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Report on and recommendations arising from the visit of Dr Michael Warne (University of Queensland) and Robert Sluggett to Kununurra

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Introduction

Dr Michael Warne of the Reef Catchments Science Partnership and Robert Sluggett of Farmacist Pty Ltd were invited by Richard George of Department of Primary Industries and Regional Development (DPIRD) to visit Kununurra, Western Australia. The project was financially supported by the National Water Grid Authority project "Managing water quality to enable future irrigation development in the Kimberley Region". The aim of the visit was for Dr Warne and Rob Sluggett to engage with farmers, key stakeholders and staff from DPIRD in order to understand the agriculture and water quality in the Ord and Keep river region; and to share their experience of working with Queensland farmers, stakeholders and government to improve land management practices that minimise the off-site transport of pesticides and selecting the use of pesticides that pose lower risk to aquatic ecosystems. The visit occurred over three-days. A summary of the activities during the visit are provided below. Following the visit Dr Warne and Robert Sluggett were to write a brief report summarising their observations and making a series of recommendations on how to improve the situation so that pesticide pollution and their potential environmental impacts are kept to a minimum.

Trip Activities

Day 1, 28th March – visited two Ord River Stage 1 farms and held a meeting with DPIRD cropping research staff at the Frank Wise Research Station.

Day 2, 29th March – visited an Ord River Stage 1 farm, a Stage 2 farm (Goomig), the DW1 gauging and monitoring site, the Border Creek monitoring site and the Keep River between K4 and K3 pools. It also included engagement with the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) appointed Independent Reference Group. In addition, presentations were made to local industry representatives and DPIRD staff on why the Keep River has PC99 as its target, how water quality guidelines are calculated, the Pesticide Decision Support Tool and Risk Model (PDSTRM) and learnings from Queensland projects to reduce pesticide runoff from irrigated agriculture.

Day 3, 30th March– presentations were delivered to industry representatives, agronomic service providers, DPIRD research staff and growers from Ord River Stage 1 farms on how water quality guidelines are determined, the Pesticide Decision Support Tool and Pesticide Risk Model (PDST/PRM) and learnings from Queensland projects to reduce pesticide runoff from irrigated agriculture. Another farm visit and another meeting with DPIRD staff at the Frank Wise Research Station including visits to station field trials occurred in the afternoon.

Additional Industry Engagement

Prior to the visit to Kununurra, four on-line conferences were held with DPIRD staff, 4 local growers and two telephone discussions with key local service provider agronomists to assist with visit preparations.

Following the visit to Kununurra, two telephone discussions were held with local Ord Stage 1 & 2 growers to receive their considered feedback post visit.

Observations of Local Farming Systems and Water Quality Monitoring

1. The Ord has a long history of diverse crop production. Current cropping systems are dominated by maize, cotton and sandalwood with smaller areas of mung beans, chickpea, hay crops and annual and perennial horticultural crop production. Significant areas are planned to produce cotton crops with the expansion and development of new irrigation lands. This should lead to a reduction in per hectare demand for irrigation water however, this could be offset by an increase in the area cropped.

2. The diversity of crop rotations provides a range of agronomic and farm management challenges including machinery operations, weed management, herbicide rotation to manage weed herbicide resistance and crop plant back periods.

3. The Ord River Stage 1 "flow through" irrigation system currently has little tailwater recycling infrastructure installed. All farms in Stage 2 Ord River have tailwater recycling infrastructure installed. Farmers with existing tailwater recycling facilities reported that this assisted with irrigation scheduling and improved timeliness of irrigation, particularly in periods of high crop water demand.

4. Stage 1 and Stage 2 of the Ord development have different targeted levels of protection – to protect 95% of aquatic species for Stage 1 (i.e., in the Ord River) and 99% of aquatic species in Stage 2 (i.e., in the Keep River). These inconsistent levels of protection seem incongruous given the connectivity of Stages 1 and 2, the close proximity of the receiving rivers and both rivers containing sawfish (i.e., species protected under the Environment Protection and Biodiversity Conservation Act, 1999). This is likely to complicate future messaging relating to improving land management practices and water quality in the region.

5. A wide range of management practices were observed for head-ditch maintenance. These varied from planting beneficial grass species to protect the bank and smother problem weeds to maintenance with knockdown herbicides based on glyphosate and paraquat mixtures or longer-term residual weed control tank mixtures, dominated by high (labelled) rates of diuron.

6. Key herbicides that the authors were informed are being applied on-farm include: 2,4-D, atrazine, bromacil, diuron, fluroxypyr, glyphosate, haloxyfop, metolachlor, metsulfuron-methyl, MSMA, paraquat, terbuthylazine, terbutryn, trifluralin, and triclopyr. Insecticides regularly reported to be used include: chlorantraniliprole and fipronil. Planting seeds dressed with crop protection products were used but growers were not able to report the active ingredients included in these products. The growth regulator PIX and the defoliant sodium chlorate were also used extensively in the production of cotton.

7. The authors were informed by DPIRD staff that the main pesticide active ingredients (PAIs) currently and historically detected in the Keep and Ord rivers were atrazine, diuron and metolachlor. Other detected PAIs include chlorantraniliprole and fipronil.

8. Metolachlor is soluble, mobile in runoff water and has a moderately long half-life in both soil and water. The product is currently used as part of herbicide management systems to manage glyphosate resistance in the problematic grasses e.g., barnyard grass. It has good crop safety and limited plant back periods for many of the crops produced in the region. It has been reported that metolachlor is regularly detected in local water samples. The long half-life of metolachlor in soil and water provides challenges managing the environmental runoff risk from widespread use of this active ingredient.

9. Atrazine is soluble and mobile in runoff water. It has a shorter half-life in soil than metolachlor and a relatively short half-life in water. These characteristics of atrazine provides potential for it to be successfully managed where tailwater runoff is captured and stored for reuse on farm.

10. *Spodoptera litura* (Cluster caterpillar) was indicated as the key insect pest, particularly of cotton. A Queensland Department of Agriculture and Fisheries staff member is currently undertaking her PhD studying the lifecycle of this species in the Kimberley region.

11. *Spodoptera frugiperda* (Fall armyworm) is a key insect pest of maize. Its local arrival created agronomic management challenges. The industry has now adapted management techniques to minimise the impact of this pest.

12. The planting window for cotton in the Ord River valley commences on 1st February. This provides management challenges as the wet season has normally not finished. Available windows to complete farm management operations (pre-plant cultivation, bed forming and planting, herbicide application) are often narrow – necessitating significant investments in machinery. Timeliness of operations is critical when weather or ground conditions are suitable. Where weather conditions are suitable, but the ground is still wet, chemical application is often undertaken by air.

13. Agronomic skills and knowledge are high amongst farmers and agronomic advisors. The Kununurra region has a high proportion of Nuffield scholars among the farmer community.

14. Growers reported the available time period during the day where air temperature, relative humidity and wind speed are suitable for pesticide application was often limited. From the limited time of observation available to the authors, this appears to be causing the application of crop protection products at times that are conducive to losses via spray drift. Spray drift poses a risk to non-target vegetation, aquatic environments and human health. The proximity of farmland to residential environments needs additional consideration.

15. Spray drift, via observation of damaged crops and anecdotal information about beehive deaths, was reported during several discussions. Inspections of ground rigs and discussions with growers and industry advisors has highlighted a limited awareness of the importance of boom spray set up and operation and particularly, choice of appropriate nozzles to minimise the risk of spray drift. The local industry appears very aware of the risks of drift from 2,4-D products and there is widespread dis-adoption of these products. However, the knowledge about the risk from drift from other crop protection products appears inadequate. Local rural suppliers do not stock nozzles for boomsprayers.

16. All spray booms inspected had a nozzle spacing of 50cm. This is mismatched to crop row spacing (of 90cm or 1.8m beds) on some farms growing cotton and or corn. The adoption of a 1m row spacing or re-plumbing of boom nozzle spacing is required to eliminate boom overlap on consecutive sprayer passes. Boom overlap results in a doubling of pesticide application where the overlap occurs, which increases costs, potential for crop phytotoxic effects and pesticide runoff risk.

17. There is currently a lack of information available for growers and their advisors to make informed decisions about the selection and application of PAIs that pose reduced risks to aquatic ecosystems.

18. Current water quality monitoring activity appears to be undertaken by multiple agencies independently of each other. It appears uncoordinated and with limited exchange and release of results between the agencies. Results from water quality monitoring are not communicated transparently.

19. Many industry stakeholders interviewed by the authors did not receive any or timely water quality results from the different parties undertaking water quality sampling and analysis in the region. Some growers reported receiving water quality information as a phone call notifying an exceedance had occurred. The exceedance being reported had often occurred up to 6 months prior to the reporting to the grower concerned. This was considered very unhelpful in terms of linking management practices to water quality outcomes, does not foster a pathway to improvement and reduces the likelihood of grower engagement in future water quality management programs.

20. Growers and advisors engaged by the project team expressed high levels of knowledge and good diligence with pesticide stewardship and use of pesticides by label instructions. There is a general belief that following registered product label directions will result in acceptable environmental outcomes (in terms of drift risk and runoff water quality), however experience in the Ord and waterways that discharge to the Great Barrier Reef show this is not necessarily the case. This is because label restrictions are based on prospective risk modelling with sometimes fairly limited and generic rather than site- or region-specific data. Water quality monitoring, which measures what happens in the field is important as it can provide data that can lead to label changes to provide environmental protection.

21. The risk posed by pesticides is currently assessed by comparing environmental concentrations to their Australian and New Zealand Default Guideline Values (DGVs) for ecosystem protection. The combined toxicity of PAI mixtures is not considered in the Ord and Keep rivers. This means that the estimates of risk may under-estimate the true risk posed to aquatic ecosystems.

22. Default guideline values are not available for many of the pesticides currently being sold in the Ord River region. As such the risk that they pose to the environment cannot be determined.

23. The authors were informed that for the Ord River Stage 2, all chemicals that have been reported as being used on farm are included in the water quality monitoring program. However, this is not the case for Ord River Stage 1.

24. Traditional chemical analysis is called targeted analysis as the chemicals to be analysed are selected and only those chemicals are identified and quantified. More recently, non-targeted analysis has been developed. In non-targeted analysis you do not select chemicals but rather all organic chemicals that can be extracted are identified and reported. Such analysis is useful to identify if other chemicals, apart from those in the targeted analysis suite, are present in the water samples. This type of analysis is typically, only semi quantitative. But if chemicals are detected regularly then standards of these chemicals could be purchased by the analytical laboratory, and this would allow their quantification. This analysis would impose an additional cost on the monitoring program, but this could be minimised by conducting this analysis on a periodic, targeted campaign style.

Recommendations

The following recommendations have been developed specifically for the Ord and Keep rivers irrigation region, based on the authors' three-day engagement with the local industry. The recommendations are also shaped by learnings from work that has been successfully undertaken in other parts of Australia. The recommendations have been grouped under over-arching topics. The recommendations were developed with regard to the planned expansion of the Ord River irrigation scheme in the near future and to ensure that the risk posed by pesticides does not increase and cause environmental harm. GHD has undertaken three-dimensional hydrodynamic modelling of the transport and potential concentrations of pesticides in the Ord and Keep rivers (Romero, 2023). The recommendations in the current report should be considered in conjunction with the finding from that modelling.

It may also be appropriate for DPIRD to consider adopting appropriate recommendations for other cropping regions in Western Australia.

Resolving Current Water Quality Exceedances & Avoiding Future Challenges

1. Rapidly Identify and Adopt Alternatives to Metolachlor

Local industry should cease using metolachlor in the Ord and Keep river catchments and there should be widespread adoption of alternative, lower risk pesticides. *Identification of alternatives could be facilitated by recommendation 12.*

2. Restrict Atrazine use to 100% tailwater recycled fields in the Keep River Catchment

That all farms draining to the Keep River adopt a policy of only applying atrazine on farmland where 100% dry season tailwater can be captured for re-use on farm.

3. Restrict Diuron Use in Channels to those where 100% of Channel First Flush Water can be Retained on Farm

That industry either adopts a standard local practice or seeks a label amendment that requires first flush channel water to be retained and recycled on farm where diuron has been applied to channels for weed management. *This would overcome the potential risk associated the current label registration for diuron for maintenance of channels that advises to drain off channel water 72 hours post application and run to waste.*

4. Investigate Alternatives to Diuron for Channel Maintenance

Identify lower risk alternatives to diuron for weed management of irrigation head-ditches and drainage channels needs to be investigated. *Local service providers (DPIRD, NACRA) are well placed to lead these investigations or tools that provide guidance on pesticides that are less harmful to aquatic environments should be used (recommendation 12).*

Improved Relevance, Quality & Transparency of Water Quality Results

5. Review the current water quality monitoring program and its quality assurance and quality control procedures

An independent review of the water quality monitoring strategy, including a strategy for the release of data to stakeholders be undertaken. The review should consider:

- the most appropriate form of collecting water samples (i.e., grab samples or passive samplers) given the purpose of the sampling strategy;
- the appropriateness of current detection limits and limits of reporting for each pesticide compared to water quality guidelines for ecosystem protection;

- whether non-targeted analysis of pesticides (by time of flight or orbitrap type instruments) should be included as part of the water quality monitoring strategy and if so at what frequency, and where they should be collected;
- the inclusion of real-time monitoring for nitrate, conductivity and suspended solids. *This data, along with the pesticide monitoring data, should be available via a portal (recommendation 8);*
- the merit of joining the "Water Quality Monitoring Community of Practice" (contact ryan.turner@uq.edu.au) and the "Pesticide Community of Practice" (contact michael.warne@uq.edu.au) currently being established by the Queensland Government. *The aims of both these groups are to improve all aspects of water quality monitoring and pesticide science and their application by practitioners (e.g., farmers, industry, academics, regulators, and policy developers).*
- whether all the pesticides currently being analysed are relevant and that all pesticides applied in the Ord irrigation area are analysed;
- the appropriateness of current Quality Assurance and Quality Control (QAQC) procedures for handling water quality data prior to release and for handling the release of real-time data. *Comparison of existing QAQC procedures to those in other water monitoring programs such as the Great Barrier Reef Catchment Loads Monitoring Program (led by Dr Reinier Mann,* reinier.mann@des.qld.gov.au*) would be beneficial and could save considerable effort.*

6. Establish a Co-ordinated Water Quality Improvement Program

Following the review a co-ordinated program for water quality monitoring, research and development, extension and communication should be designed, established and implemented for both the Ord and Keep rivers. *Dedicated funding and resources would need to be allocated to ensure successful outcomes. The appropriate lead agency appears to be DPIRD.*

This would address the apparent disparate nature of water quality sampling, reporting and communication occurring. It will support the rapid development of an understanding of the current and future water quality challenges in the region, create an environment of transparency and trust, foster increased collaboration to meet regional water quality targets and provide rapid feedback of water quality results to stakeholders, to provide improved linkages between water quality and farm management practices.

A planned and coordinated extension program will identify gaps in knowledge and research and development priorities to address these. This will support consistent messaging and communication and enhance collaboration between the Department, service providers and the scientific community.

Based on the authors experience, a successful water quality improvement program of this nature is likely to require 4-to-5-years to develop and successfully implement.

7. Utilise a Single Government or Research Analytical Laboratory for all Sample Analyses

That a long-term relationship with one government or research analytical laboratory be established for pesticide analysis. *Such laboratories are typically more willing to work with clients to develop methods for new pesticides, including these into analytical suites and developing lower limits of reporting. This would have the additional benefit of overcoming intra-laboratory variability of results and resultant difficulties with communicating results.*

8. Provide Timely Water Quality Results to All Industry Stakeholders

All water quality results should be made available in an appropriate format to all industry stakeholders in a timely manner. *This would support an environment of transparency, trust and foster increased collaboration to help meet regional water quality targets. It would also provide farmers a better linkage of results to farm management practice. Successful examples of successful systems include the CSIRO 1622WQ App and the Pesticide Reporting Portal* (https://storymaps.arcgis.com/stories/c0f0c6d7d88a4fd3a5541fe59f41ff75). *They provide easy to understand graphical presentations of pesticide concentrations and comparisons to the appropriate Default Guideline Values. The Pesticide Reporting Portal is a public facing website. The 1622WQ App provides an ability to manage permissions for viewers of the data.*

9. Co-ordinate R&D to Rapidly Evaluate Pesticide Active Ingredients for Water Quality Risks

That field trials be urgently conducted to identify suitable herbicides to replace metolachlor and atrazine in local farming systems, with those for metolachlor being the highest priority. These trials should include efficacy work, phytotoxicity assessment (to crops) and water quality assessment (runoff sampling & assessment). *DPIRD and NACRA are well placed to lead these investigations. Engagement with local growers to conduct commercial scale assessment of currently registered alternatives is also encouraged.*

Research and/or field trials be conducted to determine the runoff risk of all key pesticides used in the Ord and Keep river farming systems. *This research could be conducted by the DPIRD Research Station and NACRA with the collaboration of local growers and service providers.*

The potential water quality implications of using flumioxazin, acrolein or potential replacement for algae control products in the irrigation system should be investigated to confirm their aquatic safety under current or likely use patterns. *This investigation should include water quality samples being collected during the efficacy assessment phase of the activity. Flumioxazin (and its metabolites) require specific laboratory procedures to analyse correctly. Advice should be sought for this work.*

Extension Program to Improve Pesticide Use and Reduce Loss from Farms

10. Advanced pesticide application training for growers and aerial operators

DPIRD should facilitate advanced pesticide application training for local growers and industry advisors to facilitate the adoption of best practice pesticide application – this should include training on matching boom sprays to the row spacing and the latest developments in nozzles that minimise spray drift. Operator safety and human health aspects should also be included.

DPIRD engage with the local aerial spray operators and facilitate the provision of specialist training in pesticide application and safety to this critical service provider.

11. Development & Extension Program to Improve Irrigation Management

Irrigation management strategies that reduce the production of tailwater should be investigated for Ord stage 1 and 2 farms. *This should lead to a reduction in pesticide losses from farmland and reduced tailwater volumes and will subsequently reduce the size of tailwater retention systems and minimise the loss of agricultural land.*

Improving Understanding of the Risk Posed by Pesticides Individually and in Mixtures

12. DPIRD rapidly provides information to farmers and all key stakeholders on the relative risk (based on toxicity, mobility and persistence) posed by all the pesticides that are currently sold and/or applied in the Ord irrigation area. *If additional pesticides are made available to farmers in the future (e.g., through changes to labels) then these should be included in this information to prevent the information becoming outdated. A new bespoke system to provide this information could be developed for the Ord irrigation area. Or alternately, an existing system, such as the Pesticide Decision Support Tool and Pesticide Risk Model (PDST/PRM) (Warne et al., 2022), could be expanded to include PAIs that are used in Ord irrigation area but are not currently included.*

13. The risk posed by all pesticides present in water samples should be determined. *A suitable method for this is the Pesticide Risk Metric developed by Warne et al. (2020) and adopted by*

the Australian and Queensland governments for the Reef 2050 Water Quality Improvement Plan (Australian Government and Queensland Government, 2018). The Pesticide Risk Metric expresses the risk as the percentage of species protected and is therefore consistent with the Australian and New Zealand Guidelines for Fresh and Marine Quality (ANZG, 2018) and the stated targets of the Ord and Keep rivers of PC95 and the PC99, respectively.

14. That third-party DGVs be developed for all pesticides detected in discharge water or in the Ord or Keep rivers that do not have DGVs. *This could be achieved by DPIRD either sponsoring the development of third-party DGVs by an organisation with the necessary expertise or it lobbies, on behalf of the Western Australian Government, to have DGVs developed for these pesticides as part of the current or future revisions of the Australian and New Zealand Guidelines for Fresh and Marine Quality.*

Further Information

Manufacturers of KP Runoff Event Samplers

BBIFMAC – Burdekin Bowen Integrated Floodplain Management Committee Inc.

Ph 07 4783 4344

Email: arwen@bbifmac.org.au

Example App for display of water quality information

CSIRO 1622WQ Application

Email: Peter.Thorburn@csiro.au

Flumioxazin Analysis

Sugar Research Australia have developed expertise in analysing flumioxazin in farm and research trial samples.

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