Best Practices for High Yields in Australia

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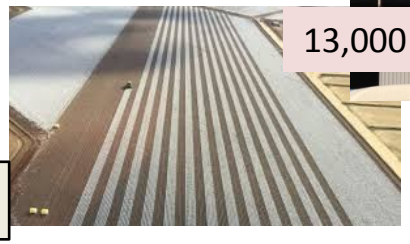
Australian Cotton Farming in 2016-17

	2016-17
Production	1,071,800 MT 4.7 mill bales
Total cotton area	460,000 ha
Number of farms	1,250
Average farm size	331 ha
Average lint yield	2,330 kg/ha
Gross income per farm	$2.03 mill

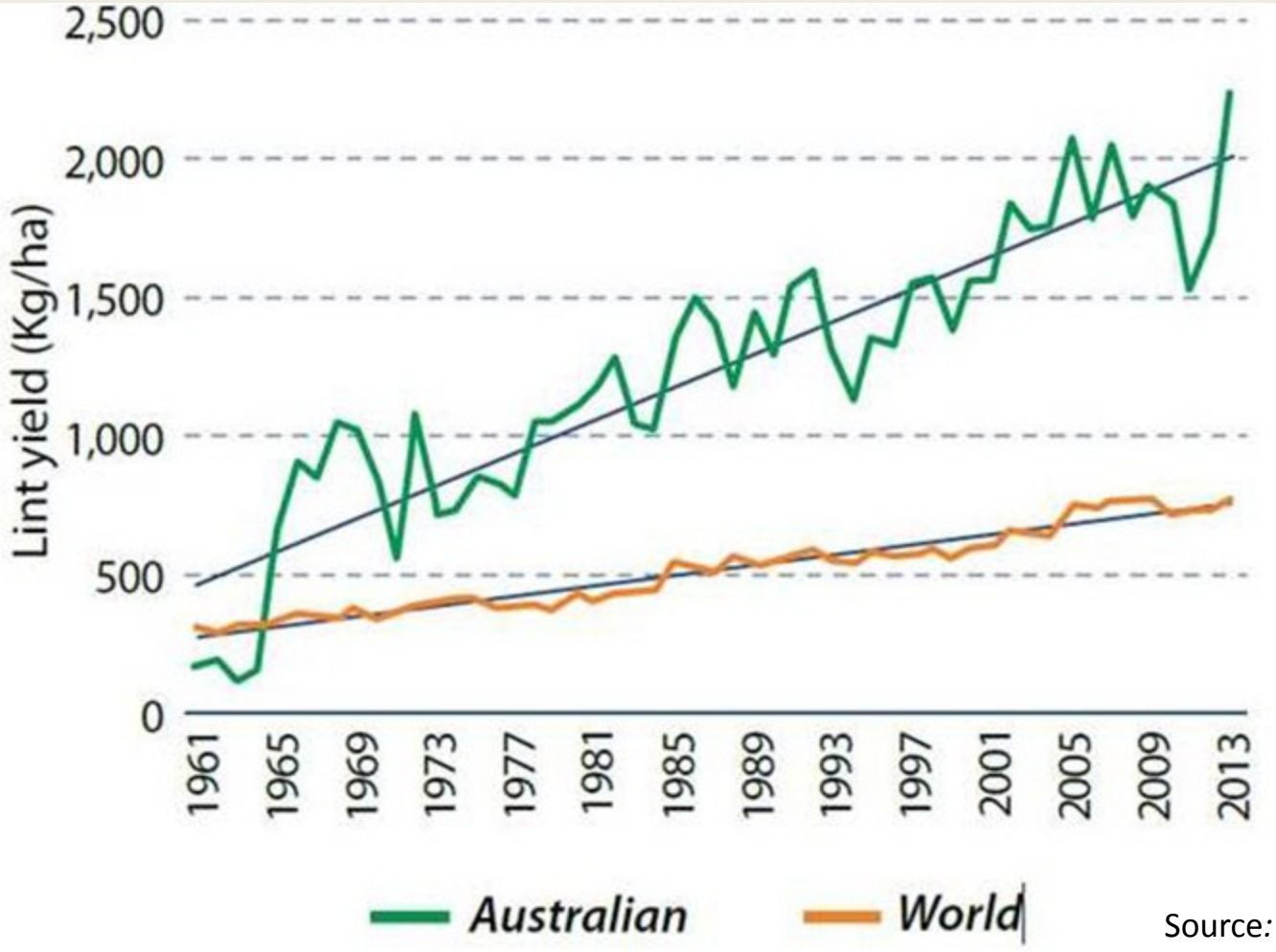
2/3rd in New South Wales
1/3rd in Queensland

13,000 ha cotton

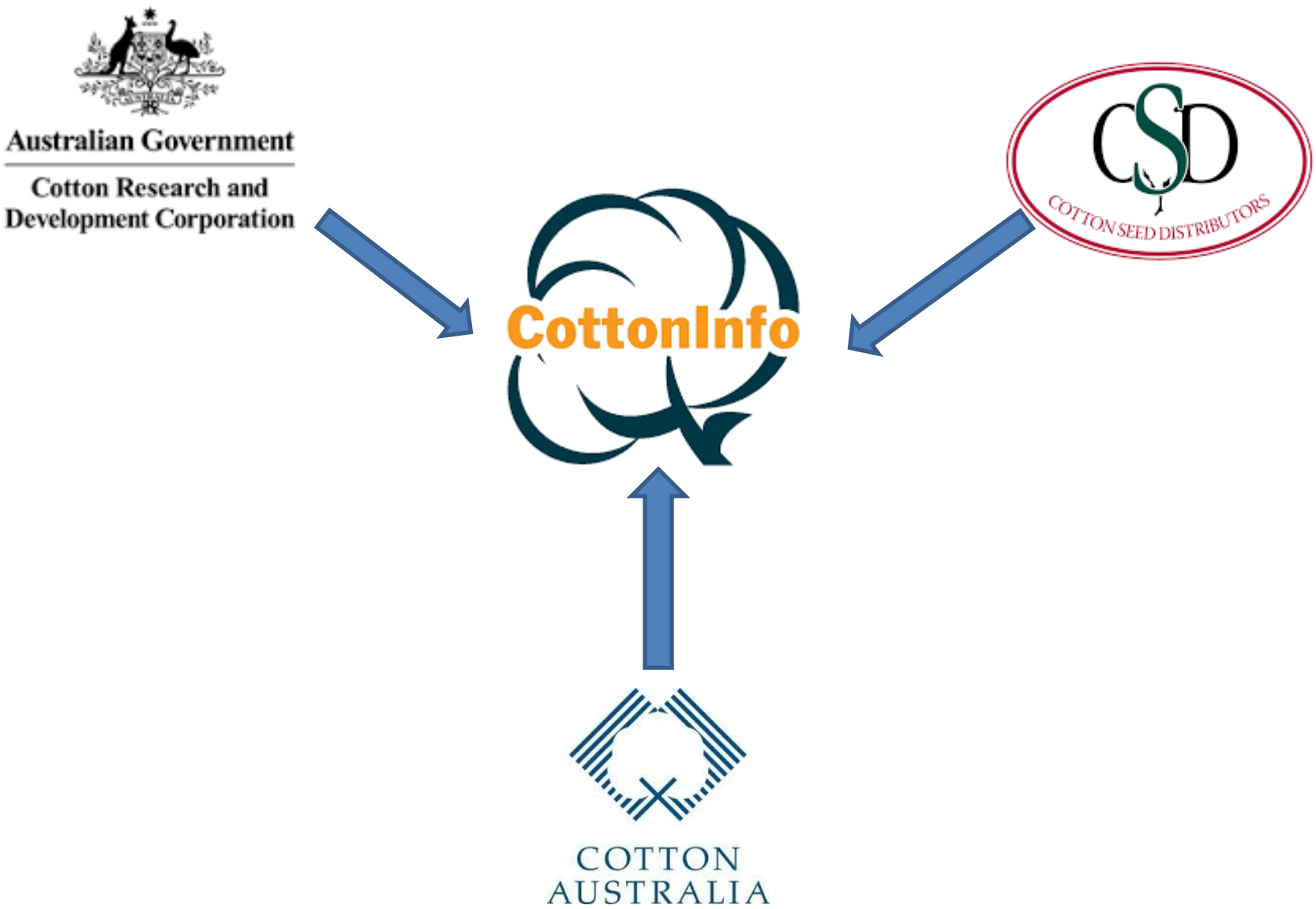


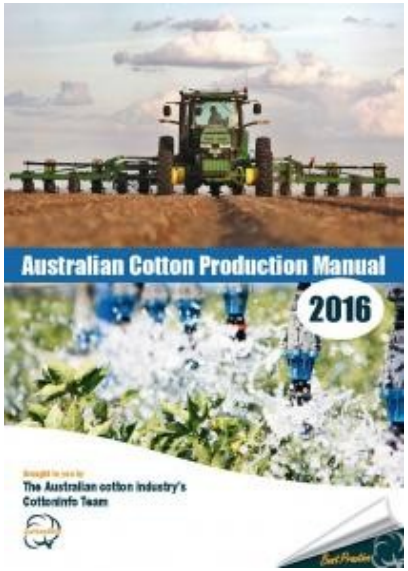
20% dryland 80% irrigated

Average cotton yields for Australia and the World 1961 to 2013

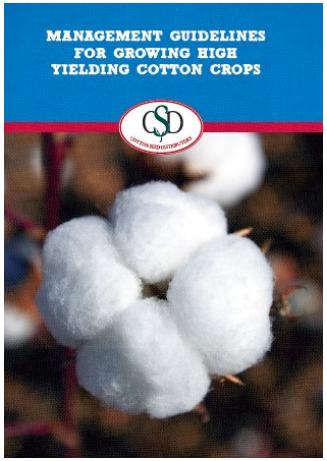


Source: *Liu et al (2013) CSIRO Plant Industry, Narrabri*


Australian Government
Cotton Research and Development Corporation
CottonInfo
CSD
COTTON SEED DISTRIBUTORS
COTTON AUSTRALIA



www.crdc.com.au/publications



www.csd.net.au

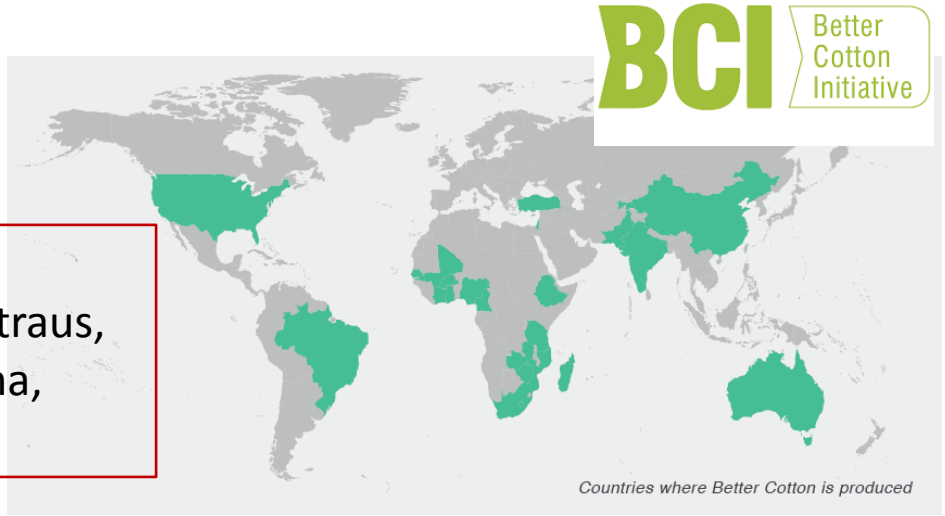
CottonInfo

www.austcottonshippers.com.au

2/3rds of Australian growers are registered - ¼ of those are certified

Global – Better Cotton Initiative

Members:
Tesco, Waitrose, Tommy Hilfigger, Levi Straus, Marks and Spenser, Net, Gap, IKEA, Puma, John Lewis, Adidas, H&M, Nike etc



1.5 mill
Licensed BCI Farmers

3.5 mill ha
under Better Cotton

2.5 mill MT
Better Cotton lint produced

Funders:
USAID, WWF, SIDA, German Federal Ministry of Econ. Co-op. and Dev., Netherlands Ministry of Foreign Affairs, IDH etc.

12%
Of global production

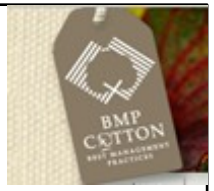
23
countries
5
continents

Source: *www.bettercotton.org*

Australian BMP Module

- Biosecurity
- Energy and input efficiency
- Fibre quality
- Human resources and work health and safety
- Integrated Pest Management
- Sustainable landscape management
- Pesticide management
- Petrochemical storage and handling
- Soil health
- Water management
- Ginning
- Classing

Process



- Grower registers
- Support from *MyBMP* team
- Self audit on-line
- Request audit
- Auditor visits farm
- Audit reviewed
- Accreditation (5yrs)

Accredited cotton

- Can be sold as *Better Cotton (+c.$3/bale)*
- Traceable through ginners, spinners, knitters etc – *all have to register*
- Fabric/garment can display BMP label

Checklist against Standards

Level: 1. Legal requirement **(*What you must do*)**

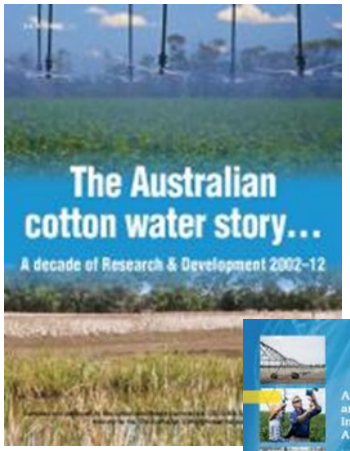
2. Industry Best Practice **(*What you should do*)**

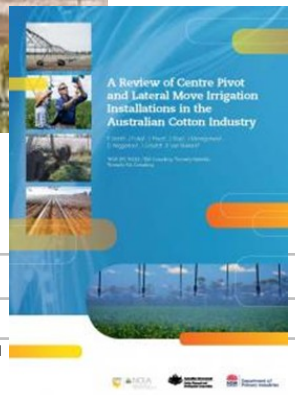
3. Innovative **(*cutting edge*)**

Source*: MyBMP*

Water Management

This module is designed to help you make efficiency gains by bringing together the latest research and knowledge on water use and management. Topics range from managing and measuring water sources and collection (storages, bores, overland flow and stored soil moisture) through to field distribution.
All aspects of water application are covered including surface irrigation, centre pivot and lateral moves, drip irrigation as well as dryland water usage.





Once you have completed this module to at least Level 2, you will have achieved the following:

- Used available tools to schedule your irrigations and monitor soil water levels;
- Estimated your soils capacity to hold and store water for your fields and soil types;
- Estimated your losses from storages and channels;
- Maintained your storages to minimise leaks and seepage;
- Maximised crop yields by understanding and managing bore water quality;
- Identified problem areas in irrigation fields;
- Matched your flow rates to soil, slope and run length so furrows come out evenly;
- Planned for and installed your centre pivot or lateral move with a professional so it works effectively;
- Ensured your drip irrigation system is operating effectively.

Resources

Title	Description		
A guide to dryland cotton	An overview of growing dryland cotton		
A Review of Centre Pivot and Lateral Move Irrigation Installations in the Australian Cotton Industry	Centre Pivot and Lateral Move continue to be favoured by growers for their potential to save water and labour, to maximise rainfall capture and minimise waterlogging and to provide soil health advantages through stubble retention and minimum tillage		
APSoil	APSoil is a database of soil water characteristics enabling estimation of Plant Available Water Capacity for individual soils and crops		Link
Australian CliMate- Climate tools for decision makers	CliMate allows you to interrogate climate records to ask questions relating to rainfall, temperature, radiation, and derived variables such as heat sums, soil water and soil nitrate, and well as El Nino Southern Oscillation status		Link
Become a certified irrigation Professional	By becoming certified, you'll be helping to lift the skills, knowledge, and standards of the whole industry		Irrigation Australia

IPM - Insects, Weeds and Diseases

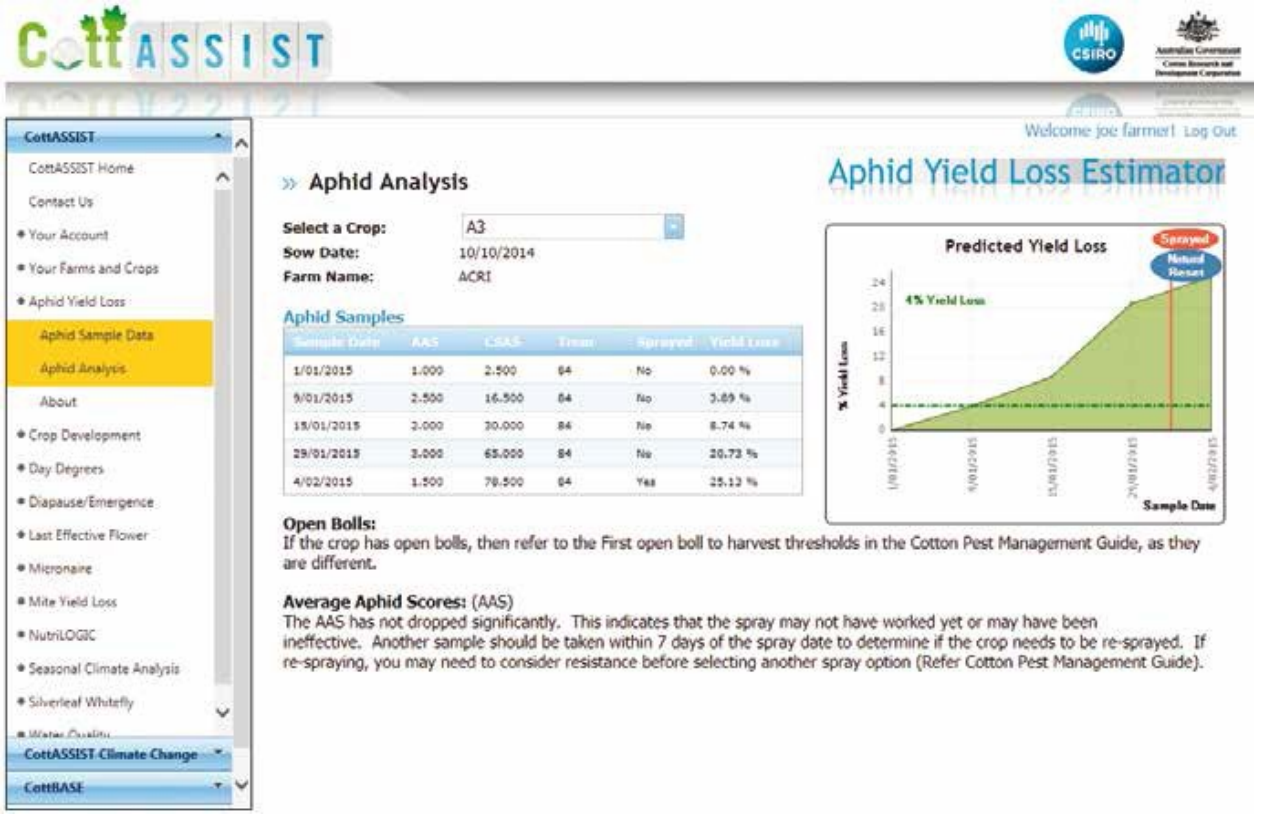
The key issues addressed in this module include:

- Monitor crops for disease and report unusual plant symptoms to Exotic Plant Pest Hotline - 1800 084 881
- Practice good integrated disease management at planting, crop and post harvest
- Practice good farm hygiene (Come Clean Go Clean) to minimise spread of pests, weeds and disease onto and off your farm
- Adhere to terms and conditions for Bollgard II® Resistance Management Plan, Roundup Ready Flex® and Liberty Link®
  Crop Management plans
- Pest control decision based on pest and beneficials correctly sampled and identified, adherence to Insecticide resistance Management Strategy (IRMS) and impact on beneficials and bees
- Correctly identify weeds and monitor weeds after herbicide applications
- Weed control decisions are based on weed species/growth stage Herbicide Resistance Management Strategy (HRMS) and rotating herbicide modes of action
- Practice good integrated weed management on the whole farm including multiple weed control methods are used in crop, fallow, rotations, and non-crop areas to manage weed burdens and herbicide resistance
- Management of volunteer and ratoon cotton plants through the year in crop and non-cropping areas

Example: Aphid yield loss estimator web tool

Includes:

- detailed sampling method to be followed
- sequential data entry protocols
- action thresholds
- options for control



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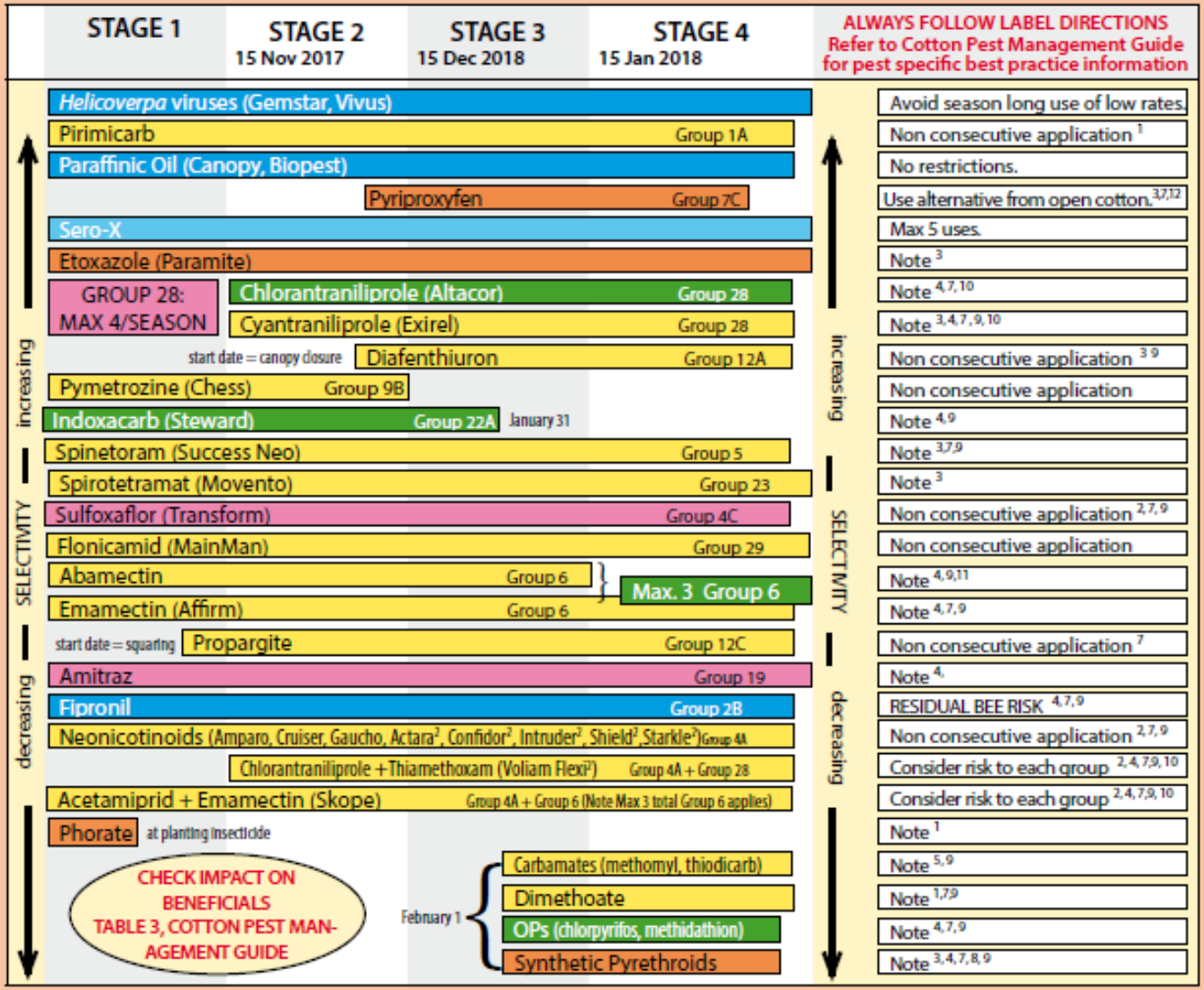
Cotton IRMS

INSECTICIDE RESISTANCE MANAGEMENT STRATEGY 2017/18

BEST PRACTICE PRODUCT WINDOWS AND USE RESTRICTIONS TO MANAGE INSECTICIDE RESISTANCE IN APHIDS, SILVERLEAF WHITEFLY, MITES AND HELICOVERPA SPECIES.

Northern Regions: Belyando, Callide, Central Highlands, Dawson



Source:
Cotton Pest Management Guide 2017-18
CRDC

Example: Bt cotton Resistance Management

Bollgard 3: In 2016-7 season 95% of Australian cotton changed to contain Bt Cry1Ac, Cry2Ab and Vip3A in high performance CSIRO varieties

Resistance monitoring by Cotton Australia and Monsanto

Helicoverpa armigera carry resistance genes:

Cry1Ac – 0.05%
Cry2Ab – 3%
Vip3A – 5%

TIMS – Transgenic and Insect Management Strategies Committee of Cotton Australia makes **Recommendations** for cropping regions

H.Armigera & H. punctigera

Managing resistance in Bt Cotton

Check List:

Level 1 Adhere to Resistance Management Practices (RMP) for Bollgard (II or 3) cotton to delay the development of Bt resistance:

- defined planting windows
- mandatory growing of refuges
- control of volunteer and ratoon cotton
- restrictions on the use of foliar Bt
- pupae busting as required (according to current industry guidelines for your region and field defoliation dates)

These RMP are in accordance with the terms and conditions of the Technology User Agreement (TUA)

Level 1 Bt cotton is managed in accordance with the terms and conditions of the Technology User Agreement (TUA)

Level 2 The refuge is managed to ensure healthy plants attract Helicoverpa spp. for the entire growing season

Level 3 Pupae busting of all Bt cotton fields regardless of defoliation date

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Detail: Bollgard 3 Crop **refuge** management in Central Queensland

SCHEDULE B – RESISTANCE MANAGEMENT PLAN FOR BOLLGARD 3 COTTON 2017–18

End of season management of refuges/trap crops

End of season pupae busting practices are not effective in the Central Queensland region as Helicoverpa are less likely to diapause. A late summer trap crop (pigeon pea) must be planted for all Bollgard 3 cotton grown in Central Queensland. The planting configuration of the trap crop should be the same as that of the Bollgard 3 crop. Irrigated Bollgard 3 must have an irrigated trap crop. Table 5 shows the requirements for the late summer pigeon pea trap crop. Dryland Bollgard 3 growers who do not have any irrigated cotton on their farm should contact Monsanto Australia for alternative options.

Refuge and late summer trap crops have different purposes. Where a pigeon pea refuge is utilised, the full pigeon pea refuge area must be managed to become the late summer trap crop. If unsprayed cotton is used as the refuge, an additional area of 1 per cent pigeon pea must be planted as the late summer trap crop. Requirements for late summer trap crops are detailed in Table 5.

TABLE 5: Late summer pigeon pea trap crop requirements in Central Queensland

Criterion	Trap crop*
Minimum area & dimension (Requirement)	A minimum trap crop of 1% of planted Bollgard 3 cotton crop is required. If sprayed conventional cotton is grown on that farm unit: the trap crop must be at least 48m x 48m. If no sprayed conventional cotton is grown on that farm unit: the trap crop must be at least 24m x 24m.
Planting time	The trap crop should preferably be planted 4 weeks after the associated Bollgard 3. Note: If growers choose to plant their trap crop to coincide with the planting of pigeon pea refuges, they must manage the trap crop in such a way that it remains attractive to Helicoverpa 2–4 weeks after final defoliation.
Planting rate**	35 kg/ha (recommended establishment greater than 4 plants per metre)
Insect control	The trap crop can be sprayed with virus after flowering, while avoiding insecticide spray drift, except where a pigeon pea refuge is converted to a trap crop. In this case the full 5% pigeon pea refuge area managed to become the late summer trap crop can only be sprayed with virus after the first defoliation of Bollgard 3 cotton.
Irrigation	The refuge/trap crop must be planted into an area where it can receive the additional irrigation required to keep the trap crop attractive to Helicoverpa until after the cotton is defoliated.
Weed control	The trap crop should be kept free of weeds and particularly volunteer Bollgard 3 cotton. When using the full pigeon pea refuge area as the trap crop, weed control must not be carried out by cultivation once flowering of the associated Bollgard 3 cotton crop has commenced.
Crop destruction	The trap crop must be destroyed 2–4 weeks (but not before 2 weeks) after final defoliation of the Bollgard 3 cotton crop, (slash and pupae bust – full soil disturbance to a depth of 10 cm across the entire trap crop area). All Bollgard 3 and associated trap crops must be destroyed by July 31.

*A pigeon pea trap crop is to be planted so that it is attractive (flowering) to Helicoverpa after the cotton crop has cut out, and as any survivors from the Bollgard 3 crop emerge. Planting pigeon pea too early (e.g. before November) or too late (e.g. mid December) is not adequate for cotton crops planted during September through to October.
**The planting rate is a recommendation based on a minimum of 85% seed germination.

Failed crops – all regions

Bollgard 3 crops that will not be grown through to harvest for various reasons and are declared to, and verified by, Monsanto as failed must be destroyed within two weeks after verification, in such a way that prevents regrowth. Crops that are abandoned before February 28 should be slashed and mulched within 4 weeks

Source:
Cotton Pest Management Guide 2017-18
CRDC

Detail: Bollgard 3 Crop **refuge** management in Central Queensland

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Source:
Cotton Pest Management Guide 2017-18
CRDC

Detail: Herbicide recommendations for Pigeonpea as Bt cotton refuge

TABLE 22: Herbicides available for use in pigeon pea (registered or permit number Per13758)

Active Ingredient	Mode of Action	Concentration and formulation	Application rate of product	Comment
Prometryn*	C	500 g/L CS	Apply up to 4.5 L/ha	Apply up to the maximum rate pre planting and incorporate, or as a post-emergent directed spray towards the base of established plants (Per13758)
		900 g/kg WDG	Apply up to 2.5 kg/ha	
Trifluralin	D	480 g/L EC*	Apply up to 2.3 L/ha	Apply up to the maximum rate pre planting and incorporate.
		530 g/L EC	Apply up to 1.5 L/ha	NSW and ACT only.
		600 g/L EC	Apply up to 1.4 L/ha	NSW and ACT only.
Butroxydim *	A	250 g/L WDG	Apply 180 g/ha	Apply the specified rate as a post-emergence spray over the top of the pigeon pea crops. Refer to label as rates are different depending on weed being controlled. (Per13758)
Fluazifop-p*	A	212 g/L EC	Apply 1 L/ha	
		128 g/L EC	Apply 1.6 L/ha	
Haloxyfop*	A	130 g/L	Apply 0.6 L/ha	
Haloxyfop*	A	520 g/L EC	Apply 0.150 L/ha	
Sethoxydim*	A	186 g/L EC	Apply 1 L/ha	Apply specified rate as a post-emergence spray over the top of the pigeon pea crops. (Per13758)
Clethodim*	A	240 g/L EC	0.250–0.375 L/ha (2–3 leaf stage)	Always apply with D-C-trate at 2 L/100 L or Hasten or Kwickin at 1 L/100 L Uptake at 500 mL/100 L spray volume. The lower doses will provide effective control if applied under ideal conditions to weed that are smaller, actively growing and free from temperature or water stress. (Per13758)
Quizalofop*	A	99.5 g/L EC	0.25–1 L/ha (dependent on growth stage and species of weed)	Refer to permit for growth stages of species and critical comments. (Per13758)
Diquat	L	200 g/L AC and SL	2–3 L/ha	Harvest aid
Diquat/paraquat	L	115 g/L + 135 g/L SC	0.6–2.4 L/ha	Apply pre-sowing, in minimum 50–100 L water. Apply specified rates for certain weeds at particular growth stages, refer to label.
Pendimethalin	D	330 g/L EC	2.5–3 L/ha	Incorporate into the soil within 24 hours of application. Use higher rate on heavy textured soils or those high in organic matter. May be applied by aerial or ground spraying. In Macquarie Valley area, only apply by air when ground is too wet for ground application.
		435 g/L EC	1.9–2.3 L/ha	
		440 g/L EC	1.9–2.25 L/ha	
		455 g/L EC	1.8–2.2 L/ha	
		475 g/L EC	1.74–2.11 L/ha	
Metribuzin	C	480 g/L SC	0.750 L/ha	Furrow irrigated: apply after furrowing out, within 2 weeks before sowing and incorporate. For post-emergence: apply to actively growing seedling stage weeds provided crop plants have at least 2 trifoliate leaves. Do not spray if rain is likely to fall within several hours. Overhead irrigated: apply pre-emergence then irrigate.
		700 g/kg WG	0.47 kg/ha	
		750 g/kg WG	0.47 kg/ha	

*Use of these products is under permit (Per13758).

NOTE: Only apply to pigeon pea crops that are to be destroyed at the end of the season or to be harvested for seed for refuge replanting only. No crop product or crop residue is to be fed to livestock. Refer to all labels and permit conditions. Please go to www.apvma.gov.au to check allowable usages.

Source: *Cotton Pest Management Guide 2017-18 CRDC*

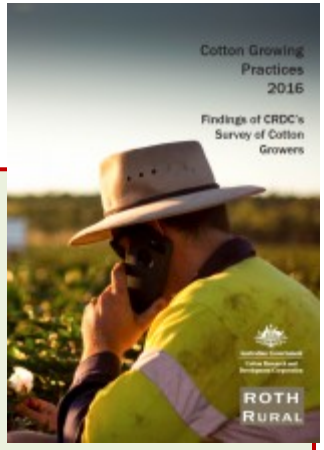
Does BMP work?

- **Yield averages:** Irrig: **2,815Kg/ha**
  Semi irrig: **1,453kg/ha**
  Dryland: **817kg/ha**

- **Water use efficiency : up 40%** 2001-2010
  (now 1/3 of global average water use/bale)

- **Insecticide use:** **down 92%** 2002-2016

BMP certified farmers getting $3/ bale price premium



Survey of Cotton Growing Practices (2016) CRDC

- 35% of farms host Industry research trials
- 85% use *CottonInfo* frequently
- 99% connect by internet
- 90% of growers are soil testing
- 81% of growers are measuring moisture at harvest (max. 12.5%)
- 51% using growth regulators early season and 73% at cut-out
- etc.etc.

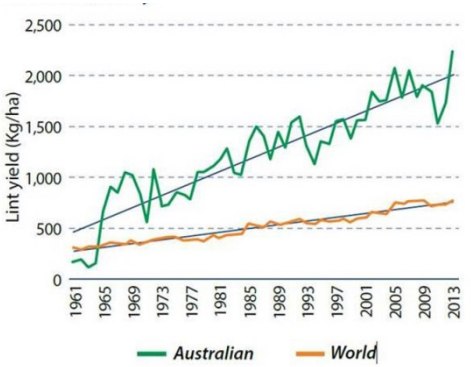
But……

- Bollgard II in 2002-3 reduced insecticide use by 85%

- Yield 18.3Kg yield inc./yr 1995-2009 was due to:
  - *48% cultivar*
  - *28% management*
  - *24% interaction cultivar/ management*

Source: *Liu S. et al. (2013) CSIRO Plant Industry, Narrabri*

Yield growth 1995-2013



CSIRO breeding (local germplasm from late 1980s) has provided:

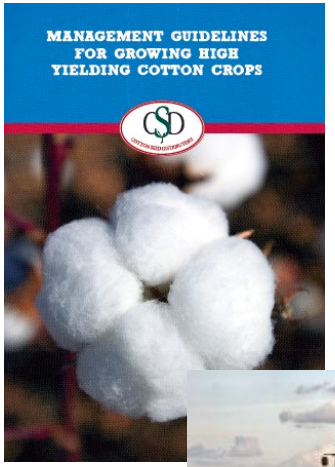
- Increased yield potential
- Improved length, strength and micronaire
- Okra leaf for whitefly, spider mite and bollworms
- Bacterial blight, Verticillium, cotton bunchy top resistance
- *Etc etc*

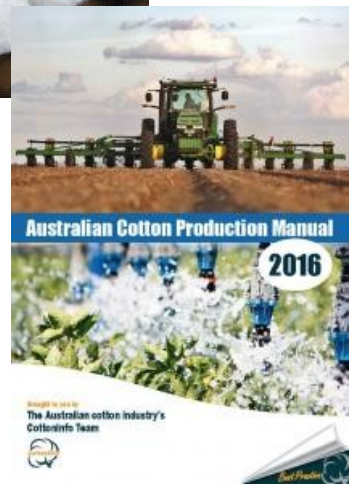
Source: *Stiller and Wilson DOI:10.5772/58414*

So……

BMP in Australia

- Is heavily promoted
- Is heavily adopted
- Is improving grower knowledge/ compliance
- Is providing environmental benefits
- Has grower financial benefits





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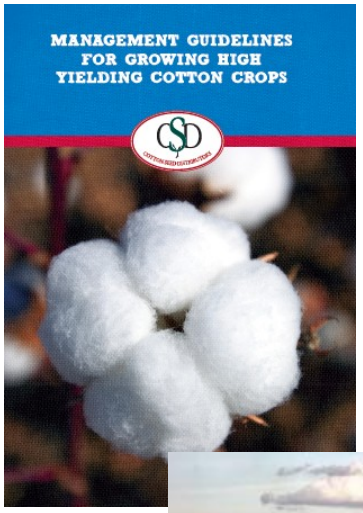
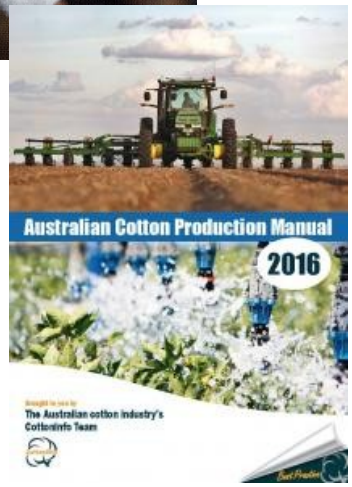


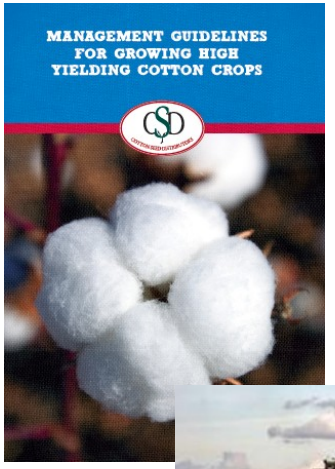


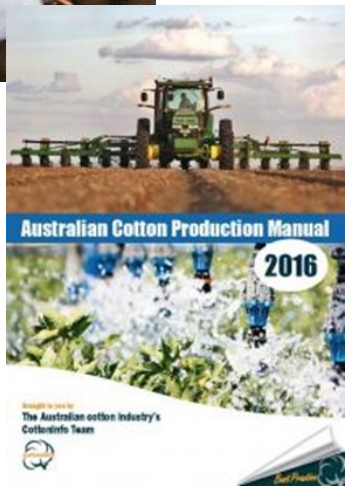
Is this BMP system transferable?

- *Probably only in highly capitalised, professionally managed systems with very strong technical and extension back up.*

So……

- **BMP in Australia**
  - Is heavily promoted
  - Is heavily adopted
  - Is improving grower knowledge/ compliance
  - Is providing environmental benefits
  - Has grower financial benefits





Is this BMP system transferable?

- *Probably only in professionally managed, highly capitalised systems with very strong, technical and extension back up.*

However…. *The information for each aspect of production MAY be useful*

Download at:

csd.net.au

crdc.com.au/publications

Thank You

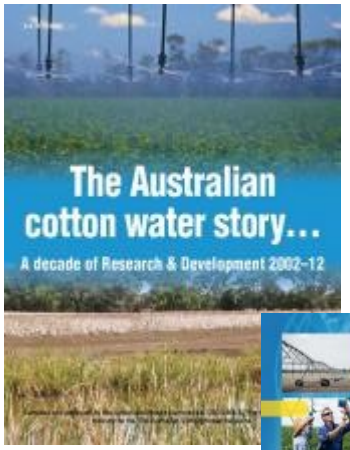
Acknowledgements:

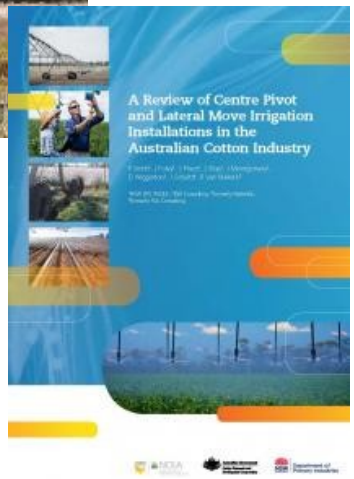
Cotton Research and Development Corporation
Cotton Australia
Cotton Seed Distributors
CottonInfo
*My*BMP

Australian Cotton Production Manual www.crdc.com/au/publications
Best Management Practices www.cottoninfo.com.au

Eg Water

80% irrigated – 2,815Kg/ha
20% dryland – 817 kg/ha





GM - Who developed what that is growing in Australia?

Crop	MONSANTO	BAYER	Dow AgroSciences
Canola	Herbicide tolerance	Herbicide tolerance	
Cotton	Herbicide tolerance Insect resistance	Herbicide Tolerance	Herbicide tolerance Insect resistance

CSIRO cotton varieties cover most of the area but the traits are from the multinationals

Source: OGTR

GM cotton growing areas of the World by 2013

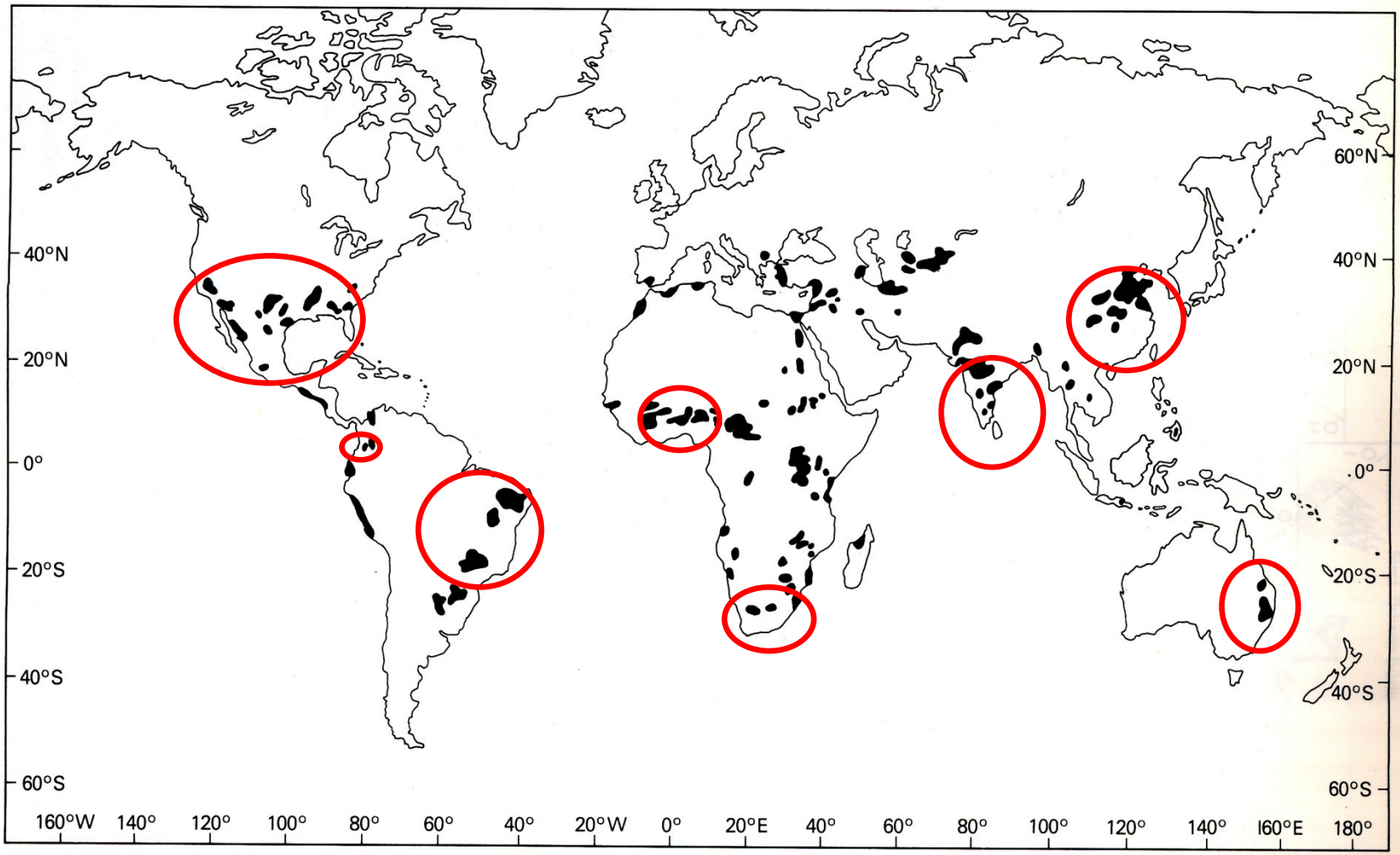
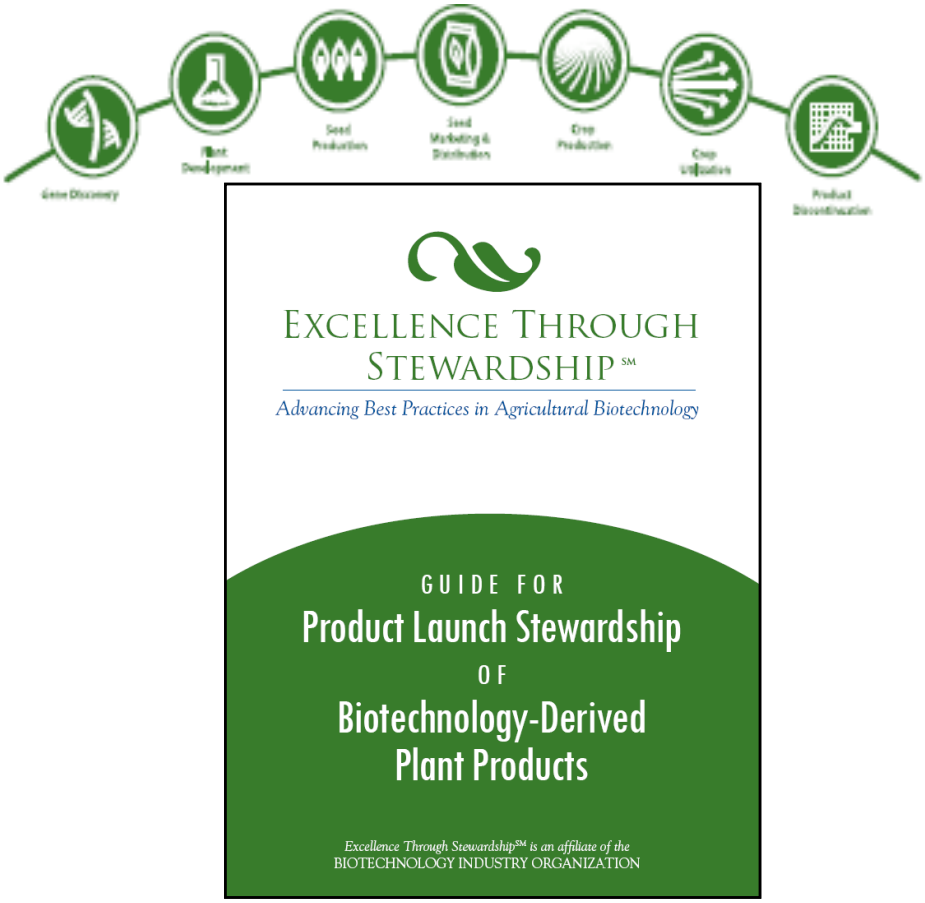


Fig. 1.4 Principal cotton growing areas of the World

Responsible stewardship as an obstacle to competition

- Voluntary agreement between all biotech majors
- Requires 'traceability'
  - from the first lab experiments
  - experimental and field testing stages
  - regulatory trials
  - sales to dealers
  - sales to farmers
  - product pipeline to consumers
- Sets the bar impossibly high for anyone else!



http://www.excellencethroughstewardship.org