Developing & Implementing a Biodiversity Strategy for Processing Tomato Farms

G.S. Dalton, J.S. McMaster & L.C. McMaster
Outsourced Environmental
PO Box 169, The Basin, Victoria 3154 Australia

Keywords: Biodiversity, Sustainability, Environmental Management System, EMS, Monitoring

Abstract:

The Unilever & Horticulture Australia, Sustainable Agriculture Project, "Grow Sustainably™" has developed a system to incorporate farm biodiversity into Environmental Management Systems (EMS) via a six (6) step process. Ten biodiversity parameters were selected and used to assess the biodiversity status of five pilot farms over two monitoring seasons. A farm biodiversity management and enhancement plan was developed in line with project goals, local and regional biodiversity goals. Significant opportunities for biodiversity enhancement were found with existing areas of permanent vegetation per farm ranging 5% to 10% of farm area. Enhancement plans also considered the role of permanent vegetation for stock and crop shelter, water table management, surface water management, timber products, and aesthetics. An overview is given of the Grow Sustainably™ Biodiversity Strategy method, including the sustainability indicator and parameter selection process, the assessment process, the subsequent biodiversity enhancement planning and works implementation process, linking farms with catchment and regional priorities.

INTRODUCTION

The development of agriculture has caused a significant change in the native flora and fauna in most agricultural areas around Australia. Current farming practices can also have a positive or negative impact on biodiversity. This paper outlines how farm biodiversity is incorporated into an Environmental Management System for the "Sustainable Production of Processing Tomatoes". Ten biodiversity parameters were selected and assessed and biodiversity enhancement plans were developed. Enhancement plans were linked to multiple benefits of on-farm permanent vegetation and legislation and local and regional strategy requirements. A six (6) step biodiversity parameter methodology has been established.

BIODIVERSITY PARAMETER METHODOLOGY

Selecting biodiversity parameters (Step 1).

Biodiversity is one of ten sustainability indicators selected as part of the Unilever global sustainable agriculture program. In the context of the global program, sub indicators are referred to as sustainability parameters[1]. International literature was consulted for possible biodiversity parameters and parameter selection criteria. The main publications used to determine the criteria for evaluating sustainability parameters were OECD (1994), Walker and Reuter (1996), RIRDC (1997), Fairweather and Napier (1998) and Anderson et al (2001). The primary criteria used to select biodiversity parameters were that the parameters must be; 1) Measurable (including it being repeatable, accurate, scientifically sound and flexible); 2) Interpretable against a threshold value; 3) Representative of high quality biodiversity; 4) Sensitive to environmental change; and 5) Cost effective. The biodiversity parameters selected for application to Processing Tomato farms are listed in Table 1. Threshold values

[1] *Further details about the Unilever Sustainable Agriculture Program and the sustainable indicators can be found in the paper presented by West & McMaster (Unilever's Contribution to Sustainable Agriculture) at the 3rd National Conference on Environmental Management Systems (2003) and on the website; www.growsustainably.com.*

were determined for each biodiversity parameter and are cited in Table 2. The details on how each threshold value was determined are too lengthy for this paper, but one abbreviated example is as follows:

Threshold for shape of permanent vegetation area.

It is well accepted that blocks or round shaped areas of native vegetation are better for biodiversity than narrow, long areas. This is related to the fact that vegetation areas have differences in microclimate, weed invasion and fauna movement between their edges and centre. Hence edges or boundaries should be minimised in order to maximise the internal stability of an ecosystem. The boundary to area ratio of conservation blocks of native vegetation has been used at a national level (SCARM 1998). The units used were km boundary/km^2 of native vegetation, where a low value indicates greater conservation benefits. Nationally the ratio varied from 0.025 to 0.3. Boundary to area ratio's were considered applicable at a farm level by using m/ha rather than km/km^2.

The effect of the shape of one hectare of native vegetation on its boundary distance is illustrated in Figure 1. The B:A ratio for each block of permanent vegetation is calculated and the threshold is the percentage of the permanent vegetation hectares that have a B:A ratio of 400.

Discussion of selected parameters.

The selected parameters represent high quality native vegetation and water quality. The criteria of 'Connectivity' and 'Habitat features', which are commonly quoted as essential for biodiversity objectives were not used as it is difficult to establish threshold values for them, they are insensitive to farm management practices and too much emphasis has been placed on connectivity in the past. "Data is increasingly showing that isolation in many landscapes is not the real problem for most birds, it is the lack of habitat" (Lambeck, pers. comm. 2001). In the study farm regions, 100 ha of woodland that is cleared results in a thousand or more woodland birds losing their habitat and disappearing (Bennett et al 1998). High quality native vegetation parameters were selected instead of fauna parameters for environmental management systems because of the following advantages they offer

1. Property level parameters.

Areas of flora provide the habitat (structural diversity, leaf litter, food and shelter) requirements for fauna. On a property the 'habitat' may be of high quality but the fauna may not have moved in – because of the time lag (possibly years) in their arrival, or for other reasons beyond the control of the landowner. For example, within a region other landowners may not have areas of flora that connect for species habitat or migratory patterns. The Grow Sustainably™ project is developing parameters applicable at the farm-level, so they need to be independent of surrounding farms and regional interactions with birds, mammals and reptiles. Therefore, the only fauna parameters that would be of use are those that are independent of connectivity and address fauna that readily inhabit small and isolated areas of vegetation and are not highly mobile (of limited territory), a focus being the relatively immobile invertebrates such as soil beetles (Sarre, pers. comm. 2001).

2. Threshold values.

Local benchmarks, which can be used to determine threshold values, are more readily available for flora than for fauna. That is, reference areas of undisturbed vegetation of the same EVC are available, or can be created using historical flora information and current species association information. Given the complexity of fauna interactions, the threshold levels for fauna are more difficult to determine.

3. Monitoring difficulty.

Flora is easier to monitor because it is not put to flight by the presence of humans, measurement is not as time bounded as fauna and requires less resources. Also, it is very complex to monitor and interpret fauna presence and interactions on a variety of sites due to the incidence of periodic events such as drought, fire and floods and in response to flowering patterns of Eucalypt trees (Bennett et al 1998).

4. Links to degradation.

Flora provides more obvious visual indications of degradation from salinity, soil erosion and weed invasion.

5. Wide benefit.

Loss of suitable habitat can affect large numbers of fauna species (20%) in a bioregion (Ahern 2000), so focusing on high quality native vegetation has the potential to benefit large numbers of fauna species, rather than monitoring a few fauna species.

The use of parameters describing high quality native vegetation concurs with the statement in ANZECC (2000), that "the extent and condition of native vegetation by type is the best available surrogate for the condition of terrestrial ecosystem diversity at this time". It is recommended that a bird, mammal or reptile species that will likely inhabit high quality native vegetation on each property be selected as a fauna icon for each farm, according to the threatened species conservation priorities (Ahern et al 2000, Lambeck pers. comm. 2001). By default, focusing on threatened species also focuses on the other key threats of a region (Ahern et al 2000).

Biodiversity assessment

Using the selected parameters and their threshold values (potentially sustainable or conducive to a more stable environment), the biodiversity status of five case study Tomato farms was assessed. Multiple blocks of vegetation on a farm were combined to form a composite farm biodiversity status. Assessments were presented as an "Eco-map" (Figure 2) which indicates visually the parameters that meet or exceed the threshold values and those that do not and which subsequently require farm management actions. The 'picture' given by an Eco-map is more holistic and easier to interpret than systems that present assessments as one final score. The challenge for the farmer is then to implement appropriate environment and Best Management Practice (BMP) techniques to "adjust" the parameter scores back to (or to exceed) the threshold value represented by the circle, so that improved sustainability is achieved. Figure 2 is an Eco-map from one farm showing that for a number of biodiversity parameters, change or improvement is required (BMP's and biodiversity enhancement plans/actions are needed) to adjust them to a more sustainable or desirable level.

INCORPORATING BIODIVERSITY IN THE EMS

Assessment and information collection

Completing the biodiversity assessment data is the first part of the data collection process for the biodiversity component of the EMS for Grow Sustainably™. The other information required is given below.

To help identify the effect of management practises on biodiversity it is necessary to assess - Possible farm threats from biodiversity (Example in Table 3) and Possible impacts and benefits of farm management on biodiversity (Example in Table 4). Support information required included - Structural descriptions and species lists for EVC's[2] matching those on-farm, Flora species of conservation significance for each on-farm EVC, A review of legislation that may influence management practises relating to biodiversity, and Local and regional natural resource and biodiversity strategies that may influence management practises.

Implementation plan

To prepare an implementation plan the steps are – (1) From the Eco-map determine the general strategies required to achieve the Eco-map thresholds; (2) For these strategies select specific actions applicable to the property (Table 5); (3) Based up the assessment of possible farm benefits from

[2] *Ecological Vegetation Class (EVC): Vegetation structure and floristics that describe local patterns of vegetation diversity and reflect environmental influences.*

biodiversity (Table 4) prepare a plan to address the benefits the grower would like to achieve. It is likely that new areas of permanent vegetation will be part of this plan. In consultation with the grower, the farm is mapped to show how permanent vegetation areas might enhance biodiversity, assist with the management of groundwater and salinity surface water and nutrients, and the provision of shelter, timber products and enhance aesthetic appeal; the final multiple benefits plan will be accomodate these purposes for permanent vegetation; (4) Address any threats to the farm from biodiversity and permanent vegetation areas, as raised in Table 3. (5) Modify the plan to meet the objectives of local and regional strategies for biodiversity, salinity, etc; (6) Modify the plan to meet legislation requirements; (7) Prepare a detailed works plan and budget.

Priority actions

The possible actions need to be prioritised. The following criteria are used to help set priority actions: 1. Legal obligations – Are there any legal (compulsory) obligations that require attention? (For example, grazing of remnant vegetation or other activities that may entail legal risk). 2. Achieving ‘No Net Loss’ – What actions will avoid futher biodiversity decline? 3. Priority for farm production benefit – What are the largest farm production benefits from managing or establishing permanent vegetation areas? 4. Incentive or marketing benefit – Is there any funding available or price incentives for achieving ‘Net Biodiversity Gain’? 5. Implement wider strategies – Are there any non-compulsory local, regional, State or National strategies (e.g., biodiversity, environmental flow, groundwater) that apply to the property?

The above criteria are applied to generate a short-list of actions which are then further prioritised according to – a. Cost of time and money – What is affordable ?; b. Which action gives the biggest return for effort?; c. Personal preferences – Which actions are preferred by the grower ? Since many actions will address more than one prioritising criteria, it is helpful to list the actions and prioritising criteria in a table to clarify and select the actions that address the most criteria.

Monitoring

The Grow Sustainably™ system is consistent with the Plan, Do, Measure and Improve cycle (PDMI) common to most EMS. For the biodiversity element of the EMS, the Planning phase involves the collation of information on biodiversity parameters and the interaction of farm management with biodiversity to prioritise actions. Once developed, these plans are then implemented (‘Doing Phase’). Given the strong monitoring focus of Grow Sustainably™ and the Unilever program, the Measuring phase is used to track progress and improvements against the plans, actions and selected biodiversity parameters in subsequent years. Monitoring involves reassessing the biodiversity parameters, modifying the Eco-map and determining ‘Improvements’.

CASE STUDIES

The biodiversity strategy was used on five pilot farms participating in the Unilever Sustainable Agriculture Project on Tomatoes over two monitoring seasons. Significant opportunities for biodiversity enhancement were found with existing areas of permanent vegetation per farm which ranged from 5% to 10% of farm area. For example the Eco-map (Figure 2) shows there are adequate areas of permanent vegetation of good B:A ratio for biodiversity, but strategies are needed to enhance biodiversity via – managing remnant vegetation to encourage vegetation strata; revegetating to increase the strata levels and the species richness; reducing nutrients and chemicals entering water bodies (the results for frogs and aquatic macro-invertebrates indicate the water quality is poor); controlling weeds in permanent vegetation areas.

In general, it is likely that achieving biodiversity thresholds will depend upon managing existing native vegetation sites by removing or controlled grazing, weed control, feral vertebrate control and strategic revegetation. Also, establishing new area of native vegetation to extend, link or make more block-shaped the existing areas of native vegetation will be important.

A formal, scaled, biodiversity enhancement plan & map was generated for each Tomato property showing areas of native vegetation (current & planned) along with the location & multiple benefits of the biodiversity initiatives for that farm.

CONCLUSION

The farm biodiversity system developed as part of the "Grow Sustainably™" project has helped growers implement prioritised management actions to improve on-farm biodiversity. Therefore this system is effectively functioning as one part of the total "Grow Sustainably™" Environmental Management System.

Literature Cited

Ahern, L., K Lowe, A. Moorrees, G. Park and R. Price (2000). A strategy for conserving biodiversity in the Goldfields bioregion, Victoria. Department of Natural Resources and Environment, Victoria.

Anderson, S., K. Lowe, K. Preece and A. Crouch (2001). Incorporating Biodiversity into Environmental Management Systems for Victorian Agriculture – A discussion paper. The State of Victoria, Department of Natural Resources and Environment, Victoria 2001.

Bennett, A. F. and L.A. Ford (1997). Land use, habitat change and the conservation of birds in fragremented rural environments: a landscape perspective from the Northern Plains, Victoria, Australia. Pacific Conservation Biology, Vol. 3:244-61.

Bennett, A., G. Brown, L. Lunsden, D Hespe, S Krasna, J. Silins (1998). Fragments for the Future. – Wildlife in the Victorian Riverina (the Northern Plains). Department of Natural Resources and Environment, East Melbourne.

Bulman, P. and G. Dalton (2000). Farm Revegetation Design – Optimising Your Benefits. Primary Industries and Resources, SA, Adelaide.

Fairweather P.G. and G.M. Napier (1998) Environmental Indicators For National. State Of The Environment Reporting: Inland Waters: Australia: State Of The Environment Environmental Indicator Report, Environment Australia, Department of the Environment.

Lambeck, R. (2001) personal communication (Draft report).

OECD Core Set (1994). Environmental Indicators Pub. Organisation for Economic Co-Operation and Development, 1994, Paris, France.

RIRDC (1997). Sustainable indicators for Agriculture: Introductory guide to Regional/National and On-farm Indicators. Rural Industries Research and Development Corporation, ACT (Australia).

Sarre, M. (2001). Personal communication.

Streamwatch (2001). www.streamwatch.org.au/bugs/spring/bugs/guide.

Walker J. and D. J. Reuter (1996). Indicators of Catchment Health: A Technical Perspective Pub. CSIRO, Australia.

West, S. (principal author) (1998). The Streamwatch Manual – The complete Streamwatch guide to water quality monitoring. Sydney Water Corporation.

Tables

Table 1: Biodiversity parameters evaluated

Flora		Fauna	
• Size • Shape • Connectivity • Structural profile • Floristic composition • Conservation status • Habitat features	• Health • Degradation • Soil cover • Soil micro-flora • Presence of regeneration • Weed invasion • Excessive native fauna pressure	• Birds • Mammals • Reptiles • Aquatic macro-invertebrates • Insects • Spiders • Amphibians	• Soil fauna • Feral fauna

Table 2: The selected biodiversity parameters, how they are measured & their threshold values

Assessment of On-Farm Permanent Vegetation Areas		
Parameters	***How measured***	***Threshold value***
1. Size of permanent vegetation areas	% of farm	10%
2. Shape of permanent vegetation areas	B:A ratio	100% of area in blocks with B:A < 400
3. Vegetation strata	Rating based upon comparison with undisturbed EVC	Rating of 10
4. Species richness	% of species in undisturbed EVC	100%
5. Conservation status	Rating based upon the published status	Rating of 100
6. Health of native vegetation	Rating	Rating of 100
7. Weed invasion of native vegetation	Rating	Rating of 100
8. Feral fauna in native vegetation	Rating	Rating of 100
Assessment of Water Bodies		
Parameters	***How measured***	***Threshold value***
9. Frogs	% abnormality converted to a score	Abnormality score of 100
10. Aquatic macro-invertebrates	Pollution index using the "Streamwatch[3]" system	Pollution index of 50

Table 3: Example of possible farm threats from biodiversity

Possible threat from biodiversity	**Comments on on-farm threats**	**Threat perceived by a tomato grower**
1. Habitat value	Reptiles, birds and mammals may migrate to crops and cause losses. For example, crows pull out tomato seedlings.	Not obvious
2. Fire risk	Loss of assets and resources.	Potential risk
3. Opportunity cost	Potential cost of lost production from areas with native vegetation.	Of concern
4. Management costs (e.g. environmental weeds, rabbits and foxes)	Cost of time and money.	Not major
5. Revegetation costs for biodiversity enhancement	Cost of lost production from land, plus cost of revegetation works.	Not major cost

[3] *Streamwatch (2001), West, S. (1998).*

Table 4: Potential Management Impacts upon Biodiversity & Potential Benefits of Investing in Farm Biodiversity

Potential (Negative) Management Impacts	Potential Biodiversity Benefits
• Clearance of native vegetation • Pesticide Residue build-up in soil • Pesticide conative vegetation or aquatic systems[1] • Fertilizer leakage into aquatic systems • Soil nutrient toxicity for Native vegetation or promotion of introduced species[1] • 6.Change in landscape hydrology affecting native vegetation ecosystem survival[1] • Livestock destruction of native vegetation & soil structure • Cultivation & Cultural degradation of native vegetation • Habitat creation for introduced predators & feral herbivores • Introduced weed competition disadvantaging native species[1] • Reduction in stream flow affecting aquatic life [1] – Tomato Growers acknowledge there is or may be an issue	• Aesthetics and recreation[2] • Genetics • Groundwater and salinity control[2] • Pollination • Surface water management and nutrient and silt filtration[2] • Honey production • Shelter[2] • Bush foods and new industries • Firewood, fence-posts and building timber[2] • Biodiversity credits • Seed sales • Carbon credits • Habitat value • Reduction in council rates due to biodiversity protection • Micro-flora – improving soil structure and nutrient cycling [2] – Tomato Growers acknowledge there are or may be benefits

Table 5: Management strategies that can be used to help achieve biodiversity targets

Indicator	Management Strategies
Size of native vegetation	Revegetate to establish buffer zones and extend areas of native vegetation
Shape of native vegetation	Revegetate to establish buffer zones and extend areas of native vegetation
Vegetation strata	Remove grazing (fencing), control weeds, control feral vertebrates, revegetate, controlled burning to release germination, reduce effects of irrigation, nutrient loading and soil erosion which encourage weeds and reduces native vegetation
Species richness	As above
Conservation status	Reduce effects of irrigation, nutrient loading and soil erosion which encourage weeds and reduces native vegetation, initiate species recovery programs
Health of native vegetation	Groundwater or salinity management, remove pressure from excessive nutrients. (use vegetation buffer zones, review fertiliser use, review leaching – location/flow & amount), Revegetation to establish floristic composition to balance the ecosystem, Revegetation to buffer native vegetation from wind exposure and agricultural practices
Weed invasion of native vegetation	Manage weed seed sources, weed control in native vegetation, including fire as a weed management tool, stock removal to reduce weed seed source and lower nutrient loading (includes the use of fencing), modified irrigation to reduce groundwater levels encouraging for weed growth and reducing native vegetation health, modified fertiliser practices to reduce nutrient loads
Feral fauna	Implement control programs
Frog abnormalities	Reduce use of pesticides and surfactants, increase the use of IPM and beneficial insects (reducing dependence on chemicals), avoid spraying near irrigation channels & waterways (buffer zones), regularly calibrate chemical spray equipment (keep records), train staff and contractors on risks and BMP's
Aquatic macro-invertebrates	Reduce pollution of water with nutrients, heavy metals and pesticides. Strategic use of pesticides

Figures

Figure 1: Effect of shape on the boundary of one hectare of native vegetation areas

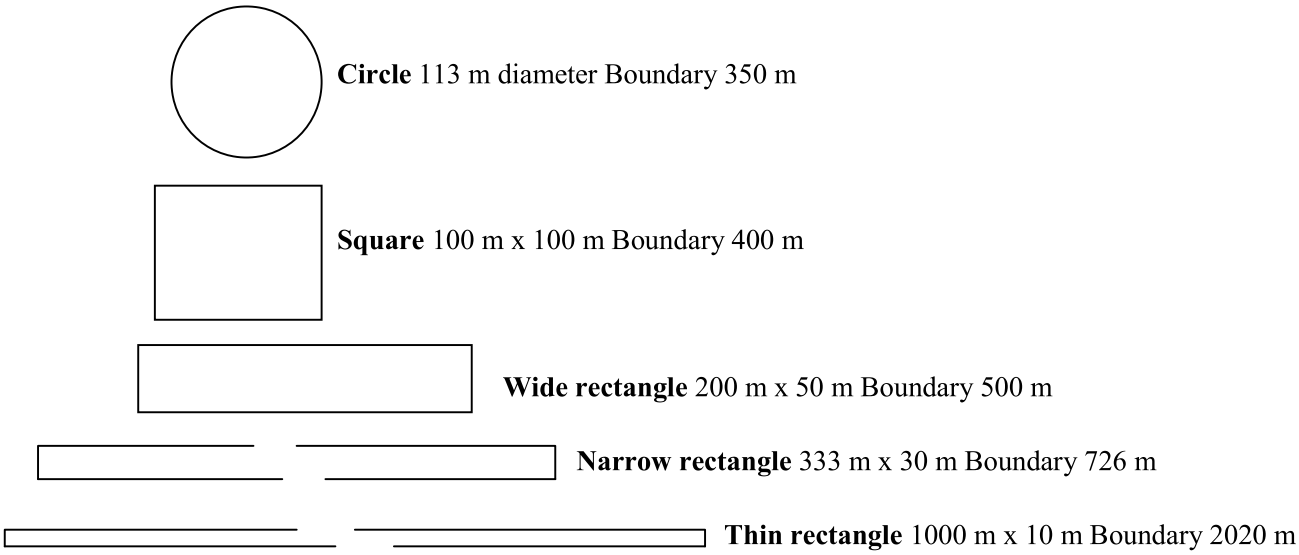

Figure 2: Example Biodiversity Eco-map