PROSPECTS FOR RAIN-FED COTTON

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INTRODUCTION

The wild ancestors of cotton are found in the arid regions of the world. They are adapted to survive long periods of extremely dry weather and to respond to an occasional storm or flash flood by rapidly producing fruit while conditions are favourable. Modern cultivated cottons have inherited these attributes, making the crop uniquely adapted for both rain-fed and irrigated production. In Australia cotton was grown for over 100 years as a rain-fed crop before the introduction of the intensive irrigated technology. Rain-fed production is undergoing a renaissance prompted by a high cotton price and low grain prices resulting in the emergence of a new technology derived from a marriage of modern broadacre grain production and irrigated cotton production. The extent of rain-fed production is about 30,000 ha, equally divided between Central Queensland, the northern Darling Downs and northern New South Wales. The increasing importance of rain-fed production can be judged by having 3 papers devoted to the topic at this conference. Bruce Pyke and Ian Titmarsh have dealt with the question of varieties and pest management. This paper examines the influence of climate on the prospects for and limitations to rain-fed production.

ASSESSING THE INFLUENCE OF CLIMATE

The yield potential of the climate of a region for rain-fed cotton can be assessed from long term weather records. First a daily water balance is calculated, like a bank balance with deposits (rainfall) and withdrawals (transpiration from the crop, evaporation from the soil surface, runoff and drainage). Just as his bank balance determines a person's economic activity so the water balance determines a crop's activity, showing whether there would have been sufficient soil water to sow and establish a crop, whether it could have produced squares and what the boll carrying capacity would have been. The second consideration is temperature which determines whether it would have been warm enough for germination, how fast squares could have been produced and bolls matured and whether frost would have terminated growth at the end of the season before water stress or cut out did.

These effects of water balance and temperature have been integrated in a computer model to estimate the potential number of bolls that could have been set, filled and matured, and thus indicate the yield potential for any possible sowing date in the period covered by the weather records.This analysis of weather data is particularly useful where the crop has not been grown for long period in a region and there is a dearth of experience with it. However it is only one approach and not the final word on the topic. The results needed to be tempered with common sense and with experience, however limited.

Analyses were done for the major regions of rain-fed production: Central Queensland, Darling Downs and East Moree. In addition the Breeza Plains and the Upper Namoi valley were included because of interest in rain-fed production. The Central Gwydir valley was included in view of the perennial shortfall of irrigation water and the Lower Namoi because it too is subject to occasional irrigation shortfall. Weather records for 70 to 90 years were available for this study. To be conservative stations from the drier part of the range in each region were used; Emerald, Dalby, Goondiwindi, Breeza, Carroll and WeeWaa respectively for the regions in the order mentioned. A standard cracking grey clay soil was assumed capable of holding 200mm of available water in a 1.3 m profile. The implications of soils with more or less available water holding capacity will be examined. The first sowing opportunity in the period 15th September to 13th December was determined for each year at each location. The yield potential of the crop sown at that time was estimated. A sowing opportunity was defined as 25mm of water in the top 100mm of soil and a mean temperature of 18°C for 3 days. Gross margins have been calculated by assuming variable costs to be \$600 per ha and and the price of cotton \$450 per bale. Crop failure is defined as failing to recover growing costs or breakeven.

POTENTIAL YIELD

Table 1 shows the mean of potential yields for all years in which it was judged possible to sow a crop together with gross margins, and the probability of failing to sow a crop. The yields and gross margins are apparently promising, although the probability of failing to sow is relatively high, particularly at Lower Namoi, Central Gwydir and Breeza. It is possible that in this study sowing conditions were defined too stringently, but this seems unlikely .

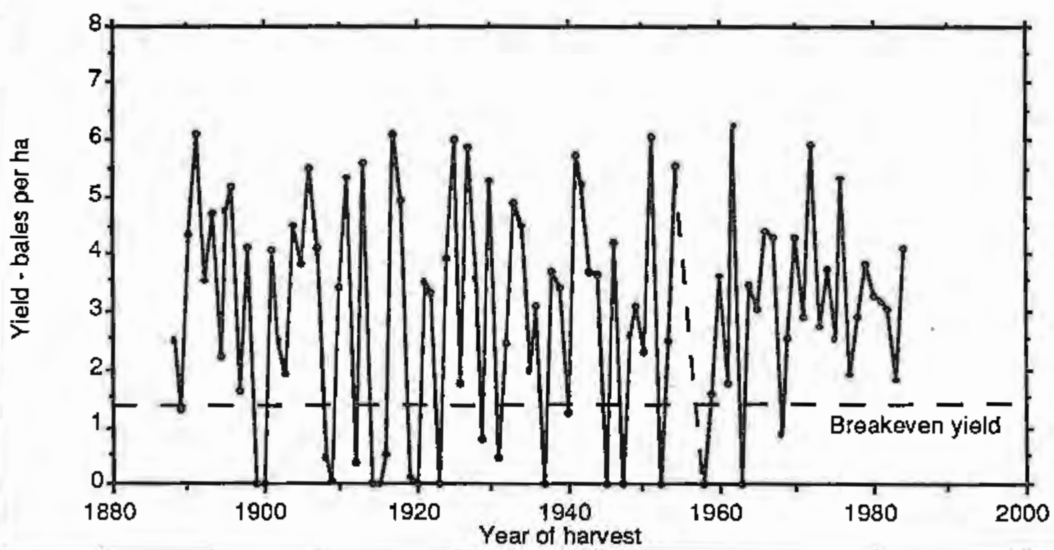
RISK

Although the mean potential yields are promising, there is much variation from year to year, as shown in Figure 1 for Darling Downs. The zero yields are mostly the years when crops were not sown. The breakeven yield is shown in Figure 1. It is

TABLE 1. 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 bales per ha	gross margins $ per ha	years failed to sow	years failed to breakeven
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
Cent. 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

FIGURE 1: EXPECTED YIELDS OF RAIN FED COTTON ON THE DARLING DOWNS



the yield which is just sufficient to recover growing costs and amounts to 1.3 bales per ha with the assumed prices and costs. In Figure 1, one crop in 7 sown on Darling Downs failed to breakeven. The yields of sown crops in Figure 1 have been rearranged in ascending order in Figure 2 to show the probability of achieving a particular yield, together with yields for other locations. The risk of failing to breakeven is least on the Darling Downs and greatest on the Breeza Plains and is given in Table 1 for each location. A grower can draw his own breakeven line on Figure 2 and read off the probability of failing to breakeven.

The occasional failure for one year may be acceptable but not perhaps the risk of two or more in a row. The combined risk of either failing to sow or failing to breakeven ranges from a low of 1 year in 5 on the Darling Downs to a high of 1 in 2 in the Gwydir Valley. In most cases a little over half these failures were for more than one year in succession. Recovery, in terms of making good the losses, occurred within one year in half of the occasions, except at Breeza and the Gwydir Valley, where in two out of three cases recovery took more than 1 year, and on the Downs, where the risk of not recovering within a year was very low.

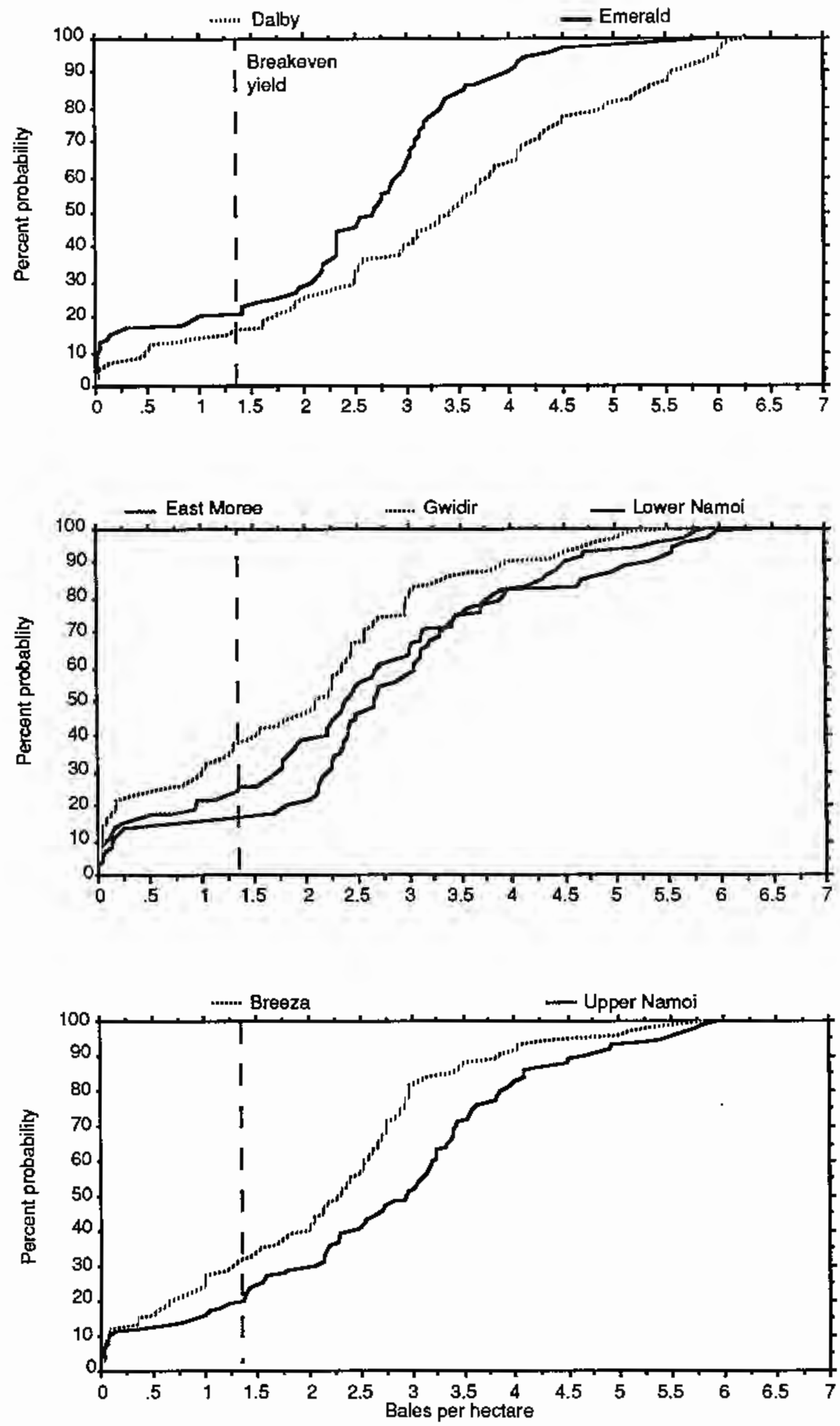
RISK REDUCTION STRATEGIES.

Fallowing. Fallowing is a strategy to increase subsoil water at sowing. The strategy has been evaluated for cotton grown in alternate years with approximately 18 months of fallow between crops. Fallowing increased yields 1 year in 3 or 4, depending on the region. Mean yields and gross margins, and the risk of failing to breakeven have been compared with those for cotton grown every year, with the results shown in Table 2. Fallowing increased yields and gross margins and reduced, but by no means eliminated, the risk of crop failure. The advantages of fallowing must be balanced against the loss of production when a successful crop could have been grown on the fallowed country.

TABLE 2: Effects of fallowing in the major regions

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

FIGURE 2: Yield probabilities.



Subsoil water. In this study potential yield increased by an average of 3 kg lint for each mm of water stored at sowing in all regions except Central Queensland, where more reliable summer rain reduced it to 0.9 kg. The amount of stored water at sowing (and the equivalent depth of wet soil in brackets) needed to breakeven in the driest season was estimated and ranged from 60mm (0.47m) in Central Queensland, through 110mm (0.96m) on the Darling Downs to an average of 148mm (1.35m) for all other regions except Gwydir which required an additional 25% stored water. Although these amounts could be used for deciding whether to sow in order to avoid a crop failure, the practice would greatly reduce the number of years in which a crop could be sown and many years of high yield potential with adequate summer rain would be missed. Depth of subsoil water has been advocated as part of the sowing decision, for example subsoil wet to 0.6m on the Darling Downs and to 1m for East Moree. With fallowing there was always sufficient subsoil water. Without fallowing including depth of subsoil water in the sowing decision on the Downs increased the failure to sow rate from 1 year in 10 to 1 in 3, and 3 out of 4 of the additional years without a crop could have grown successful crops. In the East Moree region the failure to sow rate increased from 1 year in 5 to 1 in 3, and two out three of the additional years could have grown successful crops.

Skip Row Planting. This strategy omits planting every third row in order to increase the water available to the planted rows and thus delay the onset of water stress. Yields, gross margins and the risk of failing to breakeven for skip row cotton are compared with those for solid planted cotton in Table 3. Skip-row planting increased the yield in a few years (1 in 5) in all regions but reduced it in most (in 2 years in 3 to 5), resulting in an overall reduction in mean yield. Variable cost are also reduced by skiprow (assumed to be $500 per ha). As a result the effect on gross margins and the risk of crop failure was mainly small and variable.

TABLE 3: Effects of skiprow planting in the major regions.

Region	change in mean yield - bales/ha	change in gross margins - $/ha	change in % years crop failed
East Moree	-0.15	+35	no change
Darling Downs	-0.26	-19	1:6 to 1:8
Central Qld	-0.38	-30	1:6 to 1:5

Many growers have sound management reasons for adopting a skip row configuration, apart from expectation of yield increase and risk reduction.

Soil Depth. The question of soil depth was addressed for two reasons: (i) can risk be reduced by growing rain-fed cotton on deeper soils and avoiding shallow soils? (ii) how applicable are the conclusions of this study to deeper or shallower than the standard soil used? The effect of soil depth was studied for the major regions by repeating the analysis with soils with 160mm and 240 mm of available waterholding capacity. The results in Table 4 show that mean yields increased with increasing soil depth but, surprisingly, had small and inconsistent effects on the risk of failure.

Skiprow planting and deeper soil both increased the water storage capacity available to the crop. Both increased yield only in the moderate years but not in wet years or dry years. In the wet years there was enough water anyway, so extra storage capacity was no advantage. In dry years, there was little water to store and the limited capacity was sufficient.

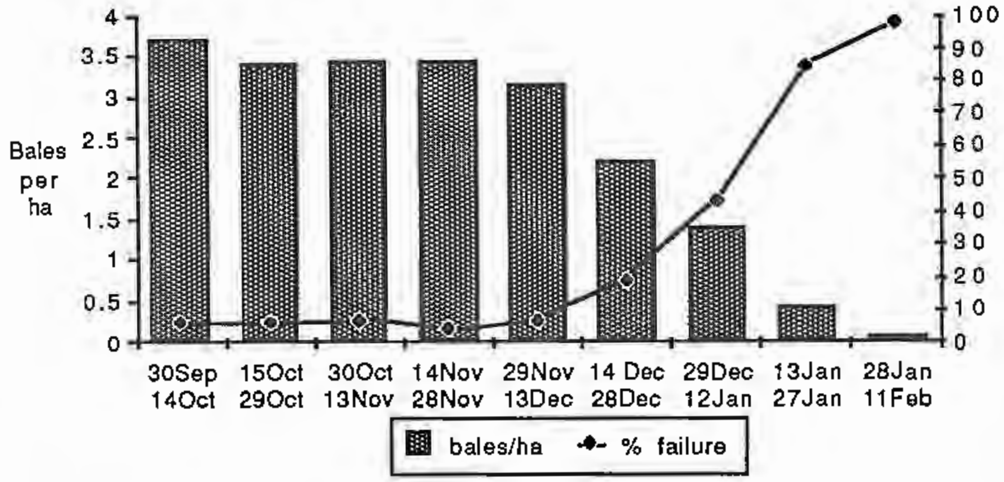
TABLE 4: Effect of soil depth on mean potential yields in the major regions.

	shallow soil (160 mm water)	standard soil (200mm water)	deep soil (240mm water)
E Moree	2.13	2.48	2.76
Darling D	2.85	3.27	3.49
Cent. Qld	2.38	2.79	2.93

THE EFFECT OF SOWING DATE.

All the analyses and evaluations done so far have been with sowing at the first opportunity between the 15th September and 13th December. Crops sown later have an increasing risk of failing to mature before the first frost, particularly at the southern locations. This risk has been evaluated by examining the expected result of sowing in successive 15 day periods starting on 30th September. The mean yields and risks of crop failure are presented for the Darling Downs in Figure 3 which shows that yield started to fall and risk of failure starts to increase after 29th November, the risk reaching 1 year in 2 on 8th January.

FIGURE 3: Effect of sowing date on the Darling Downs.



The comparable dates for each location are presented in Table 5. As expected, yield starts to decline earlier in the south and later in the north, with due allowance for the higher altitude and lower temperatures of the Darling Downs.

TABLE 5: Effects of sowing date

Region	yield starts to decline	failure reaches 1 year in 2
Breeza	14 November	15 December
Upper Namoi	29 November	14 January
Lower Namoi	29 December	14 January
Cent. Gwydir	14 December	21 January
East Moree	29 December	22 January
Darling Downs	29 November	8 January
Central Qld	13 January	10 February

TABLE 6: Years nitrogen likely to be deficient, cotton after cotton

Region	average case (soil N 45 kg per ha)	worst case (soil N 20 kg per ha)
Breeza	1 in 8	2 in 3
Upper Namoi	1 in 3	3 in 4
Lower Namoi	1 in 4	4 in 5
Cent. Gwydir	1 in 6	1 in 2
East Moree	1 in 4	2 in 3
Darling Downs	1 in 2	4 in 5
Central Qld	1 in 3	3 in 4

NITROGEN REQUIREMENTS

The likelihood of nitrogen being deficient, and fertiliser being required, can be judged from the estimates of potential yield and the probable capacity of the soil to supply nitrogen. A grey cracking clay soil can supply between 20 and 90 kg N per ha to a cotton crop, depending on cropping history and weather, the higher figure being after fallow and the lower one after heavy cropping with severe soil compaction. When cotton is grown after an 18 month fallow, the soil might supply on average 80 kg N per ha, sufficient to produce 6 bales per ha, a yield potential rarely encountered. Consequently, when rain-fed cotton is grown after fallow, nitrogen is unlikely to be deficient nor fertiliser required. However, when cotton is grown every year or after sorghum, soil supply might average 45 N kg per ha, which is sufficient for only 3.5 bales per ha, and nitrogen will be deficient in years when yield potential exceeds this. In those years the crop is likely to respond to the application of nitrogen fertiliser. The probability of such years (yields in excess of 3.5 bales per ha) is given in Table 6.

On this basis, nitrogen is most likely to be deficient on the Darling Downs, which is significantly the only region where nitrogen is usually applied to rain-fed cotton. In a worst case scenario (only 20 kg N per ha, sufficient for 1.8 bales per ha), nitrogen will be deficient, and the crop would respond to applied nitrogen, in most years in all regions, as also shown in Table 6. In order to distinguish average, worst case or any other situation, the soil nitrate test needs to be calibrated for rain-fed cotton to indicate the likelihood of an economic response to nitrogen in conjunction with experiments to determine the rate. Meanwhile 50kg N per ha appears to be a reasonable rate to apply.

CONCLUSIONS

At current prices rain-fed cotton growing should be profitable when averaged over several seasons. However, occasional failures appear climatically unavoidable: either failure to sow or failure to recover growing costs. Glen Keefer in a similar study recently reported in the Australian Cotton Grower suggested the risks may be even greater in Central Queensland. The risk of failing to breakeven can be reduced but not eliminated by fallowing and by timely sowing. Skiprow planting is unlikely to reduce risk and is likely to reduce production, but may be desirable for other reasons. Sowing only when there is sufficient subsoil water to avoid a crop failure will increase the risk of failing to sow and may preclude cropping in seasons that subsequently turn out to have adequate rainfall for a successful a crop. Reducing the risk of failing to sow depends on developing the technology for stubble and fallow management and water injection. Although growing rain-fed cotton is subject to a relatively large risk, it can be taken as a calculated risk.

In view of these risks, rain-fed cotton production is most suited to be part of a mixed cropping enterprise or in conjunction with irrigated cotton production where water allocations are unreliable. Rain-fed cotton is too risky to be suitable for a single activity enterprise.

Management and research should concentrate on realising as much of the potential as possible in the good years in order to survive the poor years, rather than raising the yields in poor years. Little can be done for dry years as cotton is already very drought tolerant; it will survive but not produce much. A 10% increase in yield in a good year is worth more than a doubling of the yield in a poor year.