



# *Deep Drainage Forum Friday 29th May 2009 ACRI, Narrabri*

## **SUMMARY**

**A forum to present findings from current deep drainage research and highlight opportunities for future work and extension**



This summary was prepared by Helen Dugdale, Janelle Montgomery and Des McGarry

## *Program - Deep Drainage Forum, Narrabri 29/05/09*

<b>Session 1. – Groundwater at the catchment scale</b>			
Chair: Paula Jones			
9.15 – 9.20	Janelle Montgomery	NSW DPI	Welcome and outline of the day, housekeeping
9:20 – 9.30	Helen Dugdale	CRDC	Purpose of the day History of DD research. What we need to do.
9.30 - 9.45	Lexie Donald	NWC	Deep Drainage – NWC Perspective
9.45 - 10.00	Bryce Kelly	UNSW	3D model to integrate geological info into groundwater info
10.00- 10.15	Willem Vervoort	USyd	Developing stochastic deep drainage maps for the Cocks' Creek catchment
10.15-10.30	Des McGarry	DERM	Groundwater monitoring and irrigation management in the St George Irrigation Area
10.30 – 10.45	Questions to all speakers		
<b>Morning tea break</b>			
<b>Session 2. – Deep drainage at the catchment scale</b>			
Chair: Peter Smith			
11.15 – 11.30	Mark Silburn	DERM	Usefulness of Deep Drainage modelling - where has the Deep Drainage gone?
11.30 – 11.45	Jenny Foley	DERM	Use of EM38 to measure soil water & how wet is it really down there?"
11.45-12.00	Rick Young	NSW DPI	Deep drainage and salt mobilisation under dryland cropping on the Cryon plain – has it occurred and does it matter?
12.00– 12.15	Anna Greve	UNSW	Use of Electrical Resistivity probes to produce 3D map of water movement in cracking clays
12.15 – 12.30	Questions to all speakers		
<b>Lunch</b>			
<b>Session 3. Deep drainage at the field scale</b>			
Chair: Graham Harris			
1:15 – 1.30	Anthony Ringrose-Voase	CSIRO L&W	High frequency measurements of deep drainage using the ACRI lysimeter Part 1
1.30 – 2.15	Anthony Nadelko & Des McGarry	CSIRO/DERM	Visit Lysimeters
2.15- 2.30	Anthony Ringrose-Voase	CSIRO L&W	High frequency measurements of deep drainage using the ACRI lysimeter Part 2
2.30 - 2.45	Thusitha Gunawardena	DERM	Irrigation management impacts on deep drainage
2.45 - 3.00	Damien Field	USyd	Field method for measuring deep drainage potential
3.00 -3.30	Questions to all speakers & Discussion		
<b>Afternoon tea break</b>			
<b>Session 4. Most important session – Wrap up, Where to from here</b>			
Facilitator: Peter Smith			
4.00– 4.45			Wrap up - Where to from here ?
4.45– 5.00	Paula Jones Bruce Pyke	CRC CRDC	Extension & investment perspective

## **Positive results on DD Research:**

- Much progress has been made, gaps identified, good forum and connections made.
- Des and Thusitha's work – DD occurs but varies considerably year to year based on climatic and management decisions.
- Growers in general are more aware of DD and wanting to prevent losses from the system – need some DD as it's a natural process to reduce any adverse effects (salinity).
- Lysimeter, comparison of methods to measure DD - Gaining other people's information can be difficult. Lack of data eg ACRI only has 1 year of measured data –Comparisons haven't happened, perhaps not enough data. Good area to explore ASAP.
- Review of DD Research (Des has 7 years of research).

**Results from evaluations at the end of the forum:** The vast majority of attendees were most satisfied with the forum and appreciated the information supplied, the contacts made and the possibility for future collaboration and material for extension. Quite a few commented that they would have preferred a longer forum to enable more information from the researchers, more discussion time and more time to elaborate on possible future work.

Many gained a lot of information, some gained different ideas from the forum that they will incorporate into their work. Quite a few stated that the DD message is still not clear and more collaborative work needs to be done. Extension officers would like information/help on DD extension materials.

There were a number of suggestions from the funding bodies, such as "Discussions with the Cotton CRC regarding the priorities developed during the forum and what could be progressed especially in adoption of knowledge gained in the past decade".

## **How have we succeeded since 1999?**

At the end of the forum participants reviewed the progress made since the first DD forum in 1999. It was agreed that the progress against the top 4 nominated priorities has been quite good. Overall, many more growers are conscious of DD, and the impact on WUE, as well the need for leaching salts.

The following provides a summary of the discussion as to how research and extension has succeeded in terms of the top 4 priorities from the 1999 Water Balance Workshop.

- 1. Measure H<sub>2</sub>O properly – NMM (Neutron Moisture Meter) calibration, shrinkage. - Progress:**
  - Situations and tools have changed since then.
  - There is more instrumentation available and our understanding of this instrumentation has improved.
  - We have come a long way on this issue.
  - Need to now look more at the usefulness of EM (electro-magnetic) surveys and resistivity measurements.
- 2. Measurement of drainage. – Progress:** Have made some progress but still some way to go.
  - Have gone from not knowing how to measure DD to actually being able to do it using a range of different methods.
  - Much data has been collected in the last 10 years regarding DD. This data needs to be "mined" to get maximum output/benefits.
  - Biggest knowledge gap is: "Connectivity between DD and groundwater(s)".
  - We can now quantify the amount of DD and have data to assess the effects of on-farm management.

- Measured averages are 100-200 mm DD per year, but this is greatly influenced by water availability, in-field position (head versus tail locations) and transpirational demand.
- The 2009 DD forum included discussion about how much DD, researchers were finding and the affects of farm management. The average of 100 - 200 mm per year has been recently (greatly) reduced in drought conditions. The ACRI lysimeter in 2008/09 recorded less than 50 mm, but it is unsure whether this was because the first irrigation was not until Christmas due to good rain early in the season, or because the subsoil was particularly dry early in the season.
- The principles that drive DD are the soil water deficit, which increases between irrigations as the crop develops, and the incidence of rain. Rain can reduce or increase drainage depending on when it occurs. Immediately after an irrigation, rain will add to drainage. However, if rain reduces the frequency of irrigation, it can also reduce drainage as the amount of rain received in a short time is generally much less than the amount applied during an irrigation event
- Repeatedly seeing high DD early in the season and lower DD at the end of the season.
- Diminishing quantities of DD from headditch to taildrain under furrow irrigation system.
- We now know that climate variability and water management have a large influence on the amount of DD.
- Uncertainty persists on actual quantities of DD with at times conflicting quantities between the different measurement methods. However, all measures are showing DD is certainly occurring.
- Required are better measures of ET (Evapotranspiration) so the water balance can be closed.
- SaLF – not recommended for measurements of DD.
- A key extension article developed by the CRC Water Team in collaboration with CRC and CRDC DD researchers is “Deep Drainage Myth-Busters”. This article needs further promotion in the cotton and grains industries, and any new information added to the WATERpak manual.
- In terms of research requirements, there is a need to look at drainage beyond the root zone and also to consider the quality of these drainage waters. In particular, these considerations should focus on the vadose zone.
- Develop guidelines/myth busters to explain forthcoming outcomes of (above) investigation of water dynamics in the vadose zone. Also, develop written materials in the Cottongrower, Spotlight and the various cotton-related Websites
- An additional research requirement is to further/better analyse DD solutes at the farm and catchment scales.

**3. Measuring/modelling/predicting runoff especially rainfall runoff on a field and whole farm scale – Progress:**

- There is plenty of data available for runoff amounts during irrigation events and there is a good understanding of this.
- More work is needed for rainfall runoff.

**4. Audit evaluate and standardise ET estimation especially Penman equation – Progress:**

- This is quite an involved issue. Progress has been made but ET is very variable and better measures of ET are still required.
- More work yet to be done on ET estimation at both field and catchment scale.
  - Need good crop data
  - Uncertainty of ET estimations mostly related to canopy and crop type.
    - eg, for cotton need to examine the affect of row spacing on ET. Ultra narrow spaced cotton would have higher ET early in the season.
  - If green leaf area is required for accurate ET measurements, should integrate DD research with precision agriculture projects which are probably already measuring leaf area (canopy).
  - Better weather station network required. – (BOM has money for weather stations from NWI) in key locations to make SILO data more accurate
  - Variation of the wind function for calculating ETo needs to be incorporated – Alan Beswick, QDERM, has done some work on this. As has Des Whitfield, Vic.

- Both modellers and irrigators need extension material on “How to estimate ET”.
  - Jenelle Hare (QLD PIF, DEEDI) has developed a good extension article regarding this
  - Growers need further education of what ET is, particularly an understanding of the components so they appreciate why it varies
  - Revamp and recycle Jenelle Hare’s article and distribute more widely and frequently
- CRCIF ET SMS mobile phone service has proven useful to growers at pilot scale. It supplies local ETo info in a timely and useful manner that growers need. Need to investigate with Bill Williamson intentions for expanding and commercialising this service.
- ET is used for calibration purposes and closing water balance – but measurements need to be more precise for this. Research needed to improve and standardise.
- Catchment scale understanding of ET needed to feed into catchment scale understanding of DD
- Remote sensing could be used as a data source for catchment scale determination of ET, and perhaps farm scale too. Overseas work is using this to some extent eg. USA, Italy. John Hornbuckle, CSIRO, Griffith, is looking at this – investigate potential for further r&d.

## Priorities List 2009

A list of research and extension priorities was developed during the last session of the DD forum.

**Topic and solutions/suggestions are as follows:** (At the most general level it was considered that the “soon to be appointed” Water specialist has a lot of work ahead of them)

### EXTENSION

- a) Deep Drainage – what defines too much or too little (How to calculate the leaching fraction)
  - Too little consideration has been given to the soil leaching fraction to ensure there is no build up of salts. What defines “too much” is more questionable. The forum suggested a base amount of 10mm/irrigation event and that anything greater was an economic decision by the grower. However, it was also suggested that in some instances there is an amount of DD that we cannot do much about as it’s due to bypass flow.
  - Need to establish whether we need a ‘formal’ leaching fraction or whether natural events (e.g. winter rain or rain after an irrigation event) provide sufficient leaching
  - Update Waterpak; update BMPs; explain to growers about leaching fractions
- b) EM38 for irrigation scheduling and soil moisture measurement
  - This information needs to be collated. Cotton Extension team to work with Jenny Foley – use of an EM as a research tool, grower trials and possibly irrigation scheduling for growers.
- c) Develop Management procedures for DD
  - Include latest research finding
  - Management to reduce DD.
  - Leaching Fraction
  - Technical resource for myBMP, updates for WATERpak manual.
- d) Quick method/tool for showing DD
  - We’re not going to ‘measure’ drainage easily in farmer’s field. However, we might be able to develop simple tools to know when its occurring
  - Develop a DD calculator or guidelines to show when DD might occur.
- e) Grower understanding of soil moisture probe information
  - Relates mostly to being aware that uncalibrated moisture probes do not measure moisture change in actual mm.
  - This information is in the Cotton/Grains Irrigation course, but not many are doing this course.
  - Need extension article that outlines what available soil monitoring tools can do and their limitations – NMM, capacitance, EM38 ( Joint article NSW DII, Qld PIF)
- f) Water Balance Modellers and irrigators
  - How to estimate ET.– Write a story explaining ET. Again, to consider re-use/revamp Jenelle Hare’s ET article
  - Suggestion to have ET updates sent by SMS to their phones – Bill Williamson’s project.
- g) Reuse of Irrimate results to estimate DD
  - There is a backlog of data on this. Suggestion that funding is gained to pay someone to check this data. Rod Smith (NCEA) has written a paper explaining how DD is estimated from Irrimate data.

### Research Priorities

- a) **How fast does water move through the regolith/ When does DD become recharge?**
  - Research needs to be good at measuring DD and know what the drivers are
  - Also need to be good at measuring groundwater response
  - Need the 3D link between the root zone and the aquifers.
  - Need to look at drainage beyond the root zone and also look at quality of this drainage. Concerted effort in the vadose zone. (CRDC to liaise with researchers)
  - Need ground water people that have an understanding of what’s happening above.
  - Maule’s Creek study tries to link all of this. It’s the type of work that needs doing in other areas.
  - Need to have a push on analysing DD solutes at farm scale (& catchment scale)

**b) Facility to measure Total Water Balance for cropping systems – Clay Soils**

- Deep drainage has been measured in isolation, but there are few studies that have tried to measure all components of the water balance.
- Closing the water balance provides a check of the DD measurements.”
- For this to be done, need better understanding and estimation of Evapotranspiration (ET) (next priority).
- Discussions with GRDC and CRDC re possibility of measuring sites already set up with Lysimeters.

**c) Uncertainty of ET measurements at the field scale and catchment scale.**

- Eddie Correlation systems available that can do this at the field scale – still needs support.
- Need to validate the ET estimates that we are using in extension.
- At the catchment scale – use remote sensing. Need to link up with Evan Christiansen and John Hornbuckle (CSIRO). More work required to check the rigour of the work CSIRO are doing. Evan Christian and John Hornbuckle to do this. This point is also covered in extension priorities.

**d) Link DD research with Precision Ag research projects**

- Only a couple of projects currently funded with Precision Ag (Cotton CRC and CRDC)
- Need involvement with GRDC.
- Des’s pragmatic link between DD and Precision AG
- Des/Thusitha – Gathered yield monitor data from their trial fields. Could not use the commonly presented multicolour maps, but got the raw results and plotted them. Found differences along the length of the field (particularly greater yield at head ditch than tail ditch) and tried to relate to DD measurements and also ET.

**e) Define management of irrigation research**

- This relates to irrigation trial protocols. Included in this are records of irrigation management that affect DD such as irrigation system, advance time, flow rates etc.
- When DD research is carried out, it is important to keep records of irrigation management given influence of management on DD.
- Need to draw up protocols for irrigation research – Steve Yeates, Rose Roche.
- Could use Verity Gett’s High Yielding Irrigated Grains irrigation protocols document as a starting document and get CRC researchers and extension staff to add to it.

**f) Deep drainage comparison to FAO56, integrate ET with canopy at catchment scale.**

Two parts to this research

- a) DD Comparison of methods
- b) Integration of ET with canopy– links into remote sensing , already discussed above.
- c) Review of remote sensing, what’s happening overseas.

**g) Thresholds Salinity/quality guidelines.**

- Thresholds need revisiting.
- Nilantha has also looked at this in the past, refer to his work.
- Darling Downs farmers – some are using poor quality water – needs work here.
- Water quality is an issue in a lot of areas – broader than cotton.
- This type of work is happening at the moment – given climate, coal seam gas etc.
- How useful are the thresholds? Quite complex.
- Measure water quality of leachates. Thusitha running SODICS and SaLF, samples to Toowoomba, working, with DERM at Toowoomba. Using Mark Silburn and Brett Robinson’s modelling skills and Thusitha and Des’s real data.

## **Summarised Deep Drainage Priorities List - 2009**

### **EXTENSION**

#### **1. Develop Management Guidelines for Deep Drainage (DD) –**

Technical resource that provides information to irrigators about DD in irrigated cotton and grain soils

- What defines too much or too little
- How to calculate the leaching fraction
- Factors contributing to DD
- Management for reduced DD to acceptable levels
- Expand on information in DD “Myth Busters” article
- Technical resource for myBMP, updates for WATERpak manual.

**WHO:** Contractor: CRDC and Cotton CRC

**HOW:** Commissioned project through CRDC and Cotton CRC

#### **2. Update ISID Database -**

- Existing quality Irrimate data held by consultants and NSW and DPI Primary Industries needs to be uploaded onto the ISID database.
- Re-evaluation of Irrimate results to estimate DD

**WHO:** Contractor

**HOW:** Commissioned project through CRDC

### **RESEARCH**

#### **1. How fast does water move through the regolith? When does DD become recharge?**

- Concerted effort to understand water movement in the vadose zone.
- Need the 3D link between the root zone and the aquifers.
- Maule’s Creek study is an example of work that needs to be undertaken in other regions

**WHO:** Paula Jones, Cotton CRC

**HOW:** -Organise research group to move forward on these issues.

- Contact National Centre for Groundwater Research and Training

#### **2. Uncertainty of ET measurements at the field scale and catchment scale**

- Eddy Correlation systems available that can do this at the field scale – still needs support.
- Need to validate the ET estimates that we are using in extension.
- Review of remote sensing - what’s happening overseas.
- Integration of ET with canopy – links into remote sensing
- Need to link up with Evan Christiansen and John Hornbuckle (CSIRO).

**WHO:** Graham Harris

**HOW:** Cotton CRC to contact CSIRO and NWC

#### **3. Facility to measure Total Water Balance for cropping systems – on irrigated systems**

- Closing the water balance provides a cross-check of the DD measurements.
- Continue to recognise the importance, but also the complexity and broadness of this subject area.

**WHO:** CRDC

**HOW:** Requires further dedicated discussions between GRDC, CRDC and SRDC.

#### **4. Thresholds salinity/water quality guidelines**

- Ensure on-going evaluation of water quality applied, DD leachate and connected groundwaters
- Thresholds need revisiting in terms of soil, water and plant impacts.

**WHO:** All researchers in subject area – eg soil, plant, DD and ground water researchers

**HOW:** - Continued investigation of plant and soil salinity and sodicity levels at lysimeter sites.

- Bring together a group of researchers to review current knowledge and gaps.

## 2009 Deep Drainage Forum – List of participants

Name	Organisation	
Des McGarry	Dept of Environment and Resource Management	
Thusitha Gunawardena	Dept of Environment and Resource Management	
Anthony Ringrose-Voase	CSIRO Land and Water	
Anthony Nadelko	CSIRO Land and Water	
Mark Silburn	Dept of Environment and Resource Management	
Jenny Foly	Dept of Environment and Resource Management	
Willem Vervoort	University of Sydney	
Rick Young	Consultant	
Bryce Kelly	University of NSW	
Anna Greve	University of NSW	
Lexie Donald	National Water Commission	
Janelle Montgomery	NSW DII	
Jenelle Hare	Primary Industries and Fisheries, DEEDI	
Lance Pendergast	Primary Industries and Fisheries, DEEDI	
Peter Smith	NSW DII	
David Wigginton	Cotton Catchment Communities CRC	
Duncan Weir	Cotton Catchment Communities CRC	
Graham Harris	Primary Industries and Fisheries, DEEDI	
Paula Jones	Cotton Catchment Communities CRC	
Helen Dugdale	CRDC	
Bruce Pyke	CRDC	
Kathryn Minehan	Queensland Murray-Darling Committee Inc.	
Tim Weaver	NSW DPI	
Lisa Lee	University of NSW	
Peter Gregg	Cotton Catchment Communities CRC	
Steve Yeates	CSIRO	
Brett Robinson	Dept of Environment and Resource Management	