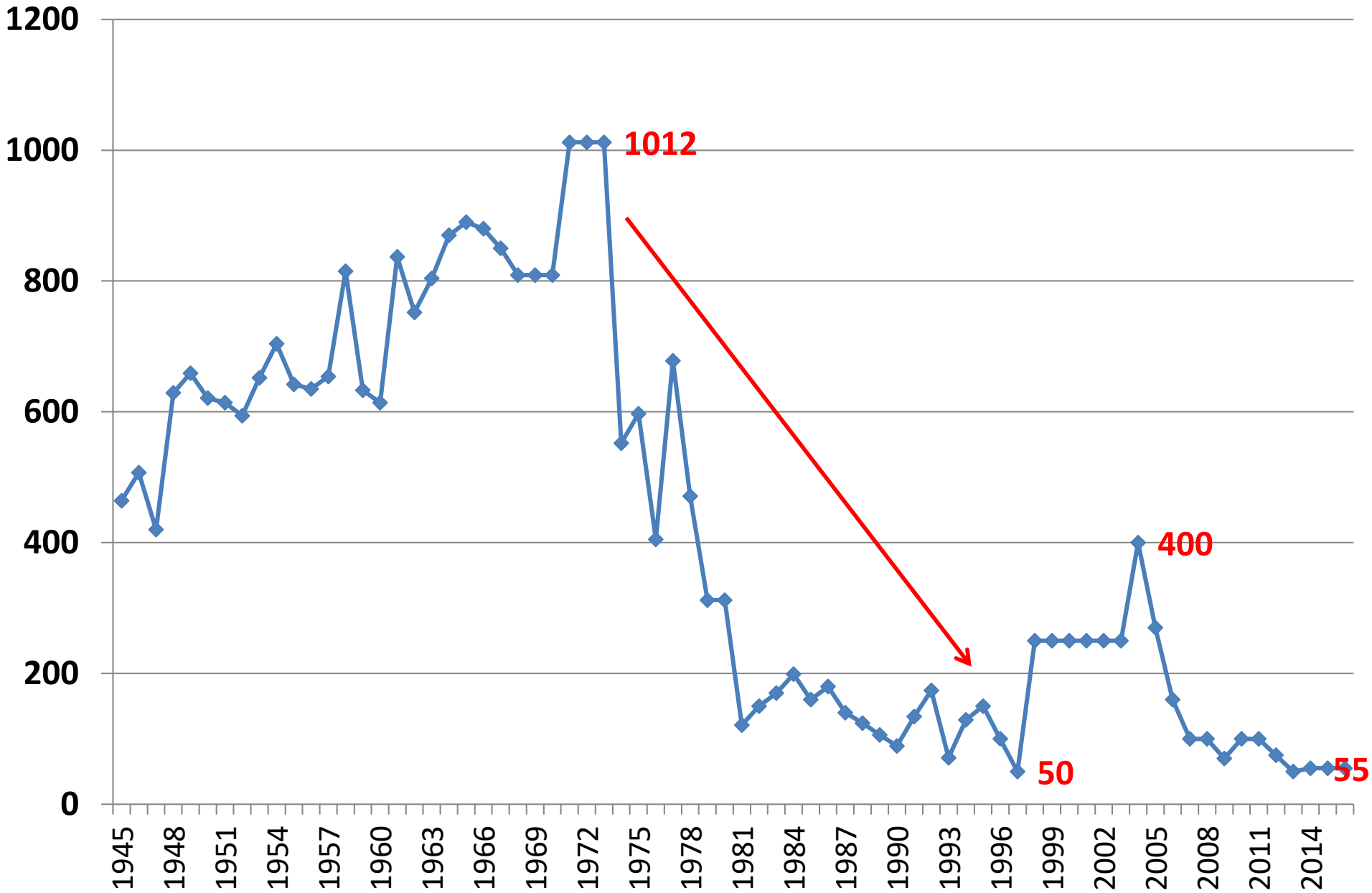

Argentina '000 ha
1200
1000
800
600
400
200
0
969
605
370
1945
1948
1951
1954
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014

Mexico area '000 ha

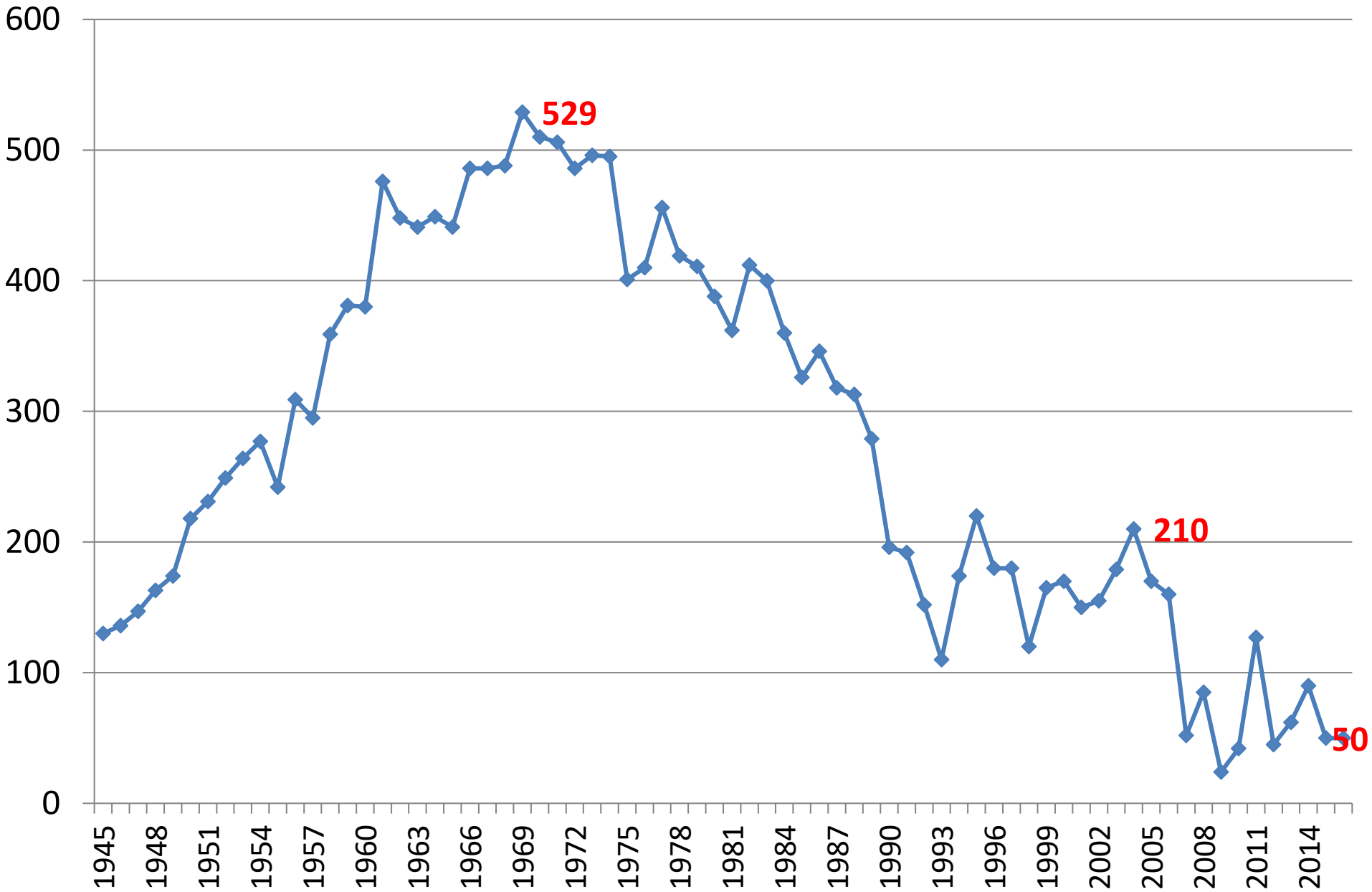


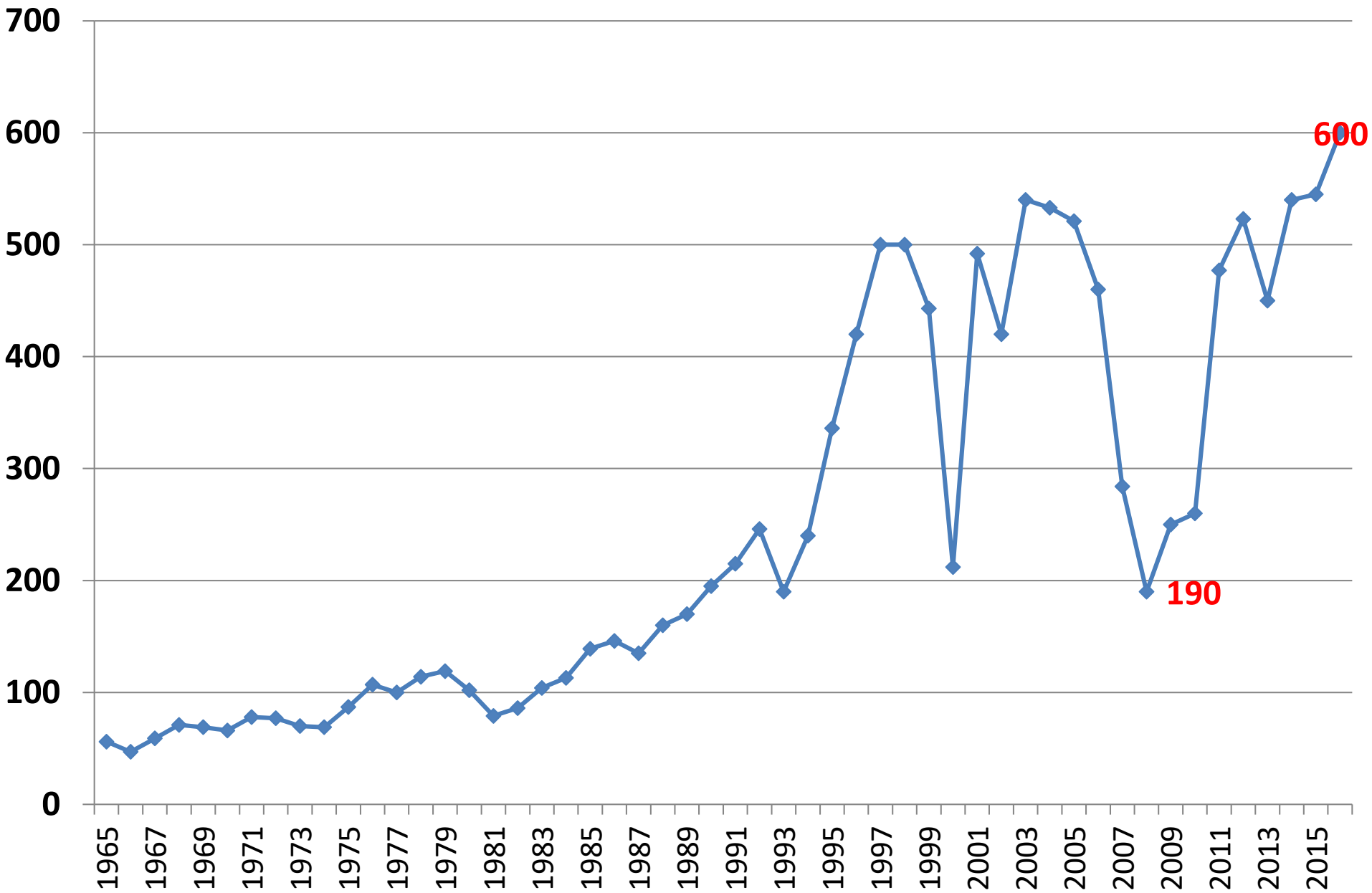

Egypt area ‘000 ha
900
800
700
600
500
400
300
200
100
0
834
307
55
1945
1947
1949
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015

Uganda area '000 ha

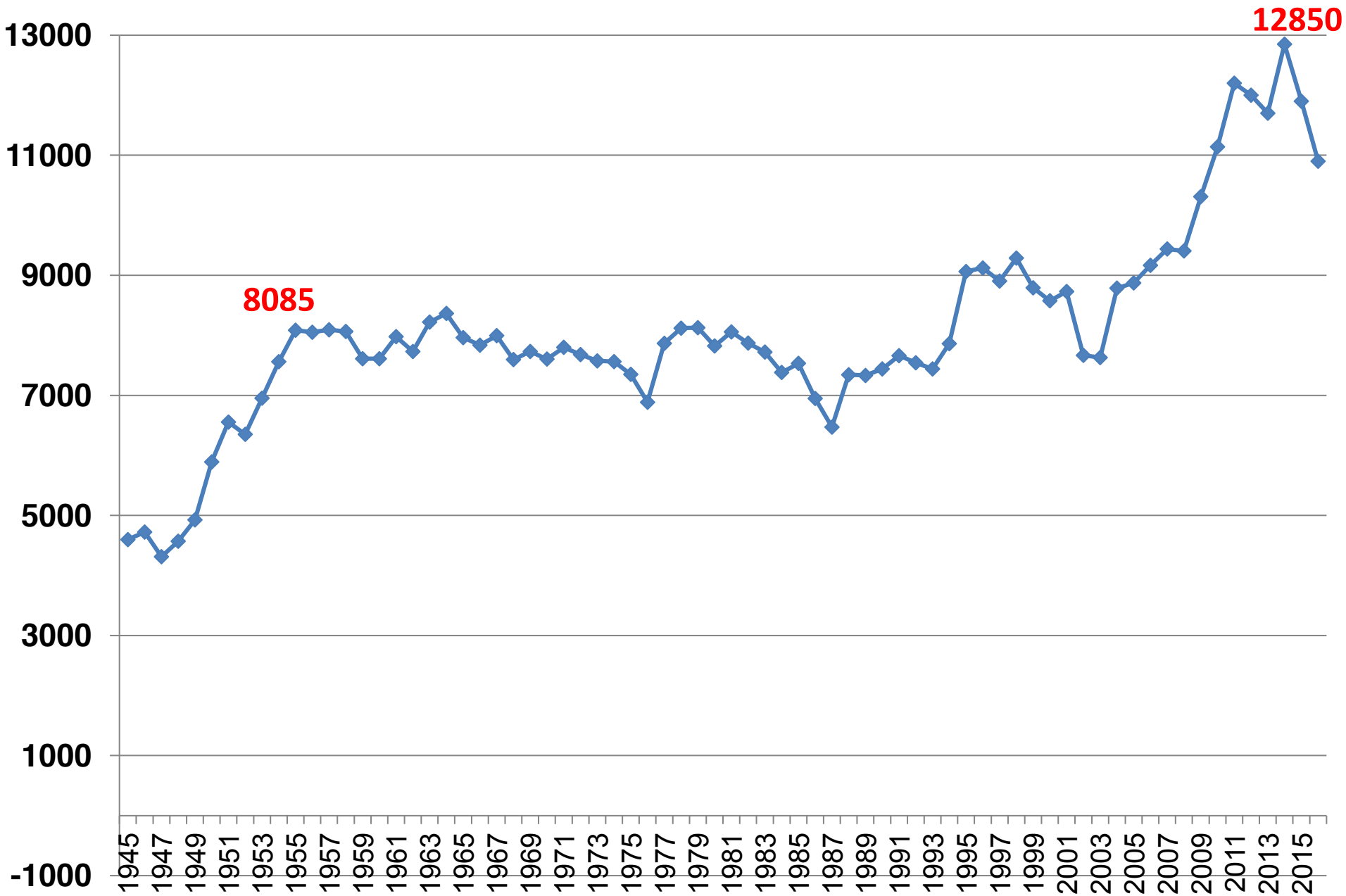


Sudan area '000 ha




Mali area '000 ha
700
600
500
400
300
200
100
0
600
190
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015

India area '000 ha



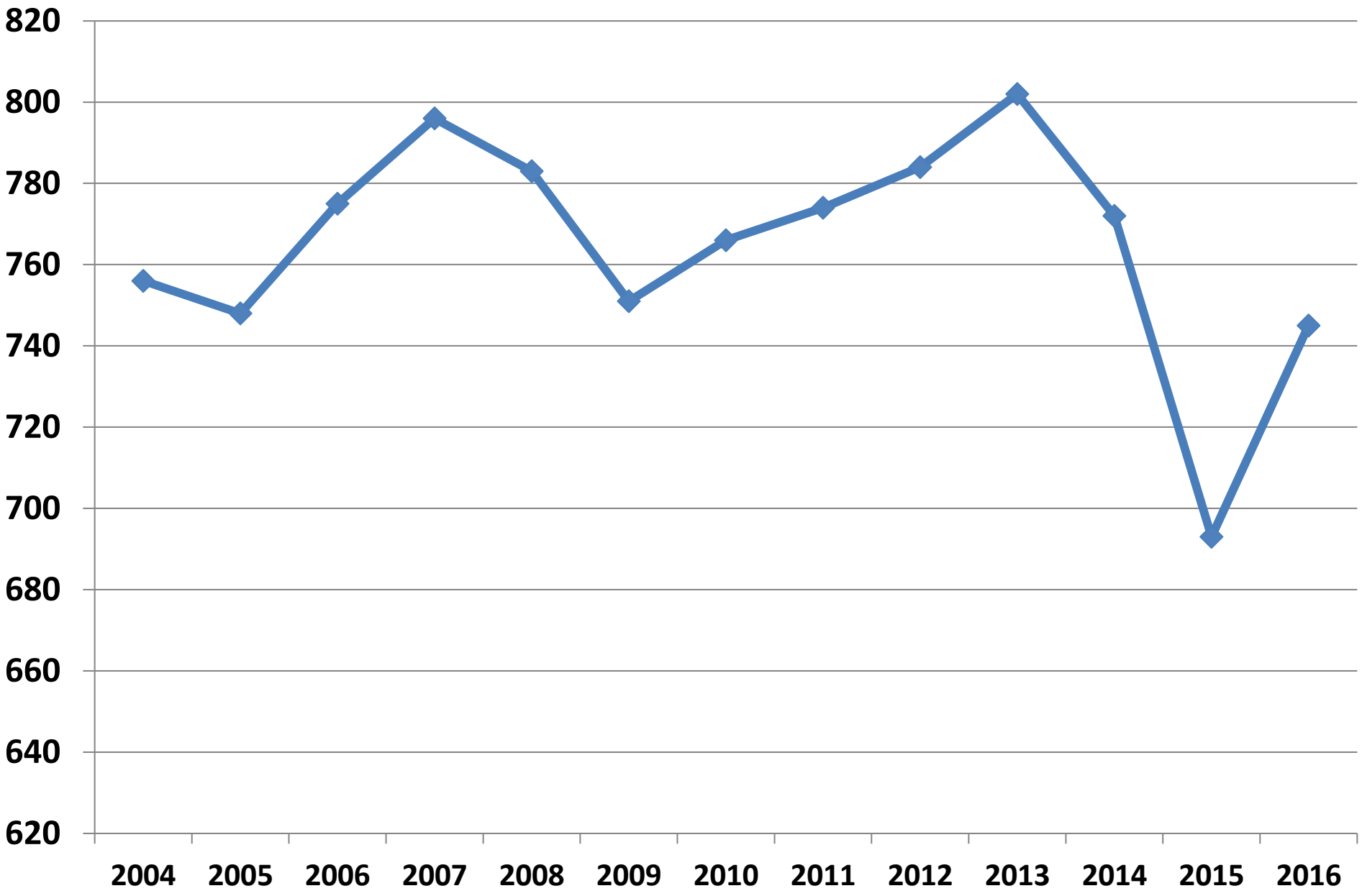
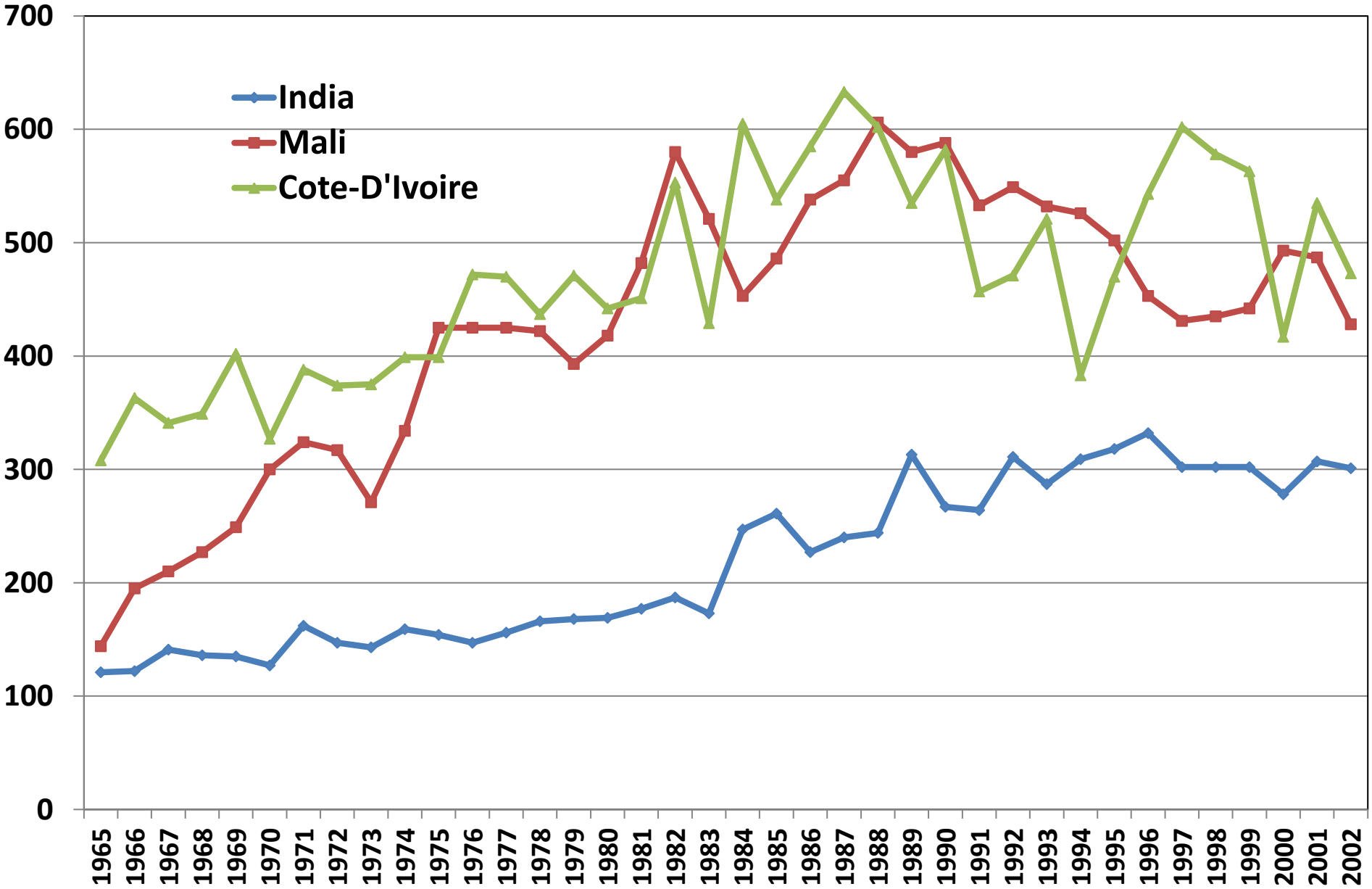
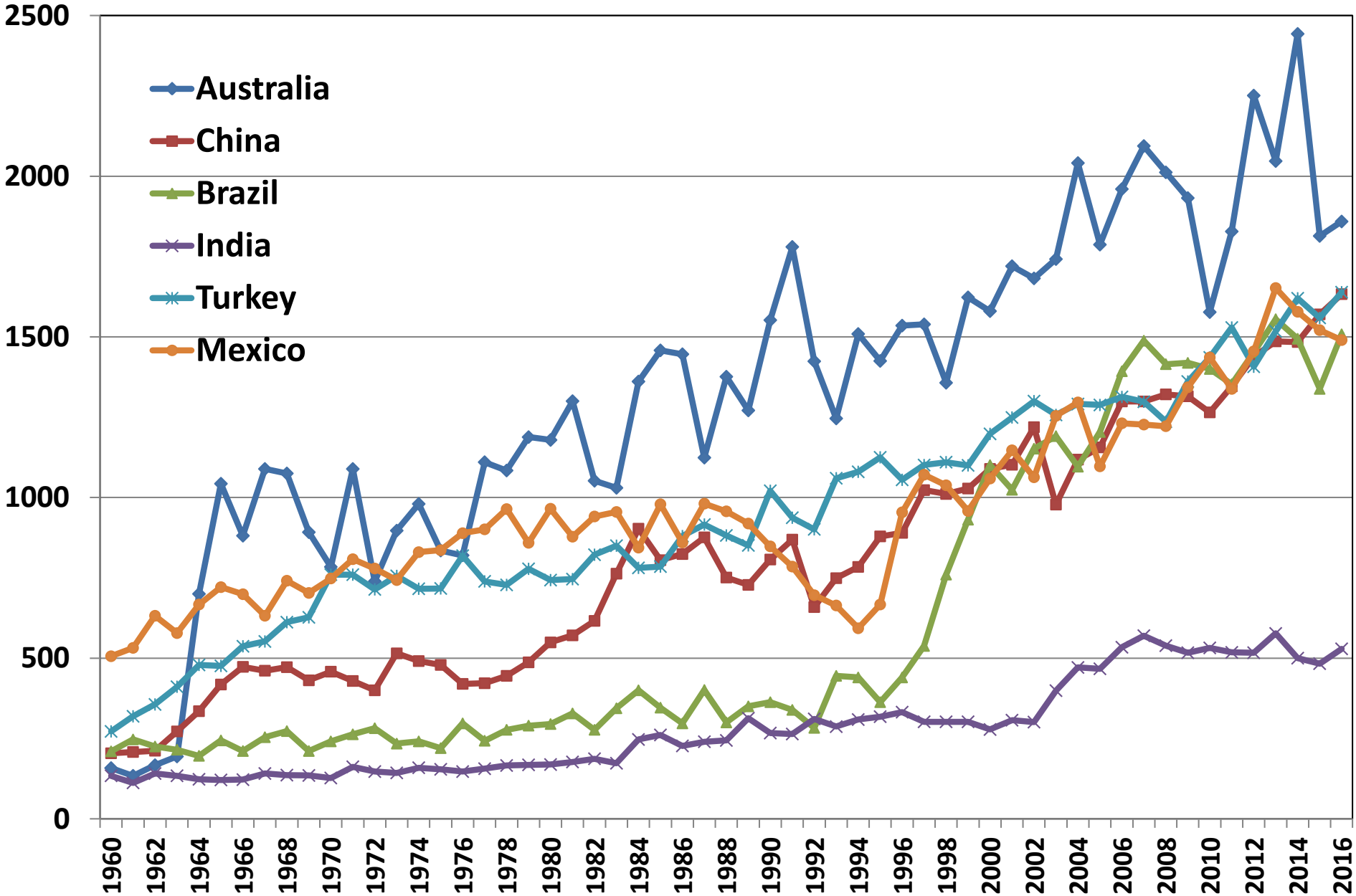
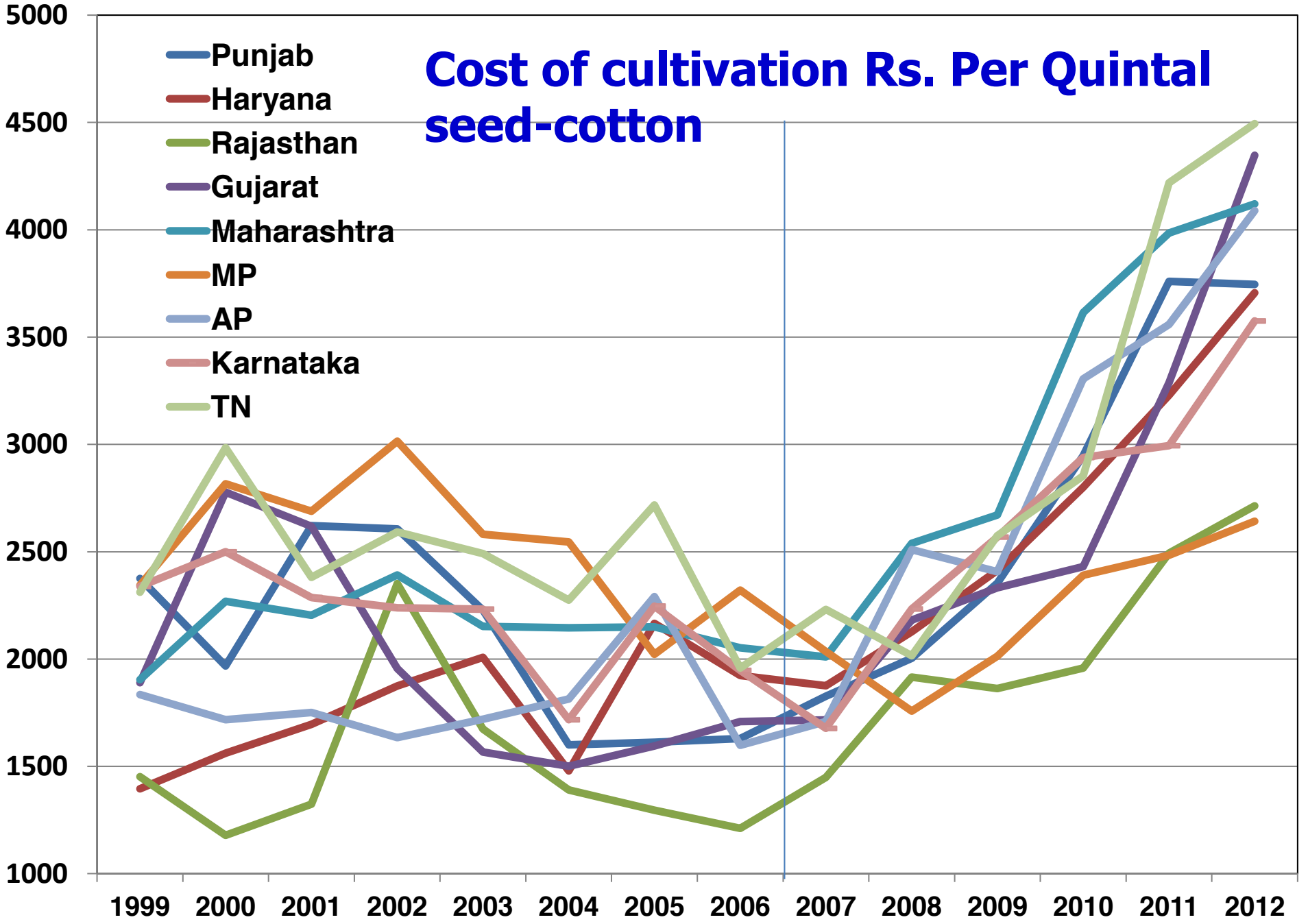

Global Yield Kg/ha
820
800
780
760
740
720
700
680
660
640
620
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

Figure 1. Cotton lint yields Kg/ha in India, Mali and Cote D'Ivoire



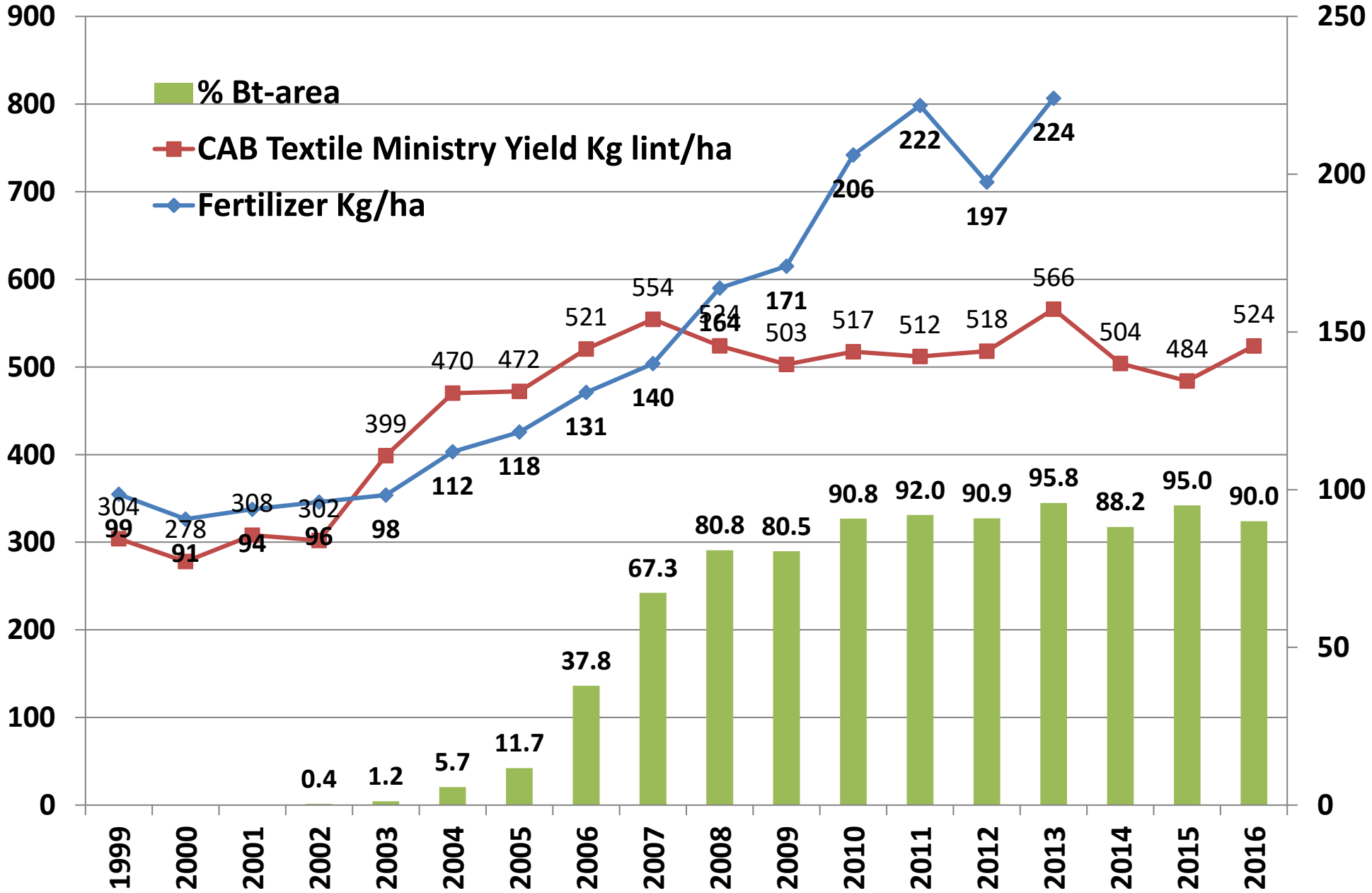
Cotton lint yields Kg/ha



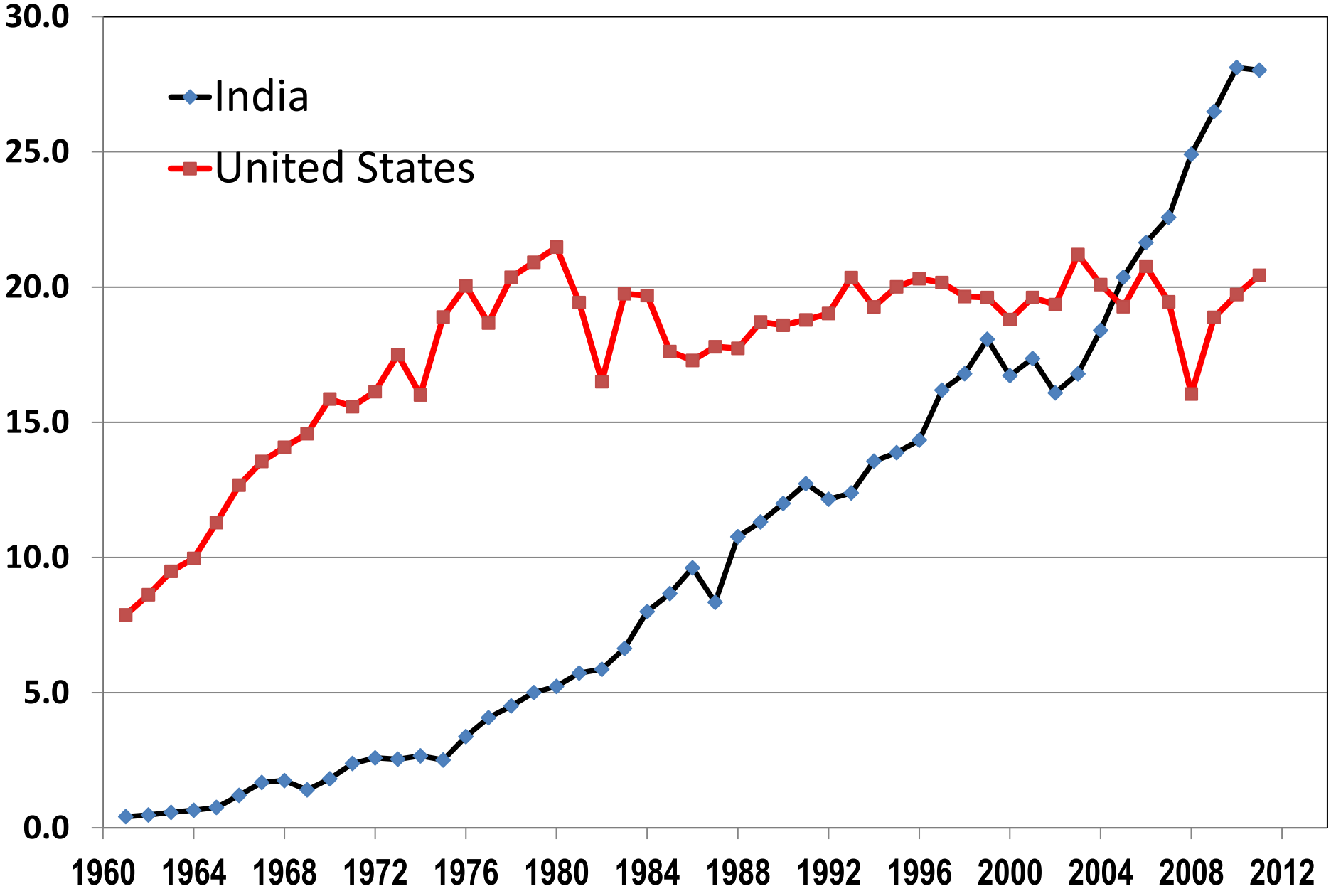


Source: DES, Ministry of Agriculture, India

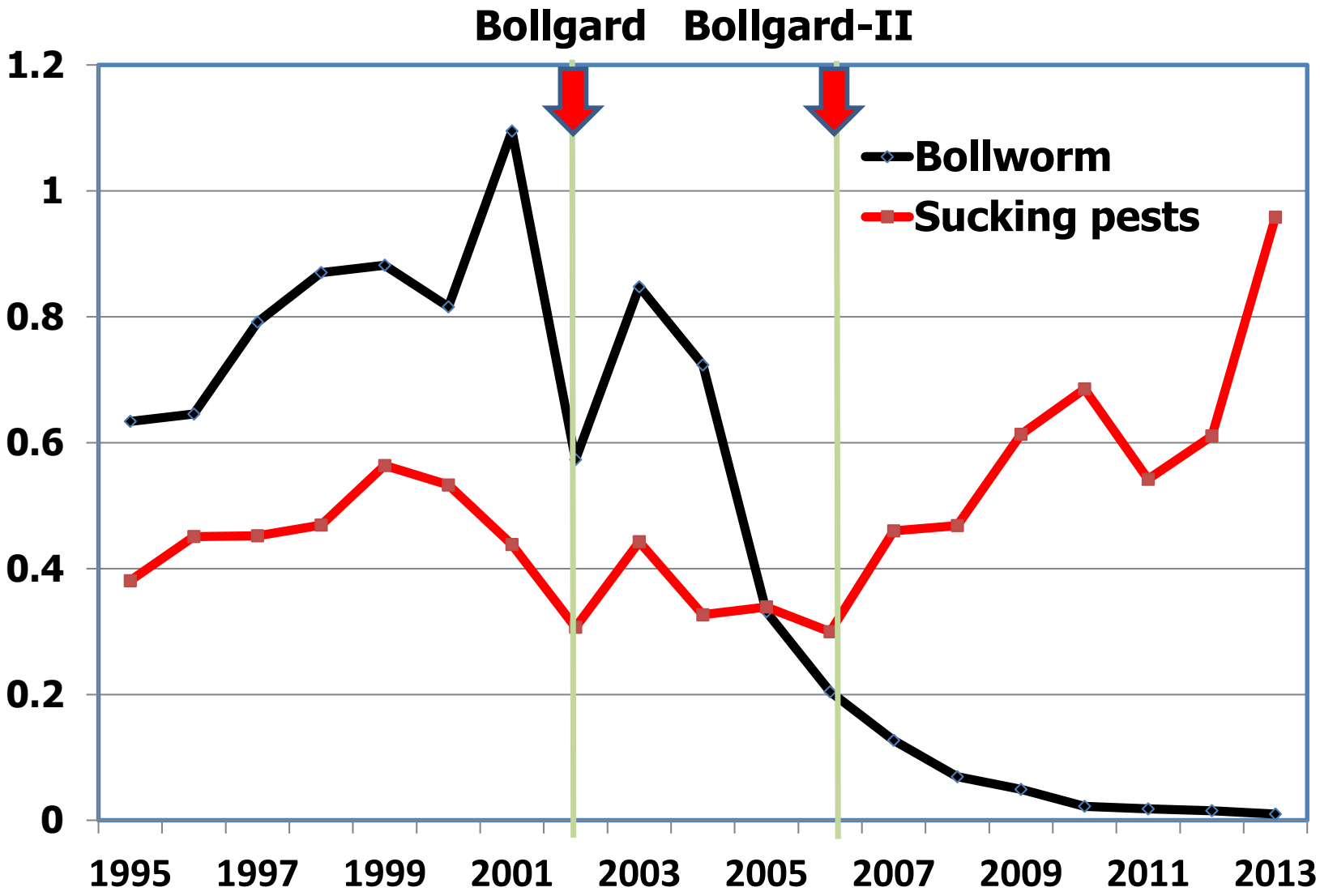
Figure 3. Cotton lint yields Kg/ha, % Bt-cotton area and fertilizer usage Kg/ha in India



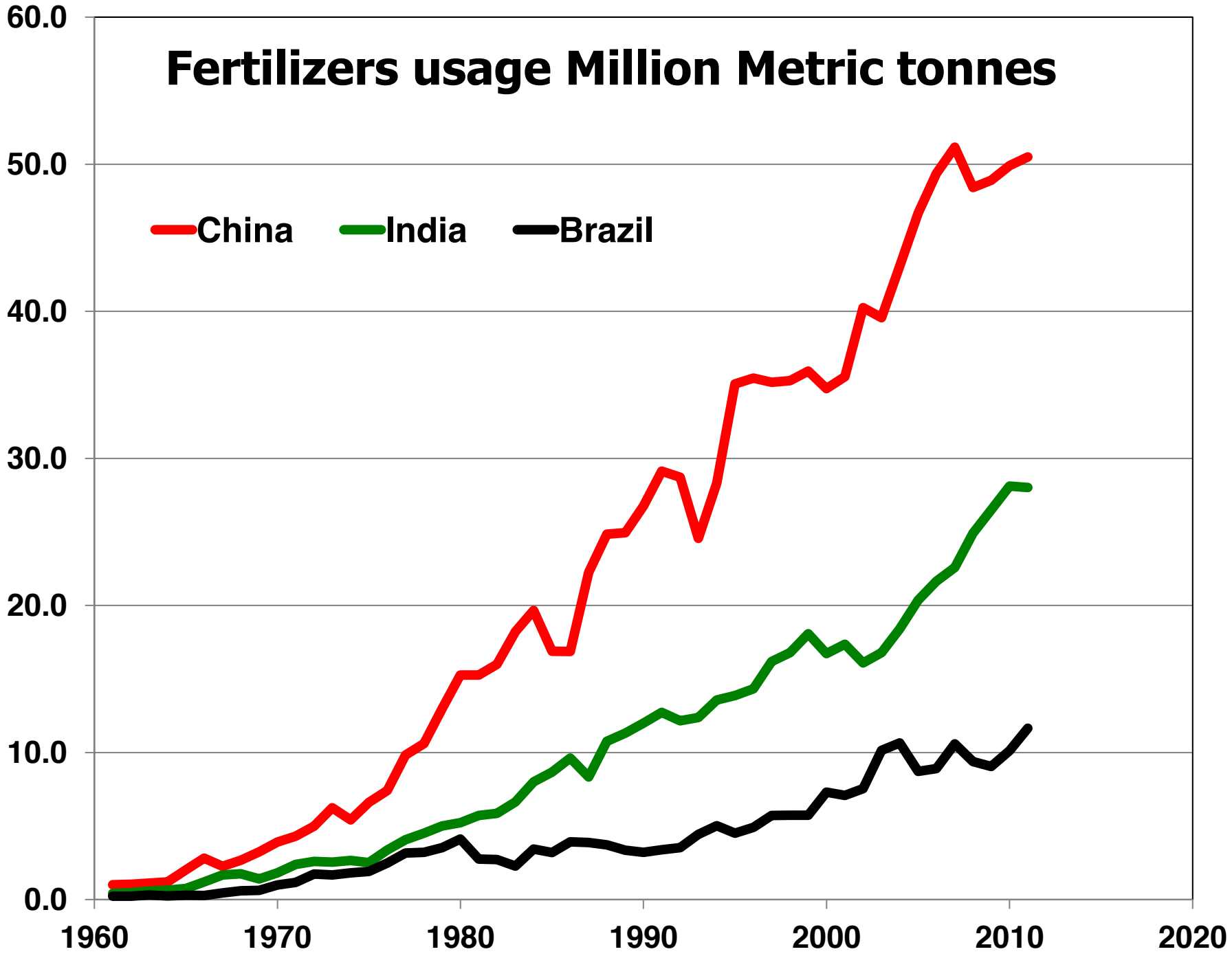
Fertilizer use M tonnes



Insecticides Kg/ha



Kranthi, CAI statistics and News 2014


Fertilizers usage Million Metric tonnes
China
India
Brazil
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1960
1970
1980
1990
2000
2010
2020

Soils are not responding properly to fertilizers

More fertilizers are being used

More Water + fertilizers = more insects

Chemical insecticides are used

Insects developed resistance

More insecticides are being used

Food and water has dangerous chemicals

TURKEY

REASONS FOR YIELD INCREASE

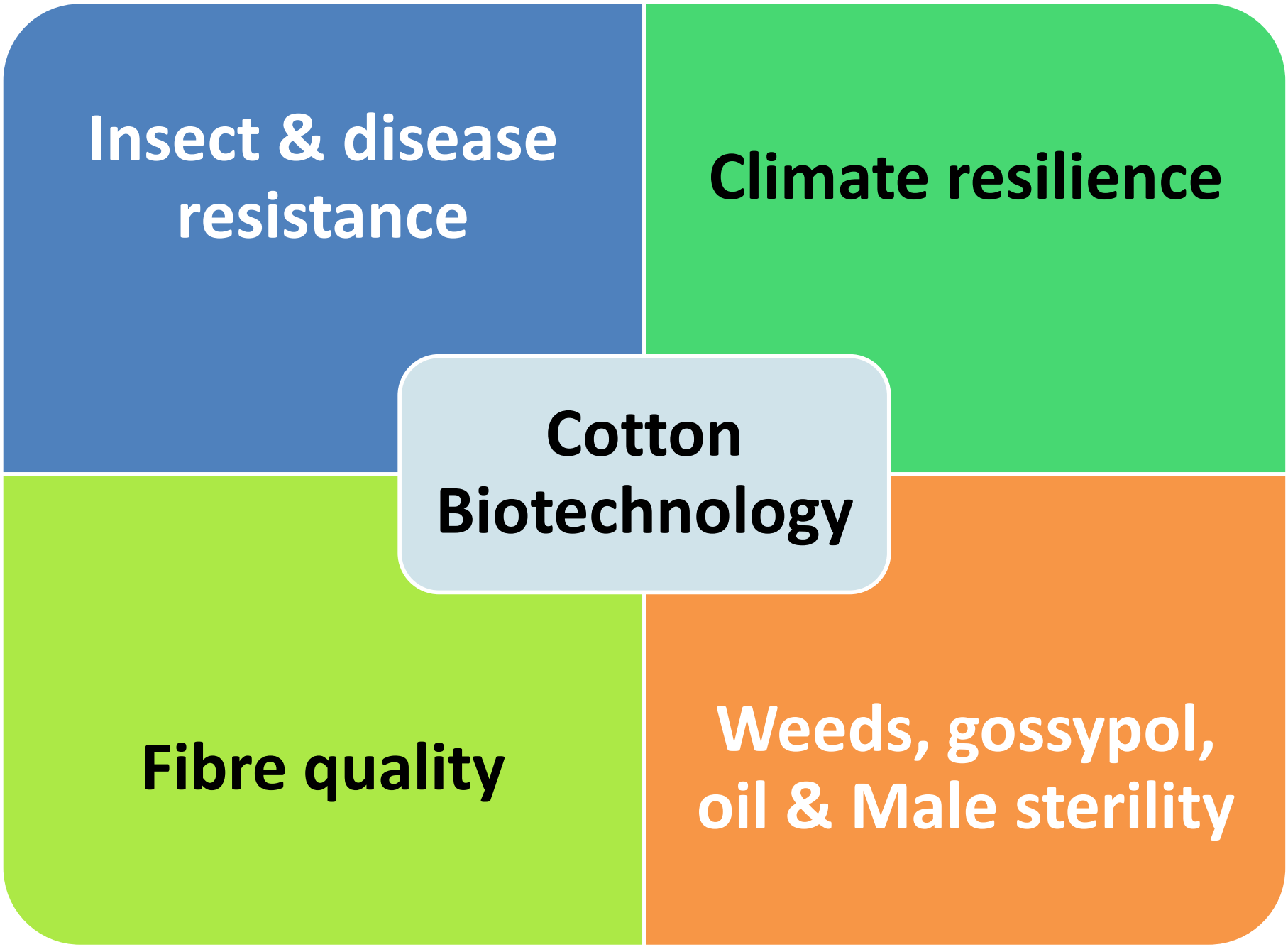
Mechanization
New high yielding varieties
Technologies of IPM and INM
Availability of irrigation all through season
Increase in usage of good quality certified seeds

AUSTRALIA

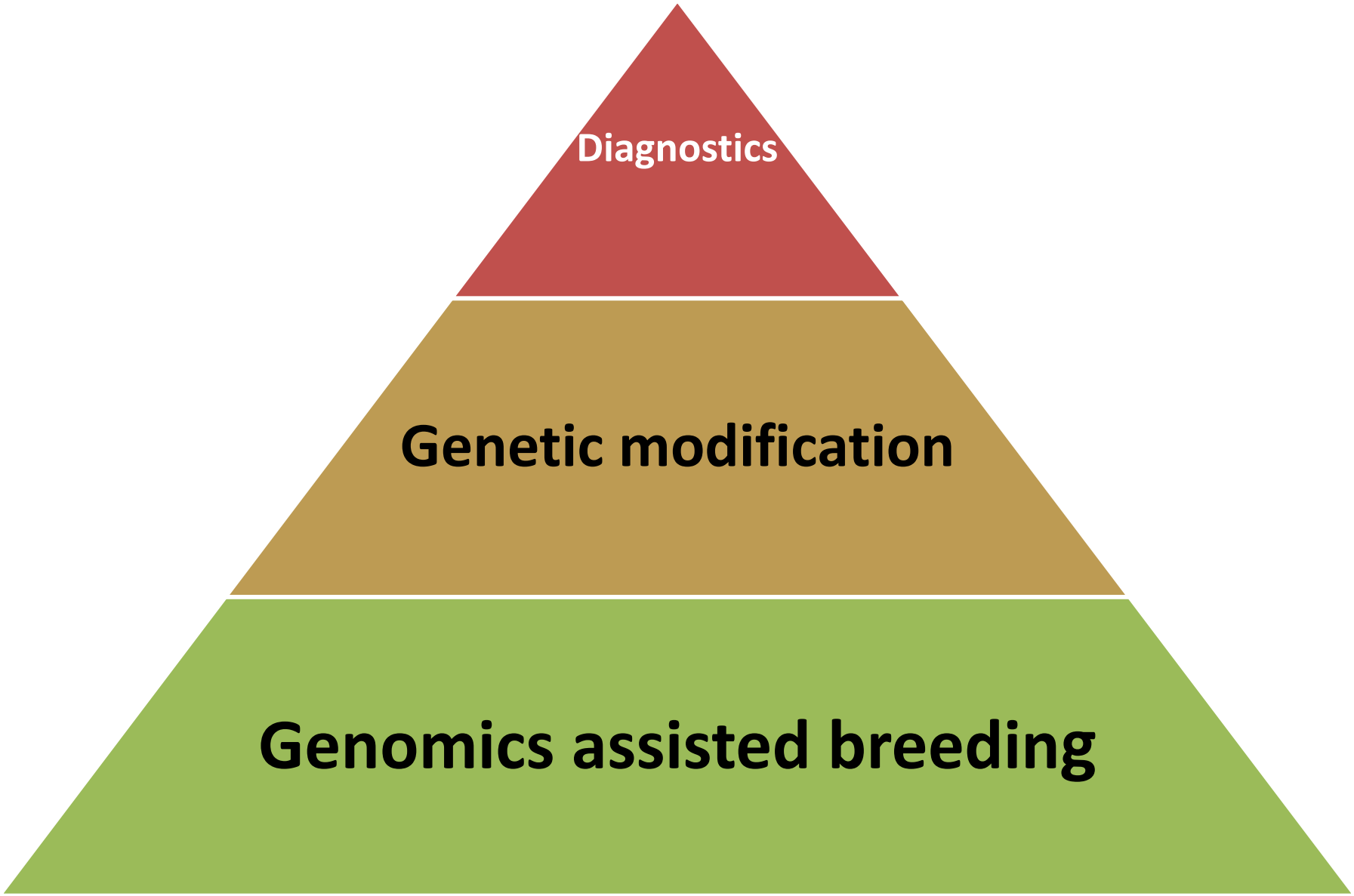
REASONS FOR YIELD INCREASE

Precision Mechanization
New high yielding varieties
Optimization of plant density
Precision Technologies of IRM, IPM and INM
Outstanding application of science on the field

Technologies for the 21st Century


Insect & disease resistance
Climate resilience
Cotton Biotechnology
Fibre quality
Weeds, gossypol, oil & Male sterility

The Power of Biotechnology



GM technology

provides exclusive solutions for

VIRAL DISEASES

CRYPTIC INSECTS

SALINITY

DROUGHT

CLIMATE CHANGE

QUALITY IMPROVEMENT

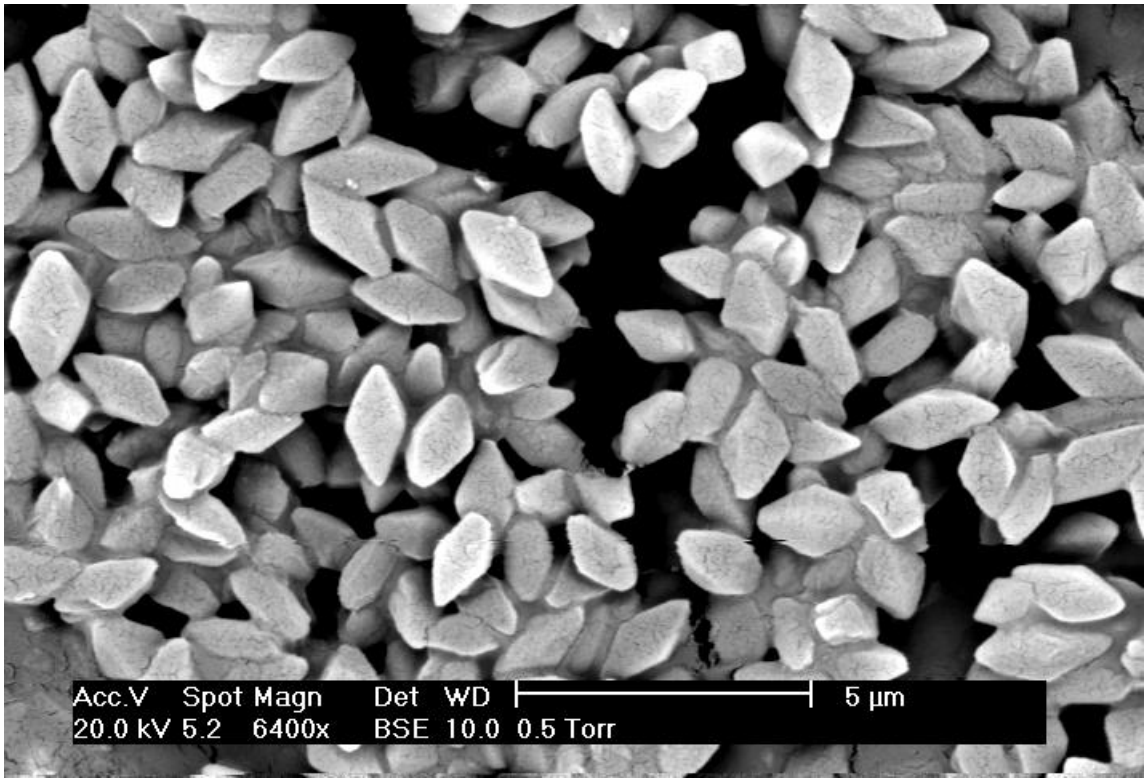
Bollworms

American

Pink

Spotted

Bacillus thuringiensis



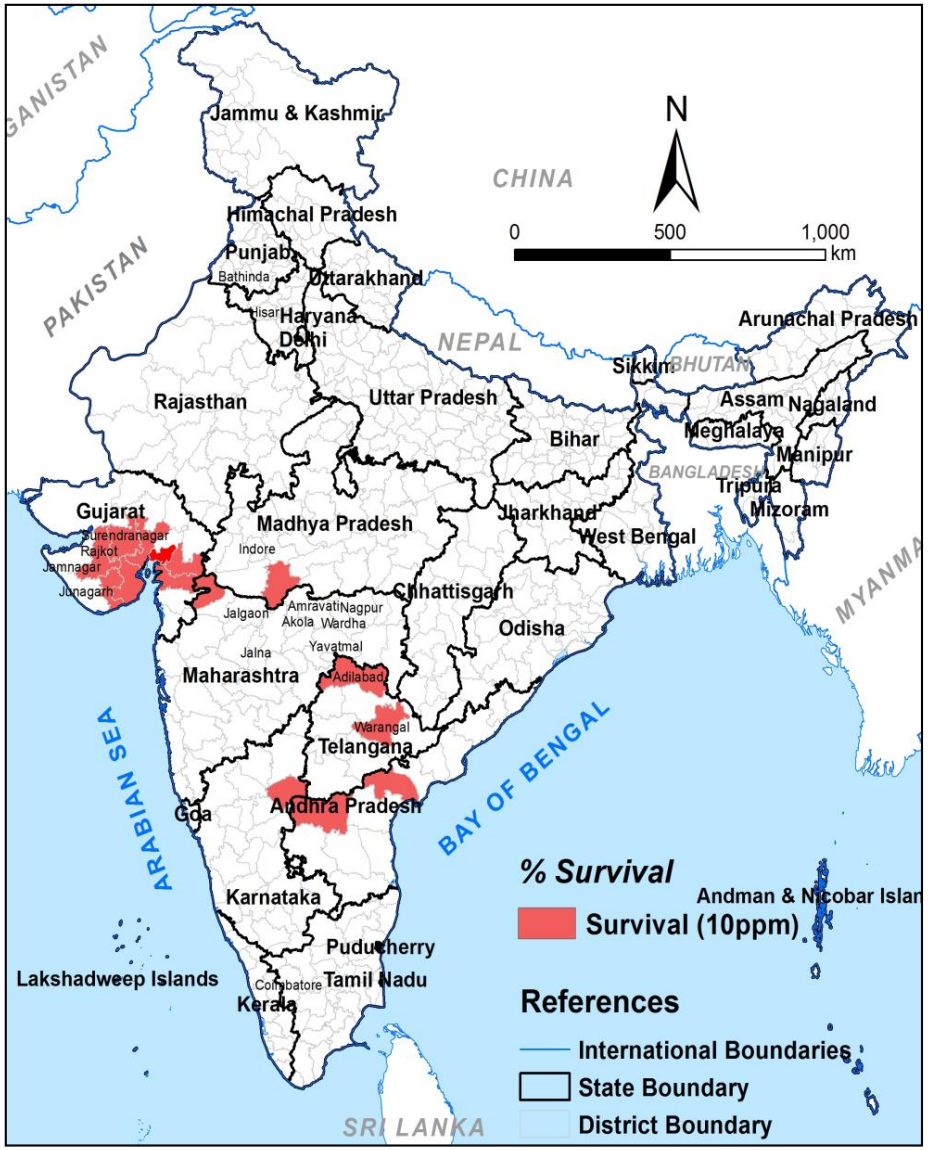
https://en.wikipedia.org/wiki/Bacillus_thuringiensis

Resistance to Bt Crops

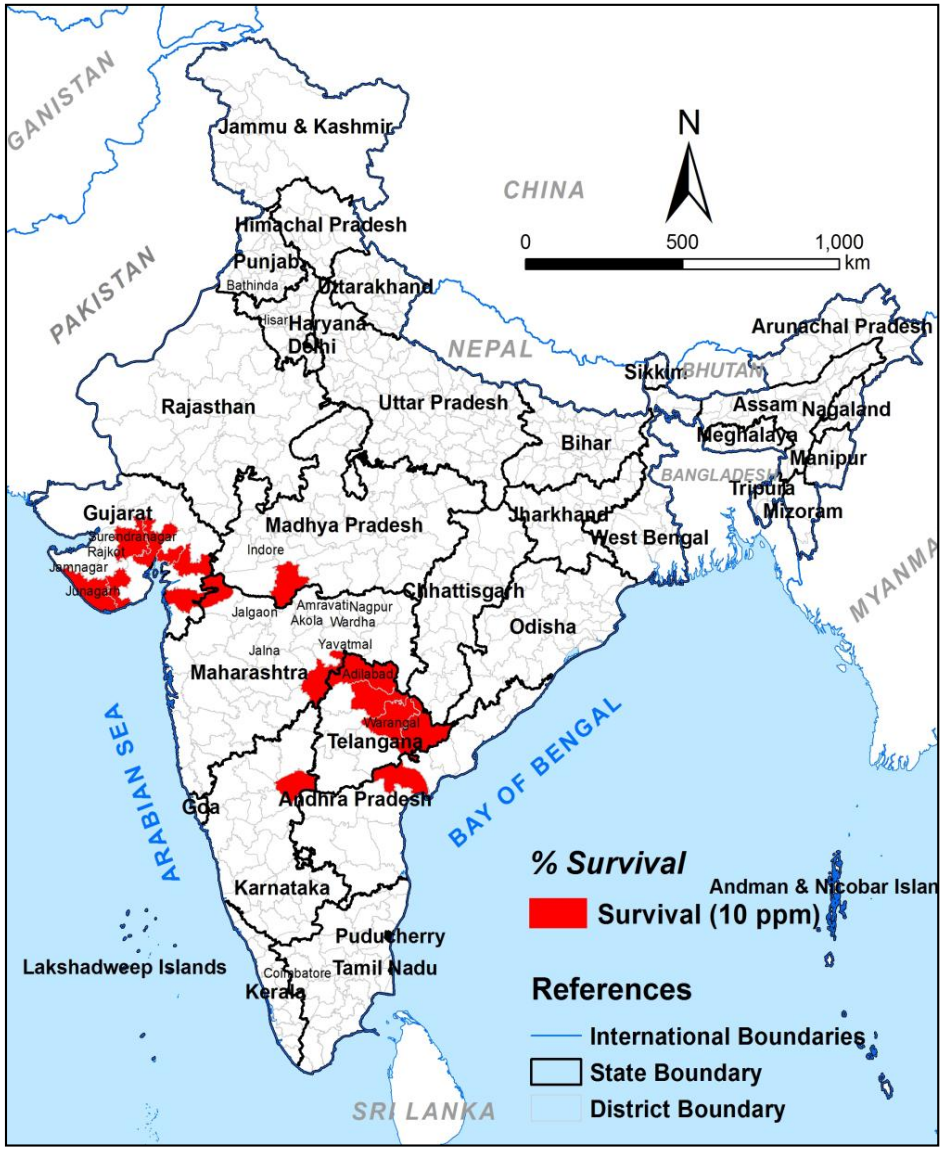
Bt transgenic crops			
Fall armyworm, ***Spodoptera frugiperda***	Bt Cry 1F **corn**	Puerto Rico	2010
Pink bollworm, ***Pectinophora gossypiella***	Bt Cry 1Ac **cotton**	India	2011
African stem borer ***Busseola fusca***	Bt Cry 1 Ab **corn**	South Africa	2011
Western corn rootworm, ***Diabrotica virgifera***	Bt Cry 3 Bb 1 **corn**	USA	2011
Cotton Bollworm ***Helicoverpa zea***	Bt Cry 1 Ac **cotton**	USA	2010

PINK BOLLWORM RESISTANCE TO BOLLGARD-II

Resistance to Cry1Ac



Resistance to Cry2Ab



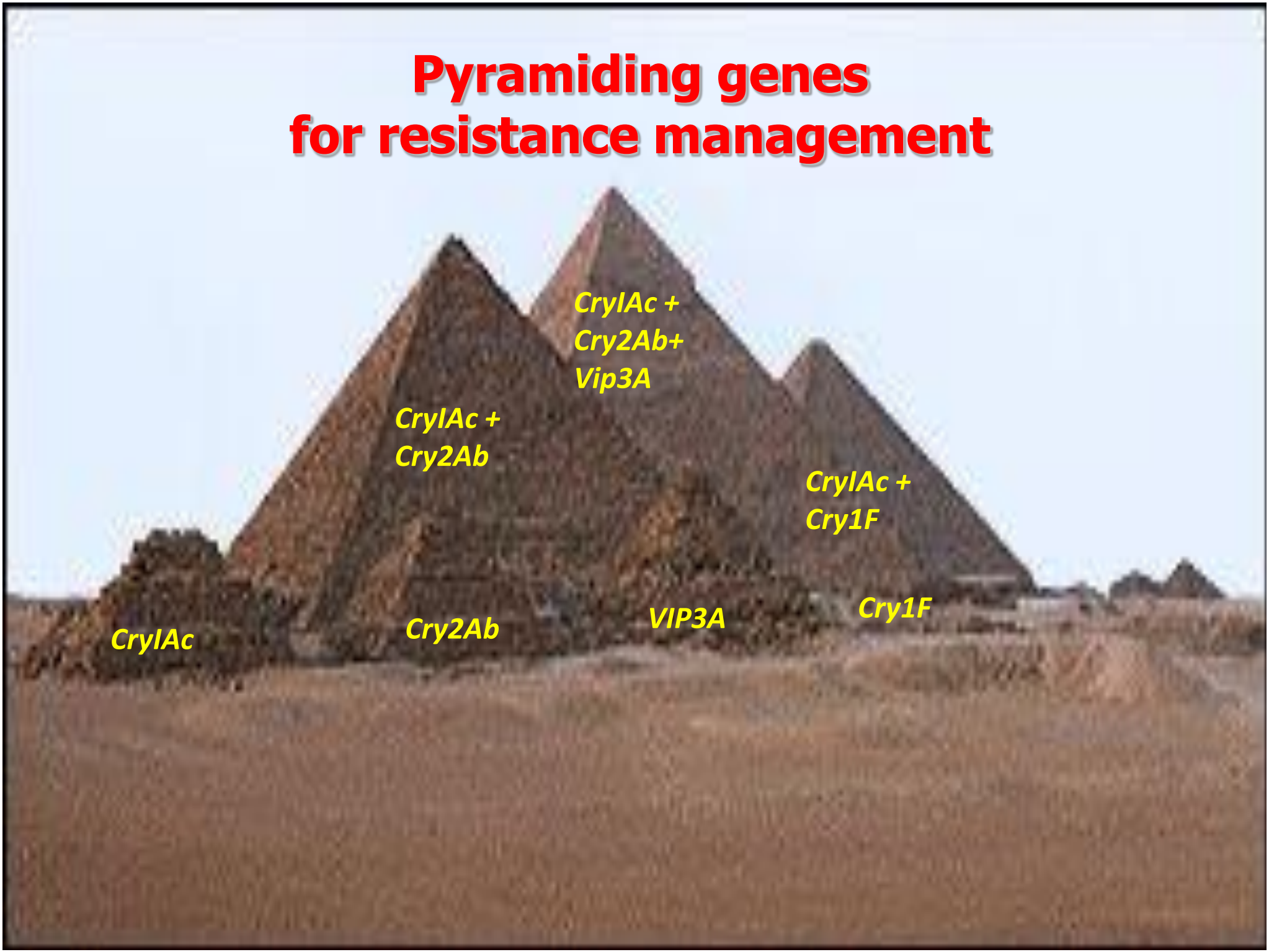
ICAR-CICR data unpublished

Minor Pests Became Major Pests






Pyramiding genes for resistance management



Decoding the Cotton Genome

Gossypium raimondi (D_5)

775 Mb *Wang et. al 2012, Patterson et al., 2012*

Gossypium arboreum (A_2)

1694 Mb *Li et al., 2014*

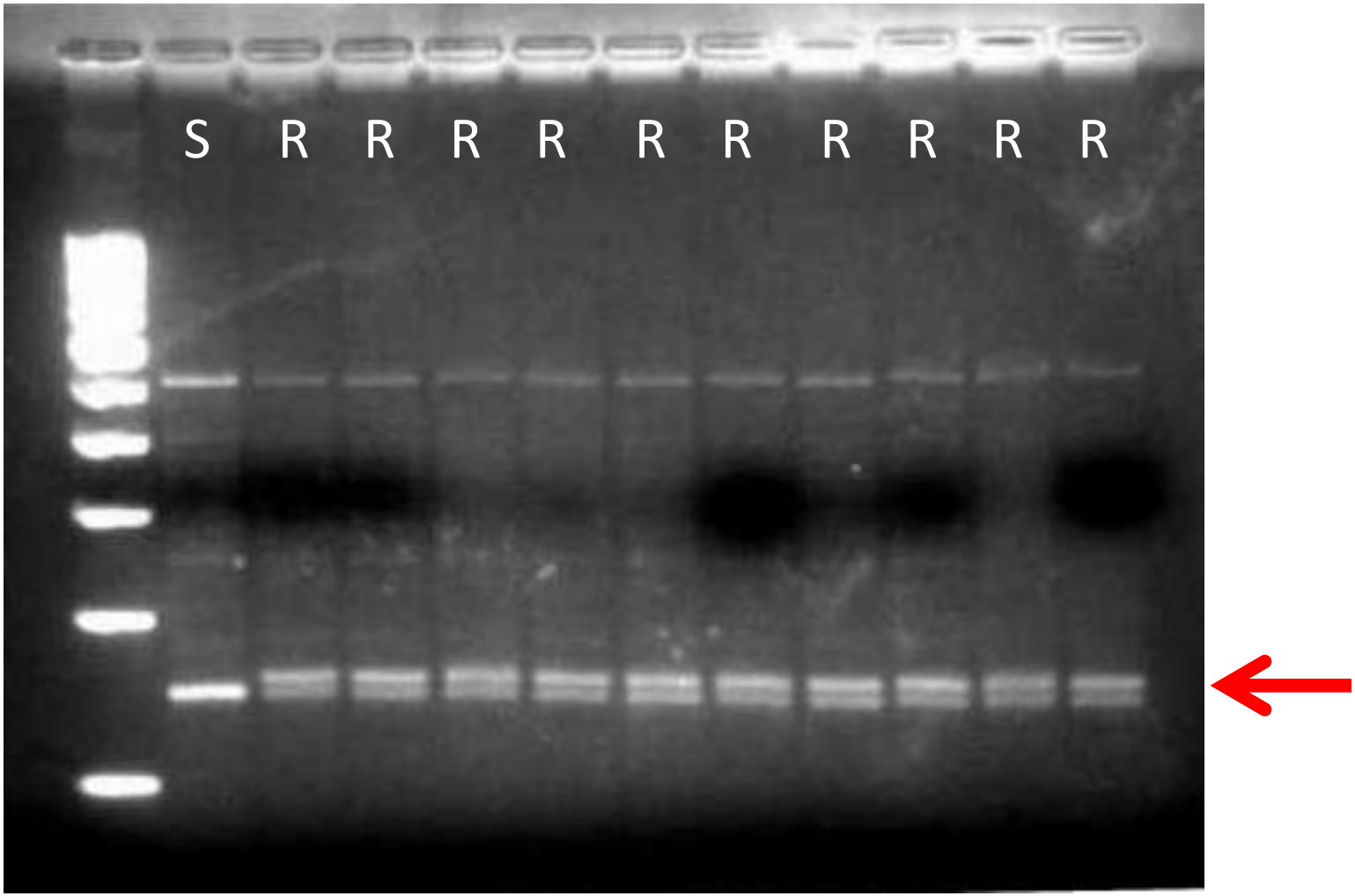
Gossypium hirsutum (AD)

2400 Mb *Li et al., 2015; Zhang et. al 2015*

Marker Assisted Breeding

for Bacterial Leaf Blight Resistance

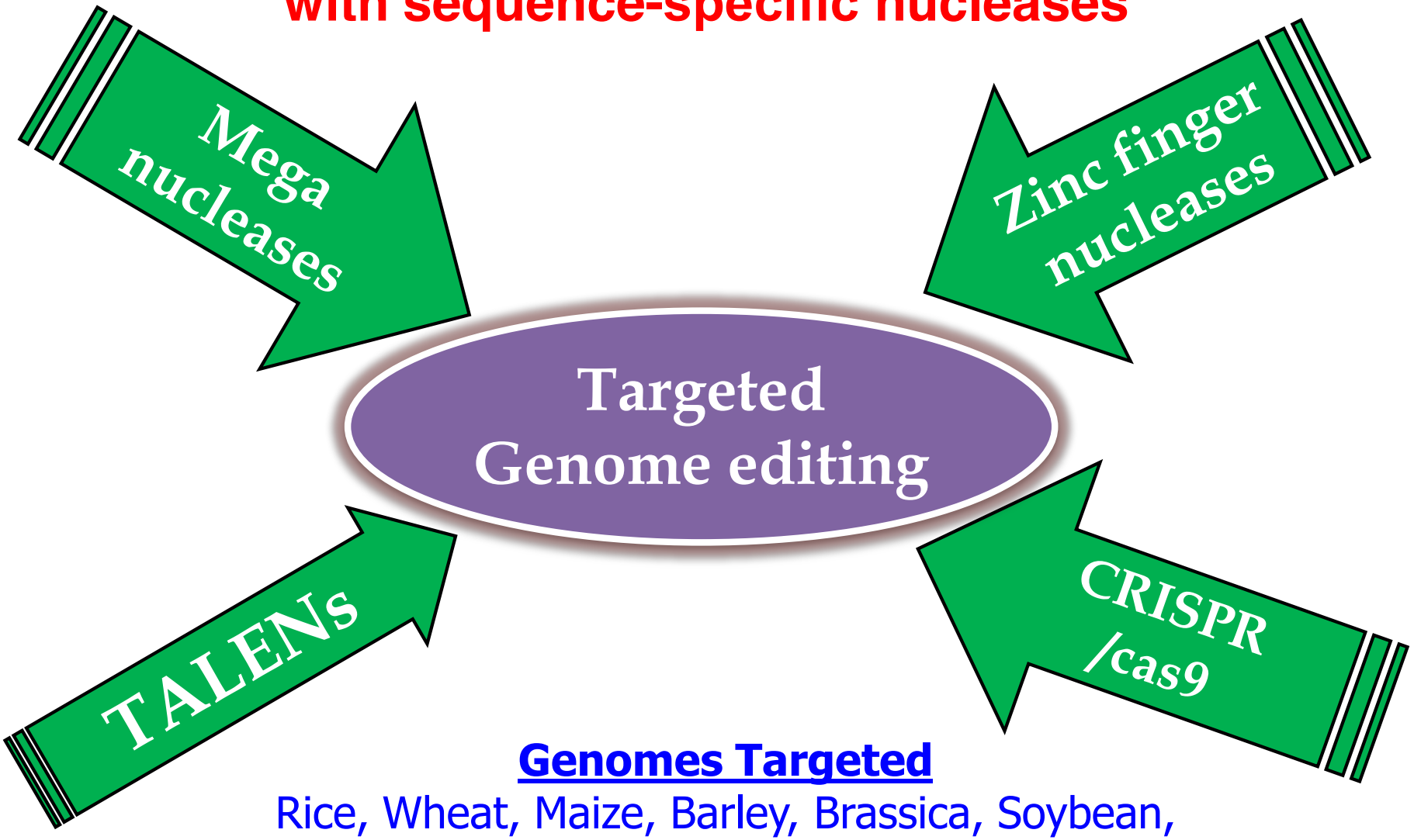
CIR 246 Marker



EXCITING GENE EDITING TOOLS

New Technologies

Targeted Genome editing with sequence-specific nucleases



Genomes Targeted

Rice, Wheat, Maize, Barley, Brassica, Soybean, **COTTON,** Arabidopsis and tobacco

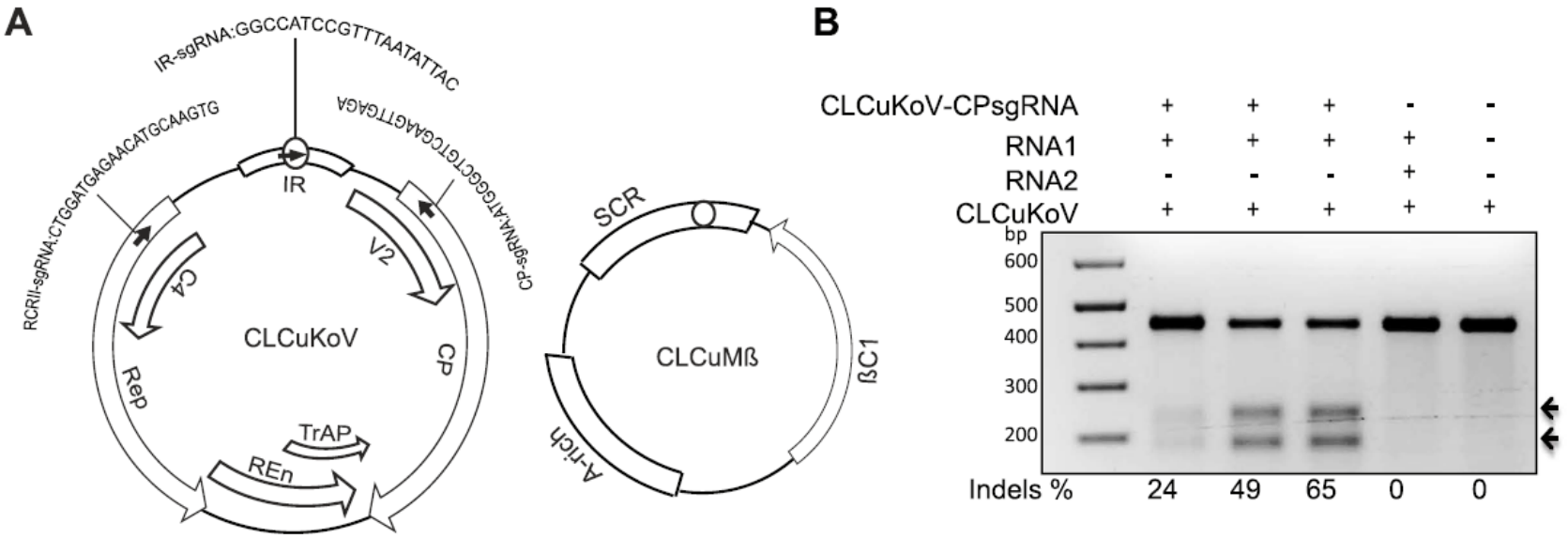
SCIENTIFIC REPORTS

OPEN

CRISPR/Cas9-Mediated Immunity to Geminiviruses: Differential Interference and Evasion

Received: 18 March 2016

Zahir Ali, Shakila Ali, Manal Tashkandi, Syed Shan-e-Ali Zaidi & Magdy M. Mahfouz



Medicine

The Nobel Prize in Physiology or Medicine 2006

"for their discovery of RNA interference - gene silencing by double-stranded RNA"

Photo: L. Cicero

Andrew Z. Fire

Stanford University
School of Medicine
Stanford, CA, USA

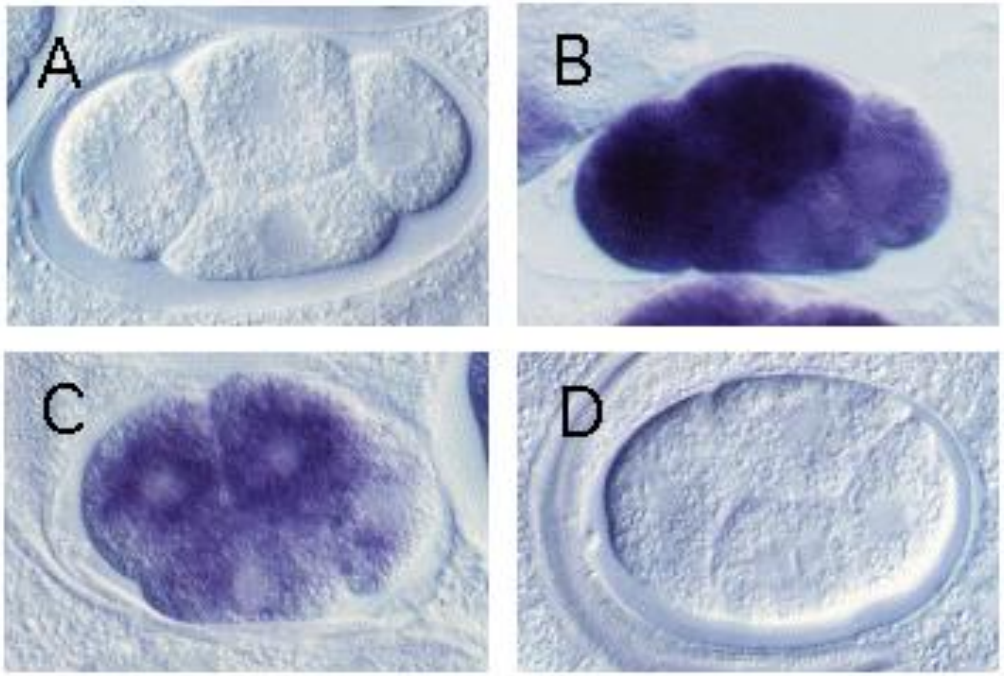
Photo: J. Mottern

Craig C. Mello

University of
Massachusetts Medical
School
Worcester, MA, USA

Potent and specific genetic interference by double-stranded RNA in *Caenorhabditis elegans*

Andrew Fire*, SiQun Xu*, Mary K. Montgomery*,
Steven A. Kostas*†, Samuel E. Driver‡ & Craig C. Mello‡



A. Negative control
B. Normal pattern of endogenous *mex-3* RNA
C. Injected with purified *mex-3* antisense RNA
D. Injected with dsRNA corresponding tp *mex-3*

Nature Vol 391, February 1998

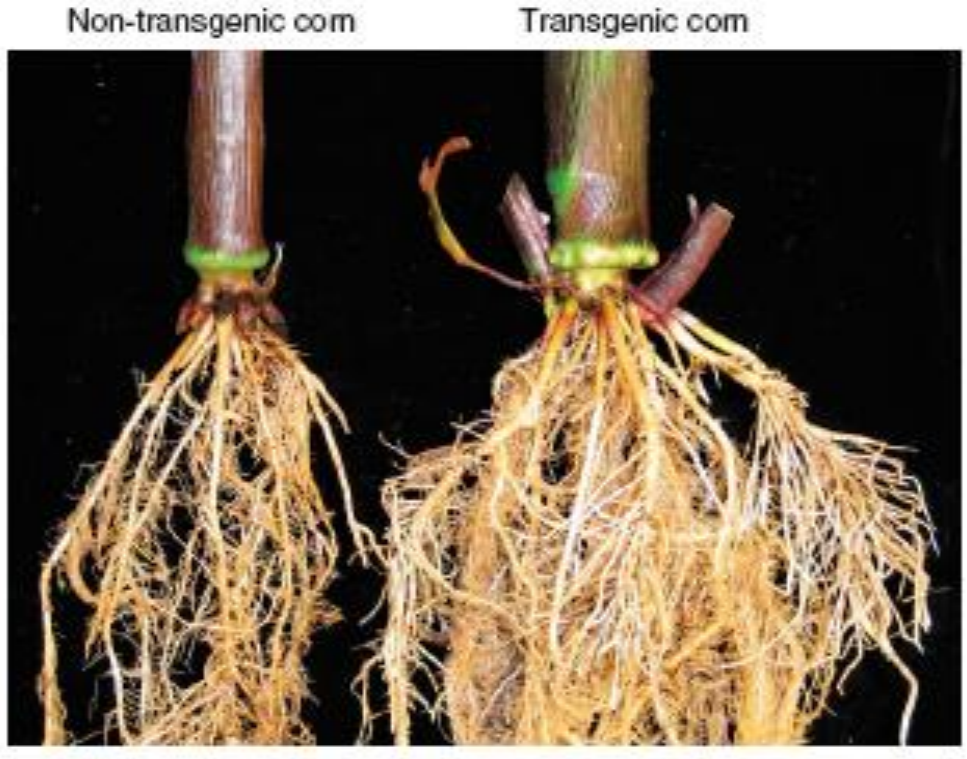
Long shelf life GM Tomato

Gene silencing kills insects

nature biotechnology Volume 25 NOVEMBER 2007

Control of coleopteran insect pests through RNA interference

James A Baum[1], Thierry Bogaert[2], William Clinton[1], Gregory R Heck[1], Pascale Feldmann[2], Oliver Ilagan[1], Scott Johnson[1], Geert Plaetinck[2], Tichafa Munyikwa[1], Michael Pleau[1], Ty Vaughn[1] & James Roberts[1,3]



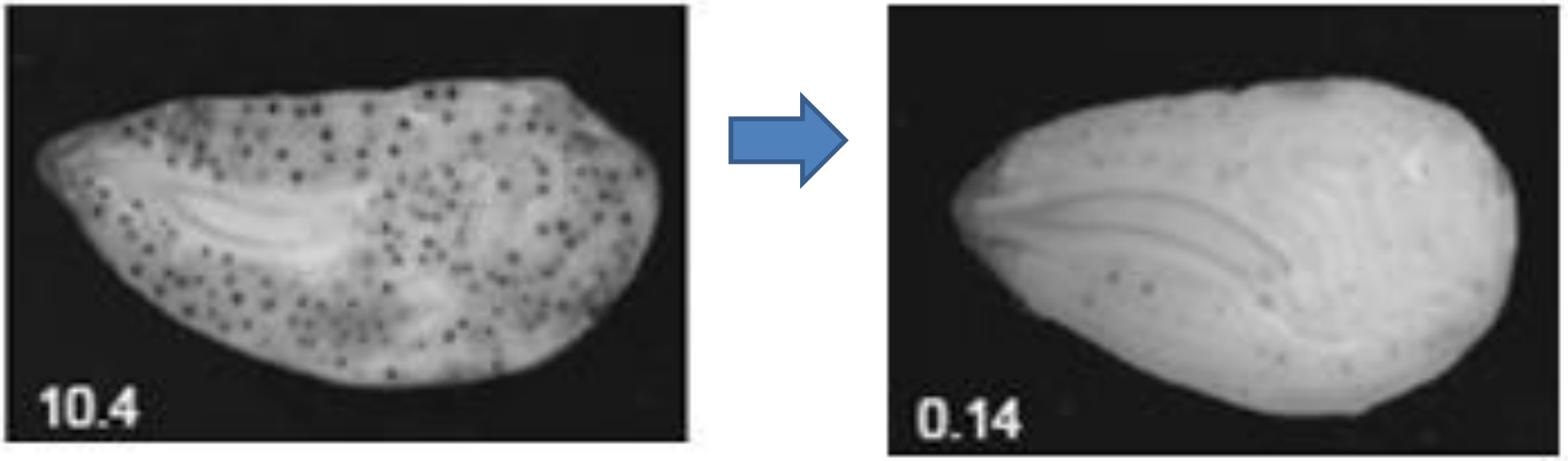
Gene silencing starves bollworms

nature biotechnology Volume 25 NOVEMBER 2007

Silencing a cotton bollworm P450 monooxygenase gene by plant-mediated RNAi impairs larval tolerance of gossypol

Gossypol Reduction in seeds

Dr Kirthi Rathore, Texas 2006



Future GM Cotton fibers using silk genes from silkworm, *Bombyx mori* and spider *Araneus* sps.

Spider silk: 5 times stronger than steel, twice as elastic as nylon. water proof and stretchable

Silkworm silk: 5-10 times more extensible than cellulose. Better thermal properties

A pencil thick spider silk strand can stop a boeing 747 in flight !!

A Few Exciting Examples

Ringspot-Virus resistant GM papaya

by over-expression of the virus coat protein

Drought Resistant GM Cotton Maize and Tomato

Salt-Resistant GM Tomato crop

GM Wheat and Cotton that scare aphids

Rothamstead Station UK

Aphid alarm pheromone produced by transgenic plants affects aphid and parasitoid behavior

Michael H. Beale, Michael A. Birkett, Toby J. A. Bruce, Keith Chamberlain, Linda M. Field, Alison K. Huttly,

Some more exciting examples

ARTICLE

Received 5 Nov 2013 | Accepted 30 Jan 2014 | Published 25 Feb 2014

DOI: 10.1038/ncomms4353 OPEN

A plant factory for moth pheromone production

Bao-Jian Ding[1], Per Hofvander[2], Hong-Lei Wang[1], Timothy P. Durrett[3], Sten Stymne[2] & Christer Löfstedt[1]

Male-sterile insects

ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in Insect Science

Back to the future: the sterile insect technique against mosquito disease vectors

Rosemary Susan Lees, Jeremie RL Gilles, Jorge Hendrichs, Marc JB Vreysen and Kostas Bourtzis

Traceability issues
GM detection issues

Cotton Fibre typing
Applied DNA Sciences

DNA/RNA detection 30 minutes
Loop-Mediated Isothermal Amplification (LAMP)

Chem. Soc. Rev., 2013, 42, 8649–8682 | 8649

OPTICAL NOSE

Themed issue: Chemical and biological detection

ISSN 0306-0012

RSC Publishing

The Royal Society of Chemistry 2013

REVIEW ARTICLE

Jon R. Askim, Morteza Mahmoudi and Kenneth S. Suslick

Optical sensor arrays for chemical sensing: the optoelectronic nose

Conventional Science plays a major role

VARIETAL TRAITS

1. Short duration (140-160 days)
2. High harvest index
3. Resistance to sucking pests
4. High ginning%
5. Amenable for high density

Canopy management

Plant training practices are done for canopy management and also to facilitate nutrients to be redirected to fruiting parts.

- **Restricting plant height:**

Aeration and ventilation in the high density crop is ensured by controlling the plant height to 65-70 cm. 100% compliance

- **Topping:** 100% compliance
- **Removal of vegetative branches:**

Compliance in 50-70% of the farms

- **Removal of unproductive plant parts:**

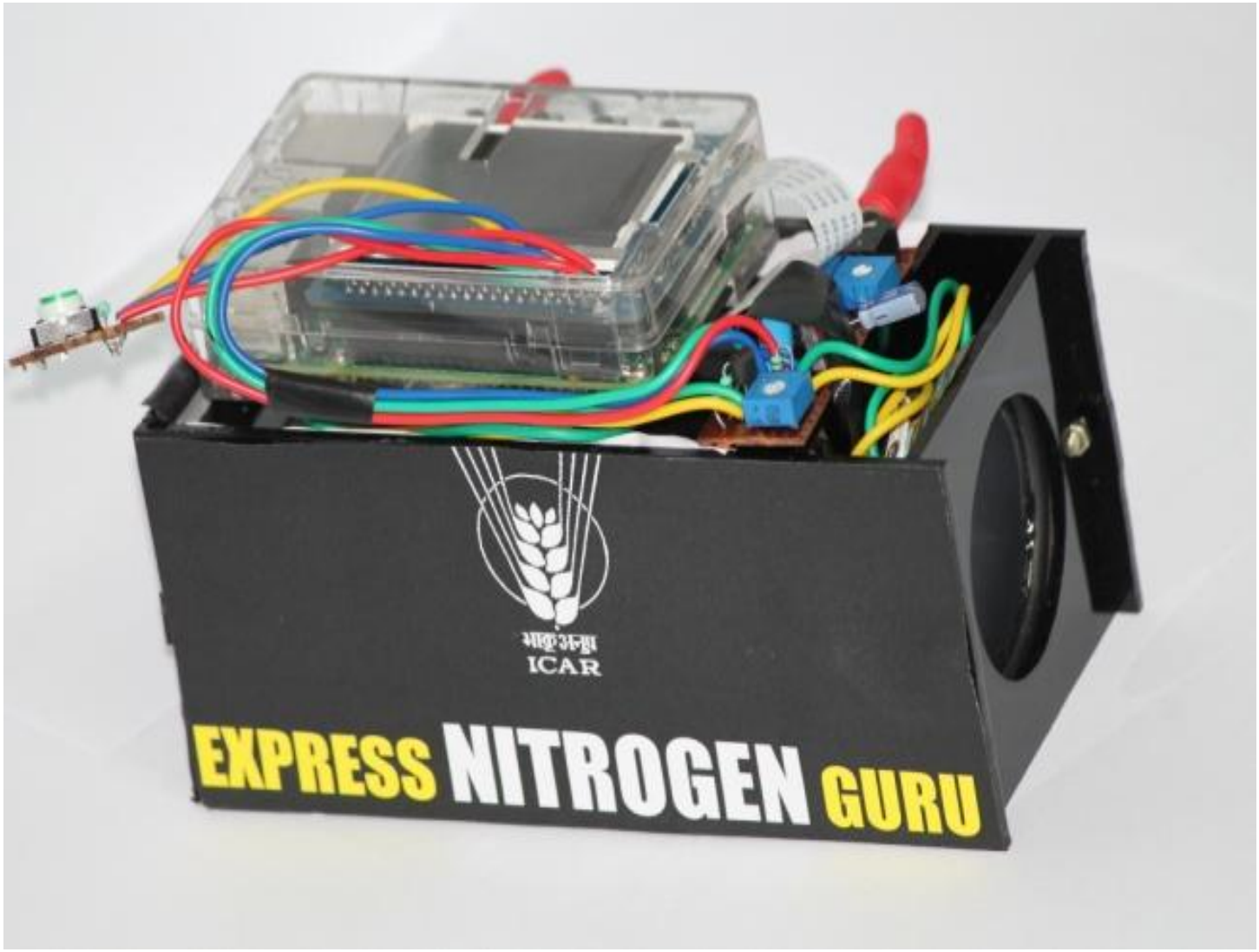
100% compliance

- **Removal of early fruiting branches:**

100% compliance

- **Bt-cotton in local varieties:**

Bt-cotton technology is introduced into the locally adapted varieties for effective bollworm protection.



Mobile hand-held device.
Voice advisory in 10 languages

Fungus inside plants kills insects

Special section:

Entomopathogenic fungi as endophytes: plant–endophyte–herbivore interactions and prospects for use in biological control

Stefan Vidal[1,*] and Lara R. Jaber[2]

[1]Georg-August-Universität Göttingen, Department of Crop Protection, Agricultural Entomology, Grisebachstrasse 6, 37077 Göttingen, Germany
[2]Department of Plant Protection, Faculty of Agriculture, University of Jordan, Amman 11942, Jordan

Discovery of new biological control

Fusarium pallidoroseum

Anthocoris sp

M. anisopliae

Promuscidea unfasciativentris **(Chalcidodea: Aphelinidae) and** ***Aenasius sp.*** **(Chalcidodea: Encyrtidae) Parasitization ranged from 20-70%**

Management




Conservation Agriculture

Biological -Soil nutrient and health enhancement

Cropping systems: Cereals-Legumes/pulses-Fodder

Use Biotech to the best potential

Short duration varieties

Early sowing

Judicious fertilizers

Conserve Natural control

Intercropping for IPM

USE IPM STRATEGIES

Thank You