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**R**ow crop farmers with experience in growing maize, sorghum, sunflowers, soybeans and other summer row crops have no difficulty in adapting to cotton. Land preparation is similar to other summer crops. Compacted fields should be avoided or deep worked early in the land preparation stage. Minimum tillage and tramlining have enormous potential to reduce compaction problems.

While fallowed areas with a full profile of moisture are preferred, 60cm of wet soil at planting is a minimum on the deeper alluvial soils. In the hotter lower rainfall areas, 90cm of wet soil is a more realistic starting level. Obviously, long term climatic indicators such as El Nino should also be considered in conjunction with stored moisture level.

## CROP DEVELOPMENT

Temperature is a major factor affecting cotton production. It:

- determines the length of the growing season. Frost will stop the growth of cotton plants, hence the likely date of the first frost in autumn determines the season length.
- has a strong influence on fibre development, particularly on fibre diameter
- directly influences the rate of crop development. At temperatures below 12°C, cotton development ceases.

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.

**Table 21: 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

### KEY POINTS:

- **Agronomic management of cotton demands a higher level of expertise than is required for alternative crops. Growers must pay greater attention to detail of the timeliness of all operations**
- **Agronomic practices impact on both yield and quality**

Typical values of day degrees to attain some development stages are given in **Table 21**.

Day degrees =

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

**When daily minimum temperature falls below 12°C, (Daily min temp - 12) = 0.**

### VARIETIES

Historically, varieties bred for high yielding irrigated environments have been tested under dryland conditions, and recommendations made based on their performance. CSIRO now have a dedicated dryland breeding program which aims to improve both yield, and stability of yield under dryland conditions.

Considerable research has focused on examining the physiological differences between the okra and normal leaf types. CSIRO research has confirmed results from the USA where okra leaf plants had consistently greater canopy photosynthesis per unit leaf area compared with normal leaf plants. This, coupled with greater photosynthesis rates gave the okra leaf types greater water use efficiency. This increase in leaf productivity and efficiency is an important contributor to the yield advantage of the okra leaf types observed in Australia.

This research also examined the effect of variety maturity on dryland yield. In all seasons the later maturing cultivars performed best. Regression analysis indicated that for every one day increase in cultivar maturity there was a 29kg/ha increase in lint yield. Obviously this yield increase would only continue while the cultivar maturity is less than the available season length. This research relates to medium and full season areas, with normal sowing times. For shorter season areas (such as eastern Downs and Breeza) or late sowings, the medium to early varieties perform best.

## Other Considerations

Yields obtained in dryland variety trials vary greatly from season to season due to differing rainfall patterns. Trials can only be assessed with confidence after a number of trials over a number of seasons. It can be misleading to make variety selections based on one year of results.

Since new variety development is very dynamic, information on specific varieties is obtainable from the planting seed companies.

Early orders for cotton seed generally close late July. Most dryland growers prefer to waive the discount which accompanies early orders, and make their varietal selection closer to planting. In this way, they can be assured of planting conditions as well as fine-tuning their variety to the actual time of planting.



Figure 12: Typical skip row configuration used in dryland cotton growing.

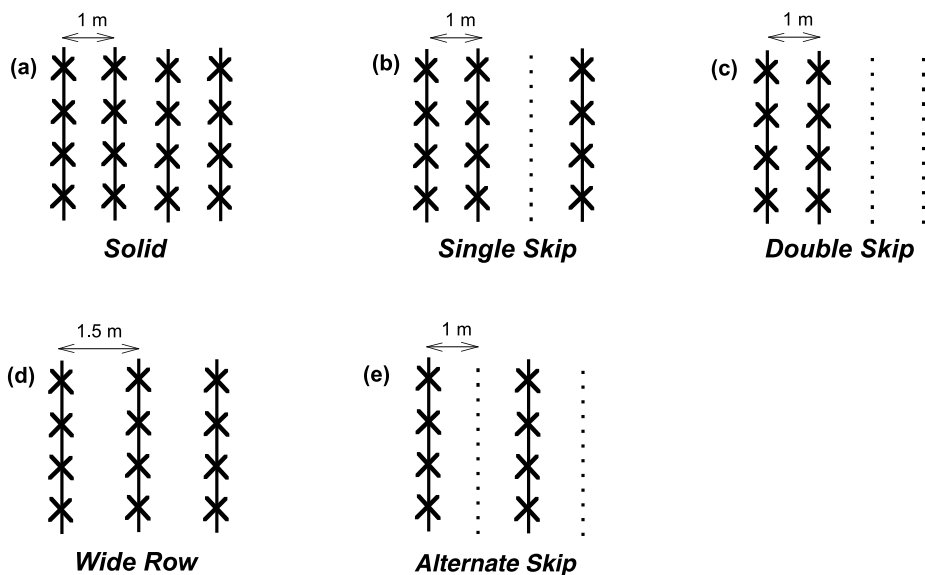
## PLANTING CONFIGURATION

One of the management techniques that dryland growers have at their disposal is being able to modify row configuration. Growers can choose to sow their crops using conventional solid row configurations similar to those used in Australian irrigated production, or use configurations that considerably modify row spacing or remove entire rows. Configurations that have entire rows missing from the sowing configuration are often referred to as skip-row configurations. In many cases choice of a row configuration is influenced by each individual farmer's attitude to risk. The risk is associated in attempting to balance what yield might be forsaken in those years where conditions are suitable for high crop yields versus reducing variable costs and providing some insurance against crop losses through low yields or poor fibre quality in dry years using alternative row configurations.

Choosing a row configuration involves many, often complex, considerations. The choice of configuration can influence the potential yield and risk of production, fibre quality, input costs, machinery set up, and general crop management.

A number of row configurations (Figure 13) have been used by dryland growers, with the predominant configurations being solid, single skip and double skip. Other configurations used by some growers include wide row and alternate skip that are essentially solid row configurations with considerably wider row spacings.

Figure 13: Diagrammatic representation of a range of alternative row configurations used in dryland cotton production. Solid lines represent rows with plants present, while dotted lines represent skipped rows.



Mostly the modified configurations aim to provide a reserve of soil moisture beside the planted rows thus extending plant growth during periods of soil moisture stress. In areas where soils have higher soil water holding capacity, solid row configurations are favoured. Conversely where soils have lower water holding capacity and more variable rainfall, skip row configurations are favoured. However, as mentioned previously, growers may often choose different configurations for other reasons.

### *Water Extraction Patterns in Skip Configurations*

There is sometimes concern that crops grown in skip row configurations are not able to extract all water from the skip to depth. Work undertaken by Phil Goyne on the Darling Downs has explored the extraction patterns of dryland cotton under different row configurations (**Figure 14**). His work conclusively showed that in both double and single skip row configurations the crops had water available for a longer time and during critical stages of growth. He also found that moisture at all positions across the skip could be depleted to within the lower limit of plant available water holding capacity (**Figure 14**). Similar results have also been found by Bange and Richards (unpublished data) for a range of soil types in northern NSW.

Cyclic water use patterns may also occur within skip row cotton. Water which is readily available is first extracted from under the plant line and then across into the skip. After this has occurred the plant will concentrate on extracting water at lower depths, back under

the plant line before once again utilising the water within the skip.

## *Yield Potential and Planting Configuration*

A number of field studies have been conducted to compare the relative yield of skip row configurations compared with solid plant configurations. They generally show that when yields of solid configurations are high, skip row configurations have a penalty; however when yields of solid configurations are low the difference in yield between skip rows and solid configurations are small. In the studies by Marshall (1994) (**Figure 15a**) there were no differences when yields were below approximately 2b/ha, while in studies by Goyne (2000) single and double skip configurations actually exceeded solid at low yields (**Figure 15c**). Hearn (1999) combined all the data collected from field experiments and produced a mean response (**Figure 15d**).

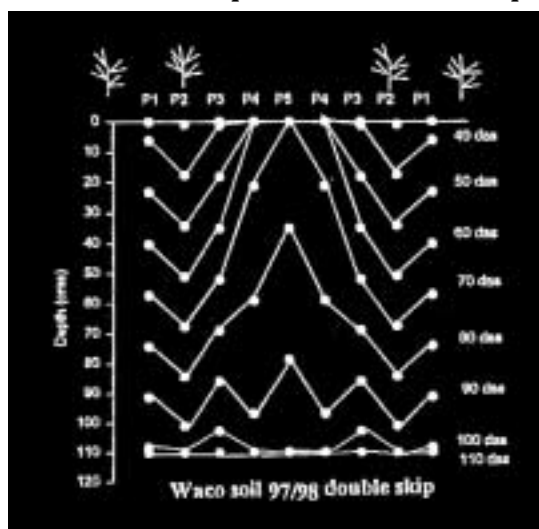
Tables presented in the chapter entitled Dryland Cotton Potential & Risk in this manual use the OZCOT crop simulation model to assess regional potential yield for three different row configurations (solid, single and double).

### *Planting Configuration and Fibre Quality*

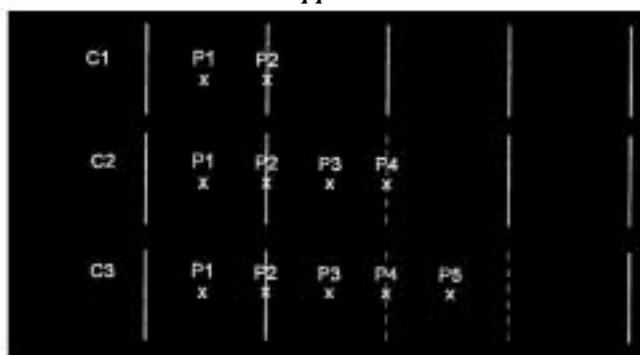
#### **Fibre Development**

The production of dryland cotton is generally carried out after a lengthy fallow of 12–18 months duration, in an effort to maximise soil moisture storage, and hence minimise adverse effects of inadequate rainfall during the growth of the crop. Periods of insufficient soil water not

**Figure 14: Positions of neutron probe tubes used to measure water extraction in studies and an example of water extraction patterns for double skip (Goyne, 2000).**

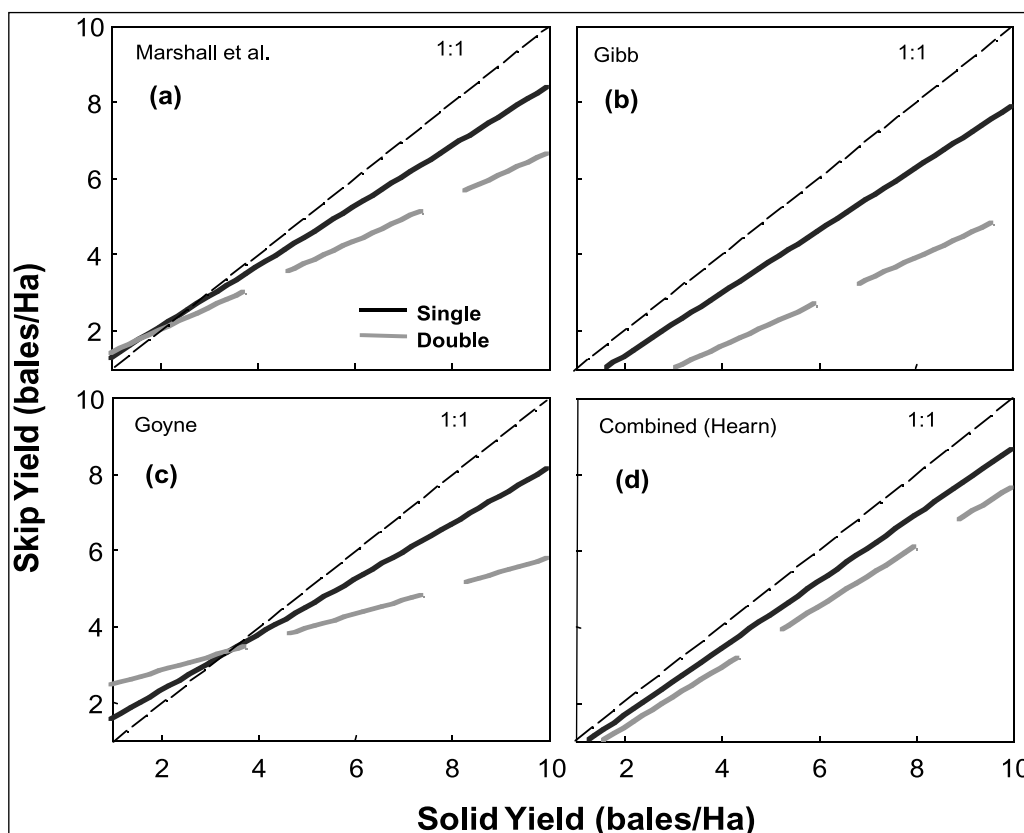


*Solid lines are rows of cotton  
Broken lines are skipped rows*



**C1 = Solid, C2 = Single, C3 = Double.**

**Figure 15: Relationships derived from measured field data that show the relationship of yield of skip row configurations versus solid row configurations. Solids lines are single skip row configurations; broken lines are double skip row configurations.**



only reduce the quantity of lint produced but also impact on fibre characteristics, short fibre length historically being the most serious characteristic affected. Achievement of commercially desirable fibre length requires adequate soil moisture during the first 20 days of boll development following flowering. Once length is determined, fibre thickening then occurs.

Seasonal temperature affects crop development and thus causes flowering time to vary between seasons. It is important for fibre development that adequate soil water for crop growth coincides with the time of peak flowering. **Table 22** shows the date of planting, time to first flower and time to peak flower for four years of trial crops grown at Pirrinuan near

Dalby in a row configuration trial. (The data in **Table 23** serves to illustrate the extreme variation which can occur in crop development. In this example for both crop yield and fibre length considerations). Growers should aim to have peak flowering corresponding with the period with the highest probability of rainfall, which is late January, early February (similar for all dryland areas). The use of skip row configurations provides some insurance against poor fibre quality at this peak time of flowering by providing a larger soil reserve available to the crop and delaying moisture stress.

Micronaire is another fibre quality characteristic which can vary considerably between seasons, more so in irrigated cotton production than dryland. The desirable fibre for cotton spinners

**Table 22: Differences in flowering characteristics of crops in row configuration trial, Pirrinuan near Dalby, in four seasons 1995-1998. (Goyne, 2000)**

Year	Variety	Planting date	Days to first flower	Days to peak flower
1995-96	Sicot CS189+	Nov 2nd	73	-
1996-97	Siokra V-15	Oct 11th	102	118 (Feb 6th)
1997-98	Siokra V-15i	Oct 14th	71	100 (Jan 22nd)
1998-99	Siokra V-15i	Oct 8th	83	106 (Jan 22nd)

**Table 23: Influence of row configuration on major fibre characteristics in a series of Central Queensland trials. Data from Bruce Pyke, published in Marshall et al. (1994).**

Trial location/season	Row Configuration			Solid yield Bales/ha	
	Fibre measurement	Solid	Single skip		Double skip
Orion 1989/90	Length	D		*	1.4
	Uniformity	*		*	
	Strength			*	
	Micronaire	D(high)	D(high)	*	
Orion 1990/91	Length	D		*	2.6
	Uniformity			*	
	Strength			*	
	Micronaire		*	D(low)	
Dalby 1991/92	Length	D	D	*	3.6
	Uniformity			*	
	Strength			*	
	Micronaire	D(high)	D(high)	*	
Biloela 1990/91	Length	D		*	5.5
	Uniformity	*			
	Strength		*		
	Micronaire			*	
Biloela 1990/91	Length			*	4.4
	Uniformity			*	
	Strength			*	
	Micronaire	*			

\* = best for that characteristic (longest , strongest, most uniform, lowest micronaire >3.5)  
D = commercial discount incurred

**Table 24: Fibre quality characteristics from two seasons of row configuration trials on Darling Downs QLD (Goynes, 2000)**

		Solid	Single skip	Double skip	
<b>Pirriuan</b> <b>1997/98</b>	Yield (b/ha)	3.2	3.4	3.2	No Sig.diff
	Length	33/32	35/32	36/32	Sig. diff
	Strength	30.4	32.9	32.9	Sig. diff
	Micronaire	4.2			No Sig.diff
	Uniformity %	82.8			No Sig.diff
<b>Macalister</b> <b>1998/99</b>	Yield (b/ha)	8.7	7.6	5.3	Sig diff.
	Length	34/32			No Sig.diff
	Strength	28.6			
	Micronaire	4.2			
	Uniformity %	81.5			

lies in the micronaire range 3.5 – 4.9. High micronaire cotton is most likely to occur in dryland crops in situations when the crop suffers early boll loss, due to either heavy insect pressure or water stress, and then encounters good late season growing conditions. A lot of surplus photosynthate will be deposited in a reduced number of bolls, resulting in much thicker fibres.

Conversely low micronaire cotton can occur if boll setting is delayed, and the crop then encounters lower average temperatures during March-April while fibre thickening is in progress. Skip row configurations can reduce the degree of fruit shedding in crops suffering moisture stress, thereby maintaining a better spread of boll maturity.

Fibre strength is also responsive to soil moisture availability, with lower strength characteristic of crops where some degree of moisture shortage was evident during fibre maturation. Variety has a big influence on fibre strength. Varieties used in Australian dryland production seldom incur a penalty (HVI fibre strength <28gm/tex).

#### Experimental Comparisons of Row Configuration on Fibre Quality

Two trials conducted in dryland cotton during the last 12 years have examined extensively the influence of row configuration on fibre quality. One trial conducted by Bruce Pyke in Central Queensland early in the 1990's (published in Marshall et al., 1994) showed that there were

significant effects of row configuration on fibre quality, especially staple length and micronaire (Table 23).

The second study was by Goynes (2000) on the Darling Downs who also measured the impact of row configuration on fibre quality. In some years, fibre characteristics were significantly influenced by row configuration, and in others there was no effect. The experiment in which there was no effect was also associated with high yields and little moisture stress (Table 24). Goynes (2000) summarised his results stating 'that length and strength were generally higher for the skip row configurations than the no skip treatments but micronaire was lower'.

Cotton Seed Distributors has also been conducting variety trials at a number of sites in the dryland growing regions over a period of years. Table 25 below illustrates the fibre length data collected and summarised from ten of these trials, over seasons from 1997 to 2000. Growers at five of the sites used a solid configuration, the other five used skip row.

The data shows that fibre length measured below base grade was recorded in 56% of situations where cotton was grown in solid plant, compared with only 11% with skip row configurations. Furthermore, the degree of shortness of fibres has been much more severe in solid plant with 30% below 33/32's (1.03in.), compared with skip where those below base grade fell just below the 35/32 (1.09in.) mark.

**Table 25: Data on fibre properties of varieties appearing in Cotton Seed Distributors dryland variety trials conducted at ten different sites over four seasons 1997-2000**

	Fibre Length Below base				Base	Total
	<1.0	1.00 - 1.03	1.03 - 1.06	1.06 - 1.09	> 1.09	
<b>Solid plant</b>	3	14	20	21	45	103
<b>Skip row</b>	-	-	2	9	86	97
<b>Total</b>						200

**Table 26: Discounts for fibre length and micronaire, and corresponding bale price reduction at AUD/USD = 0.50. Period 1996 versus 2001, discounts averaged across merchants**

	Fibre length (ins)				Micronaire	
	31/32	32/32	33/32	34/32	G4 (<3.5)	G6 (>4.9)
<b>1996 points</b>	-1350	-950	-550	-200	-275	-300
<b>AUD \$/bale</b>	135	95	55	20	27.50	30
<b>2001 points</b>	-1650	-1350	-1025	-600	-500	-300
<b>AUD \$/bale</b>	165	135	102.50	60	50	30

**Table 27: Input cost changes with skip row plantings from Marshall et al. (1994).**

Item	% Reduction from solid plant		Comments
	Single skip	Double skip	
Seed	20	33	
Starter fertiliser	33	50	
Soil applied insecticide	33	50	
Water injection	33	50	Time saved in refills
Banded herbicide	33	50	
Early insecticides	33	50	
Late insecticides, defoliant	25	30	Bigger bush
Picking	20-25	33-40	
Mid, late season application	Ground rig use in lieu of aerial application		

An examination of the same data set showed 10 instances of micronaire below base (5% of entries), 9 of these being for solid, and only two instances of high micronaire (1% of entries), both in skip configurations.

Importantly, some consideration of fibre quality issues and their impacts on economics of dryland production systems is necessary when choosing row configurations. **Table 26** highlights the considerable discounts imposed on bale prices with a range of fibre lengths below base grade and micronaires below and above base grade. The table also illustrates the increasing importance that has been placed on producing quality fibre, as shown by the increase in the size of discounts since 1996.

#### **Economics of different row configurations (Yield vs Quality)**

Various economic analyses, which include costs of production, are provided by both the Queensland and New South Wales State Government Departments of Agriculture. In many cases there is some financial gain in using skip row configurations, by reducing variable costs, not from increased yields. Marshall et al. (1994) outlined in their paper the approximate differences in production between different row configuration systems (**Table 27**). It is important to note however, that the use of skip row does not always reduce costs. In some cases skip row configurations will require additional use of plant growth regulators, late season insect sprays, and an additional inter-row cultivation or spray for weed control.

While superior gross margins from skip row cotton can be achieved due to savings in

variable costs, additional gains (or insurance against losses) can be made by maintaining base fibre quality resulting from the extra soil water available for developing bolls.

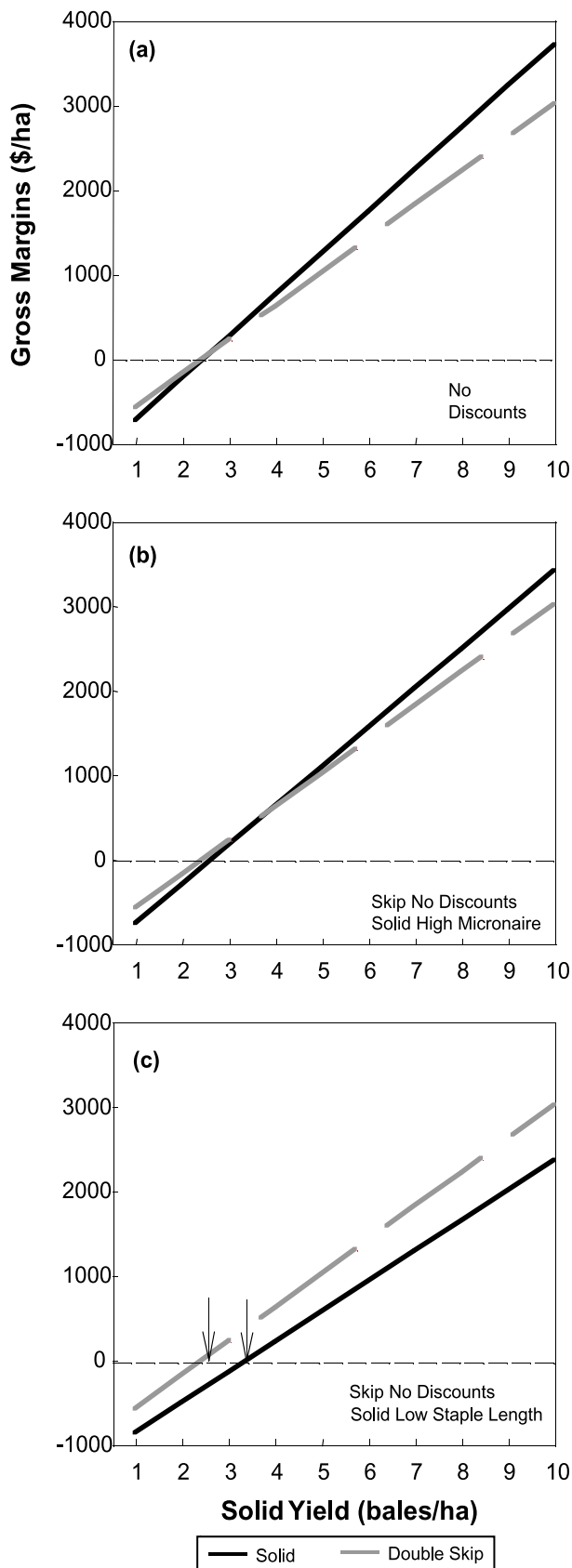
To compare the relative impact of the combined differences in yield, costs of production and fibre quality the following analysis was conducted. Assumptions used in this analysis are outlined below:

Variable costs Solid	- \$1236.07/ha
Variable cost Double skip	- \$869.99/ha
Seed return/t seed	- \$115/t
Lint returns/bale (Ginout 0.37)	- \$450/bale
High micronaire discount (>4.9)	- AU\$30/bale
Staple Length discount (32/32)	- AU\$135/bale
Yield response Skip versus Solid- Combined response (Hearn, 1999; <b>Figure 15d</b> , shown previously).	

The analysis also assumes that no adjustment for costs is made when expected yields are likely to vary.

The analysis showed that when no deductions for fibre quality were applied, the gross margins for double skip and solid were similar to that of solid configuration at low yields (**Figure 16a**). The divergence in gross margins in this analysis as yields for solid increase is primarily due to the differences in yield potential between solid and double skip configurations as for yield comparisons in **Figure 15d**. When a discount for high micronaire is applied to the solid row configuration the difference in the gross margins between solid and double is less, but not considerably (**Figure 16b**). However, when a discount for low staple is applied for a solid configuration, it has a significant effect on the

**Figure 16: Economic comparison of double skip row to solid configuration, accounting for difference in costs and yield. No discounts for quality (a); Discount for high micronaire in solid (b); and Discount for low staple length in solid (c). Arrows in (c) highlight the breakeven yield point.**



gross margin compared with double skip (Figure 16c). The breakeven yield in this last analysis has moved from approximately 2.5 bales/ha to 3.5 bales/ha. This analysis emphasises the importance of considering quality aspects as well as yield and costs in choosing row configuration.

## SEED TREATMENTS

A number of fungicides and insecticides are registered for use as seed treatments on cotton. Pre-treated seed can be purchased from your distributor. 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 late plantings into warmer soils.

### Fungicides

#### PCNB (Quintozene®, Terrachlor®)

- active against Rhizoctonia spp.

#### (Apron®, Mantle®)

- systemic fungicide active against Phythium and related species of fungi which cause 'damping off' of seedlings

### Insecticides

#### Thiodicarb (Semevin Super®)

- provides systemic thrip control for up to 10 days after emergence

#### Imidacloprid (Gaucho®)

- provides systemic thrip control for up to 21 days after emergence

#### Thiamethoxam (Cruiser®)

- provides systemic thrip control for up to 21 days after emergence

### Seed colouring

The polymers, Peridiam (blue, green, red, violet) on CSD seed and Nacret (blue, green) on Deltapine seed are used as seed coatings. They enhance the application and effectiveness of fungicides and insecticides, improve seed flow, and leave a unique colour on the seed which improves seed visibility and allows both planting depth and rate to be easily checked.

## PLANTING

### Considerations

Soil temperatures should be > 15.5°C at 10 cm depth at 8.00 am.

Earlier plantings under cooler soil temperatures result in poorer establishment, slower development and greater vulnerability to seedling insects and diseases

Later plantings risk having cooler autumn

**Table 28: Regional planting times.**

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

conditions which affect fibre development. Insecticide costs may also be higher as a greater number of expensive Stage III sprays may be required.

### Plant Populations

The recommended plant population in all dryland row configurations is 7 to 8 plants/m of row. It is even more desirable to have these plants evenly spaced. Plant populations that are too high may reduce yield by encouraging excessive plant competition, while plant populations that are too low, even when evenly spaced may sacrifice yield, encourage excessive growth and cause difficulties at harvest.

Marshall et al. (1994) explored the impact of plant population within the row with different row configurations over a number of experiments. Results showed that there was a high degree of flexibility in the plant population in the row before yields were affected. Results of single skip configuration experiments, which was their most comprehensive data set, showed that there was no consistent relationship between plant population and final crop yield (**Figure 17a**). When the yield data were made relative to the maximum yield in each experiment it again showed there was no consistent response and highlighted the flexibility of plant population (**Figure 17b**). In the range 5 to 15 plants there

was no instances where low yields were related to plant densities in the row. Goyne (2000) also found no effects of in row plant population on yield.

In general, dryland cotton has a lower potential to compensate for gappy stands. Little data exists on the impact of gappy stands in dryland cotton, but if replanting is considered the same principles as for irrigated production would apply. Research suggests that replanting be considered when gaps bigger than 50cm constitute 20% of the stand.

**Desirable:** 7-8 plants/metre row

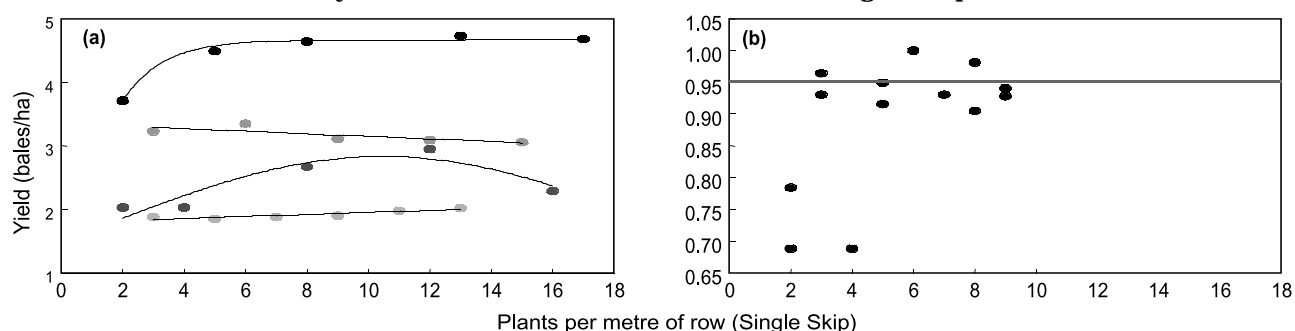
**Equivalent:** 45,000 to 55,000 plants/ha (single skip).

#### 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 reduction 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 generally satisfied with 4 to 5 plants per metre of row on solid row configurations.

A step by step procedure for working out quantity of seed required, using **Table 29**, follows:

**Figure 17: Relationships of single skip row configuration yields versus in row plant population (plant /m of row) (a) and the relative yield (to the maximum measured) for a range of experimental sites.**



**Table 29: Seed quantity required.**

Plant Stand Required plants/m	Solid Plant kg/ha	Single Skip kg/ha	Single Skip + Tram Line kg/ha	Double Skip kg/ha
4	5.9	3.9	3.7	3.0
5	7.4	4.9	4.6	3.7
6	8.9	5.9	5.5	4.4
7	10.3	6.8	6.4	5.1
8	11.8	7.8	7.3	5.9
9	13.3	8.8	8.2	6.6
10	14.8	9.7	9.1	7.4

1. Decide what final plant stand you want per metre of row.
2. Move across the table until you find the appropriate planting configuration.
3. Multiply the number obtained by the paddock size (ha). This will give the total quantity of seed (kgs) required.

**Table 29** uses the following assumptions:

- 1 metre row spacing
- 90% germination
- 75% establishment
- average seed size (10000 seeds/kg)

Actual germination percentage can be obtained from the seed companies. Rates should be adjusted for the prevailing conditions.

Example:

Plant stand required is 7 per metre

From single skip column, seed quantity required per ha is 6.8kg

If paddock size is 120ha, total quantity of seed is  $6.8 \times 120 = 816\text{kg}$  (41 bags)

### Planting depth

Cotton is very sensitive to both depth of soil and soil pressure above the seed. Seed planted deeper than 5cm may fail, or at best be very slow to emerge. Such a delay can set the plant back significantly, making later management and crop conditioning operations very difficult.

**Table 30: Insecticides/Fungicides at planting (rates in kg/ha).**

Product	TEMIK 150 G	Chlorpyrifos	THIMET 200 G
Method of Application	in-furrow granules	in-furrow spray or bait	in-furrow granules
Aphids	3 - 7	-	3
Jassids	3 - 7	-	3
Mites	3 - 7	-	3
Thrips	3 - 7	-	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 4L Chlorpyrifos (500g/L) + 5L sunflower oil.

Excessive presswheel pressure, large lumps of pressed soil, or crusting due to heavy rainfall can all seriously affect emergence, as the young cotton shoot must push the seedling leaves through the surface layer. Therefore, 4–5cm depth of planting, with light presswheel pressure or rolling, good soil tilth and the seed sitting in moist soil are the recommendations for good emergence.

### 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, especially in association with unfavourable establishment conditions, e.g. cool or dry seedbeds.
- The granular insecticides Temik, and Thimet® are registered to control sucking insect pests on seedling cotton. They are not widely used in dryland production. (see **Table 30**)
- Rhizolex, is registered for the control of Rhizoctonia (a seedling disease). Plantings into cool, wet soil, particularly following soybeans, are most likely to be affected. The seed treatments Quintozene and Terrachlor should provide adequate protection in most dryland situations.

## NUTRITION

### Nutrient requirements

**Table 31** indicates that N, P, and K are the nutrients most likely to be deficient, limit crop growth and may require the addition of fertiliser. Zinc is the only other nutrient to which fertiliser responses have been documented in dryland cotton.

### Fertiliser

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 generally used with dryland cotton on the Darling Downs, less so in other areas.

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

- rotational history of the field. 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 should be taken
  - Some growers use the petiole nitrate test
- Fertiliser rates commonly used in dryland cotton are listed below:
- 30 to 80kg N/ha depending on soil moisture and above factors
  - 5 to 15kg P/ha on soils responsive to phosphorus.

**Table 31: Nutrient removal rates and uptake by 2.5b/ha cotton crop**

Major Nutrients	Removal in lint + seed (Kg/ha)	Total uptake (Kg/ha)
Nitrogen	28	47
Phosphorus	5	13
Potassium	15	75
Calcium	3	50
Magnesium	3	20
Sulphur	0.2	6

Micronutrients	Removal in lint + seed (g/ha)
Zinc	0.03
Manganese	0.03
Boron	0.05
Copper	0.008
Iron	0.17

Reference: Constable, G. (1988) ACGRA Conference

Zinc and phosphorus mixes are used by some growers at planting time as a way of reducing potential long fallow disorder problems, and topping up zinc levels on older, high producing 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 this relies on good tramlining systems.
- The band should be located at least 10cm below the anticipated seeding depth to avoid the detrimental effect of high nitrogen concentrations on seed germination.
- Some farmers apply an excessive amount of N to their cereal crop which allows a residue of N to be available to their next cotton crop.
- Phosphorus is relatively immobile in the soil and hence placement is critical. If applied at planting, it should be placed 5cm to 10cm below and to the side of the seed.
- Zinc deficiency can be corrected by incorporating fertiliser pre-sowing or at-sowing, or with foliar treatments.

### REFERENCES

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**Figure 18: Side-dressing nitrogen into a no-till field at the CRC's dryland farming systems trial at Warra**