



31-8-2004

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Kelly Lavell

Robert Summers


David Weaver

Martin Clarke

John Grant

See next page for additional authors

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Recommended Citation

Lavell K, Summers RN, Weaver DM, Clarke MF, Grant J, Neville SD (2004) An audit of the uptake of agricultural nutrient management practices in the Peel-Harvey catchment. Presented at the 7th International RiverSymposium, Brisbane Australia, Aug 31st – 3rd Sept 2004

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Authors

Kelly Lavell, Robert Summers, David Weaver, Martin Clarke, John Grant, and Simon Neville

An audit of the uptake of agricultural nutrient management practices in the Peel-Harvey catchment

Kelly Lavell^{*}, Robert Summers^{*}, David Weaver^{**}, Martin Clarke^{*}, John Grant^{**}, Simon Neville^{***}

^{*}Department of Agriculture Western Australia, 120 South West Hwy, Waroona 6215
(Email: klavell@agric.wa.gov.au; rsummers@agric.wa.gov.au; mfclarke@agric.wa.gov.au)

^{**}Department of Agriculture, Western Australia. 444 Albany Hwy, Albany, WA, 6330
(Email: dweaver@agric.wa.gov.au; jgrant@agric.wa.gov.au)

^{***}Ecotones and Associates, RMB 1050, South Coast Highway, Denmark WA 6333
(Email: silou@denmarkwa.net.au).

Abstract

Recent funding through the Coastal Catchments Initiative aims to significantly reduce the discharge of nutrients to the waterways of the eutrophic Peel-Harvey catchment. A range of projects within this initiative have been developed, which include activities designed to develop, test and implement point and non-point source best management practices (BMP) for the control of nutrient export, and to audit the current levels of adoption of these practices. Landholders who manage approximately 30% of the catchment area have been interviewed under major BMP themes of fertiliser management, soil amendment, perennial pastures, riparian and water management, revegetation, irrigation management and effluent management. The BMP audit indicates that whilst some management actions are in place, there is significant scope for further works, and therefore gains to be made in improved water quality.

Keywords

BMP audit, land management practices, nutrient budgets, Peel Inlet and Harvey Estuary.

INTRODUCTION

Deterioration of water quality and the appearance of algal blooms in the Peel Inlet and Harvey Estuary have been associated with a period of large-scale land clearing, construction of an extensive drainage network and the importation of nutrients in fertilisers and feed. Attempts to control the algal blooms led to the construction of the Dawesville Channel at a cost of more than \$50 million. Whilst this may have increased nutrient flushing to sea, the delivery of nutrients from the catchment into the rivers and estuary has not been reduced by the construction of the channel. As a consequence there continues to be algal blooms and fish kills in other parts of this waterway system, such as the lower river reaches. Closure of river tributaries of the Peel-Harvey estuarine system to fishing and swimming have become more common, leading to a reduction in environmental, recreational, social and economic value associated with the waterways of this region. A complete discussion of the Peel-Harvey issues has been presented by Hodgkin and Hamilton (1993).

A recent attempt to significantly reduce the discharge of nutrients, specifically phosphorus (P) to the waterways of the coastal Peel-Harvey catchment has been initiated through the Coastal Catchments Initiative. A range of projects within this initiative have been developed, which include activities designed to develop, test and implement agricultural best management practices (BMPs) for the control of nutrient export from point and non-point source land uses.

Nutrient balance case studies (Neville and Weaver, 2003) suggest that for many agricultural landuses, inputs (fertiliser and feed) exceed outputs (products produced). The selection of management actions can impact on nutrient balance and potential losses by influencing the amount of nutrients entering individual properties, as well as the amount being recycled within the farm system, the amounts being stored in the soils and the amounts leaving properties in the form of products being removed or sold. Auditing the uptake of best management practices for water quality

management is an important step in establishing the extent of works currently in place, and the additional works required to achieve water quality or management action targets. It is important in establishing a link between water quality trends and levels of management implementation.

Detailed information on farm practices that influence water quality in the catchment of the Peel Inlet and Harvey Estuary has been limited to fertiliser application rates and soil testing (Yeates *et al.*, 1985; Attwater, 1997). In this study, farmers were surveyed to provide information for the assessment of current practices and a budget of the farm nutrients so that modelling could be used to derive an assessment of the impact of changes to practice from the current nutrient reduction effort (*status quo*). A discussion of the modelling approach and outcomes can be found in Weaver *et al.* (submitted). This paper discusses the findings of a landuse and agricultural management practice audit conducted in the Peel Harvey coastal catchment. Included in the audit was an attitudinal survey designed to assess factors that encourage or impede change, and to understand what landholders perceptions were of the impact their management practices had on water quality.

METHODS

Land use survey

Information derived from historical mapping was updated through the input of knowledge of local farmer groups, field assessment (34% of the area) and aerial photography (13%). In addition, some unsupervised reclassification of urban fringe areas was carried out on a property size basis (2% of the area). As part of the BMP audit the land uses of the properties surrounding those audited were cross-checked including the area of cleared land and property titles making up the farm operation and this was used to update the land use database.

Estimates of numbers of operators in each enterprise were developed to draw up a sampling framework (US EPA, 1997) based on information from state government databases or mailing lists. This was cross checked using the landuse map based on the numbers of parcels found in the surveys for each farming enterprise and the number of parcels per property. Actual sample sizes achieved are shown in the Table 1 with the major landuses of grazing and dairy being less than 20%.

Table 1. Survey land use populations and confidence limits.

Landuse	Estimated Population.	Surveyed Population
Annual Horticulture	8	2
Dairy cattle	44	20
Feedlots	7	4
Grazing	220	48
Horses (studs/training)	21	7
Perennial Horticulture	45	14
Pigs	5	4
Poultry	20	11
Total	370	110

BMP and Nutrient Balance Survey

Landholders who manage approximately 30% of the catchment area were interviewed including 101 farms considered to be diffuse sources of nutrients and 9 considered to be point sources. Each was audited under major BMP themes of fertiliser management, soil amendment, perennial pastures, riparian and water management, revegetation, irrigation management and effluent management. Only the diffuse source properties are discussed here, except for the effluent control section which refers specifically to dairy effluent. The farmer surveys were conducted between October 2003 and June 2004. Each survey was conducted by a trained interviewer using a detailed

structured personal interview with the farm manager. Aerial photographs with cadastral boundaries of the property were taken to the interview based on pre-interview questions. Photographs were used to verify property boundaries and to document site information on spatially explicit practices.

Ninety six questions were asked to develop information for a farm gate nutrient balance (Neville *et al.*, [submitted]) as well as an assessment of the practices that influence the retention and utilisation of nutrients on the farm. Information about the cost of some practices was also gathered. Of the farms that were audited 78 completed an additional survey which assessed the impacts and costs of implementing the BMPs, perceptions of their impact on water quality and what would motivate landholders to change. Note that this survey was aimed at commercial agricultural operations and did not target urban or hobby farming areas.

RESULTS AND DISCUSSION

Landuse survey

The average parcel size of audited agricultural properties was 24 hectares (ha), however most farms manage several parcels which gave an average farm size of approximately 270 ha.

Table 2. Proportion of major landuses based on major landuse in cadastral lots/parcels.

	Number of parcels		Area (ha)	
Vegetated	3531	11%	27230	15%
Urban & peri-urban	25683	77%	23492	13%
Agriculture	4276	13%	130732	72%
Total	33490		181454	

Fertiliser management

Fertiliser was applied to 82% of the surveyed properties and of those 72% employed soil testing at some stage. Of those indicating they used soil testing 65% tested every three years or sooner as recommended. Ten percent only soil tested once at the time of purchase or when the land use was changed. Fifty five percent of those fertilising followed the recommendations resulting from soil testing and fertiliser decisions were based variously on fertiliser company advice (37%), tradition, parents or neighbour (37%), scientific evidence (21%), financial circumstances (19%), independent consultants (13%), Department of Agriculture (8%), and 5% used other means such as visual indicators, climatic conditions and convenience. Sixty five percent kept records of soil tests and 58% kept records of fertiliser applications.

Many of the participants in the survey said they do not trust fertiliser companies and most are not able to interpret their own soil test results. Farmers are hesitant to follow recommendations given by fertiliser companies as the recommended amounts are often considered unaffordable. This causes some farmers to not bother soil testing and to continue applying fertiliser according to recommendations given by parents or neighbours.

If a farmer does soil test it does not necessarily mean they follow the fertiliser recommendations given. Farmers will often soil test to determine the acidity of their soils, which they are familiar with, and lime at the district application rate if the soil is too acidic.

Tissue testing was taken up by 36% of fertilising properties with 53% of those testing every 3 years or less; and 27 % testing only once. Tissue testing was mainly used on horticultural properties, its value is limited on pastures to the presence of trace element deficiencies or the general status of the major nutrients and cannot be used to recommend application rates for the major elements.

Only 8% of those fertilising, used a slow release fertiliser which was mainly compost or coastal superphosphate. There was some confusion about the slow release nature of coastal superphosphate with many not realising that the phosphorus (P) is no longer in a slow release (partially acidulated superphosphate) form. Only the sulphur in coastal superphosphate is in the slow release elemental form which slowly becomes available after being oxidised by soil micro-organisms. Also there are no effective slow release or low water-soluble forms of inorganic P on the market in W.A. (other than a few expensive home or horticultural products).

Fertilisers were applied in multiple applications in 54% of cases, after the break of the season 32% and before the break of the season 14%. Some apply fertiliser before the break of the season because of the poor trafficability after rain and because of discount fertiliser rates if purchased early. Multiple small applications are the most desirable to increase the efficiency of use of nutrients in applied fertiliser and reduce the risk of loss. Slow release fertilisers have been shown to greatly reduce this risk (Yeates *et al.*, 1985; Summers *et al.*, 2000,) whilst reducing the need for multiple applications.

Leaving unfertilised buffers to watercourses was used by 47% of those surveyed, but of those 58% had a buffer of 10 metres or less. Those with substantial buffers of 50 metres or more (14% of those with buffers) were mainly on properties which had drains or streams on adjacent properties or were only farming a small area of the property such as vineyards.

Only one surveyed property, a dairy farmer, used a nutrient budgeting approach to fertiliser management which was reflected in the nutrient input:output ratio being low and close to balanced. Nutrient budgeting is technically demanding and there has to date been an absence of appropriate software in Western Australia that can facilitate and track nutrient balance factors such as farm product outputs, fertilisers and feed inputs which are necessary for a nutrient balance.

Eighty percent of those fertilising used a fertiliser spreader that was calibrated. Owner operator equipment is believed to be calibrated based on spreading a known amount over a known area but not based on actual calibration tests. Contract fertiliser spreaders have generally calibrated based on years of experience, although one fertiliser spreading contractor uses precision spreading equipment including load cells weighing the load and GPS tracking and calculating the spreading rate.

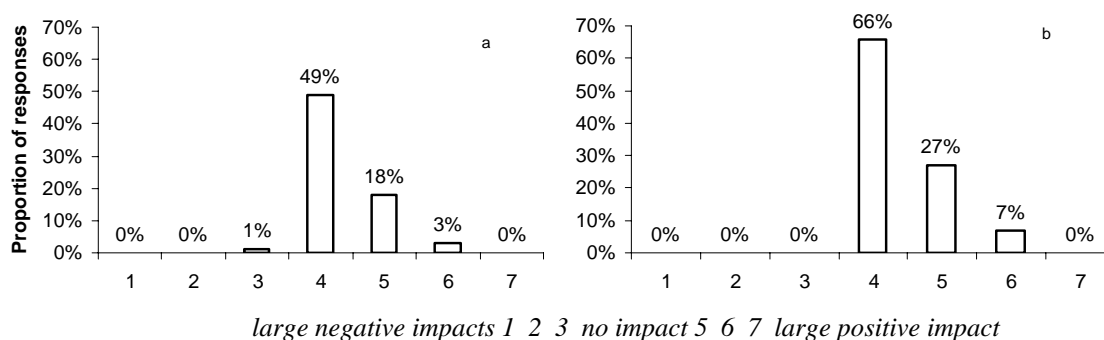


Figure 1. Responses from: a) Do you believe your nutrient management practices are having an impact on your neighbours? b) What type of an impact do you believe your management practices are having on the wider community?

Most farmers in the Peel Harvey believe their farm management practices were not having a negative impact (social, economic and/or environmental) on themselves, their neighbours or anybody in the wider community. Farmers were also asked what type of impact their nutrient management practices (fertiliser practices, riparian/drain management, effluent management, and irrigation management) would be having on themselves, their neighbours or other people in the wider community. The majority of farmers believe their nutrient management practices have a large

positive impact on themselves, no impact at all on their neighbours and also no impact on the wider community (Figure 1). Surveyors recall only 2 or 3 farmers talking about the water quality problems in the Peel Harvey and recent fish kills in the Serpentine River but these farmers believed their own management was not responsible for any problems.

Based on the responses to questions on fertiliser management it was estimated that the current levels of adoption of practices to restrict fertiliser applications to the required nutrient quantities and forms in appropriate locations and times was around 5 to 10%.

Soil amendment

Fourteen percent of properties had amended soils with materials to retain water or nutrients, however, only a small proportion of each property had been treated (<15%). Soil amendment, particularly the use of P sorbing materials such as Alkaloam™, are very effective means of controlling P leaching from sandy soils (Summers *et al.*, 1996) which dominate the catchment.

Perennials

Half of all the properties surveyed had perennial pastures with 33% growing kikuyu, 14% growing Rhodes grass and 11% growing couch grass, however the proportion of each property under perennials was only 25% leading to the conclusion that 12.5% of the catchment had perennials. Increases in production, nutrient retention and removal and water use (White, 2003) could be achieved with more widespread and better use of perennials.

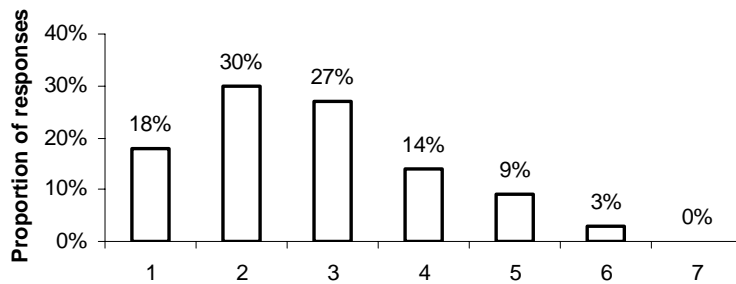
Riparian and water management

Of the properties which had streams or drains on them (68% of those surveyed), 69% had stabilised stock or vehicle crossings and of these 42% had accessed funding subsidies for crossings. Seventy percent of those with watercourses allow livestock to access them for water, but elsewhere on all of the properties there were off-stream watering points, i.e. most properties have both stream access on some part of their property as well as having off-stream watering points. Most stockyards are situated away from drains (66%). Wetlands, riffles, meanders, or grassed waterways were constructed on 13% of the properties and 21% of the properties utilised existing wetlands to retain water and nutrients. One farm had a detention pond and one had a basin specifically constructed for detention of water for sediment deposition.

Landholders were asked if they had fenced any of their streams and drains and 41% had some watercourses which were fenced on both sides, 31% were completely unfenced, 9% were fenced on one side and 15% had a mix. Twenty percent allowed grazing in the fenced areas. Sixty percent of those who fenced received funding for their fencing and revegetation of watercourses.

Subsurface drainage was carried out in 10% of properties with streams and drains. A controlled drainage system was constructed on 7% of properties using weirs and other structures to manipulate the water table for maximising production and minimising water loss. Also, on 7% of properties a drainage re-use system was used to capture water for re-use in irrigation.

Half of farmers fencing drains spent up to \$10,000 on drain/riparian management which is approximately 2 km or 2 hectares of fencing often including revegetation along a watercourse. Farmers were also asked about the cost of maintaining the structures they described in their drain riparian management system, such as spraying weeds and repairing fences and 32% said there were no on going maintenance costs involved, while 27% said there was \$500 maintenance per property each year. Most farmers consider maintenance as a part of farming life and not a cost (Figure 2).



Insignificant cost, not noticeable 1 2 3 4 5 6 7 High cost, large burden on the business

Figure 2. Responses to: How do you consider the total cost of drain/riparian management on your overall farm budget?

Almost half (48%) of farmers believed the cost of establishing and maintaining the drain and riparian management structures discussed was relatively insignificant and not noticeable on their farm budget. A further 27% considered their expenses as slightly significant, but not a burden on the farm budget. Surprisingly the farmers that spent \$100,000 or more indicated the costs were not a large burden on the business.

The surveyed farms had approximately 15 km of drains each, with most less than 2 km fenced, which equates to 13% of the drains fenced. Only 22% of those combined effective practices i.e. only 3% of the drains employed effective riparian management. This compares with a local assessment of approximately 600 km fenced on 7760 km of watercourses or 7%. Most fencing has concentrated on main channels with lower order small streams and drains remaining unmanaged.

Revegetation (not watercourses or waterbodies)

63% of properties had revegetation, however the average area of revegetation was 9.6 ha. Given the average property size was 270 ha, this level of revegetation is less than 4% for each property where this action was undertaken, and around 2% overall.

Irrigation management

Thirty six respondents used irrigation (35%). Of these 36% surface irrigated (border check), 36% sprinkler irrigated, 22% used drip irrigation and 14% used micro-spray irrigation. Sixty nine percent maximised (>2 days) the time between fertilisation and irrigation which minimises the risk of runoff and leaching, similarly 53% eliminated drainage after irrigation. Fourteen percent left an unfertilised buffer, on average 17 m wide, between the irrigated area and the drainage lines. To recycle the water and nutrients, 28% had some sort of water reuse system in place. Horticultural properties had automated irrigation (53%) whilst the remainder were dairies which were manually irrigated. The scheduling of irrigation was decided by experience in 80% of cases, soil moisture measurements in 11% of cases, evaporation 5% and a combination of evaporation and crop water requirements in 8% of cases.

None of the irrigated dairies with predominantly flood irrigation (border check) had a complete suite of practices which could adequately minimise risk of nutrient loss. Also current research is showing that irrigators' perception of their effectiveness is much greater than their actual practice with substantial runoff after each flood irrigation going unnoticed or unrecognised including very high nutrient concentrations from recent fertilisation. Horticultural properties had more efficient practices than flood with no runoff from irrigation water and automation. Unfortunately the scheduling based on experience tends to over-watering limiting the effectiveness of some of the gains of other efficient practices.

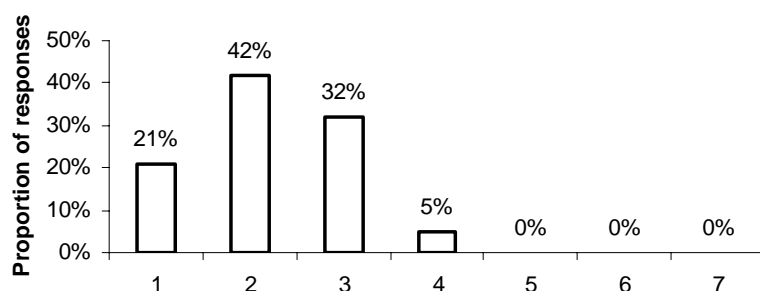
Effluent management

The management of effluent is restricted to effluent management on 22 dairies where 81% had an effluent management strategy. All collected manure, 45% separate solids, 23% have a trafficable sump, 68% have ponds of some sort, 27% said their ponds were too small and overflowed, 13% spray irrigate onto paddocks, 74% apply manure directly to land either from a sump, ponds, or mix it with irrigation water. Several used simple overland flow and one indicated effluent was directed into a watercourse. Fifty four percent had buffers between effluent spreading areas and watercourses. Forty percent avoid rainfall and waterlogging when applying effluent. Seventy three percent applied effluent to nutrient retentive soils and 4% applied effluent at a rate considered correct for nutrient requirements as determined by soil testing. Only 4% reused effluent for washdown. Of those who flood irrigated, all believed they contained the effluent on the bay when irrigating. Effluent from feed pads was directed to an effluent treatment system in 28% of cases.

Only one property had a complete effluent management system with all components operating correctly. Dairy effluent systems are now in the process of being upgraded with direct assistance through the federally funded Dairycatch project.

At least \$10,000 was spent on their effluent management systems by 47% of farmers which is the average cost of concreting yards, constructing a solid separation system (trafficable sump) and an effluent pond, 25% have spent \$5000, which is the average cost of concreting the holding yards and constructing an effluent pond, 16% have made no expenditure on effluent treatment. Most farmers apply solid effluent material to pastures around the dairy which are often fertilised at the same rate as the rest of the property. This leads to an overload of nutrients concentrated around the dairy. Also as herd sizes are growing, many old ponds are overflowing and most dairy farmers are planning to improve their effluent reuse systems.

Farmers were asked about the cost of maintaining their effluent treatment systems and 33% of farmers said that there is no maintenance cost, 19% said it costs them \$500 a year to maintain their system. A further 33% have said that they would usually spend \$1000 a year. Once again labour and time is not factored in by many farmers, even when asked as it's accepted as a part of farming life. Those farmers that had a more advanced effluent reuse system with irrigation had the highest maintenance costs. Again the farmers were also asked how significant the total cost of establishing and maintaining their effluent treatment system was on the farm budget. Seventy four percent of farmers classed the expense as relatively insignificant to the farm budget (Level 2 and 3, Figure 3).



Insignificant cost, not noticeable 1 2 3 4 5 6 7 High cost, large burden on the business

Figure 3. Responses to: How do you consider the costs of establishing and maintaining your effluent treatment system?

Forty two percent of participants planned to make some degree of change to their nutrient management practices in the near future while 58% did not plan to change. Of those who were changing, many were planning multiple changes with 28% of changes expected to fertiliser management including soil testing to determine an accurate fertiliser regime, application of fertiliser after the break of the season, split applications and the use of fertiliser buffers. A further 20%

indicated changes to effluent management with the majority wanting to improve or implement an effluent re-use system. Twenty percent of farmers surveyed were also planning to complete revegetation work for a range of reasons, many relating to reducing erosion, and providing shade and shelter for stock. Of those not considering change, many considered they were doing enough (30%), for others age was a big factor (16%) and industry uncertainty (16%) especially in the dairy industry was holding some back. When asked what would make them change 35% think they are doing enough, 16% want funding to encourage them, 8% think they are too old, and 8% think training would help.

The final question was “If there are people in the area not using what you understand to be best practice in nutrient management, how do you believe they should be encouraged?” Forty eight percent of replies related to training or demonstration and 33% related to assistance.

CONCLUSIONS

Whilst there are a significant number of management practices to improve water quality being carried out throughout the catchment area, there is still substantial opportunity for improvement. Also some of these practices require a chain of events (treatment train) to reach their full capability, e.g. nutrient management requires that soil tests must be carried out, regularly, properly interpreted by an unbiased source in possession of the full facts about the site. This survey has shown that less than 10% of those surveyed completely met these criteria, coupled with timing of applications, lack of suitable fertilisers, inadequate buffers and failure to take account of nutrients in imported feed or moved within the property it is unlikely that fertiliser is being adequately managed.

Whilst the majority of the catchment area is rural there appears to be little acceptance that agriculture is contributing to declining water quality and there was a strong perception in the agriculture sector that the urban areas were not being adequately addressed considering their close proximity to the estuary and intensity of land use. Also there was considerable confusion as to what are the best practices to minimise the impact on water quality which was supported by a strong desire for training and demonstration.

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