On-Farm Water Quality Monitoring Program

Protocol and log book

The University of Sydney
Cotton CRC Research Project 2.03.04

Cotton Catchment Communities CRC

The University of Sydney

On-Farm Water Quality Monitoring Program: Protocol and log book

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This document has been prepared to fulfill milestones in Cotton CRC project 2.03.04.

Reference: Crossan, A. N (2007) On-Farm Water Quality Monitoring Program: Protocol and log book. The University of Sydney and Cotton Catchment Communities Cooperative Research Centre. Sydney.

Contact: Dr A Crossan on (02) 9351 2112 or a.crossan@usyd.edu.au

Cover image: Brolga Boogie on Couch by MT Rose (reproduced with permission)

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Introduction

Thank you for participating in this research project, your commitment, feedback and time are sincerely appreciated.

This water quality program is part of the Cotton CRC's catchment research program which is sponsored by the CRDC. The data collected are to be used for research project 2.03.04 which focuses on farm water quality and remediation.

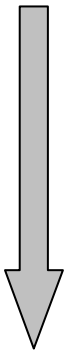
The overall aims of this program are two fold. Firstly, to assess the use of straight-forward water quality testing kits on irrigation properties. Secondly, to measure the quality of irrigation runoff. There are 20 participants in this program and we expect this will produce a unique and valuable data set. The data collected will be used to report on current management practices. In future, these kinds of data could be used to measure success in improved water management practice, economic benefits of more efficient nutrient use, or even potential reductions in greenhouse gas emissions. With sufficient data quality in this program, we hope to report runoff water quality and determine the economic benefit of best practices that reduce nutrient losses. To this end we depend on the quality of your results, detailed feedback and comments.

If you have any problems we will be happy to help out, either to assist in clarification of protocols or to help with some sampling if required at critical times. From time-to-time your extension facilitator will make contact and provide updates or extra materials.

If you have any questions during the program or afterwards, feel free to contact your extension facilitator, the Cotton CRC (Paula Jones 6799-2440) or The University of Sydney (Angus Crossan 02 9351-2112).

Program Outline

The following table outlines the stages of the water quality monitoring program:

Stage	Description	Timing
I	Familiarisation with the sampling kit and protocols; personal protection and safety, storage conditions, rinsing and cleaning.	**Oct 07**  **June 08**
II	Choose a test site (one irrigation set); your extension contact will assist.	
III	Recording general field characteristics; including slope, soil type, cotton variety (or crop variety).	
IV	Keep a record of field treatments and irrigations in your log book; including treatments made 12 months prior to planting.	
V	Monitor every irrigation event of the test field that the samples allow (at least 6). Record data and fax results as collected.	
VI	Return tests kits and completed log books.	
VII	Receive a report of your results.	

Sampling Kit Contents

Each kit is uniquely numbered and contains the following:

- Sampling vessel (1L plastic beaker)
- Thermometer
- Merck™ Multi test strips (pH/CH/TH/NO_2/NO_3)
- Merck™ Ammonium test strip box
- Merck™ Phosphate test strip box
- Merck™ Chloride test strips
- Salt concentration test strips (EC)
- Water bottle (for distilled water only) (1L)
- 2 x plastic pipettes (for distilled water only)
- 2 x 5 mL Syringes (Marked A and B)
- 3 x 50 mL tubes for dilutions and pH adjustment (Marked A, B and pH)
- Nitric acid in dropper bottle
- Sodium hydroxide in dropper bottle
- Merck™ Universal Indicator strips for pH adjustment.
- Small packet of paper wipes
- A plastic zip lock bag for solid wastes

You will also need:

- A stopwatch or a wrist watch with a seconds hand
- A clip board and pen
- Personal protection equipment as required. See instructions in each test kit for warnings and information.

Notes:

Check that the contents of the kit are complete.
Seal all containers when not in use.
Your extension contact can supply additional supplies if required.
Keep kits out of direct sunlight. The test strips are stable up to the date stated on the pack when stored in the closed tube at +2 to +8 °C.

Choosing a test site

For the purpose of this program you will need to select a test site that will be used throughout the season. The ideal site would be a large section of an irrigated field that is representative of the entire property. Choose a site that will be convenient to sample, both with respect to location and timing of irrigations.

Samples will be collected and analysed from the head ditch and the tail drain (runoff) during the irrigation. You might need to access the sampling zone during wet weather or during poor light. Each sample will consist of filling a 1 L plastic beaker; consider using the drop box if suitable. See the diagram below for an example.

Field characteristics

Once a test site is identified, please fill out the following table of general information. Please draw a rough diagram (or include a field map) showing the test site with sampling zone locations.

	General information regarding the test site					
A	Total field size (ha)		Length of field (m)		Width of field (m)	
B	Test site size (ha)		Length of test site (m)		Width of test site (m)	
C	Slope of field		Soil type		Cotton variety planted	
D	Any other					

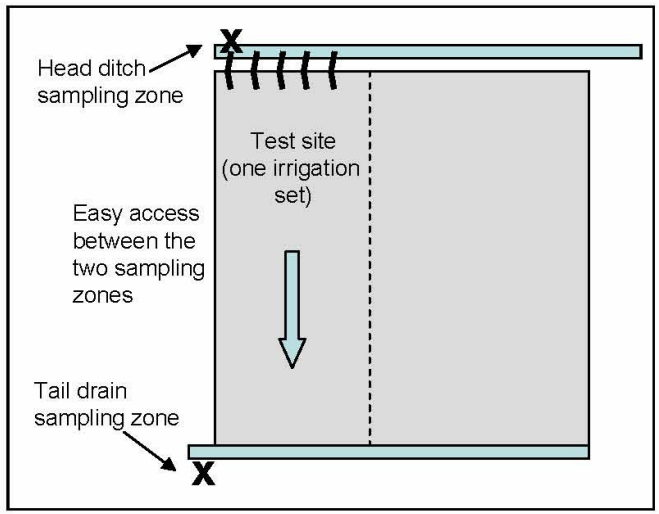


Diagram showing theoretical field layout for sampling

Please draw a rough diagram of your experimental site here or on the back of this page:

Record of field treatments

Please record all field treatments applied to the testing site (Start the record 12 months prior to the current planting and continue for the duration of the program)

Date	Field treatment and details (amount of fertilizer/type of ground preparation)	Comments/Notes

Outline of monitoring events

This section outlines the process involved when conducting a monitoring event, which is to occur every time the test site is irrigated until the test strips run out (6 irrigations or as many times as the test site is irrigated).

This analytical plan is designed to adapt to your irrigation, not dictate it. The following table outlines the general process. The specific timing of irrigation is to be determined by the irrigator. Exact timing of tasks can vary, depending upon actual events, yet the general process should be similar for each event.

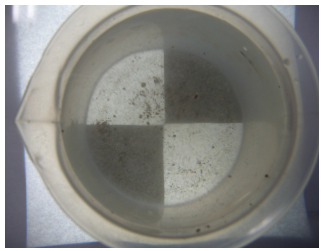
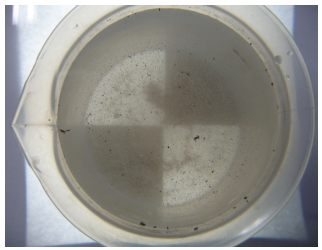
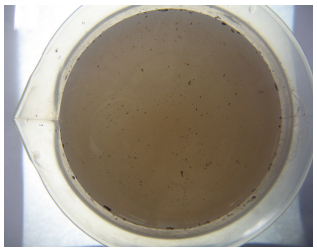
Order	Process	Description
A	Plan and schedule sampling	The estimated time required is 1.5 hrs for each event including analysis, sampling, reporting and clean-up. Prepare for sampling when preparing to irrigate.
B	Conduct irrigation as usual	The analytical program should fit around your irrigation schedule. Record the timing of the start and finish of the irrigation and estimate the volume of water applied to the test set.
C	Start irrigation	Record time (and flow if possible).
D	Runoff starts	Record time and start sampling.
E	Sampling and analysis	Runoff 1, Runoff 2, Runoff 3, Head 1, Head 2, Runoff 4, Runoff 5, Runoff 6. NB: Head 1 sample can be taken prior to runoff starting, record time of analysis.
	(Conduct sampling over the duration of the irrigation runoff)	Space out analysis of samples in even intervals depending upon the duration of runoff. For example; if runoff usually lasts 40 min, then take samples every 5 mins.
	Conduct analysis	Follow **Sampling protocol (page 7)** and conduct analysis on each sample.
F	Irrigation stopped	Record the time.
G	Runoff stops	Complete all analyses.
H	Record irrigation parameters for each experimental set	Ensure all data are record and best estimates of irrigation and runoff volumes.
I	Fax completed results sheet	Fax results to (02) 9351-5108 as soon as possible. Keep the results sheet with your log book.
J	Ensure test kit is clean and stocked for next irrigation event	Request more distilled water if necessary. Contact your extension facilitator for any queries or supplies.

Sampling protocol

Order	Process	Description
1	Collect water sample	Use 1L plastic beaker to collect the head or tail water sample. Rinse three times in water to be sampled.
2	Measure turbidity	Using the turbidity circle and the chart to compare and record turbidity (page 11).
3	Measure temperature	Measure and record the temperature of the sample.
4	Conduct analytical tests	Following the instructions in each kit, or the quick reference sheet (following page), to conduct the analytical tests: Multi (pH/CH/TH/NO_2/NO_3) → NH_4 → PO_4 → Check pH → Cl^- → EC
4a	Check pH prior to Chloride test	Ensure that the pH from the Multi test shows a result for the Chloride test (5-8 pH).
4b	Adjust pH if necessary for Chloride test	See pH adjustment protocol and conduct Chloride test (page 12).
4c	Dilute samples if values too high	Identify high analytical values (above the maximum measurement zone) and refer to the dilution procedure (page 11). Repeat analysis of exceeded values only.
5	Rinse syringes and dilution/sub-sample vessels	Empty sample container and rinse out all containers and syringes in distilled water.
6	Repeat process for all samples	Complete data sheet and fax to 02 9351 5108 as soon as possible.

Turbidity protocol

Collect the sample in the 1L plastic beaker and place on the circle pattern (printed underside of test kit lid). After 10 seconds, observe the level of turbidity against the chart below. Record the score in the data sheet.

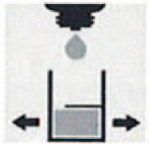
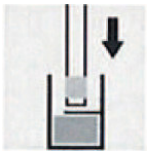
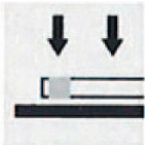
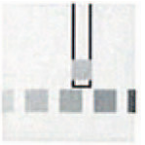
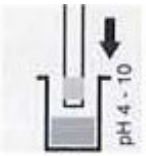
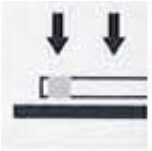
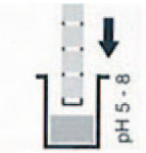
0	1	2	3	4	5
LESS					MORE
					

Temperature protocol

1. Carefully remove the thermometer from the case. This is most easily achieved by using both thumbs and forefinger just above the silver clip.
2. Immerse the thermometer into the samples and gently agitate (5 secs). Allow the temperature to stabilise.
3. Do not allow the thermometer to come in contact with the walls of the beaker during temperature stabilisation or reading.
4. When a stable temperature is obtained, record the temperature of the sample. Wipe the thermometer after use.

Analytical Procedures

Quick Reference Table. Refer to the individual kits for detailed instructions

Measurement		Quick Reference Instructions
pH	Acidity/Alkalinity	 Dip for 2 sec  Tap off excess  Wait 1 min  Read and record
CH	Carbonate hardness	
TH	Total Hardness	
NO_2^-	Nitrite	
NO_3^-	Nitrate	
NH_4^+	Ammonium	 Sub sample 5 mL  Add 10 drops of NH_4-1  Dip for 3 sec  Tap off excess  Wait 10 sec  Read and record
PO_4^{3-}	Phosphate	 Dip for 1 sec  Tap off excess  Add PO_4-1  Wait 15 sec  Tap off excess  Wait 1 min  Read and record
Cl^-	Chloride (check pH)	 Dip for 1 sec  Shake off excess  Wait 1 min  Read and record
EC	Salt Concentration	See package for details and instructions

Images reproduced from Merck™ test strip instruction documents.

Example of water quality results sheet (see notes on the next page)

Water Use Information						
A	Sampling Date		Kit Number		Irrigation Type	
B	Irrigation start time		Irrigation finish time		Irrigation number	
C	Volume of water applied		Runoff start time		Runoff volume	
D	Estimation uncertainty		Runoff finish time		Runoff volume uncertainty	
E	Please record the time required to complete sampling event (include planning, cleaning and administration)					
F	Any other comments/thoughts?					

Analytical Results													
Sample	Time	T	Temp	pH	CH	TH	NO_2^-	NO_3^-	NH_4^+	PO_4^{3-}	Cl^-	EC	Sample description/Comments
	At sample collection	Turbidity	(°C)	Acidity/ Alkalinity	Carbonate hardness	Total hardness	Nitrite	Nitrate	Ammonium	Phosphate	Chloride	Salt conc.	Please record a brief description of sample e.g. Comment on pH, colour and/or clarity. Or anything different about the sample?
Runoff 1 (R1)													
Runoff 2 (R2)													
Runoff 3 (R3)													
Headwater 1 (H1)													
Headwater 2 (H2)													
Runoff 4 (R4)													
Runoff 5 (R5)													
Runoff 6 (R6)													
Sample ( ) Dilution [ ]													
Sample ( ) Dilution [ ]													
Sample ( ) Dilution [ ]													

Notes for completing Water Quality Results Sheet

The data collected for this project will be used for research. Please record data as accurately as possible and make comments describing estimates or explanations if necessary. The more accurate the data (and explanations) the better the results and inference we can make with regard to nutrient transport and farming practices. High quality data will be more useful for feedback into the research program and give us more confidence in reporting these results to you.

The following notes add some detail and explanation to the sample recording sheet:

A: Record the date of sampling, kit number for identification and irrigation type (e.g. flood or lateral) to allow comparisons between similar operations.

B: The irrigation start and end times will allow the duration of irrigation to be determined. Record the number of the irrigation after fertilizer application, e.g. first, second, third and so on. This information is used to better understand nutrient transport in subsequent irrigations.

C + D: This is probably the most important aspect of nutrient transport, if you have any queries, please ask your extension contact.

- Record the volume of water applied and make a note of the method used to determine the volume in your log book. Indicate if the volume is per hectare or total for the experimental set including the units (i.e. "Megs"=Megalitres or Litres or Megalitres per hectare). Runoff from the field is a critical aspect for this project. Please monitor this closely for the selected experimental zone.
- Indicate the uncertainty of your determination as a percentage or as a range in the measurement units:
  - Example 1: If you can apply 0.1 ML per hour (per hectare) and the water was turned off somewhere between 4.30 pm-4.45 pm, then the uncertainty range in this example is 0.025 ML (one quarter of the hourly figure).
  - Example 2: If you apply somewhere between 1.0 and 1.2 ML per Hectare, then 0.2 ML/ha (or 20%) is the uncertainty estimation.
  - Example 3: Both of the above situations may occur, in which case the uncertainties are combined. i.e. 0.2 plus 0.025 ML (both per hectare), which gives 0.225 ML/ha or (Record original details in notes/logbook if too complex and time consuming).
- Try to be as precise as possible in your measurements of time and volume to reduce the uncertainty.

E: We'd like to know how long each sampling task took (include preparation and review of protocols). This information will be used to further develop the sampling kits and protocols.

F: Please record any comments or thoughts you have during the project. Indicate if there are any significant differences from the previous sampling events. Feel free to use this to communicate any opinions or ideas you have regarding the program.

Dilution protocol

If any of the analytical results are **above** the maximum reading then follow these instructions:

I. Using Syringe A to take 5 mL of sample and place into Dilution Vessel A, fill the dilution vessel to the 50 mL mark with distilled water and shake well.

II. Repeat the test only for the high measurements using the new solution in Vessel A.

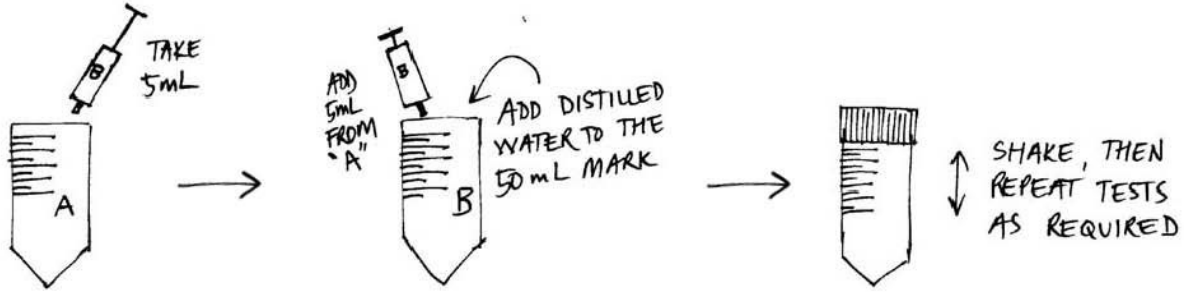
III. Record results indicating the Sample *e.g sample number* (***R6***) and Dilution [***A***] at the bottom of the results sheet in the space provided.

IV. If the results are still higher than maximum reading, use syringe B and take 5 mL from Dilution A and place into Dilution Vessel B. Fill dilution vessel B to the 50 mL mark and shake well.

V. Repeat measurements as required from the new solution in Vessel B. Record results and indicate the Sample number ( ) and Dilution [***B***].

Dilution A

Dilution B



pH adjustment protocol

For the chloride test it is important that the pH is in the correct range (between 5 and 8 pH units). Otherwise incorrect results will be given because of interference and cross reaction.

1. Before conducting the Chloride (Cl^-) test, check the pH result from the earlier Multi test.
2. If the sample shows a pH less than 5 or greater then 8, transfer about 50 mL of the sample to the pH vessel. Record the pH using the Universal Indicator pH strips.

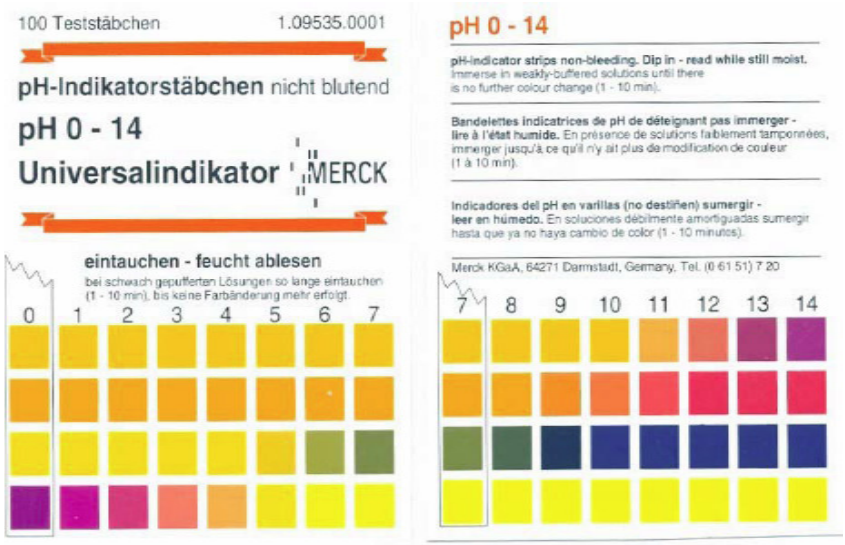
3a. **High pH (above 8):**

- If the pH is above 8, add a drop of diluted Nitric Acid (0.02 N) from the dropper bottle to the sub-sample.
- After adding a drop of Nitric Acid to the sub-sample, shake the mixture and test the pH with the Universal Indicator. [Submerse the strip into the sub-sample until there is no further colour change. Read the colour whilst still moist against the chart in the container].
- Repeat the procedure and measure pH with a new indicator strip for each measurement until the pH value is between 5-8.

3b. **Low pH (below 5):**

- If the pH is below 5. Repeat the above protocol using Sodium Hydroxide (0.02 N) instead of Nitric Acid until the pH is in the 5 to 8 pH range.

4. Once the pH is in the desired range, record the new value in the comments space, and follow the instructions for conducting the Chloride test on the sub-sample.
5. Record the results for the Chloride test in the results sheet.



Universal indicator instructions and colour chart; used to correct the pH of a sample if the pH is not in the required range for the test strips. An important consideration for the chloride test

Image reproduced from Merck™

Notes and comments