Cotton RESEARCH & DEVELOPMENT

Annual, Progress and Final Reports

Part 1 - Summary Details

REPORTS

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number: **CRC 51C**

Annual Report: ☐ Due 30-September

Progress Report: ☐ Due 31-January

Final Report: ☒ Due 30-September (or within 3 months of completion of project)

Project Title: Whole farm salinity management strategies for cotton production in the Macquarie Valley.

Project Commencement Date: 1/7/03 **Project Completion Date:** 30/06/04

Research Program: 4 Farming Systems

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COTTON RESEARCH AND DEVELOPMENT CORPORATION

FINAL REPORT

Whole farm salinity management strategies for cotton production in the Macquarie Valley

CRC 51C
July 2003 to June 2004

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NSW DEPARTMENT OF PRIMARY INDUSTRIES

Australian Government

Cotton Research and Development Corporation

Part 3.3 – Final Reports (due 3 months after completion of project)

Outline the background to the project.

Every drop of irrigation water delivered to farms contains salt. In NSW as no surface drainage is allowed off farm this salt has to accumulate somewhere on the farm. Irrigation water is added to the root zone where it extracted for crop growth leaving the salt behind, hence this is where the salt is stored. If this salt is not removed the concentration will build up and result in salinity. How irrigators manage this salt will have a major influence on the life span of their farm. The only path that the salt can travel is down, into the soil. This salt needs to be flushed or leached down through the soil. This flushing of the root zone is termed the leaching requirement and has been called the "necessary evil" of irrigation. However if there is too much leaching or deep drainage then a watertable may develop, but if there is insufficient leaching then salinity will occur. A balance is needed between excess water draining below the root zone and a build up of salts in the root zone. This balancing act requires development of management options at a whole farm level to manage salinity.

The risk of salinity having a major impact on cotton production in NSW has generally been considered to be low. However, given the above scenario and recent electromagnetic induction (EMI) surveys conducted in the Namoi, Gwydir and Border Rivers by the Cotton CRC have highlighted the increase in the incidence of localised salinity. This increase in localised salinity has been associated with excessive drainage from irrigation channels and storages. There is no evidence; however of broad scale increase of salinity, but recent research conducted by the Australian Cotton CRC, NSW DPI, NSW DIPNR and Macquarie 2100 in the Macquarie Valley has highlighted this region as a potential high-risk area for salinity.

Greg Brereton DLWC (1996) reported two groundwater mounds present in the Lower Macquarie valley, one north of Narromine and another south east of Warren. These areas of shallow watertables were associated with light soils and intensive irrigation. The salinity risk assessment (DLWC 2000) report for the Boggy Cowal system, the sub catchment that encompasses a majority of the irrigated area south of the Macquarie from Narromine to Warren, as very high. The shallow watertable salinity in this sub catchment ranged from 1000 to 10000 EC units. Combined with the continued rise of the shallow watertables in the Macquarie Valley this poses a significant threat to long term cotton production in this area of the Valley.

Significant difference in the movement of water and salts among different soil types in the Macquarie Valley has been identified (Willis 1995, Friend DAN 99C). Increased deep drainage was measured under a winter fallow following a cotton crop (Friend DAN 99C). However if a cereal crop was grown following a cotton crop the deep drainage was reduced by 50%. This reduction was measured on both a red and grey soil. The measured deep drainage on the grey soil was three times the deep drainage than the red soil. The potential for irrigated cotton to contribute significant quantities of water to the watertable is high particularly for the grey soils. The grey soils are the preferred cotton growing soils in the Macquarie Valley. Hulugalle (2002) has also shown that initial crop irrigations contribute significantly to total volume of deep drainage.

Hulugalle has also reported the negative impact of the increase of ground water salinity on cotton production in the Lower Namoi. This research suggests that the accepted salinity threshold of 7.7 dS/m soil salinity is too high. Significant yield losses may occur at lower soil salinities. This susceptibility to salinity may be similar to the relationship between sorghum and salinity identified by Daniels *et al.* 2001. This research conducted on the Liverpool plains measured 50% yield reduction at soil salinities (EC_e) of 2.8 dS/m while the accepted salinity threshold is 6.8 dS/m.

At the recent CRDC Farming System workshop conducted at Narromine there was considerable interest in development of irrigated farming systems that would reduce deep drainage and in turn minimise the risk of waterlogging and salinity. Many well established growers in the Valley have been trialling different farming systems to minimise deep drainage as well as have undertaken long term monitoring of soil chemical properties. In some cases over 30 years of experience has developed what appears to be a sustainable irrigated farming system. By sharing the scientific skills of NSW DPI staff with the practical skills of these growers the evolving farming systems in the Macquarie Valley can be evaluated and extended.

In the review of the salinity risk in the Macquarie region it has become evident that an increase in salinity and shallow watertables in these regions is likely to have a significant negative impact on the cotton industry over the next 10 years. However what has also become evident is that growers are aware of the risk and some are investing their own time and money into development of farming systems that aim to minimise the effect of salinity on the sustainability of the irrigated cotton farming in the Macquarie Valley.

Brereton, G. (1996) Ground water conditions for the irrigated lands between Narromine and the Macquarie marshes DLWC
Daniels *et al.* (2001) Relationship between yield of grain sorghum (Sorghum bicolor) and soil salinity under field conditions *Australian Journal Experimental Agriculture* v 41 211-217
Friend, J. (2000) Assessment of winter crop rotation phases for salinity prevention in cotton based rotation systems: Final report Cotton R&D Corporation
Hulugalle *et al.* (2002) Long term effects of cotton rotations on the sustainability of cotton soils Final Report Cotton R&D Corporation
Humphries, E. (2000) Salinity Risk Assessment of the Central West Catchment Published by Central West Catchment Management Committee Orange NSW
Willis, T. (1995) An evaluation of deep percolation resulting from cotton irrigation in the Lower Macquarie Valley Master Thesis Charles Sturt University

List the project objectives and the extent to which these have been achieved.

- Identify and establish suitable commercial farm sites for long term monitoring
- Monitor deep drainage across all treatments
- Monitor irrigation water quality at regular interval and establish initial treatments to assess the impact of water quality on salt balance and crop performance.
- Collect and collate historical farm data on soil, water and crop
- Development of a detailed research proposal that meets alternative funding bodies priorities

Identify and establish suitable commercial farm sites for long term monitoring

Five sites representing the main cotton growing soil types in the Lower Macquarie Valley were selected and soil sampled in late October and May 2004 (Fig 1; Table 1). Field selection was based on being a representative irrigated cotton soil of the Macquarie Valley as well as a representative irrigation water source. One of the sites sourced irrigation water from a moderately brackish (1.0 dS/m) bore. Three sites are supplied by schemes and the other by a river pump.

Electromagnetic induction techniques such as the Geonics EM31 have been proven as valuable tool to identify areas within fields of similar texture and salt content (Beecher and Hume 1996). In the present study existing EM 31 survey data collected by AgNVet Services, of the identified fields were analysed and the median EM 31 value from the field survey was determined. The median EM 31 value was used in conjunction with EM 31 survey to identify suitable sampling sites.

The sampling site was located in the field with a differential GPS (accurate to 0.5 m). Three soil samples were taken within 5 m around the identified point to a depth of 2.1 m in 300 mm increments. Soil samples were taken in November 2003 and May 2004. These soil samples were analysed for exchangeable cations; specifically calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) (cmol (+)), pH, electrical conductivity of the saturated soil extract (ECe υS/m), chloride in the saturated soil extract (Cl mequiv) and moisture content of the saturated paste or saturation percentage (SP). The latter is used as an indicator of clay content and site soil variability.

Table 1 Long term monitoring sites covering the a range of irrigated soils in the Macquarie Valley

Major Formation	Type	Farm ID	Water Source	Lat	Long
Trangie	meander plain	Ww	Scheme	32° 03’ 30.79015	148° 06’ 28.35545
Bugwah	meander plain	Bu	Scheme	32° 02’ 55.83255	148° 05’ 08.30589
Bugwah	meander plain	Bw	Bore/ Scheme	32° 13’ 56.02468	148° 04’ 51.31744
Marra Creek	back plain	Ya	Scheme	31° 22’ 16.38266	147° 49’ 08.17597
Marra Creek	flood plain	Dr	River	31° 25’ 35.16801	147° 44’ 35.78199

To determine if the irrigation had an effect on the measured soil chemical and physical properties a statistical analysis was performed on the results. The statistical analysis employed mixed models to investigate the effect of irrigation on the soil parameters measured at the individual sampled sites. Replicate and depth were fitted as random effects in the models with a spline term fitted to the depth covariate. The differences between pre irrigation and post irrigation measurements were used as the dependent variables in the mixed models. The analysis determined if the slope and intercept terms of the mixed models were significant and also computed the variance components corresponding to the random factors (rep, depth, spline).

There was no significance slope or intercept terms relating to the mean difference in saturation percentage (SP) at all sites except for the slope at the Ya site (Tables 2 and 3) This suggests that the sites sampled before and after the irrigation season were the statistically the same. The significant slope at Ya site suggest that the Ya site may be quite variable in soil texture and care should be taken in interpreting the soil chemical results.

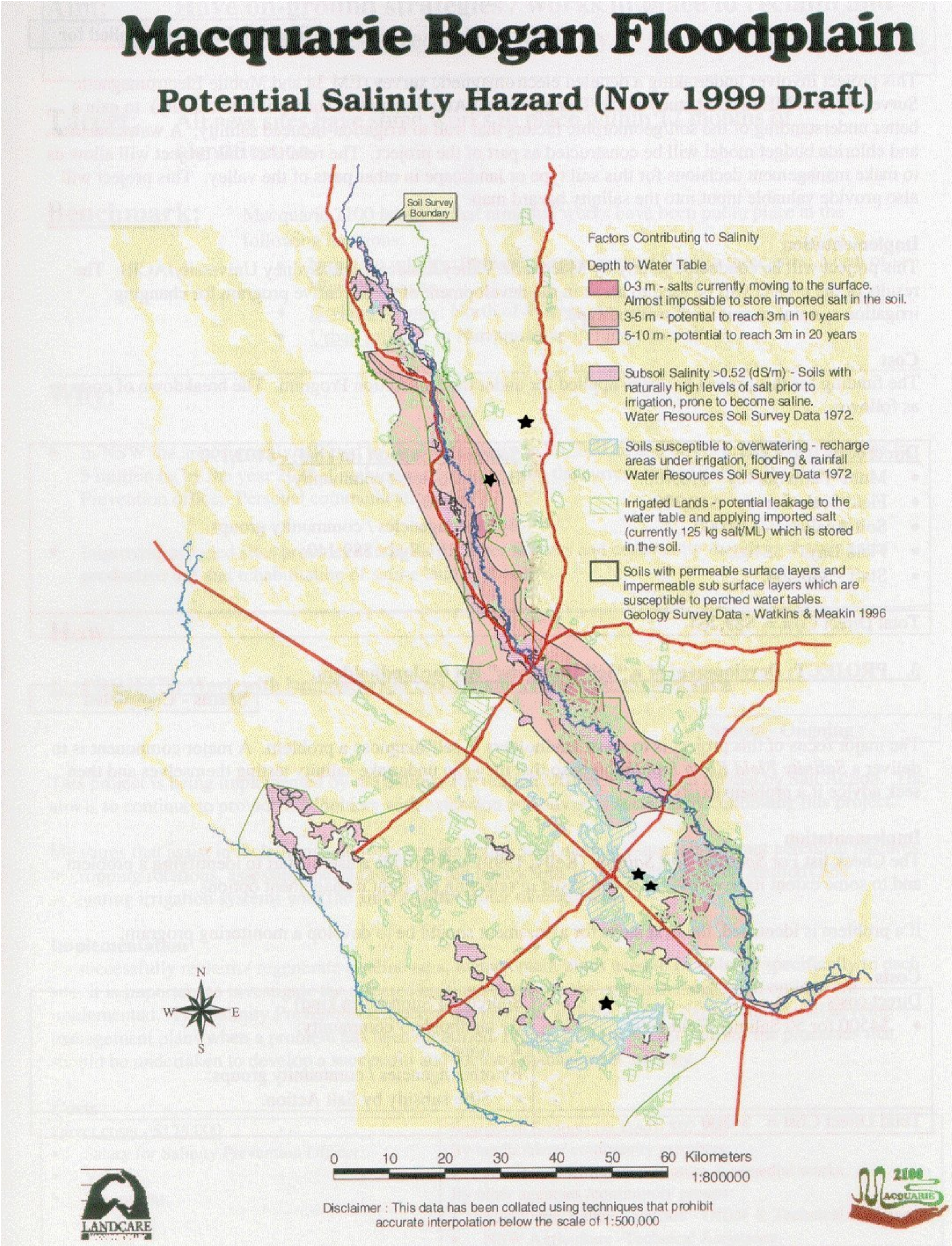

Figure 1 Potential Salinity Hazard for the Macquarie Bogan flood plain. (Project sites marked with star)

Table 2 Probability that the slope is significantly different from zero

Site	Ece	Cl	SP	Ca	K	Mg	Na	pH
Dr	ns	ns	ns	ns	0.0236	ns	ns	ns
Bw	<0.01	<0.001	ns	ns	ns	ns	<0.001	ns
Bu	<0.05	<0.001	ns	ns	ns	ns	0.044	ns
Ya	ns	ns	0.005	ns	ns	<0.01	ns	ns
Ww	ns	<0.05	ns	ns	ns	ns	<0.05	ns

Table 3 Probability that the intercept is significantly different from zero

Site	Ece	Cl	SP	Ca	K	Mg	Na	pH
Dr	ns	ns	ns	ns	ns	ns	ns	ns
Bw	ns	ns	ns	ns	ns	<0.05	ns	ns
Bu	ns	<0.05	ns	<0.05	ns	<0.05	<0.01	ns
Ya	ns	ns	ns	ns	ns	ns	ns	ns
Ww	<0.01	<0.05	ns	<0.05	ns	<0.05	<0.01	ns

There were significant slope terms relating to the mean difference in the Na content of the soil for the three meander plain soils (Bw, Bu, Ww) (Tables 2 and 3). All three soils increased in Na content after irrigation. The upper 50 cm of the Bw site soils became sodic (ESP greater than 6%) after irrigation compared to the pre irrigated samples (Fig 2). There was no significant change in the Na content of the back plain soils due to the 2003-04 irrigation season (Ya, Dr) (Fig 2). This result suggests that irrigation during the 2003-04 season on the lighter meander plain soils increased the risk of sodicification of these soils while there was no such effect on the heavier back plain soils.

There were significant slope terms relating to the mean difference in the chloride content of the soil for the three meander plain soils (Bw,Bu,Ww) (Table 3). All three soils decreased in chloride content after irrigation (Fig 3). This difference in chloride content between the sampling periods suggests that there was deep drainage and this drainage allowed the chloride to leach from the root zone.

There was a similar pattern of leaching for the electrical conductivity of the soil solution for the Bw and the Bu sites. The statistical analysis suggests that there was an increase in the salinity at the top of the profile due to the irrigation while the salinity decreased below about 1.0 m (Tables 2 and 3; Fig 4). There was no significant slope term at either the Ww Du or Ya sites (Tables 2 and 3).

These results suggests that during the 2003-04 irrigation season the there was an increase in both the electrical conductivity and the chloride content of the lighter soils in the present study. This finding suggests that there has been an increase in the salt storage in the soil. The long term effect of this will need to be assessed in light of the flushing effect of winter rainfall. Given the 12 month time line of the present study it is difficult to assess such effects.

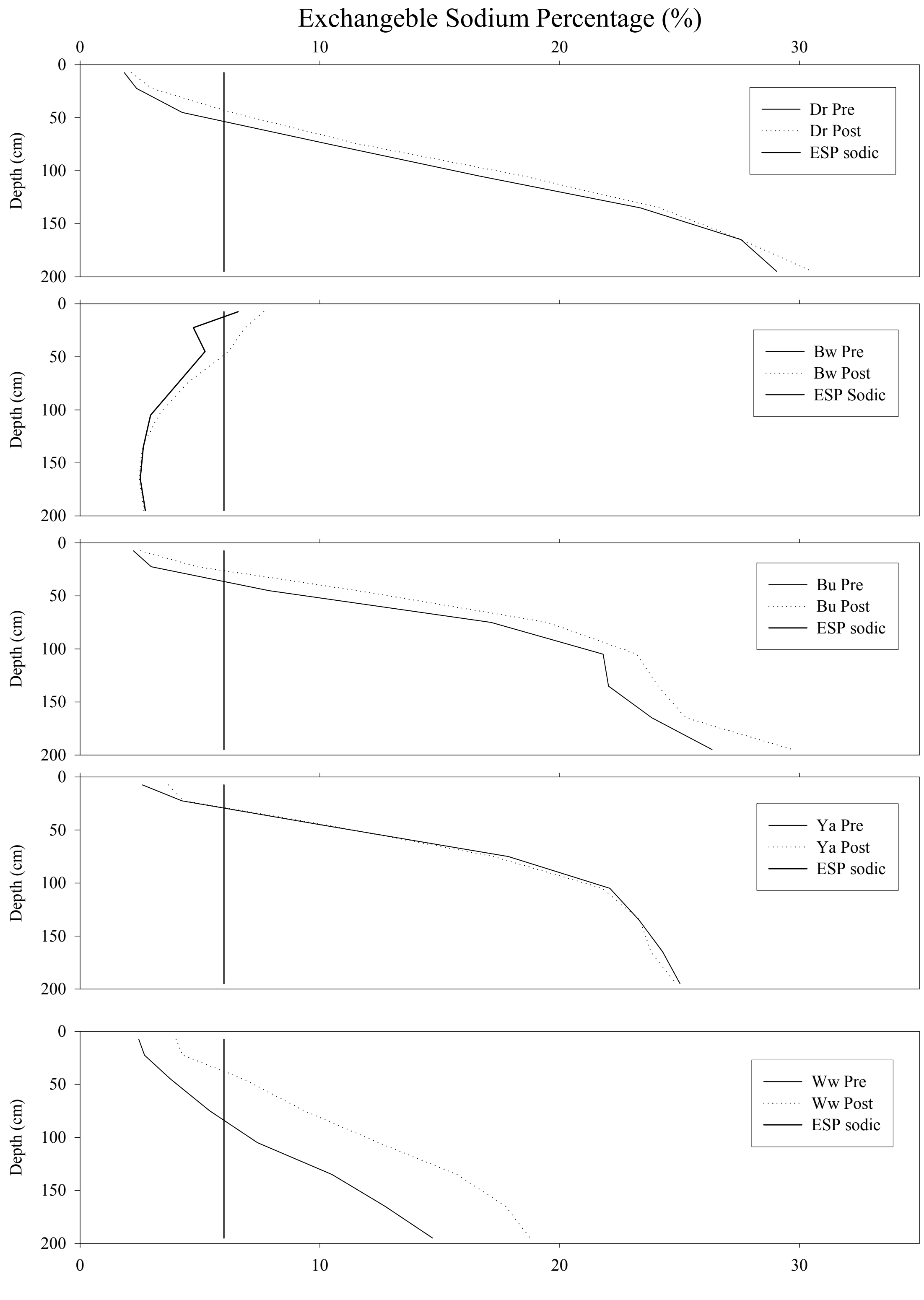

Figure 2 Measured Exchangeable sodium percentage on five key soil types in the Lower Macquarie valley

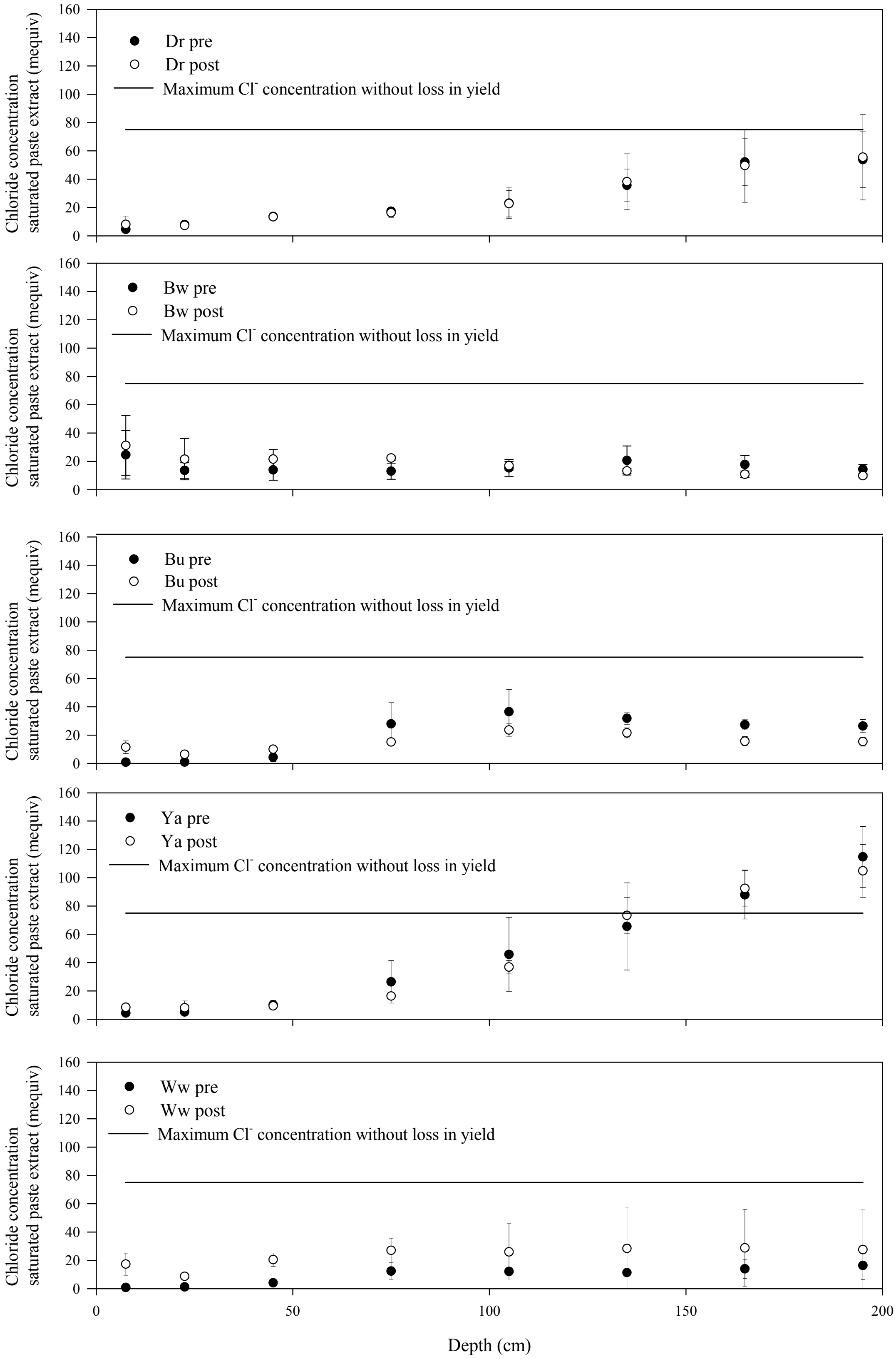

Figure 3 Mean chloride concentration in a saturated soil extract from key irrigated cotton soils in the Macquarie Valley

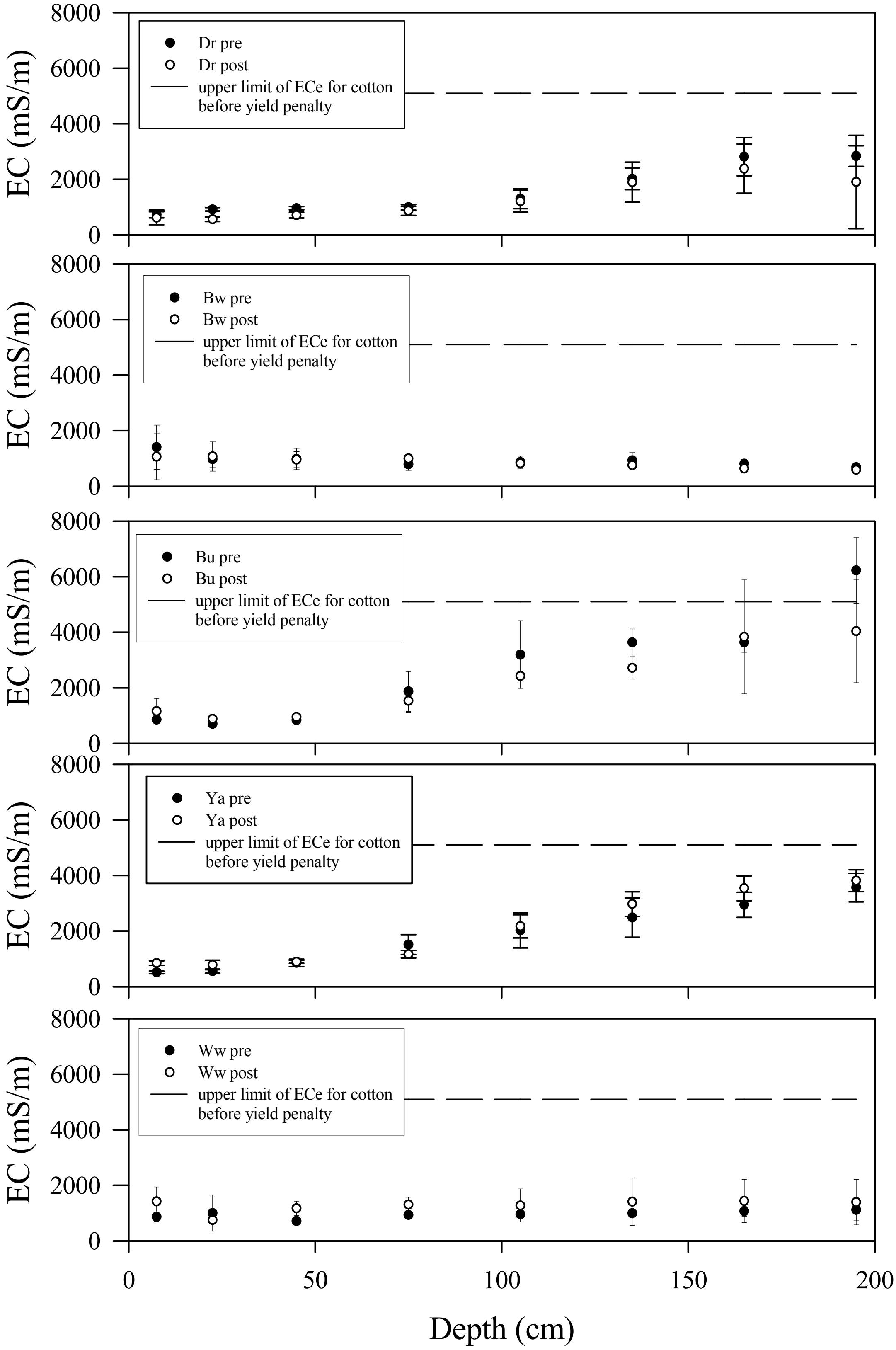

Figure 4 Mean electrical conductivity in a saturated soil extract from key irrigated cotton soils in the Macquarie Valley

Monitor deep drainage across all treatments

Deep drainage was determined for the five sites by solute mass balance (Equation 1) (Slavich 1992, Willis 1995, Friend 2000, Weaver *et al.* 2004). This method has been used extensively to determine deep drainage under irrigated cotton in the lower Macquarie Valley (Willis 1995, Friend 2000, Weaver *et al.* 2004). Willis (1995) compared three methods to determine deep drainage and found that solute mass balance was the most accurate method to determine deep drainage

At two of the sites (Dr and Bw) flow meters were installed in the head and tail ditches. The meters measured the volume of water delivered to and drained from the fields. This data in combination with the soil chemical data was used to determine the volume of deep drainage by solute mass balance. Where flow meters were installed the volume of water applied to the field was measured as well as the volume of water drained from the field. The difference was assumed to be the volume of water that infiltrated the soil. This value was used in the solute model.

The results of the solute model show that the volume of water that was lost as deep drainage is very soil type dependant (Table 2; Fig 5). More water was lost to deep drainage on the lighter textured meander plain soils (Bu, Ww, Bw) than the heavier back plain and flood plain soils (Table 2; Fig 5).

Table 4 Estimates of deep drainage by solute mass balance on irrigated cotton in the Lower Macquarie Valley 2003-04

Major Formation	Type	Farm	Sub Soil Texture	Deep drainage (2.1 m)
Marra Creek	flood plain	Dr	Medium Clay	4.3
Bugwah	meander plain	Bw	Silty Clay	69.7
Bugwah	meander plain	Bu	Silty Clay	11.0
Marra Creek	back plain	Ya	Medium Clay	1.7
Trangie	meander plain	Ww	Silty Clay	11.4

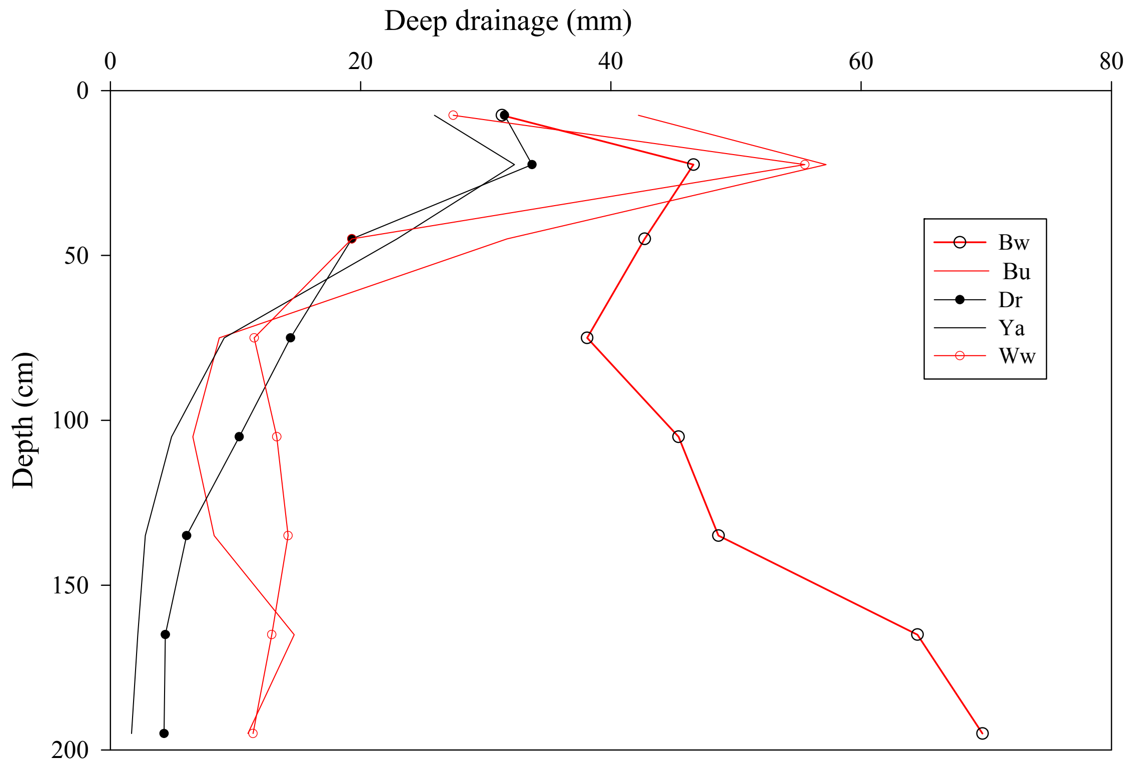

Figure 5 Estimated deep drainage under irrigated cotton crops on key soil types Macquarie valley 2003-04

The volume of water draining from below the root zone for all soils was well below the estimates of the previous study of Friend (2000) (63 -578 mm over 18 months) but consistent with the increase in long term deep percolation rates due to irrigation measured by Willis 1996 (7.7-94 mm/yr). This decrease in the measured deep drainage in the present study may be due to the effect of restricted water allocation (19%) and improvements in the irrigation management. Hulugalle (2002) (CRC 12) has suggested that a substantial amount of deep drainage occurred as a result of the initial irrigation, however due the restricted irrigation allocation the crops were not irrigated until the first week in December, well after the usual date.

The pattern of deep drainage is consistent with previous reports, the lighter red soils have substantially higher deep drainage rates than the heavier grey soils. The increased drainage under the site irrigated with the saline bore (Bw) may be due to an electrolytical effect in which high EC water partially flocculates the soil and increases deep drainage (Beecher 1992).

Monitor irrigation water quality at regular interval and establish initial treatments to assess the impact of water quality on salt balance and crop performance.

At the two sites were flow meters were installed (Dr and Bw) irrigation flow were monitored and grab samples of irrigation water were taken for chemical analysis. At the other sites (Ww, Bu , and Ya) the irrigators were asked to estimate the volume of water supplied to the field. Additional flow meters were purchased as well as logging EC meters in November 2003 however the company (Unidata) went into voluntary receivership in December and the units were not delivered until April 2004. This equipment was vital for measurement of the changes to water quality during the season. However some water samples were taken for analysis as well as historical water quality test were obtained. The test showed that the EC of the water varied over the season however given the limited sampling it is difficult to describe the variation and determine any effect. The data derived from the soil sampling and the water measurement allowed the salt balance to be determined for two sites (Dr Bw) and estimated for three sites (Ya, Ww Bu).

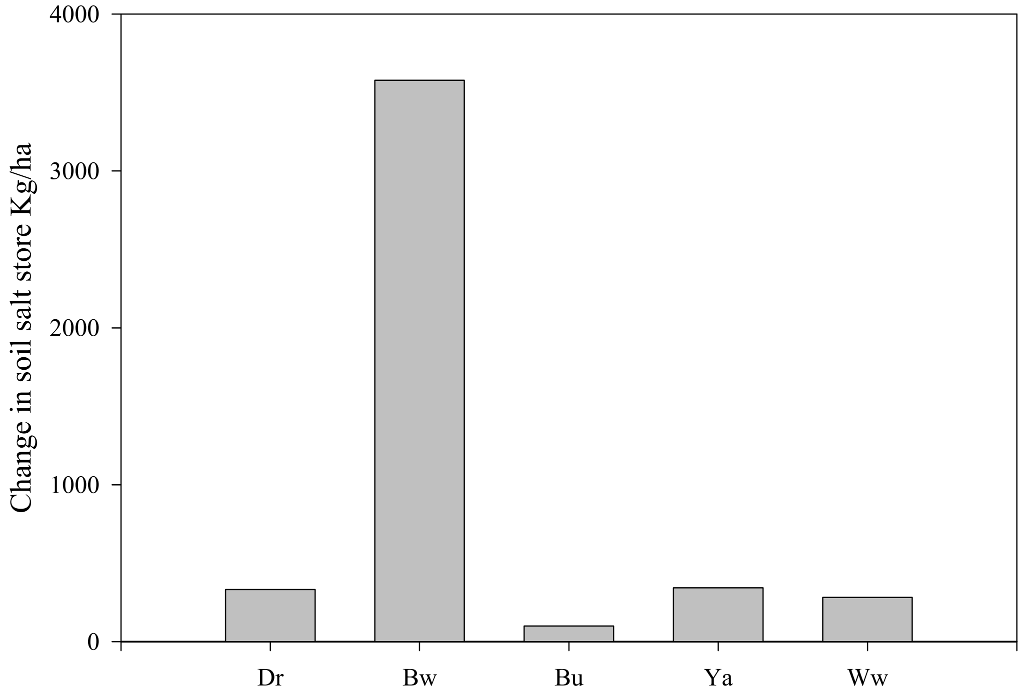

Figure 6 Change in salt storage (kg/ha)

The change in soil salt stored was calculated by measurement of the EC of in the grab samples of the irrigation and tail water, this was converted to salt load by combing this data with the volume of water applied to the field. Losses of salts consisted of salt leaving via the tail water or as deep drainage. The amount of salt draining past the root zone data was estimated by combining the deep drainage with the measured ECe at that depth. The amount of salt leaving in the tail water was measured by the average measured EC of the tail water with the estimate or measurement of water drained from the field.

The results show that all treatments increased the salt store over the observation period (Fig 6). The biggest increase occurred on the Bw site. In which there was an additional 3.5 t of salt stored per ha (Fig 6). This estimate does not account for any effect of leaching by winter rainfall. Previous studies (Friend 2000) showed that winter rainfall has a significant effect on the amount of deep drainage and hence leaching of salts. Again it would be difficult to draw too many conclusions without undertaking additional post winter sampling.

Collect and collate historical farm data on soil, water and crop

Long term farm soil and water data has been collected and collated for one site. Some historical yield data has also been collected. The yield data was used to pinpoint areas of high and low yield. Initial analysis of the soil data in conjunction with yield maps suggests that areas of low yield also have high sub soil nitrates present after harvest. This suggests that the plant was not or could not access the nutrients. The finding has enabled the grower to eliminate nutrition as a factor in yield. The grower has identified these areas of low yield and high sub soil nitrates as areas of restricted infiltration.

Development of a detailed research proposal that meets alternative funding bodies priorities

This objective was not achieved. The original plan was to approach the CW CMA and CRC IF for additional funding. The CW CMA is still being established and the investment plan has yet to be finalised, while the CRC IF will only fund post graduate studies. It is hoped that the CMA will be operational in the later part of 2004 or early part of 2005 and this will allow negotiation of a research agreement.

Beecher H.G, Hume, I.H (1996) Rice land suitability assessment Final report Rural Industries R&D Corporation

Friend, J. (2000) Assessment of winter crop rotation phases for salinity prevention in cotton based rotation systems: Final report Cotton R&D Corporation

Hulugualle *et al.* (2002) Long term effects of cotton rotations on the sustainability of cotton soils Final Report Cotton R&D Corporation

Willis, T. (1995) An evaluation of deep percolation resulting from cotton irrigation in the Lower Macquarie Valley Master Thesis Charles Sturt University

Detail the methodology and justify the methodology used.

Electromagnetic induction techniques such as the Geonics EM31 have been proven as valuable tool to identify areas within fields of similar texture and salt content (Beecher and Hume 1996). The sites were selected from EM 31 surveys carried out by AgnVet Services over the last 4 years.

The sites were identified as waypoint in SST Toolbox by AGnVET staff, the waypoints were then uploaded into a Trimble TDC1 datalogger attached to a Trimble ProXL GPS linked to a Fugro Omnistar demodulator that provides differential corrections to the GPS. In the field the waypoints were located using the GPS and at each point three holes were hand augured to a depth of 2.1 m within 5 m of the identified location. The soil was divided in to the following depth increments 0-15 cm, 15-30 cm, 30-60 cm, 60-90 cm, 90-120 cm, 120-150cm, 150-180 cm, 180-210 cm. The soil was air dried and ground to pass through a 2 mm sieve.

Deep drainage was measured by chloride mass balance at the on farm monitoring sites. This methodology has been widely used to measure deep drainage under cotton in the Macquarie valley balance (Willis 1995, Friend 2000, Weaver *et al.* 2004).

The following projects have successfully measured deep drainage using this method:

Willis, T. 1995 An evaluation of deep percolation from cotton irrigation in the Lower Macquarie Valley M App. Sc. Thesis Charles Sturt University Wagga Wagga

Friend, J. (2000) Assessment of winter crop rotation phases for salinity prevention in cotton based rotation systems: Final report Cotton R&D Corporation DAN 99C

CRC 12C Long-Term Effects of Cotton Rotations on the Sustainability of Cotton Soils II (Hulugalle, Weaver and Scott 2002)

The steady state chloride mass balance model used is presented below

$$L = \frac{[(IC_i) - z(\overline{S}_{(0-z)t1} - \overline{S}_{(0-z)t2})]}{C_z}$$ **Equation 1**

where

I = Infiltration of water from irrigation and rainfall (mm)

C_i = Concentration of chloride in irrigation (meq l^{-1})

z = depth increment (m)

C_z = mean chloride concentration of drainage water (meq l^{-1})

$$C_z = \frac{C_{SP}\theta_{SP}}{\theta_g}$$ --Equation 2

$$S_{(0-z)} = 0.814 C_{SP}\theta_{SP}\rho_s$$ --Equation 3

where

C_{SP} = chloride concentration of saturated paste extract (□mol cm^{-3})

θ_{SP} = water content of saturated paste (g g^{-1})

ρ_S = soil bulk density (g cm^{-3})

θg = *saturated moisture content at which drainage occurs (g g^{-1})

0.814 = factor accounting for anion exclusion in the saturated paste

(*The saturated moisture content was estimated as 93% of the total porosity, and the total porosity was calculated from the bulk density).

from CRC 12C (Hulugalle, Weaver and Scott 2002)

The air dried ground soils were sent to the NSW DPI laboratory at Wollongbar where exchangeable cations (Al, Ca, Mg, K and Na) were measured by the method of Gillman and Sumpter (1986), pH was measured in water. ESP was calculated dividing the concentration of sodium by the sum of the 4 (Ca, Mg, K and Na) cations.

Saturated soil paste extracts were prepared by placing approximately 70 g of air dried ground soil in a 50 mm pvc tube cut into 50 mm lengths. The pvc tube is placed on a cutlery tray covered in blotting paper. The tray is placed in a 20 l plastic basin and filled with distilled water until water just covers the top of the cutlery tray. The water level is monitored and the samples remain in the basin until they are fully saturated (usually 48 hours) or until a spatula can slice the soil and the paste falls back on itself. After the soil has been saturated approximately 35 g of the soil paste is placed in an ultra centrifuge tube and placed in an ultra centrifuge and spun for approximately 10 min at 9000 rpm. The resultant supernatant (soil extract) is decanted and analysed for electrical conductivity and chloride.

The EC is determined using a TPS 900C EC meter. A sample of the soil extract is sucked up into the probe and the reading taken. The sample is then disposed of and the electrode is rinsed. Chloride concentration was measured by coulometric-amperometric automatic titration method (Cotlove *et al.*1958).

The measured soil chemical data was analysed in SPLUS software using the Spatial Analysis Mixed Models (SAMM) interface. SAMM estimates variance components under a general linear mixed model by residual maximum likelihood (REML).

For each measured parameter a spline was fitted to the depth covariate to obtain the soil profile for that parameter. The spline allowed for small variations in the sample at individual depths. The statistical models fitted replicate, depth of the sample and the spline term as random effects and fitted the differences between pre irrigation and post irrigation measurements as the dependent variables. The analysis determined if there were significant slope and intercept terms in the mixed models and also computed the variance components corresponding to the random effects (rep, depth, spline).

Gillman, G.P., and Sumpter, E.A. 1986. *Aust. J. Soil Res.*, **24**, 61-6

Cotlove, E., 1958. An instrument and method for automatic, rapid, accurate and sensitive titration of chloride in biologic samples. Journal of Laboratory and Clinical Medicine, 51:461-468.

Provide a conclusion as to research outcomes compared with objectives. What are the "take home messages"?

Five long term monitoring sites were established on major irrigated cotton growing soils in the Lower Macquarie Valley. These sites will enable long term monitoring of deep drainage and changes to the salt store in the major irrigated cotton growing soils.

There was an increase in the soil salt store over all sites. This finding does not account for any winter leaching that may occur. The highest increase in the salt store came from a site that used moderately brackish water. This site had an 3.5 t /ha increase in the soil salt store over one irrigation season.

Over the irrigation season deep drainage was higher under meander plain soils (red soils) than compared to the back plain soils (grey soils).

From the initial analysis it appears that irrigation may increase the risk of sodicification on the meander plain soils. There does not appear to be such a risk on the back plain soils.

Detail how your research has addressed the Corporation's three Outputs - Economic, Environmental and Social?

All three key ouputs are addressed by the project.

- Economic outputs are addressed as this research contributes to a better understanding of the long term land and water management strategies.
- Environmental outputs are addressed in this research by contributing to an increased understanding of the processes of salt and water movement in irriagtd coton farming systems. Base line data collected in this project will enable monitoring of the salt content (salinity) and salt compostion (sodicity).
- Social this research will enable better understanding of water and salt management which will allow BMP program for water and salinity management to be developed.

Provide a summary of the project ensuring the following areas are addressed:

a) technical advances achieved (eg commercially significant developments, patents applied for or granted licenses, etc.)

b) other information developed from research (eg discoveries in methodology, equipment design, etc.)

c) are changes to the Intellectual Property register required?

The project has provided an opportunity to establish long term monitoring sites with high quality baseline data. These sites can be monitored for changes in key soil chemical properties that in turn can be used to assess the long term effect of irrigation water quality, crop and water management on the productivity and sustainability of irrigated cotton farming systems in the Lower Macquarie Valley.

The project has measured the deep drainage on major irrigated cotton growing soils for the 2003-04 season.

Detail a plan for the activities or other steps that may be taken:

- **(a) to further develop or to exploit the project technology.**
- **(b) for the future presentation and dissemination of the project outcomes.**
- **(c) for future research.**

An additional post winter soil sampling is planned if the unspent funds can be rolled over. The soil will be analysed for EC and Cl and possibly Na if funds permit. Additional data analysis will be undertaken particularly documentation of cropping history on the five sites.
Additional funding will be sought from CW CMA to continue the understanding of the salt and water dynamics under irrigated farming systems in the Macquarie Valley. Particular emphasis will be placed on establishing the effect of irrigation water on the sodium levels on the meander plain soils irrigated with lower quality water.
Detailed results of the study will be distributed to the five co-operators, and result summaries will be distributed amongst the cotton industry in the Macquarie Valley.

List the publications arising from the research project and/or a publication plan. (NB: Where possible, please provide a copy of any publication/s)

Publication of the results is planned over the next 6 months, it is planned for an article to appear in Australian Cotton Grower, as well as a fact sheet comprising of data derived from the study.

Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. Where possible include a statement of the costs and potential benefits to the Australian cotton industry or the Australian community.

As yet it is difficult to assess the effects of the results of the present study on the cotton industry. The establishment of long term monitoring sites may have great benefit to the cotton industry in terms of assessment of the physical and chemical changes to the soil resource as a response to changes in water quality and farm management.

Part 4 – Final Report Executive Summary

Five sites representing the main cotton growing soil types in the Lower Macquarie Valley were selected and soil sampled in late October and May 2004. Field selection was based on being a representative irrigated cotton soil of the Macquarie Valley as well as irrigation water source. One of the sites sources irrigation water from a moderately brackish (1.0 dS/m) bore. Three sites are supplied by schemes and the other by a river pump.

The pattern of measured deep drainage is consistent with previous reports, the lighter red soils have significant higher deep drainage rates than the heavier grey soils. The increased drainage under the site irrigated with the saline bore (Bw) may be due to an electrolytical effect in which high EC water partially flocculates the soil and increases deep drainage (Beecher 1992).

The upper 50 cm of the meander plain soil (Bw) became sodic (ESP greater than 5%) after irrigation compared to the pre irrigated samples. There was no significant change in the Na content the back plain soils due to the 2003-04 irrigation season (Ya, Dr). This result suggests that irrigation during the 2003-04 season on the lighter meander plain soils increased the risk of sodicification of these soils while there was no such effect on the heavier back plain soils.

The change in soil salt stored was calculated and the results show that all sites increased the salt store over the observation period (Fig. 6). The biggest increase occurred on the meander plain soils irrigated with the bore. At this site an additional 3.5 t/ha of salt was stored in the top 2.1 m. This estimate does not account for any effect of leaching by winter rainfall. Previous studies (Friend 2000) showed that winter rainfall has a significant effect on the amount of deep drainage and hence leaching of salts. Again it would be difficult to draw too many conclusions without undertaking additional post winter sampling.

Long term farm soil and water data has been collected and collated for one site. Some historical yield data has also been collected. The yield data was used to pinpoint areas of high and low yield. Initial analysis of the soil data in conjunction with yield maps suggests that areas of low yield also have high sub soil nitrates present after harvest. This suggests that the plant did not or could not access the nutrients. The finding has enabled the grower to eliminate nutrition as a factor in yield. The grower has identified these areas of low yield and high sub soil nitrates as areas of restricted infiltration.

The objective of development of a detailed research proposal that meets alternative funding bodies priorities was not achieved. The original plan was to approach the CW CMA and CRC IF for additional funding. The CW CMA is still being established and the investment plan has yet to be finalised, while the CRC IF will only fund post graduate studies. It is hoped that the CMA will be operational in the later part of 2004 or early part of 2005 and this will allow negotiation of a research agreement