

**COTTON RESEARCH AND DEVELOPMENT CORPORATION**

# **FINAL REPORT**

**“DEVELOPMENT OF SUSTAINABLE IRRIGATED CROPPING  
SYSTEMS IN THE BOURKE DISTRICT”**

**DAN 86C**

January 1993 to December 1996

**Principal Researchers:** Ms Shauna McGuire (Jan 1993 - Feb 1995)  
Mr David Kelly (August 1995 - June 1996)  
Mr Danny Norris, *District Agronomist Bourke*

**Project Supervisor:** Mr Gus Shaw, ACRI Narrabri



**NSW Agriculture**

*“A final report prepared for the Cotton Research and Development Corporation”*

**ISBN 0 7310 9826 9**

## **BOURKE SUSTAINABLE IRRIGATED CROPPING SYSTEMS PROJECT**

### **SUMMARY**

The Bourke Sustainable Irrigated Cropping Systems project (B.S.I.C.S.P) was implemented in 1993-94 as an initiative of the Bourke Cotton Growers association and the Bourke Cotton Growers Landcare group. The project received half of its funds from the National Landcare programme.

The need for the project was conceived through the desire of growers to see research and extension carried out locally. This was to alleviate the problems of perceived irrelevance of research carried out in Narrabri where growing conditions are markedly different. Because the position was to be only a part time, many of the outcomes relied on strong grower cooperation and much of the research was to be an analysis of current grower records rather than 'in field' research.

The aim of the project was to develop and promote best practice in the sustainable production of cotton in the Bourke Irrigation area. The areas of focus highlighted were:

- insect pest management
- optimum sowing window
- cultivation practice
- nitrogen management
- soil conditioners
- chemical application
- crop rotations.

The results of local research work were to be disseminated to all growers in the valley through small group meetings, field days and publications.

Shauna McGuire was employed as Technical Officer (Sustainable Irrigated Cropping Systems) from January 1993 to February 1995 and the position remained vacant for 6 months.. In this time, Danny Norris, District Agronomist continued work on the project. David Kelly was appointed to the position from August 1995 to June 1996. Danny Norris left the district in January 1996 and was not replaced. For the remaining 6 months of the project an effort was made to employ a temporary assistant to complete some of the collection and analysis of grower records. This did not eventuate as growers indicated that they did not wish to contribute their records any more because of a concern with security and confidentiality of this information.

The CRDC funded portion of the Bourke Sustainable Irrigated Cropping Systems Project ended its 3 year term in December 1996. It was the aim of all staff involved in the project that all objectives would be met. Due to periods where there were vacancies in staff some objectives were not addressed fully although there were still many very positive outcomes.

Work in the area of insect pest management focussed on integrated strategies of pest control. This included soft option trials, the promotion of EntomoLOGIC and the use of the Lepton test kit, and the coordination of a number of IPM focussed workshops and meetings. Positive results in trials and good grower interest suggests that with continued extension support, there could be good adoption of IPM principles.

The process of identifying an optimum sowing window for cotton in the Bourke District was assessed by the analysis of grower records made available for the local data base and addressed such factors as, yield, insecticide costs and water use. Analysis of these data suggested that insecticide costs increased with later crops. This could be explained by the need to use the more of the expensive stage III chemicals in the later crops. Other correlations were attempted between the other factors suggested, although no relationships were found.

Soil management and cultivation practice issues were addressed by a series of field days involving soil pits and hands on demonstrations. These made growers more aware of the various methods of soil management and the impact on the soil of various operations.

Several investigations were undertaken in the area of sodicity and salinity management. These included gypsum rate trials and a review of the affects of flooding fields. Conclusions from this work suggested more scope for research in this area.

There were two major events conducted to promote efficient and safe application of pesticides. These were, a spray application workshop held in collaboration with the Centre for Pesticide Application and Safety, and an aerial trial was performed using water sensitive paper to measure drift and droplet size, comparing micronairre and CP nozzles at the 1995 Bourke Cotton Field Day.

The B.S.I.C.S.P. promoted the use of rotation and alternative crops such as grain legumes and cereals by discussing them at field days and meeting and preparing gross margin budgets for crops such as peanuts, pima cotton and mung beans.

The project in many ways acted as a catalyst to the local adoption of technology that has been developed outside of the Bourke district. It has allowed researchers to include Bourke in their work as the B.S.I.C.S.P. could act as a liaison between growers and researchers, be involved in the collection of data, and in the dissemination of results to local growers. It has also provided the district with a person who can be responsible for the organisation of field days/ walks and extension. Successful events organised as a part of the project included; two major soil workshops, spray application meeting. The B.S.I.C.S.P. also played a large role in organising the Bourke Cotton Field Days in 1994, 1995, and 1996 which consistently attracted around 100 people.

This project provided numerous benefits to the cotton industry in the Bourke area. With the base that has been established over the past three years, further work could continue to increase the adoption of new technology. This will be especially important at this time with issues such as transgenic cotton, insecticide resistance, and all aspects of integrated pest management being at the forefront of the industry. Successful adoption of these issues will be greatly enhanced by the presence an of a extension officer who is able to devote a proportion of their time to cotton issues.

## **INTRODUCTION**

The Bourke Sustainable Irrigated Cropping Systems project (B.S.I.C.S.P) was implemented in 1993-94 as an initiative of the Bourke Cotton Growers Association and the Bourke Cotton Growers Landcare group. The project received half of its funds from the National Landcare programme. The final report for this part of the project appears as an appendix to this document.

The need for the project was conceived through the desire of growers to see research and extension carried out locally. This was to alleviate the problems of perceived irrelevance of research carried out in Narrabri where growing conditions are markedly different. Because the position was to be only part time, many of the outcomes relied on strong grower cooperation and much of the research was to be an analysis of current grower records rather than 'in field' research.

In 1992 the Cotton Research and Development Corporation (CRDC) board of management visited the Bourke district and offered 'in principle support' to co-fund research with the Natural Resource Management Strategy. It was decided that cotton production issues could be addressed as well as land management issues and in a collaborative role with the District Agronomist.

The result of this work was to be disseminated to growers through regular reports, grower meetings and field days.

## **OBJECTIVES**

To develop and promote best practise in the sustainable production of cotton in the Bourke Irrigation area. The results of local research work was to be disseminated to all growers in the valley through small group meetings, field days and publications.

These research and extension activities would focus in the areas of:

- Insect pest management
- Optimum sowing window
- Cultivation practice
- Nitrogen management
- Soil conditioners
- Chemical application
- Crop rotations

Consultation with local growers and agronomists was to be done at the beginning of each growing season to ensure the work remains relevant as new issues arise.

## **RESULTS AND DISCUSSION:**

In the first year of this project a report on trials was published which covered in great detail the activities completed in this season. This has been included as an appendix to this document and can be referred to when more detail is required.

What should be considered as well as these specific areas are the more holistic impacts this project had in the district. The presence of a person devoted to cotton in the area allowed an immediate response to issues that arose. This included field days/ meetings, fax outs, and grower consultation on issues of importance. It also meant that there was someone in the district to act as a liaison for visiting researchers, which encouraged more quality research to be conducted in the district.

### **Insect Pest Management**

Work in this area has been on several fronts and is at the forefront of industry issues, especially as we become more aware of the importance of integrated pest management (IPM). This was indicated in a meeting conducted in October 1995 conducted by Dr Robert Mensah where a general consensus suggested that more on-farm trials needed to focus on IPM.

Two soft option trials were done in the 1994-95 season to compare treatments of conventionally sprayed cotton and those using 'softer sprays' (predominantly Bt's and Bt/ low rate endosulfan mix). These trials included one on upland (Sicala V2) and one on pima cotton. They were done in collaboration with local growers and followed the IPM trial protocol put out by the CRDC. Some interesting conclusions were realised. In the trial on upland cotton (with Clyde Agriculture) Bt sprays were used in the 'soft' treatment while predominantly endosulfan sprays were used in the conventional treatment. Plant mapping data showed lower fruit retention and higher levels of tipping out in the 'soft' treatment, but plants were able to compensate and figure 1 shows, there was no significant yield variation.

The trial with pima cotton (with Darling Farms) showed similar results to the Clyde trial, but no yield results were able to be obtained due to wet weather.

These results are very encouraging in terms of giving growers confidence in adopting IPM technology without suffering a yield decrease.

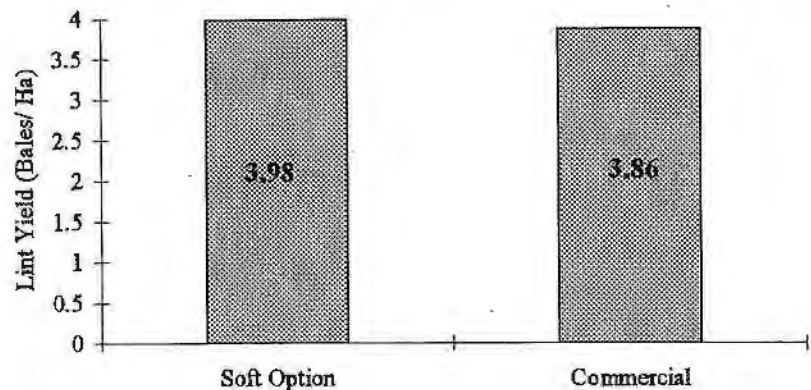


Figure 1. Yield results on Clyde Agriculture IPM Trial

Having a comparatively long season compared with many other districts, Bourke could be a place where this technology could be fully utilised because of the greater amount of time the plants have to produce compensatory growth.

EntomoLOGIC, the industry funded pest management decision support system was promoted through the B.S.I.C.S.P. with the organisation of training workshops in all three years of the project, and where possible demonstrating its effectiveness in on-farm trials. This resulted in 3 of the 4 corporate agronomists and consultants using it as a regular management tool. This constituted a vast majority of the Bourke cotton growing area.

There were a number of other meetings and field days during the project that aimed to make growers more aware of the concepts of IPM and other technologies. Dr Robert Mensah of ACRI Narrabri conducted a full day meeting on in October 1995 and addressed such areas as, beneficial insects, the role and management of lucerne, and the importance of using soft sprays early in the season to prevent the flaring of mites. Dr Gary Fitt attended a growers meeting and talked with growers about the importance of pupae destruction as a part of the Insecticide Resistance Strategy. At this meeting growers expressed an interest in this and since that time Dr Fitt has included Bourke in his national pupae survey. The issue of pupae control was also addressed at a soil and land management field day in June 1996 where Murray Schoenfisch of the CRDC spoke about machinery options in pupae control.

In October 1995 the staff of the B.S.I.C.S.P. were involved in teaching a 'Cotton Crop Checking' course at Bourke College of TAFE. The 8 students in the class were taught about the growth characteristics of cotton, identification of pest and beneficial insects, neutron probing, and other areas of general agronomy. As a part of this course we conducted a assessment of the distribution of Heliothis insects across a cotton field, and whether this was related to the position in the field (ie. head ditch etc.). The work showed that the variation across the field was very great, but did not appear to follow any pattern. Results from this were documented and presented to the students and some growers.

The benefits of the Lepton® test kit were demonstrated by the B.S.I.C.S.P. through the compilation and distribution of the local results on a weekly basis to all consultants/ agronomists/ resellers. In 1995 about 4 growers used the test kit. Results from tests done by Robin Gunning identifying levels of pyrethroid, carbamate and endosulfan resistance were also compiled and sent to growers and agronomists. The information generated in both the Lepton® and resistance tests proved to be a very valuable tool in the informed selection of insecticide sprays.

B.S.I.C.S.P. staff played a very important role within the district in regards to the insecticide resistance management strategy. This included reminding growers of the importance of plough-down, and in the 1994-95 season, assisting in a valley wide tour to assess the effectiveness of local plough down efforts. It also involved encouraging growers to adhere to the spray windows for the Resistance Management Strategy

### **Optimum Sowing Window.**

The idea of identifying an optimum sowing window for cotton in the Bourke District was an issue raised by local growers, although not as a high priority. It aimed to involve all parameters in the crop such as yield, insecticide, and water use.

Data collection for this began in the 1993-94 season on Pima cotton. Results from this season indicated a positive correlation ( $R^2=0.53$ ) between sowing date and the pesticides costs. It suggested that an increase of approximately \$100/ ha in the 10 days between the 5th and 17th of October. This could be explained by the need to use the more of the expensive stage III chemicals in the later crops. Other information to support this was a similar correlation ( $R^2=0.42$ ) was made between the cost of mite sprays and sowing date. This showed a similar increase in cost over the same period. The results of this work were compiled in a report and given to growers.

This comparison was done in the following season with a similar result in the past season, again this was attributed to the greater use of stage III chemicals with these later crops. This information was passed on to growers. No significant relationship was found with any of the other data this season.

With these positive results from the previous two seasons it was intended that these investigations should continue. The vacancy in the T.O. position and the lack of data in the following season meant that this was not possible.

Other correlations were attempted between the other factors suggested, although no relationships were found.

### **Cultivation practice**

The work in this area was intended to be focussed around making growers more aware of the various methods of cultivation practice through field days, field inspections and meetings. There were two of these meetings during the project.

The first of these meetings was a part of the Soilpak programme in 1994 and involved inspecting soil pits comparing wide beds and 1m rows, and middle busted compared to uncultivated soils. This proved to be a very worthwhile exercise with about 35 growers and consultants attending.

Another meeting was held in June 1996. This was seen as a high priority at the time because there was many fields in the district that had experienced a wet pick. The field day allowed growers to assess damage done to wet fields by driving machinery and attempting to cultivate. There were several other issues addressed on the day including basic soil tests (pH, structure, and texture), options for crop rotations, and the best methods for pupae control. Again, growers showed a lot of interest in the day, with about 35 people in total attending.

Because there was no bench marking survey done during this project it is difficult to assess if there were any significant changes to cultivation practice by local growers as a result of these field days. It was evident however that some short term gains were made, especially as a result of the latter of these field days when a number of growers delayed cultivation to avoid causing structural damage to their soil.

## Nitrogen Management

The issues associated with the timing and quantity of nitrogen was identified by growers as an area for investigation. It was intended that this would incorporate trial work, field testing and the use of the district data base.

Some investigation was done on the district data base comparing nitrogen application rates with other available parameters such as yield, pesticide, and growth regulator use. No correlation was found here, mainly because the range of application rates was not varied enough (ie. most growers used either 140 or 180 units of N per season).

B.S.I.C.S.P. staff also assisted researchers from other valleys with their work in the Bourke district. The aim of this was to encourage more researchers to the area and increase the level of quality information that was being generated. This work included work with Neville Gould, an engineer from NSW Agriculture, Trangie who was testing a new anhydrous ammonia distribution system. Ian Rochester from ACRI Narrabri also included Bourke in his investigations into the nitrogen fixation properties of various grain legumes. This involved acting as a liaison between the growers and researchers, organising sites, and assisting in the collection of samples. With the large amount of growers using peanuts as a rotation crop, this data will be viewed with a lot of interest.

## Soil Conditioners

The soils predominantly used for irrigation in the Bourke irrigation area are naturally sodic (ESP >5%) and have a high  $EC_e$ . These soil properties have been attributed to some decreases in cotton yields, and a major concern for the long term sustainability of the land. Because of this, growers see the problems of salinity and sodicity as high priority areas and use a number of management options in an attempt to manage them. The role that the B.S.I.C.S.P. aimed to play in this area was to assess the various methods used and report results to growers.

An opportunity arose in the 1995-96 season to undertake a study to assess the effectiveness of flooding cotton fields in an attempt to 'wash' soluble salts through the soil profile and out of the root zone. This was done in conjunction with the application of gypsum which was intended to displace exchangeable sodium and cause it to become soluble. This test involved comparing the soil properties of flooded and non-flooded fields. It showed that there was a lower Exchangeable Sodium Percentage (ESP), but no difference in  $EC_e$  in the upper levels of the flooded fields. This may indicate that sodium was being removed from the upper part of the soil profile, but it was clear that there was scope for more work on this.

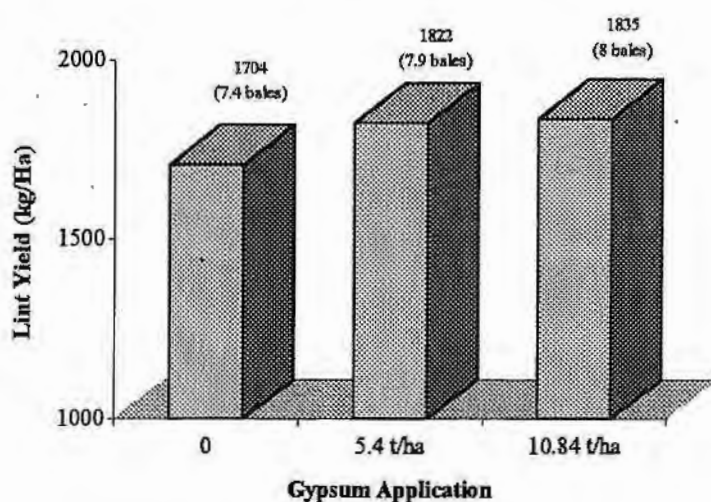


Figure 2 Yield results from Gypsum trial

Another investigation was done on various rates of gypsum, utilising data collected by Steve Buster of Darling Farms. The work showed a yield increase from increased gypsum use in the two crops following the application (see figure 2). It was intended that this be written up as a journal article and published. This was not able to be taken to completion because of the projects premature end. Some preliminary results however were included in the poster displayed at the 1996 ACGRA Cotton Conference which appears at the start of this document.

## **Spray Application.**

In the area of spray application the B.S.I.C.S.P. aimed to educate growers, consultants, and spray operators in efficient and safe application of chemicals.

To achieve this a spray application workshop was held in collaboration with the Centre for Pesticide Application and Safety. This involved a lecture and an in- field demonstration on such things as nozzle selection, suitable weather conditions, and droplet size. A majority of local growers and consultants attended this meeting and the feedback from this was positive.

At the 1995 Bourke Cotton Field Day an aerial trial was performed using water sensitive paper to measure drift and droplet size, comparing micronaires and CP nozzles, with particular relevance to defoliation. This exercise enabled a large number of growers and other industry people to see first hand the quality of the various application methods.

## **Rotation Crops**

The B.S.I.C.S.P. aimed to promote the use of rotation crops such as grain legumes and cereals because of the benefit they provide to soil structural and chemical properties.

The use of rotation crops was a parameter that was proposed to be used in the district data base, determining if the use of such crops had any affect on the following cotton crop. Preliminary investigations with limited data failed to show any consistent trend with this data.

The use of peanuts as a rotation crop increased during the time of the project. The advantages of this crop in terms of nitrogen fixation and improving soil organic matter were quickly seized upon and promoted through the project. An important aspect of this was the compilation of gross margin budgets for peanuts and mung beans which were published in the 1993-94 season summary.

Peanuts were also given attention at the 1996 Bourke Cotton Field Day where visitors were able to inspect a mature crop and listen to speeches by growers and consultants on their experiences.

Bourke is also one of the only growing areas in Australia producing commercial quantities of Pima cotton. The advantage of this crop is that, if successful it is able to be more efficient (\$/Megalitre of water) than the Upland varieties. A local gross margin budget was also produced for this crop and published in the 1993/94 Season Summary.

## **CONCLUSIONS, RECOMMENDATIONS & APPLICATION TO THE INDUSTRY**

The CRDC funded portion of the Bourke Sustainable Irrigated Cropping Systems Project ended its 3 year term in December 1996. It was the aim of all staff involved in the project that all objectives would be met. Due to periods where there were vacancies in staff, some objectives were not addressed fully although there were still many very positive outcomes as this document has already outlined.

The project has in many ways acted as a catalyst to the local adoption of technology that has been developed outside of the Bourke district. This has covered all facets of cotton production; from the extensive work involved in validating investigating early season soft option insect control, to soil structural management.

It has also provided the district with a person who can be responsible for the organisation of field days/ walks and extension meetings and attracting researchers/ industry experts to the area to present their work. Successful events organised as a part of the project included; two major soil workshops, spray application meeting. The B.S.I.C.S.P. also played a large role in organising the Bourke Cotton Field Days in 1994, 1995, and 1996 which consistently attracted around 100 people.

Having a person devoted to cotton in the district made it easier for researchers to include Bourke in their work as they could act as a liaison between growers and researchers, be involved in the collection of data, and in the dissemination of results to local growers. This has been successful in a number of instances in the past three years such as; assisting Ian Rochester with nitrogen fixation work and Neville Gould with the anhydrous ammonia manifold.

This project has provided numerous benefits to the cotton industry in the Bourke area. With the base that has been established over the past three years, further work could continue to increase the adoption of new technology. This will be especially important at this time with issues such as transgenic cotton, insecticide resistance, and all aspects of integrated pest management being at the forefront of the industry. Successful adoption of these issues will be greatly enhanced by the presence of an extension officer who is able to devote a proportion of their time to cotton issues.

#### **PROJECT STAFF & RESOURCES**

Shauna McGuire was employed as Technical Officer (Sustainable Irrigated Cropping Systems) in January 1993 and set about implementing the objectives of the project. She resigned in February 1995 and the position remained vacant for 6 months due to a staff freeze in the NSW public service. In this time, Danny Norris, District Agronomist continued work on the project, although his time had to be shared with his other duties. David Kelly was appointed to the position in August 1995. Danny Norris left the district in January 1996 and was not replaced as was David Kelly who left in June 1996. After this point an effort was made to employ a temporary assistant for 2 months to complete some of the collection and analysis of grower records. This did not eventuate as growers indicated that they did not wish to contribute their records any more because of a concern with security and confidentiality of this information.

This withdrawal of support, along with a large period of time with no person permanently employed on the project (12 months of the 3 year project) meant that some of the objectives could not be fully reached. As well as this, priorities for investigation changed over the project as feedback was received from growers and national issues in the cotton industry evolved.

## COMMUNICATION OF RESULTS:

### PUBLICATIONS:

- 1994. Bourke Cotton Growers Association 1993-94 season summary. *NSW Agriculture Publications*
- 1996. Bourke sustainable Irrigated Cropping Systems Project. *Poster presented at the ACGRA Cotton Conference.*

In addition to these two officious publications, newsletters were regularly distributed to growers outlining progress of research, research ideas and current issues (ie. Lepton test kit results, resistance figures, day degrees)

### • FIELD DAYS & MEETINGS

#### 1994.

- Needs analysis workshop at the commencement of the project
- Soil Pit workshop to promote SOILpak
- Gary Fitt attends growers association meeting to discuss IPM
- Lance McEwan & David Larsen attend growers association meeting to promote Technology Resource Centre
- EntomoLOGIC Workshop.
- Bourke Cotton Growers Field Day

#### 1995

- Integrated Pest Management Workshop with Dr Robert Mensah
- Needs analysis workshop at the commencement of the season
- B.S.I.C.S.P. staff involved in teaching TAFE Cotton Crop Checking course
- Bourke Cotton Growers Field Day

#### 1996

- B.S.I.C.S.P. display at the Bourke Show
- Bourke Cotton Growers Field Day
- Soil and land preparation Workshop
- Presentation of project findings at Cotton Consultants Association Meeting- Warren

In addition to all of these events B.S.I.C.S.P. staff regularly attended the monthly Bourke Cotton Growers Association meetings, giving updates on the project, providing input when necessary and enabling them to keep in touch with all local issues.

# BOURKE SUSTAINABLE IRRIGATED CROPPING SYSTEMS PROJECT

AIM: To develop & promote Best Practice for Sustainable Irrigated Cotton Production in the Bourke District



NATIONAL LANDCARE PROGRAM



- Installation of a piezometer network to monitor local water tables.

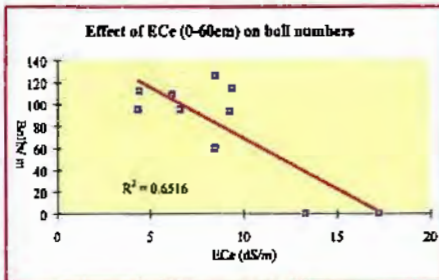
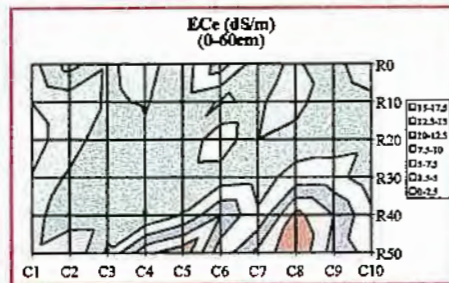


COTTON RESEARCH & DEVELOPMENT CORPORATION



- Measurement of soil salinity in selected areas.

Comparisons are made here between ECe & boll numbers/m.



High ECe areas here are associated with seepage from a large channel.

- Development of Neutron probe calibration equations specific to the soils in the Bourke district.

Equations for each depth developed by Nerida Green U. NSW.

20 cm:	$\theta_v = 1.062n - 0.314$
30 cm:	$\theta_v = 1.006n - 0.298$
40 cm:	$\theta_v = 0.992n - 0.275$
50 cm:	$\theta_v = 0.953n - 0.243$
60 cm:	$\theta_v = 0.508n - 0.029$
80 cm:	$\theta_v = 1.240n - 0.401$
100 cm:	$\theta_v = 0.847n - 0.197$
120 cm:	$\theta_v = 0.369n + 0.033$

Ponded site to create a "wet" soil profile.



- Workshops to develop best practice in the structural management of irrigated cropping soils in the Bourke district.

- Intensive monitoring of insects across a field. *Heliothis* populations of 100m x 100m grids across a cotton field.

1. Larvae (Average) metre wide quadrats/metre in cell in 100m x 100m grid

0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Students from Bourke TAFE college assisting with bug checking.



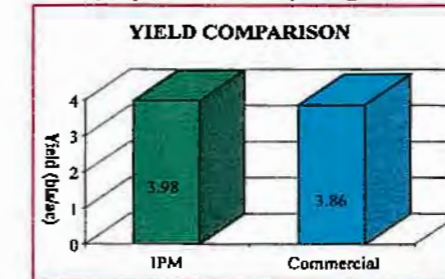
- Education on best practice in pesticide application.

Bourke growers and consultants inspect the performance of spray equipment using UV lights.

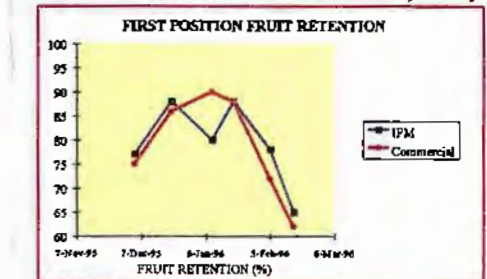


- Investigations into the implications of integrated pest management in the Bourke district.

No significant difference in final yields in this soft option trial at Clyde Agriculture.

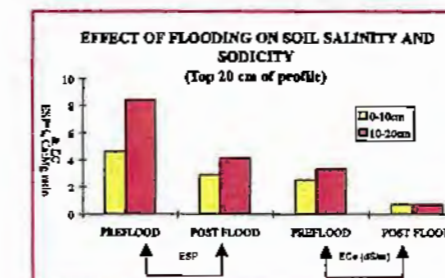


First position fruit retention for both treatments over the season was satisfactory.

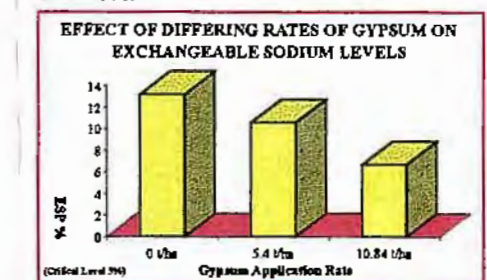


- Analysis of various methods of managing sodicity & salinity in Bourke soils

Some growers have trialed flooding fields with several feet of water for an extended period of time to "wash" sodium through the soil profile. This data shows some decrease in ESP in the top 20 cm of soil as a result of flooding.



Application of gypsum to sodic soils has been shown to decrease ESP and improve structure.



**MURRAY-DARLING BASIN  
NATURAL RESOURCES MANAGEMENT STRATEGY**

**FINAL REPORT**

**“Development of Sustainable Irrigated Cropping Systems Project”**

**WN 0327.93**

**January 1994 to June 1996**

**D.A. Norris,      NSW Agriculture, Bourke  
D.G. Kelly,        NSW Agriculture, Bourke  
S.F. McGuire,    NSW Agriculture, Bourke**



**NSW Agriculture**

**ISBN 0 7310 9807 2**

**MURRAY-DARLING BASIN  
NATURAL RESOURCES MANAGEMENT STRATEGY PROGRAM**

**Project Description:** An action-research project involving Bourke Cotton Growers' Association Landcare Group and NSW Agriculture to monitor key factors in irrigated land use management and to evaluate them in terms of land use management and farm design.

**Project No.:** WN 0327.93  
**Project Title:** Development of sustainable irrigated cropping systems.

**Managing Agency:** NSW Agriculture  
**Project Manager:** Mr. A.J. Shaw, Program Leader Cotton  
**Project Duration:** January, 1994 to June, 1996

**Project Abstract:** The *Development of Sustainable Irrigated Cropping Systems* project ran in conjunction with a Cotton Research and Development Corporation-funded project focused on cotton production issues. Activities included establishing and monitoring a district network of test wells/piezometers, on-farm case study of water use, EM-31 mapping of selected areas of farms and sites of proposed artificial waterbodies, EM-38 mapping of areas of saline soil and proximate to artificial waterbodies, neutron probe calibration, use of Landsat TM imagery for farm planning, limited analysis of efficiency index vs. key production features using commercial field data, use of SOILpak, grower workshops, information days and educational activities. No significant association could be found between yield of cotton/ML and independent cotton production variables. It was found that soil sodium levels had a significant effect on cotton yield and that areas of management-induced salinity related to soil saturation due to seepage from artificial waterbodies, especially when storages overlay or are formed from soil of high saturated hydraulic conductivity. Electromagnetic soil surveys revealed significant areas of potential concern; later validated by physical and chemical soil tests. Changes to farm design resulted.

**Expenditure Statement:**


	Expenditure of NRMS Funds	Expenditure of Other Funds (CRDC)*grower levy	Value of In-kind Contributions	
			Community	Other
<b>Monies spent on:</b>				
Salaries and Wages	\$ 31 917.12	\$ 46 522.00		
Operating Items	\$ 16 731.40	\$ 11 978.74		
Capital Items				
<b>TOTAL</b>	<b>\$ 48 648.52</b>	<b>\$ 58 500.74</b>		
<b>Funds used by:</b>				
Community	\$ 48 648.52	\$ 58 500.74		
Government				
<b>TOTAL</b>	<b>\$ 48 648.52</b>	<b>\$58 500.74</b>		

**Project Declaration:**

Report prepared by: Danny Norris  
Role in project: NSW Agriculture staff (District Agronomist)  
Telephone No.: (049) 398888  
Report completed: February, 1997

I/We declare that the details of the expenditure and information provided in this report are accurate and complete

  
Project Director/Manager

  
Department/Division Organisational Head

## EXECUTIVE SUMMARY:

1. The *Development of Sustainable Irrigated Cropping Systems* project was an action-research project involving the Bourke Cotton Growers' Association Landcare Group and NSW Agriculture to examine the resource use aspects of irrigated cropping and attempt to relate these to the production system. It was ambitious in its conception and was concurrently funded through the National Landcare Program for the resource system investigations and through the Cotton Research and Development Corporation for the production system investigations. The yield of cotton per megalitre of water diverted from the Darling River was originally intended as a factor which would ultimately link the two fields of investigation. The project finished before it was due, lacked continuity of agency staff and was forced to respond to changing group dynamics. Significant progress was made in the project nonetheless with findings relating resource system condition to overall production.

2. The project was developed from group discussions and involved needs analysis/direction-setting workshops during the course of activities. A set of activities was formulated to determine where improvements could be made to the efficiency of use of water diverted from the Darling River. This involved quantifying the proportion of irrigation water which was used by the cotton plants and that which was lost through deep drainage, evaporation or run-off as the starting point for determining where efficiency of water use could be improved. The use of flow meters on river pumps was imminent at the time of application for funds and diversion output was to be used. A combination of difficulty with meters and grower resistance to data use as a result of water administration changes meant that there was not sufficient data available. Changes in approach were forced as a result.

3. Seepage losses from off-river earthen water storages was identified as a likely factor contributing to localized management-induced salinity. On-farm monitoring of evaporation vs. volume losses during periods of irrigation inactivity and the correlation between piezometer level changes and irrigation activity confirmed this.

4. Electromagnetic induction survey with an EM-31 (electrical conductivity measurement between 0-6m depth of soil) was performed on a nominated 200ha of each Landcare Group member's farm. Significant changes to farm development proposals were made as areas of potentially unsuitable soil texture were identified. Soil pits and chemical and physical tests were undertaken to "ground truth" survey maps. It was apparent from this that there were considerable levels of soil sodium in the district prior to irrigation.

5. Electromagnetic induction survey with an EM-38 (electrical conductivity measurement between 0-60cm depth of soil) was performed for group members and the output used to confirm the source or otherwise of problems in some fields and along water reticulation structures.

6. Group members actively experimented with alternative irrigated crops during the project. Pima cotton and peanuts are more water use efficient than upland cotton and have encouraging gross margins/ha. Both crops are now established in the district and production is supported by industry infrastructure such as roller gins for Pima and a sorting/drying plant for peanuts.

7. Group members also experimented with ways of being more water use efficient and trialed different planting configurations such as skip-row and double skip row, anti-transpirants and drip irrigation. Trial data presented at the Annual Bourke Cotton Industry Field Day indicated that furrow-irrigated cotton had 137 bolls/m prior to picking while drip-irrigated cotton had 171 bolls/m. Final yield data and cost comparisons were not available at the time of writing.

8. A number of investigations were undertaken using data from commercial fields. Those which were statistically significant and relevant to the objectives of the project are listed:

➤ **Soil sodium content significantly affects cotton production.** A significant negative relationship was found between soil Exchangeable Sodium Percentage and lint yield of cotton ( $R^2 = 0.2037$ ;  $p = 0.04$ ). A field trial using the EM-38 and soil test calibration reflected this when a significant negative relationship was found between soil Electrical Conductivity (ECe) and fruit counts (bolls/m;  $R^2 = 0.6516$ ;  $p = 0.0048$ ), plant height ( $R^2 = 0.72$ ;  $p = 0.0022$ ) and plant height:node ratio ( $R^2 = 0.77$ ;  $p = 0.00078$ ).

➤ **Applied gypsum will lower soil ESP in the top 20cm of soil.** Gypsum applied at a rate of 10.8 tonnes/ha lowered soil ESP from 12% to 6%. (data courtesy Steve Buster)

9. A number of important community education activities were undertaken as part of the project. These included field days, presentations at local agricultural shows, newspaper and radio interviews, a magazine feature in *Australian Cotton Video*, an outline and feature in a Landcare Forum in the Macquarie Valley, involvement in Bourke High School work experience program, participation in project activities by TAFE Multiskills students and contribution to the Western Catchment Management Committee's *Draft Strategy for Irrigated Land*.

10. Several recommendations (some reinforcing or supporting existing practice) are made with respect to encouraging on-farm trials, guidelines for siting off-river earthen storages, conditions for irrigation development proposals, training of government agency staff, landholder establishment and monitoring of piezometers/test wells on irrigation farms, and research on the fate of re-distributed sodium in the soil profile and quantifying the effect of this. Anonymous comparative analysis on a per field basis has merit for variables additional to the financial variables commonly used. Environmental variables reflecting soil sodium level, water diverted from the source river system and a yield/water use index could be considered.

## ACKNOWLEDGEMENTS

The potential list of acknowledgements is huge and best attempts to make it comprehensive will still undoubtedly lead to glaring omissions. A considerable number of obvious acknowledgements need to be made. Foremost among these are the members of the Bourke Cotton Growers' Association who welcomed new staff and spent much time, energy and farm resources in assisting project staff. These included:

The Buster Farming Partnership ("Darling Farms") of Jack, John, Sam, Daniel and Steve Buster; Jason Fritsch and Perry Brown (agronomists); Steve Roser, Dave Halliday, Peter Rainer, Greg Simpson and Mark Fulton (farm managers);

Tony Thompson of "Prattenville Irrigation";

David Newbury of "Ferguson Farms";

Clyde Agriculture through the late Michael Maughan and then John Wettenhall (General Manager (Cotton Operations at Bourke); Ray Nalder, Pablo Vega and Warrick Forbes (agronomists), Dale Hyland, Fred Harvey, John Ferguson and John Regin (farm managers);

Neville and Russell Simpson of "Alambie Plains";

Ian Green of "Barham Farms";

Merv, Jill, Andrew, Stuart and John Gordon of "Carbuu";

Malcolm McIntosh of "Lodebar"

Bill Maroulis (General Manager), Mitch Abbo (agronomist) and Melissa Hull of Darling Fertilizers; and

John Temperley (consultant) Cottonomics and Seed & Grain Bourke.

Of this group of people, special mention should be made of Jack Buster, Jill Gordon, David Newbury, Tony Thompson, Dale Hyland, Bill Maroulis, John Temperley, Mitch Abbo, Jason Fritsch, and Warrick Forbes for being prepared to make things happen.

Others to make a significant contribution to the project were David Robson, Alan Amos, and Trevour Mount of NSW Department of Land and Water Conservation; Nerida Green; Lois Davidson at Bourke Airport for providing weather station data; and Warwick Harrison of Hassall & Associates (consultant).

NSW Agriculture staff not directly involved in the project but from whom a "pound of flesh" was taken included Adam Kay, Tracy Willis, James Holden, David Larsen, Dallas Gibb, Kerry Holmes, Debra Gaffney, David Hall, David McKenzie, Tracey Bird, Sue Condon, Diane Gardoll and Richard Dibley.

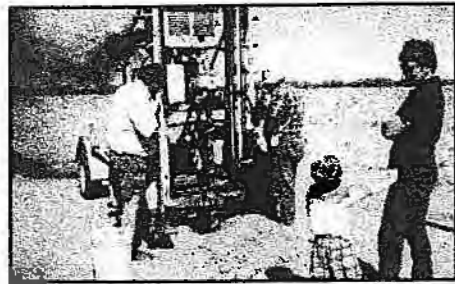
Finally, the Western Catchment Management Committee and the National Landcare Program for their support for the project's objectives and the provision of the financial resources to make it possible.

# BOURKE SUSTAINABLE IRRIGATED CROPPING SYSTEMS PROJECT

AIM: To develop & promote Best Practice for Sustainable Irrigated Cotton Production in the Bourke District

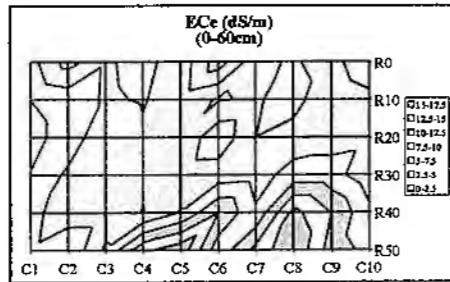


NATIONAL LANDCARE PROGRAM



- Installation of a piezometer network to monitor local watertables.

- Measurement of soil salinity in selected areas.



Comparisons are made here between ECe & boll numbers/m.



COTTON RESEARCH & DEVELOPMENT CORPORATION

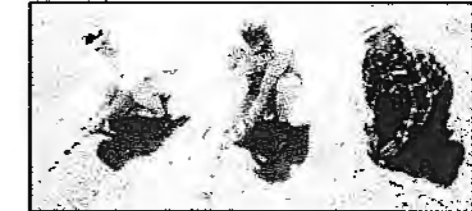


- Intensive monitoring of insects across a field. *Heliothis* populations of 100m x 100m grids across a cotton field.

2. Larvae (average/metre with maximum/metre in call in brackets)

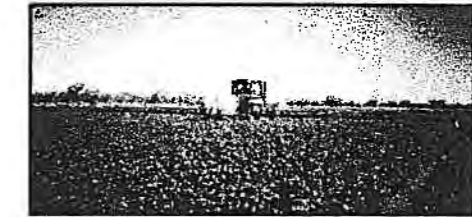
Row	1	2	3	4	5	6	7	8	9	10
1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1
3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2
4	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
5	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4
6	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
7	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6
8	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7
9	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
10	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9

Students from Bourke TAFE college assisting with bug checking.

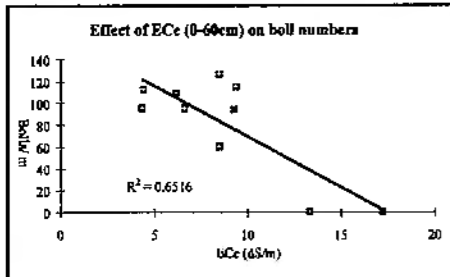


- Education on best practice in pesticide application.

Bourke growers and consultants inspect the performance of spray equipment using UV lights.



High ECe areas here are associated with seepage from a large channel.



- Development of Neutron probe calibration equations specific to the soils in the Bourke district.

Equations for each depth developed by Nerida Green U. NSW.

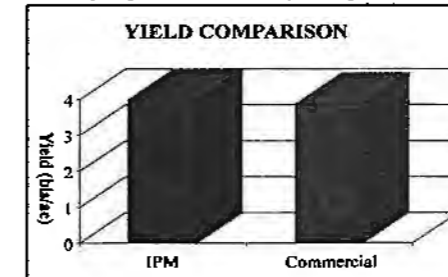
- 20 cm:  $\theta_v = 1.062n - 0.314$
- 30 cm:  $\theta_v = 1.006n - 0.298$
- 40 cm:  $\theta_v = 0.992n - 0.275$
- 50 cm:  $\theta_v = 0.953n - 0.243$
- 60 cm:  $\theta_v = 0.508n - 0.029$
- 80 cm:  $\theta_v = 1.240n - 0.401$
- 100 cm:  $\theta_v = 0.847n - 0.197$
- 120 cm:  $\theta_v = 0.369n + 0.033$

Ponded site to create a "wet" soil profile.

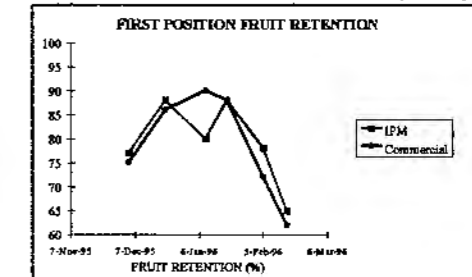


- Investigations into the implications of integrated pest management in the Bourke district.

No significant difference in final yields in this soft option trial at Clyde Agriculture.

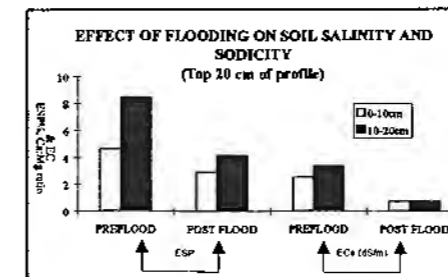


First position fruit retention for both treatments over the season was satisfactory.

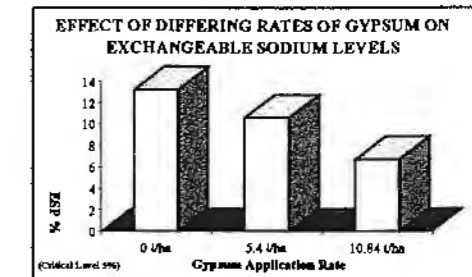


- Analysis of various methods of managing sodicity & salinity in Bourke soils

Some growers have trialed flooding fields with several feet of water for an extended period of time to "wash" sodium through the soil profile. This data shows some decrease in ESP in the top 20 cm of soil as a result of flooding.



Application of gypsum to sodic soils has been shown to decrease ESP and improve structure.



- Workshops to develop best practice in the structural management of irrigated cropping soils in the Bourke district.

## TABLE OF CONTENTS

<b>Introduction:</b>	<b>1</b>
1.1 Project background	1
1.2 Project location	1
1.3 Project objectives	2
<b>Activities:</b>	<b>3</b>
2.1 Initial proposals	3
2.2 Log of activities	4
<b>Outcomes:</b>	<b>8</b>
3.1 Physical and environmental impacts	8
3.2 The local community	15
3.3 Adoption of results	16
3.4 Publications produced	16
3.5 Media publicity/public relations	17
<b>Evaluation:</b>	<b>18</b>
4.1 Progress vs. specifications for project activities	18
4.2 Progress according to stated objectives	22
4.3 Progress according to time and budget	23
<b>Conclusions:</b>	<b>25</b>
5.1 Conclusions arising from the project	25
5.2 Recommendations	26
5.3 Declaration	28

## **INTRODUCTION:**

### **1.1 Project Background**

The *Development of Sustainable Irrigated Cropping Systems* project arose following the discovery of an apparently significant body of saline water in a couple of excavator-dug pits installed to assess the suitability of a proposed site for an artificial waterbody (an above-ground earthen water storage). An impromptu information day was held and growers in the district expressed an interest in examining the situation further.

Discretionary funding was received from the Western Catchment Management Committee to install a network of bores (piezometers/test wells) to provide further information regarding the location and extent of any shallow saline ground water bodies. Dr. Trevor Mount and Ian Kelly of the (then) NSW Department of Water Resources provided advice regarding the possible situation and design of sampling. A total of thirty nine bores were installed to a depth of up to 6m. A number of the bores remained dry. As a result of drill logs and a subsequent period of monitoring of the wet bores, it appeared that the dynamics of the pressures or variation in the depths to saline water in the bores was correlated in a number of cases with management of irrigation systems (see Norris, 1994). This was most obvious when wells were located near large above-ground earthen water bodies such as irrigation storages and main supply or return channels.

The apparent link between irrigation management and the location of saline areas was presented to the Bourke Cotton Growers' Association. A steering committee was formed with representatives of the local cotton growing community. These included Ray Nalder (Senior Agronomist, Clyde Agriculture), Warwick Harrison (Consultant Agronomist, Hassall & Associates), Snow Friese (Farm Manager, Ferguson Farms), Jack Buster (Buster Farming Partnership), John Temperley (Consultant Agronomist, Cottonomics) and Danny Norris (District Agronomist, NSW Agriculture). The committee planned activities to examine the irrigated cropping systems more closely to provide some guidelines for management. A proposal to apply the National Landcare Program (NLP) for funding was presented to growers.

A visit to Bourke by the Board of Management of the Cotton Research and Development Corporation (CRDC) at this time offered "in-principle support" to co-fund research in the area of cotton production issues. Establishing irrigation efficiency was seen as critical to long term maintenance of soil and water resources (a major NLP focus) while optimizing yield was seen as critical to the maintenance of the industry and the business goals of the co-operating growers (a major CRDC focus). Thus monitoring the lint yield of cotton per megalitre of water diverted from the Darling River for irrigation was seen as a way of rationalizing the resource *versus* production issues in the respective agenda of the funding bodies.

### **1.2 Project Location**

Members of the Bourke Cotton Growers' Association Landcare Group came from predominantly the floodplain within a 20km radius of the town of Bourke in north western New South Wales. Members also came from Louth (100km south west) and Brewarrina (100km east). The following graphic is taken from the preliminary Geographical Information System which was begun during the project using Arcview® software. It shows that most irrigators are dependent on the Barwon-Darling system although the property in Louth received water from the Warrego River. During the project significant flows into the system came from the Bogan, Macquarie, Namoi, Barwon

## DESCRIPTION OF ACTIVITIES:

### 2.1 Initial proposals

A look through the funding applications for the project reveals the degree of "evolution" which took place. This will be discussed further in the project evaluation (section 4). The initial proposal for the three years of the project appears in table 1. It should be re-emphasized that a similar table was prepared for the Cotton Research and Development Corporation to account for the remaining 50% of project time.

**Table 1:** Initial description of activities submitted to NLP in 1993

	1994	1995	1996
<b>JAN</b>	<b>COMMENCE PROJECT</b> Planning of logistics	Continue data collection each irrigation	Draw together important practical measures which have arisen from workshop sessions.
<b>FEB</b>	Calculation of storage and channel volumes		Preparation of a follow-up submission for NLP funding to extend whole farm approach into a regional integrated management plan
<b>MAR</b>	Monitor established piezometers	<b>Last Irrigation 94/95</b>	
<b>APR</b>	Install all new piezometers	Collation of data and reporting on district WUE, water tables and salinity monitoring.	Involvement in the implementation of aspects of whole-farm plans
<b>MAY</b>	Monitor volumes pumped from Darling river	Establishment of cotton yield/megalitre of water.	Monitor the cotton yield from 95/96 season and, using WUE data, estimate cotton yield/megalitre from pumping records
<b>JUN</b>	<b>Pre-watering or watering up for 94/95 season</b> Monitor EC of river, supply and return channels, storage and piezometers.	Workshops to extend WUE results and implications.	Monitor water tables and salinity of piezometers throughout the season
<b>JUL</b>	Monitor levels in piezometers	Preparation of submission for carry-on finance.	Report on progress of piezometer survey over the past 3 years
<b>AUG</b>	Soil salinity (with Em38)	<b>Stage II</b> Preparation of summaries of workshops	Final report on project with reference to the possibility of developing regional integrated management plans
<b>SEP</b>		Development of strategies to increase cotton yield/megalitre	
<b>OCT</b>		Workshops on Whole Farm Planning to introduce strategies and demonstrate practical ways to implement strategies.	
<b>NOV</b>	<b>1st Irrigation 94/95 season</b> Repeat measurements each irrigation		
<b>DEC</b>		Monitor water tables and salinity	

The project was intended to run from January, 1994, until December, 1996. The following log of activities indicates that project activities ceased in June, 1996. Details relating to this will be discussed in section 4.

at Hungerford Field Day (c.2000 people)

- Shauna prepared poster and answered enquiries

*July, 1994:*

- Shauna attends NSW Department of Water Resources workshop on wetland management
- Whole-district piezometer monitoring
- Delivered EM-31 maps and reports from CSU to growers and conducted interviews

*August, 1994:*

- Participated in EM-34 sampling adjacent to above-ground storage and ground-truthing DWR geomorphological transect at "Prattenville" with DWR and Libyan trainees
- Compile grower data from 1993/94 season re paddock water use, yields etc.

*September, 1994:*

- Compile grower data from 1993/94 season re paddock water use, yields etc.

*October, 1994:*

- District piezometer recording pre-1994/95 growing season

*November, 1994:*

- Visit to district by Dr. Jim Rhoades and Dr. Scott Lesch (salinity management consultants from San Joachin Valley, California) and John Triantifillis (Sydney University)
  - conducted paddock tour and travelling workshop

*December, 1994:*

- Attended Cooperative Research Centre for Cotton Production Conference at Narrabri
  - Shauna presented project outline and district overview
  - Danny presented paper on salinity/sodicity management in the Bourke district
- Undertook correlations and regression analyses of available grower data

*January, 1995:*

- Data analysis of grower information
- Collection of soil samples and plant tissue samples from actively growing crop to review relationships between plant tissue and soil nutrient levels in cotton
- Ground-truthing EM-31 maps (gypsum outcrops confounding results in some instances)

*February, 1995:*

- Preparation for Annual BCGA Field Day
  - compiled case studies of different water management strategies (eg. skip rows, delay first irrigation etc., anti-transpirants)
- BCGA Field Day

- December, 1995:*
- Monitoring of water storage levels following irrigation
  - Compilation of crop water use data
- January, 1996:*
- Continue monitoring crop water use for case study
  - mid-season piezometer monitoring
  - Dave conducts EM-38 surveys of areas selected by group members and produces maps and reports
  - Purchase of digital Landsat TM data for local GIS development
  - Preparation of application for a new project to commence in January 1997 to undertake a land and water management plan for the district
- February, 1996:*
- Danny transfers to C.B. Alexander Agricultural College, "Tocal" and District Agronomist position not re-filled
  - Piezometer monitoring
  - Examination of grower-generated data relating to flooding of fields
- March, 1996:*
- Annual BCGA Cotton Industry Field Day
  - Piezometer monitoring
- April, 1996:*
- Bourke Show
    - combined display with Bourke Cotton/Wool Committee
  - Piezometer monitoring
- May, 1996:*
- Compilation of data for water use efficiency case study
  - Piezometer monitoring
- June, 1996:*
- Soil Management Workshop
  - Installation of strategic piezometers along main supply channel of case study property to locate possible sources of transmission loss (located according to EM-31 survey results)
  - David Kelly TO(SICS) resigns to take up position as Cotton Industry Development Officer at Warren
  - BCGA decides not to continue project and funding ceases
  - Poster, *Bourke Sustainable Irrigated Cropping Systems Project*, presented by Dave at Australian Cotton Growers Association Conference in August, 1996 (see attachment)

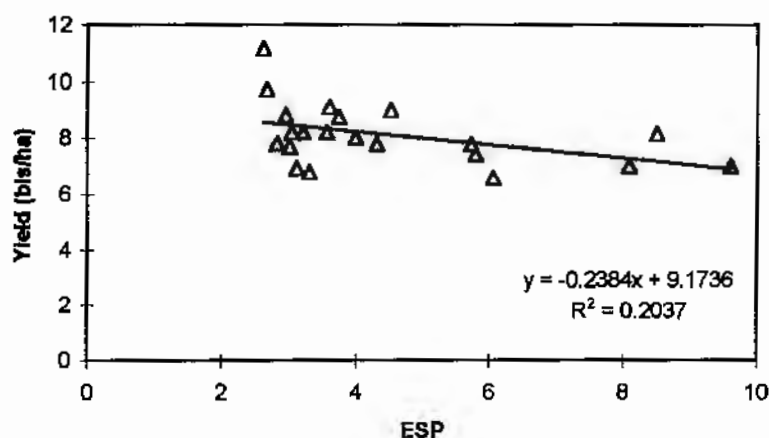


Figure 1: Relationship between cotton lint yield (bales per hectare) and soil Exchangeable Sodium Percentage (ESP)

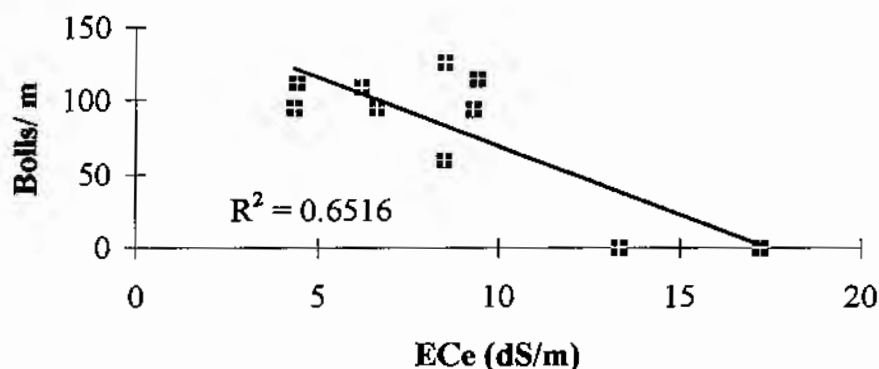
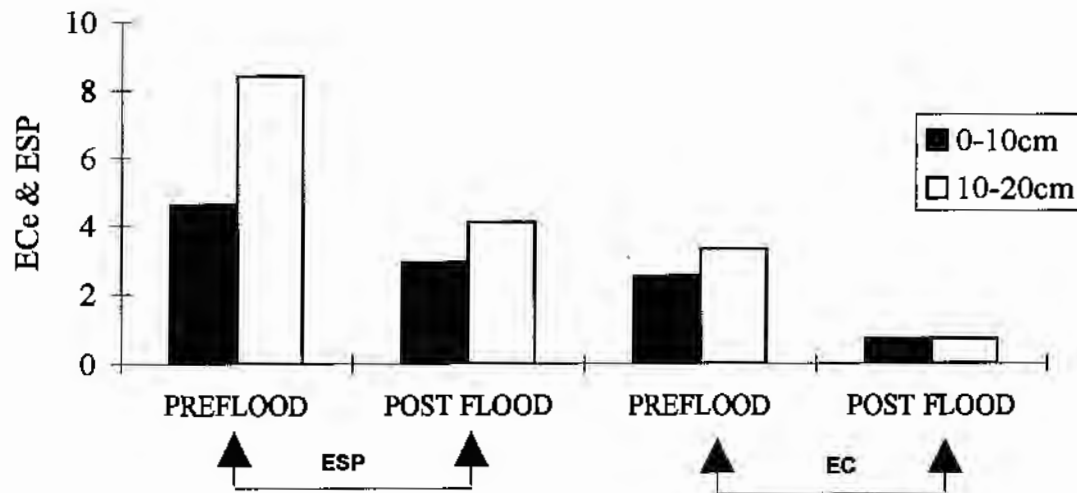


Figure 2: Relationship between cotton boll numbers (bolls per metre) and soil Electrical Conductivity (ECe dS/m)(from Kelly, 1996)

The use of technology demonstrated and promoted by the project such as electromagnetic induction (EM-31 and EM-38) can have obvious benefits when locating fields and water storages within farms by identifying the variation in soil electrical conductivity. The yield implications of a high EC or ESP soil *versus* a low EC or ESP soil (see Figs. 1 & 2) would suggest that if development can take account of this variation, economic benefit will be gained.

The effect of ECe and ESP (Figs. 1 & 2) has resulted in some growers experimenting with ways to modify soil chemistry and redistribute sodium salt. The distribution of sodium in uncultivated soil in the cotton growing area commonly sees increasing ECe and ESP with increasing depth below the ground surface (Green, 1994). Fig. 3 illustrates the increase in ECe and ESP with a



**Figure 5:** Effect of flooding on soil salinity and sodicity in the top 20 cm of the soil profile (n.s.)(from Kelly, 1996)

The use of gravity in directing water around the farm makes the storage(s) a focal point which determines the irrigation infrastructure. There are a number of examples where group members used the results of the electromagnetic survey maps to redesign a storage to avoid areas of potential seepage loss or where field dimensions were altered. The prospect of a leaking storage is also a considerable economic risk. Seepage makes some stored water unavailable as it waterlogs surrounding soil and may salinize land within the radius of this saturated zone. Once the crop is established and heading towards the end of the irrigation season, every megalitre of irrigation water can produce an additional bale of cotton lint (J.D. Buster, pers. comm.). The inferred opportunity cost of irrigation water lost through seepage, combined with the reduction in productive potential of the land salinized in the vicinity of a leaking storage (in line with Figs. 1 & 2) can be significant alone. When these inferred or assumed costs are considered along with the interest rates charged on loans for storage construction, the cost of rehabilitation of salinized areas and the project life of the investment; the siting of off-river irrigation storages and, to a lesser extent, main supply channels is extremely important.

The installation of shallow piezometers and test wells around the district provided group members with a stimulus to think about what was happening under the ground's surface. The piezometers located adjacent to suspected leaking storages were able to partly confirm this suspicion and allow the landholder to think about the dynamics of water depth and how it related to farm management. Fig. 6 illustrates the relationship between volume in the storage (relating to irrigation) and the depth to water in the piezometers near two off-river storages. The results suggest that the zone of hydraulic effect of the storages extends beyond the storage walls. It may be that this zone of saturated soil has a boundary and is a closed system. This would depend on the soil types involved. Soil physical tests undertaken on two of the dominant soil types and presented in table 2 (p.13) indicate that soil type is critical in determining the structural suitability of earthen storages.

**Table 2:** Example of soil physical features of major soil types

FEATURE	LOAMY CLAY	SANDY LOAM
Permanent wilting point %	18	4.9
Field capacity moisture %	26	6.0
Saturated hydraulic conductivity ( $\mu\text{m/s}$ )	11	29

Data collected during the on-farm water use efficiency monitoring case study revealed that, after being filled in early in early June in 1996 until irrigation activity began at the end of 1996, an estimated 63% of water lost from the storage could be attributed to pan evaporation. The remaining 37% (calculated by change in storage depth) was likely to have been lost to subsurface saturation of soil. As this was a newly constructed storage and being filled for the first time, it is likely that a large part of this saturation was establishing a subsurface boundary to the storage. Soil tests and EM-31 survey did not indicate that the soil type of the storage would transmit water (loamy clay, non-sodic, no significant gypsum concretions). Thus this water would be virtually irretrievable but the storage may not have lost so much over and above evaporation in subsequent seasons.

Amendments to Part IV of the Environmental Planning and Assessment Act of 1979 have introduced more regulation into the construction of artificial waterbodies. Applications will generally require some evidence to demonstrate site suitability. The use electromagnetic induction technology and comprehensive soil survey, as practiced and encouraged by members of the group is now becoming standard industry practice.

In using the neutron gamma moisture probe to monitor crop water use, it became obvious that pre-irrigation (to fill the soil profile prior to planting) and first irrigation were inefficient in terms of plant water use as there were no actively growing plants to use water (although pre-irrigation can enhance plant establishment). Fig.7 shows the effect of time on the volumetric soil moisture content. This was taken from work done with the TAFE Multiskills students and shows the rapid rate of depletion of soil moisture reserves in the absence of actively growing plants. Some water would have soaked below the sampling depth of the neutron probe and a significant proportion would have evaporated. It was always maintained by growers and consultants that little water would penetrate below 1m in the profile from an irrigation. If this is the case, evaporation is indeed significant when plant canopy cover and root mass is low.

With evaporation at irrigation being an important factor, the possibility of drip irrigation was investigated further by Clyde Agriculture in the 1995/96 season in a trial comparing 145ha of drip irrigated cotton with 145ha of furrow irrigated cotton. Final yield information was not available at the time of writing but fruit counts on 8 March, 1996 and presented at the BCGA Field Day showed that the drip irrigated crop had 171 bolls/m vs. 137 bolls/m. Further work is being proposed in this area of management.

### **External references cited:**

All references which were derived from the project are listed in section 3.3. The following are references which have been cited to support points made in discussion:

Ghassemi, F., Jakeman, A.J. and Nix, H.A. (1995) *Salinisation of land and water resources: Human causes, extent, management and case studies*. University of New South Wales Press Ltd., Sydney

Mount, T.J. (1992) *Yanda creek salt inflow project: Bourke New South Wales hydrogeological framework studies, 1992/93*. NSW Department of Water Resources, July, 1992; TS92032. Government printer, Sydney

### **3.2 The Local Community**

The project was fortunate to have the support of members of the Western Catchment Management Committee, a number of members of which are from the area around Brewarrina, Bourke and Louth and for whom issues relating to the river are of great importance. The river is an important point of social focus and the source of much emotion, particularly in relation to irrigation-based industries such as cotton. The construction of large off-river storages to reduce the risk of lost production due to extended periods of low flow is an important feature of irrigation management. Water is diverted from the Darling River in times of high flow and may remain in storage for many months. If flow ceases and water quality declines, the quantity of water in storage for irrigation becomes conspicuous.

Obviously, if irrigators can demonstrate that water is being managed according to best practice and the community is sufficiently aware of this, community perceptions of the irrigation industries will improve. Project activities such as involvement in local shows and field days and regular community newspaper and radio interviews were an effective way of allowing community comment and providing information. The community of Bourke is relatively small but the community of people with a stake in the management of the Darling River is considerable.

The Bourke Cotton Growers' Association Landcare Group involves almost all cotton growers in the district and each of the members was involved in actions. Involvement was at least through participation in EM-31 surveys of land and piezometer installation. Labour and access to machinery and maps was frequently provided by the respective landholder. Access to the intellect of the group members is something which was greatly valued. Some members became very involved in activities and spent a great deal of time, energy and money to contribute to activities. Trials with rehabilitation of land through plantings of Old Man Saltbush, experimentation with alternative crops and invited input from salinity management experts from the US (additional to the visit by Drs. Rhoades and Lesch co-ordinated by the CRC for Cotton production) were undertaken completely on grower initiative but probably stimulated by the early findings of the project. Public awareness of such activities could only have resulted in some degree of positive feeling.

The teaching consultancy on cotton crop checking undertaken with NSW TAFE was not a formal part of the project but students actively participated in gathering water use data using the neutron gamma moisture probe. This was an important community benefit derived from the project as it

to Bourke Cotton Growers' Association

Kelly, D. (1995) *An analysis of flooding of cotton fields to combat sodicity in the Bourke district*. Report to Bourke Cotton Growers' Association

Kelly, D. (1996) *Bourke Sustainable Irrigated Cropping Systems Project*. Poster presentation to 1996 Australian Cotton Growers' Association Conference, Broadbeach, Qld.

McGuire, S. (1994) *Bourke district cotton trial report summary 1993/94*. NSW Agriculture, Dubbo.

Norris, D. (1994) Salinity management in the Bourke district. In *Proceedings of the Cooperative Research Centre for Cotton Production Soil Management Workshop, November, 1994, Narrabri* (D. McKenzie, ed.)

### 3.5 Media publicity/public relations

Agricultural shows and field days held at Bourke, Brewarrina and Hungerford were attended by project staff and were an effective way of exposing the local community to project activities and to illustrate that Landcare was active in the region. A wider audience was addressed through local radio station 2WEB. This involved interviews with Diane Tyson who received funds from the Murray Darling Basin Commission for such work. 2WEB has a vast network and activities such as field days or simply a progress report or general "chat" about project activities and outcomes would be broadcast. Group members were also approached for interviews with Diane. Interviews were also given to the Rural Report on ABC radio's 2CR at Orange which has the largest broadcast area in NSW.

*The Western Herald* at Bourke provided interviews and photographs promoting new staff members and there were often information pieces in the weekly column of the District Agronomist or in the Cotton Growers' column. *The Land* also ran articles on the activities of the group or the arrival of new staff. Photos of group members at local show displays and in regional features were also published. Some articles dealt in detail with project objectives and activities. Examples of these were:

<b>Preventing a dam shame,</b>	<i>The Land</i> , August, 1994
<b>Bourke growers cotton on to green ideals,</b>	<i>The Land</i> , July 18, 1996
<b>Bourke growers keen to lift crop management,</b>	<i>The Land</i> , Sept.5, 1996; p.11

The project was also featured in a magazine segment for *The Australian Cotton Video* with Shauna doing pieces to camera at different locations and responding to interview questions.

NSW Agriculture participated in Bourke High School's work experience program and work experience students would often assist the Technical Officer and/or District Agronomist in project activities. These students expressed a desire to pursue career paths in agricultural or environmental management following this experience. The 3 months that Nerida Green spent working on the project in fulfilling her practical work requirements for her B.Env.Eng. was of great assistance in beginning the project prior to the receipt of funding and employment of a full-time Technical Officer. It was on a voluntary basis and would no doubt have been good career preparation.

inactive bores became active.

### **3. Install new piezometers**

An additional 10 bores were installed using the EM-31 maps as a guide. The availability of a drill rig was a problem for some time but the bores were eventually installed

### **4. Monitor EC of river, supply and return channels, storage and piezometers**

An EC meter was purchased for this purpose and used to monitor EC of piezometer water. This was characteristically highly saline and did not vary greatly per piezometer but did vary between piezometers. The Charles Sturt University team conducting the EM-31 surveys and Ian Kelly (Water Resource Consultant) sampled EC of appropriate piezometers to ground-truth their observations at different times. Preliminary investigations of supply channel and return channel suggested that return or tail waters were more saline. Appropriate sampling was a difficulty and Shauna was working on this prior to her resignation. Following her resignation and the time elapsed to the employment of a replacement, other activities assumed higher importance in the context of reduced time for the project.

### **5. Map soil salinity (EM-38)**

The project required access to the EM-38 used in research projects at NSW Agriculture's Trangie Agricultural Research Centre and a period of general rainfall to standardize soil moisture. An extended period of rain in the Bourke district which coincided with the availability of the instrument did not occur until January, 1996. Dave conducted an intensive period of sampling and generated maps and reports for interested group members. This activity far exceeded the expectations of the original project and provided landholders with a valuable farm management resource.

### **6. Plant water use during successive irrigations**

To successfully use the neutron moisture probe to monitor absolute water use it should be calibrated to soil type. This was undertaken by Nerida Green (Green, 1994) with assistance from Shauna. Shauna then standardized the probes of all the local consultants using a water drum (each probe gives a different relative read-out). This allowed probe data from the consultants to be used. Collation of this data proved difficult with data available only ever forthcoming from one consultant which was subsequently used.

### **7. Establishment of cotton yield per megalitre of water**

This was possible for roughly 10% of the cotton growing area with the records provided from the growers. The index was then analyzed against a range of independent environmental and production variables such as soil EC, soil ESP, heat units (an indicator of growth potential), nitrogen use and insecticide use. Over the 3 seasons analyzed there was no statistically significant relationship between yield per megalitre and any of the factors.

### **8. Development of strategies to increase cotton yield per megalitre of water**

The 93/94 and 94/95 cotton growing seasons were extremely dry with extended periods of no pumping due to widespread drought in the Darling Catchment. Thus management tended to be atypical and a range of strategies to increase cotton yield per megalitre were

## **2. Collation of data and reporting on district WUE, water tables and salinity monitoring**

District WUE was not calculated due largely to inability to access the volumes diverted from the Darling River but also the difficulty in calculating storage volume discussed earlier (section 4.1.1). The small amount of field data from neutron probes and crop yields which was forthcoming from landholders and consultants would not support a district-wide analysis. No evidence for a district-scale water table and associated salinity was found at the scale of sampling. As bores were generally associated with localized sub-surface and surface salinity it was more appropriate to report to the relevant landholders and discuss the implications.

## **3. Workshops to extend WUE results and implications**

Not undertaken due to lack of information as outlined in point 2.

## **4. Draw together practical measures from the workshops**

A report on the yield differences of a trial comparing drip-irrigated cotton with conventional cotton was distributed to growers at the '96 BCGA Field Day and reports on the effect of soil EC on cotton and also on the use of flooding of fields and gypsum use for sodicity management were also prepared and circulated during the project. No report was prepared for the growers which drew all of this information together into a package due basically to lack of time and the demands of activities with perceived higher priority.

## **5. Report on progress of piezometer survey over the 3 years of the project**

As outlined in point 2., there was no evidence of a district-scale water table and active piezometers were associated with localized sub-surface and surface salinity. It was considered more appropriate to report to the landholders concerned rather than produce a general report.

### **4.1.3 Activities undertaken in addition to original description**

#### **1. EM-31 surveys**

Following the experience of attempting to adequately sample the district with bore holes, it was considered more cost effective to stratify the sampling with electromagnetic induction surveys. The 0-6m resolution of the EM-31 was most appropriate and CSU, Wagga Wagga undertook the survey contract. Each group member nominated 200ha of land to be surveyed with most selecting proposed above-ground storage sites, main supply channel extension sites, new fields and areas of known problems. The resulting maps and reports were an excellent tool for farm design and resulted in significant changes in development proposals to avoid areas of potential soil texture problems.

#### **2. Purchase of GIS software**

Following the interest in the hard copy Landsat TM prints of the cotton growing area in 1993 (growers purchased these themselves) the idea of a preliminary Geographic Information System was discussed. This was to act as a visual way of showing variation in the growth of the crop across the district in relation to factors such as soil type and to store field data on a range of variables such as yield and yield/megalitre. This approach was the precursor to the Land and Water Management Plan and potentially a powerful way to perform comparative analysis. Staff turnover and discontinuity was a problem in

a general statement of objectives was included in *Part 12* of this application. This read:

'The project aims to investigate the factors and significance of water use efficiency (WUE) in the Bourke irrigation area and to develop appropriate management strategies to improve the WUE. It is intended to deal with this issue from an integrated management approach.'

**[Bourke Cotton Growers' Association, Community Group Application  
1993/94 (new project), National Landcare Program]**

The original stated objectives were generally completed, although the specifications did vary in some areas (see section 4). The activities were modified as more information was reviewed and as the group's priorities shifted. The sampling of bores found no evidence of a regional scale water table and hence the focus of salinity shifted very much into the integrated management area of examining the impact of water use efficiency on the production system and the impact of soil sodium on production. As discussed previously, there were no statistically significant relationships between cotton lint yield per megalitre of water and any of the independent variables of cotton production. Although water was ultimately a limiting factor to cotton production, there was no evidence that efficient use of water would impact on production variables (provided there was water in storage or available during the irrigation system - something growers have little control over).

Thus, the major impact of inefficiency is likely to be in the development of soil salinity, a feature demonstrated to have a statistically significant effect on production. The most powerful motivation for the growers to be more efficient was thus to demonstrate the process and potential for salinity on-farms rather than spending too much time and resources on examining the details of water use efficiency. Had the focus of the project been along these lines, the objectives may have been worded differently. The eventual resistance of the group to the analysis of water use efficiency was a significant additional motivating factor in adjusting the project objectives.

### **4.3 Progress according to time and budget**

#### **4.3.1 Time**

The project commenced on 1 January 1994 and terminated six months before the due date, on 30 June 1996. The early termination arose as the result of the resignation of the staff engaged on the project and the lack of success in recruiting new staff for the short period to the end of the project. Continuity of staffing was a problem experienced at a number of times during the project, but in most of the cases before June 1996 satisfactory alternative arrangements were made. The majority of planned objectives and activities were therefore undertaken, as well as a number of additional activities. There were some aspects of the project which were incomplete at 30 June 1996 and these have been discussed in section 4.

#### **4.3.2 Budget**

With periods of positions being vacant and resulting periods of relative inactivity, the project finished well within the planned budgetary constraints. Table 4 outlines the information regarding allocation and expenditure for the project.

## CONCLUSIONS:

### 5.1 Conclusions arising from the project

Impacts of the project extend beyond the physical effects of the activities undertaken. A significant negative relationship between soil Exchangeable Sodium Percentage (ESP) was established from commercial field data and reflected in a subsequent investigation which found a significant negative relationship between soil Electrical Conductivity (ECe) and average plant height, plant height:node ratio and fruit retention (number of bolls/m). This is a powerful incentive for cotton growers to ensure that management does not elevate soil ESP or soil EC, especially in the root zone.

There is potential for management-induced salinization and there is already some localized evidence of it in the Bourke irrigation area. Electrical Conductivity of the Darling River (salinity) increases with declining flow and much of the soil resource available for irrigation contains naturally occurring sodium salt. The infrastructure for furrow irrigation, such as construction of large above-ground earthen water storages and supply channels, can result in waterlogging of significant areas outside the walls of the storage. This facilitates the mobilization and concentration of sodium salts in the soil profile proximate to the storage. When associated with soils of high saturated hydraulic conductivity, there is potential for movement of salts beyond the perceived storage boundary.

Electromagnetic induction survey (EM-31 and EM-38) combined with ground truthing with backhoe pits, bore holes, and soil physical and chemical tests is expensive but effective as a tool for farm design. With some guidance, landholders were able to use the mapped output to great advantage. Land development costs for irrigation are over \$2000.00 per hectare. Ensuring that unsuitable land is not developed and that the cost of rehabilitation is avoided is a significant benefit for the expense of the EM survey.

Cotton growers in semi-arid areas strive for water use efficiency by necessity and, in Bourke, rely upon objective tools such as neutron gamma moisture probes and pressure bombs to ensure efficient scheduling. There are options to make some aspects of the farming system more efficient such as drip irrigation but more work needs to be done in this area. The fluctuation and unpredictability of flow in the Darling River makes manipulation of other aspects of the system more challenging.

Risk management for low river flows in the form of large off-river storages is an inefficiency attributable to the irrigated cropping system. In particular the storage of thousands of megalitres of water above ground level for several months without any irrigation activity increases the potential for evaporation, seepage, waterlogging and salt mobilization to occur. Some irrigators challenge the attribution of evaporation from storages on the basis that high flows end up evaporating downstream or flowing into the ocean.

Review of electromagnetic survey data and grower records of field soil tests shows that a proportion of the Bourke irrigation area has been developed on soils which have levels of naturally-occurring sodium. Management of this is a challenge for growers who, generally, express a desire to farm for the long term. In the short term, practices such as gypsum application and flooding of fields have been shown to improve the establishment of plants and re-distribute

### **3. Clear guidelines for storage construction**

Further to point 2., where earthen walls are used, assessment of saturated hydraulic conductivity should be undertaken. Procedures such as wetting and compaction of clay lining and limits to the depth of borrow pits are examples of guidelines which may be determined. Some storages in the Bourke district conform to these guidelines.

### **4. Farm design and infrastructure**

(1) Proposed developments on unregulated streams (and along some regulated streams) will frequently have storages and (artificial waterbodies) associated with proposals and hence will be required to submit an Environmental Impact Assessment. The remainder of the development should be subject to assessment along with the artificial waterbody as they are mutually dependent. In most instances, tailwater dams and main supply channels for any significant furrow irrigation development will exceed the specifications of an artificial waterbody as outlined in the amendments to Part IV of the Environmental Planning and Assessment Act (1979).

(2) Where artificial waterbodies are not involved, Local Environmental Plans often include restrictions on landforming and thus should involve a Development Application and some form of rigorous assessment.

### **5. Research on re-distribution of salts in the profile**

The project demonstrated the ability of gypsum application and flooding of fields to re-distribute sodium in the profile. Investigations were not designed to determine the fate of sodium in the profile once liberated. More research to determine this fate and quantify its effect on long term sustainability would be desirable.

### **6. On-going group facilitation training in land management agencies**

Action-research is potentially powerful but requires much skill. All staff were formally trained and experienced in group management before becoming involved in this project and received further training while the project was in progress. Despite this, different approaches may have brought different outcomes. Emphasis on group management in training and review of qualifications is important.

### **7. Piezometer/test well monitoring**

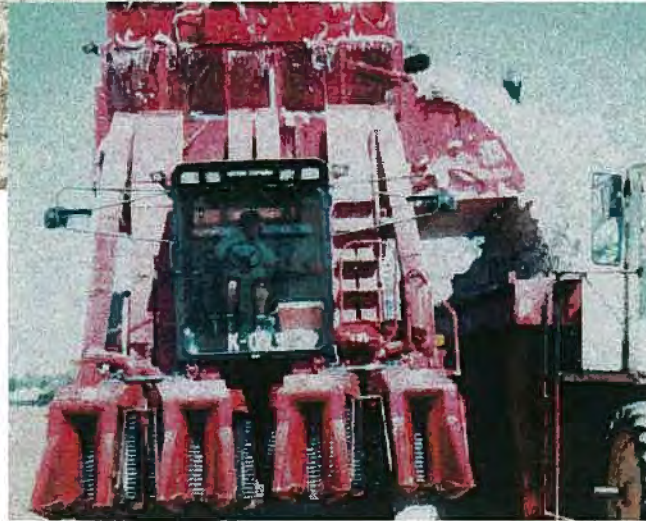
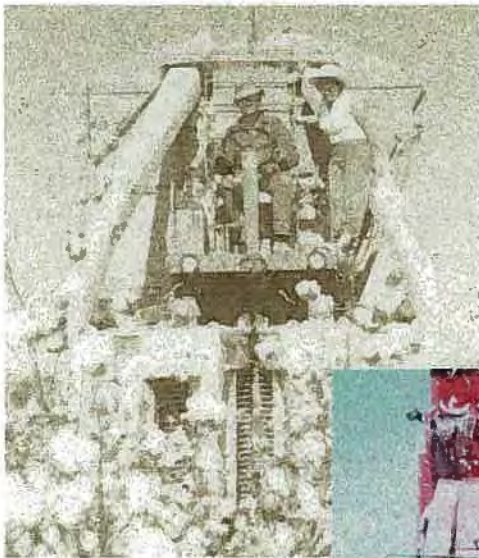
With EM-31 survey maps in-hand, piezometers/test wells can be put in a number of locations on-farm to monitor the happenings beneath the irrigation system. Existing bores should be maintained and studied accordingly by landholders.

### **8. Reference areas on farms**

Soil sampling in the project was quite extensive but lacked reference sites where non-cultivated, non-irrigated soil of the respective soil types could be obtained to act as a baseline. This would be useful to assess the degree of change from the "natural state" due to agricultural management. Areas of existing farms could be identified and set aside for this by growers and their consulting agronomists. It could be built in as a condition for proposed developments.



# Bourke Cotton Grower's Association 1993/94 Season Summary



Compiled by:  
**Shauna McGuire**  
Technical Officer  
Sustainable Irrigated Cropping Systems  
NSW Agriculture, Bourke

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## **BOURKE DISTRICT COTTON SEASON SUMMARY - 93/94**

**Bourke Cotton Growers Association Landcare Group**

**Compiled by Shauna McGuire**

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## **ACKNOWLEDGMENTS:**

Many thanks go to the following people who have assisted in providing information to be used for the benefit of all growers and industry personnel, and in particular members of the BCGA. Without the cooperation of these people this summary would not have been possible.

Sam Buster

David Newbury

Rob Ditchfield

Peter Reid

Warwick Forbes

Pablo Vega

Jason Fritsch

Jack Buster

Steve Buster

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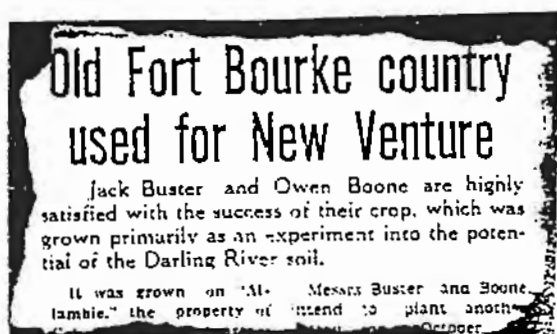
**CONTENTS:**

Bourke Cotton 1965/94	-	-	-	-	-	-	1
Bourke District Report	-	-	-	-	-	-	3
On Farm Cotton Trial Reports							
1. Pioneer variety trial, Latoka	-	-	-	-	-	-	5
2. CSD variety trial, Darling Farms	-	-	-	-	-	-	6
3. Australian Cotton Cultivar Trial, Long Meadows							8
4. Phosphorus and Zinc trial, Latoka	-	-	-	-	-	-	11
5. Nitrogen trial, Darling Farms	-	-	-	-	-	-	13
Gross Margin Budgets, Bourke District							
1. Upland Cotton	-	-	-	-	-	-	17
2. Pima	-	-	-	-	-	-	19
3. Peanuts	-	-	-	-	-	-	21
4. Mungbeans	-	-	-	-	-	-	22
Bourke Soil Pit Workshops	-	-	-	-	-	-	23
Outlook for 94/95	-	-	-	-	-	-	25



## Bourke Cotton 1965/94

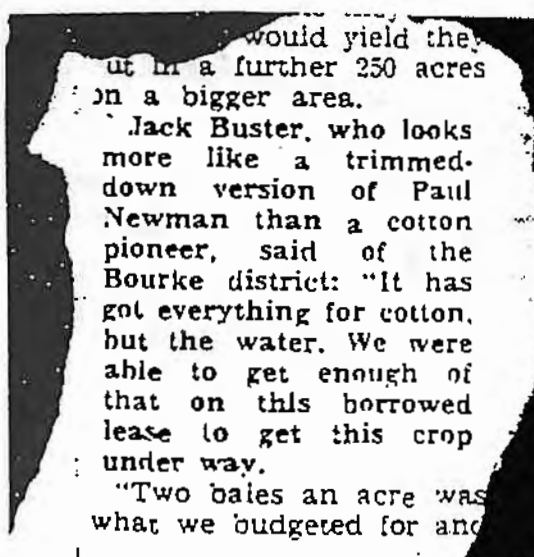
In 1965 two American cotton growers had a vision: flat country, clay soil, hot weather and no rain. For many, these are hardly the elements which constitute paradise! But with this vision came the realisation that these conditions were true for Bourke - an ideal place for growing cotton. For these two men it was to become their destination and for one, it was the beginning of a lifestyle and an industry which would later become a significant social and economic force in the town of Bourke.



Boone and Buster approached Collin Sutton of "Alambi" (now farmed by Neville Simpson), which was once part of the original Fort Bourke Station.

It was agreed that a 15 acre experimental plot would be grown on "Alambi". The experimental plot emerged well and a further 250 acres

were sown. Emergence of the first cotton crop grown in Bourke took place on October 15, 1966. The first pick began six months to that day yielding 2 bales per acre and took three weeks to complete. The second pick followed shortly after.



In the years that followed, the Buster operation grew steadily and more and more farmers began to recognise the remuneration of this potentially lucrative enterprise. A hot, dry climate, deep alluvial grey cracking clay soils and access to the most extensive river system in Australia makes cotton a major growth industry in the district.

The expansion of Bourke's total production area is on a sturdy incline, which is likely to continue, as long as growers remain aware of the limitations of land and water resources. In doing so a profitable, prosperous and sustainable industry will carry cotton and Bourke well into the future, and benefit future generations.

## Cotton thriving in Bourke area

The cotton industry in the Bourke area was introduced about 10 years ago by Messrs. Jack Buster and John Stone, two Californians who spent their first two years in the district at Wee Waa.

At this beginning, the district was one of the poorest in the State.

It is now one of the most highly cultivated districts in the State.

detected while in the US and is now becoming prevalent in some Australian areas.

It is believed that this is becoming prevalent through continuous use of the seed for cotton without resorting to crop rotation.

In other areas, particularly the Namoi district,

the cotton industry has been introduced from plants brought from the States. The seed is treated with various other things, but such seeds at the time of the cotton strike.

It is believed that the seed used in the district is independent of the seed used in the States.

# First cotton crop off at Bourke

The first cotton to be grown and irrigated at Bourke is being successfully harvested producing two bales per acres.

The crop is being trucked more than three hundred miles to a gin at Wee Waa cotton-growing district.

In grim, forbidding looking country west of the Darling at Bourke, where there has been only partial relief from one of the worst droughts the district has experienced, American cotton growers, together with their Australian partners, have purchased freehold and western leases to start cotton and irrigated grazing.

Typically, the Americans have done things in a big way.

Some have invested their "last dime."

One irrigation channel is six miles long and as big as a single-lane expressway. It almost rivals the Darling itself.

One land plane is 70 ft. long.

### Expense

Cumbersome cotton harvesting equipment, looking top-heavy, lumbers through the crop at about three miles per hour. Machinery was imported at considerable expense from Wee Waa in anticipation of a big crop.

The newcomers have planted more cotton, sunk more money, than most would dare.

A syndicate of three bought 3200 acres freehold. They were Messrs. R. Stokes, from Wee Waa and California, T. Jauquin, formerly of California, and P. Perry, from Wee Waa.

Mr. Wilson C. Ferguson, formerly of Imperial Valley, California, has 2000 acres freehold west of the river.

Mr. Jack Buster, from California, took up a Western Lands lease on a 30,000-acre property, for

Bourke, with Mr. Boom, Messrs. Buster and

are currently planted on 250 acres of property last

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Newspaper extracts courtesy of "The Western Herald", Bourke.

## Bourke District Report

By Pablo Vega

The Bourke district production was 67,579 bales of cotton (Upland = 54,708, Pima = 12,871) for the 1993/94 season (Fig.1). This is the highest level of cotton production in the history of the district and represents a 30% increase on the 1992/93 season.

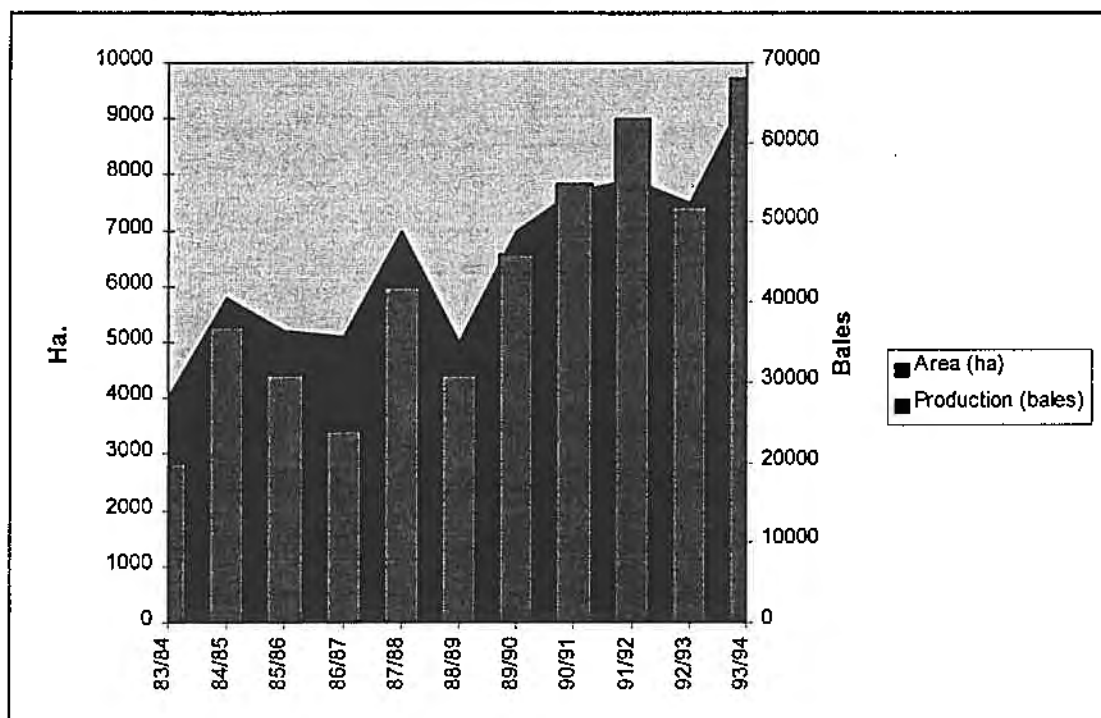


Figure 1: Bourke - area and production

Despite difficulties experienced throughout the season, the Bourke district crops have turned out very well. The district average yield for upland cotton was close to 7.4 bales/ha and for pima cotton, 6.2 bales/ha. The typical temperature fluctuations at planting time affected plant growth to varying degrees. Generally early crop development was good and only small amounts of replanting were necessary due to herbicide damage.

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Good growing conditions during November and December promoted rapid growth and fruit production - most crops started flowering by mid to late December.

Unexpected cold night temperatures began at Christmas and persisted until the second week of January, causing a decrease in growth rate.

Early insect pressure this year was higher than normal with constant heliothis egg lays of more than 30 eggs/m. Mirid numbers were very high at squaring time. Two or more sprays for sucking pests were required on most crops. Insect activity dropped down in late December with many growers achieving long intervals between sprays (3- 4 weeks). However, this did not last long when heliothis pressure began to increase again in early February. Lepton Test Kit proved to be an essential tool for insect management.

Most growers had enough water supply to finish off the crop. Unfortunately some growers ran out of water by January, thereby halving yield potential. Heavy rainfall in mid February (125-150mm) accompanied with cold and cloudy conditions caused prolonged waterlogging periods resulting in high levels of boll rot infestation in the early crops where bolls were either opened or opening when the rain came.

With another dry picking season, satisfactory yields and favourable cotton prices, growers at Bourke have nothing to complain about.

## On Farm Cotton Trial Reports

### 1. Pioneer Variety Trial - Latoka, Field 5.

*Pablo Vega - Clyde Agriculture*

*Warwick Forbes - Clyde Agriculture*

*Delta & Pine Land Company Pty. Ltd.*

#### **COMMENTS:**

This trial was planted on 10 October 1993 into moisture. Insufficient rainfall after planting lead to early irrigation in November which slowed crop growth. High aphid pressure prevailed soon after establishment. Heliothis pressure was constant until late December necessitating frequent insecticide applications. Temperature conditions were favourable for cotton throughout November and December. Unexpected cold night temperatures began at Christmas and persisted until mid January, causing a decrease in growth rate. Defoliation commenced on March 22 with Dropp and Prep, and Prep alone on March 29. The trial was picked on 11 April 1994. The field was in wheat last season and first year cotton the previous season.

#### **RESULTS:**

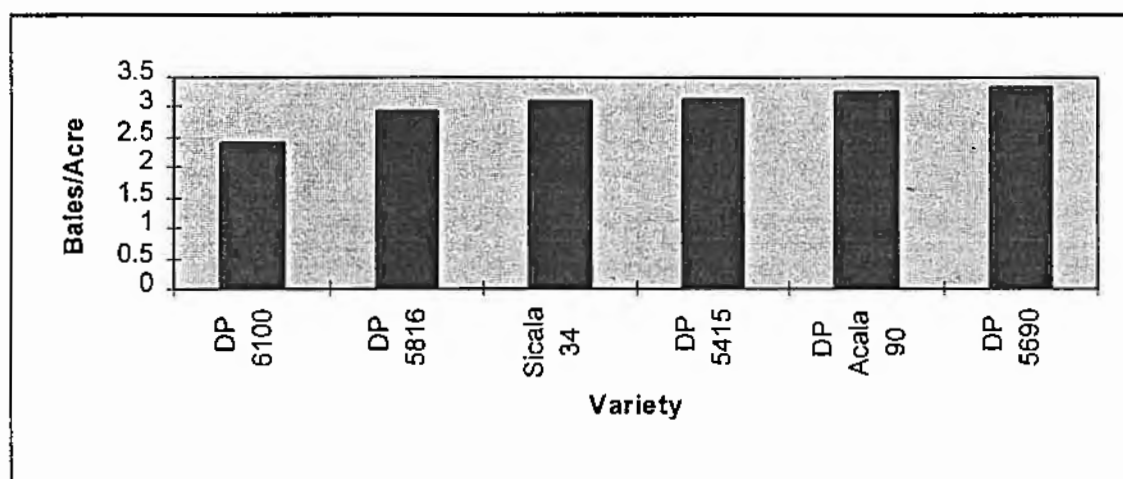


Figure 2: Lint yields of variety trial - Clyde Agriculture Bourke

Table 1: Lint yield and quality of variety trial - Clyde Agriculture Bourke

Variety	DP ACALA 90	DP 5415	DP 6100	SICALA 34	DP 5690	DP 5816
Gin Out Turn %	37.4	38.5	35.1	36.2	37.5	37.1
Yield - bales/ha	8.07	7.76	5.95	7.68	8.2	7.24
Yield - bales/ac	3.27	3.14	2.41	3.11	3.32	2.93
% of Mean 3.03 avg	108	104	80	102	109	96.0
Length	1.13	1.12	1.15	1.16	1.12	1.14
Uniformity	83.1	83.0	84.6	83.0	82.5	82.0
Strength	29.1	28.6	31.3	30.5	29.3	28.4
Micronaire	3.9	4.0	3.8	3.6	3.8	3.9
Grade	21.0	11.0	21.0	21.0	21.0	21.0

**2. CSD Variety Trial - Darling Farms, Field 63.**

*Jason Fritsch - Darling Farms*

*Steve Buster - Darling Farms*

*Cotton Seed Distributors Ltd.*

**COMMENTS:**

The trial was sown on October 13 and irrigated up. Nitrogen fertiliser was applied in July at 160 kg/ha with 50 kg DAP/ha. There was some herbicide damage early on with the cool conditions, but surviving plants grew out of the damage by first flower. The crop had seven irrigations and when defoliated on March 26 had accumulated 2217 Day Degree units. The field was fallow before this cotton crop.

**RESULTS:**

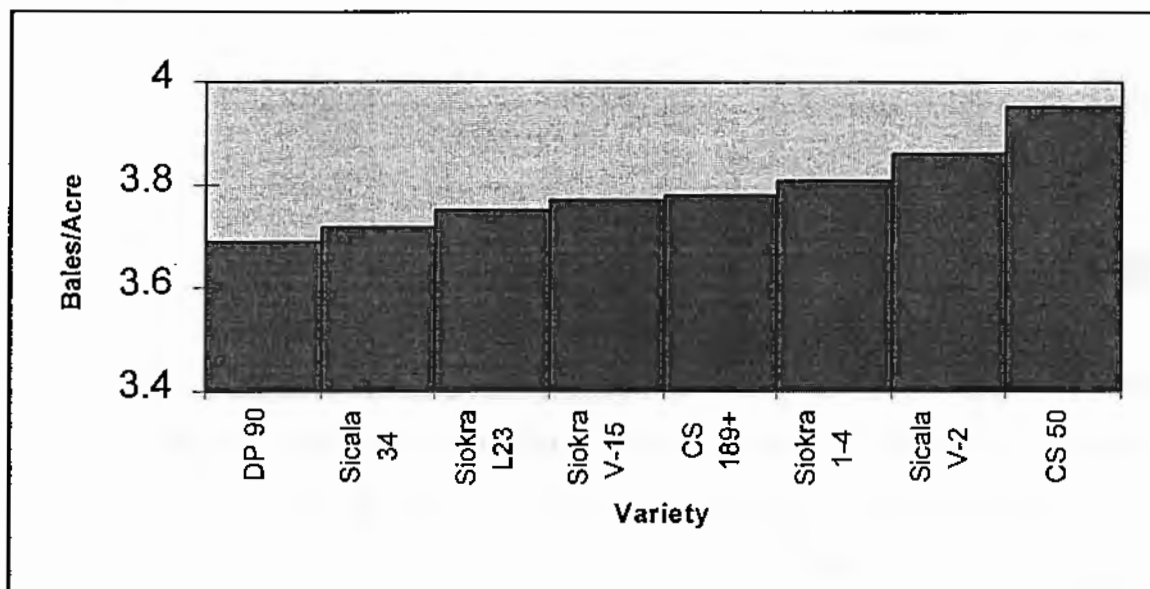


Figure 3: Lint yields of variety trial - Darling Farms, Bourke

Table 2: Lint yield and quality - variety trial, Darling Farms, Bourke

Variety	CS50	Sicala V-2	Siokra 1-4	CS 189+	Siokra V-15	Siokra L-23	Sicala 34	DP 90
Yield B/ha	9.75	9.53	9.41	9.33	9.32	9.26	9.19	9.13
Yield B/Ac	3.95	3.86	3.81	3.78	3.77	3.75	3.72	3.69
Gin T/O	37.58	36.32	36.95	35.03	35.63	37.48	36.36	35.62
Colour	31-1	21-2	31-2	31-2	31-1	31-1	31-2	31-1
Staple	1.11	1.13	1.13	1.11	1.15	1.13	1.15	1.12
Micro-naire	3.80	4.00	3.80	3.90	3.70	3.80	3.80	4.10
Gms/ Tex	25.9	26.6	25.4	27.5	27.9	28.4	27.5	27.1
% Siokra 1-4	103.60	101.26	100.00	99.06	98.97	98.36	97.66	96.96

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### 3. Australian Cotton Cultivar Trial - Long Meadows, Field 1.

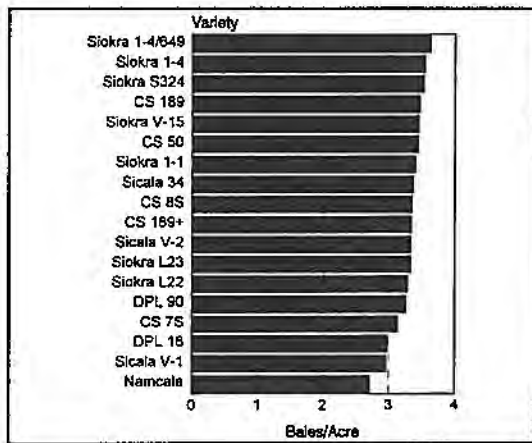
*Pablo Vega, Warwick Forbes - Clyde Agriculture*

*Peter Reid, Lindsay Heal - CSIRO Cotton Research Unit, Narrabri*

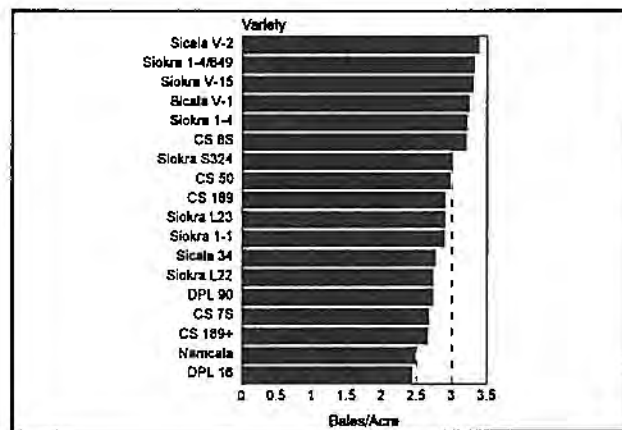
#### COMMENTS:

The Australian Cotton Cultivar Trials are a series of small plot-trials (14m by 3 rows) conducted by CSIRO at 13 different sites throughout the cotton growing regions. The purpose of these trials is to assess the performance of new varieties in different cotton growing areas prior to their commercial release. Following are the results of plot-trials conducted at Bourke, Warren and Narrabri in the 93/94 season. The results collected in Warren and Narrabri are quite different to those collected in Bourke. According to Peter Reid (CSIRO), the very good performances at Bourke by the 1-4 lines, and particularly Siokra S324, were a little surprising. Of course not too much weight should be put on one seasons results. Further plot-trials will be conducted at Bourke in the 94/95 season.

### A) Bourke



### B) Warren



### C) Narrabri

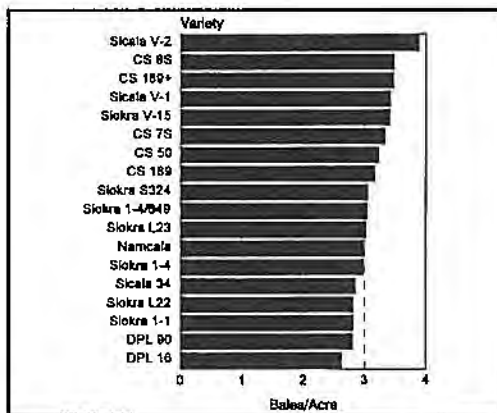


Figure 4: Mean yields of the Australian Cotton Cultivar Trials (see also Table 3).

Table 3: Mean yields of the Australian Cotton Cultivar Trials for Bourke, Warren and Narrabri

Variety	Bourke		Warren		Narrabri	
	Kg/ha	B/Acre	Kg/ha	B/Acre	Kg/ha	B/Acre
Siokra 1-4/649	2036	3.63	1856	3.31	1704	3.04
Siokra 1-4	1989	3.54	1800	3.21	1670	2.98
Siokra S324	1984	3.53	1678	3.0	1712	3.05
CS 189	1945	3.47	1627	2.90	1771	3.16
Siokra V-15	1933	3.45	1849	3.30	1912	3.41
CS 50	1926	3.44	1666	2.97	1810	3.23
Siokra 1-1	1907	3.40	1617	2.89	1575	2.81
Sicala 34	1889	3.37	1550	2.76	1600	2.85
CS 8S	1878	3.35	1795	3.20	1952	3.48
CS 189+	1871	3.34	1489	2.65	1944	3.47
Sicala V-2	1868	3.33	1896	3.38	2174	3.88
Siokra L23	1868	3.33	1625	2.90	1696	3.02
Siokra L22	1840	3.28	1532	2.73	1576	2.81
DPL 90	1828	3.26	1531	2.73	1573	2.80
CS 7S	1757	3.13	1496	2.67	1867	3.33
DPL 16	1670	2.98	1361	2.43	1467	2.62
Sicala V-1	1658	2.96	1819	3.24	1918	3.42
Namcala	1518	2.71	1392	2.48	1675	2.99

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#### **4. Phosphorus and Zinc Trial - Latoka, Field 6.**

*Pablo Vega, Warwick Forbes - Clyde Agriculture*

*Michael Vaughan, Craig Bradley - Incitec Ltd.*

##### **AIM:**

To examine the response of yield of cotton to pre-plant phosphorus and phosphorus plus zinc fertiliser.

##### **METHOD:**

The trial was randomised with three treatments and four replicates. Treatments were applied in a band during July 1993 (field planted on 11 October 1993 with CS50). Soil tests taken from this field on 29 September 1993 showed P levels to be 10 mg/kg (Colwell) and Zn levels to be 0.3 mg/kg. The treatments were as follows:

1. Nil (control)
2. 100 kg/ha Crop King Ultimate Z pre-plant (9.4% N, 20.5% P, 2.2% S, 2.5% Zn)
3. 100 kg/ha Crop King Starterfos pre plant (10.0% N, 22% P, 2.3% S)

##### **RESULTS:**

Petioles were sampled from each treatment twice during the season and were subject to a full tissue analysis. Results showing nitrogen, phosphorus and zinc levels are shown in Table 4. Figure 5 shows raw yields in response to each treatment.

Table 4: Leaf Analysis Results (average of all replications) of Phosphorus and Zinc trial - Clyde Agriculture

		Nil	Ultimate Z	Starterfos
<b>Nitrogen %</b>	07-Dec	04.88	04.78	04.67
	29-Dec	04.16	04.17	04.00
<b>Phosphorus %</b>	07-Dec	00.39	00.37	00.35
	29-Dec	00.57	00.87	00.64
<b>Zinc mg/kg</b>	07-Dec	54.25	56.75	55.00
	29-Dec	30.75	35.75	31.75
<b>N/P Ratio</b>	07-Dec	13.00	13.00	13.00
	29-Dec	07.00	05.00	06.00

A number of trends can be observed from the data shown in Table 4. It would appear that between the first and second sampling dates there has been a decrease in levels of nitrogen and zinc, and an increase in phosphorus. However, given that these trends are consistent between both treatments and the control, it is likely that they have occurred in response to localised environmental conditions. Therefore, there does not appear to have been any apparent response to the treatments. The uptake of phosphorus under treatment 2 (Ultimate Z) does appear to be somewhat greater than for treatment 3 and the control.

Figure 5 shows that there is a difference between treatments. Yield seems to have responded favourably to treatment 2, which may be attributed to the increase in phosphorus uptake observed in Table 4. Nevertheless, it would appear that in this case treatment 2, Ultimate Z, has provided the best yield response.

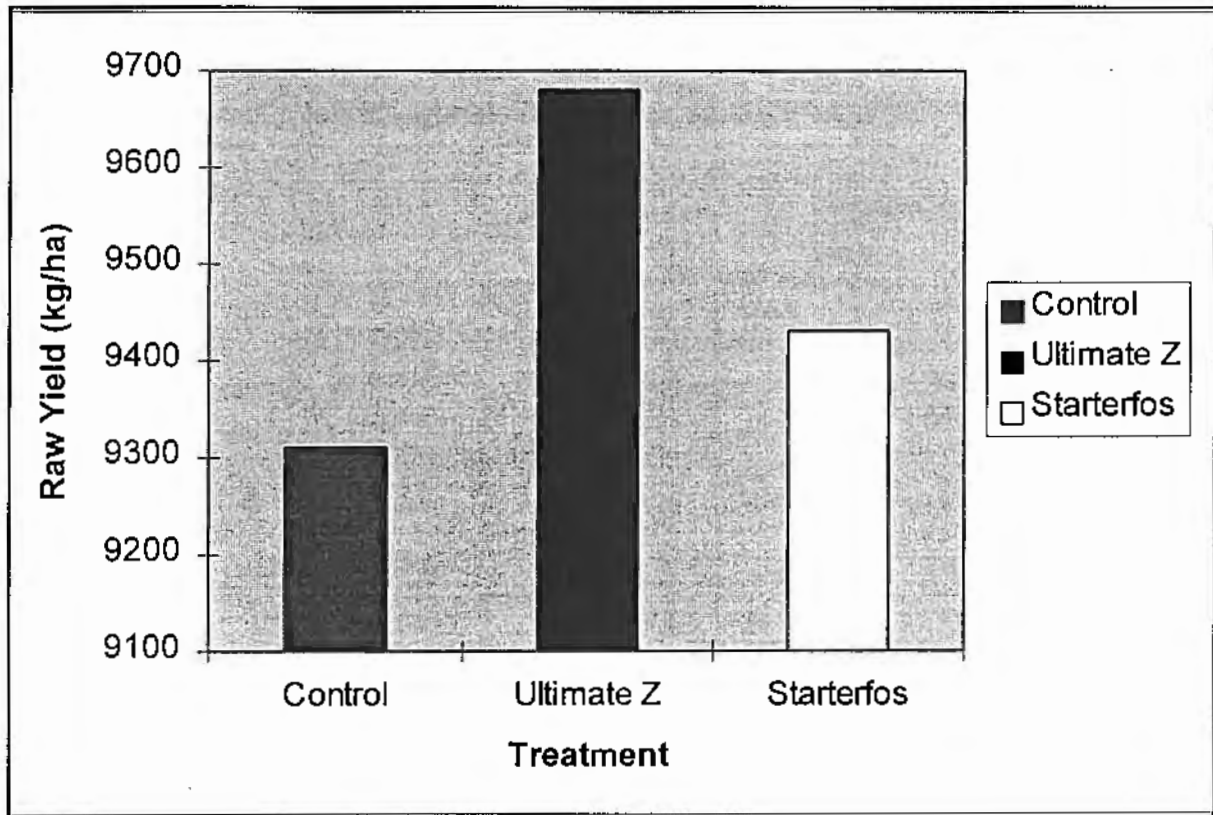


Figure 5: Yield response to applications of phosphorus and applications of phosphorus with zinc - plot of means (Courtesy: C. Bradley, Incitec Ltd.).

### 5. Nitrogen Trial - Darling Farms, Field 3.

Jason Fritsch - Darling Farms

Rob Ditchfield - UNE

Steve Buster - Darling Farms, UNE

#### AIM:

This experiment was aimed at evaluating the nitrogen requirement of Pima cotton (Var. S-6) grown on grey cracking clay soil at Bourke, NSW.

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## **METHOD:**

The experiment was set up as a randomised complete block design, with four replications. The treatments were 50, 100, 150 and 200kg N/ha. Each block was approximately 0.69 ha. A zero nitrogen block was included at one end of the trial but was not included in the analysis. Nitrogen was applied as anhydrous ammonia approximately six weeks prior to planting. Planting took place on 23/10/94 and the crop was harvested on 6/4/94. Results recorded were lint yield, dry matter production, nitrogen uptake, fruiting characteristics and petiole nitrate levels.

## **RESULTS:**

The optimum rate of nitrogen application was 170 kg N/ha, which gave a yield of 1294 kg lint/ha. The maximum lint yield was 1296 kg lint/ha from a nitrogen application of 182 kg N/ha. The regression equation for the response of lint yield to the application of nitrogen is shown below in Figure 6 a).

Three petiole nitrate samples were recorded for the second half of the season and from these results the decline in petiole nitrate levels with Day Degrees were calculated. As shown in Figure 6 b) below a decline in petiole concentration of 0.011 g NO<sub>3</sub> per day degree would mean no nitrogen fertiliser should be applied. However, if the rate of decline was 0.025 g NO<sub>3</sub> per day degree 150 kg nitrogen should be applied.

In conclusion, on a fallow field following wheat, a fertiliser rate of 150 kg N/ha could be applied and depending upon the rate of petiole N decline, a further 20 kg N/ha can be applied bringing the total applied to 170 kg N/ha. These results are similar to those found in previous years.

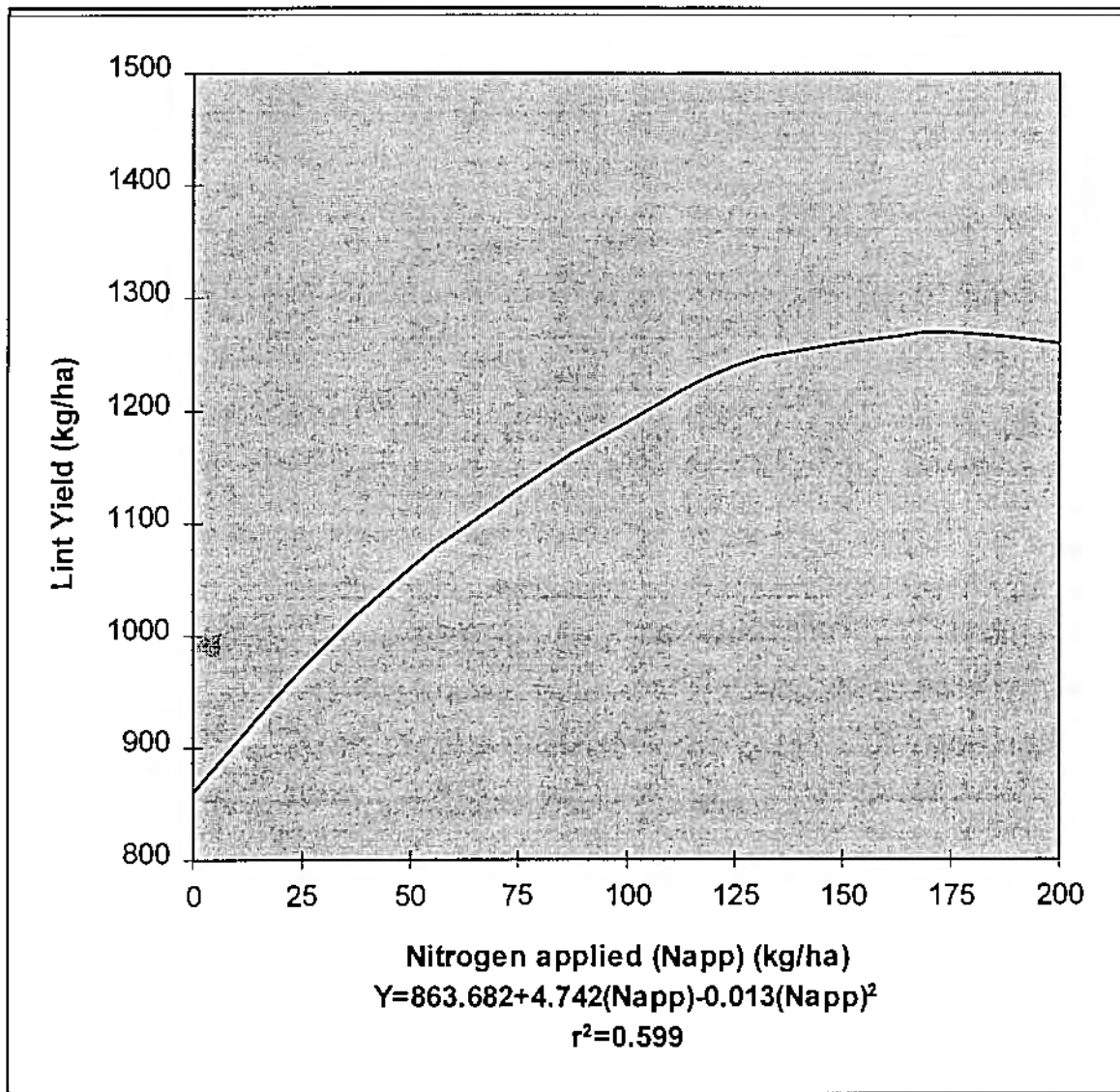


Figure 6 a): Pima lint yield as a function of applied nitrogen

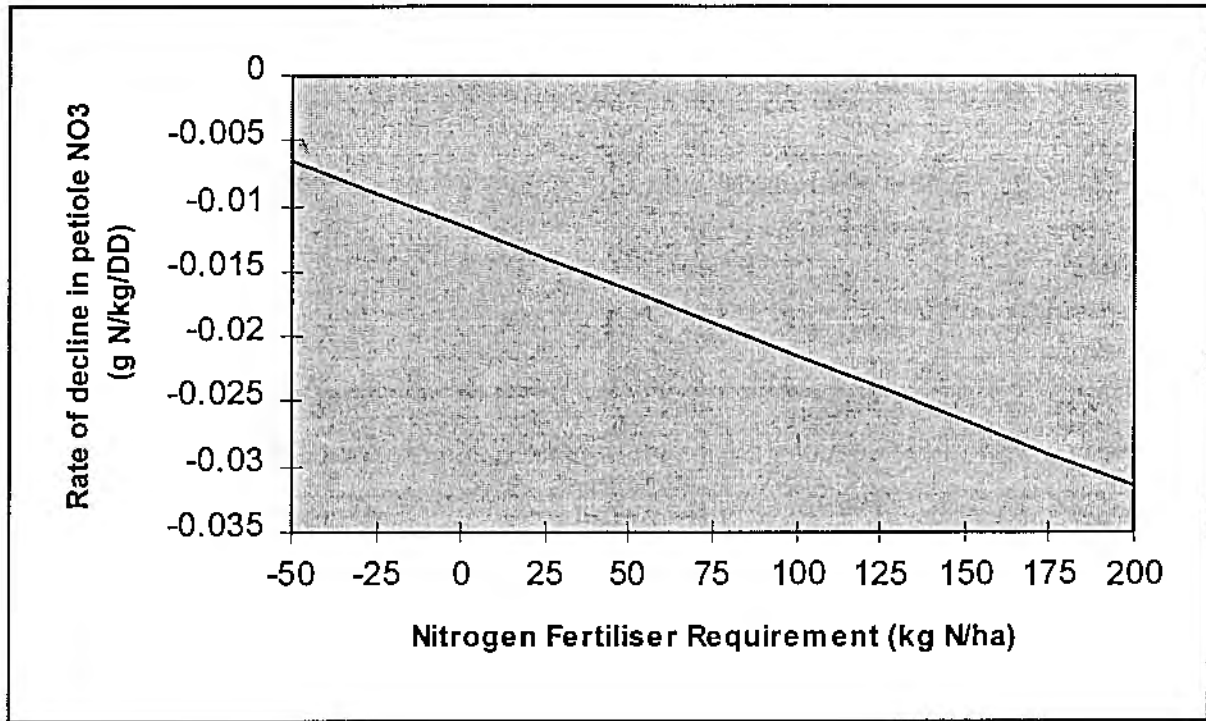


Figure 6 b): Rate of decline in petiole N levels with increasing day degrees as a function of applied nitrogen

## Gross Margin Budgets - Bourke District

(Sam Buster, Darling Farms; David Newbury, Ferguson Farms)

Note: These Gross Margin Budgets should be used only as a guide.

### 1. Upland Cotton (Irrigated)

#### a) Gross margin budget:

Income		Standard Budget \$/ha	Your Budget \$/ha
8.0 bales (lint)/ha@	\$460/bale (at gin)	3680	
8.0 bales (seed)/ha@	\$39/bale (at gin)	312	
<b>A. Total income</b>		<b>3992</b>	

Variable Costs (\$/ha)		
Cultivation	250	
Chipping	50	
Sowing	62	
Consultant	24	
Fertiliser and application	190	
Herbicide and application	110	
Insecticide and application	270	
Water pumping costs	170	
Contract harvesting	333	
Cartage to gin	72	
Ginning charges	520	
ACF and research levy	20	
Labour (irrigation etc.)	120	
<b>B. Total Variable Costs</b>	<b>2191</b>	

<b>C. Gross Margin (A-B)</b>	<b>1801</b>	
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Note: Contract cartage to gin = \$9/bale; ACF levy and Research levy = \$2.5/bale; Ginning charges=\$65/bale. Cultivation and sowing costs include wages, fuel, interest and depreciation on tractor.

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b) Effect of yield and price (lint and seed) on gross margin per hectare for Upland cotton: sensitivity table

YIELD bales/ha	\$240/bale \$20/bale	\$350/bale\$ 30/bale	\$460/bale \$39/bale	\$570/bale \$48/bale	\$680/bale \$58/bale
3.30	-\$974	-\$578	-\$185	\$208	\$604
4.24	-\$801	-\$292	\$212	\$717	\$1226
5.18	-\$629	-\$7	\$610	\$1226	\$1848
6.12	-\$456	\$278	\$1007	\$1735	\$2469
7.06	-\$284	\$564	\$1404	\$2244	\$3091
<b>8.00</b>	-\$111	\$849	<b>\$1801</b>	\$2753	\$3713
8.94	\$62	\$1134	\$2198	\$3262	\$4335

## 2. Pima Cotton (Irrigated)

### a) Gross margin budget

Income		Standard Budget \$/ha	Your Budget \$/ha
6.0 bales (lint)/ha@	\$700/bale (at gin)	4200	
6.0 bales (seed)/ha@	\$59/bale (at gin)	354	
<b>A. Total income</b>		<b>4554</b>	

Variable Costs (\$/ha)		
Cultivation		250
Chipping		50
Sowing		62
Consultant		24
Fertiliser and application		190
Herbicide and application		110
Insecticide and application		270
Water pumping costs		170
Contract harvesting		333
Cartage to gin		72
Ginning charges		660
ACF and research levy		20
Labour (irrigation etc.)		120
<b>B. Total Variable Costs</b>		<b>2331</b>

<b>C. Gross Margin (A-B)</b>		<b>2223</b>
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Note: Contract cartage to gin = \$9/bale; Ginning charges = \$110/bale; ACF levy and Research levy = \$2.5/bale; Cultivation and sowing costs include wages, fuel, interest and depreciation on tractor.

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b) Effect of yield and price on gross margin per hectare for Pima cotton: sensitivity table

YIELD bales/ha	\$480/bale \$40/bale	\$590/bale \$50/bale	<b>\$700/bale</b> <b>\$59/bale</b>	\$810/bale \$68/bale	\$920/bale \$78/bale
2.24	-694	-427	-160	108	375
3.18	-323	57	436	815	1195
4.12	49	540	1032	1523	2015
5.06	420	1024	1627	2231	2835
<b>6.00</b>	792	1507	<b>2223</b>	2939	3654
6.95	1163	1991	2819	3647	4474
7.88	1535	2475	3414	4354	5294

### 3. Peanuts (Irrigated)

#### a) Gross margin budget

Income	Standard Budget \$/ha	Your Budget \$/ha
4.0 tonnes/ha@ \$750/tonne	3000	
<b>A. Total income</b>	<b>3000</b>	

Variable Costs (\$/ha)		
Cultivation	96	
Chipping	150	
Sowing and inoculation	225	
Consultant	10	
Fertiliser and application	153	
Herbicide and application	113	
Insecticide and application	0	
Water pumping costs	70	
Contract harvesting	270	
On farm freight, cleaning and drying	120	
Labour	70	
<b>B. Total Variable Costs</b>	<b>1277</b>	

<b>C. Gross Margin (A-B)</b>	<b>1723</b>	
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Note: Extra costs would be incurred for drying and cartage

#### 4. Mungbeans (Irrigated)

Note: The information presented is from a commercial crop and does not necessarily reflect the potential productivity of irrigated mungbeans.

**COMMENTS:** In "hindsight" the following management operations would be considered in the future:

- \* sow straight into metre wide beds following cotton as opposed to relisting;
- \* pre irrigate and plant into moisture rather than planting dry;
- \* apply pre emergent herbicide as opposed to post emergent and ensure that inoculant survives. This will reduce expenses incurred by fertiliser application later on.

##### a) Gross margin budget

Income:	Standard Budget \$/ha	Your Budget\$/ha
0.5 tonnes/ha@ \$650/tonne	325	
\$15/ha wheat	15	
<b>A. Total Income</b>	<b>340</b>	

Variable Costs (\$/ha):		
Cultivation	33	
Sowing	36	
Fertiliser and application	47	
Herbicide and application	67	
Insecticide and application	0	
Water pumping costs	16	
Contract harvesting	30	
Cartage	33	
Grading and bagging	56	
<b>B. Total variable costs:</b>	<b>318</b>	

<b>C. Gross margin (A-B):</b>	<b>22</b>	
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## **Bourke Soil Pit Workshops**

26th & 27th May 1994

Soil conditions in cotton growing areas throughout Bourke appear to be in a satisfactory condition. This was the conclusion drawn following the observation of 15 soil pits in the area earlier this year. Soil pit sites were selected by growers in fields where soil structural problems were suspected, based upon previous crop performances. However, several soil structural problems were identified, and the importance of permanent beds and more informed management decisions became evident.

In some poor yielding fields, significant compaction was evident and is thought to have occurred two or three years previously. These fields have since been perhaps left fallow, grown wheat or deep ripped. Re-listing has then taken place and what has emerged is a compaction problem under the seed bed as it overlies an old wheel furrow.

A soil management system which has been successfully used to overcome the limitations of soil compaction is bed farming. Beds here are taken to mean kept in the same place, plants separated from traffic, and wide. Where rotation farming is utilised, permanent beds may not be ideal for all crops, but the focus here is on the benefits of permanent beds to overcome soil compaction which can reduce cotton production.

Using this system, soil loosening of surface layers and addition of gypsum (only in sodic soils) combined with bed formation using specially designed equipment, leads to creation of a root-zone area which is non-limiting (Fig. 7) for root growth. The beds are kept well aerated due to good surface drainage of excess water through the furrows. As traffic is largely confined to the furrows, soil recompaction of beds is reduced, providing longer term soil improvements and crop yield increases (Jayawardane and Chan, 1994).

A number of cases were observed where compaction was isolated to the "shoulders" of beds and the bed centre was in good structural condition. Therefore, conditions enabled good downward root penetration, but lateral root movement was restricted. Under these conditions, furrow busting may be beneficial and the necessity to deep rip should be questioned if soil structure in the bed centre appears to be adequate.

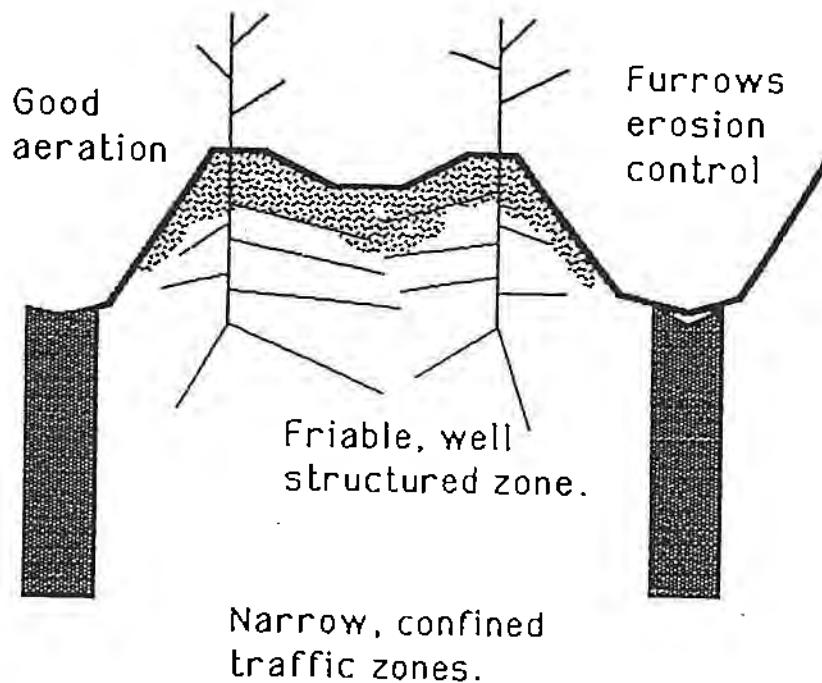


Figure 7: Desirable profile architecture for cotton (Source: Proceedings of Cotton Soil and Farming Systems Coordination Meeting, Dec. 1993).

The benefits of soil pits are fast becoming recognised as a useful tool that enables growers to become familiar with current soil conditions. This enables them to make the most cost-effective decisions, especially about tillage practices where savings can be made. An understanding of soil physical conditions and carrying out the appropriate treatments, is a positive step towards long term sustainability and profitability of cotton growing in Bourke.

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References:

Cotton Research and Development Corporation. (1993). 'Proceedings of Cotton Soil and Farming Systems Coordination Meeting'. (Ed McKenzie, D.C., NSW Agriculture). pp. 32-45.

Jayawardane, N.S., and Chan, K.Y. (1994). The management of soil physical properties limiting crop production in Australian sodic soils - a review. Aust. J. Soil Res. 32, 13-44.

**Outlook for 94/95**

The outlook for the 94/95 season looks bright with most growers having enough storage to begin irrigations having taken advantage of high river flows early in the year. However, growers will be relying on summer rainfalls to see them through to end of the season.

Throughout the winter several new storages have been under construction, which upon completion, will expand Bourke's total above ground water storage capacity estimate to 104,400 MI. The break down of this total is shown in Table 5.

Approximately 10,255 ha of cotton was proposed for the 94/95 season. However, due to water shortages the area of cotton planted has been reduced to about 9,048 ha at the time of writing and further reductions may become necessary. This will depend largely upon water availability in January.

Water-use efficiency, salt and sodicity continue to be issues which growers would like quantified. Electromagnetic (EM 31) surveys throughout the area were conducted by Charles Sturt University's Centre for Conservation Farming. Some interesting information was revealed regarding the distribution of susceptible soil types. Areas where potential problems exist were also identified. The most important message however, is that salinity is not isolated to any one farm. It has the potential to affect the entire district and every irrigator will need to take measures to ensure that this

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does not happen.

Table 5: Above ground water storage capacity estimate for the Bourke district, following completion of new storages.

Property Name	Storage Capacity (megalitres)
Clyde Agriculture	51,800
Darling Farms	31,000
Ferguson Farms	5,500
Prattenville	5,000
Alambi	4,000
Carbuu	4,000
Barham	2,800
Lodebar	300
Rocky Plains	-
<b>Total</b>	<b>104,400</b>

Improving the efficiency of water-use is a high priority for two main reasons:

- 1) water is a precious and limited resource to cotton growers in this region, and
- 2) inefficiency of water-use can induce salinity and a host of other environmental problems.

Initially, data will be collected to develop a water-use efficiency "model" at Prattenville. It is hoped that once problem areas and losses are identified this knowledge can be applied and tested on other farms.

A number of trials have been proposed for the 94/95 season and are shown in the Tables 6 and 7 below.

Table 6: Proposed on-farm cotton management trials for 1994/95.

Property Name	Trial	Treatments
<b>Clyde Agriculture</b>	Australian Cotton Cultivar Trial	
	Side Dress N Trial	<ol style="list-style-type: none"> <li>1. 175 kg N/ha pre plant</li> <li>2. 119 kg N/ha pre plant 60 kg N/ha side dress</li> <li>3. 60 kg N/ha pre plant 120 kg N/ha side dress</li> </ol>
	Zinc - Phosphate Trial	<ol style="list-style-type: none"> <li>1. Control</li> <li>2. MAP</li> <li>3. MAP + Zn</li> <li>4. ZnSO<sub>4</sub> monohydrate</li> </ol>
	Insecticide Trial - Soft V's Hard option	<ol style="list-style-type: none"> <li>1. Avoid use of organophosphates and pyrethroids</li> <li>2. Make use of Bt's where possible and use of ovicidal rates</li> </ol>
<b>Darling Farms</b>	Mulching V's Pull/Rake/Burn Trial	
	Tillage Trial 1	<ol style="list-style-type: none"> <li>1. Control</li> <li>2. Furrow bust - light</li> <li>3. Furrow bust - heavy</li> <li>4. Middle bust</li> <li>5. Middle bust/Furrow bust</li> <li>6. Deep rip</li> </ol>
	Tillage Trial 2	<ol style="list-style-type: none"> <li>1. Furrow bust</li> <li>2. Middle bust and furrow bust</li> </ol>

Darling Farms cont.	Potassium Trial	<ol style="list-style-type: none"> <li>1. Control</li> <li>2. Soil applied 200 kg KCl/ha</li> <li>3. Water run 100 kg KCl/ha - 1st flower</li> <li>4. 3×10 kg KNO<sub>3</sub>/ha applied 10 days after first flower</li> </ol>
	Precision planter V's Kinze planter	
	S6 V's S7 Pima Trial	
	Temick V's No Temick Trial	

Table 7: Proposed on-farm peanut trials for 1994/95.

Darling Farms	Plant Population Trials (2)	<ol style="list-style-type: none"> <li>1. 80 kg seed/ha</li> <li>2. 100 kg seed/ha</li> <li>3. 120 kg seed/ha</li> </ol>
	Variety Trial	Streeton V's Flo Runner
	Plant Configuration Trial	Double V's Single plant
	Herbicide Trial	<ol style="list-style-type: none"> <li>1. 2 L Prometryn + 2.5 L Stomp -preplant incorp.</li> <li>2. 300ml Spinnaker in 35% band + in-furrow application 2L Prometryn + pre plant Stomp</li> </ol>
	Nitrogen Trial	<p>Treatments applied around 1st flower</p> <ol style="list-style-type: none"> <li>1. Control</li> <li>2. 25 kg/ha</li> <li>3. 50 kg/ha</li> </ol>

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Bourke cotton growers have been fortunate that Dr Graeme Blair of the University of New England has included soils from the Bourke district in his investigation of the nutrient and carbon status of soils. The results of these investigations are expected to provide some useful information. Comparisons are made between virgin and cultivated soils of different ages and soil types. Comparisons are also made with other valleys.

Similarly, Dr Gary Fitt of CSIRO has expressed interest in including Bourke in his studies of overwintering heliothis pupae.

Bourke's involvement in extensive studies such as these is a positive step towards sustainability of the local industry. With the Sustainable Irrigated Cropping Systems project in place, it is hoped that the Bourke Cotton Growers Association will gain further recognition and partake in many more inter-regional research projects.





