

Spend \$0.00 in seasonal handfeeding: fit perennial pastures and legume trees into an annual farming system. The case study of the Western Midlands of Western Australia

Tim Wiley¹ and B Wilson²

¹Department of Agriculture WA, PO Box 110, Geraldton WA 6530 Australia

²"Tagasaste Farm", PO Box 63, Lancelin WA 6044 Australia

twiley@agric.wa.gov.au

Summary. Western Australian broad acre agriculture has traditionally been based solely on annual crops and pastures. This farming system results in a lack of feed in autumn. In autumn and early winter paddocks were being overgrazed, and in spring being undergrazed. Recently, a range of perennial pasture options have emerged in the West Midlands of Western Australia. The challenge is to find ways to integrate these perennial pastures into West Midlands farms to optimise the benefits within the whole farm system.

It has been found that even small areas of perennial pasture can significantly increase the whole-farm stocking rate. This is due to an increase in the autumn feed supply and also to unplanned changes in the grazing of the rest of the farm, which turn out to be beneficial. Grazing pressure on other paddocks with annual pastures was reduced in autumn and early winter when it is damaging and increased in winter and spring when it benefits annual legumes.

The perennials have been targeted at soils where annual pastures and crops perform poorly. The strategy is to then move stock around the farm to take advantage of the diversity of feed supplies. The aim is to have a grazing plan where stock run on green feed all year round. A grazing plan should also optimise the grazing management on each particular pasture type. With a range of pasture types, it should be possible that at any given time the stock are on the pastures that need grazing and off the pastures that need resting. Two models are presented to show where stock would be grazed on farms that have paddocks of annual pasture, tagasaste, lucerne and sub tropical perennial grasses.

Introduction

To be sustainable, grazing systems need to encompass not only sound technical agronomic components, but to be integrated in a systematic manner to the financial, social and ecological environments of the farm where they are going to be implemented. This is the fundamental principle that supports the concept of sustainable farming and/or sustainable grazing systems

This paper is bringing the highlight of a long-term (i.e. 10 years) project undertaken in Western Australia in association with a group of innovative farmers who explored the possibilities and boundaries of designing technologies matched to their specific environmental, economic and social conditions. Under an applied research framework this group, with the support of several funding organisations, explored new avenues in the design of local technologies using the available resources including perennial grasses, lucerne (*Medicago sativa*), and legumes trees (i.e. *Chamaecetisus palmensis*, or tagasaste and/or lucerne tree).

What is a farming system?

A farming system is the way in which the components of a farm interact. Every farm is a system, as are parts within it such as a paddock, a grazing rotation or a stock-watering network. Therefore, farmers are systems managers.

A system is where inputs do not have a direct and simple connection to outputs. A system contains intermediate components that interact with each other. These interactions do not occur as a simple linear process where one step only affects the next step in the chain. The steps in systems interact with a range of others steps and that makes the process complex. As a result, simple change in one input can result in a variety of changes in different outputs. Also, a change in one output can be the net result of changes in a number of different inputs.

Savory and Butterfield (1999) state that in human related systems the inputs are not just physical or biological, but also include the actions and decisions of people. The integration of the human action with the remaining components surrounding the decision environment creates the best conditions for the setting of holistic goals. These holistic goals will be integrative and will define a ranking scale in terms of human values to the decision-making process and systems management.

Managing a system is about making decisions on inputs so as to optimise the outputs. Successful management requires that the people making the decision have an understanding of how the components interact and the whole system functions. Systems managers make decisions based on their prediction of what will happen given that they take a certain action. Managers usually consider a range of possible actions and then decide on which of these will give the best outcome (from their perspective). The problem for managers is that systems are

always much more complex than they first appear. Even simple systems with few components will have a large number of possible outcomes.

deBono (1991) gives an example of this relationship between simplicity and complexity. His example is where a person has to get dressed in the morning and there are 11 separate items of clothing to put on. A decision has to be made about the order in which each item of clothing is put on. That means selecting the first item, then second and so on. It is calculated that there are 39,000 different sequences for putting on just the 11 separate items of clothing. In systems management it is never possible to consider all the possibilities when making decision or to recognise all the possible consequences of taking even one simple action.

Systems managers must use models of how the system operates to predict the consequences of certain actions. A wide variety of systems models are used. They include mathematical, visual, written and conceptual models. All people use conceptual models of systems, which are simply their current understanding of how and why things happen. Other models or 'decision-making tools' can help in giving managers a better understanding of how their system works. Farms are such complex systems that the best understanding can only be derived from using a range of models that look at the farm from different perspectives. Different perspectives could include economic, agronomic, animal production, water use, environmental and social.

One aspect of broad acre farming systems that usually gets little consideration is whole farm grazing management. Grazing management decisions will not only affect how the stock will perform but also crop production and weeds, soil fertility, erosion, pasture growth and persistence, salinity, people time management and farm profitability.

Systems are also influenced by factors beyond the control of the manager. In a farming system this includes things like the weather and market prices and all of them come together to fulfil the upmost expectations of the decision maker in terms of aspirations, environmental care and profitability (Stinner et al. 1997).

Farming systems of the West Midlands of Western Australia

The West Midlands of Western Australia is made up of a diverse range of soil types. The mix of soil types not only varies between districts and farms, but also within paddocks. This diversity has traditionally been seen as an obstacle to farming, but can be turned into an advantage if it is exploited within a 'systems' approach.

The West Midlands has a Mediterranean climate with cool wet winters and hot dry summers. Farming systems have traditionally been based solely on annual crops and annual pastures. The carrying capacity has been limited by the shortage of feed in autumn and early winter. Animal performance is also restricted by the poor quality of feed over summer and autumn. In autumn animals must be fed quality supplements just to maintain weight.

In recent years, a wide range of new pastures species has become available. This includes the fodder shrub tagasaste, lucerne and sub tropical perennial grasses. These perennials all have different seasonal patterns of growth and management requirements. By integrating a range of these types (or 'functional groups') of perennials into farms it should be possible to increase carrying capacity and year round animal performance. This could be achieved by strategically moving stock around the farm using e.g. time controlled grazing and proper resting periods (Savory and Butterfield 1999) so as the animals only graze each pasture type when it is most productive and of best quality.

Perennial pastures in whole farm systems

The pastures and grazing management of a farm can be looked at as a system where the input of feed is balanced against the consumption of feed by the livestock. The output of this system is the animal production, both in stock numbers and animal performance. There is also a feedback mechanism where the grazing method itself affects how well the feed grows.

On a farm with just annual pastures, the pasture feed supply varies considerably over a season. It is characterised by an excess of feed in spring and a shortage in autumn. The other feature is that all paddocks have a similar pattern of feed supply. Adding perennial pastures to such a farm will improve the whole farm feed supply by increasing the amount of feed available in summer and autumn.

Small areas of perennial pastures and legume trees that supply feed in autumn can increase the whole-farm carrying capacity by a considerable amount. It is not just the extra feed that is grown by the perennial, but also it leads to better utilisation of the annual pastures in other paddocks. If farmers can carry more stock through autumn, they will also have more stock to eat the spring flush of annual grasses.

Tagasaste in a sand plain farming system.

Perennial pastures can also improve the annual pastures in other paddocks due to changes in whole-farm stock movements. An example of that has been with tagasaste on sand plain

farms. Changes in grazing management required for tagasaste have had an unplanned, but beneficial impact of annual pasture paddocks.

Tagasaste is a fodder shrub that has a few simple rules to be grazed properly. Firstly, it cannot be grazed in a continuous manner by sheep beyond 6 weeks. It may be locked up from grazing for up to 11 months. This means the feed can be saved until the autumn or early winter period when the supply of annual pasture is very limited. With cattle the grazing is much more flexible, as cattle can continuously graze tagasaste without damaging the plants.

The second rule for grazing tagasaste is that it must be hard grazed and/or mechanically cut at least once in the first 6 months of the year. This prevents flowering, which has an adverse effect on subsequent tagasaste growth and palatability.

Plates 1 and 2. Tagasaste legume tree lookout



Source: AAC personal file 2003

A system evolved on the sand plain where paddocks of tagasaste were locked up for 11 months and then grazed with about 100 sheep per hectare for 4 weeks. This once-a-year intensive grazing gives a year round stocking equivalent to 8 sheep per hectare. It was found that under this system only 10% of the farm needed to be planted to tagasaste to replace all the hand feeding of sheep in autumn and early winter. Analysis showed that this was profitable at any wool price because it related to the forgone cost of feed supplements (Oldham et al. 1992). Plates 1 and 2 allow to observe the structure of a tagasaste tree and the typical leaf structure that has favoured the naming of tagasaste as lucerne tree.

On farms where tagasaste was used to replace hand feeding in autumn, there was a surprisingly big increase in whole-farm carrying capacity. In many cases, the whole farm stock numbers doubled over time despite only about 10% of the farm being planted down to tagasaste. This was because there had been other changes to the farm system that were unplanned but beneficial.

Because all the stock were on tagasaste in late autumn and early winter the annual pasture paddocks were de-stocked by default. The annual pastures started to improve because of this change in grazing. The annual pasture seed bank was not being reduced, and the paddocks stopped eroding from being over grazed in autumn. After the break of the season the grazing could be deferred on the annual pastures until they were well established.

A less obvious benefit was that the winter and spring stocking rates were increased on the annuals as the tagasaste paddocks were then all locked up. Heavy winter and spring grazing favours the sub clover that drives the annual grasses.

Farmers also began grazing at higher stocking pressures. They had bigger mobs on smaller paddocks. This helped reduce the problem of being 'understocked and overgrazed'. This happens where stock grazed at low numbers can select out the most palatable plants in the pasture. They keep returning to these same plants until they kill them from over grazing.

Other perennial pasture types.

The success with tagasaste stimulated farmers and researchers to look for other perennial pasture options. It has been found a range of perennial pastures including sub tropical perennial grasses, sub tropical perennial legumes and lucerne can all persist in the West Midlands (Wiley 2003). The different types of perennials fit on different soil types and paddock rotations on the farm. Lucerne is ideal to be used as a phase pasture in cropping paddocks.

The sub tropical grasses are very drought tolerant and can survive on the poorest soil. When they are planted on areas with shallow water tables, they are extremely productive over summer. Often these 'wet patches' are very small, but because of their productivity they can be significant within the whole farm. An example of this is where Peter Nixon at West

Gillingarra (450 mm rainfall) ran 370 weaner sheep on 1.4 hectares for 28 days (264 DSE/ha) and produced 1,100 kg/ha liveweight gain (Wiley 2004,, pers. com.). Plate 3 shows the main author of this paper in a tyagasaste extension day.

Plate 3. Extension day on Tagasaste farming system



Source: AAC personal file 2003

Whole farm pasture integration.

The challenge now is to integrate the range of pasture types to give maximum animal production (and reduce land degradation). Each type, or 'functional group', of pastures has different management requirements. All benefit from rest at particular times and hard grazing at others.

With a diversity of pasture types then it should be possible to develop a year-round grazing plan where the stock are on the right pasture at the right time. This plan should also allow stock to be run on good quality feed year round. Even with dry annual feed on some paddocks, it should be possible to move stock around the farm so that they are only on green feed.

A whole-farm grazing model.

While many farmers in the Northern Agricultural region are planting a range of perennial pastures, there are still a wider range of options they should consider. Farmers are starting to think about how a whole farm grazing system might work with a range of different pasture options. Two examples are given below of farms with differing mixes of soil types and therefore pasture options. These options have been tested throughout the extension services of DPI-WA in the sand plains of Western Australia (Wiley 2004, pers. com.).

The first model (see Figure 1) is one for a farm, which is all deep sand (B Wilson 2004 pers. com.). The second model (see Figure 2) is for a farm with a mix of deep sand, good gravel and some areas with shallow fresh water tables, which is a typical mix on much of the Northern Agricultural Region of WA. These models take account of where the best quality feed will be at different times of year and when each pasture type is best grazed.

Deep sand farm

On the deep sand farm, $\frac{1}{2}$ the pasture is tagasaste, $\frac{1}{4}$ annual pasture and $\frac{1}{4}$ perennial grass based pasture. In this case-study, the farm only run cattle so the tagasaste could be continuously grazed if required. Plate 4 provides an overview of whole-farm grazing model 1

Plate 4 Whole-farm grazing system 1 (deep sand)



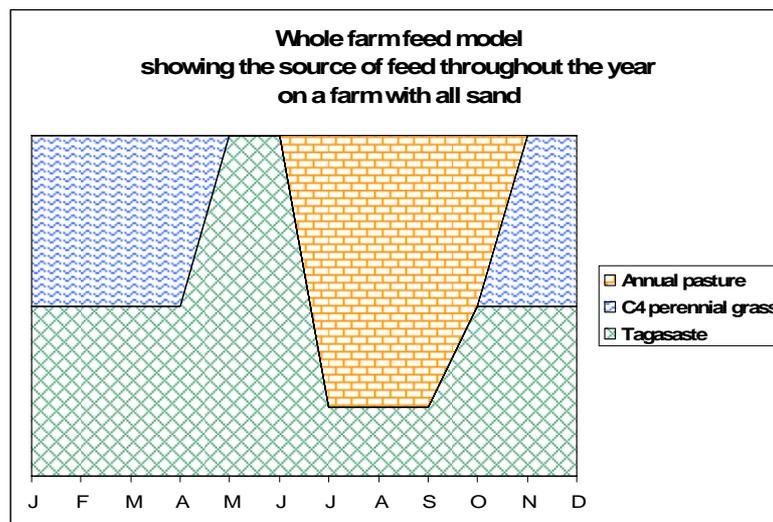
Source: Wilson 2004

The annual pasture paddocks were grazed heavily from a month after the opening rains up until the end of spring. The annual paddocks were then locked up for the rest of the season as all but some residual pasture for ground cover had been eaten. This type of heavy grazing during the growing season meant that a high proportion of the annual pasture was consumed. On a typical farm with only annual pasture only about 1/3 of the pasture grown ends up being eaten by stock.

Tagasaste provided feed throughout the year and the summer feed supply was topped up with the perennial grass pastures. The sub tropical (C4) grass grows actively over summer, but slowed down when temperatures dropped after the first winter rains (see Figure 1).

All the stock were put on to tagasaste after the opening rains. This allowed the annual pastures to have grazing deferred for a month to allow them to get away. Grazing pressure on some annual pastures can be reduced in spring if the farmer wants to increase the seed set in those paddocks.

Figure 1: Sources of feed on deep sand farm



Mixed soil farm

In the case-study of a farm with mixed soil types, the annual pastures were also only grazed during their growing season. Lucerne paddocks were grazed just after the opening rains. They were grazed again at the end of spring to supply high quality feed to keep weaners growing. Tagasaste was planted on 10% of the farm and was used to replace hand feeding. It supplied the bulk of the feed in late autumn and just after the break to defer grazing on annuals. The sub tropical perennial grasses (C4 grass) supplied the feed during summer and most of autumn (see Figure 2).

These farming systems did not only increase carrying capacity and animal productivity but also had major benefits to the environment. Western Australia suffers major problems from erosion and salinity due to the farming systems being based totally on annuals. Continuous broad acre planting of perennials will overcome many environmental problems. Plates 5 and 6 offer an overview of the whole-farm grazing system 2 (mixed soil farm).

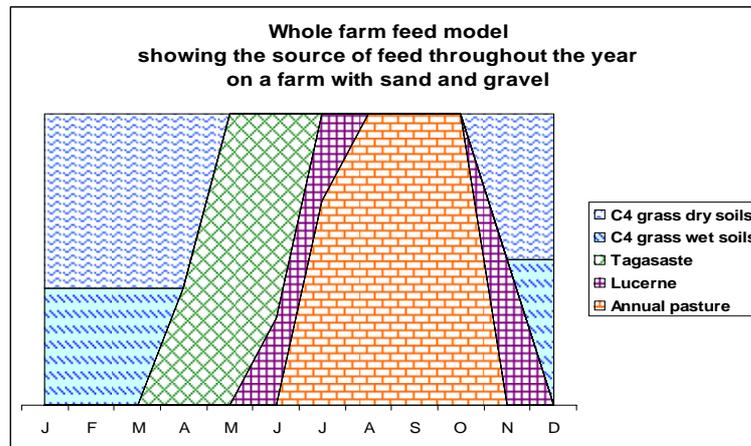
Plates 5 and 6. Overview of whole-farm grazing system 2 (mixed soil)



Source: Wilson 2004

Currently the Department of Agriculture and the 'Grain and Graze' project are gathering data from a wide range of different pastures on the feed quantity and quality over the season. This will then be used for computer based whole-farm systems modelling. Data will also be gathered to evaluate the impact of these grazing systems on the health of the ecosystems.

Figure 2. Sources of feed on mixed soil farm



Highlights

- A range of new perennial pastures – i.e. grasses and legume trees -have been found that will complement the annual native and introduced pastures in Western Australia.
- The benefits of the perennial pastures are more than just supplying some additional feed. Effectively, with proper systematic grazing systems, there is an overall improvement in the ecosystem health and sustainable productivity.
- Among those perennial pastures, a highlight is the effect of legume trees (i.e. *Chamaecetisus palmensis*) incorporated into the whole grazing system.
- By using perennial pastures strategically within the whole farm, the annual pastures in the paddocks are also improved.
- With a range of pasture types, stock can be moved around the farm so as each pasture receives its own most appropriate grazing and rest period.
- Animal production should improve as animals can be run on green feed all year round.
- The economic implications of combined annual-perennial grasses and legume trees are evident because of the forgone expenses in hand-feeding livestock along the year.

Acknowledgements

The development of perennial pasture grazing systems in the Northern Agricultural Region of Western Australia has been supported by the Department of Agriculture WA, CLIMA, AWI, MLA, Martindale Foundation, UWA, SGS, Grain & Graze, the Salinity CRC, the Evergreen Farming group, the Mingenew Irwin group, Victoria Plains LCD, West Gillingarra LCD, Dandaragan LCD and the Liebe group.

References

- De Bono E 1991, *I am right you are wrong*, Penguin Books, London.
- Oldham C, Fortune J, Mattison B and Wiley T 1992, "Advances in Research on Tagasaste No 2." Martindale Research Project, School of Agriculture, University of Western Australia, Nedlands.
- Savory A and Butterfield J 1999, *Holistic Management. A New Framework for Decision Making*, Island Press, Washington.
- Stinner DH, Stinner BR and Martsolf E 1997, 'Biodiversity as an organised principle in agroecosystem management: case studies of holistic resource management practitioners in the USA"', *Agricultural Ecosystems and Environment*, 43 1956-2003.
- Wiley T 2003, 'The potential of sub tropical perennial pasture species in Western Australia"', in *Agribusiness Sheep Updates 2003*, Peterson A. and Butler, Department of Agriculture Western Australia, Perth.
- Wilson B 2004, 'The role of tagasaste in a sustainable grazing system' in *Proceedings of 2004 AFBMNetwork Conference*, 5 December 2004, Orange.