Australian Dryland Cotton Production Guide

NSW Agriculture

COTTON Cooperative Research Centre

DPI QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

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QUEENSLAND COTTON

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Australian Dryland Cotton Production Guide

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CRC for Sustainable Cotton Production

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FOREWORD

Cotton growing in Australia has had its ups and downs for over a century. Prior to the early sixties most, if not all, cotton was dryland or as it is now known, raingrown. The 'new age' for cotton growing in Australia began with the establishment of a viable industry in NSW based on irrigation and other expertise brought from the USA by two Californians. In Queensland, virtually at the same time, several irrigation farmers on the Darling Downs were successfully experimenting with irrigated cotton. As the irrigation based industry expanded, little attention was focused on raingrown cotton. Several pockets of this type of farming were carried on in Central Queensland mainly around Biloela.

The success of irrigated cotton resulted in a rapid but well managed expansion of the industry. Research into insect control and plant breeding has gradually placed the Australian industry to the fore by world standards.

The expertise at all levels of the industry did not go unnoticed by broadacre farmers. Already highly efficient at farming in a semi arid environment, a number of these farmers turned their attention to raingrown cotton.

The proximity to existing ginning facilities of huge quantities of suitable land for raingrown cotton has seen large scale plantings in Northern NSW and Southern Queensland particularly on the Darling Downs in Queensland and East Moree in NSW.

The cotton industry is an energetic progressive and successful industry looked upon with envy by other rural industries. It requires a disciplined managerial approach. To those contemplating entering our industry, we welcome you and ask that you accept our standards.

This book is a concentration of expert information for existing and potential raingrown cotton growers compiled jointly by officers of the Queensland Department of Primary Industries, and NSW Agriculture. Its contents cover all raingrown cotton areas and is an example of the interest and dedication of those associated with our industry.

Evan Layt
REGIONAL MANAGER - DALBY
QUEENSLAND COTTON CORP. LTD

COTTON
AUSTRALIA

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INTRODUCTION

Cotton (Gossipium spp.) belongs to the family Malvacae, which originated in the hot arid regions of the tropics and sub-tropics of Africa, the Middle-East, Asia, Australia, the Americas, Hawaii and certain islands in the South Pacific. Although now modified and adapted to grow in a broad range of environments, cotton does best in areas with a long, hot season.

It has been used as a textile for many thousands of years. Cotton fabrics dating back to 3000 B.C. were found in the Indus Valley in Pakistan and cotton specimens dating to 2500 B.C. were found in Peru.

The plant was introduced into Australia with the First Fleet in 1788 and was first planted in the Sydney area, with disappointing results due to the unfavourable climate. Cotton was farmed commercially for the first time at Moreton Bay in 1840. Early production was confined almost entirely to Queensland.

The modern cotton industry as we know it, commenced in the early 1960's. From modest beginnings in NSW and Queensland, Australia's cotton industry has grown rapidly to become the nation's fourth largest rural export earner (behind wool, meat and wheat). Close to 95% of Australia's annual cotton crop is exported as fibre, currently netting the country nearly $1 Billion each year in overseas sales.

Today cotton is grown from Hillston in the south to Emerald in the north by approximately 1000 cotton growers. About 80% of the Australian crop is produced in northern and western NSW with the remainder in southern and central Queensland.

Most is grown under irrigation with dryland plantings fluctuating yearly according to seasonal conditions. In recent good seasons dryland has accounted for up to 20% of the area planted to cotton but less than 10% of the crop production.

A nucleus of experienced growers and consultants has demonstrated that dryland cotton can be profitably produced, providing growers adhere to a fairly strict set of management guidelines. The objective must always be to keep costs to a minimum. Dryland cotton is an expensive crop to grow and profit margins can easily be eroded unless a tight rein is kept on expenses. Growers should take advantage of every cost saving measure available, without jeopardising crop viability.

Summary of considerations for growing dryland cotton;

* Reliable summer cropping areas,
* Paddock has over 1 metre of subsoil moisture, free of summer weeds, without sticks, stones and too many trees and away from houses,
* Do a cash flow budget,
* Finance to grow the crop (costs are typically $600 to $700/ha),
* Services of a reliable and experienced dryland cotton consultant/agronomist,
* Gear-up with machinery, either internally, contractors or share with neighbours; particularly consider:
    - 3 point linkage tractor
    - planter
    - spray rig
    - harvesting, picking gear
* Discuss growing the crop with experienced growers and consultants and agronomists.
* Contact your chemical supplier to budget your chemical needs.

The very attractive yields, prices and profits obtained by dryland cotton farmers during the past several seasons provides no guarantee for the future. New farmers should approach the crop with caution.

> Dryland cotton does not hold the answer to reversing financial problems overnight. It is not a crop for the faint hearted, inexperienced or financially trouble farmer, or for those in climatically unsuitable areas.

Growers considering dryland cotton farming should first have the capital resources required to grow the crop. A commitment by the farmer to a high level of managerial expertise is also necessary. The cotton industry's rapid adoption of advanced production technology bears witness to the high degree of managerial skills required. Successful summer row crop farmers should find the transition to cotton easier.

These notes address in detail the many basic needs for producing a successful crop including:

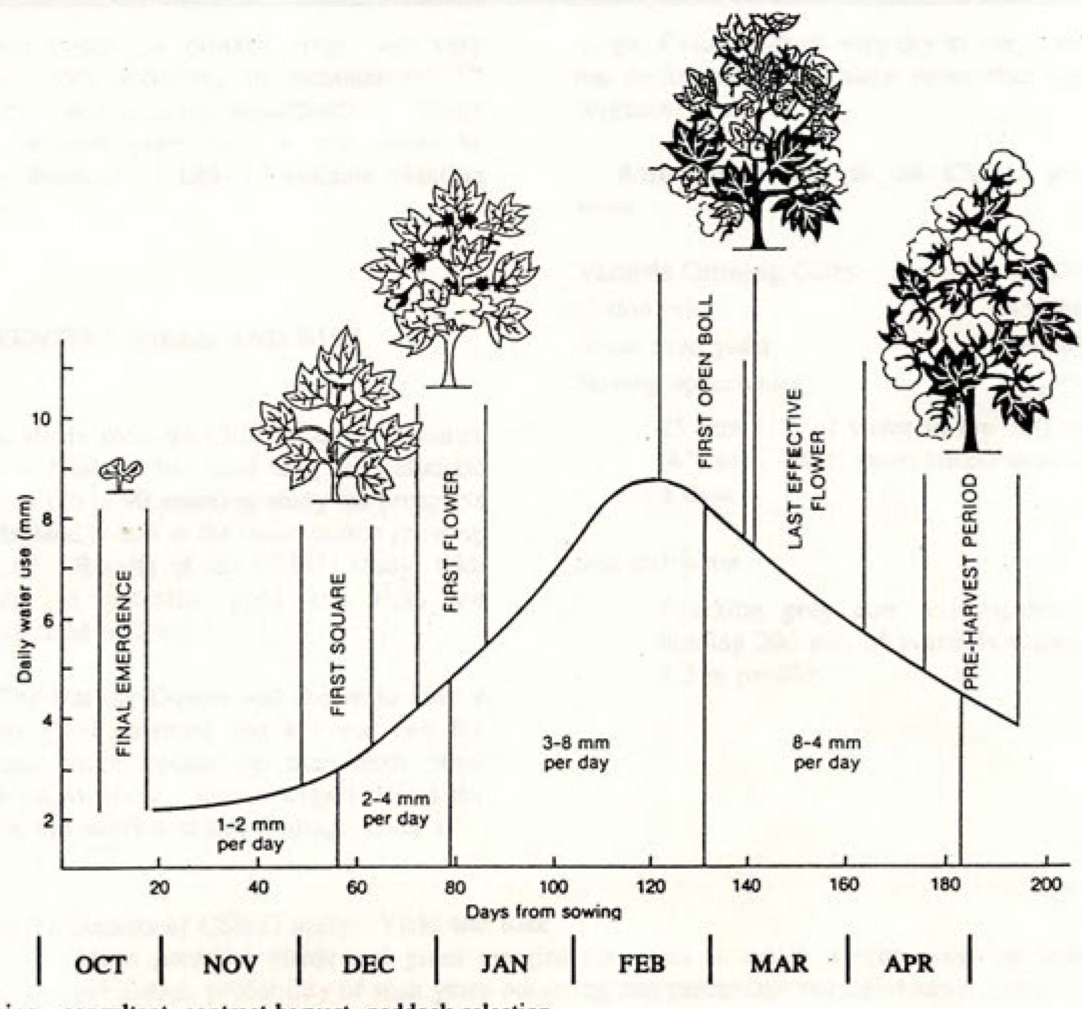
- budgeting
- machinery
- fallow management
- varieties
- sowing
- nutrition
- herbicide program
- insect management program
- defoliation
- picking
- contractors
- marketing

Figure 1 shows a seasonal calender for cotton based on a crop water use chart from the NSW Department of Agriculture.

Other cotton references include:

- Darling Downs Summer Crop Management Notes 1993
- Pesticide Application Guidelines ($5), QDPI & CRBIA, Dalby
- Tractor Performance Handbook, DPI, Dalby ($5)
- Pesticide Application Guidelines, DPI and Goondiwindi Agronomists Group ($5)
- The Cotton Pesticide Guide, NSW Agriculture, Agdex 151/680
- Dryland Cotton Growing, NSW Agriculture, Agdex 151.
- SOILpak.
- Temperature Requirements for Cotton, Ag Fact, p5.3.5.
- Managing Cotton with Nitrogen Fertiliser, Ag Fact, p5.3.4.
- Insect Pests of Cotton, Ag Fact, p5.AE.1.
- Diseases of Cotton, Ag Fact, p5,AB.3.
- Weed Control in Cotton, Ag Fact, p7.2.2.
- Improving Soil Structure with Gypsum.
- Pesticides - Your Questions Answered.

Figure 1: Cotton Seasonal Calender
(Water Use Chart courtesy NSW Department of Agriculture)



Planning - consultant, contract harvest, paddock selection

Land Preparation - fertiliser, herbicide

Planting

Emergence - 7 to 14 days

Squaring - 42 days after sowing

Flowering - 65 days after sowing

Boll Opening - 63 days after flowering >

Crop Conditioning >

Harvest >

Soil insects

Seedling insects - thrip, jassid, mirid

Tipworms, heliothis

Heliothis

Rough & Pink Spotted Bollworm

DRYLAND COTTON POTENTIAL AND RISK

Cotton yields for dryland crops will vary considerably according to seasonal rainfall patterns, and planting opportunities. There may be some years when a crop cannot be sown because of lack of suitable planting rains.

POTENTIAL YIELD AND RISK

Brian Hearn from the CSIRO Cotton Research Unit at Narrabri has used long term climatic records (70 to 90 years) to study the prospects for dryland cotton in the major cotton growing regions. Results of the CSIRO study, with respect to potential yield and risk, are summarised in Table 1.

The Darling Downs was shown to have a higher yield potential and a lower risk for dryland cotton production than most other areas of Australia. Recent experience in the region has confirmed this finding. Over a range of seasons from very dry to wet, cotton has performed significantly better than grain sorghum.

Assumptions used in the CSIRO study were:

Variable Growing Costs:	$600/ha
Cotton price:	$450/bale
Break even yield:	1.3 bales/ha

Sowing opportunity:

25 mm (1") of water in top 100 mm (4") soil. 18°C mean temperature for 3 days

Soil and water:

Cracking grey clay soil capable of holding 200 mm of available water in 1.3 m profile.

Table 1. Results of CSIRO study - Yield and Risk
Mean potential yields and gross margins for years in which a crop could be sown, percentage probability of such years occurring and percentage failure of sown crops.

Region	Mean yield for years sown bales/ha	Gross margins for years sown $/ha	Years failed to sow	Years failed to break even
Breeza	2.13	360	1 in 5	1 in 3
Upper Namoi	2.71	620	1 in 5	1 in 5
Lower Namoi	2.81	665	2 in 7	1 in 7
Central Gwydir	1.98	291	1 in 3	2 in 5
East Moree	2.48	514	1 in 5	1 in 5
Darling Downs	3.27	873	1 in 10	1 in 6
Central Qld	2.79	655	1 in 7	1 in 6

RISK REDUCTION

The level of risk can be substantially reduced if growers only plant on a full profile of soil moisture. Fallowing with an 18 month break between crops as a strategy to increase subsoil moisture will reduce the risk of crop failure and increase yield in 1 year in 3 or 4 years.

The effects of fallowing on reducing risk from the CSIRO study are shown in Table 2. These advantages must be balanced against the loss of production when a successful crop could have been grown on the fallowed country. The risk of crop failure is not eliminated.

Table 2. Effects of fallowing on risk in three regions

Region	Increase in mean yield - bales/ha	Increase in gross margin - $/ha	Decrease in failure to breakeven
Darling Downs	0.35	158	1 in 6 to 1 in 14
Central Qld	0.19	84	1 in 6 to 1 in 8
East Moree	0.30	138	1 in 5 to 1 in 7

Other results derived from the CSIRO study were that:

- *Fallowing* - the risk of failing to breakeven can be reduced but not eliminated by fallowing and by timely sowing.
- *Skip row planting* - overall is unlikely to reduce risk and is likely to reduce production but may be desirable for other reasons. Skip row planting increased yield in a few years (1 in 5) in all regions but reduced it in most years (2 in 3 to 5) resulting in the overall reduction in yield.
- *Time of sowing* - yield starts to fall and the risk of failure starts to increase with later sowing. The latest sowing date ranges from mid November on the Breeza, through end of November for the Darling Downs, mid to late December for the Gwydir and Namoi to early January in Central Queensland.
- *Nitrogen fertiliser* - most likely to be required on the Darling Downs, the Upper Namoi and Central Qld with little or no need in other regions.

CONCLUSIONS

Dryland cotton should be profitable when averaged over years whilst prices exceed the $350 to $400/bale range. Occasional failures are climatically unavoidable.

The growing of dryland cotton is subject to a relatively large risk but it can be taken as a calculated risk. It is probably better suited to a mixed cropping enterprise or in conjunction with irrigated cotton production where water allocations are unreliable than as a single crop enterprise.

CROP YIELDS

DARLING DOWNS

Darling Downs crop statistics (1985/92) show significant variation in yield across the Darling Downs and in particular quite high yields for the Central Downs (Pittsworth and Millmerran shires). This in part is a result of a shorter period of dryland cotton on the Central Downs (fewer growers and smaller areas), and more favourable seasons when compared with the Northern Downs. Nevertheless, higher yields would be expected on the Central Downs.

Mean dryland cotton yields for the period 1985 to 1989 were:

- Northern Downs:

  Wambo/Chinchilla shires - 3.22 b/ha

- North eastern Downs:

  Jondaryan shire - 3.82 b/ha

- Central Downs:

  Millmerran/Pittsworth shires - 4.32 b/ha

Known farm yields have ranged from as low as 0.5 bales/ha to an extreme high of 8.0 bales/ha over all years, and the full range was experienced in 1990/91. The very low yielding crops were planted on less than a full profile of moisture following sorghum or cotton. In contrast, the very high yielding crops were grown on the central plains and associated with timely and favourable rainfall and a favourable flood during February.

A study of six farms in the Dalby region in 1987/88, a moderate season, showed a yield range of 3.1 to 4.49 bales/ha and an average of 3.84 bales/ha. Mean variable costs for this group was $564/ha with a mean gross margin of $784/ha.

In summary, the predicted yield potential from the CSIRO study are accurate and form a good base on which to evaluate the risk of dryland cotton production. The importance and value of a full profile of moisture at planting is emphasised, it represents the least risk. However planting on 60 cm (2 feet) of wet soil is a reasonable risk on the Darling Downs.

MOREE DISTRICT

In recent years the Moree district has grown around 10 to 12,000 hectares of dryland cotton. The majority of crops are grown in eastern areas around Croppa Creek, Pallamallawa, Terry Hie Hie, and Gurley, with some good results on the plains around Tulloona and Millie. Experience with dryland crops further west has been limited.

Yields over recent years have been highly variable, with virtual crop failures in some areas during the 1992/93 season following yield highs of over 5 bales/hectare in the 1991/92 season.

Average yields of the more experienced growers are in the 2 to 3 bales/ha range.

CENTRAL QUEENSLAND

Dryland cotton has been grown in Central Queensland since the 1920's. Over time, the total area has fluctuated wildly in response to variable seasonal conditions, changing prices and market trends. Farm yields in recent years, and prediction models based on longterm rainfall records both indicate an average yield of 2.5 bales/ha is feasible.

Known farm yields vary considerably about this average. In recent years, they have ranged from lows of 0.5 bales/ha to highs of

4.5 bales/ha. The probability of obtaining higher yields is increased by fallowing, use of minimum tillage, and adoption of a planting rule, based on 80 cm depth of wet soil.

NAMOI VALLEY

Dryland cotton yields in Narrabri shire have averaged about 3.0 bales/ha over the last 10 years, although average yields for the last 5 years exceed this figure. This may reflect the adoption of better growing technology.

Crop yields show large variation from year to year. Lint yields as low as 0.9 bales/ha and as high as 6.5 bales/ha have been obtained by growers in Narrabri Shire.

LIVERPOOL PLAINS

Cotton was first grown on the Liverpool Plains in 1982/83 as an irrigated crop. However, in the last three years, dryland cotton production has expanded rapidly and will exceed 6000 ha in 1993/94. Dryland crop yields have been as high as 6 bales/ha in 1991/92 and as low as 1.5 bales/ha in 1992/93. Average district dryland yields have been 3.5, 4.3 and 2.5 bales/ha for the last three years.

The greater use of minimum and no tillage systems will increase yields and reduce the risk of crop failure. Crops are sown with 90 cm of wet soil. For 1993/94 the wet soil depth is at least 120 cm.

The southern parts of the Liverpool Plains are relatively too cool to successfully grow cotton to date.

SOUTH WEST QUEENSLAND

The area of dryland cotton has steadily increased in the South West broadacre farming lands of Waggamba, Tara and Murilla Shires over the last 4-5 years. Yields have averaged about 2.5 bales/ha, ranging from 1.0 - 4.5 bales/ha. Much of the cotton is planted into long fallowed no-tilled winter cereal stubble, a proven technique for maximising soil moisture storage. A depth of 90 cm of soil moisture at planting is important to maximise the probability of at least breaking even.

SUMMARY

A summary of potential dryland cotton yields for the major regions in Queensland and NSW are presented in Table 3.

Table 3. Dryland cotton yield potential (bales/ha).

Region	Long Fallow		Short Fallow	
	Average	Range	Average	Range
Darling Downs	3.2	2.0 - 5.0	2.25	0.4 - 3.0
Moree	2.5	1.0 - 5.0	n/a	n/a
Central Qld	2.5	1.75 - 4.0	1.5	0.4 - 2.5
Namoi	3.0	0.9 - 6.5	n/a	n/a
Liverpool Plain	3.0	1.5 - 6.0	2.5	1.0 - 4.0
Sth West Qld	2.5	1.75 - 4.0	n/a	n/a

CROP ECONOMICS

GROSS MARGINS

Crop gross margins representing the difference between gross income and the variable costs of producing the crop are presented for solid and double skip row plantings in the major dryland cropping areas in the following tables. It is important for growers to do their own budgets with their own costs. The effects of different prices and yields on the gross margins are shown in associated tables.

Gross margins do not measure farm profit as they do not take into account fixed or overhead expenses such as rates, taxes, insurance, interest and depreciation on machinery and buildings. Fixed costs are not included as they are expenses that are incurred regardless of the area of crop grown and will change very little over the time a crop is grown. In addition, the amount of fixed costs per hectare varies considerably between properties making it difficult to provide a reliable guide to these costs.

Assumptions used in these gross margins include:

- Average season yields following a winter cereal crop and long fallow.
- Prices are based on SLM+ 1 1/32 inch grade with an average discount of $25/bale.
- Selection of pesticides varies markedly depending on pest species and seasons.
- An average to high number of insecticide applications using a soft approach to maintain predators.
- Chlorpyrifos for wireworm control.
- PBO and Bt have been tank mixed with pyrethroids, endosulfan or thiodicarb according to Strategy Guidelines.
- For the skip row crops, allowances for associated cost savings have been included.
- No labour costs.
- Machinery costs refer to the variable costs of fuel, oil, repairs and maintenance for both the tractor and implement.
- Contract picking or stripping costs. Owner operated costs would be of the order of:

Spindle pickers:	$100/ha (solid plant), $ 50/ha (double skip)
Stripper:	$ 45/ha (solid plant)

- Chemical prices are those recommended at August 1993.

FINANCE

Financing the crop is a major consideration. Figure 2 and 3 have been developed as a guide to when costs will be incurred during the season using the gross margins for Northern NSW and Southern Qld and the Darling Downs respectively.

Crop credit is available through agricultural chemical resellers and allows growers the option of deferring chemical costs until after picking. Interest is charged at current short term money market rates, e.g. bank bill rates.

At picking, pre-ginning loans (module advances) are available from most processors and merchants. Details should be discussed with appropriate personnel.

Table 4. Dryland Cotton gross margin - Solid plant
Darling Downs

Item	Time	No.	Rate/ha	Band	Price/Unit	Cost $/ha	Your estimate
VARIABLE COSTS							
Machinery Operations							
cultivation-chisel	Jan, Apr	2			$7.84/ha	16	
cultivation-scarify	Jun	1			$4.74/ha	5	
cultivation-scarify	Aug	1			$4.74/ha	5	
cultivation-tyne + herbicide incorporation	Sept	1			$2.97/ha	3	
planting	Oct	1			$5.88/ha	6	
cultivation-inter-row	Nov, Dec	2			$4.73/ha	10	
contract picking & module building	May	1			$255/ha	255	
Seed	Oct		10 kg	100%	$1.69/kg	17	
Fertiliser							
Urea	June		80 kg	100%	$0.42/kg	33	
MAP	Aug		40 kg	100%	$0.49/kg	20	
Herbicide							
glyphosate	Aug	1	0.5 L	100%	$13.25/L	9	
trifluralin	Sep	1	2.1 L	100%	$ 6.50/L	14	
Insecticide							
chlorpyrifos (planting)	Oct	1	0.5 L	20%	$20.00/L	2	
dimethoate (g)	Oct	1	0.3 L	30%	$ 9.40/L	3	
endosulfan +			2.1 L	40%	$ 8.60/L	9	
Bt (g)	Nov	1	1.5 L	40%	$12.50/L	8	
Bt (g)	Nov	1	3.0 L	40%	$12.50/L	17	
thiodicarb +			0.5 L	50%	$27.00/L	9	
Bt (g)	Dec	1	1.5 L	50%	$12.50/L	9	
endosulfan (g)	Dec	1	2.1 L	75%	$ 8.60/L	16	
pyrethroid (g)	Jan	1	0.7 L	100%	$ 8.00/L	8	
pyrethroid +			0.7 L	100%	$ 8.00/L	8	
Bt (g)	Jan	1	1.5 L	100%	$12.50/L	19	
pyrethroid +			0.7 L	100%	$ 8.00/L	8	
PBO (a)	Jan	1	0.3 L	100%	$39.50/L	13	
chlorfluazuron (a)	Feb	1	2.5 L	100%	$18.00/L	52	
Total insecticide + application						180	
Conditioning							
Harvade (R) +			0.5 L	100 %	$50.00/L	32	
Catapult (R)(a)	Mar	1	2.0 L	100 %	$ 7.00/L	14	
Chipping	Nov					42	
Consultant	May					45	
Insurance	Sep					20	
Ginning costs	May				$65.00/b	210	
Module lift + transport	May	$180/module @ 17 bales/module			$10.60/b	37	
ACF and Research Levies	May				$ 3.00/b	11	
TOTAL VARIABLE COSTS						$981.00	
INCOME							
Lint 3.5 b/ha	SLM+ 1 1/32				$360.00/b	1260.00	
Seed 1.16 t/ha					$130.00/t	150.00	
GROSS INCOME						$1410.00	
GROSS MARGIN						$428.00	

(a) aerial application included @ $7.00/ha (g) ground application included @ $2.21/ha

Table 5. Effect of yield and price on gross margin per hectare - Darling Downs

SENSITIVITY TABLE

YIELD bales/Ha	$288 /bale $130 /tonne	$324 /bale $130 /tonne	At Gin Price **$360 /bale** **$130 /tonne**	$396 /bale $130 /tonne	$432 /bale $130 /tonne	**Lint price** **Seed price**
2.45	-$93	-$5	$83	$171	$259	
2.80	-$3	$97	$198	$299	$400	**Gross**
3.15	$87	$200	$313	$427	$540	**Margin**
3.50	$177	$303	**$428.71**	$555	$681	**($/Ha)**
3.85	$267	$405	$544	$683	$821	
4.20	$357	$508	$659	$810	$962	
4.55	$447	$611	$774	$938	$1,102	

SENSITIVITY GRAPH

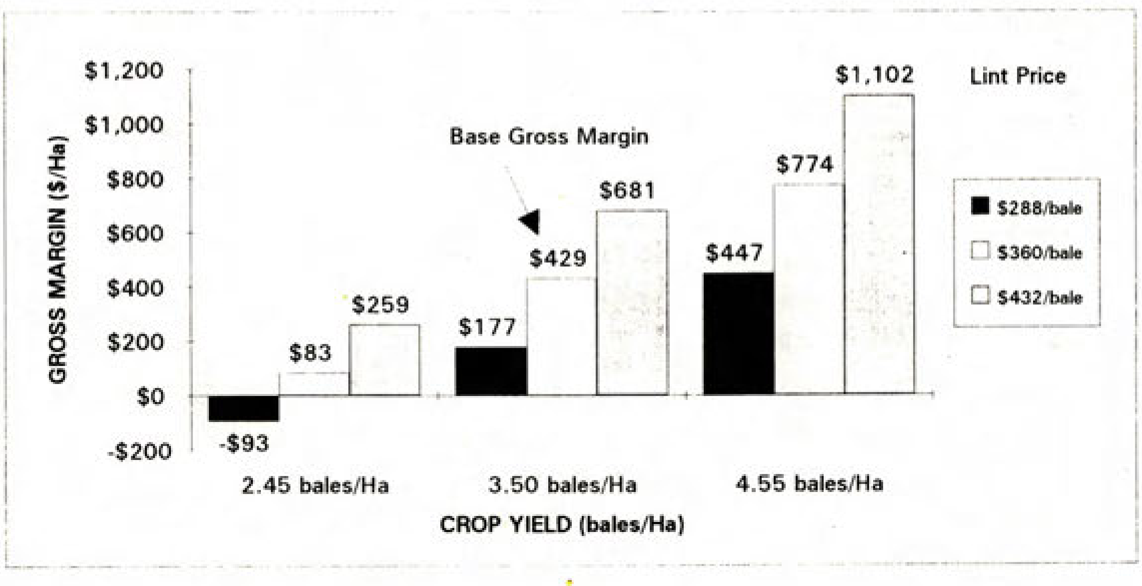


Table 6. Dryland cotton gross margin - Skip row
NSW North West Plains and Qld South West Downs

Item	Time	No.	Rate/ha	Band	Price/Unit	Cost $/ha	Your estimate
VARIABLE COSTS							
Machinery Operations							
cultivation-chisel	Jan, Apr	2			7.84/ha	16	
cultivation-scarify	Jun	1			4.74/ha	5	
cultivation-tyne + herbicide incorporation	Sept	1			2.97/ha	3	
planting	Oct	1			5.88/ha	4	
cultivation-inter-row	Oct, Dec	2			4.73/ha	6	
contract stripping & module building	May	1			$100.00/ha	66	
Seed	Oct		10 kg	66%	$1.69/kg	11	
Fertiliser							
Urea	Jun		60 kg	100%	$0.42/kg	25	
Herbicide							
glyphosate (g)	Aug	1	0.5 L	100%	$13.25/L	9	
trifluralin	Sep	1	2.1 L	100%	$ 6.50/L	14	
Insecticide							
chlorpyrifos (planting)	Oct	1	0.5 L	20%	$20.00/L	1	
endosulfan	Oct	1	2.1 L	30%	$ 8.60/L	5	
endosulfan +			1.5 L	40%	$ 8.60/L	5	
Bt (g)	Nov	1	1.5 L	40%	$12.50/L	5	
Bt (g)	Nov	1	3.0 L	40%	$12.50/L	11	
endosulfan +			2.1 L	50%	$ 8.60/L	7	
Bt (g)	Dec	1	1.5 L	50%	$12.50/L	6	
endosulfan (g)	Dec	1	2.1 L	75%	$ 8.60/L	10	
pyrethroid (g)	Jan	1	0.7 L	100%	$ 8.00/L	5	
pyrethroid +			0.7 L	100%	$ 8.00/L	5	
Bt (g)	Jan	1	1.5 L	100%	$12.50/L	12	
pyrethroid +			0.7 L	100%	$ 8.00/L	5	
PBO (a)	Jan	1	0.3 L	100%	$39.50/L	8	
thiodicarb (a)	Feb	1	2.5 L	100%	$18.00/L	52	
Total insecticide & application						140	
Conditioning							
Sprayseed (R) +			2.0 L	100%	$7.40/L	11	
wetter (g)	Mar	1	0.13 L	100%	$5.00/L	1	
Chipping	Nov					42	
Consultant	May					45	
Insurance	Sept					20	
Ginning costs	May				$65.00/b	132	
Module lift + transport	May	$180/module @ 17 bales/module			$10.60/b	23	
ACF and Research Levies	May				$ 3.00/b	7	
TOTAL VARIABLE COSTS						$578.00	
INCOME							
Lint 2.20 b/ha	SLM+ 1 1/32				$360.00/ba	792	
Seed 0.73 t/ha					$130.00/t	94	
GROSS INCOME						$886.00	
GROSS MARGIN						$308.00	

(a) aerial application included @ $7.00/ha (g) ground application included @ $2.21/ha

Table 7. Effect of yield and price on gross margin per hectare - NSW North West Plains and Qld South West Downs

SENSITIVITY TABLE

YIELD bales/Ha	$288 /bale $130/tonne	$324 /bale $130/tonne	At Gin Price **$360 /bale** **$130/tonne**	$396 /bale $130/tonne	$432 /bale $130/tonne	**Lint price** **Seed price**
1.21	-$105	-$62	-$18	$26	$69	
1.54	-$20	$35	$91	$146	$202	**Gross**
1.87	$65	$132	$199	$267	$334	**Margin**
2.20	$150	$229	**$308**	$387	$466	**($/Ha)**
2.53	$235	$326	$417	$508	$599	
2.86	$319	$422	$525	$628	$731	
3.19	$404	$519	$634	$749	$864	

SENSITIVITY GRAPH

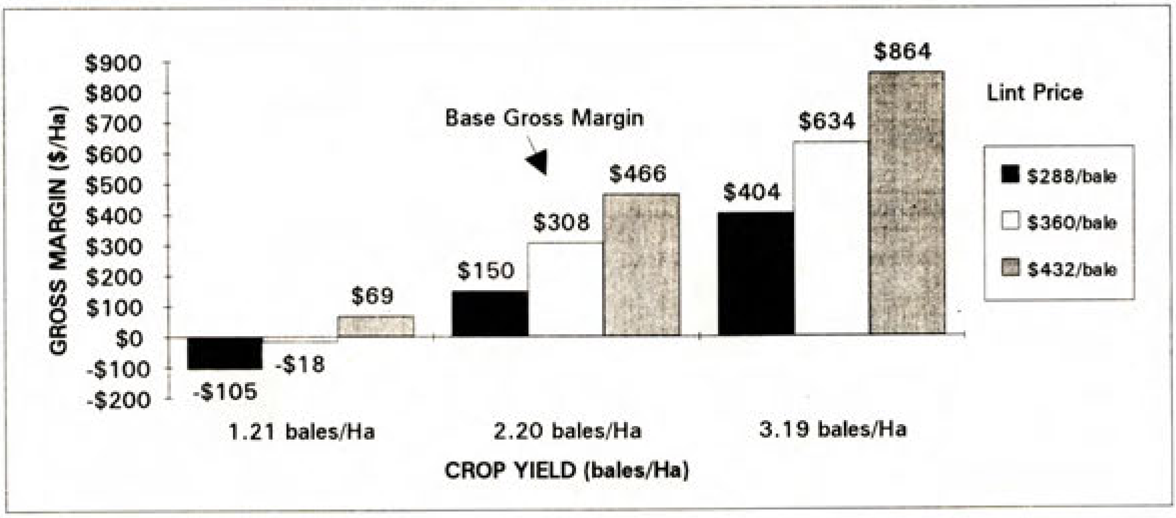


Table 8. Dryland cotton gross margins - Solid plant
NSW North West Slopes - Liverpool Plains

*

Item	Time	No.	Rate/ha	Band	Price/Unit	Cost $/ha	Your estimate
VARIABLE COSTS							
Machinery Operations							
cultivation-chisel	Jan, Apr	2			$7.84/ha	16	
cultivation-scarify	Jun	1			$4.74/ha	5	
cultivation-tyne +							
herbicide incorporation	Sept	1			$3.00/ha	3	
planting	Sept	1			$5.88/ha	6	
cultivation-inter-row	Oct, Dec	2			$4.73/ha	10	
contract stripping &							
module building	May				$100.00/ha	100	
Seed	Sep		10 kg	100%	$1.69/kg	17	
Fertiliser							
Urea	Sep		80 kg	100%	$0.42/kg	33	
Herbicide							
glyphosate(g)	Aug	1	0.5 L	100%	$13.25/L	9	
trifluralin	Sep	1	2.1 L	100%	$ 6.50/L	14	
Insecticide							
chlorpyrifos (planting)	Sep	1	0.5 L	20%	$20.00/L	2	
endosulfan (g)	Oct	1	2.1 L	30%	$ 8.60/L	8	
endosulfan +			1.5 L +	40%	$ 8.60/L	7	
Bt (g)	Nov	1	1.5 L	40%	$12.50/L	7	
Bt (g)	Nov	1	3.0 L	40%	$12.50/L	17	
thiodicarb +			0.5 L +	50%	$27.00/L	9	
Bt (g)	Nov	1	1.5 L	50%	$12.50/L	9	
endosulfan	Dec	1	2.1 L	60%	$ 8.60/L	13	
endosulfan	Dec	1	2.1 L	75%	$ 8.60/L	16	
pyrethroid (g)	Jan	1	0.7 L	100%	$ 8.00/L	8	
pyrethroid +			0.7 L +	100%	$ 8.00/L	8	
Bt (g)	Jan	1	1.5 L	100%	$12.50/L	19	
pyrethroid +			0.7 L +	100%	$ 8.00/L	8	
PBO (g)	Jan	1	0.3 L	100%	$39.50/L	13	
chlorfluazuron (a)	Feb	1	2.5 L	100%	$145.00/L	52	X
Total insecticide + application						196	
Conditioning							
thidiazuron +			0.2 L	100%	$230.00/L	53	
crop oil +			2.0 L	100%	$ 2.50/L	5	
salt (a)	Mar	1	20.0 L	100%	$ 1.10/L	22	
Chipping	Nov					42	
Consultant	May					45	
Insurance	Sept					20	
Ginning costs	May				$65.00/b	150	X
Module lift + transport	May	$180/module @ 17 bales/module			$10.60/b	26	
ACF and Research Levies	May				$ 3.00/b	7	
TOTAL VARIABLE COSTS						$778.00	
INCOME							
Lint 2.5 b/ha	SLM+ 1 1/32				$360.00/b	900	
Seed 0.83 t/ha					$130.00/t	107	
GROSS INCOME						$1007.00	
GROSS MARGIN						$229.00	

(a) aerial application included @ $7.00/ha (g) ground application included @ $2.21/ha

Table 9. Effect of yield and price on gross margin per hectare - NSW North West Slopes - Liverpool Plains

SENSITIVITY TABLE

YIELD bales/Ha			At Gin Price			
	$288 /bale	$324 /bale	**$360 /bale**	$396 /bale	$432 /bale	**Lint price**
	$130/tonne	$130/tonne	**$130/tonne**	$130/tonne	$130/tonne	**Seed price**
1.38	-$240	-$191	-$141	-$92	-$42	
1.75	-$144	-$81	-$18	$45	$108	**Gross**
2.13	-$47	$29	$106	$182	$259	**Margin**
2.50	$49	$139	**$229.18**	$319	$409	**($/Ha)**
2.88	$146	$249	$353	$456	$560	
3.25	$242	$359	$476	$593	$710	
3.63	$339	$469	$600	$730	$861	

SENSITIVITY GRAPH

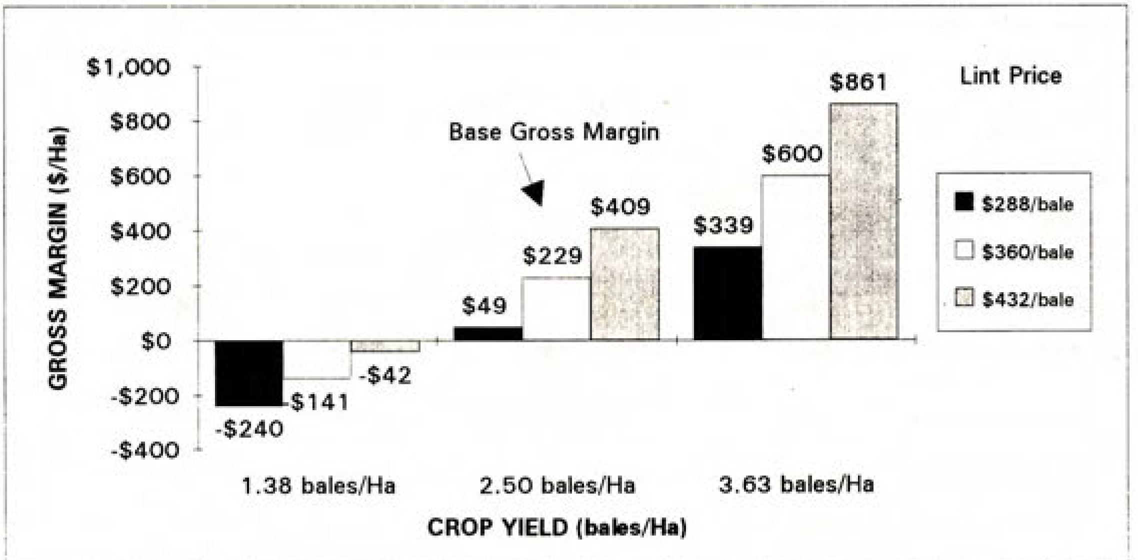


Table 10. Dryland cotton gross margin - Skip row
Central Queensland

Item	Time	No.	Rate/ha	Band	Price/Unit	Cost $/ha	Your estimate
VARIABLE COSTS							
Machinery Operations							
cultivation-chisel	Dec, Apr	2			$7.84/ha	16	
cultivation-scarify	Jul, Nov	2			$4.74/ha	9	
planting	Dec	1			$5.88/ha	6	
cultivation-inter-row	Jan, Feb	2			$4.73/ha	6	
contract stripping & module building	May	1			$100.00/ha	66	
Seed	Dec		8 kg	100%	$1.69/kg	9	
Fertiliser							
MAP	Nov		40 kg	100%	$0.49/kg	20	
Herbicide							
glyphosate +			0.8 L	100%	$13.25/L	13	
2.4-D (g)	Dec	1	0.5 L	100%	$ 5.65/L	3	
Cotogard (R)	Dec	1	4.0 L	30%	$12.35/L	10	
Insecticide							
endosulfan (g)	Jan	1	2.1 L	40%	$ 8.60/L	6	
endosulfan +			2.1 L	40%	$ 8.60/L	6	
Bt (g)	Jan	1	1.5 L	40%	$12.50/L	5	
Bt (g)	Jan	1	3.0 L	40%	$12.50/L	11	
endosulfan +			2.1 L	60%	$ 8.60/L	9	
Bt (g)	Feb	1	1.5 L	60%	$12.50/L	7	
thiodicarb (g)	Feb	1	1.5 L	100%	$27.00/L	28	
endosulfan +			2.1 L	100%	$ 8.60/L	13	
Bt (g)	Mar	1	1.5 L	100%	$12.50/L	13	
endosulfan +			2.1 L	100%	$ 8.60/L	13	
PBO (a)	Mar	1	0.3 L	100%	$39.50/L	9	
thiodicarb (a)	Apr	1	1.5 L	100%	$27.00/L	31	
Total insecticide + application						152	
Conditioning							
Harvade (R) +			0.5 L	100%	$50.00/L	21	
Catapult (R)(a)	Apr	1	2.0 L	100%	$ 7.00/L	9	
Chipping	Jan					42	
Consultant	May					45	
Insurance	Dec					20	
Ginning costs	May				$65.00/b	120	
Module lift + transport	May		$180/module @ 17 bales/module		$10.60/b	21	
ACF and Research Levies	May				$ 3.00/b	6	
TOTAL VARIABLE COSTS						$593.00	
INCOME							
Lint 2.0 b/ha SLM+ 1 1/32					$360.00/b	720	
Seed 0.66 t/ha					$130.00/t	86	
GROSS INCOME					$400/b	$805.00	
GROSS MARGIN						$212.00	

(a) aerial application included @ $7.00/ha (g) ground application included @ $2.21/ha

Table 11. Effect of yield and price on gross margin per hectare - Central Queensland

SENSITIVITY TABLE

YIELD			At Gin Price			
	$288 /bale	$324 /bale	**$360 /bale**	$396 /bale	$432 /bale	**Lint price**
	$130 /tonne	$130 /tonne	**$130 /tonne**	$130 /tonne	$130 /tonne	**Seed price**
1.4	-$86	-$36	$15	$65	$115	
1.6	-$35	$23	$80	$138	$196	**Gross**
1.8	$17	$82	$146	$211	$276	**Margin**
2.0	$68	$140	**$212**	$284	$356	**($/Ha)**
2.2	$120	$199	$278	$357	$436	
2.4	$171	$258	$344	$430	$517	
2.6	$223	$316	$410	$503	$597	

SENSITIVITY GRAPH

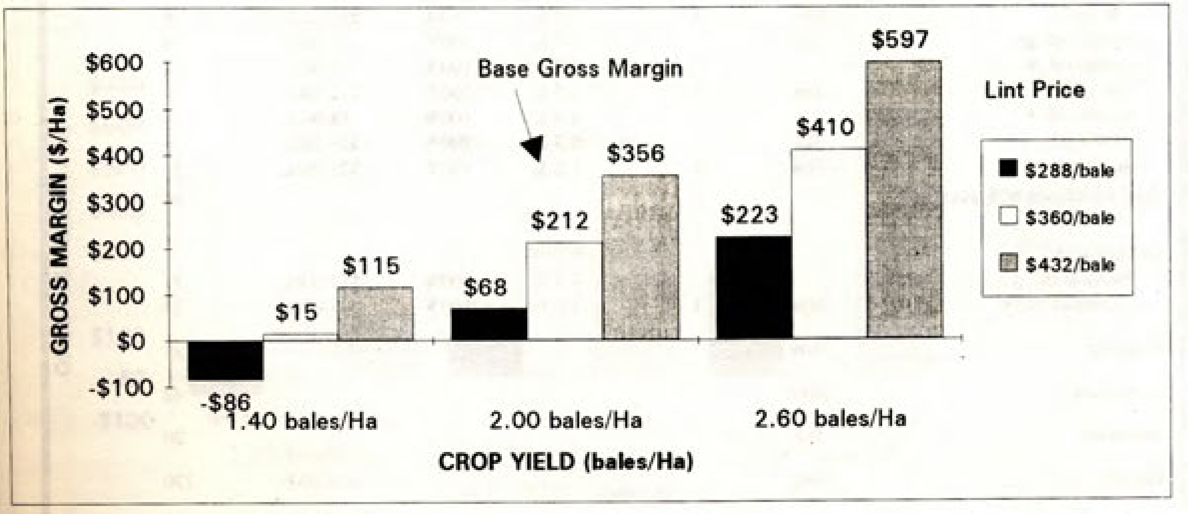


Table 12. Dryland cotton gross margin - Double skip Western Downs

Item	Time	No.	Rate/ha	Band	Price/Unit	Cost $/ha	Your estimate
VARIABLE COSTS							
Machinery Operations							
cultivation-chisel	Jan, Apr	2			$7.84/ha	16	
cultivation-scarify	Jun	1			$4.74/ha	5	
cultivation-scarify	Sept	1			$4.74/ha	5	
cultivation-tyne + herbicide incorporation	Sept	1			$2.97/ha	3	
planting	Oct	1			$5.88/ha	6	
cultivation-inter-row	Oct, Dec	2			$4.73/ha	5	
contract picking and module building	May	1			$200.00/ha	100	
Seed	Oct		10 kg		$1.69/kg	8	
Fertiliser							
MAP	Sep		30 kg		$0.49/kg	15	
Herbicide							
glyphosate (g)	Aug	1	0.5 L	100%	$13.25/L	9	
trifluralin	Sep	1	2.1 L	100%	$6.50/L	14	
Insecticide							
chlorpyrifos	Oct	1	0.5 L	20%	$20.00/L	1	
omethoate (g)	Oct	1	0.3 L	30%	$49.00/L	3	
endosulfan +			2.1 L	40%	$8.60/L	5	
dimethoate (g)	Nov	1	0.3 L	40%	$9.40/L	1	
thiodicarb +			1.5 L	50%	$27.00/L	11	
Bt (g)	Dec	1	1.5 L	50%	$12.50/L	5	
endosulfan +			2.1 L	60%	$8.60/L	7	
Bt (g)	Dec	1	1.5 L	60%	$12.50/L	6	
pyrethroid (g)	Jan	1	0.7 L	100%	$8.00/L	4	
pyrethroid +			0.7 L	100%	$8.00/L	4	
Bt (g)	Jan	1	1.5 L	100%	$12.50/L	9	
pyrethroid +			0.7 L	100%	$8.00/L	4	
PBO (a)	Jan	1	0.3 L	100%	$39.50/L	6	
thiodicarb (a)	Feb	1	1.5 L	100%	$27.00/L	21	
Total insecticide + application						86	
Conditioning							
Harvade (R) +			0.5 L	100%	$50.00/L	32	
Catapult (R)(a)	Mar	1	2.0 L	100%	$ 7.00/L	14	
Chipping	Nov					21	
Consultant	May					42	
Insurance	Sep					20	
Ginning costs	May				$65.00/b	120	
Module lift + transport	May		$180/module @ 17 bales/module		$10.60/b	21	
ACF and Research Levies	May				$ 3.00/b	6	
TOTAL VARIABLE COSTS						$550.00	
INCOME							
Lint 2.0 b/ha	SLM+ 1 1/32				$360.00/b	720	
Seed 0.66 t/ha					$130.00/t	86	
GROSS INCOME						$806.00	
GROSS MARGIN						$256.00	

(a) aerial application included @ $7.00/ha (g) ground application included @ $2.21/ha

Table 13. Effect of yield and price on gross margin per hectare - Western Downs

SENSITIVITY TABLE

YIELD bales/Ha	$288 /bale $130/t	$324 /bale $130/t	At Gin Price **$360 /bale** **$130/t**	$396 /bale $130/t	$432 /bale $130/t	**Lint price** **Seed price**
1.4	-$43	$8	$58	$109	$159	
1.6	$9	$66	$124	$182	$239	**Gross**
1.8	$60	$125	$190	$255	$320	**Margin**
2.0	$112	$184	**$256**	$328	$400	**($/Ha)**
2.2	$163	$242	$322	$401	$480	
2.4	$215	$301	$388	$474	$560	
2.6	$266	$360	$453	$547	$641	

SENSITIVITY GRAPH

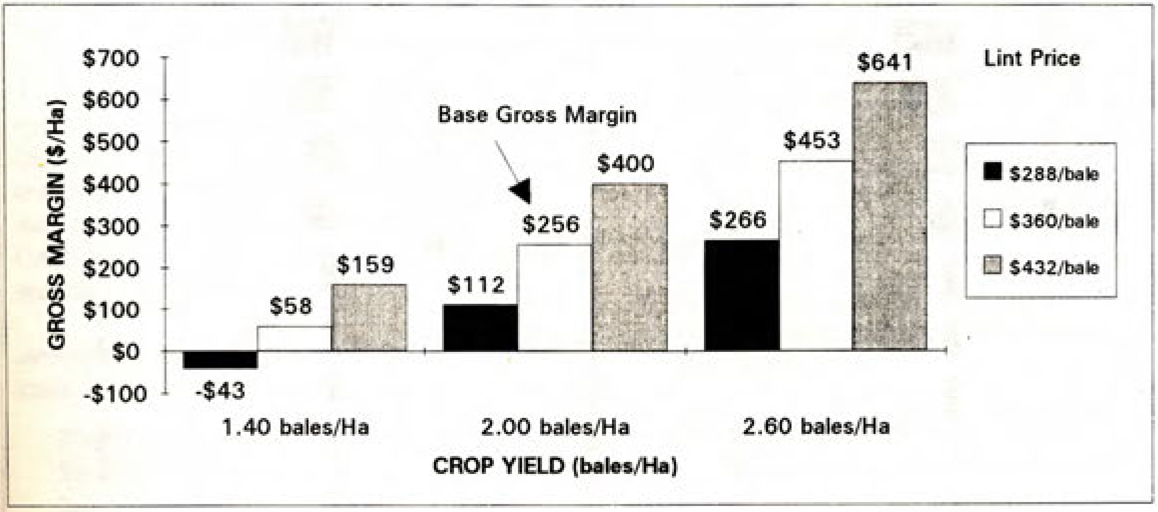


Figure 2. Two year cash flow for dryland skip row cotton; Northern NSW and Southern Qld

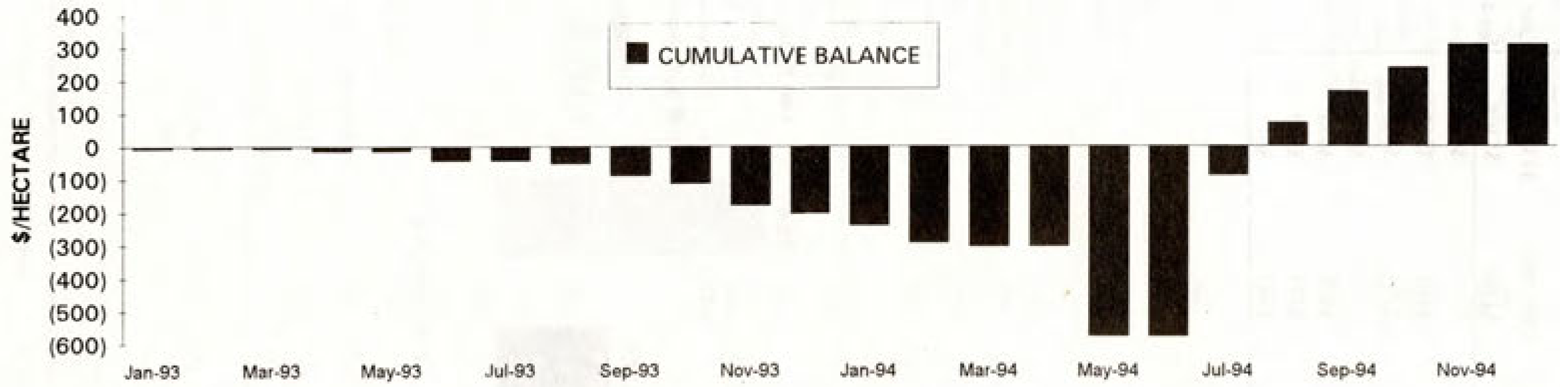
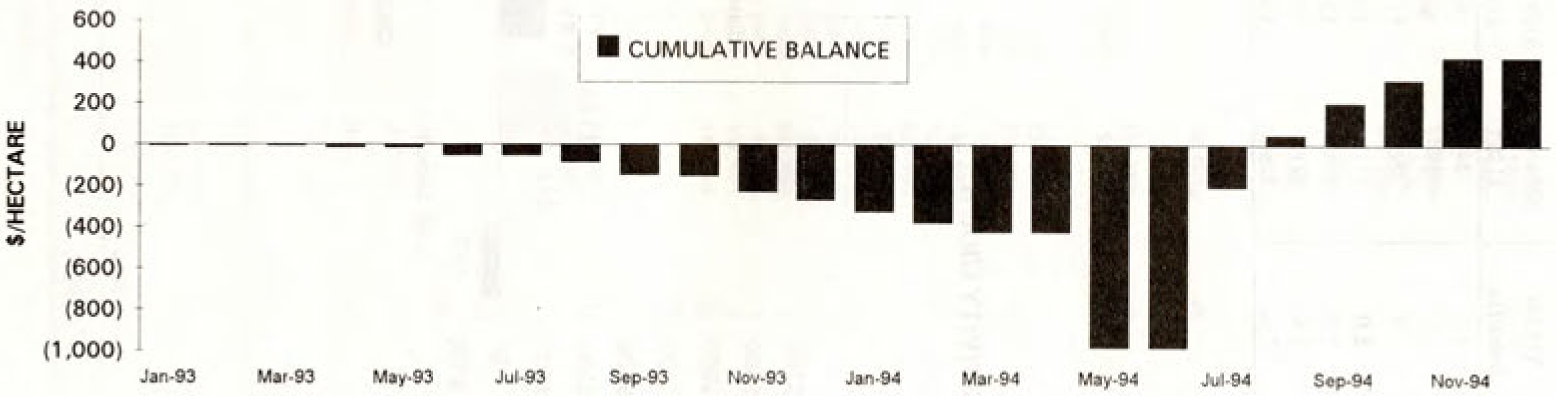


Figure 3. Two year cash flow for dryland solid plant cotton; Darling Downs Qld



MACHINERY REQUIREMENTS

Machinery is an important consideration for new cotton growers. There are some operations such as spraying and picking that can be done by a contractor. In some seasons the demand for these services is going to be great and the availability limited. Examine the cost of not doing the job on time verses the cost of financing new equipment. Machinery operating costs are given in Table xx.

Before purchasing new equipment look at the existing equipment that is already on the farm and see what can be used or modified to suit. For example most conventional broadacre boom sprayers can be cheaply modified to successfully spray cotton. Planting equipment used for summer crop planting of sunflower or sorghum should be adequate. A toolbar is quite easy to modify or build for inter-row weed control. Lay-by chemicals can be applied with conventional spray equipment by selecting different nozzles and reducing spray pressures.

Alternatively it may be possible to co-operate with a neighbour in some operations. Determine how much time is available to complete the task and then compare this with the existing capacity to do the job. BE CAREFUL - most people over estimate a machine's capacity.

Acceptable time periods to complete various tasks:

Planting - 7 days
Spraying - 3 days
Inter-row cultivate - 7 days
Harvest - 21 days

Typical machinery requirements for 200 - 400 ha of cotton:

Tractor (150 kW)
Planter - 8 row (12 m)
Spray rig - 12 m
Nurse tank - 8000 litres
Inter-row cultivator - 12 m
Slasher
Module tarps (100) + Cotton ropes

Work rates

Planting 6 ha/hr
Spraying 12 ha/hr
Picking: Spindle - (2 row) 0.5 ha/hr
Stripper - (4 row) 2.4 ha/hr
- (4 row) 1.2 ha/hr

TRACTORS

Whilst all types of tractors are being successfully used on cotton farms, the Front Wheel Assist design is becoming very popular. This design is ideally suited to a row crop situation because:

- larger percentage of weight over the front axle gives better stability when using heavy 3 pt linkage equipment
- larger diameter front tyres can carry large spray tanks with less damage to axle and tyres
- front tyres can be operated at lower pressure and therefore help reduce soil compaction
- better tractive efficiency allows more engine power to be utilised at the drawbar.

Whilst this type of tractor has many advantages over 2WD, major inefficiencies can occur if the tractor is operated with insufficient lead on the front tyres. The front tyre must run 2-5% faster than the rear tyre. The lead is altered by changing the weight distribution front to rear, increasing or decreasing tyre pressures and the fitment of dual tyres.

Common symptons of incorrect lead are: excessive wear on the rear tyres; a rough ride; the tractor running easier when in 2WD; and leaking front differential seals. More details on assessing lead are contained in the DPI publication Tractor Performance Handbook.

If alterations have been made to the tractor's original set-up then at least check that the weight split is 40% front: 60% rear and the front tyres pressures are at least 30 kPa higher than the rear tyres.

PLANTING MACHINERY

Planting machines need to be able to meter the seed accurately and place the seed consistently at depths no greater than 5 cm. Deep planting MUST BE AVOIDED.

Precision planters are becoming more common in dryland cotton. Problems have been encountered when double disc openers have been used on uneven, wet seedbeds. When planting into raised beds the double discs are kept free from a build up of mud because of the dry crust on the surface. When planting "on the flat", wet spots in the field cause mud build up and often require planting to be delayed. For this reason, a tyne opener is preferable for dryland cotton planting. Whilst precision planters are preferable, combines and airseeders have given satisfactory results. A press wheel is required with all machines and pressures similar to that for sunflower are necessary (1-2 kg/cm width).

Improvements to the metering/placement accuracy for both combines and air-seeders can be attained by:

- Rotating the fluted/peg roller at the maximum speed whilst exposing as little of the roller as possible to achieve the desired seeding rate.
- Replacing older convoluted hoses with modern smooth bore hoses.
- Keeping air velocities up in the hoses leading to the distribution heads.
- Using two distributor head outlets per row.
- Ensuring adequate diffusion of air in the seed tubes leading to the planting boot. Drilling of holes in the seed tube may be necessary.
- Using a stronger planting tyne and a small duckfoot planting boot.

A compromise between the precision planter and the combine/airseeder is the press wheel planter unit that can be retro-fitted to the latter units. This type of unit improves sowing depth control and includes a presswheel. The major disadvantage of adding these units is that the extra weight at the back of the machine may cause problems especially in lifting.

Hilling up is not necessary for dryland cotton planting but some hilling during inter-row cultivation can improve harvesting. It provides a shallow furrow for the picker wheels allowing the picker heads to pick closer to the ground.

Moisture Seeking

Removing the surface layer of dry crusted soil may allow the placement of the seed into moisture at the correct depth. Whilst this technique allows for timely planting it may help to concentrate chemicals in the furrow if a heavy rainfall event occurs. If soil is washed back into the furrows immediately after planting, seedling establishment time will be increased and seedling vigour decreased due to the increased depth from which seedlings must emerge.

Water Injection

Whilst water injection is used successfully by a number of growers it is not a substitute for insufficient planting moisture. Seed must still be placed into soil moisture with the added water used only to reduce the dry back effect. The primary role of water injection is as a carrier for a starter fertiliser such as MAP, zinc application and for seedling protection with insecticides such as Lorsban.

Water injection allows the seed to imbibe moisture at a faster rate, which in-turn increases the rate and evenness of establishment. Whilst plant vigour is often increased the total percentage of established plants may not. Water is generally directed into the seed trench about 5cm behind the seed tube. Water rates will vary from 500 to 2000 L/ha with 1000 L/ha a common application rate. Planting efficiency which equates to area planted per day is substantially reduced by water injection. Reductions of between 20 to 40% in area planted per day are common. If water is the only additive in this operation, both the economic and agronomic benefit of water injection must be questioned.

Seed Soaking

Soaking seed can speed up germination by 1 to 2 days. Under hot, dry conditions conducive to rapid drying within the seedbed, this may provide a better overall establishment. Generally, seed is soaked for 2.5 to 3 hours, dried overnight, and then planted without delay next day, to avoid emergence of the radicle (primary root) prior to planting. Quantities sufficient for half a day's planting are generally done at one time. If planting is delayed, seed can be salvaged by complete drying on a tarp.

The actual process involves placing seed into hessian wheat bags or perforated drums, and immersing in a tank of water, remembering to allow room for expansion. The swollen seed, generally about 30% larger, necessitates the changing of planter plates for planting. Another drawback is the likely loss of seed treatments, increasing the risk of seedling diseases under cool seedbed conditions.

INTER-ROW CULTIVATING

In-crop weed control is most economically accomplished by cultivation. Any 3pt linkage bar can be setup with either cultivating tynes or knives. Depth control wheels are recommended especially with heavier bars. The width of cultivating bars should be matched to some multiple of the planter to overcome the problem of guess rows. Tracking devices are also being used to overcome uneven row spacings.

SPRAYING EQUIPMENT

For economic reasons dryland cotton is best sprayed with ground rigs. There is a range of ground sprayers available and all have worked satisfactory when correctly set-up and operated. Operating speeds will vary according to field conditions. Ground speeds of 20 km/hr are possible early in the season but these will reduce to 14-15 km/hr towards the end of the season. If higher ground speeds are required later in the season, access tracks may be smoothed by using either 3 pt linkage blades, drag rings or any other levelling device.

The different rigs available are:

Conventional Boom sprayer

This machine works effectively if droppers and additional nozzles are added as the crop grows. The boom width and nozzle spacing need to be matched to the planter. Uneven guess rows and crooked rows can cause problems especially as the plant matures.

Either cone or flat fan nozzles can be used. Flat fans offer some advantages as a wider fan angle can be selected and less nozzles are required when the plant size increases. Operating pressures need to be a minimum of 450 kPa and water volumes not less than 60 L/sprayed hectare. Spray volumes will need to be increased for conditioning - 100 to 200 L/ha.

Air assisted booms

Air assisted booms can be classified into air blast sprayers and misters. The major difference between these is that air blast sprayers produce droplets through hydraulic nozzles whilst misters use the air stream to produce the droplets. Air is then used by both machines to transport the droplets to the target. Air assist booms give better coverage on the underside of the leaves and also on the lower leaves than a conventional boom. Volumes as low as 40 L/ha can be used and these sprayers will generally do a better job of conditioning. Air assist booms can normally tolerate some error in planting accuracy. They require one outlet per row, but this is sufficient season long.

Controlled droplet application sprayers

CDA applicators form droplets by means of a spinning disc and then transport the droplets into the crop by an air-blast. Most units are driven by hydraulic motors. A spray volume of 20 L/ha for water and 10 L/ha for oil based sprays would be a good starting point. One head is required per row and this needs to be correctly positioned to give satisfactory coverage. A greater level of skill is required to achieve satisfactory results with a CDA unit than with the other sprayers.

Cleaning boomsprayers

All traces of herbicide, especially 2,4-D, need to be removed from the boomsprayer before using for insecticide application. Contractors decontaminate their spray rigs, both internally and externally, with anhydrous ammonia. The total system, internal and external, needs to be first flushed with water before filling with a 25% solution of anhydrous ammonia and water solution. The solution needs to be left in the tank and lines for at least three days and some solution pumped through the system every day. The chassis and external parts of the spray rig should also be washed down each day with the solution. In older booms, where residues have built up in the lines, the spray lines may have to be replaced.

CALIBRATING BOOMSPRAYS

Precise pesticide application reduces the risk of poor pest control or plant damage, and increases grower control over pesticide costs. In cotton, the frequency of pesticide application, the range of products being used, and the changing nature of the plant's growth form, all necessitate a high degree of skill in and understanding of boomspray calibration.

Chemical recommendations on labels are always given on a SPRAYED area basis which assumes a full row coverage (aeroplane coverage). When calibrating a boomspray for dryland cotton, it is critical to make the correct conversion from PADDOCK area to SPRAYED area. This conversion requires an allowance to be made for plant configuration and band width.

Static calibration method

- Check all nozzles. Collect the output from every nozzle for a given time, for example, 30 seconds, and replace any that vary by more than 10% from the manufacturer's specifications. Calculate the average flow per nozzle in L/min.

- Note number of nozzles set up per row of cotton; it may vary from 1 to 5, depending on stage of season.

- Calculate speed:

  a) Select rpm and gear to give required forward and pto speed
  b) Measure time to cover 100 m run on ground surface to be sprayed
  c) Repeat several runs and average the times

$$\textit{Speed (km/hr)} = \frac{\textit{Run length (m)} * 3.6}{\textit{Time}\ \text{(sec)}}$$

- Determine application rate per paddock ha. Application rate per paddock ha is determined by focusing on the output from a nozzle(s) over one row unit. The width of this row unit is influenced by the planting configuration used.

Table 14. Effective row width

Planting configuration	Effective row width (m)
Solid plant	1.0
Single skip	1.5
Single skip + Tramline	1.6
Double skip	2.0

$$\textit{Application rate/paddock ha (L/ha)} = \frac{\textit{Av flow/nozzle (L/}\text{min}) * \textit{no. of nozzles/row} * 600}{\textit{Speed (km/hr)} * \textit{effective row width (m)}}$$

Note 1. The number 600 is a conversion factor, to allow for changing min to hr, km to m, m^2 to ha.
For Example, $\frac{60 * 10{,}000}{1000}$

Note 2. If a mixture of nozzle types is being used for a row, add their individual average flow rates, rather than multiplying the Average flow/nozzle by the number of nozzles/row.

- Determine paddock area per tankful

$$\textit{Paddock area/tankful (ha)} = \frac{\textit{Tank capacity (L)}}{\textit{Application rate/paddock ha (L/ha)}}$$

Conversion of PADDOCK area to SPRAYED area

At this stage, it is necessary to convert paddock area to sprayed area. Chemical recommendations and water volumes are always expressed in relation to sprayed area. Paddock area is always a larger value than sprayed area.

- Determine the band factor. Allowance needs to be made for changes in the plant's growth form and leaf area during the growing season, and hence the percentage of any planted cotton row to which spray is applied. In the determination of this band factor, both the height of the crop and the planting configuration need to be considered, plants in skip configurations tending to be larger in overall size. The band factor also incorporates the varying percentage of a paddock sprayed, depending on what planting configuration is used.

Table 15. Band factor for varying crop height and planting configuration.

Crop Height (cm)	Solid Plant	Single Skip	Single Skip +Tramline	Double Skip
10	0.25	0.15	0.15	0.125
15	0.30	0.20	0.20	0.15
30	0.40	0.25	0.25	0.20
40	0.50	0.35	0.30	0.25
60	0.75	0.50	0.45	0.40
80	0.90	0.60	0.55	0.50
90	0.95	0.70	0.65	0.55
100	1.00	0.75	0.70	0.60

- Calculation of sprayed area per tankful

$$\textit{Sprayed area/tankful (ha)} = \textit{Paddock area/tankful} * \textit{band factor}$$

$$\textit{Application rate/sprayed ha (L/ha)} = \frac{\textit{Tank capacity (L)}}{\textit{Sprayed area/tankful (ha)}}$$

Example 1 (part A): Determine the sprayed area of cotton treated with a boomspray when the following conditions apply:

Flow per nozzle (L/min) = 0.4
No. nozzles per row = 3
Double skip planting
Tank capacity (L) = 1000

$$Speed = \frac{Run\ length\ (m) * 3.6}{time\ (sec)}$$
$$= \frac{100 * 3.6}{40}$$
$$= 9\ km/hr$$

$$Application\ rate/paddock\ ha = \frac{flow\ per\ nozzle * no.\ of\ nozzles/row * 600}{speed * effective\ row\ width}$$
$$= \frac{0.4 * 3 * 600}{9 * 2}$$
$$= 40\ L/ha$$

$$Paddock\ area/tankful\ (ha) = \frac{Tank\ capacity}{Application\ rate}$$
$$= \frac{1200}{40}$$
$$= 30\ ha$$

At the time of spraying, crop conditions were:

Plant configuration = double skip
Plant height = 60 cm

From table 15, band factor will be 0.4

$$Sprayed\ area/tankful = Paddock\ area/tankful * band\ factor$$
$$= 30 * 0.4$$
$$= 12\ ha$$

Determination of amount of chemical to be added to tank

Chemical recommendations on labels are always given on a SPRAYED ha basis.

$$Quantity\ of\ chemical\ needed/tankful\ (L)$$
$$= sprayed\ area/tankful\ (ha) * chemical\ recommendation$$

Example 1 (part B):

Label recommendation for product is 2.0 L/ha

Using rates per sprayed area (ha),

Amount of chemical to be added to 1000 L tank

$$= \text{sprayed area/tankful (ha)} * \text{chemical rate}$$
$$= 12\ ha * 2.0\ L/ha$$
$$= 24\ L$$

Alternate method - using rates per paddock area (ha)

- Determine paddock area per tankful (method as above): 30 ha
- Determine amount of chemical to be added per tankful

$$\text{Chemical rate/paddock area} = \text{Chemical recommendation on label} * \text{band factor}$$
$$= 2.0 * 0.4$$
$$= 0.8\ L/ha$$

Amount of chemical to be added to 1000 L tank

$$= \text{Paddock area/tankful} * \text{chemical rate/paddock area}$$
$$= 30 * 0.8$$
$$= 24\ L$$

Note: To determine the water volume per sprayed hectare, if required, for example, to check label water volume recommendations.

$$\text{Application rate/sprayed ha} = \frac{\text{Tank volume}}{\text{Sprayed area/tankful}}$$
$$= \frac{1200}{12}$$
$$= 100\ L/ha$$

Water Quality

The quality of the water used can adversely affect a herbicide's performance. Ideally water should be clear, colourless, odourless and neutral in pH. When available, rain water is the best bet. If water contains excessive solids obvious problems such as nozzle blockages will occur. Less obvious will be the binding of the chemical to the suspended materials and subsequent loss in its effectiveness. The effectiveness of some chemicals can be drastically reduced by suspended clay particles. As well solids accelerate nozzle wear. IF A COIN CAN NOT BE SEEN IN THE BOTTOM OF A BUCKET OF WATER IT IS TOO DIRTY TO USE FOR SPRAYING.

Water which is either acid or alkaline in pH may break down or hydrolyse specific chemicals. If the water is known to be alkaline, spraying should commence immediately after mixing. Water high in calcium or magnesium salts (hard water) may also cause problems with mixing as the stability of suspensions and emulsions is reduced.

A quick guide to the suitability of water for spray applications can be obtained using the following procedure:

1. Make up 500 mL of correctly diluted spray in a clear glass sealed container according to the manufacturer's instructions.

2. Mix thoroughly.

3. Allow to stand for 30 minutes. If, after this time, creaming, sedimentation or separation into layers occurs, the water may be unsuitable for mixing sprays. If suspected of being unsuitable, a sample of this water should be chemically analysed for salt and hardness levels.

Different brands of the same chemical may react differently because of different additives in each formulation.

If poor quality water has to be used, spray immediately after mixing, ensure adequate agitation is occurring in the tank and reduce the total water volume if at all possible.

Herbicides are often used to control weeds during the growing season.

The target for these applications can be either the soil as is the case of pre-plant or lay-by sprays or the weed as in most of the post emergent sprays.

Soil Applied

All soil applied herbicides have residual activity in the soil, the length of this residual varying with type of herbicide, temperature and moisture conditions. The biggest hazard with soil applied herbicides is uneven application, or stripiness. This results from either spray application problems or poor soil condition.

General Conditions

- Application timing is very important. If targeting deep germinating weeds (eg burrs), early application is important for effective control. This is because the herbicide must be washed into the germination zone for those weeds.

- Soil conditions are also important to ensure even application. Some herbicides need to be mechanically incorporated for effective weed control, and cloddy soil can lead to stripiness of application. Soil moisture prior to application can also be important, with products such as Cotoran® and Cotogard® being drawn into the soil better if it is wet.

Nozzles

- Wide angle flat fan nozzles will usually be the most practical.

- Flat fans can be either evens or tapered. Tapered fans should be used where you are getting nozzle overlap, such as in broadacre application.

  110° nozzles should be used for broadacre application.

  Low pressure nozzles are preferable in a lay-by situation,

- Nozzle size will be determined by the water rates being used. Some soil applied herbicides require high water volumes (150 to 250 L/ha) and therefore nozzles may need to be 003 or 004 size.

- Spray drift does not usually pose a threat with soil applied herbicides. Pressures should be maintained in the 200 to 300 kPa range.

Nozzle configuration

- There are a number of different configurations which can be effectively used for lay-by spraying. A single dropper between the rows with two nozzles can be as effective as two droppers with a single nozzle on each. The most important consideration is the nozzle height and its direction toward the soil under the crop.

Plant applied

The aim of post emergent herbicides application is to control the weeds between the rows but not affect the cotton plants. This is most effectively achieved by using a shielded sprayer. Whilst many commercially available shielded sprayers are available, farmer manufactured versions are operating quite efficiently.

Table 16. Estimated farm machinery operating costs ($/ha)

	Fuel (L/ha)	Fuel & Oil	Repairs, & Maint.	Total Operating cost	Fixed Cost	Total	Labour	Total $/ha	Total Plus 20% profit
TILLAGE:									
Chisel Plough	7.0	3.85	2.50	6.35	5.20	11.55	2.00	13.55	16.25
Scarifier	5.5	3.00	2.00	5.00	4.20	9.20	1.80	11.00	12.20
Offset - heavy	11.0	5.50	3.00	8.50	9.50	18.00	3.50	21.50	25.80
- medium	6.0	3.30	2.00	5.30	4.00	9.30	2.00	11.30	13.60
Row crop cultivator	4.0	2.20	1.50	3.70	1.50	5.20	1.60	6.80	8.20
Field cultivator	4.0	2.20	1.50	3.70	4.00	7.70	1.60	9.30	12.40
Disc Tiller	6.0	3.30	1.60	4.90	3.70	8.60	2.00	10.60	12.70
Ripper	7.0	11.00	3.00	14.00	7.00	21.00	7.00	28.00	33.60
Fire-harrow	2.0	1.10	0.30	1.40	0.80	2.20	0.80	3.00	3.60
PLANTING:									
Combine	5.0	2.75	1.50	4.25	4.50	8.75	2.00	10.75	12.90
Air Seeder	5.0	2.75	1.50	4.25	5.00	9.25	2.00	11.25	13.50
Row crop planter	4.0	2.20	2.00	4.40	8.50	12.70	2.50	15.20	18.20
HARVESTING:									
Cotton Harvesting - spindle	45.0	25.00	43.00	68.00	130.00	198.00	15.00	213.00	255.00
Cotton Harvesting - stripper	11.0	6.00	39.00	45.00	35.00	81.00	7.00	88.00	106.00
SPRAYING:									
Boomspray	2.0	1.10	0.75	1.85	2.00	3.85	0.80	4.65	5.00

1. Rule of thumb for tractor fuel usage:
   1 engine kW/hr = 0.25 L/hr
   (100 kW tractor = 25 L/hr)
2. Costs are 'ball park' estimates which should be used as a guide only.
3. Fuel: 50 ¢/L

FALLOW MANAGEMENT & CROP ROTATION

Wherever dryland cotton is grown, the amount of stored soil moisture at planting time is the critical agronomic factor when making the decision to plant. In those areas with higher summer rainfall and/or soils with better water holding capacity eg Central Darling Downs, Liverpool Plains, 60 cm of wet soil is considered to be the minimum requirement. 90 cm of wet soil is the minimum required for the majority of the dryland cotton growing areas. This would translate to 140-180 mm stored plant available water, depending on soil type.

TYPES OF FALLOWS

Normal fallow

Dryland cotton is commonly brought into the cropping system on a twelve month fallow from a winter cereal. The following are important considerations in fallow management:

- retention of high levels of cereal stubble on the soil surface until planting and beyond if possible will maximise rainfall infiltration, reduce soil movement on both undulating and floodplain areas
- timely control of weeds and volunteer cereals will reduce moisture loss.
- chemical weed control in the early part of the fallow may help retain post harvest soil cracking patterns which aid soil profile wetting from the bottom up; less soil disturbance slows moisture loss from the surface layers, reduces weed germination.

Short fallow

Quite good yields have been obtained from cotton grown after a short (six month) fallow from sorghum or mung beans in years of average or better rainfall. To maximise the storage of autumn rainfall especially after a sorghum crop, management practices such as pre-harvest crop spraying or post-harvest stubble spraying with glyphosate, may increase the amount of moisture stored. The earlier that the preceding crop can be planted the previous spring, the longer the time afforded to replenish the profile during the fallow period.

If the country has to be worked, operations should be light, and as few as possible. Heavy operations which create a rough, open surface will require an excessive number of subsequent passes, with potential compaction problems in wet winters.

Double/opportunity crop

The opportunity to plant cotton into good levels of soil moisture soon after the harvest of a winter cereal crop may occur in up to 20-30% of years in the more northern parts of the cotton growing area.

This is most likely to occur when a dry harvest, free of wheeltracking problems, is followed by good early storm rainfall. Grain drying allows an earlier start to grain harvesting, and therefore increases the time available to take advantage of any opportunity that arises. The use of rainfall probability indicators such as SOI index will assist in decision making especially in opportunity cropping scenarios.

SEEDBED PREPARATION

Two major requirements for cotton planting are sufficient soil moisture stored in the profile and a suitable seedbed.

The seedbed

Cotton can be a difficult crop to establish. A seedbed of fine tilth is required to ensure good seed-soil contact and even germination. Most soils will require a number of workings during the fallow to obtain the desired tilth. This has to be addressed on paddocks prepared under a no-tillage regime, with some form of zone tillage at or prior to planting. Care needs to be taken in preparing land, not to 'shallow up' the seedbed too early. The plant is very sensitive to soil temperature at germination. Effective spreading of the stubble and tailings when harvesting the preceding crop helps to avoid zones of variable soil temperature and soil moisture level.

Managing soil compaction

Cotton is very sensitive to compacted soil. Avoid working if the soil is too wet and use the minimum tyre pressures on all wheeled equipment. If wheeltracks have come through from the previous harvest, nurture them early. Fill and level track marks by light cultivation with either light offsets or a cultivator. During the planting operation, avoid planting into wheeltracks. If no-tilling, tramlining the paddock in its planting configuration early in the fallow will help overcome this problem.

If soil compaction problems are suspected, take a shovel and physically check the soil profile. If dense layers are found, cultivation at a depth just below the damaged areas is the most effective means of amelioration. Subsequently, management strategies should be adopted so as to minimise re-occurrence.

Weed control

Weed control is important in the fallow and the crop. Many of the residual herbicides applied in grain cropping systems are phytotoxic to cotton. These include the sulfonyl ureas used in winter cereals and atrazine used for sorghum. The residual life in the soil of many of these is unpredictable but is dependent on climatic conditions and soil pH. As a general rule, if there is any likelihood that cotton will be the following crop, these groups of chemicals should be avoided during the previous crop as well as the fallow.

Trifluralin is one of the cheapest and most effective herbicides for use in cotton. In areas where the planting window is narrow, its application pre-plant can eliminate sorghum as a late substitute. Its requirement for incorporation into a relatively stubble free seedbed creates some problems in minimum till situations. The practice of banding herbicides requiring minimal incorporation, during planting, is an alternative.

Diuron is another residual herbicide that can restrict later planting choices if used in the fallow. In fact, in dryland cotton, there is a trend away from use of residuals even at planting, because many of them require good soil moisture levels to become active. A greater reliance is being placed on use of knockdowns, through improvements in shielded sprayer technology.

A clean weed free start is essential for a cotton crop. This is best achieved by the application of a knockdown herbicide(s) immediately pre-plant or post-plant, pre-emergent. Weeds at this stage are normally young, fresh and very susceptible to relatively low rates of herbicide. When selecting herbicides for pre-plant application, note that 2,4-D products have a 10-21 day plant-back interval with cotton. Table 9 provides full details on plant back periods for a number of herbicides. More detailed information on herbicide selection for fallow weed control is contained in chapters on fallow management in Queensland Regional Crop Management Notes or NSW Agriculture Weed Control Books for winter and summer crops.

Nitrogen application

In dryland cotton, nitrogen is normally incorporated in a pre-plant application. This application should occur late in the fallow to reduce the likelihood of denitrification, yet early enough that any concentrated band of fertiliser does not reduce germination. The use of 'cold-flo' anhydrous ammonia or granular products reduces the need for deep application and accompanying seedbed damage.

If planting with a tine planter, the opportunity exists to use N -injector tines to apply all N fertiliser requirements during the planting operation, without damaging the seed.

CROP ROTATION

There are a number of factors that need to be taken into consideration when looking at developing rotations involving dryland cotton. These include:

- soil moisture accumulation
- provision of surface cover
- potential for influencing Heliothis population dynamics
- potential for disease build-up
- influence on VAM
- influence on fallow nitrogen

Only in years of well above average winter/spring rainfall would back to back cotton be likely in a dryland situation. Table 10 outlines a number of possible rotational options likely to be used in the dryland cotton areas.

Rotation 1 is the most commonly practiced rotation in the dryland cotton areas. It maximises the chances of high levels of stored soil moisture at planting. If a conventional tillage strategy is followed, surface cover levels are frequently low with associated potential for soil erosion. The low cropping frequency may reduce VAM levels in the soil with consequent fertility problems. However this is more likely to be a problem when dryland cotton is grown on a 18 month fallow from a previous cotton or sorghum crop.

Rotations 2,3 and 4 are dependent on good rainfall soon are the completion of cotton harvest. They increase the frequency of cropping. Rotation 4 provides better surface cover during the summer fallow, usually resulting in better soil moisture storage and erosion control. While rotations 3 and 4 have the potential to reduce artificial nitrogen inputs, the chickpea option can potentially increase later season Heliothis pressure in an area.

Rotation 5 also increases the frequency of cropping, and the level of ground cover. To maximise the chance of re-wetting the soil profile before cotton, the alternative summer crops must be planted as early as possible.

Economics are not included in the Table, as the relative return between the different crops included varies each year. If looking for sustainable systems, these other factors must also be considered.

Table 17. A guide to plant back periods for cotton

CHEMICAL	PRODUCT	ACTIVE CONSTITUENT	APP. RATE PER HECTARE	PLANT BACK PERIOD	COMMENTS
sulfonylureas	GLEAN SIEGE	750g chlorsulfuron/kg	15-20g	24 months with a minimum of 700mm rainfall 27 months with a minimum of 700mm rainfall Glean is not recommended where soil pH is above 8.5	where soil pH is 6.6-7.5 where soil pH is 7.6-8.5 where soil pH is above 8.5
	ALLY	600g metsulfuron/kg	5-7g	15 months with a minimum of 700mm rainfall 18 months with a minimum of 700mm rainfall 18 months and then a further 700mm rainfall	where soil pH is 5.6-8.0 where soil pH is 8.1-8.5 where soil pH is above 8.6
	HARMONY M	682g thifensulfuron + 68g metsulfuron/kg	40g	15 months with a minimum of 700mm rainfall 18 months with a minimum of 700mm rainfall 18 months and then a further 700mm rainfall	where soil pH is 5.6-8.0 where soil pH is 8.1-8.5 where soil pH is above 8.6
	LOGRAN	714g triasulfuron/kg	30-35g	12 months 22 months 24 months	where soil pH is up to 6.5 where soil pH is 6.5-7.5 where soil pH is above 7.6
	AMBER POST	20g triasulfuron + 600g terbutryn/Kg	250-500g	14 months	
2,4-D	2,4-D AMINE	500g 2,4-D amine/L	up to 0.7L 0.7-1.4L above 1.4L	10 days after at least 15mm rainfall 14 days after at least 15mm rainfall 21 days after at least 15mm rainfall	Breakdown of 24-D is dependent upon microbial action under warm, moist conditions. Nominated plant back periods only commence after there has been in excess of 15mm rainfall. Extreme caution needs to be exercised under very dry conditions.
	2,4-D ESTER	800g 2,4-D ester/L	up to 0.35L 0.35-0.7L 0.7-1.1L	10 days after at least 15mm rainfall 14 days after at least 15mm rainfall 21 days after at least 15mm rainfall	
	TILLMASTER	180g 2,4-D amine + 90g glyphosate/L	up to 2.0L 2.0-4.0L 4.0-6.0L	10 days after at least 15mm rainfall 14 days after at least 15mm rainfall 21 days after at least 15mm rainfall	
	TILLMASTER CT	100g 2,4-D amine + 100g glyphosate/L	up to 3.6L 3.6-5.4L	10 days after at least 15mm rainfall 14 days after at least 15mm rainfall	
	SURPASS	225g 2,4-D IPA salt/L	Up to 1.5L 1.5-3.0L 3.0-4.6L	10 days after at least 15mm rainfall 14 days after at least 15mm rainfall 21 days after at least 15mm rainfall	

Table 17 (cont.)

CHEMICAL	PRODUCT	ACTIVE CONSTITUENT	APP. RATE PER HECTARE	PLANT BACK PERIOD	COMMENTS
dicamba	DICAMBA 200 BANVEL	200g dicamba/L	up to 0.6L 0.7-1.4L	7 days 21 days	Breakdown of dicamba occurs by microbial activity under moist soil conditions. The nominated plant back periods should only commence after there has been in excess of 15mm rainfall. Extreme caution needs to be exercised under very dry conditions.
	SANDOBAN	60g dicamba + 150g glyphosate/L	up to 2.0L over 2.0L	7 days 21 days	
picloram	TORDON 50-D	50g picloram + 200g 2,4-D/L	500ml	12 months	
	TORDON 242	26g picloram + 420g MCPA/L	1.0L	12 months	
fluroxypyr	STARANE	300g fluroxypyr/L	up to 500ml 500ml-1.5L 1.5-4.0L	14 days 28 days 60 days	Fallow Spray. Mainly used at lower rates of 250-500ml/ha. Either alone or in tankmixes with glyphosate.
triclopyr	GARLON 600	600g trichlopyr/L	80-160ml	7 days	Fallow Spray. Used in tankmixes with glyphosate for the improved control of paddy and camel melons.
clopyralid	LONTREL	300g clopyralid/L	70ml 150ml 300ml	7 days 14 days 56 days	Fallow Spray. Used in tankmixes with glyphosate for improved control of milk thistle.
oxyfluorfen	GOAL CT	240g oxyfluorfen/L	75-100ml	No plant back period required at the rates specified.	Fallow Spray. While Goal does have soil residual action, the spike rates of 75-100ml used to tankmix with glyphosate should present no soil residue problems in cotton when used as a pre-plant treatment. The chemical provides improved control of prickly lettuce, mallow, medics and stinging nettle.
atrazine	Various Products	500g atrazine/L	2.5L/ha 2.5-6.5L/ha	6 months 18 months	Damaging residues from high rates of atrazine may persist for up to 18 months depending on weather conditions and soil type. Atrazine is more persistent under the following conditions - increasing soil pH (alkaline soils) - increasing clay content of the soil - low soil temperatures - low soil moisture levels. Residues persist for considerably longer on alkaline clay soils, and extreme caution needs to be exercised on clay soils where the soil pH is above 8.0. Atrazine breakdown is also strongly influenced by seasonal conditions. Rates of breakdown slow considerably under dry conditions and can stop altogether under extreme conditions such as drought.

The table of plant back periods is provided only as a guide. Growers are advised to carefully read the label of any chemical that is likely to pose potential residue problems.

Table 18. Some possible rotational cropping options for dryland cotton

S	W	S	W	S	W	S	W	S	W	S	Soil $H^{2}0$	Surface Cover	Insects	Disease	VAM	Nitrogen
Cotton	Fallow	Fallow	Winter Cereal	Fallow	Fallow	Cotton					++	-	++	++	-	O
Cotton	Opp. Winter Cereal	Fallow	Winter Legume	Fallow	Fallow	Cotton					++	+	+	++	+	++
Cotton	Opp. Winter Legume	Fallow	Fallow	Cotton							+	+	+	+	+	+
Cotton	Opp Winter Cereal	Fallow	Fallow	Cotton							+	++	++	++	+	O
Cotton	Fallow	Sorghum Millet Mungbean	Fallow	Cotton							-	++	+	++	++	-

KEY:

++ Has strong positive impact on the factor with respect to cotton.
\+ Has some positive impact on the factor with respect to cotton.
O Has little impact on the factor with respect to cotton.
\- Has negative impact on the factor with respect to cotton.
N.A. Not Applicable.

AGRONOMY

Agronomically there are not large differences between the management of cotton and grain sorghum, apart from the obvious differences in some of the herbicides and insect management. Land preparation, fertiliser rates and herbicide application are very much the same.

Graingrowers with successful experience in maize, sorghum, sunflowers, soybeans and other crops should not have any difficulty adapting to cotton. Land preparation is similar to other summer crops. Plough pans or compacted layers will cause similar problems for cotton as they do for sunflowers. Compacted fields should be avoided or deep worked early in the land preparation stage.

Whilst long fallowed areas with a full profile of moisture are preferred, 60 cm of wet soil at planting is a reasonable risk on the deeper soils. In the hotter and lower rainfall areas, 90 cm of wet soil is a more realistic starting level.

CROP DEVELOPMENT

Temperature is a major factor affecting cotton production. It:

- determines the earliest and latest planting dates,
- effects the length of the growing season. Frost will stop the growth of cotton plants, hence the date of the first frost in autumn determines the end of the season,
- has a strong influence on fibre development, particularly on fibre diameter, and
- is directly related to the rate of crop development. At temperatures below 12°C, cotton development ceases.

$$\textit{Day degrees} = \frac{(\textit{Daily}\ \text{max.}\ \textit{temp.} - 12) + (\textit{Daily}\ \text{min.}\ \textit{temp.} - 12)}{2}$$

The higher the average temperature, the quicker the plant will develop through its major growth stages. A common way of expressing the accumulation of heat over the season is as day degrees, or heat units.

The sum of daily day degree values can be used to compare the crop's developmental stage with its potential development.

Typically values of day degrees to attain some developmental stages are given in table 19.

Table 19. Crop development stages

Phase	Day Degrees	Days (range)
Planting to Emergence	80	7 to 20
Emergence to First Squares	425	34 to 45
Square to Flower	270	20 to 30
Flower to Open Boll	750	40 to 80
Planting to Crop Maturity		140 to 200

VARIETIES

Hotter long season areas:

- Siokra L22 (often called simply L22)
- Siokra L23
- Deltapine 90 and 5690
- CS 189+
- Siokra 1-4 (late plantings only)

Shorter season areas:

- Siokra L23 (earliest plantings only)
- Siokra 1-4
- Siokra S324
- CS 7S
- Sicala V-1
- Deltapine 5415

Varieties bred for the high yielding irrigation environment have also proved to be the highest yielding under dryland conditions, in general.

Seasonal length seems to have a major influence on the relative performance of varieties. In the shorter season, cooler areas (eastern Downs, eastern Namoi) mid to short season varieties do well. By contrast, long season varieties yield the best in more northern and western areas. However, even there, mid to short season varieties are best grown for late plantings.

Dryland variety trial results often vary greatly from place to place and season to season. Overall trials can only be assessed with confidence after a number of trials over a number of seasons.

The relative yields (expressed as a percentage of Siokra 1-4's yield) over four seasons and a total of 14 large scale CSD trials are as follows:

Siokra L22/L23	106.4
DP90	102.3
CS 189	101.6
Siokra 1-4	100.0
Sicala 33/34	99.0

Besides these varieties later releases including Sicala V-1, CS 189$^+$, CS 7S and Siokra S324 are being evaluated. So far Sicala V-1 has done well in some areas and seasons, CS 189$^+$ usually outyields CS 189 and Siokra S324 yields well in cooler districts and at late plantings.

Other considerations

i) Okra leafed varieties - L22, L23, Siokra 1-4 and Siokra S324, have better tolerance to insect pests and mites. Spray costs may be reduced by up to 15%.

ii) Deltapine 90 is susceptible to Bacterial Blight, while all CSIRO bred varieties are resistant to this disease.

iii) Some CSIRO varieties including L22, Siokra 1-4 and Sicala 34 (Table 1) have superior fibre length and under dryland conditions usually suffer less short staple penalties. The CSIRO bred varieties are also less likely to be penalised for coarse micronaire in hot areas. CS 7S and Siokra S324 are less likely to incur penalties for low micronaire at late plantings.

Table 20. Staple lengths of 5 dryland trials over 3 seasons

Variety	Mean
Siokra 1-4	1.09
Siokra L22	1.09
Siokra L23	1.07
Siokra S324	1.06
Sicala 34	1.09
Sicala V1	1.05
CS 7S	1.03
CS 50	1.07
CS 189	1.06
CS 189$^+$	1.08
DP90	1.06

Notes on varieties

Siokra L22
This CSIRO bred variety is increasingly being grown as it is a consistent top yielder in full season areas and under all except extreme conditions, has a length advantage. It has short fruiting branches, and usually holds its first set bolls high off the ground. The okra leaf helps achieve better pest control.

Siokra L23 is very similar in growth and appearance to Siokra L22. In small scale (research) dryland trials it has out yielded all others including L22. However, its staple length is not quite as long as L22's.

Deltapine 90
DP90 is a high yielding, later maturing good quality variety. It is a normal leaf, tall plant and is the only major variety susceptible to Bacterial Blight. Has been widely grown since the early eighties and is very adaptable. A strong forager for moisture, but appears less able to compensate for early setbacks (hail, insects, etc).

Deltapine 5415
Early to mid maturing variety with bushy plant, normal leaves and small bolls. Good fibre quality with 2% higher gin turnout than Deltapine 90.

Deltapine 5690
Similar to Deltapine 90, normal leaf, but slightly earlier maturing. It is 3 to 5% higher yielding with high fibre quality. Good seedling vigour.

CS189$^+$
This slightly higher yielding and better quality replacement of CS 189 resembles DP 90 in most growth and fibre characteristics, but has the advantage of being Blight resistant. It's tolerance to Verticillium Wilt is very good, approaching that of Sicala V-1.

Siokra 1-4
A versatile true mid-season variety and a consistent top performer in the cooler dryland areas. Compensates well for early damage (hail, insects, etc) and does well across planting dates, ranging from early to late. Again, its okra leaf helps ensure effective control of pests.

Siokra S324
An even earlier maturing variety than Siokra 1-4. Usually outperformed by Siokra 1-4 except in the shorter season areas. Also suited to late planting in longer season areas.

CS7S
Normal leafed, very early type for very short season areas. Compact plant with cluster fruit. Good fibre characteristics and holds micronaire well under unfavourable conditions and it has good tolerance to Verticillium Wilt.

It yields well in cool areas, although not early maturing.

PLANTING CONFIGURATION

Selection of planting configuration involves many more factors than simply yield potential. It is an important consideration however, because it will affect some of the management decisions and input costs that follow during the growing season, e.g. insecticide costs, ground rig vs aerial application, weed control and picking.

On the very deep black clay soils of the Central Darling Downs, Gunnedah and Breeza with high soil moisture holding capacity and in areas of more reliable rainfall, solid plantings usually have a yield advantage over the skip row plantings. If a good dryland maize crop is possible, then solid plant cotton should also be possible.

Skip row plantings are likely to be better suited on soils of lighter texture, and shallower soils with a lower soil moisture storage capacity or in areas of lower rainfall. In SW Queensland and the Gwydir and McIntyre Valleys on northern NSW, single skip row is the most widely used configuration because it is seen to provide the best balance between cost containment and yield performance. In Central Queensland, time of planting and starting soil moisture has a big influence on the planting configuration chosen. Double skip is not used widely except on the western Downs where crop establishment is not a problem, but the desire to contain growing costs is important.

Since 1984 QDPI and ICMS Research have conducted over 28 separate experiments which included comparisons of solid and skip row plantings in both Central Queensland and on the Darling Downs. These experiments were part of a Cotton R & D Corporation project and have provided a series of simple correlations for comparing the yields of the various solid and skip row combinations.

Apart from yield, a comparative analysis of profitability of the different row spacing configurations must also take into account cotton prices and the substantial differences in growing costs between each. An example of the relative economic benefits of skip row compared to solid is detailed in figure 4. This figure has been based on the yield relationships generated as part of the trials mentioned above as well as a number of assumptions. These assumptions are: cotton price - $350 nett with no grade variations between configurations; insecticide sprays...solid - 6, single skip - 7, double skip - 8; harvesting...pickers for solid - $200/ha, for single skip - $136/ha and for double skip - $100/ha; strippers...$62/ha + $0.05/kg seed cotton.

The analysis given in figure 3 shows that the skip row configurations will out perform solid at yield levels below the 2 to 3 bales/ha range while single skip and solid will out perform double skip above 2.5 bales/ha. Solid only tends to out perform single skip above 3.5 bales/ha.

SEED TREATMENTS

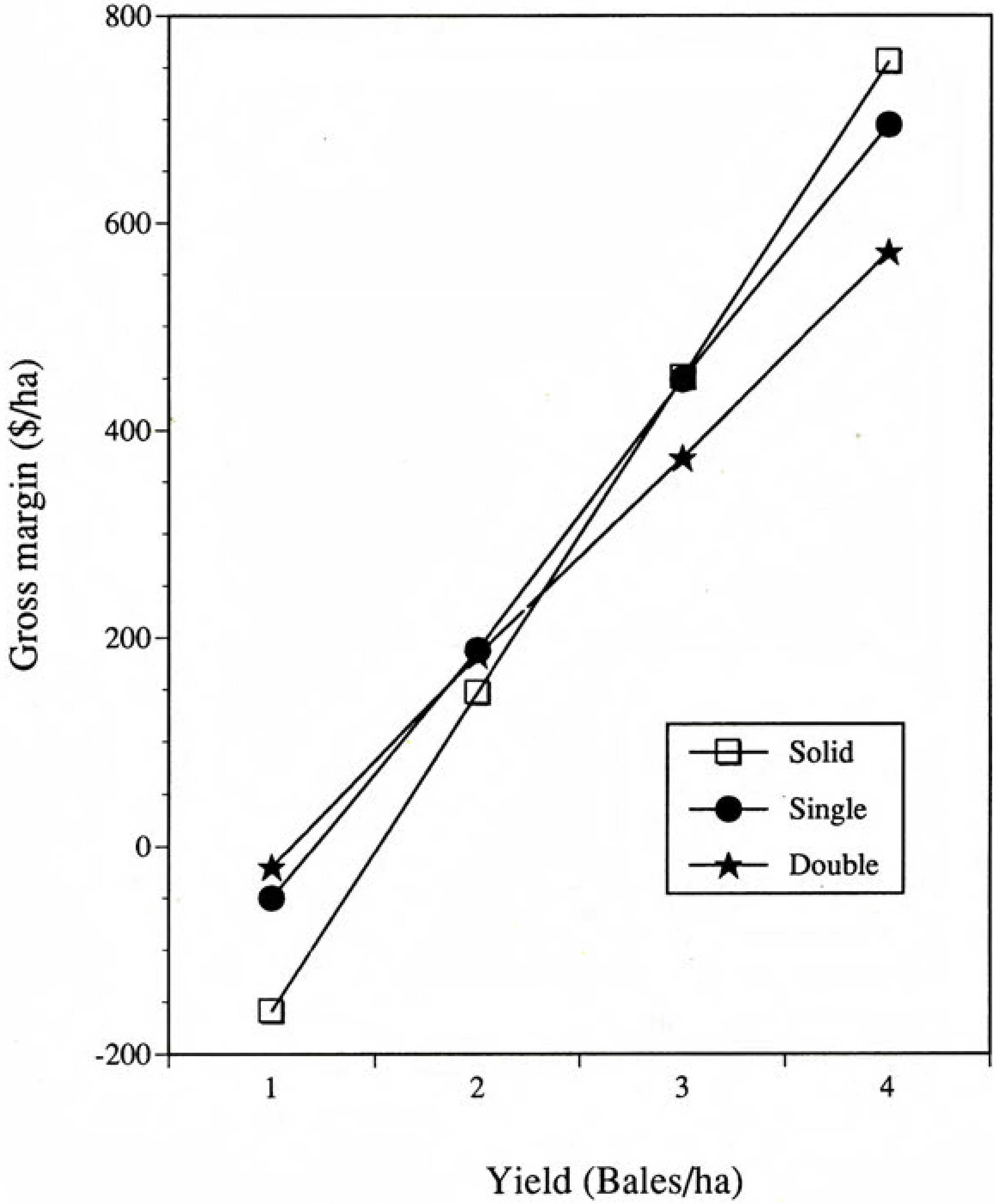
A number of fungicides and insecticides are registered for use as seed treatments on cotton. Seed can be purchased pre-treated from your supplier. The seed treatments provide some insurance against damage or loss of seedlings. Early plantings into cool and wet soils slow plant development and make seedlings more prone to damage from disease and sucking insects. The treatments are less important with later and warmer plantings.

Fungicides

Terraclor® - active against Rhizoctonia sp.

Apron® - systemic fungicide active against Pythium and related species of fungi which cause 'damping off' of seedlings.

Figure 4. Yield and gross margin relationships for three row spacing configurations in dryland cotton.



ecticides

hene® - a systemic insecticide active against thrip and aphid for up to 4 weeks.

nevin® - provides systemic thrip control for up to 20 days post planting.

Seed colouring

Peridiam Blue (CSD) and Glossy Red (Deltapine) seed coat colouring is being offered as a new treatment in 1993/94. It enhances the application and effectiveness on fungicides and insecticides, seed flow, and leaves a unique colour on the seed which allows both planting depth and rate to be easily checked.

ANTING

nting times

ble 21. Regional planting times

	Northern NSW, Darling Downs, Sth West Qld	Central Highlands	Liverpool Plains
'referred	early October to mid November	mid November to late December	early October to mid November
.atest	mid December	mid January	late November
Earliest	late September	late September (high risk)	late September

nsiderations

Soil temperatures should be 16 to 17° and rising.

Earlier plantings under cooler soil temperatures results in poorer establishment, slower development and greater vulnerability to seeding insects and diseases.

Later plantings than suggested risk having cooler autumn conditions affect fibre development. Insecticide costs may also be higher as a number of more expensive Stage III sprays may be required.

Plant populations

Desirable 7-8 plants/metre row

Equivalent to 45,000 to 55,000 plants/ha (single skip)

Considerations

- Evenness of the stand is more critical than the absolute population achieved. A gappy stand is difficult to manage due to the large range in plant size. Yield limitation and delayed maturity may also result.
- Trials suggest that row configuration has little effect on the desirable number of plants per metre. In practice, however, growers are happy with 4 to 5 plants per metre row on solid row configurations.

Seeding rate

Range 6 to 12 kg seed/ha

To calculate your needs, determine:

- desired plant population (eg) 50,000 plants/ha
- germination percentage (eg) 95%. All seed is supplied at a minimum of 70% germination
- establishment percentage (eg) 70%
- seeds per kilogram (eg) 10,000 seeds/kg. This will be provided on the bags.

Sowing Rate (kg/ha)

$$= \frac{\text{Desired plant population x 10,000}}{\text{seeds per kg x germ \% x estab \%}}$$

$$= \frac{50{,}000 \times 10{,}000}{10{,}000 \times 95 \times 70}$$

$$= 7.5 \text{ kg/ha}$$

Seeds per metre (solid rows)

$$= \frac{\text{Desired seeding rate x seeds per kg}}{10{,}000}$$

(eg)

$$= \frac{7.5 \times 10{,}000}{10{,}000}$$

$$= 7.5 \text{ seeds per metre}$$

Seeds per metre (single skip row)

$$= \frac{\text{Desired seeding rate x seeds per kg x 1.33}}{10{,}000}$$

$$= \frac{7.5 \times 10{,}000 \times 1.33}{10{,}000}$$

$$= 10 \text{ seeds per metre}$$

Planting depth

The cotton plant is very sensitive to both depth of soil and pressure above the seed. Seed planted deeper than 5 cm will fail to, or at best be very slow to emerge. Such a delay can set the plant back weeks in later stages, making pest management and crop conditioning operations very difficult. Excessive presswheel pressure, pressing large lumps of soil, or crusting due to heavy rainfall can all seriously affect emergence, as the young emerging cotton plant has little strength. Therefore, 5 cm depth of planting, with light presswheel pressure or rolling, and good soil tilth.

Table 22. Insecticides/Fungicides at planting (rates in kg/ha)

Product	TEMIK 150 G	chlorpyrifos	DISYSTON 50	THIMET 200 G
Method of Application	in-furrow granules	in-furrow spray or bait	in-furrow granules	in-furrow granules
Aphids	3 - 7	-	14	3
Jassids	3 - 7	-	-	3
Mites	3 - 7	-	14	3
Thrips	3 - 7	-	14	3
Mirids	5			5
Earwigs		5 kg Bait mix/ha*		
Crickets		2.5 kg Bait mix/ha*		
Wireworms		in-furrow spray 5-15 mLs/100 m row		
False wireworms		in-furrow spray 5-15 mLs/100 m row		

* Chlorpyrifos grain bait: mix 4 L chlorpyrifos (500 g/L) + 5 L sunflower oil

Considerations

- Wireworms and false wireworms can be a major problem for all wide row planted summer crops. These soil dwelling insects are best controlled with in-furrow treatments at planting. Treatment after planting is impractical.
- Assess numbers of wireworm and false wireworm prior to planting using soil samples. Control is warranted where significant numbers exist and where establishment conditions are unfavourable (eg) cool or dry seedbeds.
- The granular insecticides Temik®, Disyston® and Thimet are registered to control sucking insect pests on seedling cotton. They have not been widely used in dryland production.
- Rhizolex® is registered for the control of Rhizoctonia (a seedling disease). Plantings into cool, wet conditions, particularly following soybeans, are most susceptible. The seed treatment Terraclor should provide adequate protection in most dryland situations.

NUTRITION

Nutrient requirements

Table 23 indicates the relative nutrient uptake and removal by a 2.5 bale/hectare cotton crop.

Table 23. Nutrient removal rates

Major nutrients	Removal in lint + seed (kg/ha)	Total uptake (kg/ha)
Nitrogen	45	85
Phosphorus	10	15
Potassium	14	46
Calcium	2	34
Magnesium	4	13
Sulphur	2	N/A

Micronutrients	Removal in lint + seed (kg/ha)
Zinc	0.036
Manganese	0.012
Boron	trace
Copper	0.070
Iron	trace

Reference: Donald, L. (1964) 'Hunger Signs in Crops' 3rd ed.

The table indicates that N, P, and K are the nutrients most likely to be limiting crop growth and which may require the addition of fertiliser. Zinc is the only other nutrient to which fertiliser responses have been documented.

Fertilisers

In general, dryland cotton is fertilised similarly to other summer crops, although cotton's root system may access nutrients at greater soil depth. Fertiliser is commonly used on the Darling Downs.

When deciding on fertiliser rates for dryland cotton, consider the following:

- rotational history of the paddock. Requirements are greater following sorghum or cotton than after a long fallow from a cereal or legume crop.

- responses to fertiliser in other summer crops

- responses to fertiliser in dryland cotton on similar soils in the district

- soil tests can also be useful

Fertiliser rates commonly used on the Darling Downs are:

- 40 to 70 kg N/ha depending on soil moisture and above factors

- 30 to 40 kg MAP/ha on Mywybilla, box and Anchorfield ridge soils

Timing and placement

- **Nitrogen** is generally applied pre-sowing, either broadcast and incorporated or banded. It should be delayed until late in the fallow, especially if the profile is full of soil moisture to reduce the risk of loss by denitrification. In reduced tillage systems, banding may be preferable but relies on good marking systems.

  The band should be located at least 10 cm below the anticipated seeding depth to avoid the detrimental effect of high nitrogen concentrations on seed germination.

- **Phosphorus** is relatively immobile in the soil and hence placement is critical. If applied at planting, it should be placed 5 to 10 cm below and to the side of the seed.

- **Zinc** deficiency can be corrected pre-sowing incorporated or with foliar treatments.

WEED CONTROL

Cotton is a very poor competitor against weeds and even moderate weed infestations will result in a considerable reduction in yield.

Young seedling weeds begin to compete with cotton about four weeks after emergence of the crop, which means that the initial weed control operations must be completed by this stage of development. The crop will then have to be kept weed free through until at least 10 to 14 weeks after emergence to ensure that no yield loss results from weed competition.

Lint quality can also be reduced by weed contamination, while heavy weed infestation can cause difficulties during picking.

Weed control can be achieved through:

- Crop Rotation
- Weed control in fallow
- Inter-row Cultivation
- Herbicides
  - pre-plant treatments
  - post-plant treatments - over the top
    - directed sprays
    - shielded sprays
  - pre-harvest treatments
  - spot spraying, e.g. Chemi-hoes
- Manual weeding using chippers.

Further details on spray application equipment and shielded sprayers are outlined on page 30.

Table 24 provides a guide to the weeds controlled by herbicides registered in cotton. Tables 26, 27, 28 and 29 provide a brief summary of the herbicides registered for use in Queensland. New South Wales herbicide registrations may differ slightly from the information provided, and NSW cotton growers are advised to refer to the NSW Cotton Pesticide Guide (1993/94) for further details. Further details on weed control methods, and the main residual chemicals used in cotton, are outlined in the NSW Agriculture Agfact - WEED CONTROL IN COTTON. Copies of this article are available from NSW Agriculture and QDPI offices servicing the main cotton growing areas.

Growers should give careful consideration to their choice of soil residual herbicides, particularly in areas such as the Darling Downs or Liverpool Plains where there is only a relatively short sowing window of 6 to 8 weeks for cotton. If a planting opportunity fails to eventuate for cotton in these areas, judicious use of soil residual herbicides may enable growers to reconsider other crop options for a December-January planting (e.g. sorghum, sunflower, and mungbeans).

See Table 30 for further details on re-cropping intervals using residual herbicides in cotton. These have been developed in consultation with the agrochemical industry and are intended only as a guide. The re-cropping intervals listed can often be modified to suit local seasonal conditions, or soil type variations. Seek further advice.

Table 24. A guide to weeds controlled by soil residual herbicides

Common Name	Trifluralin 1.4-2.8 L/ha	Pendimethalin 3.5-4.5 L/ha	Dual 2 L/ha	Fluometuron 4.5-6.0 L/ha	Diuron 1.8-3.5 L/ha	Prometryne 3.3-4.5 kg/ha	Fluometuron + prometryn 3.5-5 L/ha
ANNUAL GRASSES							
• General	S	S	S	MS	MS	MS	MS
• Barnyard Grass	S	S	S	MS	MS	MS	MS
• Urochloa	S	S	S	MS	MS	MS	MS
• Volunteer Cereals **	MS	MS	MS	S	S	S	S
Amaranthus	S	S	T	S	S	S	S
Annual ground cherry	T	T	T	MS	MS	MS	MS
Anoda weed	T	T	T	-	T	-	-
Apple-of-peru	T	T	T	S	S	S	S
Bathurst burr **	T	T	T	S **	S **	S **	S **
Blackberry nightshade	T	MS	MS	S	S	S	S
Black pigweed	S	S	T	S	S	S	S
Bladder ketmia	T	T	T	S	MS	S	S
Bellvine	T	T	T	MS	MS	S	S
Caltrop (Yellowvine)	S	S	T	S	MS	S	S
Camel melon **	T	T	T	S	S	S	S
Caustic Weed	T	T	T	S	MS	S	S
Cowvine (Peachvine)	T	T	T	MS	T	S	S
Deadnettle	MS	-	T	S	S	S	S
Fathen	S	S	T	S	S	S	S
Iceplant	T	T	-	S	S	-	-
Johnson grass from seed	S	S	MS	MS	T	T	T
Jute	PS	PS	MS	MS	PS	MS	MS
Mintweed	T	T	MS	MS	MS	S	S
Mung bean **	T	T	T	MS	MS	MS	MS
Native rosella	T	T	T	S	-	-	S
Noogoora burr **	T	T	T	S **	S **	S **	S **
Nutgrass	T	T	T	T	T	T	T
Paddy melon (Prickly)	T	T	T	S	S	S	S
Parthenium weed	T	T	T	S	S	S	S
Pigweed	S	S	T	S	S	S	S
Rattlepod	T	T	T	S	S	S	S
Thynchosia	T	T	T	-	-	-	-
Sesbania pea	T	T	T	MS	MS	MS	MS
Sorghum almum from seed	S	S	MS	MS	T	T	T
Sowthistle	T	T	T	S	S	S	S
Sunflower **	T	T	T	S **	MS	T	MS
Thornapples **	T	T	T	S **	S **	S **	S **
Wireweed	S	S	T	-	-	S	MS
Wild gooseberry	T	T	T	S	MS	S	S

S Susceptible
T Tolerant
- Not known

MS Moderately Susceptible
PS Some activity but limited data

** Because of their large seed size, these weeds may germinate below the herbicide band, thus reducing the level of control achieved.

The weeds listed in table 24 have been rated according to their susceptibility under average-good conditions.

Since the level of control with the soil residual herbicides is largely influenced by rainfall, seedbed soil conditions, and other environmental factors, there is no guarantee that any treatment will always have the effect indicated in the table.

ALWAYS READ THE LABEL OF THE PRODUCT BEFORE USE.

Common names for weeds can vary quite significantly from area to area, and can create confusion when discussing control options.

In order to avoid any unnecessary misinterpretation, the recommended common names as used by CSIRO are given precedence over the other more localised common names.

Table 25. Weed characterised by identification problems between areas

Recommended Common Name - CSIRO -	Scientific Name	Other Names
Annual Ground Cherry	Physalis ixocarpa (formerly Physalis angulata)	Physalis, Gooseberry
Bellvine	Ipomoea plebeia	Morning Glory
Bladder Ketmia	Hibiscus trionum	Wild Cotton
Caltrop	Tribulus terrestris	Yellowvine, Bullhead
Cowvine	Ipomoea lonchophylla	Peachvine
Jute	Corchorus olitorius	Native Jute
Legumes: • Emu-Foot	Psoralea tenax	wild Lucerne, Native Lucerne
• Rattlepod	Crotalaria species	Various other names
• Rhynchosia	Rhynchosia minima	Rhyncho
• Sesbania	Sesbania cannabina	Yellow Pea-Bush
Melons: •Camel melons	Citrullus lanatus	Afgan melon, Pie melon
• Prickly Paddy melon	Cucumis myriocarpus	Paddy melon
Native Rosella	Abelnoschus ficulneus	
Urochloa	Urochloa panicoides	Liverseed Grass
Wild Gooseberry	Physalis minima	Physalis, Gooseberry

Table 26. A guide to herbicides registered in cotton

ACTIVE CONSTITUENT	COMMERCIAL PRODUCT	CONCENTRATION grams a.i./L or Kg	FORMULATION	MANUFACTURER/ DISTRIBUTOR
chlorthal-dimethyl	DACTHAL W 750	750 g/Kg	WP	Incitec
diquat	REGLONE	200 g/L	SL	ICI
diquat + paraquat	SPRAY SEED	75 g + 125 g/L	SL	ICI
diuron	AGURON 500 SC	500 g/L	SC	Incitec
	DIURON 500	500 g/L	SC	Davison
	DIURON 500 SC	500 g/L	SC	Bayer
	DIURON FLO	500 g/L	SC	Rhone Poulenc
	DIURON FLOWABLE	500 g/L	SC	Farmoz
	DIURON LIQUID	500 g/L	SC	Nufarm
	KARMEX	800 g/Kg	WP	DuPont
	DIURON 900 WG	900 g/Kg	WDG	Rhone Poulenc
	DIURON 900 DF	900 g/Kg	WDG	Nufarm
	DIUREX 900 WG	900 g/Kg	WDG	ICI
	DIURON 900 WG	900 g/Kg	WDG	Bayer
	DIUGRANZ	900 g/Kg	WDG	Incitec
2,2 - DPA	PROPON 22-DPA	740 g/Kg	SP	Nufarm
fluazifop	FUSILADE	212 g/L	EC	ICI
fluometuron	FLUOMETURON 500 SC	500 g/L	SC	Incitec
	FLUOMETURON 500 SC	500 g/L	SC	Davison
	FLOWABLE COTORAN 500 FW	500 g/L	SC	Ciba Geigy
	FLOWABLE FLUOMETURON	500 g/L	SC	Rhone Poulenc
	FLOWABLE FLUOMETURON 500 SC	500 g/L	SC	Farmoz
fluometuron + prometryn	BANDIT LIQUID	250 + 250 g/L	SC	Incitec
	BANDIT WDG	425 + 425 g/L	WDG	Incitec
	FLOWABLE COTOGARD 500 FW	250 + 250 g/L	SC	Ciba Geigy
glyphosate	GLYPHOSATE 300 D	300 g/L	SL	Davison
	GLYPHOSATE 360	360 g/L	SL	Nufarm
	ROUNDUP	360 g/L	SL	Monsanto
	GLYPHOSATE CT	450 g/L	SL	Nufarm
	GLYPHOSATE 450	450 g/L	SL	Davison
	ROUNDUP CT	450 g/L	SL	Monsanto
	GLYPHOSATE 700	700 g/Kg	WSG	Davison
	PACER SOL-TECH	850 g/Kg	WSG	Monsanto
	WEEDMASTER CT	850 g/Kg	WSG	Nufarm
haloxyfop	VERDICT 104	104 g/L	EC	Dow-Elanco
	VERDICT DF	260 g/Kg	WSG	Dow-Elanco
metolachlor	DUAL	720 g/L	EC	Ciba Geigy
MSMA	DACONATE	800 g/L	SL	Incitec
	MSMA	500 g/L	SL	Rhone Poulenc
pendimethalin	STOMP 330E	330 g/L	EC	Incitec
prometryn	GESAGARD 500 FW	500 g/L	SC	Ciba Geigy
	PROMETRYN 500	500 g/L	SC	Farmoz
	PROTON	500 g/L	SC	Incitec
	GESAGARD 500	500 g/Kg	WP	Ciba Geigy
	PROMETRYN 500 WP	500 g/Kg	WP	Incitec

Table 26 (cont).

ACTIVE CONSTITUENT	COMMERCIAL PRODUCT	CONCENTRATION grams a.i./L or Kg	FORMULATION	MANUFACTURER/ DISTRIBUTOR
sethoxydim	SERTIN 186 EC	187 g/L	EC	Schering
trifluralin	TREFLAN	400 g/L	EC	Hoechst
	TRIDAN	400 g/L	EC	Rhone Poulenc
	TRIFLURALIN	400 g/L	EC	ICI
	TRIFLURALIN	400 g/L	EC	Nufarm
	TRIFLURALIN 400	400 g/L	EC	Farmoz
	TRIFLURALIN 400	400 g/L	EC	Davison

Liquid Formulations

SL	soluble liquid concentrate	- dissolves in water
SC	suspension concentrate	- forms a suspension in water, but does not dissolve
EC	emulsifiable concentrate	- oil based suspension in water.

Dry Formulations

SP	soluble powder	- dissolves in water
WP	wettable powder	- disperses, but does not dissolve in water
WSG	water soluble granules	- dissolves in water
WDG	water dispersible granules	- disperses in water, but does not dissolve

Table 27. Pre-plant herbicides - (Usually soil incorporated)

CHEMICAL	PRODUCT	RATE PER HECTARE	COMMENTS
trifluralin	various 400 g/L products	1.4-2.8 L/ha	* Most annual grasses and several broadleaf weeds * Use higher rates on heavier soils * Incorporate to 10 cm depth within 4 hrs of application * May be applied up to 6 weeks before planting
pendimethalin	STOMP 330E	3 L/ha	* Most annual grasses and several broadleaf weeds * Incorporate to 2-5 cm depth within 24 hrs of application * May need a further band spray rate of 4.5 L/ha at planting to compensate for the chemical displaced by the planting operation.
fluometuron	various 500 g/L products	2.8-5.6 L/ha	* Use higher rate on heavier clay soils * Shallow incorporation to less than planting depth - (5 cm). * Incorporate with Lillistons or equivalent * Apply just prior to incorporation * May need a further band spray rate of 1.8-3.6 L/ha at planting to compensate for the chemical displaced by the planting operation
fluometuron + prometryn	various 250+250 g/L products	2.5-5 L/ha	* Shallow incorporation to less than planting depth (5 cm) * Apply just before incorporation * Use higher rate on heavier soil * May need a further band spray rate of 2-3 L/ha at planting to compensate for the chemical displaced by the planting operation
diuron	500 g/L products	1.8-3.5 L/ha	* Broadleaf weed and some grasses * Incorporate no deeper than 5 cm with Lillistons * Ensure that cotton seed placement is below the treated soil zone * Can tank mix with trifluralin * Do not use on light soils as crop injury may result after heavy rain

Table 28. Post plant pre-emergent herbicides - (Usually surface treatments that are not incorporated.)

CHEMICAL	PRODUCT	RATE PER HECTARE	COMMENTS
diuron	500 g/L products	1.8-3.5 L/ha	* Ideally spray bare moist soil immediately after planting * Use the higher rate on heavy clay soils * Seed should be planted at least 4-5 cm deep to avoid crop damage. * Compact Soil * Do not use on light sandy soils as crop damage may result. * Use water rates of 150-200 L/ha
	800 g/Kg products	1.1-2.2 Kg/ha	
	900 g/Kg products	1-2 Kg/ha	
metolachlor	DUAL	2 L/ha	* Most Annual Grasses * Usually applied at or just after planting * Does not normally require mechanical incorporation although rain is needed within 10 days to activate the chemical. Shallow cultivation may be required if no rainfall is received. * Can be tank mixed with fluometuron and/or prometryn mixtures * Use water rates of 60-120 L/ha
pendimethalin	STOMP 330E	4.5 L/ha	* Most annual grasses and several broadleaf weeds * Can be tank-mixed with fluometuron and/or prometryn mixtures * Shallow incorporation with chains or finger harrows is recommended when applying in a band at planting * High water rates of 100-200 L/ha are recommended for post-plant treatments * Used where pre-plant soil incorporation is impractical * Apply to moist soil within 48 hours of sowing * Preplant incorporation is the preferred method where fathen and blackberry nightshade are a problem
fluometuron	various 500 g/L products	4.5-7.2 L/ha	* Apply immediately after sowing * Apply as overall spray or band * Minimum band width should be 40 cm * Use higher rates on clay soils * Severe crop injury may result if heavy rain occurs between sowing and emergence
fluometuron + prometryn	various 250+250 g/L products	3-5 L\ha	* Apply immediately after sowing * Soil should be moist at application, and rainfall is required within 3-5 days of application to activate the chemical * Apply as overall spray or band * Minimum band width should be 40 cm
	BANDIT WDG	1.8-3 Kg/ha	
prometryn	500 g/L	3.3-4.5 L/ha	* Irrigated cotton only * Apply to bare moist soil * Severe crop injury may result if heavy rain occurs between application and crop emergence

Table 29. Post emergent herbicides

CHEMICAL	PRODUCT	RATE PER HECTARE	COMMENT
DIRECTED SPRAYS - used to avoid direct contact with the cotton plant			
MSMA	DACONATE (800 g/L)	2.8 L/ha	* Directed spray at base of the cotton plant * Apply when cotton is 7 cm high up until first bloom * Performs best under hot dry conditions when air temps are above 21°C * High water rates required * For nutgrass, noogoora burr, and johnson grass
	MSMA (500 g/L)	4.3 L/ha	
prometryn	various 500 g/L products	1.1-2.2 L/ha Early spray when cotton is 15 cm high	* In irrigated cotton only * Weeds must be actively growing * Wetting agent required * Severe injury to cotton can occur where heavy rain occurs shortly after application
		2.2-4.5 L/ha 'Lay-by" spray after last cultivation	
diuron	various 500 g/L products	1.8-3.5 L/ha	* Apply when cotton is at least 30 cm high, or immediately after the last cultivation * Use higher rates on clay soils * Avoid spray drift onto cotton * Use high water rates 300-500 L/ha * Add surfactant if weeds present * Best results when weeds are actively growing
	various 800 g/Kg products	1.1-2.2 kg/ha	
	various 900 g/Kg products	1-1.9 kg/ha	
fluometuron	various 500 g/L or Kg products	1.3-2.8 L/ha early spray when cotton is 15 cm high	* Weeds should be actively growing * Wetting agent required * Apply water rates of 220-440 L/ha * Avoid contact with cotton
		2.8-5.6 L/ha 'Lay-by' spray after the last cultivation	
fluometuron + prometryn	various 250 g+250 g/L products	1.5-2.5 L/ha early spray when cotton is 30-50 cm high	* Weeds should be actively growing * Wetting agent required * Apply in 100-200 L/ha * Avoid contact with cotton
		2-3.5 L/ha 'Lay-by' spray after last cultivation	
	BANDIT WDG	0.9-1.5 Kg/ha early spray when cotton is 30-50 cm high	
		1.2-2 Kg/ha 'Lay-by' spray after last cultivation	

Table 29. (cont).

NON-DIRECTED SPRAYS - which can be sprayed directly over the top of the cotton plant			
fluazifop	FUSILADE	750 mLs - 1 L/ha	* Control of annual and perennial grasses * Apply to actively growing weeds. Lower rate for grasses 3 to 5 leaf stage * Wetting agent required: - 350 mLs Agral 60/100 L of 200 mLs BS1000/100 L
haloxyfop	VERDICT 104	1 - 1.5 L/ha	* Control of annual and perennial grasses. Lower rate for actively growing grasses 2 to 5 leaf stage. Spray oil or wetting agent is essential with the DF formulation
	VERDICT DF	200-300 g/ha	
sethoxydim	SERTIN 186	1 L/ha	* Apply to actively growing grasses at the 2 to 6 leaf stage * Add D-C-Tron crop oil at 2 L/ha
MSMA	DACONATE (800 g/L)	2.8 L/ha	* Can commence spraying when cotton is at least 7 to 8 cm high through until first bloom * Performs best under hot dry conditions when air temps are above 21°C * Can cause some burning and red discolouration of leaves. More suited to direct spray situations
	MSMA (500 g/L)	4.3 L/ha	
SHIELDED SPRAYS - to prevent any contact with the plant			
glyphosate	GLYPHOSATE 360 ROUNDUP ROUNDUP CT GLYPHOSATE CT	Label rates	* Do not apply in crops less than 20 cm in height * Do not allow spray or drift to contact any part of the cotton plant as severe injury may result * Use nozzles designed to operate at low pressures around 150 kPa eg. Spraying Systems, Extended Range. These nozzles produce a much lower proportion of driftable fines compared to conventional flat fan nozzles. * Use 2-4 nozzles per inter-row space to ensure adequate coverage of weeds * Special spray additives (eg. FLOWRIGHT) help reduce the potential for drift * Accurate tracking is essential to avoid crop damage.
PRE-PICKING SPRAYS - Once the crop is ready for defoliation			
glyphosate	ROUNDUP CT	1.25 - 2.5 L/ha	* Pre-picking spray for the control of Bathurst Burr, Noogoora Burr, winter annual weeds, and suppression of nutgrass. * Apply when at least 60% of bolls are open, and immature bolls cannot be easily cut with a sharp knife * Apply alone or in tank-mixes with DROPP or HARVADE * When tank-mixed with defoliants, a slightly higher proportion of leaf may be retained on the cotton plant - particularly where the higher ROUNDUP rates are being used * Where dense crops limit spray penetration, reduced weed control may occur. For best results under these conditions, delay ROUNDUP application until after the canopy is opened up with an initial conditioning treatment. * DO NOT APPLY TO CROPS INTENDED FOR SEED PRODUCTION.

Table 30. Minimum re-cropping interval after application in cotton (months)

	fluometuron	prometryn	fluometuron + prometryn	diuron	DUAL ®	STOMP ®	trifluralin
Barley	6	12	6	12	6	6	12
Canola	6	12	6	12	6	6	0
Chickpeas	6	12	6	12	6	0	0
Cotton	0	0	0	S	0	0	0
Cowpeas	6	12	6	12	6	0	0
Faba Beans	6	12	6	12	6	0	0
Lab Lab	6	12	6	12	6	-	0
Linseed	6	12	6	12	6	0	0
Lucerne	6	12	6	12	6	6	0
Maize	6	12	6	S	0	0**	12
Millets	6	12	6	12	6	12	12
Mung Beans	6	12	6	12	6	0	0
Oats	6	12	6	12	6	12	12
Sorghum	6	12	6	S	0*	12	12
Soybeans	6	12	6	12	0	0	0
Sunflower	6	12	6	12	0	0	0
Triticale	6	12	6	12	6	6	12
Wheat	6	12	6	12	6	6	12

* Concept ® treated sorghum seed

** Maize can be resown immediately after use in a failed crop provided the seed is sown below the treated band of soil

S The spring following application in cotton

\- No information available

The minimum re-cropping intervals after the application of herbicides in cotton are presented as a guide to assist in planning crop rotations.

While the nominated plant back periods can be reduced in some instances, this should only be done after seeking further advice, or on the basis of previous experience.

INSECT MANAGEMENT

Management of insect pests in cotton is very intensive and calls for highly skilled management inputs. Insecticide inputs constitute one of the major costs associated with cotton production.

Use a consultant

While it is not critical that new growers immediately become proficient in insect pest management, it is vital that they obtain the services of an experienced consultant.

Crop consultants will be able to provide detailed information on cotton production methods, and will have well developed strategies for the management of insect pests. A consultant should check the crop every 3 or 4 days to assess insect populations. When control is warranted the consultant will suggest the most cost effective insecticide to use, in consideration with the Insecticide Resistance Management Strategy guidelines. (See page xx).

Growers should engage a consultant and discuss insect control strategies well before planting. Regular contact and communication during the season should inform the grower of any insect control problems and crop progress.

A list of dryland cotton consultants operating in Queensland and NSW is provided on page xx.

Most consultants provide detailed crop management services other than just those involving insect monitoring and control. These services are usually provided on a contract basis for the full season. Approximate costs range from $25 to $40 per hectare.

Growers should also discuss and budget their anticipated chemical requirements with both the consultant and their agricultural chemical supplier.

Growers who would like to do their own pest monitoring should consider doing a cotton crop checking course at a TAFE.

Thresholds are important

Insect thresholds have been developed as a guide to determine the need for control. Using lower treatment thresholds will not necessarily increase yields, but insect control costs will escalate dramatically. Insect resistance will also be exacerbated if very low thresholds are adopted.

Differences between irrigated and dryland pest management

Insects cannot tell the difference between an irrigated crop and a dryland crop when moisture stress is not present, but in many seasons moisture stress will make the dryland crop less attractive to insects. The lower humidity of dryland crops also reduces the survival of many insects. In most seasons water stress will limit the yield potential of dryland cotton. Plant compensation for the loss of early squares is considered to occur at yields less than 5 to 7.5 bales/ha (depending on variety). Few dryland crops exceed these yield levels so compensation for some square loss is likely. However up to 7 days delay in maturity has been recorded when 60 squares per metre were removed (this equals about 6 heliothis larva per metre).

Dryland principles

The insect management strategy must be closely related to soil moisture status, insect pressure and realistic yield expectations. Generally aim to protect those fruit for which there is adequate moisture to produce mature bolls. Cotton has an indeterminate fruiting habit which enables it to keep producing fruit until some stress stops it. At yields below 5 bales/ha most cotton varieties can compensate for some insect damage. Varieties such as Siokra 1-4 can compensate for early insect damage very well and all "okra" leaf varieties have some tolerance to heliothis and mites.

Cotton Insecticides

Insecticides will be the major method of insect control for cotton. Insecticides are scheduled according to toxicity to humans and growers should follow the handling and mixing instructions to avoid poisoning.

Table 31 provides a list of cotton insecticides, but the relevant state label should always be consulted prior to application. Table 33 shows the insecticide groups and Table 32 is a guide to the cotton pesticide recommendations.

A strategy to minimise the development of resistance to insecticides and miticides in northern NSW and Queensland should be closely followed. The 1993/94 strategy is outlined in much more detail in the Summer Crop Insecticide Strategy on page xx. It is reviewed before the commencement of each season, and growers will need to keep informed of any changes that occur.

While seven to ten insecticide sprays will normally be required during the course of the growing season, under very high pest pressure 15 or more insecticide sprays may be required. Refer to the various crop gross margin tables in which typical insecticide scenarios have been used.

More experienced growers also have the option of using **EntomoLOGIC** to assist with their pest management decision making. This system provides field services for the monitoring of insect pest levels.

EntomoLOGIC

EntomoLOGIC is a microcomputer based insect management system developed by the CSIRO Cotton Research Unit at Narrabri.

Its purpose is to assist in making pest management decisions, and to provide a permanent record of insect pest pressures and spraying details.

EntomoLOGIC is available for both Apple Macintosh and IBM PC compatibles (a 386 or better is strongly recommended). Both have been extensively field tested over recent seasons and are being continually updated to incorporate the latest pest management practices.

EntomoLOGIC includes a heliothis development model, which predicts the mortality of eggs and the development of heliothis larvae over the next two days. This has the potential to save sprays by utilising the natural mortality of the pests.

The program supports a number of different sampling techniques. In addition to presence-absence sampling, insect counts can be entered as absolute numbers or as numbers per metre. Using equations derived from SIRATAC (no longer in use), entomoLOGIC standardises the counts to numbers per metre and suggests appropriate thresholds for each pest. A spray decision can then be easily made by the user, typically a consultant or experienced agronomist.

EntomoLOGIC for the 1993/94 season will incorporate the system of mite management developed by Lewis Wilson. This involves analysis of mite counts to estimate the economic benefits of control. The new resistance management strategy will also be incorporated, including support for the new Lepton® heliothis identification kit. There is a new reporting facility which prints pest pressure and spray reports under Microsoft Windows, helping consultants to keep their clients informed. Further information can be obtained from Lance McKewen or Warwick Madden ph (067) 99 1500.

An integrated approach

While integrated pest management is nothing new it is worth considering as a means to reduce the number of pesticide applications. Pest and predator numbers are carefully monitored and when pest populations exceed threshold a selective insecticide is used to control heliothis and minimise predator mortality.

There are a range of insecticides that are considered "soft" on predators, including Bt (*Bacillus thuringiensis*), chlorfluazuron (Helix), endosulfan and thiodicarb (Larvin) at the ovicidal rate. However they are all relatively expensive with the exception of endosulfan. Organophosphates and synthetic pyrethroids (SP's) kill predators as well as pests.

BIOLOGICAL INSECTICIDES

A number of products containing *Bacillus thuringiensis* (termed Bt's) are registered for use in cotton (Table 34). These compounds basically consist of a bacterial culture which, when used as directed, will selectively control plant feeding caterpillars such as heliothis larvae. Because of their unique properties they have an important role in the Integrated Pest Management programs that have been developed for the Australian cotton industry.

- Bt's have little or no effect on beneficial insects such as predators and parasites. When used during early season (Stage 1) they can help build up the levels of beneficial insects in the crop.

- Bt's used in combination with other insecticides can help reduce the selection pressure being placed on those chemicals through insect resistance e.g. thiodicarb, endosulfan and the synthetic pyrethroids (SP's). During Stage 2 of the Summer Crop Insecticide Strategy, guideline 12 recommends that growers use PbO with the first pyrethroid spray mixture application if *Heliocoverpa armigera* are dominant and Bt should be mixed with subsequent pyrethroids.

- Particularly useful near waterways, houses, or other environmentally sensitive areas.

There is no contact activity. The Bt's act as a stomach poison and are active only after being ingested by the caterpillar. The larvae stop feeding within minutes of ingesting the treated plant material, and cause no further damage to the plant. Bt's cause the stomach wall of the larvae to breakdown causing death due to starvation, septicaemia, and toxic shock. Sick and dying larvae can usually be found in the treated crop for up to 2-4 days after spraying. Death can be quicker under dry, hot conditions as the larvae dessicate at a faster rate.

Performance of Bt Sprays

Timing. Bt's are most effective on hatching and very small larvae. Sprays are ideally timed to coincide with the brown egg stage of development or at hatching larvae.

Crop Coverage. Thorough coverage of the main larval feeding sites is essential as the material needs to be ingested.

Environmental Conditions. If possible, apply Bt when larvae are actively feeding, and when there is low exposure to UV light. Preferably early evening or night. Additional wetting agent or stickers may be required to improve product performance under rainy conditions. Read the label for directions.

Rate. Best results are obtained at the higher registered rate, particularly if Bt is to be used alone.

Table 31. A guide to insecticides registered in cotton. This table does not imply registration in all states. The product label should always be checked prior to application.

ACTIVE CONSTITUENT	FORMULATION	COMMERCIAL PRODUCT	CONCENTRATION grams a.i./L or Kg	MANUFACTURER/ DISTRIBUTOR
aldicarb	granules	TEMIK 150 G	150 g/kg	Rhone-Poulenc
alpha-cypermethrin	EC	DOMINEX 100	100 g/L	Incitec (Agchem)
	EC	FASTAC 100	100 g/L	Shell
	ULV	DOMINEX 16 ULV	16 g/L	Incitec (Crop King)
	ULV	FASTAC ULV	16 g/L	Shell
azinphos-ethyl	EC	GUSATHION A	400 g/L	Bayer
bacillus thuringiensis	EC	DELFIN OF •	17.1 IU/mL	Sandoz
	EC	DIPEL ES	17.6 IU/mL	Abbott
bifenthrin	EC	TELSTAR 100 EC •	100 g/L	Incitec
beta-cyfluthrin	EC	BULLDOCK 25 EC	25 g/L	Bayer
	ULV	BULLDOCK 8 UL	8 g/L	Bayer
chlorfluazuron	ULV	HELIX 40 ULV	40 g/L	ICI
chlorpyrifos	EC	CHLORFOS	500 g/L	Rhone Poulenc
	EC	CHLORPYRIFOS 500 EC	500 g/L	Nufarm
	EC	LORSBAN 500 EC	500 g/L	Dow Elanco
	EC	PREDATOR 300	300 g/L	Dow Elanco
	EC	PYRINEX 500 EC	500 g/L	Koor
	ULV	CHLORFOS ULV	500 g/L	Rhone-Poulenc
	ULV	CHLORPYRIFOS ULV 500	500 g/L	Nufarm
	ULV	LORSBAN 500 ULV	500 g/L	Dow Elanco
	ULV	PYRINEX 300 ULV	300 g/L	Koor
cypermethrin	EC	SONIC EC •	200 g/L	Nufarm
	ULV	SONIC ULV •	40 g/L	Nufarm
deltamethrin	EC	DECIS 25 EC	25 g/L	Hoechst
	ULV	DECIS 5 ULV	5 g/L	Hoechst
demeton-S-methyl	EC	METASYSTOX	250 g/L	Bayer
diazinon	EC	DIAZINON 800	800 g/L	Incitec (Crop King)
	EC	GESAPON 800	800 g/L	Ciba-Geigy
dimethoate	EC	DIMETHOATE	400 g/L	Nufarm
	EC	PERFEKTHION EC 400	400 g/L	Hoechst
	EC	ROGOR 400	400 g/L	Rhone-Poulenc
	EC	ROGOR DIOSTOP EC	400 g/L	Schering
	EC	ROXION	400 g/L	Shell
	EC	SABOTEUR	400 g/L	Incitec (Crop King)
disulfoton	granules	DISYSTON 50	50 g/kg	Bayer
endosulfan	EC	ENDOSAN	350 g/L	ICI
	EC	ENDOSULFAN	350 g/L	Rhone-Poulenc
	EC	ENDOSULFAN 350 EC	350 g/L	Davison
	EC	ENDOSULFAN 350 EC	350 g/L	Incitec (Crop King)
	EC	ENDOSULFAN 350 EC	350 g/L	Nufarm
	EC	THIODAN	350 g/L	Hoechst
	ULV	ENDOSAN 250 ULV	250 g/L	ICI
	ULV	ENDOSULFAN ULV	240 g/L	Rhone-Poulenc
	ULV	ENDOSULFAN ULV 240	240 g/L	Nufarm
	ULV	ENDOSULFAN 240 ULV	240 g/L	Incitec (Crop King)
	ULV	ENDOSULFAN 250 ULV	250 g/L	Davison
	ULV	THIODAN ULV	240 g/L	Hoechst
esfenvalerate	EC	HALLMARK 50 EC	50 g/L	Shell
	ULV	HALLMARK 10 ULV	10 g/L	Shell
fenvalerate	EC	SUMICIDIN 200	200 g/L	Shell
fluvalinate	ULV	MAVRIK ULV	30 g/L	Sandoz

Table 31. (cont)

ACTIVE CONSTITUENT	FORMULATION	COMMERCIAL PRODUCT	CONCENTRATION grams a.i./L or Kg	MANUFACTURER/ DISTRIBUTOR
Lambda-cyhalothrin	EC EW ULV	KARATE EC KARATE EW KARATE ULV	50 g/L 6 g/L 6 g/L	ICI ICI ICI
methidathion	EC	SUPRACIDE 400	400 g/L	Ciba-Geigy
methomyl	SL SL SL SL SL LV LV LV LV	KIPSIN LANNATE L LANNATE L MARLIN NUDRIN 225 NUDRIN 225 INSECTICIDE LANNATE LV LANNATE LV METHOMEX LV	225 g/L 225 g/L 225 g/L 225 g/L 225 g/L 225 g/L 225 g/L 225 g/L 225 g/L	Rhone-Poulenc Incitec (Crop King) Du Pont Rhone Poulenc Shell Shell Incitec (Crop King) Du Pont Hoechst
monocrotophos	EC EC EC	AZODRIN 400 CRONOFOS 400 NUVACRON 400	400 g/L 400 g/L 400 g/L	Shell Incitec (Crop King) Ciba-Geigy
omethoate	EC	FOLIMAT 800	800 g/L	Bayer
parathion-methyl	EC EC EC	FOLIDOL M500 BL METHYL PARATHION 500 PARATHION 500 M	500 g/L 500 g/L 500 g/L	Bayer Incitec (Crop King) Rhone-Poulenc
phorate	granules	THIMET 200 G	200 g/kg	Cyanamid
profenofos	EC EC EC ULV ULV ULV	CURACRON 500 EC CURACRON 500 EC SABRE 500 EC CURACRON 250 ULV CURACRON 250 ULV SABRE 250 ULV	500 g/L 500 g/L 500 g/L 250 g/L 250 g/L 250 g/L	CGS Ciba-Geigy Incitec (Crop King) CGS Ciba-Geigy Incitec (Crop King)
propargite	EC	COMITE 600	600 g/L	ICI
sulprofos	EC ULV	HELIOTHION EC HELIOTHION ULV	720 g/L 360 g/L	Bayer Bayer
thiodicarb	SL LV FS	LARVIN 375 LARVIN LV SEMEVIN 500	375 g/L 350 g/L 500 g/L	Rhone-Poulenc Rhone-Poulenc Rhone-Poulenc
thiometon	EC	EKATIN	245 g/L	Sandoz

* Pending Registration

Table 32. Insecticide recommendations for the main insect pests on cotton 1992/93

Product rate in L/ha

		Aphids	Heliothis		Tipworm	Jassids	Mirids	Mites	Pink Spotted Bollworm	Rough Bollworm	Thrips
			Larvae	Eggs							
Bacillus thuringiensis (B.T.)		See table on page xx									
chlorfluazuron	ULV 40 g/L		2.5								
chlorpyrifos	EC 500 g/L								1.0		
	ULV 500 g/L								1.0		
dimethoate	EC 400 g/L	0.5				0.35	0.34-0.5				0.35-0.5
endosulfan	EC 350 g/L		2.1		2.1	2.1				2.1	2.1
	ULV 240 g/L		3.0		3.0	3.0				3.0	3.0
methomyl	SL, LV 225 g/L		1.8-2.4	0.4-1.0							
monocrotophos	EC 400 g/L				1.5-1.8	0.25-1.2		0.9-2.0		2.0	
omethoate	EC 800 g/L	0.25				0.7	0.14-0.28				0.14-0.28
parathion methyl	EC 500 g/L	0.7									
profenofos	EC 500 g/L	1.0	1.5-2.0					1.0			
	ULV 250 g/L	2.0	3.0-4.0					2.0			
propargite	EC 600 g/L							2.5			
thiodicarb	SL 375 g/L		1.5-2.0	0.5							
	LV 350 g/L		1.5-2.0	0.5							
thiometon	EC 245 g/L	0.4									

Table 32. (cont).

		Aphids	Heliothis		Tipworm	Jassids	Mirids	Mites	Pink Spotted Bollworm	Rough Bollworm	Thrips
			Larvae	Eggs							
PYRETHROIDS.											
alpha-cypermethrin	EC 100 g/L		0.3-0.5							0.3-0.5	
	ULV 16 g/L		2.0-3.0							2.0-3.0	
beta-cyfluthrin	EC 25 g/L		0.6-0.8								
	ULV 8 g/L		1.9-2.5								
bifenthrin	EC 100 g/L		0.6-0.8					0.6-0.8			
cypermethrin	EC 200 g/L		0.4-0.6								
	ULV 40 g/L		2.0-3.0								
deltamethrin	EC 25 g/L		0.5-0.7						0.5-0.6		
	ULV 5 g/L		2.5-3.5						2.5-3.0		
esfenvalerate	EC 59 g/L		0.2-0.7						0.4		
	ULV 10 g/L		1.0-3.5						2.0		
fenvalerate	EC 200 g/L		0.2-0.7						0.4		
fluvalinate	ULV 30 g/L		3.3-5.0					3.3-5.0		3.3-5.0	
lambdacyholothrin	EC 50 g/L		0.3-0.4						0.36		
	ULV 6 g/L		2.5-3.5						3.0		

Bacillus thuringiensis (Bt)	See table 34 on page 66.

The above list provides a guide to the main insect pests of cotton on the Darling Downs, together with the more commonly recommended insecticides used for their control. A range of other insect pests can be a problem at times, and may influence the decision on which spray to use.

Your crop consultant will normally provide a recommendation based on the combination of insect species present, insect populations (pressure), seasonal conditions, and stage of the growing season. The Summer Crop Management Strategy also places restrictions on when certain insecticides should be used.

Table 33. Insecticide chemical groups

Carbamates	Chitin Inhibitors	Organochlorines	Organophosphates	Pyrethroids
aldicarb	chlorfluazuron	endosulfan	chlorpyrifos	alpha-cypermethrin
methomyl			demeton-S-methyl	beta-cyfluthrin
thiodicarb			dimethoate	deltamethrin
			disulfoton	esfenvalerate
			monocrotophos	fenvalerate
			omethoate	fluvalinate
			parathion-methyl	lambdacyhalothrin
			phorate	
			profenofos	
			sulprofos	
			thiometon	

Table 34. Registered label rates (L/ha) for BT's 1993-94.

	DELFIN OF *	DiPel ES
Insects Controlled	Heliothis Tipworm	Heliothis
Used Alone	1-2 L	1-3L
Bt + Larvin	1-2 L Delfin + (0.5-1 L Larvin)	1-2 L DiPel + (0.5-1 L Larvin)
Bt + Endosulfan	1-2 L Delfin + (1L Endosulfan EC) or + (1.5L Endosulfan ULV)	1-2 L DiPel + (1.1-2 L Endosulfan EC) or + (1.5-3.0L Endosulfan ULV)
Bt + pyrethroid	1-2 L Delfin + pyrethroid	1.5-2 L DiPel + pyrethroid

There are a number of other Bt products pending registration. It is likely that another 3 or 4 products may be available for 1993-94.

THE SUMMER CROP INSECTICIDE STRATEGY
Managing Insecticide Resistance in Helitohis

KEY STRATEGY GUIDELINES
(New or modified guidelines are identified by bold type)

1. Do not respray a pyrethroid or endosulfan failure with the same chemistry, unless the failure is due to poor application or similar, as indicated by the presence of *Heliocoverpa punctigera* post-spray (use the new Identification Kit to determine the species of the surviving larvae).

Previously: Do not respray a suspected pyrethroid failure with another pyrethroid.

2. In multiple spray crops, use at least three of the six available chemical groups.

3. The use of ovicides is encouraged when egg pressures warrant it.

4. Pyrethroids should be targeted only on newly hatched *Heliocoverpa armigera* larvae (no problem in controlling larger susceptible *Heliocoverpa punctigera* larvae). Applications on larger resistant *Heliocoverpa armigera* larvae will be ineffective and will increase levels of pyrethroid resistance. Regular and thorough scouting is essential to achieve this objective.

Previously: Pyrethroids should be targeted only on small larvae (less than 5 mm). Applications on larger resistant larvae will be ineffective and will increase levels of pyrethroid resistance. Regular and thorough scouting is essential to achieve this objective.

5. Do not use pyrethroids or endosulfan alone on significant *Heliocoverpa armigera* populations (use the new Identification Kit and then consult the 'Stop/Go Mixture Charts'). Where indicated, use mixtures with *Bacillus thruingiensis* (Bt), methomyl, thiodicarb, etc.

Previously: Avoid pyrethroids when there is high *Heliocoverpa armigera* pressure.

6. If a pyrethroid is used to control sorghum midge, do not follow up with another pyrethroid for heliothis control as the midge spray will have already selected for pyrethroid-resistant heliothis.

7. Minimise the use of endosulfan in all crops where reasonab ly cost effective alternatives exist.

8. Encourage the cultivation of cotton and alternative crop residues where over-wintering pupae are present, particularly where endosulfan or pyrethroids have been used.

Previously: Cultivate cotton crop residues thoroughly to minimise survival of over-wintering pupae.

9. Cotton growers should avoid growing December-flowering crops (mainly early sown maize and sunflowers) in predominantly cotton areas. They act as resistance nursery crops producing large numbers of *Heliocoverpa armigera* for the Stage 2 pyrethroid window.

10. Avoid consecutive sprays of pyrethroids where *Heliocoverpa armigera* are emerging from neighbouring maize, sorghum or sunflower fields, as levels of resistance are exacerbated by selection of moths before mating.

11. To encourage late season parasitism and to minimise carry over of resistant over-wintering pupae, avoid endosulfan, pyrethroids or profenofos as the last heliothis spray for the season on cotton.

Previously: Wherever possible, avoid using any endosulfan or pyrethroid spray as the last spray for the season on cotton, in order to help reduce carryover of resistant individuals.

12. Where pyrethroid mixtures are indicated and PBO is to be used, it should only be used as the first pyrethroid spray mixture. Subsequent pyrethroids can be mixed with Bt or conventional insecticides as required.

Previously: In cotton, alternate PBO and Bt as additives to the second and third pyrethroid sprays. If only one pyrethroid is used, add either PBO or Bt if the pyrethroid is to be applied toward the end of the Stage 2 window.

13. Avoid continuous sprays of any one chemical group (including Bt's). Alternate wherever possible and avoid excessive use of any one product to limit the development of resistance or avoid potential environmental problems. Some products (e.g. profenofos, propargite and chlorfluazuron) are considred to be at greater risk than others. Excessive use of these products is suggested as:-

a) more than 2 consecutive or 3 total profenofos sprays (either alone or in mixtures) per season

b) more than 1 propargite spray per season (except for a re-spray due to poor application, timing etc).

c) more than 2 chlorfluazuron (Helix®) sprays per season.

14. In order to avoid flaring mites, avoid early Stage 2 use of pyrethroids alone if there are more than 5 to 10% of plants infested with mites. Instead use either Bt, endosulfan, endosulfan/Bt mixtures, thiodicarb/Bt mixtures or pyrethroid/OP mixtures.

15. Avoid the use of broad spectrum sprays early in, to encourage beneficials and integrated Pest Management.

Table 35. The Summer Crop Insecticide Strategy Stages

SOUTHERN QUEENSLAND AND NORTHERN NEW SOUTH WALES

	Stage 1	Stage 2	Stage 3
Cotton	up until 25 December NO PYRETHROIDS	December 26 - February 13 USE PYRETHROIDS	from February 14 → NO PYRETHROIDS NO ENDOSULFAN
Other Summer Crops	No restrictions on pyrethroids for control of heliothis or other pests		

EMERALD IRRIGATION AREA - IRRIGATED CROPS

	Stage 1	Stage 2	Stage 3
Cotton	up until 31 December NO PYRETHROIDS	January 1 - February 3 USE PYRETHROIDS	from February 4 → NO PYRETHROIDS NO ENDOSULFAN
Other Summer Crops	No restrictions on pyrethroids for control of heliothis or other pests		

DISEASES

Diseases are usually not a problem in dryland cotton, although seedling diseases and Bacterial blight can sometimes be present. The Agfact, 'Diseases of Cotton' available from New South Wales Department of Agriculture provides a detailed reference. Brief information is given in this section.

Seedling blight

This disease can be caused by several fungi, including pythium and rhizoctonia, which are common soil inhabitants.

Damage is most likely when soil temperatures are low, and in the case of pythium, when soil moisture levels are high.

Control measures to reduce the effect of seedling blight include:

1. Early seed-bed preparation so that plant residues have ample time to decompose.
2. Delay planting until soil temperature at planting depth is at least 17°C.
3. Do not plant seed deeper than necessary, and
4. A seed dressing containing *metalaxyl* is registered for the control of pythium, while *quintozene* is registered for soil application to control *Rhizoctonia solani*.

Verticillium Wilt *(Verticillium dahliae)*

The fungus is a common soil inhabitant, which can infect many crops and weeds.

It penetrates the roots and grows in the water conducting tissue, blocking water uptake and causing wilt symptoms. As a result, a dark brown discolouration of the water-conducting tissues of the roots and stem becomes apparent. The disease favoured by cool air and soil temperatures, excessive soil moisture and soil nitrogen levels. Proper management of irrigation and fertiliser application should provide some measure of control of this disease.

Cotton should not be planted in areas where there is a high infestation of the fungus in the soil and individual fields should not be sown to cotton for more than four years in succession. Susceptible weeds, in cotton fields, should be destroyed.

Bacterial Blight *(Xanthomonas malvacearum)*

This bacterium survives on infested cotton residue, but may be introduced on seed. The disease is favoured by wet windy weather and injured tissues are very susceptible to infection. As a result, hail damaged crops are often severely infected. The use of acid delinted seed will provide good control of seed borne bacteria. Two cultivars with some resistance to this disease, Siokra and Sicala, are now available and could be useful in areas where the disease is frequently severe. Prompt cultivation of crops after harvest, so that residues have ample time to decompose, will also assist in the control of the disease.

SPRAYING AGRICULTURAL CHEMICALS

Agricultural chemicals applied under unfavourable weather conditions from poorly adjusted and operated equipment can drift away from the target.

Crops and pastures can be damaged from the spraydrift of herbicides while people, stock and water supplies can be affected by insecticide drift. The resulting pollution, crop damage and the potential health hazards are something that is no longer environmentally acceptable. Additionally, pesticide which drifts away from the target reduces the efficiency of the product on the target and spray failures are a waste of money and effort.

SPRAY SURE

When spraying pesticides from their own equipment, growers should:

- Be sure the equipment is functioning correctly. Check that nozzles are in good condition, use low pressure, high volume and keep the boom at the right height. Use nozzles which produce larger droplets and if possible consider raindrop nozzles.
- Be sure pesticides are mixed thoroughly and according to the label.
- Be sure the recommended registered pesticide is used for the job at hand.
- Be sure pesticides are applied at recommended rates.
- Be sure only target plants or weeds are sprayed.

Growers using the services of commercial operators can rely on the operator for these aspects, but it is imperative that he is given full details, preferably with a map, showing:

- compass directions;
- area to be sprayed;
- location of homes, susceptible crops, stock, bee hives, sheds, dams, etcetera;
- topographical features and hazards; and
- real property description.

SPRAY SAFE - AVOID SPRAY DRIFT

Before beginning spraying activity growers should be mindful of safety in the pesticide distribution. The movement of spray droplets off target as spray drift is a grave risk when using pesticides. Factors contributing to drift are:

- Weather conditions during and immediately after application.
- Droplet and particle size. This is determined by the application method and equipment used with large nozzles at low pressure reducing drift danger.
- Nature of the spray mixture, that is its volatility.
- Height and distance. The greater the height and distance from the target plant at which weed killers are discharged the greater is the risk of drift.
- Direction of application. Spraying upwards or into a wind increases the risk of drift.

Safe distances and buffer zones

Safe distances with respect to drift from spraying operations are entirely dependent on weather conditions and good application. A light wind is highly desirable and essential to carry droplets down into the crop and onto the target. Provided there is this wind there should be little wind drift and no risk to susceptible crops, homes, stock, sheds and water supplies, downwind from the target area. A buffer zone of 300 metres should be adequate for most spraying situations.

However, if the conditions are wrong or equipment is incorrectly set or operated, drift can be substantial and safe distances simply cannot be defined. Under high winds, pesticide can drift several kilometres. Likewise, fine droplets suspended in the air under calm conditions or in hot dry conditions can drift almost anywhere.

Communication

Communicate with neighbours, aerial and commercial operators notifying them of susceptible crops as well as the location of sheds and homes on your property.

At the same time, determine the location and nature of these things on neighbouring properties.

When spraying, communicate your plans to neighbours who may be affected and discuss any drift risks with them. UHF radios are a great asset in this regard as most commercial operators use them.

Ground supervision of aerial spraying by a responsible person in communication with the pilot is essential. If conditions become unsuitable during the spray operation, tell the operator to stop.

Records

Commercial operators are required by law to keep records of all spraying operations and it is a recommended procedure for all users of agricultural chemicals. Such records can provide good evidence of such operations, should a dispute arise.

Records should include:

- date and time of application;
- chemical used and rate;
- crop/pest and area sprayed;
- weather conditions; and
- equipment and operating conditions.

Mud Map for aerial spraying

To help commercial operators sketch a *mud map* of your property showing prominent land marks, homes and other buildings especially, and reference points. Note susceptible crops both on your property and on your neighbours.

Wind conditions

The best conditions to spray in is when a light breeze is blowing at, no more than 10 to 12 km/hr; preferably blowing away from problem area and across the direction travel. Do not spray in strong winds greater than 15km/hr, or if the wind is in the direction of nearby susceptible crops, homes, sheds, stock or water supplies. Avoid spraying under still warm conditions as fine particles can travel considerable distances and it is impossible to predict where they will come down as they will drift in the direction of the next wind.

Wind speed

As a guide to estimating wind speed, Table 25 is part of the Beaufort Scale of Wind speeds for the range of chemical spraying up to No. 3, when spraying should cease.

Smoke signals

Use ground smoke signal fires to indicate wind direction and strength and stop spraying if these conditions suddenly change and become unfavourable. Signal fires are a great help to commercial contractors and also serve as an indicator to neighbours. A burning tyre makes an ideal smoke signal. The installation of a windsock adds permanency to wind direction and strength so long as it is centrally located and highly visible. Smoke needs to be generated for the full spraying period.

Table 36. Beaufort scale of wind speeds

Beaufort number	Speed (km/hr)	Description	Guide for judging
0	less than 1	Calm	Smoke rises vertically
1	1 - 5	Light air	Direction of wind shown by smoke drift, but not wind vanes.
2	6 - 11	Slight breeze	Wind felt on face; leaves rustle; ordinary vane moved by wind.
3	12 - 20	Gentle breeze	Leaves and small twigs in constant motion; wind extends light flag.

Avoid spraying if smoke rises vertically.

Inversions

Do not spray under *inversion* conditions. This is where a blanket of cold air is trapped above the ground and temperatures increase with altitude rather than decrease. Blankets of fog or smoke indicate such conditions as smoke will not rise, but drift at a constant height under the inversion layer.

Temperature and Humidity

High temperatures can have a two-fold affect on drift - that of volatilisation and evaporation. Firstly, higher ground temperatures establish air currents which result in spray mists carried high and dispersed over a wide area. Secondly, the high temperatures can evaporate the liquid in the droplets and the particles of pesticide or herbicide can be carried as a fine dust over long distances. Avoid spraying in temperatures greater than 30°C especially for growth regulator herbicides, for example, dicamba, 2,4-D and MCPA.

It is preferable to spray under high humidity. This is particularly important when water is the carrier as low humidities are often associated with high temperatures and thus, high rates of evaporation. Avoid spraying when relative humidities drop below 45%. Under inversion conditions, do not spray with high humidity as it extends droplet lift and increases herbicide uptake, thus increasing drift hazard.

In general spray when temperatures are less than 32°C and the relative humidity is high; that is, when the difference between wet and dry bulb temperatures is less than 10°C (See Table 37).

Table 37. Temperature and humidity levels when spraying should cease

Temperature (°C)	Humidity (%)	
	Aerial	Ground
20	37	23
25	44	32
30	50	38
35	54	33
40	57	47

HARVEST

GROWTH REGULATION

In some years with ideal growing conditions, some degree of vegetative growth control may be necessary mid-season to ensure that the plant remains manageable for later pesticide and defoliant applications, and picking. The use of a growth regulator, applied once or alternatively as a lower rate split application may be warranted under these conditions.

CONDITIONING

An October sown crop will show first open bolls around mid-February. The rate at which bolls open is temperature dependant, ranging from 2 to 3% per day and up to 5% as boll opening progresses. Cooler, short season areas such as the Central Downs and Breeza Plain will be slower than other areas.

Conditioning (or defoliation) is usually commenced late February/early March when unopened bolls are quite firm and around 50 to 65% of bolls have opened.

Conditioning (by artificial means) results in the abscission or shedding of foliage earlier than would have occurred naturally. It artificially prepares a crop for harvest. The term desiccation (the rapid drying and death of foliage) is often used to describe conditioning.

The objectives of conditioning include:

- Removing or reducing the canopy of foliage allowing more efficient operation of the pickers.
- Promoting earlier picking.
- Eliminating material that could stain cotton fibres.
- Reducing the trash content of seed cotton.
- Reducing the chances of lower boll rot occurring in rank cotton.

The type of chemical (Table 27) to use, whether one or two sprays are needed and the timing of these sprays are some of the more important decisions to be made.

Table 38. Crop conditioners

Active Chemical	Product	Concentration	Rate/Hectare	Manufacturer/Distributor
dimethipin	HARVADE	600 g/L	• 0.5 L + 1 L Catapult • 0.5 L + (0.25 - 0.5 L) accelerate	Ciba-Geigy
diquat	REGLONE	200 g/L	• 2 - 3 L • 0.7 L + 16.5 L sodium chlorate	ICI
paraquat + diquat ***	SPRAYSEED	125 g/L + 75 g/L	• 1 - 2 L • apply in dryland situation only	ICI
ethephon	PREP 720	720 g/L	• Pre Conditioner 1.3 L • Conditioner 2 - 3 L	Rhone-Poulenc
endothal	ACCELERATE	64 g/L	• (1.5 - 2 L) + 10 - 12 L sodium chlorate • (0.25 - 0.5 L) + 0.5 L HARVADE	Shell
magnesium chlorate **	MAGSOL	480 g/kg	• 5 - 7 kg	Hoecht
sodium chlorate	ATLACIDE	240 g/L	• 11 - 16.5 L	ICI
	LEAFEX	300 g/L	• 11 - 22 L	(Amalgamated) Rhone Poulenc
thidiazuron **	DROPP	500 g/kg	• Ideal conditions: 50 - 100 g + 2 L D-C-TRON • Average conditions: 100 - 150 g + 2L D-C-TRON • Adverse conditions: 150 - 200 g + 2L D-C-TRON	CGS
oleyl alcohol etc	CATAPULT	420 g/L	• 0.5 -1.0 L • surfactant added to HARVADE	Ciba-Geigy

** Pending changes to registration at the time of printing
*** Pesticide order in NSW; not registered in Qld

Major conditioning problems occur with lush rank crops or lodged crops creating a thick impenetrable canopy, and late crops hit by frost. Decisions on the best way to handle these and other crop situations should be taken in consultation with an experienced adviser. In most of the area, dryland cotton planted in October is usually ready for harvesting in early March, approaching 100% boll opening.

PICKING

Cotton picking is a specialised operation requiring two machines, spindle picker or stripper harvester, and the module builder. Current growers are fully equipped for owner operation whilst new growers need to decide on buying machinery or using a contractor.

For new growers, the use of contract harvesters is recommended. It is difficult to justify the purchase of harvesting equipment, particularly if the enterprise could be abandoned after one season. For those with longer term intentions, fully reconditioned pickers are available but used module builders may be scarce for those wanting to purchase their own equipment. Another option is to form a pool arrangement and share with other new growers.

Moisture content in the cotton determines the initial start of picking, the length of picking day (early starts and late finishes) and (failing breakdowns) the uninterrupted continuation of picking until harvest is completed.

Harvest should commence when the moisture content drops below 12%. A moisture meter can be used or the seed can be bitten; it will crack if ready for harvest.

Excessive moisture in cotton causes spindle wrap (difficult for the gin to handle) which leads to lower out-turns, lower quality cotton and lower returns to the grower.

Wet cotton in the module also results in increased temperatures with a subsequent deterioration in both the quality and quantity of cotton ginned. Quality loss depends on how wet and for how long the wet cotton remains in the module before ginning.

Wet harvests have shown that the decision to start, and/or continue picking is not that simple. There will always be trade-offs between the chance of further rain versus getting the crop off, and the damage this can cause if cotton is too wet. Growers need to be aware that picking well into the night may be good in terms of completing harvest, but disastrous in relation to potential quality damage.

The spindle picker

Spindle picking is generally the slowest and most expensive way of harvesting dryland cotton.

Spindle pickers have the advantage of being able to operate under a wide range of crop conditions and in both high and low yielding crops, generally producing higher out-turns (less trash). In high yielding crops, spindle pickers are superior to stripper harvesters. They can also be contracted to pick irrigated cotton.

A great deal of care and attention should be paid to setting up a picker and maintaining these settings during harvest. At all times follow the manufacturer's instructions. Correct height adjustment of the picker heads, and proper adjustment of pressure doors, doffers and moisture pads will guarantee efficient picking and result in better quality and greater quantity of cotton harvested.

Cleanliness of the picker basket is very important. The top of the basket and grid bars should be cleaned regularly to avoid contamination of clean cotton as it is emptied into the module builder. Failure to clean results in dirty cotton, more pin trash, lower uniformity ratios, lower micronaire, lower quality and thus lower returns to the grower.

The stripper harvester

Stripper harvesting is generally the cheapest way of harvesting dryland cotton. Stripper harvesters must be fitted with pre-cleaners.

Stripper harvesters can harvest both high and low yielding crops. On crops of less than around 3.5 b/ha, they are cheaper to operate than spindle pickers. However as the crop get heavier, the slower, more inefficient and expensive they become, compared to spindle pickers. In lower yielding crops a higher proportion of the bolls, those more difficult for spindles, will be harvested resulting in a higher yield.

Stripper harvesters have a lower out-turn than spindle pickers (29% to 32% compared to 36 to 38%), and cotton may be a ½ grade lower ($14 discount per bale) compared to spindle pickers. In some instances there has been a full grade difference. There is a higher risk of lower micronaire as more immature bolls may be harvested whilst excessive bark can also result in a discount of $20 per bale.

MODULES AND IN-FIELD HANDLING

Modules are an aspect that some growers pay a lot of attention to and others pay very little. Even, well compacted, but not over compacted, consistent modules, dome shaped on top to shed water, should be the objective.

Properly built modules are easier to move, shed water, don't break apart, contain more bales and are thus cheaper to transport per unit.

Modules should always be built in flood free areas with easy truck access. Ideally they should be on mounded compacted pads with all weather access a further advantage.

Avoid contamination of any kind. Regularly check hydraulic fittings. Blown hoses can spray oil over the module, contaminating the cotton causing severe downgrading. Other contaminants, particularly plastic in the module will also cause severe downgrading.

Module tarp covers are an item commonly overlooked by growers. In some cases, this can be an expensive oversight conservatively costing the grower between $50 and $60 per bale due to downgrading of cotton during a wet harvest.

Tarps are designed to protect modules in the field. Modules can be valued at anything from $3,000 to $5,000 and even up to $10,000 depending on the price of cotton. Skimping on module covers can easily cost far more than the value of the tarps in downgrading during a wet harvest.

Tarps should be checked annually for holes and either repaired or replaced. Old tarps should also be inspected to ensure that they are not worn out and that the weave is still in good condition and not starting to let go.

Poorly built modules tend to be flat on top encouraging water to pool during a wet harvest. If tarps are holed, or old or worn out, water seeps into the cotton resulting in losses through rotting, heavy spotting and contamination resulting in severe downgrading.

Care should also be taken with the way tarps are tied down. Ropes tend to channel water into the module. It is best if ropes are covered by flaps to prevent this problem. Modules should be sited away from floodways and areas of poor access after rain.

Module handling is a relatively expensive operation which is organised by contractors. Costs are made up of the module lift plus one way distance of travel to the gin. Chain beds are used for short hauls. Flat beds and in-field loaders are more economic for longer hauls.

GINNING, QUALITY AND CLASSING

INTRODUCTION

Dryland cotton is ginned and classed in exactly the same way as irrigated cotton, and under average to good growing conditions, the quality of each is similar. When seasonal conditions are more extreme, however, dryland cotton lint quality can be inferior and can receive a range of discounts, some heavy. This is particularly so in very dry seasons and in situations where dryland cotton has been planted late. The main quality characteristics of dryland affected by adverse conditions include: staple length, micronaire and grade. These are discussed in the relevant sections below.

GINNING

Cotton ginning is the process of removing the fibre from the seed and baling it into 227 kg bales - thus making it a saleable commodity to spinning mills. The process includes cleaning of both seed cotton and lint to remove trash collected during mechanical harvesting.

The gin cannot perform miracles. It cannot improve quality; it can only preserve it. To do this task, a ginner's options are limited to moisture control, the amount of cotton in the cleaning machinery at a given time, bypassing certain machinery and adding moisture at the press.

The importance of good agronomy, the best conditioning possible, clean and efficient picking and careful placement of modules are of the utmost importance in obtaining good grades. In effect, the grower to a large degree is setting his grades in the field.

QUALITY AND CLASSING

The role that quality plays in the marketing of cotton is unique among all other field and fruit crops. Cotton quality alone is expressible by a multitude of measurements performed by cotton classers and described in the wide range of grades set out in Table 39.

The price received for cotton is very dependent on these quality gradings and can vary substantially from quoted prices accordingly. Base cotton prices are quoted for **middling, 1 3/32 inch length**. Premiums and discounts apply for higher and lower grades respectively. Discounts are also applied for either very coarse (high micronaire) or very fine (low micronaire and immature cotton). The cotton industry has historically employed both visual and mechanical methods to determine quality. Most aspects of visual cotton classing are gradually being replaced by the HVI (High Volume Instrument) system which determines most quality specifications by instrument.

Visual methods based on definite and specific grades established by the U.S.D.A. for upland cotton determine the differing qualities and describe cotton for buying and selling when samples are not available. Cotton classers are skilled in determining those grades visually but now also use HVI systems. A classers grade is composed of three components: trash, preparation, and colour.

Greater detail on cotton quality and grade is available from cotton classers, and only the most important points are included in this section.

The characteristics of quality which directly influence price, are:

- Colour
- Trash
- Preparation
- Staple Length
- Micronaire
- Strength

Colour

The colour groups reflect the varying amount of colour from white through spotted and yellow to gray. True colour can only be assessed under light conditions which are set for universal testing. Colour difference can only be observed when compared with universal standards.

Mature cotton, when the bolls first open, is white and clean. Yellow colour may be a consequence of premature cessation of development by frost, drought or early harvest aid application. Gray is largely a result of exposure to moisture and field weathering. Weathering can be controlled, but the risk of weathering damage can be reduced by minimising the time between first and last boll opening. Fungal development or sugars on the lint due to honeydew from aphids can also produce gray cotton, but this can be managed by controlling aphids before they produce significant honeydew.

Under certain circumstances, e.g. drought stress, **dryland cotton** can produce more light spotted grades than irrigated cotton. Otherwise colour tends to be similar.

Trash

Trash represents the non lint particles such as leaf, bracts, bark and grass, most of which can be removed by lint cleaners during ginning. However, any major adjustments during ginning or milling to remove trash also removes lint and reduces gin out turn. Bark and grass can be more difficult to remove because they align with the fibres, and are a major problem in milling. Grass and/or bark or honeydew in the sample will result in a discount of the order of US$15.00/bale.

High trash levels are due to poor defoliation, inadequate harvest management, excessive weed infestations and, to a lesser degree, inadequate gin cleaning.

Certain factors decrease leaf drop and thus the harvest of clean, dry seed cotton which can be ginned for high quality. These include:

- Hairy leaves (not present in current varieties)
- High residual nitrogen (not usually a problem in dryland)
- Rapidly growing juvenile plants (poor boll set or late cotton)
- Ample soil moisture
- Disease free plants
- Regrowth (due to rainfall at defoliation or just prior to harvest)
- Cool temperatures for five days following crop conditioning
- How much humidity before and during crop conditioning
- Water stress before crop conditioning (common problem in dryland)
- Excessive conditioner or desiccant application
- Inadequate conditioner or desiccant rates

Many picking problems can be avoided if:

- Spindles are sharp and turning
- Excess oil and grease are cleaned from picking heads
- Moistener pads and doffer columns in good condition and properly adjusted
- Doffer lugs barely clear each spindle

- Pressure plates are adjusted according to crop condition
- Spindle cleaner used in moistening system where green leaves are present
- Picking units and baskets are cleaned and inspected at every dump
- Picking wet cotton or adding too much water is avoided.
- Harvesting should be delayed until dew has dried, humidity is below 50%
- Seed cotton moisture is less than 12% (use a moisture meter or bite the seed, they should crack. This often means starting to pick around 10.00 am or later).
- Seed cotton is kept dry during handling and storage. If cotton is wet, keep it separate from dry cotton and advise the ginner to see if it can be ginned early.

For stripper harvest, the last four points above also apply along with the following:

- Ensure that the crop is adequately defoliated/desiccated
- The stripper is fitted with an efficient pre-cleaner

Preparation

Preparation relates to the evenness and orientation of the lint in the sample. Factors contributing to poor preparation include spindle twist or wrapping during picking and roping or knotting (neps) of immature or very fine fibres in the ginning process.

Staple Length

Length is measured on a sample of fibres known as a "pull" when hand classing and is measured to the nearest 1/32 of an inch. HVI determine length in inches on a "beard" or tuft of lint formed by grasping fibres with a clamp.

Fibre length is controlled to a large degree by variety, although weather and management can also influence it. Maximum fibre length is determined during the fibre elongation phase in the first sixteen (16) to twenty (20) days after flowering.

During elongation length is decreased by high temperatures, very severe water stress and potassium deficiency. It is increased by moderate temperatures during that same period. Under dryland conditions, staple length tends to range from similar to irrigated cotton (1 3/32 inches) down to very short (1 inch or less). *It is wise to apply a staple discount of up to 1/16th inch for budgeting purposes in dryland cotton.*

Ginning and lint cleaning can also reduce length if lint moisture is below 5%, but this seldom occurs because moisture is usually added to seed cotton in this condition to allow better flow through the gin.

Table 39. Cotton grades, symbols and codes

Grade	Symbol	Code
White		
Good Middling	GM	11
Strict Middling	SM	21
Middling Plus	Mid+	30
Middling	Mid	31
Strict Low Middling Plus	SLM+	40
Strict Low Middling Plus	SLM	41
Low Midding Plus	LM+	50
Low Midding Plus	LM	51
Strict Good Ordinary Plus	SGO+	60
Strict Good Ordinary Plus	SGO	61
Good Ordinary Plus	GO+	70
Good Ordinary	GO	71
Light Spotted		
Good Middling	GM LS	12
Strict Middling	SM LS	22
Middling	Mid LS	32
Strict Low Middling	SLM LS	42
Low Middling	LM LS	52
Strict Good Ordinary	SGO LS	62
Spotted		
Good Middling	GM S	13
Strict Middling	SM S	23
Middling	Mid S	33
Strict Low Middling	SLM S	43
Low Middling	LM S	53
Strict Good Ordinary	SGO S	63
Tinged		
Strict Middling	SM Tg	24
Middling	Mid Tg	34
Strict Low Middling	SLM Tg	44
Low Middling	LM Tg	54
Yellow Stained		
Strict Middling	SM YS	25
Middling	Mid YS	35
Light Gray		
Good Midding	GM LG	16
Strict Midding	SM LG	26
Midding Midding	Mid LG	36
Strict Low Midding	SLM LG	46
Gray		
Good Middling	GM G	17
Strict Middling	SM G	27
Middling	Mid G	37
Strict Low Middling	SLM G	37
Below Grades	BG G	81-87

Micronaire

Micronaire is measured by placing lint in a chamber, compressing it to a set volume and subjecting it to a set pressure. The reading, when related to variety, is an approximate guide to fibre thickness and has been used as a measure of fibre maturity. Other, more accurate, fibre maturity testing methods and devices are being tested and may soon be introduced but for now the general guidelines below still apply.

- Low (<3.5) micronaire indicates fine (immature) lint.
- High (>4.9) micronaire indicates coarse lint.

The desired range is 3.5 to 4.9 and discounts apply for micronaires outside that range. *Discounts for low micronaire can be heavy.* Micronaire results are grouped on the schedule for premiums and discounts as shown in Table 40.

Fibre thickening develops after the elongation phase and continues until mature according to carbohydrate supply. Hence, growing conditions which influence growth and maturity in the finishing stages of the crop will effect fibre thickening and micronaire. Insufficient carbohydrate to meet boll demand results in low micronaire whilst ample carbohydrate to mature bolls results in high micronaire.

Common causes of low micronaire include:

- Cool temperature during fibre wall development
- Potassium deficiency
- Dense plant stands
- High nitrogen
- Excess irrigation/rainfall
- Favourable fruit set and high boll retention
- Early cut-out due to frost, hail, disease or early defoliation

The most common causes of high micronaire include:

- Poor boll set
- Small boll size due to hot weather or water stress
- Variety

Ginning has little or no effect on micronaire although low micronaire cotton is more susceptible to entanglement and nepping which can affect preparation and subsequently grade.

Dryland cotton normally falls into the acceptable micronaire range, however, under hot dry conditions some varieties are prone to produce high micronaire. Late planted crops are susceptible to low micronaire and heavy discounts sometimes apply. Boll filling ceases within 5 days of defoliation, so early defoliation must be avoided.

Table 40. Micronaire discounts

Group	Micronaire	Discount US$/Bale	Price US$/Bale
G7	5.3 and above	10.00 - 25.00	325.00 - 340.00
G6	5.0 - 5.2	5.00 - 12.50	337.50 - 345.00
G5	**3.5 - 4.9**	**Base**	**350.00**
G4	3.3 - 3.4	12.50 - 20.00	330.00 - 337.50
G3	3.3 - 3.2	22.50 - 35.50	314.50 - 327.50
G2	2.7 - 2.9	50.50 - 63.00	287.00 - 299.50
G1	2.6 and below	75.00 - 151.50	198.50 - 274.25

Fibre Strength

Fibre strength is important in the determination of price if it is below 24 GMS/TEX when a discount of the order of US$15.00/bale will apply. There is no premium for high strength although it is an important element in marketing.

Fibre strength is highly controlled by variety although environmental conditions can have a small effect. **Dryland cotton** strength is usually not adversely affected by growing conditions. Most Australian varieties are of high strength and local plant breeders have agreed to eliminate varieties that do not meet a minimum standard, thus keeping Australian cotton highly competitive in the world market.

Fibre strength is measured by clamping a bundle of fibres between a pair of jaws and increasing the separation force until the bundle breaks. It is expressed in terms of grams force per tex with the following classifications:

Less than 17	very weak
18 - 21	weak
22 - 25	medium strong
26 - 29	strong (most current Australian varieties)
More than 30	very strong

Other Quality Characteristics

There are a number of other fibre characteristics measured in HVI testing which, whilst of increasing importance to spinners, do not have a direct impact on price at present. Further detail on these is available from cotton classers and they include:

- Upper Half Mean Length (UHM)
- Span Length
- Uniformity Index (UI)
- Uniformity Ratio (UR)
- Elongation (EL)
- Short Fibre Content (SFC)
- NIR - Maturity
  - Fineness
  - Sugars (honeydew)

COTTON GRADE AND PRICE

The effect of a range of grades on the price of a bale of cotton (**quoted in US$**) is set out in Table 41 for G5 micronaire. Note that premiums and discounts do fluctuate throughout the season due to supply and demand and this is reflected in the price ranges given below.

Table 41. Premiums and discounts for a range of grades and staple lengths

Grade	Premium/Discount US$/bale	Price US$/bale	Comment
SM 1 3/32	3.75 - 6.30	353.75 - 356.30	Higher grade
M 1 3/32	**Base Grade**	**$350-00**	**Base price**
SM 1 1/32	17.65 - 22.25	327.75 - 332.35	Higher grade, shorter staple
SLM+ 1 3/32	10.10	339.90	Lower grade
SLM+ 1 1/32	32.35	314.65	Lower grade, short staple
M LG 1 3/32	32.80 - 42.90	307.10 - 317.20	Base grade, discoloured
M LG 1 1/32	42.90 - 70.90	279.30 - 307.10	Base, discoloured, short staple
LM 1 3/32	45.45 - 50.50	299.50 - 304.55	Low grade
LM 1 1/32	47.95 - 75.75	274.25 - 302.05	Low grade, short staple

SUMMARY

Although it is always classed on its merits, the price of **dryland cotton** is more likely to be discounted than irrigated cotton. A number of the reasons for this have been given in this chapter such as: short staple, spotted grades and high micronaire from hot dry conditions; low micronaire from development of late bolls under cool conditions (i.e. late planting); and lower grades from extra trash gathered by stripper harvest.

When setting budgets, dryland growers should consider reducing quoted prices for base grades by $AUS20-$50/bale to provide a more realistic estimate of their likely returns.

MARKETING ALTERNATIVES

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INTRODUCTION

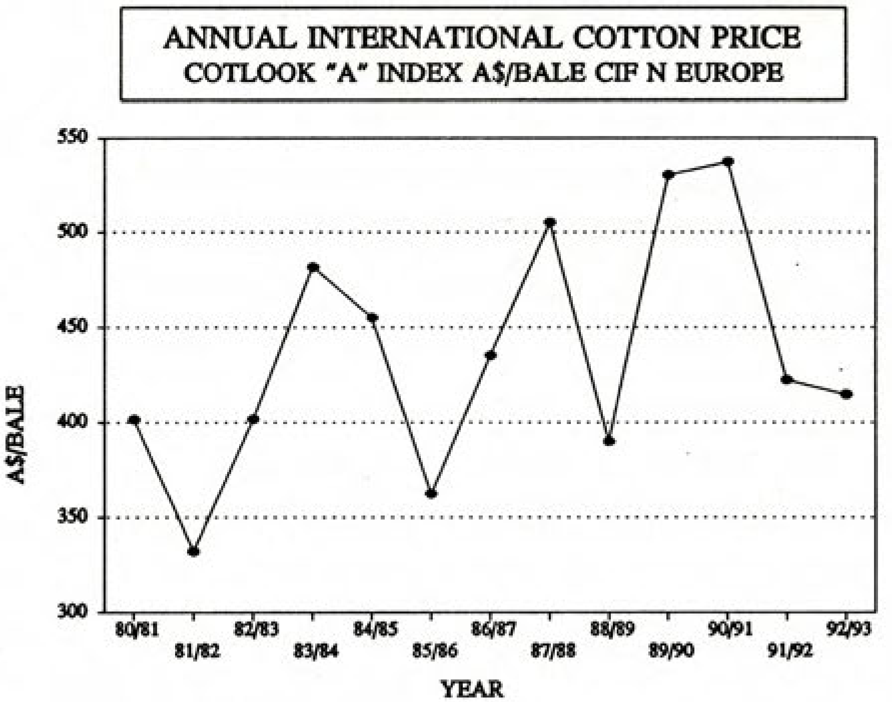
The main aim of this article is to present the important features of the marketing alternatives available to cotton growers. However, to fully understand the alternatives it is necessary to understand the marketing risks and risk management tools involved. Consequently, these matters plus some other key issues are also dealt with.

The article is not intended to advise growers on whether or not to grow cotton nor to be a "Do It Yourself" marketing kit. Growers, especially new growers, should seek advice on these matters from marketers, consultants etc. with proven records in their fields of expertise and talk to experienced growers about all aspects of marketing.

BACKGROUND

As shown in Figure 5, the average annual international price of cotton in A$/bale, which directly influences grower prices in Queensland, fluctuates considerably. Prices were very high in 1989-90 and 1990-91 but were considerably lower in 1991-92.

Figure 5.



The prices received by Australian cotton growers are determined mainly by both the international price, which is normally set in US cents, and by the value of the Australian dollar against the US dollar. As can be seen from figures 6 and 7, the international price of cotton in US cents and the US$:A$ exchange rate have fluctuated substantially on a weekly basis during the last two years.

Figure 6.

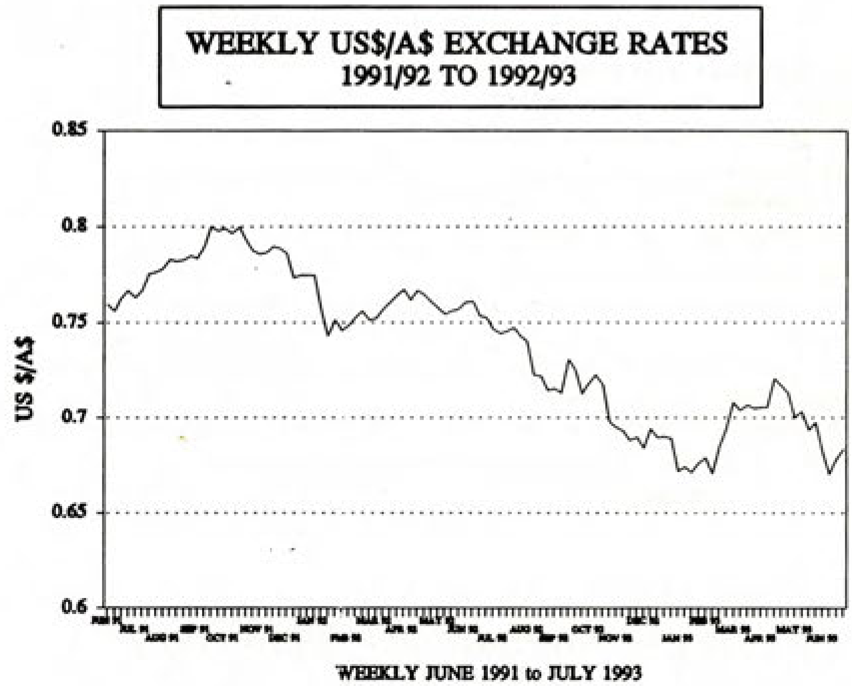
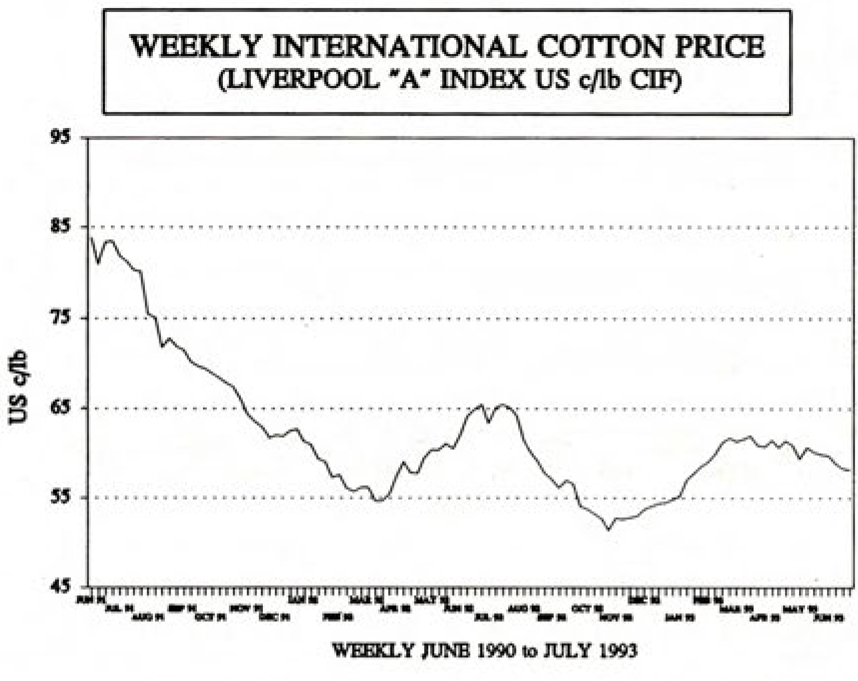


Figure 7.



These annual and short term fluctuations in prices and exchange rates are major uncertainties for cotton growers when deciding whether to plant cotton and when to sell. In addition, growers have to face the inconsistencies of seasonal conditions and the complexities of successfully growing cotton. The uncertainties of seasonal conditions are particularly important for dryland cotton growers.

All these uncertainties can be daunting for growers, especially new dryland growers. Growers may also be daunted by the wide range of marketing alternatives now available to them. However, if properly used, these alternatives can be an advantage to the grower. Indeed, growers in many other industries would welcome access to the range of marketing alternatives available to cotton growers.

Many of these marketing alternatives involve fixing or locking in a price on all or part of the expected crop before the cotton has been harvested. This ability to lock in returns before harvest can be a major advantage for some growers, because of the large investments needed to grow and harvest cotton. However, fixing prices before harvest may be very risky for some growers, especially if production levels are very uncertain. These and other marketing risks are examined briefly in the next section.

MARKETING RISKS

Marketing for a cotton grower is largely a question of the management of production and price risks. These risks are notably very complex, but personal, and vary from situation to situation and over time. Growers need to have a clear understanding of these risks and how they relate to their operations before making marketing decisions.

Production risks broadly relate to quantity (yield and area) and quality.

Quantity risk is the possibility that production may differ significantly from original expectations. If a grower enters into a contract to supply cotton at a future date prior to actually planting the crop there is uncertainty about the area to be planted (i.e., because of seasonal conditions) and the level of yield that will be obtained from the area actually planted. If a contract is entered into after planting, the yield risk exists. There is also the risk that the quality will not be as expected (e.g., as a result of seasonal conditions, pests, diseases, poor management practices etc).

Price risks broadly relate to the international price of cotton and the exchange rate to convert the international price into Australian dollars.

The price of cotton is normally set internationally in US¢/pound. This applies to both the world market price or the "spot price" and the New York futures market price which is often used for trading. So, generally, cotton is priced internationally in US¢/pound. Also, when considering the international price a further element of risk, known as the **basis**, is involved. The basis may be broadly defined as the premium or discount to the New York futures price for cotton being sold at any point in time. The basis generally takes account of differences in quality and transport costs between New York and the place where the cotton is being delivered.

Generally, the Australian grower is only interested in revenue in Australian dollars. Therefore, there is a risk associated with the exchange rate from US dollars to Australian dollars. This risk should not be under estimated. It plays a major part in influencing returns.

The extent to which the market price and the exchange rate fluctuate are shown in figures 5 and 6 which give the weekly world price and the exchange rate respectively for the last two years. Due to these fluctuations, prices in terms of Australian dollars are also unstable. This is illustrated in figure 1 which gives the annual international price per bale since 1978-79.

Although production and price risks have been treated separately in this article, the link between the two cannot be over emphasised. For example, if a grower decides to enter into a contract (either before or after planting) to sell a specified quantity of cotton at a specified time for a fixed price this results in exposure to several risks. One risk is that, if the grower had waited and actually sold the crop later, a higher price may have been achieved. Another is that not enough cotton may be produced to meet the contract requirement and, if prices go up, then the grower has to go out in the market and buy at a higher price which inevitably reduces returns (sometimes considerably). Of course, the opposite more favourable risks of prices falling and production being greater than expected must also be considered when assessing the risk.

PRICE MANAGEMENT TOOLS

Three main tools can be used to lock in, or "hedge", prices in the future. They are forward contracts, futures market contracts and options.

Forward contracts are simply agreements between buyers and sellers to trade specified amounts of commodity at a specified time for a specific price.

Futures market contracts are similar in principle to forward contracts but they are made at futures exchanges between commodity buyers/sellers and speculators. They are tradeable and usually no product actually changes hands between the contracting parties, instead positions are closed out by purchasing an opposing contract. Deposits have to be lodged when contracts are made and margin calls paid if the market moves against the owner of the contract. As mentioned earlier, much of the world's cotton is sold in basis trading using futures market contracts and a negotiated basis.

An **option** is the right but not the obligation to buy or sell a forward contract or a futures market contract. For this right the buyer or the seller pays or receives a premium. Cotton producers who have already forward priced can use options to insure against prices increasing or decreasing. Options can also be used by growers who have not forward priced to guarantee a minimum price for their cotton, and also allow them to take advantage of favourable movements in the market. Options can be very useful and flexible tools for the management of price risk.

These price management tools are used by merchants to offer a range of marketing alternatives to cotton growers or they can be used independently by growers.

MARKETING ALTERNATIVES

There are now at least eleven merchants to whom cotton growers can sell cotton. Some have their own gins while others normally require the grower to arrange for the cotton to be ginned. The marketing alternatives available from most of the merchants have been examined and a summary of them is presented below.

The names used by merchants to describe their marketing alternatives differ greatly and so do the detailed conditions associated with their alternatives. Consequently, growers should check the details of each merchant's alternatives carefully. Also a number of alternatives may be used in combination. The most appropriate alternative or combination of alternatives will be determined by many factors including individual circumstances and market conditions.

Pooling

This concept is well known to many grain growers and is used by many cotton growers. The main features of pools are:-

- the individual grower's cotton is marketed together with that of other growers in a pool;

- the pool manager markets the pooled cotton using a variety of marketing methods over the season;

- the growers receive an equalised net return adjusted for the quality of each delivery made to the pool.

The pool manager is responsible for managing the price risk of the cotton in the pool.

The area or quantity which is going to be delivered to the pool generally has to be nominated by the grower in advance but there are normally no penalties for non-delivery caused by crop failure, low yields etc.

An aspect of this alternative which could be considered a disadvantage is that the final price which the grower is to receive is not known until the pool is finalised. However, during the season most organisations operating pools estimate what the final pool net return will be. Another possible disadvantage with pooling is that payment is via a series of payments (advances) which normally start after ginning with the final payment being made several months after ginning.

Fixed Priced Contracts

Fixed priced contracts may be entered into before or after the cotton has been harvested. The main features are:-

- the contracts are usually made in A$ but some merchants also offer US$ contracts and some have US$ loans

- the contracted quantity normally must be delivered to the merchant (however, in some cases, roll-over or non-delivery clauses may be inserted in the contract).

Some merchants offer area contracts which do not require the grower to supply a specified quantity. However, in these cases, the merchant expects the grower to supply all of the cotton from the particular area contracted.

The financial advantages of fixed price contracts include the final price being known when the contract is made and 100% payment being made normally 14 days after ginning.

"On-Call" Contracts

This alternative is titled "on-call" largely because the grower can call (i.e., decide) when the price, the exchange rate and the basis are going to be fixed. The main features are:-

- the grower must undertake to deliver a certain quantity of cotton at a certain time;

- the grower can decide at any time prior to delivery when to lock in a price via the New York futures market price, the exchange rate and the basis; and

- many contracts allow growers to use options to protect a minimum price and take advantage of favourable movements in the market.

The main advantage of this alternative is that the grower has complete control over the management of those components which affect the price of the contracted cotton.

Guaranteed Minimum Price Contracts or Pools

These are similar to the fixed price and "on-call" contracts. Normally, the grower is required to supply a specified quantity unless roll-over or non-delivery clauses are included. These contracts are mainly based on the use of options to allow the grower to guarantee a minimum price. This normally represents the daily fixed price contract price less the cost of the option. However, some contracts are more flexible and also allow the grower to take advantage of favourable price movements after the contract has been entered into.

Independent Hedging

All of the alternatives covered above involve a contract to a merchant to sell cotton.

However, if growers wish they can hedge independently using futures contracts, forward currency contracts and options organised through commodity traders and banks. Independent hedging may be more difficult to arrange than via a merchant. The actual sale of the cotton to a merchant is still necessary.

MAKING THE DECISION

As shown above, a wide range of marketing alternatives are available to growers. However, the grower's choice of suitable alternatives will be influenced by many factors. In the case of dryland producers, who face greater production uncertainty than irrigators, some marketing alternatives may not be available.

New dryland growers, in particular, should be conscious of the likely high risk of their production not being as planned. Consequently, they should be very cautious in their attitude towards price risk management. They may well be best advised to consider using pools perhaps combined with the purchase of options.

Because of the range of marketing alternatives available, it can be difficult to decide how and when to use them. The following key issues should be addressed and understood when making decisions.

Marketing Policy and Strategies

All growers should have a clear marketing policy and strategies worked out to achieve objectives. Even if this just involves selling through a seasonal pool, the reasons for this strategy should be known and the forecast price should be assessed relative to alternatives.

Seeking Advice

Because marketing can be so complex, growers should seek advice from marketers and consultants with proven track records and also seek the advice, and benefit from the experience, of other growers. Growers should also look carefully at the results of using particular marketing methods/hedging strategies in previous years.

Taking Account of Risks

Both production and price risks are very real to cotton growers and potential financial losses because of them should not be underestimated. Given their total reliance on seasonal conditions, dryland growers should view production risk as critical in their planning. Also, when looking at the price risk, growers should be careful to take account of both the commodity price and the exchange rate.

Understanding Financial Implications

Growers should fully understand the financial implications of the marketing alternatives available to them. As outlined above, these can vary enormously.

Understanding Terms and Conditions

All terms and conditions of any marketing contract should be fully understood before the contract it is signed. In signing a contract, growers should bear in mind the substantial differences which often exist between the contracts offered by different merchants.

Maintaining Close Contact with the Merchant

Having entered into a contract with a merchant the grower should maintain close contact with that merchant throughout the season. If things do not go as expected in terms of production or market prices it may be possible for the merchant to recommend some solutions to the resulting problems which would not be immediately apparent to the grower.

Monitoring and Reviewing

Growers should continually monitor, review and, where necessary, revise their marketing policy and strategies during and after a marketing season.

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