DairyingForTomorrow

Targets4Change

Targets for Change

Setting Resource Management Targets for Australian Farms

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Executive Summary

These guidelines provide a means to convert environmental targets for catchments (e.g. nutrient or sediment loads) into land management targets for farmers and to design programs to help promote that on-farm change.

Communities and catchment managers around Australia are setting natural resource condition (environmental) targets as part of region-based catchment management plans sponsored by programs such as the National Action Plan for Salinity and Water Quality (NAP), the Natural Heritage Trust (NHT) and the National Landcare Program (NLP).

To achieve the environmental targets (often set for the 'end of valley'), some land management (farming) practices – and possibly land uses – may need to change.

However, the resource condition targets generally mean little to an individual farmer – and on-farm environmental monitoring could be exorbitantly expensive. It is often assumed the adoption of 'best practice' will improve natural resource condition, but that assumption may be incorrect. It also tends to promote a requirement for all land managers to adopt all the best practices, over all their land, all of the time (which may be beyond the realms of practicality).

In reality, different portions of catchments often contribute differently to catchment environments (due to different soils, slope, nearness to waterways, etc) and their relative contributions may be triggered by some specific management practices or episodic events (e.g. intensive rainfall). With better knowledge, it may be possible to encourage change toward 'doing the right thing, in the right place, at the right time'.

A priority for industries is to better understand the environmental impacts of different farm management practices, so that environmental targets can be converted to farm management targets. Doing this will require understanding of both farm-to-catchment environmental impacts and the capacity of farmers to adopt the recommended management changes.

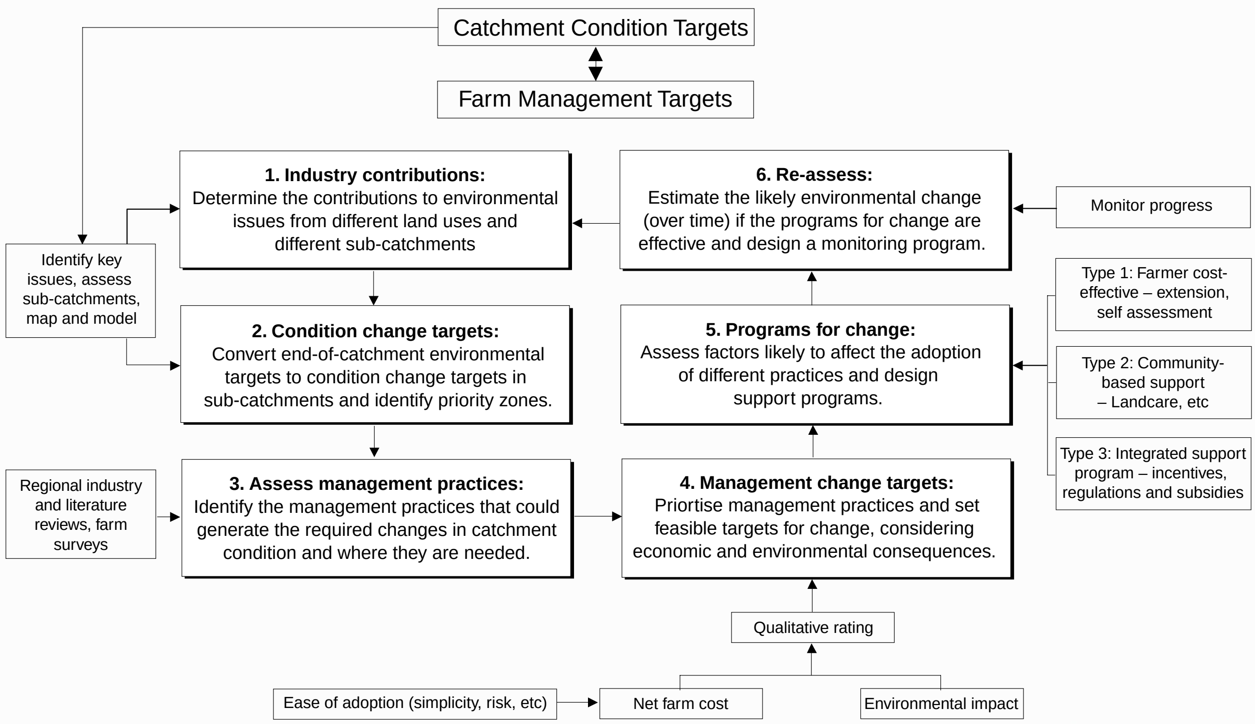
These Guidelines provide a process to establish realistic farm management targets and design appropriate programs to help farmers make management changes.

The core steps are:

1. Determine the contributions to environmental issues from different land uses and different sub-catchments.
2. Convert end-of-catchment environmental targets to condition-change targets in sub-catchments and identify priority zones.
3. Identify the management practices that could generate the required changes in catchment condition and where they are needed.
4. Prioritise the management practices and set feasible targets for change, considering economic and environmental consequences.
5. Assess factors likely to affect the adoption of different practices and design support programs.
6. Estimate the likely environmental change (over time) if the programs for change are effective and design a monitoring program.

Although presented as progressive steps, starting at Step 1, it is actually an iterative process. It may be started at any of the steps and it is often necessary to revisit, or reconsider, positions in light of subsequent information or understanding.

The principal stages are represented below. The guidelines discuss each of the six steps and the supplementary activities associated with each.



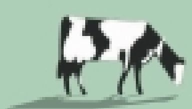
Purpose of the Guidelines

The Guidelines aim to bring about:

- increased capacity within primary industries to assess environmental issues and establish appropriate targets for change in management practices;
- better communication of industry management targets to government and the community;
- closer alignment of industry on-farm management targets with realistic catchment-based environmental targets; and
- focused programs and targeted incentives driving change in on-farm management practice to achieve specified catchment outcomes.

They present a workable procedure, aimed at the regional level, to:

- address the key environmental issues in the most important catchments;
- give clear pointers to targeted management actions addressing the key environmental issues;
- realistically address the practicalities of adoption, so there is a high probability that management actions will be adopted and targets will be achieved;
- gauge the likely environmental effectiveness of proposed actions including the time for outcomes to be apparent; and
- provide a basis for commitment by all stakeholders and the development of programs to promote on-farm change.



Targets

A target specifies an intended outcome to be achieved by some specified date. There are three levels of target:

Aspirational Targets

Aspirational targets provide general, indicative long-term outcomes for a region or catchment, such as ‘no net decline in native vegetation’, ‘a net increase in water quality’ or ‘an improvement in regional sustainability’. Targets such as these have been used to scope regional catchment strategies. This is fundamentally a task for the community, assisted by government agencies through regional catchment strategies and plans. It is not a task of these Guidelines.

Resource Condition Targets

Resource condition targets set measurable outcomes for specific natural resources, for example: ‘Mean Total Phosphorous of the abc river immediately above the xyz confluence will be less than x mg/L 95% of the time’, ‘x km of stream will have sustainable indigenous riparian vegetation by z date’. Resource condition targets may be set at various scales, notably:

- whole-of-catchment scale: (e.g. level of biodiversity preservation in the catchment, total greenhouse gas emissions);
- end-of-valley (e.g. stream flow and water quality above an estuary or terminal lake; or at a confluence with a larger river);
- sub-catchments; and
- specific river reaches or water bodies.

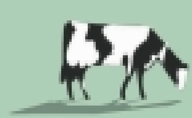
These Guidelines will help industry work with communities to set realistic resource condition targets in areas of high industry influence.

Management Practice Targets

Management practice targets set outcomes for public and private managers and resource users, for example: ‘x km of stream will be fenced and revegetated by z date’, ‘x% of farmers on y soil type will be doing ABC by 200z’ or ‘no stock will have stream access by z date’. The Guidelines provide a method for establishing detailed management priorities for the industry at sub-catchment level and strategies for their adoption.

A management target will establish outcomes in terms of rates and levels of adoption of certain practices. Management practices may include:

- works
(e.g. intercepting saline flows and constructing evaporation basins; upgrading effluent collection ponds, installing more efficient irrigation systems, fencing off water bodies or remnant vegetation, tree planting);
- operational practices
(e.g. amount and timing of irrigation water or fertilisers to be applied, tillage, pasture and grazing management, control of stock movements); and
- resource use planning
(e.g. management plans for the use of land and water at catchment, sub-catchment or farm level).



Annex A gives examples of possible management practice targets in the dairy industry corresponding to various resource condition targets. The examples are purely illustrative, and may not be applicable in all regions.

Management practice targets should be SMMART (specific, motivational, measurable, agreed, realistic and time bound):

Specific: Targets may be needed at several levels, for example at catchment, sub-catchment, industry or farm scales.

Motivational: Economic, social and environmental payoffs to farmers must be clearly visible.

Measurable: There is little point in having a target if the result cannot be measured. Targets need to be kept under review, and this requires yardsticks of progress.

Agreed: identify the relevant stakeholders and secure their ongoing involvement; with negotiated target results. This requires real partnership not just consultation; co-ordination is needed between all players. There may also be a need for education and understanding.

Realistic: Targets must take into account the response times of natural systems and the economic conditions and constraints facing farmers. Targets need to be realistically underpinned by a science base wherever possible. They also need to be consistent within a State and within the country (in similar / like regions).

Time-bound: A time-frame is needed to guide what needs to happen and when, and to measure whether progress is being made.

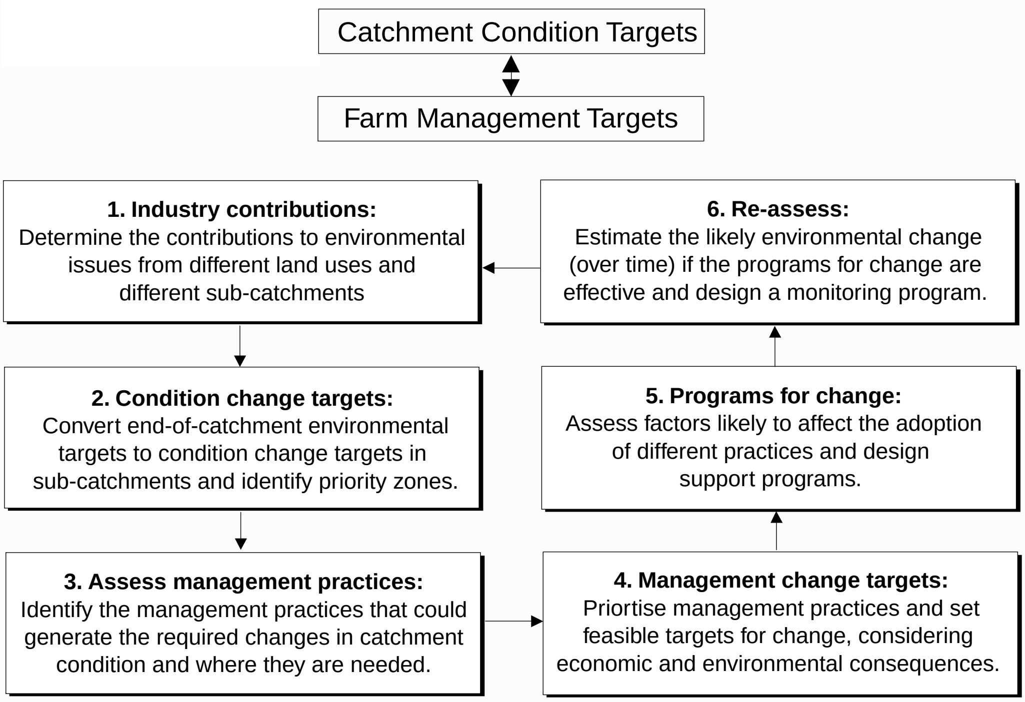
Guidelines for Setting Targets

The Core Process

Figure 1 outlines the 'Core Process' for industry target setting. This describes an iterative procedure in which industry targets for change are related to regional and catchment conditions and targets.

These guidelines will help the industry plan how to do its bit to achieve the environmental targets established by the community. The guidelines do not cover the setting of Catchment (environmental) Condition Targets. That is in the community domain through various natural resource and catchment management authorities. Industry may (and should) be active in that process as a member of the community.

Figure 1: Core Process. Setting resource management practice targets for industry.



Step 1.
Assess Industry Contributions

Step 1. Determine the contributions to environmental issues from different land uses and different sub-catchments.

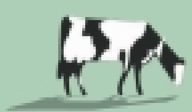
To target their activities in key environmental issues, industries need to know how they fit into the more general picture of natural resource management across a particular region.

- If the industry is a *major* player in a particular catchment issue, a high level of success in achieving industry targets may be needed to achieve environmental objectives.
- If the industry is only a minor player in the particular environmental issue, its rate of adoption of improved practices could be less critical to overall catchment outcomes. Changes that are more costly for the industry to implement may not be justified and the focus of regional natural resource management resources may be redirected.
- The impact of an industry may be more geographically concentrated in some parts of a region or catchment than others. If so, it may be possible to limit the need for high levels of change to targeted 'hot spots' and avoid the need for all producers to be at the same level of management practice.

Identify environmental priorities

Regional natural resource management and catchment plans should form a basic point of reference for industry-based management plans. Industry initiatives provide an opportunity to:

- influence the targets contained in the regional strategies;
- establish (and achieve) corresponding targets for farm management practice, thus delivering the industry contribution to achievement of catchment natural resource targets; and
- designing effective, targeted natural resource management programs for the Natural Heritage Trust, National Action Plan or National Landcare Program, etc, to provide appropriate community support for on-farm change.



A first step should be to consult all regional planning documents to collate information on key economic, social and environmental asset values.
A suggested approach is:

- Collect and map information on the physical environment. This should include geology, soils, surface and ground waters, morphology, climate, native vegetation and infrastructure such as roads and railways. Note any localities that are especially subject to degradation processes, e.g. soil erosion, salinity, nutrient leakage or waterlogging.
- Collect and map information on key economic, social and environmental assets, e.g. regionally or nationally significant wetlands, rare or threatened vegetation communities, public water supplies, key recreation or tourist sites, and highly productive agricultural soils.
- Collect, graph and map data on the catchment environment, e.g. nutrient, salt and sediment loads per sub-catchment or reach, areas of pest or weed infestation, sites of frequent algal blooms, sub-catchments with sub-optimal environmental flows, and areas of increasing salinity. Also record any environmental targets that have been set for the catchment.

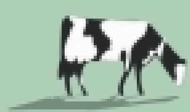
These topics are generally documented in regional catchment strategies and most of the work should already have been done. In regions where that is not the case, local data will have to be collated or reference made to equivalent state or national information.

Incorporate industry characteristics

The next step is to overlay local information about the industry – its distribution or location in the catchment, the amount and intensity of production and the application of different management practices (e.g. cultivation). Considering environmental and industry information together will provide a quick insight into potential priorities and 'hot spots'.

A suggested approach is to:

- Collect what data are available on the industry, or estimate it, e.g. statistics and a map of farm locations, number of farms, number of livestock, area of farming, cropping, etc. This information provides a base for estimating total potential impacts at differing scales from individual farm to localised hot spot, sub-catchment or catchment.
- Consider the inherent risks due to the natural environment, e.g. steep slopes, saturated soils, free-draining soils, acid soils and saline soils, and how their influence may be reduced through management changes.



The following 'decision rules' are suggested to highlight areas needing special consideration for industry target setting:

- Areas within the catchment where there is a considerable concentration of production, a susceptible environment and higher risk for impact: the full complement of management practices needs to be considered and a high level of adoption of improved practices should be sought.
- Other areas: concentrate on management practices that benefit farms as well as the environment.
- Hot spot areas are likely to be where:

  – the industry is a significant or dominant land use;

  – landforms (including slope), soils and vegetation are susceptible to degradation processes, or

  – receiving environments have a high value for economic, social or environmental purposes.

Estimate the contribution from industry

The next step is to further define potential impacts and contributions from industry.

Accurate quantitative assessment of industry impacts requires sophisticated models or Geographic Information Systems. Examples include CMSS (Catchment Management Support System), its successor EMSS (Environmental Management Support System) and the tool kit of models by the Cooperative Research Centre for Catchment Hydrology (see www.catchment.crc.org.au for more information).

A WORKED EXAMPLE:

Vasse / Sabina Catchment; WA

Applying CMSS shows that if all broadacre land uses adopted best practice, it could reduce total N loads by 25% (equivalent to 101 tonnes of N/yr) and halve concentrations to meet the long-term target of 1.0 mg/L TN. The reductions would come from improved dairy shed effluent management (4%), better fertiliser management (4%), broader establishment and sound management of perennial pastures (8%) and improved riparian management (9%). For more information, see 'Nutrient Pollution in the Vasse-Wonnerup Catchment, WA' (Kelsey, P. 2002. Department of Environment).

Industry is unlikely to be able to undertake such modelling itself; having to rely on state, university or catchment agencies to undertake such elaborate work.

Alternatively, less-formal approaches may be applied, making use of available technical information, supplemented where necessary by informed judgement.

A first step is to assess risks due to farm management to derive some ballpark estimates of the total loads (or contributions) from land used by industry, relative to other sources.

This will be coarse work but may help determine if industry is likely to contribute nearer 10% or 90% of total load or other impacts.

A WORKED EXAMPLE:

Bremer River, Qld

Flows from the Bremer eventually enter Moreton Bay, where sedimentation is a major environmental concern.

80% of sediment in Moreton Bay comes from Marburg Formation rocks.

78% of sediment comes from subsoil erosion of streambanks and gullies.

There are around 80 dairy farms scattered through the Bremer catchment. Only four are on Marburg Formation – and only two have river frontage.

Dairy farms are unlikely to be major contributors to sediment loads in Moreton Bay.

This approach inevitably exposes information gaps that must be filled by assumptions. It is imperative that the assumptions are recorded. The assumption may be that a certain parameter falls within a specified range – in which case ‘best case’ and ‘worst case’ scenarios may be calculated. Different assumptions will be made with differing degrees of confidence – and that level of confidence (e.g. high, medium or low) should also be recorded. Assessing different scenarios can help to identify key sensitivities and future research needs. Informed, documented assumptions ensure this process need not be held up by an immediate lack of knowledge or information.

A WORKED EXAMPLE:

Montagu River, Tasmania

Effluent

There are about 6,700 dairy cows in the catchment.

This equates to around 4,700 kg of P deposited in dairy sheds/yr (0.7 kg P/cow/day/285 day lactation).

Annual P loads in the Montagu range from 47,000 to 128,000 kg.

AT MOST (assuming all effluent enters the river) 4–10% of P loads could come from dairy shed effluent.

Phosphate Loads

The catchment contains 24,800 ha of forestry and native vegetation; assumed to contribute 0.5 kg P/ha/yr (i.e. 12,400 kg P/yr). The 3,000 ha of beef grazing land is assumed to contribute 1.5 kg P/ha/yr (i.e. 4,500 kg P/yr). Together that makes 16,900 kg P/yr.

Annual P loads in the Montagu vary from 47,000 to 128,000 kg.

The 5,200 ha used for dairy may therefore contribute from 30,100 kg P/yr (at 5.79 kg/ha/yr) to 94,200 kg P/yr (at 18.21 kg/ha/yr). This is in the range of loss reported from research in other areas, being from 2 to 20 kg/ha/yr.

If data are available for monthly periods or specific sub-catchments, then the same calculations may be undertaken on that basis.

Attempts to quantify potential contributions from industry to catchment condition will generate a deeper understanding of farm-catchment relationships, and may also generate more questions about environmental processes. For example, about in-stream processes (‘Do all nutrients entering a stream reach the end of the catchment?’) on-farm processes (‘Are there ‘sinks’ that capture nutrients on-farm?’) and the impact of periodic weather events (‘How do loads and concentrations vary between storm and low-flow events?).

At the conclusion of this stage, there will be a broad understanding of:

- environmental issues (e.g. salinity and biodiversity) and the directions being advocated by regional strategies;
- where the industry is located in the catchment; and
- the potential impact of industry and some practices on key environmental issues.

Step 2
Develop Condition Change Targets

Step 2. Convert end-of-catchment environmental targets to condition-change targets in sub-catchments and identify priority zones.

The next step is to approximate the effect that could be achieved by changed practice in the industry. This may be approached from either of two directions.

If there are clear environmental condition targets in local natural resource or catchment plans, and information is available on current condition, then the overall change in condition required to reach the targets may be readily determined. With the understanding from Step 1 of the industry's current place in the catchment, and its contribution to the current condition, it is possible to estimate the proportion of the required change that the community could expect from industry.

Alternatively, starting from the understanding generated in Step 1 and making a broad judgement about the potential change in contribution by industry (based on an appreciation of current practice, potential improvements and their impacts), the environmental change that could be achieved by industry action can be assessed.

Example 1: **IF**

- regional catchment strategies are targeting a reduction in nutrient accessions to waterways;
- it is known that particular rivers, streams, lakes or estuaries in the catchment are at risk;
- the industry probably contributes about 10% of the total nutrient loads in the at-risk areas; and
- it could be plausible to achieve a 30% reduction in nutrient generation at farm level by some mix of improved practices,

  THEN a broad estimate of the potential contribution of industry to improved (i.e. reduced) nutrient flow would be around 3%.

It may also be possible to identify where in the catchment improvements in nutrient management could most benefit nutrient-stressed water bodies. This information should be used to focus the implementation program (see Step 5, page 19).

Example 2: **IF**

- regional catchment strategies are targeting a reduction in aggregate water use,
- it is known that particular streams in the catchment are flow-stressed,
- it is known that industry uses about half the water diverted in the catchment, and
- it could be plausible to target a reduction in industry water use of 20%.

  THEN the maximum change in overall catchment water use from changed practice in the industry would be round 10%. Such a target would be provisional and would be subject to review and adjustment through further stages of the Core Process.

It may also be possible to identify where in the catchment improvements in water use and management could most benefit flow-stressed streams. This information should be used to focus the implementation program (see Step 5, page 19).

Where there is already a Regional Catchment Strategy, this might set out broad targets for aspects of natural resource management that concern specific industries. The resource condition targets in catchment strategies are usually expressed in broad terms, such as end-of-valley targets rather than being location-specific, and management targets may apply to agriculture as a whole rather than being specific to a commodity. In this case, it will be necessary to consider the implications of these general agricultural targets for the specific industries.

At the conclusion of this step, there will be an appreciation of the amount of environmental improvement that the community may feasibly seek from an individual industry. Where possible, these condition change targets should be tied to as fine a scale as possible (i.e. sub-catchment), with most attention to zones identified as priorities in Step 1.

Step 3.
Assess Management Practices

Step 3. Identify the management practices that could generate the required changes in catchment condition and where they are needed.

Once some broad assessment has been made of the important environmental issues and hot spots, give more thought to farm management practices that could help move towards the environmental (condition) target.

For each environmental issue in the selected catchment, a complete list of currently recommended ‘best practices’ should be used as a checklist to identify priority practices that address the particular issue and ‘hot spot’ locations. Annex B presents a list, sorted by type of farm management practice, drawn from *Dairying for Tomorrow* as a dairy industry example.

Having determined the environmental priorities for industry, it is a matter of then determining the important management practices (and critical zones) that need to change in order to meet the proposed condition change targets.

To limit repetition of the Core Process for every environmental issue in the region it is suggested that the three most important environmental issues be identified, and the Core Process applied for each of them.

Once recommended best practices have been listed to address the different environmental priorities, they should be combined into a single set. It is likely that some best management practices will help alleviate several issues, permitting some rationalisation of the list.

Evidence should then be sought on the extent to which these practices are currently adopted and, if possible, linked to geographic locations. Look for answers to questions such as, ‘If practice x is important, how many farms (or what %) in the hot spot zones have already adopted it; and what area of land is involved?’

If information isn’t to hand, consider a survey of farmers in key zones. The survey could be an extension tool in its own right (e.g. raising awareness of environmental issues, the catchment impact of different practices and of self-assessment or other such tools). Surveys can also generate data to serve as a benchmark, to fill knowledge gaps and help in modelling catchment processes. An example would be determining how much fertiliser was applied annually to help prepare a mass budget of nutrients for the sub-catchment and modelling the potential industry contribution to the environment (as in Step 2). A survey can also provide a database of people wanting more information on specified topics.

Step 4.
Set Management Change Targets

Step 4. Prioritise the management practices and set feasible targets for change, considering economic and environmental consequences.

Rating and ranking criteria

When all relevant management practices have been identified, it is important to make a critical assessment of which ones will best suit local circumstances. Determining what 'suits best' involves assessing both the implications for farmers and for environmental outcomes. Obtaining a 'best set' of practices implies eliminating some and retaining others.

Some method of rating, and then ranking, the alternative management practices obtained from Step 3 is required. There are many ways of rating alternatives, including:

- *Benefit-cost analysis*: involving valuation of environmental benefits as well as costs of changed management practices;
- *Cost-effectiveness analysis:* measuring the amount of improvement in an environmental index, per dollar of cost (e.g. tonnes of nutrient load reduced per dollar of net cost); and
- *Qualitative rating:* using scores based on local knowledge and published information.

To implement these Guidelines, a qualitative rating is recommended. This is more flexible, and less costly, but can nevertheless be used to indicate the relativities between management options – and it can incorporate more local judgement.

Suggested qualitative rating method

The suggested method attributes a score to each possible management practice, against two factors:

- *Net Farm Cost:* scored on a 5-point scale from 1 ('Negligible') to 5 ('Very High')
- *Environmental Impact:* also scored on a 5-point scale from 1 (Negligible') to 5 ('Very High')

The *Net Farm Cost* index is intended to reflect:

- direct capital and operating costs, or loss of productivity to farms;
- any indirect or intangible costs such as difficulties getting co-operation from neighbours, lack of technical know-how or legal constraints; and
- any direct financial benefit such as increased productive use of saline land, the value of carbon credits, or increased land value following management changes.

The *Net Farm Cost* is expressed *after* taking account of any benefits to farms that may offset the costs. A practice that is easy to implement (i.e. having low indirect or intangible costs) will tend to have a low Net Farm Cost. It is conceivable that some practices will have a negative net cost, i.e. they will be profitable to farmers in their own right. If so, the practice should be scored as having 'negligible net cost'.

The 'ease of adoption' of different practices will also influence the type of program required to support change. It is further discussed in that context under Step 5.

The *Environmental Impact* score reflects the degree of change in environmental condition at the sub-catchment level that can be expected if *most* farmers adopt the particular management practice. Some practices may have a more rapid environmental effect than others. Where the environmental impact will take many years the score should be downgraded one point compared with a practice that will have an immediate environmental impact. Also, if there is less certainty about the effectiveness of a practice compared with others, it should be downgraded.

In working through the rating system, it is recommended that each factor be scored separately, by first rating all possible management practices against Net Farm Cost and THEN against Environmental Impact. This order of assessment focuses attention on *relativities* across all management practices for each of the two factors separately.

Once all possible management practices have been scored against *Net Farm Cost* and *Environmental Impact*, a '*Cost-Effectiveness Index'* can be calculated. This is obtained for each management practice by dividing its Environmental Impact score by its Net Farm Cost. Table 1 shows all possible values of the Index.

The shaded cells in Table 1 highlight the values of the Cost-Effectiveness Index that will define the most preferred set of management practices. The scores indicate a relatively high environmental payoff per dollar.

An Excel spreadsheet should be used to list the practices, record scores for Net Farm Cost and Environmental Impact, and calculate the Cost-Effectiveness Score. The Excel 'Data Sort' tool can then be used to rank the practices.

Table 1: Cost-effectiveness Index for different levels of Environmental Impact and Net Farm Cost.

Net Farm Cost	**Sub-Catchment Environmental Impact**				
	Negligible (1)	**Small (2)**	**Moderate (3)**	**High (4)**	**Very High (5)**
Very High (5)	0.20	0.40	0.60	0.80	1.00
High (4)	0.25	0.50	0.75	1.00	1.25
Moderate (3)	0.33	0.67	1.00	1.33	1.67
Small (2)	0.50	1.00	1.50	2.00	2.50
Negligible (1)	1.00	2.00	3.00	4.00	5.00

Note: the cell values are (environmental impact score)/(net cost score)

The outcome of this step is that all possible management practices for addressing particular environmental issues will have been prioritised. Annex C gives an example, based on a very generalised appreciation of relative costs and environmental effects, done with no particular catchment in mind.

Having a clearer appreciation of the relative cost and environmental benefit of individual practices it is then possible to reflect on information and understandings generated by previous steps in the Core Process, and to set targets for adoption levels of various practices, with most attention to any priority ('hot spot') zones.

At the conclusion of this step, there will be a list of priority management practices and targets for adoption rates, defined regionally.

A WORKED EXAMPLE:

Upper Lansdowne Catchment, NSW

In this case study, the Targets for Change process was applied to a small number of farms and a modified (10 point) scoring system (giving a highest score of 100) was used for individual farms. The results helped identify the differing priorities for each farm and were instrumental in attracting NHT funding – and in broadening the scope of its application from 'effluent management' to 'nutrient control'.

Category	***Management Practice***	***Rating***
Reducing pressure on riparian zones	*Off-stream shade*	*13, 14*
	Off-stream watering points	*13, 14*
	River and creek crossings	*13, 14*
	Fencing strategic locations	*13, 14*
	Weed control	*13, 14*
Reduce potential for erosion	*Apply soil management (pugging, acidity)*	*15,18,20,21*
	Install drainage	*74*
	Install laneways	*78*
	Manage storm water run-off	*94*
	Use vegetation filter strips	*58*
Reduce 'leakage' of fertilisers off farm	*Fertiliser budgeting (at paddock level)*	*37*
	Regular soil testing including acidity	*33,38*
	Apply P, N & lime at suitable times	*48,49,50*
	Use vegetation filter strips	*58*
Increase water conservation during high flows	*Review total on-farm water use*	*100*
	Review security & best use of water rights	*100*

Step 5.
Design Programs for Change

Step 5. Assess factors likely to affect the adoption of different practices and design support programs.

Achieving required adoption rates is critical for industry natural resource management strategies to succeed. The adoption strategy depends on the types of Management Practice required and the ease with which they could be adopted. The preferred management practices (already selected in Step 4 of the Core Process) should now be grouped into three major types:

Type 1. Farmer cost-effective.

Type 2. Community-based support.

Type 3. Integrated support program.

Classifying the practices will draw largely on their ranking and assessment of net farm cost, from Step 4. However, it will also require renewed consideration of factors influencing the 'ease of adoption' of each practice. Important factors will include:

- simplicity (the complexity of the proposed change);
- 'trial-ability' (the ease of 'testing' the change at a small scale);
- risk (prospects of loss if the practice doesn't work);
- observable outcomes (to reinforce the value of the change); and
- compatibility (ease with which the practice fits into existing farming systems).

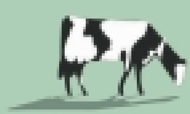
For more information on these factors see 'Understanding Landholders' Capacity to Change to Sustainable Practices' by Cary, J. Webb, T. and Barr, N. (2002) via www.affa.gov.au/brs (social science).

Type 1: Farmer cost-effective management practices (Do-able now)

This group includes the better management practices that are trial-able and will actually reap a financial reward for farmers as well as benefiting the environment. For these management practices, the adoption strategy could concentrate on self-assessment tools, extension, education (including demonstrations) and monitoring.

Type 2: Community-based management practices (Do-able with NAP & NHT)

This type of activity includes practices that can be undertaken with support from volunteers and community groups, or with financial support from governments, along the lines of traditional Landcare activities. They may involve community input in recognition of community benefit from on-farm activities. They could include programs such as revegetation, riparian zone management or water re-use. Assistance could be in the form of funds, expert advice, labour or materials.



Type 3: Integrated support program management practices (Not do-able without significant, externally funded, support)

This group of practices are likely to need a number of elements working together before being widely, or readily, adopted. They may have nil or negative economic benefit to farmers or require significant capital expenditure, risk or disruption to farming systems. A mix of incentives (e.g. funding, direct on-farm advice, soil-testing or mapping services), regulations, subsidies and cost sharing may be needed to assure adoption of these practices. Examples might be upgrades of on-farm and off-farm drainage systems, effluent treatment processes, or non-fertilisation of near-riparian land.

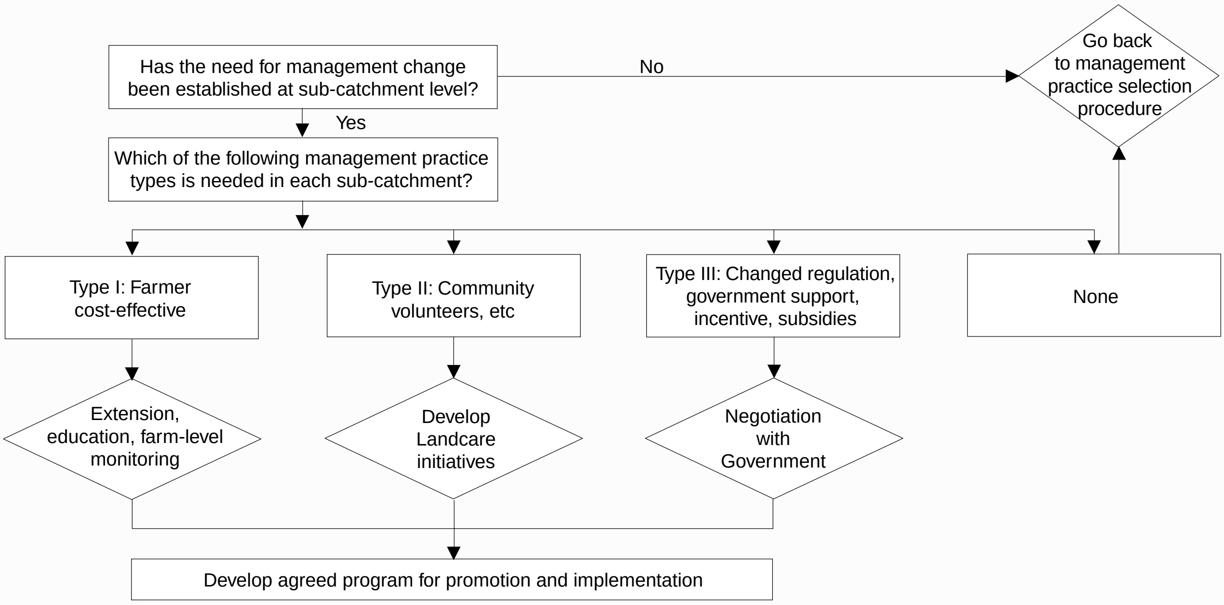
Designing programs for change

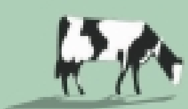
Once the relevant management practices and their types have been determined, the stage is set for a meaningful dialogue between the industry and regional natural resource/ catchment managers about the kinds of programs requiring development and implementation to promote the changes in management proposed for different districts in a catchment.

At the conclusion of this step, industry and natural resource or catchment management groups should have a shared view of the programs needed to achieve the proposed management change targets. This agreement should be demonstrated by collaborative funding proposals, etc.

Figure 2 illustrates an approach for developing an adoption strategy, starting from some predetermined package of required management practices.

Figure 2: Decision Process for Implementation Strategy.





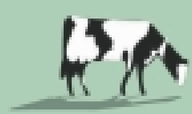
A WORKED EXAMPLE:

Montagu Catchment, Tasmania

It is estimated that lands used for dairying could contribute significant amounts to the P load of the Montagu River. Relevant management practices were scored using the Targets for Change Cost/Effectiveness Index; then assessed for 'ease of adoption'. The results were:

	Do-able now	Do-able with funding	Do-able with significant support	Environmental Effectiveness (0=none to 5=high)
Don't apply P on saturated soils	X			5
Apply P more effectively			X	5
Apply P to humps not hollows			X	2
Better application at right time	X			5
Apply P four days before rain	X			5
Use irrigation to apply P			X	3
Undertake a nutrient budget	X			4
Use plants that need less P			X	5

The results highlighted the value of preparing a farm nutrient budget and management plan. A program was subsequently instigated to provide a soil sampling / nutrient mapping / nutrient budget service to assist farmers in developing fertiliser / nutrient management plans.



Step 6.
Re-assess

Step 6. ***Estimate the likely environmental change (over time) if the programs for change are effective and design a monitoring program.***

The final step is to reassess what industry contributions to the catchment environment are likely to be if the programs designed in Step 5 were successfully implemented.

At this reflective stage, environmental and management targets should also be reviewed in the light of what has been learned. This should be done at the first iteration of the process, i.e. *before* any implementation of targets occurs. This stage is essentially about refining the environmental and management targets, so that they reflect realistic expectations about the feasible rate of change, as revealed by the deliberations required by Steps 4 and 5. This reflection draws upon understandings generated through the Targets for Change Core Process and any models or mass budgets thus developed.

When the target-setting process is repeated, perhaps in two or three years' time, it should be much easier to refine the environmental and management targets. This requires some monitoring and evaluation of achievements.

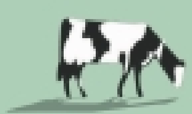
Monitoring and evaluation of progress in achieving targets for changed management practice is fundamental to an ongoing program of adaptation.

A monitoring and evaluation strategy is needed to show whether:

- the programs proposed in Step 5 are being implemented;
- the management practices targeted through Steps 3 and 4 are indeed changing (i.e. are the management change targets being hit?); and
- the desired change in resource condition from Step 2 is occurring (i.e. are the condition change targets being hit?).

The most straightforward way to monitor change in farm management practice is through a periodic survey of farms in the areas within the region that have been identified as having special priority. Information from catchment monitoring or research projects will also be required, along with records of the programs undertaken with respect to the Type 2 (do-able with NHT) and Type 3 practices (requiring further support) through industry and catchment initiatives.

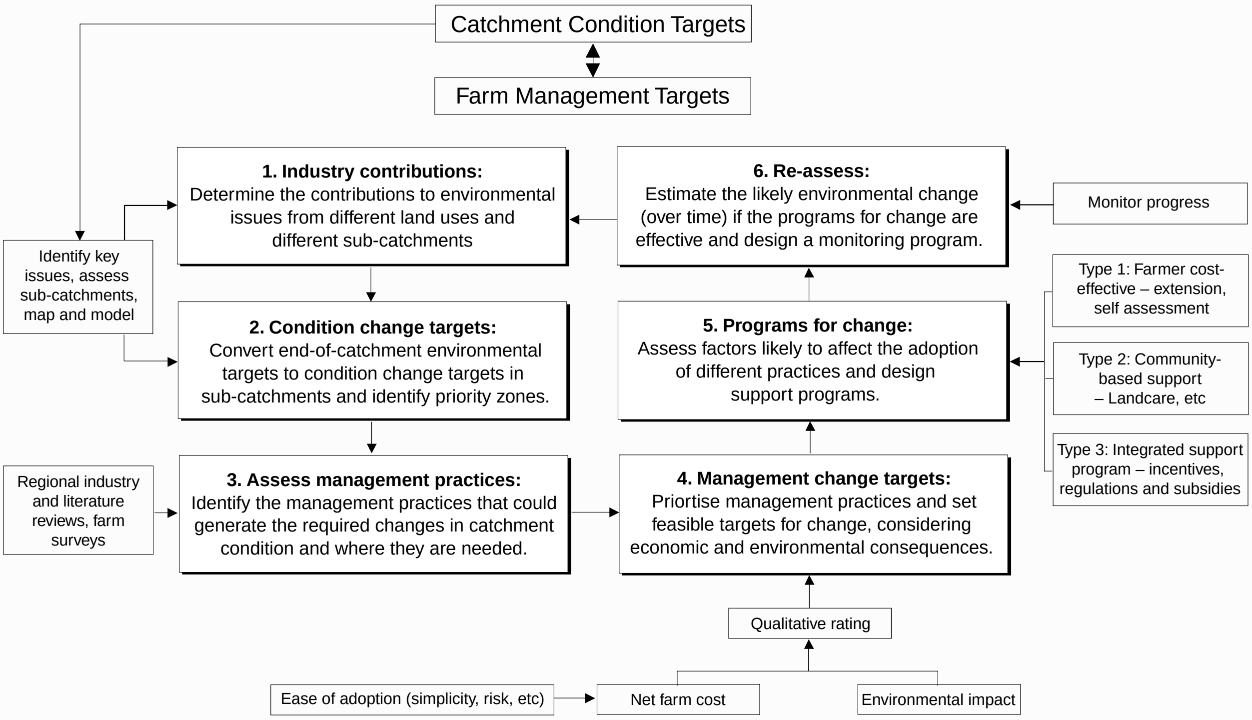
At the conclusion of this step, it will be possible to make necessary changes to condition change and management change targets and, if appropriate, to suggest changes to catchment environment condition targets in catchment plans. A monitoring and evaluation strategy should be in place to help continually improve Targets for Change decisions and to promote on-farm change for agreed environmental outcomes.

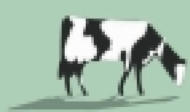


The complete process

Combining all supplementary activities outlined in previous sections with the Core Process produces the diagram shown in Figure 3.

Figure 3: The Complete Process.





Applying the Guidelines

Where

These Guidelines are intended to be used in catchments or sub-catchments where the industry:

- has a significant impact on a particular environmental issue, or
- has been identified as a major stakeholder.

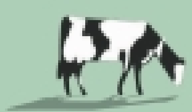
The Guidelines are not generally applicable where individual industries are widely scattered across a catchment. In such cases, it is more difficult to assign environmental impacts to specific industries.

While the Guidelines are designed for use at an industry and catchment level, they have also been applied successfully at the farm level – equivalent to working with a Landcare group. The thinking behind the Guidelines is equally relevant to small and large scales.

- The Guidelines will work best where there is (or is about to be) an integrated catchment plan, and where there is information and data available. However, they are also very effective without them.
- A lack of data is not necessarily a barrier to progress. There will rarely be sufficient data for total confidence. Data gaps may be filled by informed, documented assumptions. It is often possible to say 'We don't know exactly – but are 80% confident it is between x and y levels'.
- Documented assumptions permit scenario testing – 'OK, what if it's x? Now let's see what happens if it's y'. Such testing also helps identify sensitivities – 'Is the variation critical to an outcome or is it of negligible impact compared to other variables?'.

Scientific issues

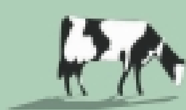
Going through the target-setting guidelines will often focus attention on those scientific uncertainties that are critical for decision-making. It will highlight processes and practices requiring more research. It also highlights the importance of recording the assumptions being made (due to a lack of data or knowledge) and the confidence limits around data; which may, in turn, inform sensitivity analyses.



Support Requirements

Governments, the community and industries are developing integrated approaches to address natural resource and environmental management issues. Key support requirements to make the *Targets4Change* program a practical success are:

- Institutional: strong links between the industry and community -based bodies.
- Geographical information and management practice data.
- Ongoing research on catchment behaviour and the effectiveness of management practices.
- Training support to improve skills in how to apply the target-setting approach.
- Financial support for implementing the target-setting process.
- Financial support for implementation of Type II & Type III management actions.

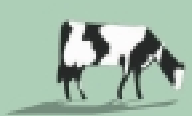


Annex A: Examples of targets

Table 2 gives examples of the types of resource condition targets that may be promulgated by a government-initiated regional catchment strategy, and gives matching examples of possible practice targets for the dairy industry in a region or sub-catchment. The dairy practice examples have been taken from *Dairying for Tomorrow*, but there are many more than are listed here. Setting practice targets involves selecting the appropriate management practices for the particular environmental issues and farm conditions in key areas.

Table 2: Examples of targets for resource condition and management practice.

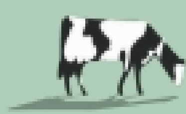
	Regional Resource Condition Targets Example	Possible Management Practice Targets
1	Surface Water Use: social, environmental, and economic demands for water will be balanced in four river basins through negotiated environmental flow regimes within seven years	– On-farm water supply channel leakage will be cut from the current 30% to 15% within 10 years – Drainage water re-use systems will be adopted by around 25% of farmers within 10 years (especially from flood irrigation) – 80% of farmers will be incorporating weather forecasts into irrigation decisions within five years – Most farmers will understand water storage (holding capacity) of soil in the root zone of plants and water needs of pastures – 60% of farmers will have completed farm management plans that include a review of total on-farm water use, e.g. shed and yards (recycle cooling water; yard wash down); stock and domestic consumption; drainage/effluent and irrigation)
2	Groundwater use: seven groundwater systems will be protected through new Groundwater Management Plans within 10 years	– 60% of farmers will monitor and manage groundwater in conjunction with surface water within five years
3	Erosion/sedimentation: 30% reduction in sediment loads at key monitoring sites in four river basins	– All farms adopt conservation tillage methods (over-sowing, minimum or zero tillage, and cultivate across slopes) within 10 years – All farms avoid cultivating during high rainfall seasons within 10 years
4	Nutrients: 50% reduction in nutrient discharges from agricultural land within 30 years	– Most farms will apply N soon after an irrigation laser level to reduce run-off and nutrient losses within five years. All farms will avoid applying fertiliser before heavy rainfalls on sloping ground or within 20m of streams – No farm will fertilise the bottom 20m of bays when flood irrigating, within three years – 75% of farms will treat collected effluent in a pond system within five years and 100% within 10 years – 60% of currently unfenced water frontages will be fenced off and stock access managed – 30% of farm area will have 'filter strips' (that include ground cover) adjacent to streams, particularly in very high rainfall areas, to reduce the physical transport of manure to streams
5	Water Salinity: Abate saline inflows to the xyz river, currently averaging 970 EC.	– All farms will maximise their irrigation efficiency to avoid over-irrigation (particularly with saline water) within 10 years – 80% of farms will not fallow during wet seasons – All farms will carefully manage the use of saline effluent
6	Land salinity: Productive use and biodiversity management will be instigated within 9,400 ha of primary saline land and 5,300 ha of secondary salt-affected land within seven years.	– All farmers will ensure sufficient irrigation water infiltrates the soil to prevent salt accumulation by capillary action within 10 years – 75% of farmers will understand and apply preventive remediation measures for irrigation or dryland salinity – 25% of farmers will plant salt-tolerant pastures
7	Weeds: Area of region affected by Regional Priority weeds (7 spp) will be reduced by 20% within 10 years.	– Plantings will be designed to minimise potential local pest and weed control problems – 25% of farmers will rip and cultivate weed-infested areas within 10 years



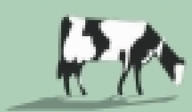
Annex B: List of management practices and indicative cost-effectiveness ratings

Table 3: Management practices mentioned in regional plans from Dairying for Tomorrow, with notional ratings against cost and effectiveness.

	Management Practice	Issue	Ratings		
			Net Cost	Environmental Impact	Cost Effectiveness
	EFFLUENT ENGINEERING AND MANAGEMENT:				
1	Collect effluent where possible e.g. sheds yards, etc.	Nutrients	2	4	2.00
2	Treat collected effluent (e.g. in a pond system).	Nutrients	3	5	1.67
3	Accommodate wet weather, herd size and soil types in a pond design or effluent management practices.	Nutrients	2	3	1.50
4	Return manure and feed refusals to the paddock.	Nutrients	2	3	1.50
5	Spread effluent over a sufficient area to avoid concentrating nutrients and water.	Nutrients	2	3	1.50
6	Minimise effluent loss and run-off from laneways and feed pads.	Nutrients	3	4	1.33
	HERD MANAGEMENT:				
7	Avoid compacting by not over-grazing or cultivating when wet and by keeping traffic to designated laneways.	Soil	1	2	2.00
8	Establish multiple entry/exits points for stock.	Nutrients	2	3	1.50
9	Adopt special grazing measures when wet (e.g. selective grazing, on-off grazing, loafing pads or lower stock numbers).	Nutrients	2	2	1.00
10	Design dairies and manage herds so cows spend only a short holding period in yards.	Nutrients	3	3	1.00
11	Fence off and manage stock access to water frontages.	Nutrients	4	4	1.00
12	Locate dairies to minimise the time cows spend on roadways.	Nutrients	5	3	0.60
13	Concentrate production to the lowest salinity soils.	Salinity	2	1	0.50
	KNOWLEDGE ENHANCEMENT: (All items have been ranked equal, but their scores will vary in different locations)				
14	Be familiar with any regional or catchment management strategies.	General	2	2	1.00
15	Understand and apply preventive remediation measures for acid sulphate soils.	Soils	2	2	1.00
16	Understand and apply preventive remediation measures for acidity.	Soils	2	2	1.00
17	Understand and apply preventive remediation measures for dryland salinity.	Salinity	2	2	1.00
18	Understand and apply preventive remediation measures for erosion.	Soils	2	2	1.00
19	Understand and apply preventive remediation measures for irrigation-induced salinity.	Salinity	2	2	1.00
20	Understand and apply preventive remediation measures for soil structure	Soils	2	2	1.00
21	Understand and apply preventive remediation measures for wet soil pugging	Salinity	2	2	1.00
	PASTURE MANAGEMENT:				
22	Select locally suited pasture species and manage their recovery from grazing to maintain adequate cover.	Salinity	1	2	2.00
23	Establish deep-rooted pastures or re-vegetate with suitable species.	Salinity	3	2	0.67
24	Plant salt-tolerant pastures.	Salinity	3	2	0.67

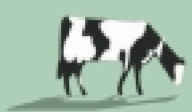


	Management Practice	Issue	Ratings		
			Net Cost	Environmental Impact	Cost Effectiveness
	PEST MANAGEMENT:				
25	Control cats, foxes and other vermin.	Biodiversity	3	4	1.33
26	Control rabbits and hares and eradicate weeds.	Biodiversity	3	4	1.33
	SOILS MANAGEMENT:				
27	Apply N soon after an irrigation laser level to reduce run-off and nutrient losses.	Nutrients	1	4	4.00
28	Avoid applying fertiliser before heavy rainfalls on sloping ground or within 20m of streams.	Nutrients	1	4	4.00
29	Reduce P loss by controlling soil erosion in cultivated lands.	Nutrients	1	4	4.00
30	Farm land according to its capability.	General	1	3	3.00
31	If flood irrigating, do not fertilise the bottom 20m of bays.	Nutrients	1	3	3.00
32	Apply fine lime when soils become too acidified and sow deep-rooted pastures with legumes to ‘mop-up’ excess N.	Acidity	1	2	2.00
33	Apply gypsum to sodic soils.	Sodicity	1	2	2.00
34	Apply nitrogen in small quantities to meet periodically during the growing season.	Nutrients	1	2	2.00
35	Apply phosphorous (P) around the beginning of pasture growth periods.	Nutrients	1	2	2.00
36	Deep rip or aerate compacted soils.	Soil biodiversity	1	2	2.00
37	Increase the organic matter content of soils through pastures and/or manures.	Soil structure	1	2	2.00
38	Prepare nutrient budgets (at the paddock or farm level) to monitor nutrient losses through milk, crops and stock and nutrient gains through legume pastures, fertilisers, feeds and manure.	Nutrients	1	2	2.00
39	Adopt conservation tillage methods (over-sowing, minimum or zero tillage, and cultivate across slopes).	Salinity, Erosion	2	3	1.50
40	Adopt shallow cultivation to avoid acid-sulphate layers unless wet.	Acidity	2	3	1.50
41	Monitor soil nutrients, pH, salinity, and groundwater levels.	Salinity	2	3	1.50
42	If flood irrigating, re-use irrigation run-off	Nutrients & Water Use	3	4	1.33
43	Avoid cultivating during high rainfall seasons.	Salinity	2	2	1.00
44	Do not fallow during wet seasons.	Salinity	3	3	1.00
45	Test and record surface soil (0-10cm) pH at least every three years.	Acidity	2	2	1.00
46	Test the nutrient levels of soils (at the same location) every 1-2 years and adjust fertiliser applications accordingly.	Nutrients	2	2	1.00
47	Understand water holding capacity of soils.	Water Use	2	2	1.00
48	Understand water storage (holding capacity) of soil in the root zone of plants.	Water Use	2	2	1.00
49	Ensure sub-surface (10-60cm) acidity does not increase.	Acidity	3	2	0.67
50	Recognise soil condition problems and their potential.	Salinity	2	1	0.50



	Management Practice	Issue	Ratings: Net Cost	Ratings: Environmental Impact	Ratings: Cost Effectiveness
	VEGETATION & BIODIVERSITY MANAGEMENT:				
51	Provide nesting boxes in re-vegetation plantations.	Biodiversity	2	4	2.00
52	Maintain tree hollows and other natural habitat.	Biodiversity	3	4	1.33
53	Manage remnant wetlands to maintain natural wetting and drying cycles, retain natural snags and eradicate introduced fish.	Biodiversity	4	5	1.25
54	Use windbreaks or shade plantings to link waterways and patches of remnant native vegetation or as part of a district, catchment or roadside program.	Biodiversity	4	5	1.25
55	Design plantings to minimise potential local pest and weed control problems.	Biodiversity	2	2	1.00
56	Establish groundcover and under-story plants as well as trees.	Biodiversity	4	4	1.00
57	Fence waterways to manage their use.	Biodiversity	4	4	1.00
58	Use a range of local native species (and local provenances if possible).	Biodiversity	4	4	1.00
59	Use vegetated 'filter strips' (that include ground cover) adjacent to streams; particularly in very high rainfall areas to reduce the physical transport of manure to streams.	Nutrients	4	4	1.00
60	Adopt direct seeding techniques or other locally proven re-vegetation methods.	Biodiversity	3	2	0.67
61	Fence off and re-vegetate degraded areas.	Salinity, Erosion, Biodiversity	3	2	0.67
62	Fence off extremely vulnerable areas.	Salinity, Erosion, Biodiversity	3	2	0.67
63	Fence off and re-vegetate recharge areas.	Salinity	4	2	0.50
64	Fence remnant vegetation to manage its use to avoid over-grazing.	Biodiversity	4	2	0.50
65	Monitor, evaluate and manage wildlife populations and their impacts.	Biodiversity	4	2	0.50
	WATER ENGINEERING:				
66	Pressurised pipes.	Water Use	2	3	1.50
67	Establish and manage a drainage water re-use system (especially from flood irrigation).	Water Use	3	4	1.33
68	Adopt suitable surface drainage practices (e.g. spoon drains, hump and hollow or plough affected areas 'in lands').	Salinity	3	3	1.00
69	Avoid drying out (oxidation) of acid-sulphate layers (e.g. use laser levelling instead of drainage and avoid new drainage or excavation).	Salinity	3	3	1.00
70	Design and locate laneways to avoid run-off induced erosion.	Salinity	3	3	1.00
71	Establish surface drains to collect runoff and/or sub-surface drains to prevent excess filtration.	Water Use	3	3	1.00
72	For flood irrigation, laser level bays (if uniform soils permit) and adopt an automated system.	Water Use	3	3	1.00
73	Install surface and/or subsurface drains or groundwater bores and manage drainage waters.	Salinity	4	4	1.00
74	Monitor, evaluate and manage wildlife populations and their impacts.	Biodiversity	3	3	1.00
75	Prevent channel leakage.	Water Use	4	4	1.00
76	Install and manage sub-surface drainage where appropriate.	Salinity	4	3	0.75

	Management Practice	Issue	Ratings		
			Net Cost	Environmental Impact	Cost Effectiveness
	WATER MANAGEMENT:				
77	If flood irrigating, do not irrigate for at least four days after applying P fertiliser.	Nutrients	1	4	4.00
78	If flood irrigating, do not over-water and minimise run-off.	Nutrients	1	4	4.00
79	If flood irrigating, ensure there is no-run-off for two irrigations after fertilising.	Nutrients	1	4	4.00
80	Apply water evenly with an irrigation system designed to match soil types.	Water Use	1	2	2.00
81	Compare estimated annual crop water requirements with the total water applied.	Water Use	1	2	2.00
82	Control water application and management	Water Use	1	2	2.00
83	Determine water needs of pastures	Water Use	1	2	2.00
84	Ensure sufficient irrigation water infiltrates the soil to prevent salt accumulation by capillary action.	Salinity	1	2	2.00
85	Incorporate weather forecasts into irrigation decisions.	Water Use	1	2	2.00
86	Maximise irrigation efficiency to avoid over-irrigation (particularly with saline water).	Salinity	1	2	2.00
87	Review the security and best use of water rights – water allocation policies permitting.	Water Use	1	2	2.00
88	Reduce N loss by minimising leaching.	Nutrients	3	4	1.33
89	After cleaning drains, water lime into spoil and hold water back for 5-7 days.	Salinity	2	2	1.00
90	Match the application rate at which water is absorbed.	Water Use	2	2	1.00
91	Monitor the quality of irrigation and drainage water.	Water Use	2	2	1.00
92	Reduce N loss by minimising nitrogen volatisation through the adequate availability of moisture when applying urea or ammonium.	Nutrients	2	2	1.00
93	Review total on-farm water use, e.g. shed and yards (recycle cooling water; yard wash down); stock and domestic consumption; drainage/effluent and irrigation).	Water Use	2	2	1.00
94	Schedule irrigation by measuring soil moisture, e.g. by tensiometer.	Water Use	2	2	1.00
95	Use and manage groundwater in conjunction with surface water.	Salinity	2	2	1.00
96	Use water efficient cleaning systems.	Nutrients	3	3	1.00
97	Use, monitor and manage groundwater in conjunction with surface water.	Salinity	2	2	1.00
98	Manage stormwater (including that from roadsides) to reduce the prospect of manure being discharged to streams.	Nutrients	4	3	0.75
99	Reduce run-off and its velocity.	Salinity	4	3	0.75
100	Carefully manage the use of saline effluent.	Salinity	3	2	0.67
101	Minimise N leaching.	Salinity	3	2	0.67
102	Concentrate inputs (such as water) on the most productive areas of the property.	Water Use	2	1	0.50



Annex C: Indicative cost effectiveness ratings and net farm cost compared

Resource Economics Unit scored 101 management practices that are mentioned in the Regional Dairy Plans in *DairyingforTomorrow*. These practices cover all natural resource management topics across all dairy regions. It is stressed that the results presented here are simply illustrative of a rating and ranking procedure, and need to be reviewed by the Dairy Regional Development Programs to reflect their local conditions in the light of firmer evidence. The results are summarised in Table 4.

Environmental Cost-effectiveness Ratings: The top 25 management practices in terms of environmental cost-effectiveness contained practices that had either:

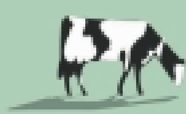
- low cost but significant environmental effect: e.g. 'provision of nesting boxes', 'farm land according to its capability', 'reduce P loss by controlling soil erosion on cultivated land' and 'control cats, foxes and other vermin'); or
- higher net farm cost but very significant environmental effect, e.g. 'Avoid compacting by not over-grazing or cultivating when wet and by keeping traffic to designated laneways' and 'Control water application and management'.

Note that the top 25 management practices listed do not include participation in Landcare-type activities. This is because the parent database in DairyingforTomorrow considered on-farm practices.

Net Farm Cost Ranking: 23 (or 92%) of the top 25 management practices ranked by Environmental Cost Effectiveness also appeared in the top 25 when ranked by Net Farm Cost. These are indicated by a '1' in the last column of Table 4. The management practices that dropped out when ranked by Net Farm Cost were (i) 'incorporate weather forecasts into irrigation decisions' and (ii) 'review the security and best use of water rights – water allocation policies permitting'.

Table 4: Top 25 management practices ranked by environmental cost effectiveness and net farm cost (based on intuitive scores by Resource Economics Unit).

	Top 25 management practices ranked by cost-effectiveness	Top 25 management practices ranked by net farm cost agreement	(=1 if item is in both lists)
1	Apply N soon after an irrigation laser level to reduce run-off and nutrient losses.	Apply fine lime when soils become too acidified and sow deep rooted pastures with legumes to 'mop-up' excess N.	1
2	Avoid applying fertiliser before heavy rainfalls on sloping ground or within 20m of streams.	Farm land according to its capability.	1
3	If flood irrigating, do not irrigate for at least four days after applying P fertiliser.	Apply N soon after an irrigation laser level to reduce run-off and nutrient losses.	1
4	If flood irrigating, do not over-water and minimise run-off.	Apply nitrogen in small quantities to meet periodically during the growing season.	1
5	If flood irrigating, ensure there is no-run-off for two irrigations after fertilising.	Apply P around the beginning of pasture growth periods.	1
6	Reduce P loss by controlling soil erosion in cultivated lands.	Avoid applying fertiliser before heavy rainfalls on sloping ground or within 20m of streams.	1
7	Farm land according to its capability.	If flood irrigating, do not fertilise the bottom 20m of bays.	1



	Top 25 management practices ranked by cost-effectiveness	Top 25 management practices ranked by net farm cost agreement	(=1 if item is in both lists)
8	If flood irrigating, do not fertilise the bottom 20m of bays.	If flood irrigating, do not irrigate for at least four days after applying P fertiliser.	1
9	Apply fine lime when soils become too acidified and sow deep rooted pastures with legumes to 'mop-up' excess N.	If flood irrigating: do not over-water and minimise run-off.	1
10	Provide nesting boxes in re-vegetation plantations.	If flood irrigating: ensure there is no-run-off for two irrigations after fertilising.	1
11	Apply nitrogen in small quantities to meet periodically during the growing season.	Prepare nutrient budgets (at the paddock or farm level) to monitor nutrient losses through milk, crops and stock and nutrient gains through legume pastures, fertilisers, feeds and manure.	1
12	Apply P around the beginning of pasture growth periods.	Reduce P loss by controlling soil erosion in cultivated lands.	1
13	Collect effluent where possible, e.g. sheds yards, etc.	Ensure sufficient irrigation water infiltrates the soil to prevent salt accumulation by capillary action.	1
14	Prepare nutrient budgets (at the paddock or farm level) to monitor nutrient losses through milk, crops and stock and nutrient gains through legume pastures, fertilisers, feeds and manure.	Maximise irrigation efficiency to avoid over-irrigation (particularly with saline water).	1
15	Ensure sufficient irrigation water infiltrates the soil to prevent salt accumulation by capillary action.	Select locally suited pasture species and manage their recovery from grazing to maintain adequate cover.	1
16	Maximise irrigation efficiency to avoid over-irrigation (particularly with saline water).	Apply gypsum to sodic soils.	1
17	Select locally suited pasture species and manage their recovery from grazing to maintain adequate cover.	Avoid compacting by not over-grazing or cultivating when wet and by keeping traffic to designated laneways.	1
18	Apply gypsum to sodic soils.	Deep rip or aerate compacted soils.	1
19	Avoid compacting by not over-grazing or cultivating when wet and by keeping traffic to designated laneways.	Increase the organic matter content of soils through pastures and/or manures.	1
20	Deep rip or aerate compacted soils.	Apply water evenly with an irrigation system designed to match soil types.	1
21	Increase the organic matter content of soils through pastures and/or manures.	Compare estimated annual crop water requirements with the total water applied.	1
22	Apply water evenly with an irrigation system designed to match soil types.	Control water application and management.	1
23	Compare estimated annual crop water requirements with the total water applied.	Determine water needs of pastures.	1
24	Control water application and management.	Incorporate weather forecasts into irrigation decisions.	0
25	Determine water needs of pastures.	Review the security and best use of water rights – water allocation policies permitting.	0
	Total		8 (92)

It is notable that the environmental impact of many higher-cost activities was not judged to be sufficient (by Resource Economics Unit) for them to be included in the top 25 practices in terms of cost-effectiveness, even though they would have greater absolute environmental impact, e.g. a Net Farm Cost score of 4 with an Environmental Impact score of 3. Examples are given in Table 5. It seems likely that these are the kinds of items where increased government regulation in future may need to be accompanied by incentives or subsidies if significant impacts on farm profitability are to be avoided.

Table 5: Management practices with the lowest (<1.0) cost-effectiveness index, as scored by Resource Economics Unit.

	Management practice	Issue	Ratings		
			Net Cost	Environmental Impact	Cost Effectiveness
1	Manage storm water (including that from roadsides) to reduce the prospect of manure being discharged to streams.	Nutrients	4	3	0.75
2	Install and manage sub-surface drainage where appropriate.	Salinity	4	3	0.75
3	Reduce run-off and its velocity.	Salinity	4	3	0.75
4	Ensure sub-surface (10-60cm) acidity does not increase.	Acidity	3	2	0.67
5	Adopt direct seeding techniques or other locally proven re-vegetation methods.	Biodiversity	3	2	0.67
6	Carefully manage the use of saline effluent.	Salinity	3	2	0.67
7	Establish deep-rooted pastures or re-vegetate with suitable species.	Salinity	3	2	0.67
8	Minimise N leaching.	Salinity	3	2	0.67
9	Plant salt tolerant pastures.	Salinity	3	2	0.67
10	Fence off and re-vegetate degraded areas.	Salinity, Erosion, Biodiversity	3	2	0.67
11	Fence off extremely vulnerable areas.	Salinity, Erosion, Biodiversity	3	2	0.67
12	Locate dairies to minimise the time cows spend on roadways.	Nutrients	5	3	0.60
13	Fence remnant vegetation to manage its use to avoid over-grazing.	Biodiversity	4	2	0.50
14	Concentrate production to the lowest salinity soils.	Salinity	2	1	0.50
15	Fence off and re-vegetate recharge areas.	Salinity	4	2	0.50
16	Plant salt tolerant pastures.	Salinity	2	1	0.50
17	Recognise soil condition problems and their potential.	Salinity	2	1	0.50
18	Concentrate inputs (such as water) on the most productive areas of the property.	Water Use	2	1	0.50

Table 6: Top 25 management practices ranked by environmental cost effectiveness and environmental impact (based on intuitive scores by Resource Economics Unit).

	Top 25 management practices ranked by environmental cost-effectiveness	Top 25 management practices ranked by environmental impact	Agreement (=1 if item is in both lists)
1	Apply N soon after an irrigation laser level to reduce run-off and nutrient losses.	Manage remnant wetlands to maintain natural wetting and drying cycles, retain natural snags, and eradicate introduced fish.	0
2	Avoid applying fertiliser before heavy rainfalls on sloping ground or within 20m of streams.	Use windbreaks or shade plantings to link waterways and patches of remnant native vegetation or as part of a district, catchment or roadside program.	0
3	If flood irrigating, do not irrigate for at least four days after applying P fertiliser.	Treat collected effluent (e.g. in a pond system).	0
4	If flood irrigating, do not over-water and minimise run-off.	Control cats, foxes and other vermin.	0
5	If flood irrigating, ensure there is no run-off for two irrigations after fertilising.	Control rabbits and hares and eradicate weeds.	0
6	Reduce P loss by controlling soil erosion in cultivated lands	Establish groundcover and under-story plants as well as trees.	0
7	Farm land according to its capability.	Fence waterways to manage their use.	0
8	If flood irrigating, do not fertilise the bottom 20m of bays.	Maintain tree hollows and other natural habitat.	0
9	Apply fine lime when soils become too acidified and sow deep-rooted pastures with legumes to 'mop-up' excess N.	Provide nesting boxes in re-vegetation plantations.	1
10	Provide nesting boxes in re-vegetation plantations.	Use a range of local native species (and local provenances if possible).	0
11	Apply nitrogen in small quantities periodically during the growing season.	Apply N soon after an irrigation laser level to reduce run-off and nutrient losses.	1
12	Apply phosphorous (P) around the beginning of pasture growth periods.	Avoid applying fertiliser before heavy rainfalls on sloping ground or within 20m of streams.	1
13	Collect effluent where possible, e.g. sheds yards, etc.	Collect effluent where possible, e.g. sheds yards, etc.	1
14	Prepare nutrient budgets (at the paddock or farm level) to monitor nutrient losses through milk, crops and stock and nutrient gains through legume pastures, fertilisers, feeds and manure.	Fence off and manage stock access to water frontages.	0
15	Ensure sufficient irrigation water infiltrates the soil to prevent salt accumulation by capillary action.	If flood irrigating: do not irrigate for at least four days after applying P fertiliser.	1
16	Maximise irrigation efficiency to avoid over-irrigation (particularly with saline water).	If flood irrigating, do not over-water and minimise run-off.	1
17	Select locally suited pasture species and manage their recovery from grazing to maintain adequate cover.	If flood irrigating, ensure there is no run-off for two irrigations after fertilising.	1
18	Apply gypsum to sodic soils.	Minimise effluent loss and run-off from laneways and feed pads.	0
19	Avoid compacting by not over-grazing or cultivating when wet and by keeping traffic to designated laneways.	Reduce N loss by minimising leaching.	0
20	Deep rip or aerate compacted soils.	Reduce P loss by controlling soil erosion in cultivated lands.	1

	Top 25 management practices ranked by environmental cost-effectiveness	Top 25 management practices ranked by environmental impact	Agreement (=1 if item is in both lists)
21	Increase the organic matter content of soils through pastures and/or manures.	Use vegetated 'filter strips' (that include ground cover) adjacent to streams, particularly in very high rainfall areas to reduce the physical transport of manure to streams.	0
22	Apply water evenly with an irrigation system designed to match soil types.	If flood irrigating: re-use irrigation run-off.	0
23	Compare estimated annual crop water requirements with the total water applied.	Install surface and/or subsurface drains or groundwater bores and manage drainage waters.	0
24	Control water application and management.	Establish and manage a drainage water re-use system (especially from flood irrigation).	0
25	Determine water needs of pastures.	Prevent channel leakage.	
	Total Common Items		**8/25**

Table 6 shows that only 8 out of the top 25 management practices rated by their overall Environmental Impact were considered to be Cost-Effective at the individual farm level. That is, according to the rough judgements expressed in the table, the other 17 practices would fall into the Type II or Type III categories, requiring community or financial support.

These scores and rankings are provided for illustrative purposes only, and should be re-worked for individual catchments using best local knowledge.

Notes

Notes

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