Grow Sustainably™

Title:
Developing & Implementing a Biodiversity Strategy for Mixed Farming Systems (Australia)

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ABSTRACT:

The Unilever & Horticulture Australia Sustainable Agriculture Project, "Grow Sustainably™" has developed a system for incorporating farm biodiversity into Environmental Management Systems.
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%. Enhancement plans also considered the role of permanent vegetation for stock and crop shelter, water table management, surface water management, timber products, and aesthetics.
This paper presents an overview of the process of developing the Grow Sustainably™ Biodiversity Strategy, and covers the sustainability indicator & 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." The process is described by which ten biodiversity parameters were selected and assessed and how 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.

BIODIVERSITY PARAMETERS

Selecting biodiversity parameters

Biodiversity is one of ten sustainability indicators selected as part of the Unilever global sustainable agriculture program. Other indicators include; Soil Fertility & Health, Soil Loss, Nutrients, Pest Management, Water, Energy, Product Value, Social & Human Capital and Local Economy. 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 that were 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, the parameters must be:

- Measurable (including it being repeatable, accurate, scientifically sound and flexible);
- Interpretable against a threshold value
- Representative of high quality biodiversity
- Sensitive to environmental change
- Cost effective

The biodiversity parameters evaluated are provided in Table 1.

Table 1: Biodiversity parameters evaluated

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

Using the above selection criteria ten biodiversity parameters were selected and their threshold values determined (Table 2). The details on how each threshold value was determined are too lengthy for this paper, but two abbreviated examples are given below.

<u>Threshold for size of permanent vegetation area:</u>

In a study in the project region, Bennett and Ford (1997) analysed the habitat requirements of woodland birds because woodland birds are more likely to be influenced by habitat change at the landscape scale than species able to live partly, or wholly in cleared environments. The study showed that to prevent decline of woodland birds 10% tree cover is the minimum for an infrastructure of native vegetation in rural landscapes. Below 10% tree cover species decline is rapid, so 10% was selected as the threshold value.

<u>Threshold for shape of permanent vegetation area:</u>

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.

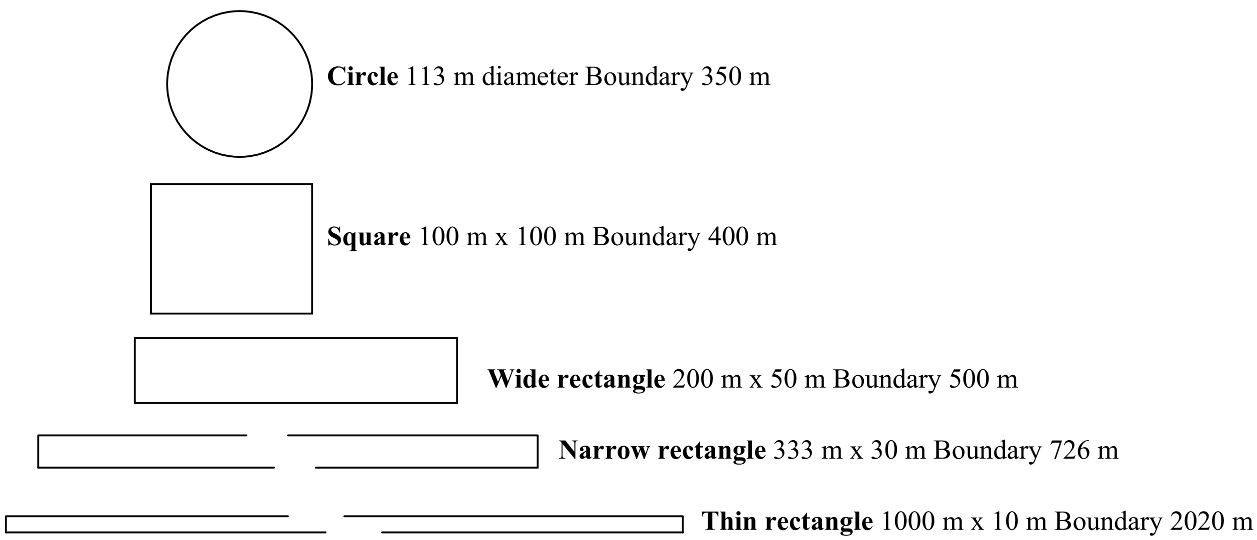
[1] *Further details about the Unilever Sustainable Agriculture Program and the sustainable indicators can be found in the paper presented by West & McMaster (Unilever's Contribution to Sustainable Agriculture) at the 3rd National Conference on Environmental Management Systems.*

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 boundary to area ratio (B:A) increases dramatically in the progression from circles and squares to wide rectangles then to thin rectangles. As the examples in Figure 1 are for 1 ha the boundaries given are the actual B:A figures. For example, the B:A of 1 square ha is 400.

Strips of 100 m wide or more are essential for woodland-dependent birds to survive among farmland (Bennett et al 1998). Therefore a 1 ha block of vegetation with a B:A of 400 should be considered as the minimum B:A. 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.

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



Discussion of selected parameters

The selected parameters are those that represent high quality native vegetation and water quality. Birds, mammals, reptiles, insects, spiders, soil fauna and feral fauna were not selected.

As to the parameters of high quality native vegetation, it is interesting to note that 'Connectivity' and 'Habitat features', which are commonly quoted as essential for biodiversity objectives, were not selected. They were eliminated because of the difficulty of determining threshold values for them and their lack of sensitivity to farm management practices. Perhaps also, 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). For the regions in which the case study farms of this project occur every 100 ha of woodland that is cleared results in a thousand or more woodland birds losing their habitat and disappearing (Bennett et al 1998).

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[2]	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

As to the selection of parameters of high quality native vegetation instead of fauna parameters, for environmental management systems the high quality vegetation parameters have the following advantages over fauna parameters:

- **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 in their arrival (which could be many years), 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. If this were the case and fauna parameters were being used then it would not be fair to a landowner to use an indicator that is dependent upon other landowners. The Grow Sustainably™ project is working on parameters applicable at the farm-level, so they must not be dependent upon 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. They should be those that readily inhabit small and isolated areas of vegetation and are not highly mobile (of limited territory). This would exclude most birds and possible many mammals and reptiles, and would bring the focus onto the relatively immobile invertebrates such as soil beetles (Sarre, pers. comm. 2001).

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

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

- **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 would be much more difficult to determine.
- **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 with fauna and less is required in terms of time and equipment for trapping and analysis. Also, it is very complex to monitor and interpret fauna presence and interactions on a variety of sites. For example, the distribution of bird species can change with periodic events such as drought, fire and floods. In addition, bird movement changes in response to flowering patterns of Eucalypt trees (Bennett et al 1998).
- **Links to degradation:** Flora provides more obvious visual indications of degradation from salinity, soil erosion and weed invasion.
- **Wide benefit:** Loss of suitable habitat has been reported to affect the largest number of fauna species (20%) in a bioregion (Ahern 2000) therefore focusing on high quality native vegetation has the potential to benefit large numbers of fauna species, rather than monitoring a few fauna species.

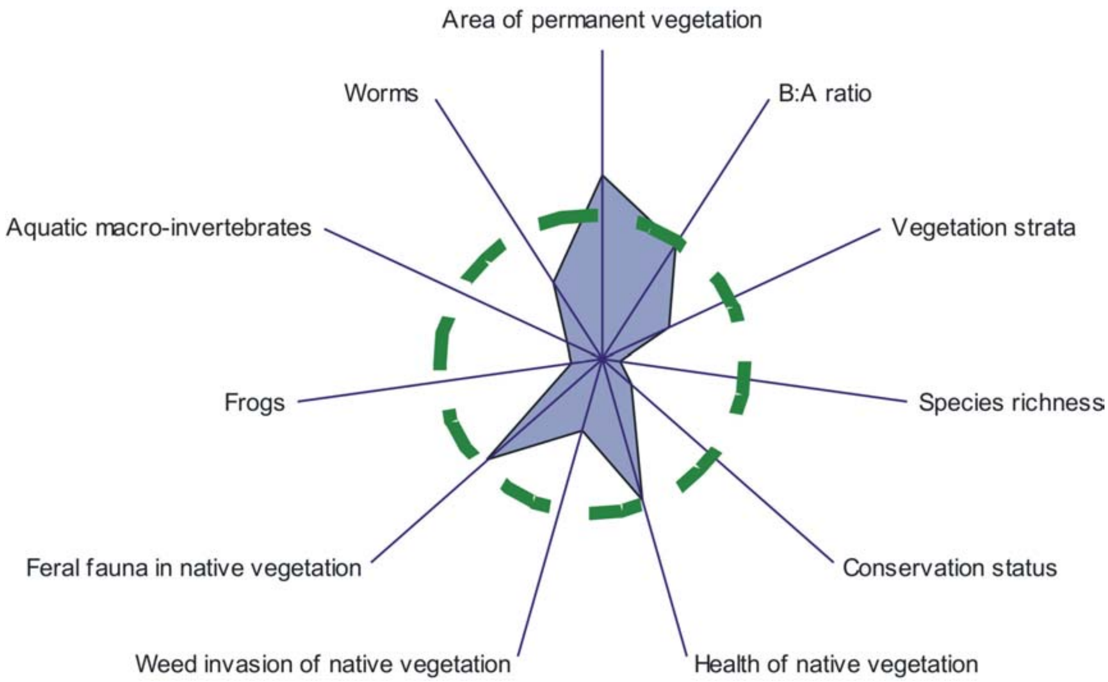
The use of parameters that describe high quality native vegetation concurs with the statement in ANZECC (2000), that "the extent and condition of native vegetation by type is the best available surrogate for the condition of terrestrial ecosystem diversity at this time."

However using local knowledge as to which birds, mammals or reptiles might inhabit a particular local vegetation community then by achieving high quality native vegetation we would also know the birds, mammals and reptiles likely to inhabit the area. Therefore, 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. A fauna icon should be selected 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 properties was assessed. Multiple blocks of vegetation on a farm are combined to form a composite farm biodiversity status. Assessments are presented as an "Eco-map" (Figure 2) which indicates visually the parameters that meet or exceed the threshold values and those that do not – that is, those that require farm management actions. The 'picture' given by an Eco-map is seen as less confusing 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 demonstrating that for a number of biodiversity parameters, change or improvement is required (BMP's and biodiversity enhancement plans/actions) to adjust them to a more sustainable or desirable level.

Figure 2 Example Eco-map



INCORPORATING BIODIVERSITY IN THE ENVIRONMENTAL MANAGEMENT SYSTEM

Assessment and information collection

Completing the biodiversity assessment data is the first part of the data collection process necessary for the biodiversity component of the Environmental Management System (EMS) for Grow Sustainably.™ The other information required is detailed below.

To help identify the effect of management practises on biodiversity it is necessary to assess:

- Possible impacts of farm management on biodiversity (Example in Table 3),
- Possible farm benefits from biodiversity (Example in Table 4),
- Possible farm threats from biodiversity (Example in Table 5).

Support information:

- Structural descriptions and species lists for EVC 's 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,
- Local and regional natural resource and biodiversity strategies that may influence management practises.

Table 3: Example of possible impacts of farm management on biodiversity

Possible impacts	Example Tomato Grower Response
1. Has there been any recent clearance of native vegetation, or is any planned for the near future, or are there any activities planned that may result in removal of native vegetation?	No
2. Are there any areas which may have pesticide residues in soil that may: ♦ affect terrestrial biodiversity; ♦ be entering aquatic ecosystems?	No
3. Are there any on-farm practises where herbicides, insecticides or fungicides may contact native plants or enter water-bodies? For example, do insecticides enter irrigation channels? Is aerial spraying of herbicides used near native vegetation? Are fungicides possibly leached into drainage water?	Yes, spray drift may contact remnant vegetation or enter irrigation channel.
4. Are there any areas where fertilisers may enter aquatic ecosystems (e.g. algal blooms)? For example, in tail drains or floodways?	No
5. Are there any areas where fertilise use raises the nutrient level of soils in permanent vegetation areas and makes them unsuitable for the growth of some native plants (and suitable for introduced weeds)?	Probably fertiliser getting under trees in 'Grey Box block.'
6. Are there any areas where the hydrological balance of the landscape is detrimental to the health and survival of the native ecosystem? (That is, areas affected by irrigation and drainage practises.)	Unsure, water balance model needed.
7. Are there areas where livestock graze and/or trample native vegetation and degrade soil structure?	No
8. Are any cultivation or cultural practices impacting on native vegetation or habitat?	Not cultivating any native vegetation areas.
9. Are there any areas that are creating habitat for introduced predators and feral herbivores?	Not likely.
10. Are there any areas (not necessarily in native vegetation) where introduced plant species are becoming environmental weeds or a weed seed source affecting native ecosystems?	Some weeds (e.g. boxthorn) coming in from north roadside.
11. Are there any water bodies where decreased stream flow may be decreasing aquatic water life?	Not applicable.
12. What are the beneficial impacts that farm management is having on biodiversity?	No obvious beneficial impacts.

Table 4: Example of possible farm benefits from biodiversity

Possible benefit from biodiversity	Comments on on-farm benefits	Benefit perceived by a tomato grower
1. Aesthetics and recreation		Yes
2. Groundwater and salinity control	One of the major benefits but may not be applicable to all farmers.	Yes, important local issue.
3. Surface water management and nutrient and silt filtration	May be of benefit where surface water is a problem and vegetation filters water.	Yes, could use biodiversity to soak up surface water.
4. Shelter	Applicable to farmers with stock and usually of best benefit in severe wind events. May reduce spray drift and increase spraying opportunities/days Any shelter benefits for tomatoes and/or other crops	Yes.
5. Firewood, fence-posts and building timber	Could be for on-farm use or sale. Beware of illegal clearing. Wood products are usually specially grown.	Maybe in future.
6. Seed sales	Seed has a potentially large benefit but only for the few farmers who find a market.	Not likely
7. Habitat value	Habitat for species conservation does not directly benefit farmers. Little is known the habitat value for insects and birds that may be beneficial to production.	Can't see how it benefits production.
8. Micro-flora – improving soil structure and nutrient cycling	May improve rainfall infiltration in native vegetation areas, which may help farm water balance.	Unsure.
9. Genetics	Source of genetic material may benefit a few farmers at some stage in the future.	No
10. Pollination	Probably no benefit to tomatoes	No
11. Honey production	Of minor benefit to some farmers	No
12. Bush foods and new industries	Of minor benefit to some farmers. Needs proper horticultural management to provide significant income.	No
13. Biodiversity credits	Potentially a large benefit (cash for growing biodiversity) but no clear guidelines at present.	No
14. Carbon credits	May not be of benefit. Carbon credit agreements are being done with large areas of forestry not small areas of vegetation on farms (unless a consortium)	No
15. Reduction in council rates due to biodiversity protection	May be of small benefit if it eventuates in the future.	No

Table 5: 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

Implementation plan

To prepare an implementation plan:

- From the Eco-map determine the general strategies required to achieve the Eco-map thresholds;
- For these strategies select specific actions applicable to the property (Table 6).
- Based up the assessment of possible farm benefits from 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. For example, does the grower want to use permanent vegetation sites to utilise groundwater and help control salinity? Or does the grower want to shelter irrigation channels from spray drift? In consultation with the grower, draw on a map of the property how permanent vegetation areas might enhance biodiversity, help with management of groundwater and salinity, help manage surface water and nutrients, provide shelter, provide timber products and provide aesthetic appeal. Discuss these permanent vegetation purposes with growers one at a time. Some of these purposes may not be important to all growers so tailer make the plans to the growers needs and goals. The final multiple benefits plan will be a selection and combination of these single purposes for permanent vegetation.
- Address any threats to the farm from biodiversity and permanent vegetation areas, as raised in Table 5. For example, are existing or new areas of permanent vegetation creating a potential fire hazard, etc?
- Modify the plan to meet the objectives of local and regional strategies for biodiversity, salinity, etc
- Modify the plan to meet legislation requirements.
- 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:

- Legal obligations – Are there any legal (compulsory) obligations that require attention? (For example, grazing of remnant vegetation or other activities that may actually constitute illegal clearing).
- Achieving 'No Net Loss' – What are the actions necessary to avoid any biodiversity decline? Especially look for any major on-farm threats to biodiversity?

Table 6: Management strategies that can be used to help achieve biodiversity targets

Indicator	Management strategies
Size of native vegetation	Revegetation to establish buffer zones and extend areas of native vegetation.
Shape of native vegetation	Revegetation to establish buffer zones and extend areas of native vegetation.
Vegetation strata	Remove grazing (fencing). Control weeds. Control feral vertebrates. Revegetation. Fire as a management tool to release germination. Reduce effects of irrigation, nutrient loading and soil erosion that create the environment favourable for weeds and less favourable for native vegetation.
Species richness	Remove grazing (fencing). Control weeds. Control feral vertebrates. Revegetation. Fire as a management tool to release germination. Reduce effects of irrigation, nutrient loading and soil erosion that create the environment favourable for weeds and less favourable for native vegetation.
Conservation status	Reduce effects of irrigation, nutrient loading and soil erosion that create the environment favourable for weeds and less favourable for threatened 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	Farm weed management to reduce weed seed source. 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 practices to reduce groundwater levels that are favourable for weed growth and less favourable for native vegetation health. Modified fertiliser practices to lower nutrient loading of the area.
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), ensure chemical spray equipment is calibrated regularly with records kept, 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

- Priority for farm production benefit – What are the largest benefits to the farm production from management or establishment of permanent vegetation areas?
- Incentive or marketing benefit – Is there any funding (Government or otherwise) or premium market price for achieving 'Net Gain'?
- Implements wider strategies – Are there any (non-compulsory) local, regional, State or National strategies that apply to the property (for example, biodiversity strategies, environmental flow strategies, or groundwater management strategies.)
- After the above criteria are used to short-list the actions further prioritising is done according to:
- Cost of time and money – What are the costs and time demands to implement the actions and what can be afforded?
- Biggest return for effort – Which actions return the best benefit for input of money and time?
- Personal preferences – Does the grower have any personal preferences that affect their decisions; such as aesthetic appeal, interest in timber products, interest in conservation, etc?

- As many actions will address more than one prioritising criteria it is helpful to list the actions and prioritising criteria in a table and select the actions that address the most criteria.

Monitoring

The Grow Sustainably™ system has been developed in a manner consistent with the Plan, Do, Measure and Improve cycle (PDMI) common to most Environmental Management Systems. In the context of this PDMI cycle, for the biodiversity element of the system, the Planning phase involves the collation of information on biodiversity parameters and the interaction of farm management with biodiversity to form the priority actions. Once developed, these plans are then implemented ('Doing Phase'). Given the strong focus Grow Sustainably™ and the Unilever program has on monitoring, the Measuring phase is then 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 Sustainable Agriculture Project on Tomatoes over two monitoring seasons. Significant opportunities for biodiversity enhancement were found with existing areas of permanent vegetation per farm ranging 5% to 10%. *Examples from this process are given below.*

For the example Eco-map (Figure 2) there are adequate areas of permanent vegetation of good B:A ratio for biodiversity, but the strategies required to enhance biodiversity are:

- Management of remnant vegetation to ensure vegetation strata are encouraged, rather than depleted. This will also help prevent no further decline of the EVC's which are of significant conservation status.
- Strategic revegetation to increase the strata levels and the species richness.
- Reduce nutrients and chemicals entering water bodies (as the results for frogs and aquatic macro-invertebrates indicate the water quality is poor).
- Weed control in permanent vegetation areas is also important but the other actions are higher priority.

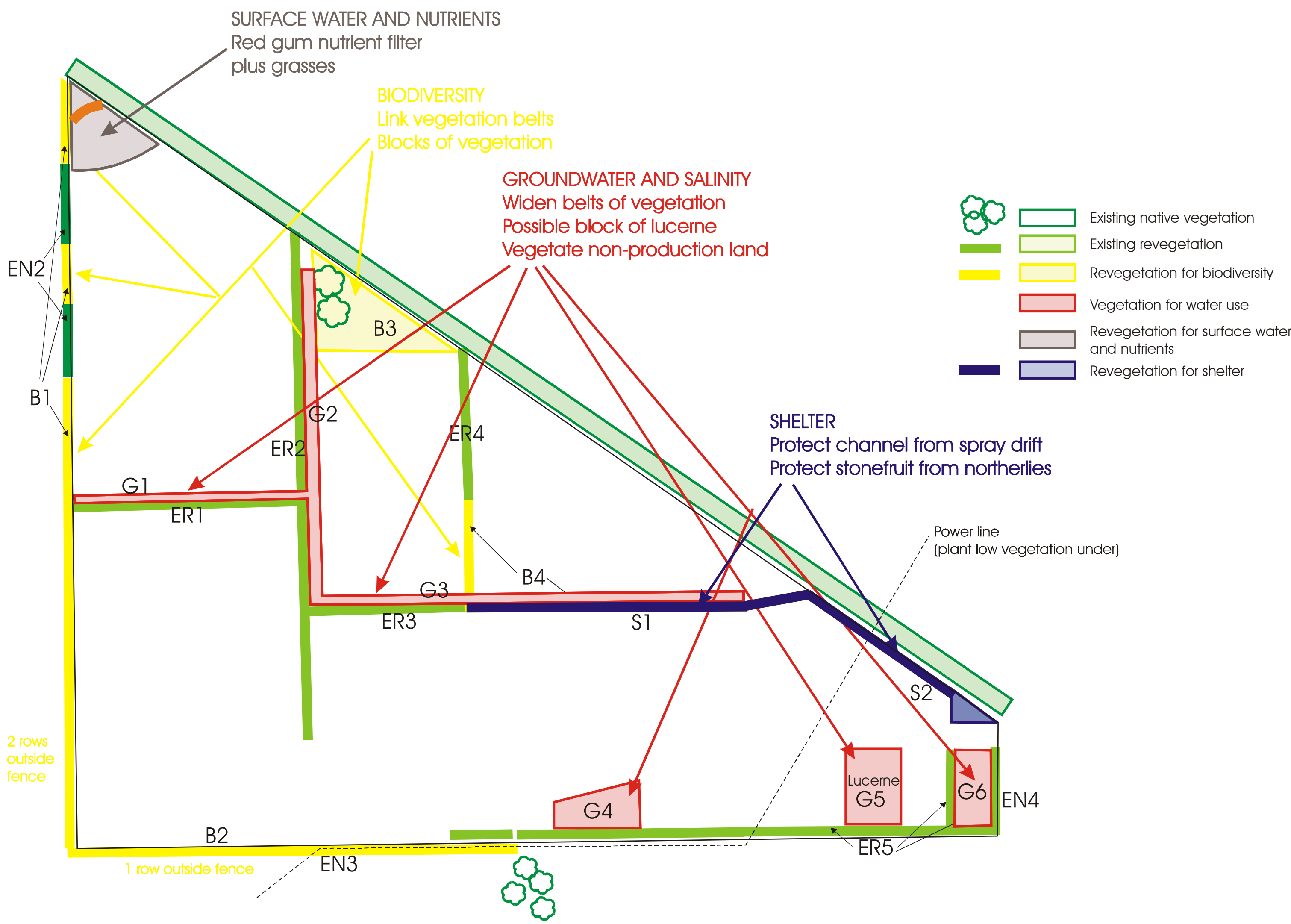
In general, it is likely that key actions for achieving biodiversity thresholds will revolve around management of existing native vegetation sites by removing or controlled grazing, weed control, feral vertebrate control and strategic revegetation. Also, establishing new area of native vegetation to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

An example of a biodiversity enhancement plan with multiple benefits from areas of permanent vegetation is given in Figure 3.

CONCLUSION

The farm biodiversity system developed as part of the "Grow Sustainably™" project has resulted in growers implementing 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.

Figure 3:Example of biodiversity enhancement plan with multiple benefits from permanent vegetation areas



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