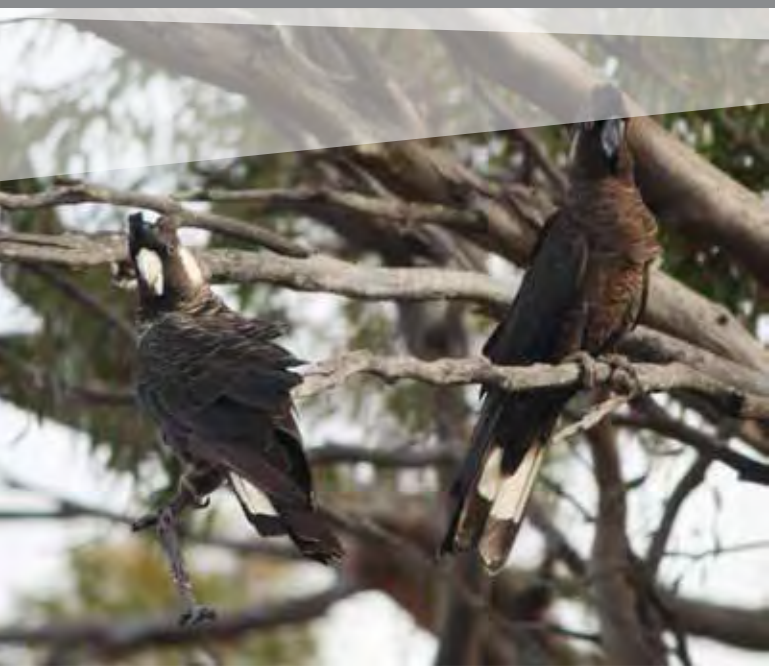
Northern Agricultural Catchments Council

SMALL LANDHOLDER GUIDE

NACC
Managing Natural Resources

A practical guide to managing smallholdings in the Northern Agricultural Region of Western Australia

Produced by the Northern Agricultural Catchments Council (NACC)



Supporting people to support the natural environment

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This *Guide* has been technically reviewed by Department of Agriculture and Food, Western Australia staff including: Mike Clarke, Angela Stuart-Street, Mike Jones, Tim Stevens, Yolandee Jones, Andrew Reeves, Russell Speed, Wayne Parker, Andrew Blake, Rob Grima and Hayley Smythe.

It has been compiled by Dr Jill Wilson of Rural Solutions WA, with initial drafting from Peter Elliott-Lockhart of Planfarm, and input from Sarah Craze, Alison Cooke, Sarah Jeffery, Marieke Jansen, Mark Logue, Fiona Falconer and Lucinda Jose.

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Coordinated by Stanley Yokwe, Regional Landcare Facilitator for the Northern Agricultural Region.

NACC, 201 Lester Avenue, Geraldton Western Australia

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INTRODUCTION

OVERVIEW

INTRODUCTION

This *Small Landholder Guide* has been compiled for managers and prospective managers of small holdings in the Northern Agricultural Region (NAR) of Western Australia. The *Guide* is intended to assist people who manage a block of land that is between 2.5 acres (1 ha) and 500 acres (200 ha) in area. The *Guide* is divided into several parts:

Technical chapters & case studies: background information relevant to the NAR

At the front is a series of chapters that contain background and technical information on a range of different topics including Planning, Soils, Water, Livestock, Agricultural Plants and the Environment.

This information has been compiled specifically for this region. (Originally, you may have seen this information in the form of a booklet. This has now been reorganised into chapters for ease of reading).

Each chapter contains a summary (Fast Facts box) and also a short list of relevant references (Follow Up box). Many of these references are available online.

Also included is a series of six case studies from this region.

A list of the chapters and case studies is included, in the Contents section of this *Guide*.

Resources

After the chapters and case studies is a list of resources and references.

The various chapters also often include references to other resources where you can find further information.

noteworthy Small Landholder Series

The Department of Agriculture and Food, Western Australia (DAFWA) has a well organised Small Landholder Information Service (SLIS) based in Waroona. For many years they have provided workshops and information for small landholders, but most activity has occurred in the southern part of the state, not the NAR.

The noteworthy Small Landholder Series has been developed by the SLIS specifically for small landholders. DAFWA has provided copies of 20 of these that have been included at the back of this *Guide*. They cover a wide range of topics, some of which are also covered to a certain extent by the local chapters in the front of this *Guide*.

A list of the noteworthy Small Landholder Series documents are listed in the Contents section of this *Guide*.

The Land is in your Hands

DAFWA has also provided copies of the booklet *The Land is in Your Hands* which contains more information. This booklet is subtitled "A Practical Guide for Owners of Small Rural Landholdings in Western Australia".

Add your own information!

This *Guide* is provided in a ring binder file so you can easily add your own useful information and notes as you go along.

THE NORTHERN AGRICULTURAL REGION

The Northern Agricultural Region (NAR) extends from north of Kalbarri to just south of Gingin and out to the clearing line in the east. 15 local government areas are included: the City of Greater Geraldton (including the former shires of Mullewa and Greenough) and the shires of Northampton, Chapman Valley, Irwin, Three Springs, Mingenew, Morawa, Perenjori, Carnamah, Coorow, Dalwallinu, Moora, Victoria Plains, Dandaragan and Gingin.

Data sources: Commonwealth of Australia 2012; and the Western Australian Agricultural Authority 2012.

CONTENTS

EXTRA MATERIAL INCLUDED

Small Landholder Series (noteworthy)

A series of the noteworthy notes can found at the back of this folder. Most chapters in this *Guide* refer to one or more of these notes for further reading, and therefore they have been provided at the back of this folder for your convenience.

- noteworthy 1. Spray safe, stay safe.
- noteworthy 2. First time fencing unravelled.
- noteworthy 4. Chainsaws for the small landholder.
- noteworthy 5. Cattle ownership is a serious step.
- noteworthy 7. Water quality critical for livestock.
- noteworthy 9. Soil testing — accurate samples yield better results.
- noteworthy 10. Supplementary feeding, keeping livestock healthy during summer.
- noteworthy 11. Soil matters — managing erosion on your property.
- noteworthy 12. Pastures ready...set...grow!
- noteworthy 13. Owning livestock: brands identification and movement.
- noteworthy 15. Finding the right advice.
- noteworthy 18. Livestock husbandry for love and money.
- noteworthy 19. Water supplies for the small rural holding.
- noteworthy 20. Be fire smart this summer.
- noteworthy 24. Got a small property? You need a property plan!
- noteworthy 29. Going organic: what you need to know.
- noteworthy 31. Horse keeping on small properties.
- noteworthy 34. Productive pasture management.
- noteworthy 40. What to consider when leasing.
- noteworthy 48. Business planning — being successful is not about luck.

DAFWA Booklet for Small Landholders

The booklet *The Land is in Your Hands: A Practical Guide for Owners of Small Rural Landholdings in Western Australia* can be found at the back of this folder. It is a valuable resource that can be used for further reading, and therefore it is provided at the back of this folder for your convenience.

USEFUL PROGRAMS

THE SMALL LANDHOLDER INFORMATION SERVICE OF DAFWA

For several years the Department of Agriculture and Food, Western Australia (DAFWA) has provided a Small Landholder Information Service (SLIS) to help small landholders make the most of their properties. The service is run out of the Waroona office, and most of the activities have been conducted in the area around Perth or to the south of Perth. However, there is considerable scope for the service to expand its activities into the NAR. If enough people want it, maybe it will happen! So let the staff know if you are interested in taking part in local activities.

The SLIS can provide a range of activities and information. They are keen to bring together various kinds of people to help you and to provide you with the opportunity to network with, and learn from, other like-minded people.

Three of the most popular services are:

- **Property planning days**
  Property planning looks at the natural features of your property, plans ways to keep them from being degraded and develops strategies to improve their condition. These workshops can give you guidance to develop a plan for your property, including aerial photographs of your property and a planning manual.

- **Field walks**
  SLIS from time to time run field walks so that people from a particular area can get together for a practical discussion or demonstration of a management issue. This could be about weeds, stock management, fencing, soil, water, or many other topics.

- noteworthy **Small Landholder Series**
  The SLIS has developed a range of information notes called noteworthy. We have included 20 of the notes with this *Guide*.

For more information go to the DAFWA website at www.agric.wa.gov.au.

NAR REGIONAL LANDCARE FACILITATOR (RLF) PROGRAM

The NAR RLF is based at NACC's Geraldton office. The *Small Landholder Guide* has been developed under the auspices of the NAR RLF program. This program conducts a wide range of activities for landholders, many of them for broadacre farmers, however there is considerable scope to do more work with people with smaller blocks.

In developing this *Guide*, the RLF held several focus groups and conducted a survey of landholders to gather information. There was considerable interest in having access to more information, to being able to participate in workshops and field days, and in developing a network of small landholders to facilitate the sharing of information, skills and equipment. These ideas are being developed.

If you would like to know more about RLF or NACC's activities visit **www.nacc.com.au**. *Under the Contacts page there is information on all the staff members and how to contact them. The office number is 08 9938 0100. NACC also works closely with Natural Resource Management Officers (NRMOs) in Perenjori and Jurien Bay.*

GETTING STARTED

PURCHASING & PLANNING

Purchasing a property

Purchasing a property can be a big investment, so make sure you are clear about your intentions and your needs before you buy. This doesn't mean you can't be flexible about your activities in the future, but it is advisable to avoid disappointment, and maybe considerable expense, by ensuring that your property provides you with an appropriate base on which to build your dream.

What are your expectations?

Do you want to develop a commercial enterprise or are you looking for a weekender, hobby farm, bush retreat or perhaps just somewhere to grow a few vegetables? The scope of your plan is important because it may dictate the type of block you need.

For instance, people often fall into the trap of thinking they can develop a horticulture enterprise without realising this will require such things as good quality water, a water licence, and planning permission. These requirements are not automatically available and will require research and/or paperwork to confirm. Alternatively, if you buy a bush block you need to be aware that cropping it, or running livestock, will be difficult as there are clearing restrictions in WA and it is unlikely that you will get permission.

What services do you need?

People often automatically assess the availability of accommodation on a new block but forget that power, communication systems, driveways and fences can all be expensive to install.

New landowners are often unaware that three phase power (or even any power!), is needed but may not be available. Do your homework, make sure what you want is available, or that you can afford to install it.

Natural assets

Is the property capable of sustaining what you want to do? The natural assets need to be able to support your activities. In particular you should assess the soil type and slope if you plan to crop; and existing pasture, fencing and yards if you want to have livestock.

If you plan productive agriculture, key questions are:

- Do the soil type, water availability and landscape suit your planned enterprises?
- Is there a good fertiliser history and freedom from troublesome weeds?
- Are there signs of land degradation – salinity, chemical contamination and/or erosion?
- Is the property at risk from floods or fire?
- Are there threatening developments nearby?

There are many questions to ask yourself (including whether you can expect any capital gains!). DAFWA has recently produced an excellent bulletin with tips on purchasing a property – see the reference below – it's comprehensive and well worth reading.

FAST FACTS

Know your expectations and needs.

Before you purchase a property, make sure that it will have the required infrastructure, assets, planning approvals and licences.

Before you start working the land, get an aerial photo, assess the landscape, natural features, fences and infrastructure, decide what is needed, and make a property plan.

Developing a property plan

A property plan is a type of map of your property showing all the natural features as well as any infrastructure including buildings, yards and fences. Any enterprises or developments you have planned are then drawn onto the map. The importance of this plan cannot be over-emphasised. Most property owners will have their plan prominently displayed on the wall somewhere, and will refer to it frequently. It does not have to be static, from time to time you will decide to change some aspects, but it is always useful to have available for reference.

With an aerial view develop layered plans

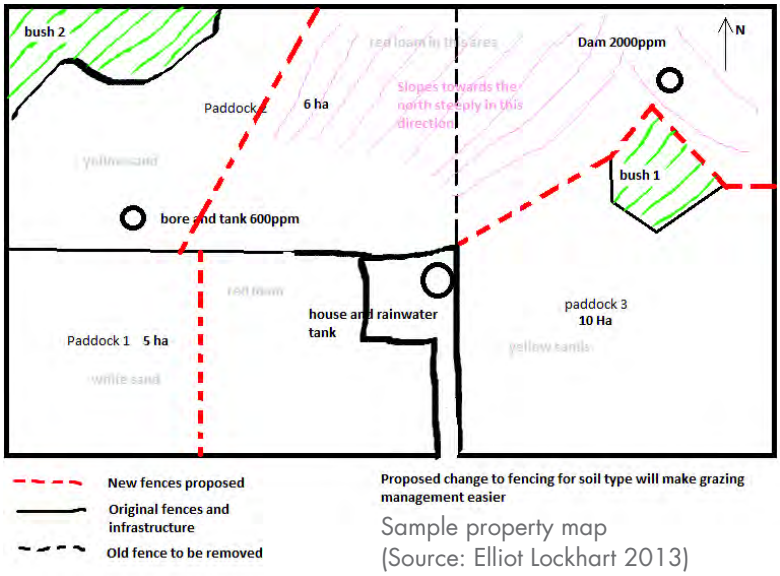
Most property plans are developed using an aerial photograph, and often incorporate clear overlays to depict various features. Three common overlays show:

- Permanent physical features such as boundary fences, buildings, yards, sheds, drainage lines, ridges, remnant vegetation, water sources and earthworks.
- Land management units, in particular soil types, depicting any areas where different management will be needed.
- What you plan to do – crops, pastures, orchard or vegetable garden, planned fencing, windbreaks etc.

Because a property plan incorporates different elements, it can help you visualise the bigger picture and it can be a useful reference for all the people involved. A plan is invaluable to refer to as you design each season's activities or whenever you are thinking of modifying how you go about things.
It is essential if you have a problem area that needs special attention.

Aerial photos can be purchased from Landgate (www.landgate.wa.gov.au) but your local DAFWA office may also give you one. There is also now mapped information readily available of soil types and physical features. Contact your local DAFWA office to find out more. If you know how to use programs such as *Google Earth* you may also find that useful.

Your map doesn't have to be sophisticated, the most important thing is that you have one, however simple. Below is an example of a simple property plan.



Sample property map
(Source: Elliot Lockhart 2013)

FOLLOW UP

Read this chapter in conjunction with information contained in the DAFWA booklet (in this *Guide)* called, *The Land is in Your Hands*. It has a section on property planning as well as many other issues.

As well as:

- noteworthy 15: Finding the right advice.
- noteworthy 24: Got a small property? You need a property plan!
- noteworthy 48: Business Planning.

SOILS

KNOW YOUR SOILS

Your ability to understand how the soils on your property behave is fundamental to the productivity of your block. Even if your plan involves letting the bush grow back, you will need to make sure that erosion is not occurring and you will also need to manage the land so that weeds do not take hold.

Variation in soil type is relatively easy to recognise, but it can be one of the hardest things to manage. Your soil is a living, breathing entity that is made of organic and inorganic material. The inorganic fraction is divided by particle size (sand, silt and clay). The organic material – termed organic matter – can be living or dead microbes and plants. The amounts of all of these things determine the fertility and structure of your soil.

As with any living thing, the soil will respond to the way it is treated. Soils that are protected from erosion and fertilised will be healthy and able to produce better pastures and crops. Soils that have lost ground cover are then prone to water and wind erosion. Erosion removes the topsoil, which is where the majority of the fertility and organic matter is, so soils become less fertile and are reduced in their ability to grow healthy plants.

For every millimetre of topsoil that is lost three per cent of the soil's total nitrogen is lost and this leads to a two per cent yield reduction in a following crop. One of the major management issues for small and large landholders is to be productive whilst minimising the effects of management decisions on the long term productivity of the soil.

Generally, Western Australian soils in the agricultural regions are referred to as lateritic, a term used to describe very weathered soils that are generally formed from granite parent rock. These soils are generally sandier and coarser than soils found in other parts of the world. Sandy soils are low in nutrients and organic matter, and nutrients also move deeper into the profile (leach) during rain and become less available.

Overlaid on the old soil are some newer soils formed from sedimentation due to fluctuating sea levels and earth movements along fault lines and from intrusions of dolerite. Dolerite is a molten rock that comes from below the surface and is forced up through the earth's crust. These significantly younger soils have much better nutrition and structure.

In general, soils formed to the west of the Darling Scarp that runs from Perth to Mingenew are the sandier, poorer soils. East of this line, soils are generally considered more productive but rainfall becomes the limiting factor. Around Geraldton and Northampton, some interactions occur with these younger soils and the better soil types that they provide.

Overleaf is a description of some of the main soil types in this region. A number of other excellent resources, such as DAFWA's *My Soil*, can help you identify your soil type.

FAST FACTS

Soils are complex and variable.

Inorganic and organic components are important.

WA soils are predominately old, sandy and nutrient deficient.

Try to identify the soil types on your property.

COMMON LOCAL SOILS

SANDS

Deep grey sands

These are non calcareous and generally have a pH between 4.8 and 5.5. They are some of the poorest soils in the region (locally referred to as silver loam). They are very prone to wind erosion if disturbed, or if soil cover gets below 50 per cent. These are generally the paddocks that have an erodibility rating of one from the Susceptibility to Erosion Table (see Erosion chapter). Good control of livestock is required to prevent the occurrence of wind erosion. Stock animals grazing in paddocks do two things to the surface cover: they eat it and they trample it, reducing the amount of cover, loosening the surface and making it more prone to wind erosion. In order to manage this problem, surface cover needs to be maintained over 50 per cent.

Leaching of nutrients in good rainfall years is a significant problem with these deep grey sands. If you have this soil type and you are trying to get good production from them, then frequent applications of small amounts of fertiliser is the strategy to use.

These sands have been made more productive and less prone to erosion through successful strategies of planting sub-tropical perennial grasses, particularly Rhodes grass and Panic grass. These grasses are for grazing enterprises; however, some ongoing trial work is being conducted where crops are sown over the established perennial pastures, but the system has not yet been perfected.

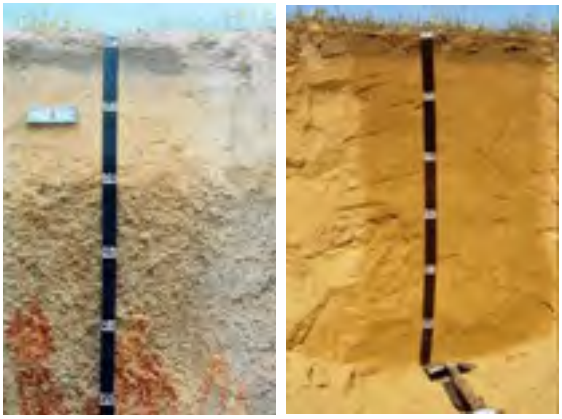
Coloured sands

Coloured sands can range from being some of the poorest soils in the region through to some of the most productive, depending on the clay content in the soil surface and its depth. Generally, in the eastern wheatbelt, soils can be very acidic, such as the Wodjil sand types (pH 3.8 to 4.8) and the more neutral (pH 4.8 to 5.5) deep sands with some colour, often yellow to brown, in the western areas. The majority of small landholders will find that they are dealing with these soils or the coastal sands.

The acidic Wodjil soils are quite hostile for many introduced species and are quite well buffered (resist change to pH). They may also contain aluminium, which is highly available due to the low pH and is toxic for root growth. Much of this area has been left to grow back to bush or remains uncleared. These soils will be an issue for landholders east of a line from Dalwallinu to Mullewa.

The more neutral sands can be quite productive; they have some nutrient and water holding capacity but will still require careful management of fertilisers due to leaching. Management of surface cover is also very important to minimise wind erosion.

Maximising plant growth rates on these soils will allow greater flexibility of management and choice of plant species.



Deep yellow Eradu sand

Coastal sands

These soils are found along the coastal strip and in the hills around the Greenough flats. They are high pH (7.0 to 9.0), grey to black/brown soils, some with limestone at varied depths. Around Jurien Bay, they can have salt lakes in the inter-dune areas but can be found as sand plains away from the coast. They will generally have limestone boulders in them. Around Geraldton, they are the sandy rises on the Greenough flats and the soils to the west of the Moresby Ranges. They can be very productive, with similar water holding capacity to the neutral yellow sands, but like them, they can be prone to leaching. The high pH can affect phosphorus availability, so good distribution of applied phosphorus is important for high productivity. These sands are more prone to wind erosion if soil

cover is not maintained, as the winds tend to be stronger in coastal areas.

Loamy earths

These are yellow or red loams with clay or gravel at the surface or depth. Generally found in the Chapman Valley and around Northampton, loamy earths can be found in all areas and are some of the better agricultural soils in the area. Soil pH generally ranges from 4.8 to 6.0 and they have a greater moisture and nutrient holding capacity than the sands, but they are still prone to leaching in heavy rainfall. Wind erosion can be a big problem in summer and autumn if soil cover is not maintained above 50 per cent. If the gravel is at the surface, it will help reduce the wind erosion risk as it adds to the cover. The areas of surface gravel can contain exposed hard laterite caprock, with patches of weak sand in between, and it is in this weak sand where most of the problems occur.

Yellow or red loamy sands

These soils are found in the central and eastern areas and near major watercourses. Generally, the pH is 5.0 to 6.0. These soils have good water and nutrient holding abilities, although they can be shallow due to rock and impermeable layers. The deep soils are some of the best in the area, but the shallow soils can be prone to water logging and water erosion.

Clays

Yellow/grey or red loamy clays are found in small pockets in most areas, with pH about 6.0 or higher. Clays can take a lot of rainfall to wet up and may be hard-setting in the summer. They may also suffer from transient water logging in the winter. If they are hard-setting, then the initial rainfall for the season may cause water erosion due to runoff.

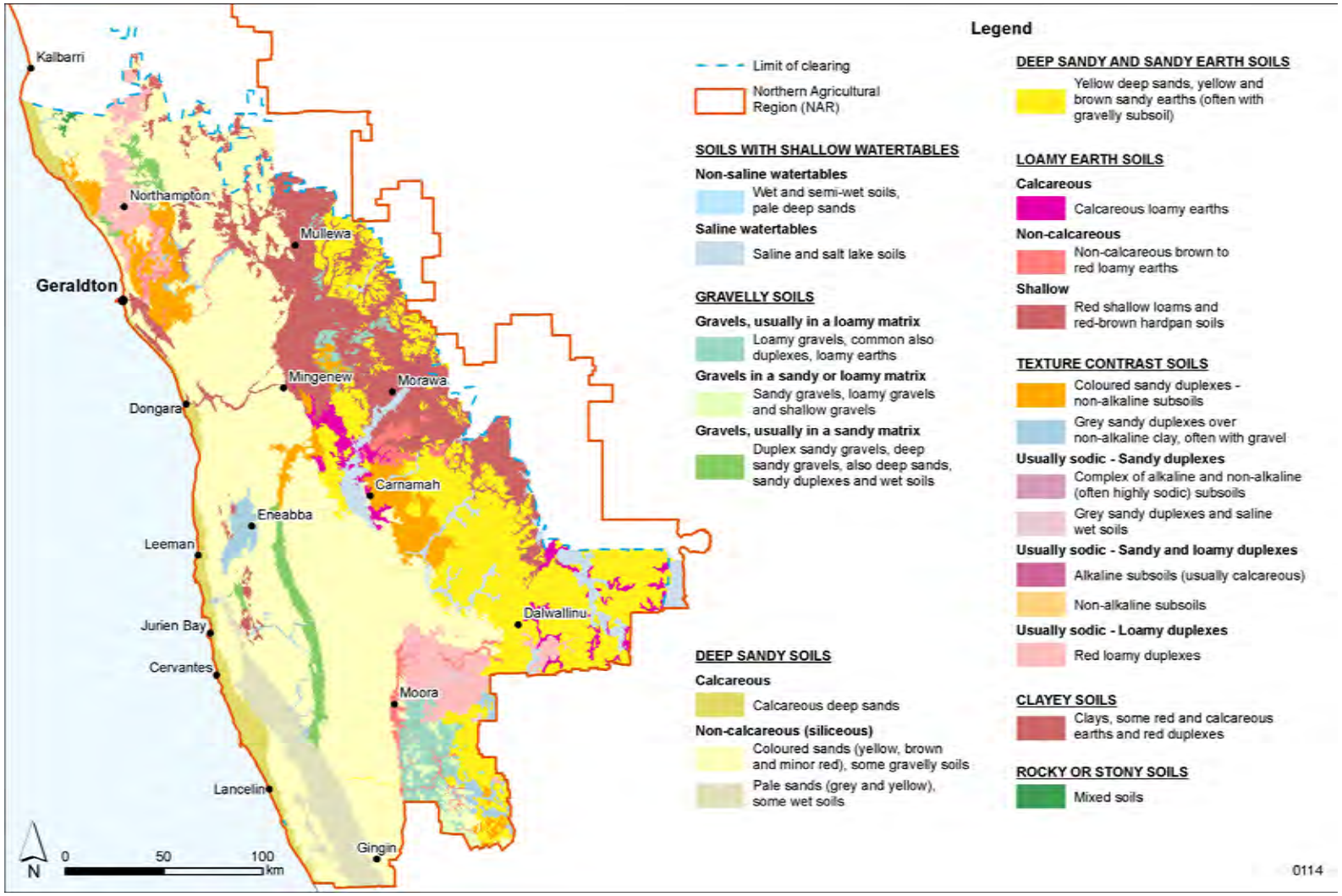
FOLLOW UP

Read this chapter in conjunction with these other Soil chapters:

- Soil Classification.
- Soil pH.
- Soil Erosion.

As well as:

- noteworthy 9: Soil Testing (in this *Guide*).
- *Soil Guide: A handbook for understanding and managing agricultural soils* (DAFWA, compiled and edited by Geoff Moore). Originally released in hardcopy as *Bulletin 4343*, dated 2004.



Data Sources: Commonwealth of Australia 2012; and the Western Australian Agriculture Authority 2012.

SOIL CLASSIFICATION

The major factors that influence and classify your soils are outlined here. The major soil types of the Northern Agricultural Region (NAR) are described in the Know Your Soils chapter where each soil is described by these parameters.

The soil profile is a combination of all these factors through the depth of the soil and can be very detailed. The profile is usually divided into topsoil and subsoil, or the A and B horizons. The difference usually relates to a change in colour and often indicates a change in fertility. The topsoil is about ten to 15 centimetres deep. There is usually a much deeper layer of subsoil below that. The makeup of this subsoil layer can have a large impact on the quality of the soil. If it has poor drainage, does not hold enough moisture or is hostile in some other way, then this will affect plant growth due to the ability of the roots to penetrate it and extract nutrients and water. Beneath the subsoil is the parent material, or the C horizon, which generally occurs at about one to two metres.

FAST FACTS

The soil profile has several layers – topsoil, subsoil and parent material.

The topsoil is the most fertile layer.

The subsoil may cause constraints such as poor drainage.

There are a wide range of descriptors used in the classification of soils, relating to features such as texture, colour and chemical and physical characteristics.

Texture: the proportion of sand, silt or clay is very important.

Soil scientists use pH, texture and the colour of the soil to classify them. Some of the words used when describing soils are:

- **Calcareous**
  This relates to the amount of calcium carbonate in the soil.
- **Leaching**
  This is the movement of water and nutrients down the soil profile.
- **Soil profile**
  This refers to the appearance of the soil as you dig deeper; the depth of the topsoil and subsoil down to the parent rock.
- **Lateritic**
  This refers to gravels and how they have formed from the weathering they have undergone.
- **Strong**
  These soils are generally heavy textured and grow healthy plants.
- **Weak**
  These soils are generally light textured, do not provide a good stubble cover and are prone to wind erosion.
- **Buffering capacity**
  This is the soil's ability to withstand changes in pH and is related to the clay content and innate fertility of the soil.
- **Soil cover**
  This is the amount of dry feed or rocks that cover the soil surface and do not get blown away.
- **Water holding capacity**
  This is the capacity of the soil to store moisture; it is related to the air spaces found around the soil particles. Sands do not have a high water holding capacity. Clays do have a high water holding capacity as the surface area of the particles, and thus space around them is greater.

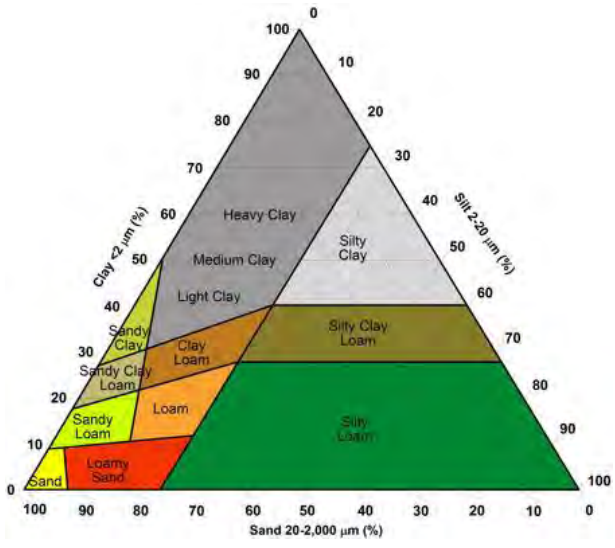
TEXTURE

Soil is classified by its proportion of sand, silt and clay and this is referred to as texture. The percentages of sand, silt and clay can be plotted on a triangle and the point where they all meet is the soil texture class (see the following diagram). Texture is one of the main features that identifies a soil, and it will also impact on its uses.

As particles are washed down the soil profile over time, this creates layers or horizons in the soil. These horizons are generally delineated by a colour change and can have different textures. This often means that a greater percentage of clay is found the deeper you dig. These horizons help soil scientists to classify soils.

The more clay there is in the soil, the greater its nutrient and moisture holding capacity. This is related to the amount of space between soil particles, similar to the way that a sponge will hold water. Coarse sponges will fill up quickly but if you lift them out of the bucket, most of the water will drain out. A fine grained sponge may take some manipulation before it is fully wet but it will hold more water and is harder to wring out.

Sands contain very little clay and so they do not have good water or nutrient holding capacity. This is important to note, as it means that sand is more likely to leach nutrients. Leaching is the term used to describe the movement of water and nutrients down the soil profile. Sands are the predominant soils of the Perth Basin and are the soils common to areas west of the Darling Scarp. Leaching of applied nutrients from these soils has been one of the major contributing factors to the problems in the Peel/Harvey inlet and has led to the blue/green algal blooms in the Swan River. Leaching of nutrients may also become a problem in the rivers in the NAR as more people move into the area and more potential for leaching occurs.



Soil Textural Triangle (Source: McDonald, 1990).

SOIL COLOUR

This is purely a description of the colour of the soil for classification purposes and it helps to define the different horizons in the soil. Generally, the redder the soil, the more iron it contains and the more colour, the stronger and heavier the soil is.

FOLLOW UP

Read this chapter in conjunction with these other Soil chapters:

- Know Your Soil.
- Soil pH.
- Soil Erosion

As well as:

- *Soil Guide: A handbook for understanding and managing agricultural soils* (DAFWA, compiled and edited by Geoff Moore). Originally released in hardcopy as *Bulletin 4343*, dated 2004.

SOIL PH

Soil pH is a logarithmic scale that measures the amount of acid or alkalinity in the soil by measuring the amount of hydrogen ions present (see the following diagram). A pH of seven means the soil is neutral (neither acidic nor alkaline). As the following diagram demonstrates, each step in the scale represents a ten-fold change, so a soil with a pH of six is ten times more acidic than a soil at pH 7. The pH of your soil and its texture are the best indicators of what your soil will grow. Soils that have a pH that is too high or low can have very low productivity.

In general, Western Australian soils range from pH 4 to pH 7, although some coastal sands or dry arid areas may range from pH 7 to pH 9. The pH is usually determined by one of two methods, either in water (pH(w)) or in Calcium Chloride (pH(Ca)). Historically, water was used to measure pH, but for WA's acidic soils, Calcium Chloride provides a more accurate measurement. Most of the current commercially available tests use Calcium Chloride or both. It is important to understand which method has been used to calculate your measurement, as pH(w) is generally 0.9 of a unit higher than pH(Ca) but it varies from 0.6 to 1.2 units on the scale. Because the scale is logarithmic, one pH unit is not just one, but ten times difference. Consequently, if you are using the wrong scale, it can give a very different result.

Low pH in the topsoil generally leads to very low pH at depth (20 to 50 centimetres). This can cause a very hostile environment for root growth and microbial survival. It will also affect the availability of many nutrients the plants need for growth (see the table on page 19). The coastal sands can have the opposite problem in that they have high pH and this also affects the availability of nutrients.

Take soil samples and test them so that you know the pH of your soil. Simple test kits can be obtained from a local agricultural reseller or hardware store. Just knowing the pH can help you gauge what nutrients might be locked up. More detailed tests are also available for measuring the actual nutrients in the soil. These results can then be used to generate a fertiliser regime for the enterprise that you are conducting. However, knowing the pH is the most useful information. Although interactions can occur between soil nutrients, pH is the major factor that influences how available nutrients are to the plant.

CHANGING THE PH OF YOUR SOIL

If your soil is too acid or too alkaline, you may want to increase or decrease the pH. Liming (see page 19) is the most common action needed.

However, the calcareous coastal soils (also known as lime or chalky soils) of this region, including the soils in and around Geraldton, are frequently alkaline, and liming will be of no assistance and possibly detrimental. Soil pH can usually be lowered by using fertilisers that contain ammonium (e.g. ammonium sulphate). Elemental sulphur is another common option. Test your pH first so that you know whether it needs increasing (e.g. by liming) or decreasing.

FAST FACTS

Soil pH measures acidity and alkalinity.

pH 7 is neutral; below seven is increasingly acidic and above seven increasingly alkaline.

pH is measured on a logarithmic scale so one point change means a ten-fold change in pH.

Nutrients are differently available at different pH levels.

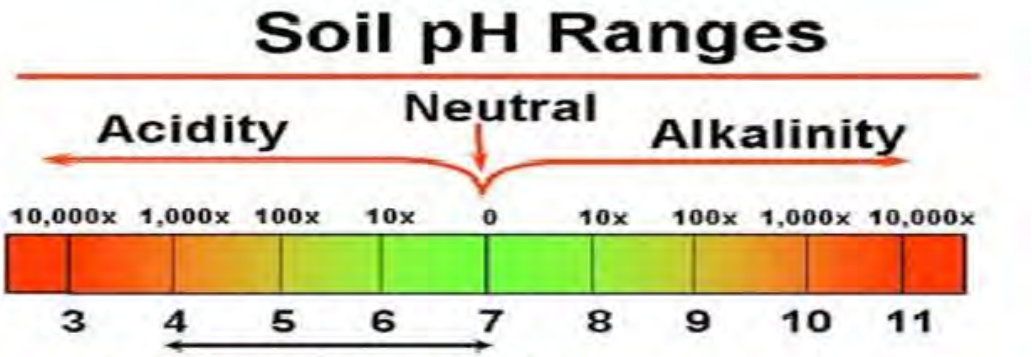
Test your soil pH – simple test kits are readily available.

You can change the pH – but make sure you test it first.

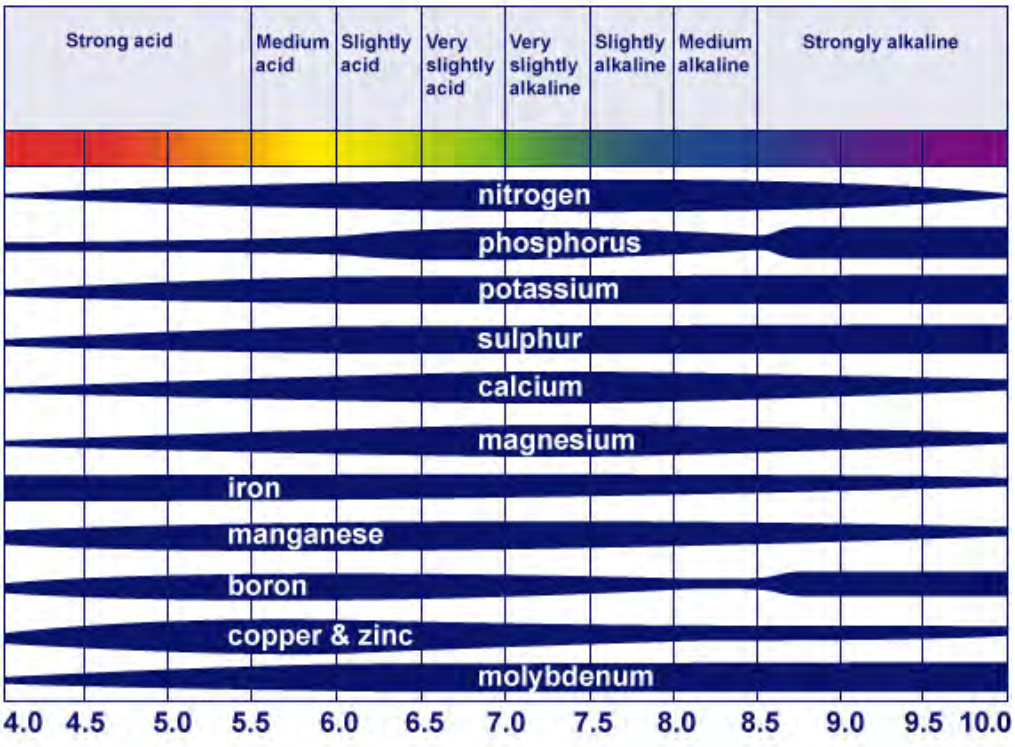
To lower the pH, use ammonium fertilisers or elemental sulphur.

To increase the pH, add lime.

Understand the particle size and neutralising value of your lime source before liming.



(Source: Glendinning 2003)



Relative availability of nutrients at various pH(w) (Source: Glendinning 2003)

LIMING TO INCREASE PH

Many factors affect the pH of soils – from the land use and fertilisers applied, to the parent rock it was derived from. The more intensively the land is used, the more acidified it is likely to be. This means liming to increase the pH may be required. However, the pH tolerance range of plants varies (see the following table) and liming may not be necessary. This will partly depend on what is planted and how much biomass gets exported off. For example, under a legume-based pasture that is cut for hay each year, the pH will drop and the productivity of your land will decline over time. Lower pH soils may also favour some of the more troublesome weed species.

If you think you need to lime, consult an adviser first (try your local reseller). Ask about the particle size and neutralising value of any lime recommended for use. The particle size (lower is better) and neutralising value (higher is better) interact to give the quality of the lime source you are using. Lime source pits vary in quality even within the pit.

Reputable suppliers will give you a current analysis of their products that will have these parameters listed. The cost of liming is determined by the quality of the lime source, the distance that it will need to be carted and the volume needed to give the required pH change. The neutralising value of the lime is important, as this is a measure of how much acidity it will change, and the particle size will affect how rapidly the pH can be changed.

See the excellent DAFWA *Bulletin* listed in the Follow Up box, for comprehensive information about liming.

pH ranges for different crops and pastures.

5.0 to 6.0	6.0 to 6.5	6.5 to 7.0	7.0 to 9.0
Couch	Couch	Lucerne	Medics
Ryegrass	Ryegrass	Barley	Couch
Rhodes grass	Rhodes grass	Medics	Rhodes grass
Sub clover	Wheat	Chickpeas	Persian clover
Triticale	Phalaris	Couch	
Lupins	Sub clover	Ryegrass	
Oats		Rhodes grass	

FOLLOW UP

Read this chapter in conjunction with these other Soil chapters:

- Know Your Soils.
- Soil Classification.
- Soil Erosion.

As well as:

- noteworthy 9: Soil Testing (in this *Guide*).
- *Soil Guide: A handbook for understanding and managing agricultural soils* (DAFWA, compiled and edited by Geoff Moore). Originally released in hardcopy as *Bulletin 4343*, dated 2004.

SOIL EROSION

WIND EROSION POTENTIAL

For most soils in this region, wind erosion will generally be a problem in late summer and early autumn. At these times, dry vegetation is often the only ground cover and winds can get quite strong.

Wind erosion potential is determined by:

- **Soil texture**
  Light (sandy) soils are more prone to wind erosion.
- **Surface condition**
  Is the soil loose, soft or hard? All soils are prone to wind erosion, however, the fragility of the soil is the key element in understanding its erosion potential. Livestock, vehicles and cultivation will all leave the soil surface looser and more prone to erosion. In this region, we have innately poor soils and therefore want to avoid losing fertility.
- **Ground cover**
  Vegetation or other material covering the ground (e.g. straw or mulch) will reduce the risk of wind erosion.

An easy way to estimate erosion potential is to assess the percentage of ground cover, together with the surface condition and soil texture. The following example is from DAFWA's *Soil Guide* – see the Follow Up box.

SUSCEPTIBILITY RATING			
Surface Texture	Surface Condition		
	Loose	Soft	Hard
Weak pale sand	1	1	2
Stronger coloured sand	1	2	3
Loam	1	2	3
Clay	1	3	3+

(Source: Moore, 2004)

1: Very erodible

2: Erodible: need to monitor

3: Less prone to erosion but monitor and maintain surface cover.

FAST FACTS

Many soils in this region are prone to wind erosion, especially over summer and autumn.

Wind erosion risk is determined by soil texture, surface condition and ground cover.

Assess the wind erosion potential of your paddocks using the tips explained here.

Monitor regularly and remove livestock once the cover reaches 50 per cent.

Fence to soil type, use perennial pastures or plant windbreaks.

Water erosion is less common in this region but can be a problem on heavier soils under high intensity rain.

To control water erosion, improve vegetation cover and use minimum tillage and/or contour banks.

The best way to measure the surface condition is to use your forefinger and try to push it over the surface of the soil.

- **Loose:** Easily marked by your finger.
- **Soft:** Your finger can mark these soils but it takes more pressure.
- **Hard:** It is reasonably difficult to mark the surface, or a crust has formed that you put your finger through.

Once you have established the susceptibility rating of your soil, look at the soil surface and assess the level of cover. This can include old plants or rocks and stones that will not move with the wind.

Variability in paddocks can make management difficult. If the soil surface is loose at the start of summer, maintaining enough cover is difficult. Livestock often camp on the poorest part of the paddock, leaving it vulnerable to erosion.

Fencing to soil type and choosing where watering and feeding points are installed will help. It is better to be proactive rather than reactive. If you think that your paddocks may be susceptible to erosion, destock them before wind erosion starts. Using the previous table as a guide, any soils that have been rated as "1" and have greater than 50 per cent cover can be grazed, but you will need to monitor carefully. When any part of the paddock gets to 50 per cent cover, it will need to be destocked.

If parts of the paddock have started to erode, then you need to reduce the wind velocity in that area or firm up the surface. This can be both difficult and expensive. Rolling bales of straw out over affected areas or laying down branches may help to reduce the wind velocity and help manage the problem. Industrial estates spray a polymer coating over the sand to hold it together.

Eroded areas are difficult to rectify and the effect can be long term. If the problems are ongoing, then planting windbreaks to reduce wind velocity or changing the grazing system to perennials may help. See the Plant section in this *Guide* for more information on this.

WATER EROSION

Water erosion is less of a problem in this region than wind erosion, mainly because we have predominately light soils, and also because high intensity rain events are infrequent. However, parts of the region, such as the loamy soils in the Chapman Valley, require water erosion management.

A guide showing about 50 per cent soil cover. (Source: Eliott-Lockhart 2013)

If rainfall intensity exceeds the infiltration of the soil, then surface runoff occurs. Water runs across the surface (sheet erosion) or forms into small channels (rill erosion). If rills are not managed, gully erosion may result.

As with wind erosion, surface cover is the key to managing water erosion. Reducing soil disturbance by using minimum tillage for crop establishment is also useful. In some cases, contour banks may also be necessary.

FOLLOW UP

Read this chapter in conjunction with these other Soil chapters:

- Know Your Soils.
- Soil Classification.
- Soil pH.

As well as:

- noteworthy 11: Managing Erosion (in this *Guide*).
- *Soil Guide: A handbook for understanding and managing agricultural soils* (DAFWA, compiled and edited by Geoff Moore). Originally released in hardcopy as *Bulletin 4343*, dated 2004.

WATER

FARM WATER SOURCES

One of the most important things to assess before you purchase a property is the quality and quantity of available water. This will give you an idea of potential enterprises that may be conducted on the property. The quality of water will have a huge impact on the potential land use. Water can be accessed and stored from a number of sources.

WATER SOURCES

Bores

Bores are holes drilled into the ground with the aim of intersecting a water stream flowing underground. The quality of the water obtained this way is variable. All bores need to be equipped with a pump to extract the water to the surface; these can be windmills, solar powered pumps, motorised pumps or electric pumps. The best pump for the situation will vary depending on the amount of water needed, the amount that can be stored and the infrastructure nearby. Bores drilled for domestic and stock use in general do not need a licence from the Department of Water (DoW), but the DoW must be contacted for a commercial enterprise.

Dams

Dams can be of varying construction; ranging from catchment dams that catch water flowing into them from surface runoff or streams, to turkey nest dams that are dug to expand soak areas. Dams across streams must be built to ensure sufficient water still flows downstream and that the catchment is not affected. Dams can store large volumes of water but, unless covered, they are very inefficient and can lose large volumes of water to evaporation and leakage. This is very evident in the northern areas, where soil types and high evaporation rates mean that dams make up a small volume of the total water sources. The construction and water entry points of the dam may contribute to poor water quality. The release of nutrients from soil and animal manures into the water can potentially create algal blooms, which can be toxic. If toxicity is suspected, water and algae samples should be sent away for testing. The soil and nutrients carried into the dam are measured in terms of turbidity and total dissolved solids (TDS).

FAST FACTS

Water can be sourced in a number of ways:

- **Bores:** Drilling can locate water, but the quality and quantity can be variable.
- **Dams:** These can be inefficient, especially where high evaporation or leakage are issues. Water is also easily contaminated.
- **Rainwater:** The easiest and best quality for drinking water, though rarely sufficient for irrigation.
- **Scheme water:** A guaranteed supply, if available, but usage may be costly if you need large amounts.
- **Desalination and filtration:** Useful if you have poor quality water; small devices are now readily available.

Rainwater

This is the easiest and best form of drinking water. It can be caught from all roof surfaces and stored in covered tanks to reduce the amount of contaminants. Maintaining gutters and letting the first rains wash the roof is advisable as these are the major sources of contamination.

When setting up a rainwater catchment system, it is worth considering how the water is going to flow into the tanks. If there is enough room, the gutters lead directly to the tank and can fill the tanks by gravity. If you need to site your storage away from the catchment roof, you will probably need a pump as well. Remember that an electric pump will be affected by any power outages.

Storage of sufficient amounts of rainwater over the summer months can be difficult, as little or no rain may fall for up to six months. As an example, 1 millimetre of rainfall on 1m^2 of catchment will capture one litre of rainfall. A block at Dongara with a 200m^2 roof and 450 millimetres of annual rainfall will generate 90,000 litres of water. This will need to be stored.

To calculate whether this is enough for your requirements, you will need to do a water budget.

A rainwater system will rarely be useful if you are irrigating, as supply will be limited by the size of the tank.

Scheme water

If your block is on the Government water supply, this is a guaranteed supply of potable or drinkable water. Water charges are usage-based, and in some cases, daily limits are in place. You will need to check this if you are planning an enterprise with high water use.

Desalination & filtration

If your sources of water are not potable (drinkable), then small-scale desalination plants and good filtering systems are available for purchase. Discuss the requirements with a suitably qualified technician.

MOVEMENT

In all cases, some movement of water needs to occur, either by gravity or under pumping pressure. Burial of pipes is recommended to prevent damage and to reduce temperature effects that can cause undue pressure and lead to pipe bursting. Unfortunately, a leak in buried pipes may go unnoticed until a significant amount of water is lost.

FOLLOW UP

Read this chapter in conjunction with these other Water chapters:

- Water Quality & Testing.
- Farm Water Use.

As well as:

- See noteworthy 19 on water supplies for the small rural holding (in this *Guide*).
- AgGuide, *A Practical Handbook: Farm Water*; Jennifer Laffan, NSW Dept. of Primary Industries www.dpi.nsw.gov.au/aboutus/resources/bookshop/farm-water-book.
- More information on farm water quality and testing can also be found in DAFWA website www.agric.wa.gov.au.

WATER QUALITY & TESTING

WATER TESTING

The major tests for water are pH, turbidity, electrical conductivity (EC) and total dissolved solids (TDS). Once you have conducted these tests on all sources of water available, then you can calculate how much water will be needed for the proposed enterprises.

Conductivity and pH tests can be done at the local pool shop, while turbidity and TDS tests will need to be done in a laboratory. Most agricultural resellers will have access to a laboratory.

WATER PH

The same scale for soil tests can be applied to water. In general, rainwater and scheme water will be around pH 7 (scheme can be slightly higher); and bores, depending on the rock (parent material) that may have been drilled in, can be from pH 4 to pH 9. The pH can affect the longevity of metal pipe work and pumps, as well as having negative effects on irrigated plants and pesticides and fertilisers. It can also irritate skin in sensitive individuals.

If you are using water for spraying pesticides, being aware of the pH of the water source you are using will help understand the effect it will have on the pesticide. All pesticides will have been tested for their stability at a range of pH values, but if you have high pH water and wish to use products that break down quickly in it, then you can make some adjustments before you have a failure. Buffering agents can move the pH to the range that you need (ameliorate the problem) or you can change what you are spraying to one less affected by the water source that you are using. Glyphosate, a popular weed killer, works best at pH 4 and degrades very quickly at pH 9. Adding a buffering agent to a high pH water source will bring the pH down to about pH 4.

FAST FACTS

Important characteristics that you should test your water for are:

- Acidity or alkalinity – pH.
- Turbidity/cloudiness.
- Salinity and electrical conductivity (EC).
- Total dissolved solids (TDS).

Correct water quality is critical for human and livestock consumption, plant growth and other processes such as spraying chemicals for best effectiveness.

TURBIDITY

Turbidity is the measurement of the cloudiness of the water. Cloudiness is caused by small particles suspended in the solution (colloids).

Dams have more turbidity after rain, as the water inflow picks up particles as it flows over the ground and stirs up clays on the bottom of the dam. Depending on the size of the particles, some will settle over time if the water is undisturbed. Colloids and some very small clay particles may always give a cloudy appearance to the water. This may cause problems if drip system irrigation is used because particles can build up and cause blockages. Colloid formation can also affect some pesticides that are bound to soil particles.

SALINITY & ELECTRICAL CONDUCTIVITY

Salinity is a major problem in Australia. In the south west corner, rising water tables are causing creeping salinity. Stock are more tolerant to saline drinking water than humans (see the following Salinity Thresholds chart) but be aware that if the salinity reading is at the upper end of the scale, it may impact on productivity by reducing meat and wool growth. If an irrigated enterprise is being considered, then understanding that salt will build up over time with the use of saline water is important. As the plant uses the water, the salts will be left behind, leaving higher and higher concentrations of salts. This makes it difficult for the plant to access all the available nutrients and water. Winter rain may flush all of this down the profile, but a gradual accumulation of salt will affect plant growth considerably.

Electrical conductivity (EC) is often referred to as salinity, but it is actually a measurement of the amount of ions in a solution. It does this by measuring how easily an electrical current will pass through a solution and this has a correlation to the amount of salts that are in the solution. The actual makeup of the salts does change the conductivity, so it is not a perfect measure. This is the best method we have for assessing the suitability of the water. The chart published by the DAFWA has three of the major scales used for measuring conductivity (EC): millisiemens per meter (mS/m), milligrams per litre (mg/l) and grains per gallon (gr/gal).

TOTAL DISSOLVED SOLIDS

Total dissolved solids (TDS) is a measure of the combined content of all substances: organic, inorganic and micro granular suspensions (colloidal). These are the solids left after water passes through a two micrometer filter. It is not an accurate measure for salt or salinity.

TDS is normally applied to fresh water systems as it picks up some of the ions associated with salinity. This test provides an indication of the hardness of the water (ability of soaps to form lather).

Hardness is generally related to the levels of Calcium (Ca2+) and Magnesium (Mg2+) in water, but can also be influenced by Carbonate (CO32-), Bicarbonate (HCO32-), Iron (Fe2+ and Fe3+) and Aluminium (Al3+). These ions are not the traditional salt ions of (Sodium Na+ and Chloride Cl-) but they can have some effects on drinking quality, irrigation systems and pesticides. They can do this by dropping out of solution and blocking drippers, or by reducing the efficacy of the herbicides.

FOLLOW UP

A good explanation of salinity and EC, and comparisons with TDS is given on the Apps Laboratory website www.appslabs.com.au/salinity.htm.

As well as:

- noteworthy 7 on water quality for livestock (in this *Guide*).
- *Rural Land Uses and Water Quality, National Water Quality Management Strategy*, 2000. www.environment.gov.au/water/publications/quality/pubs/rural-land-uses-paper9.pdf.

Salinity Thresholds

Produced by: Water Resources Group

Sponsored by: Sustainable Rural Development and Wool Programs

Livestock / Domestic Use

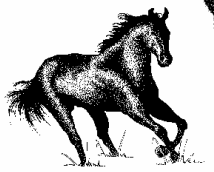
- **Hot Water Systems** 160 mS/m
- **Human Consumption** 250 mS/m

- **Poultry** 470 mS/m

- **Dairy Cattle** 550 mS/m

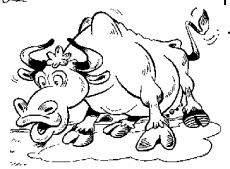
- **Showers & Baths** 620 mS/m

- **Pigs** 700 mS/m



- **Horses** 1000 mS/m

- **Lambs, Weaners & Breeder Ewes** 1100 mS/m
- **Septic Tanks** 1550 mS/m



- **Beef Cattle** 1550 mS/m

- **Adult Sheep** 1650 - 2200 mS/m

Salinity		
mS/m	mg/L*	gr/gal*
0 - 100	0 - 550	0 - 39
200	1100	77
300	1650	116
400	2200	154
500	2750	193
600	3300	231
700	3850	270
800	4400	308
900	4950	347
1000	5500	385
1100	6050	424
1200	6600	462
1300	7150	501
1400	7700	539
1500	8250	578
1600	8800	616
1700	9350	655
1800	9900	693
1900	10450	732
2000	11000	770
2100	11550	809

** Unit conversions vary with type(s) of salt in solution*

Pasture / Crop

- **0 - 80 mS/m**
  - Ladino Clover
  - Red Clover
  - Alsike Clover
  - White Clover
- **80 - 230 mS/m**
  - Strawberry Clover
  - Oats
  - Wheat
  - Rye
  - Lucerne
- **230 - 550 mS/m**
  - Birdsfoot
  - Phalaris
  - Sudan Grass
  - Perrenial Ryegrass
  - Millet
  - Wimmera Ryegrass
  - Barley
  - Tall Fescue
  - Rhodes Grass
  - Kikuyu
  - Couch Grass
  - Tall Wheat Grass
- **550 - 2000 mS/m**
  - Saltwater Couch
  - Puccinellia
  - Sand Couch

FARM WATER USE

HUMAN CONSUMPTION

Human consumption of water ranges from 125 litres per person per day to 180 litres, based on temperatures and use patterns. More efficient washing machines, dishwashers and shorter showers can be major contributors to efficient use of water supplies.

STOCK CONSUMPTION

Stock will drink more in hotter weather and consume water differently during the year. Cattle require water all year and consumption varies, but around 50 litres per head per day, year round, is a good average.

Sheep will drink around five to ten litres per head per day in the summer on dry feed. Sheep usually do not access water during the winter months so their average is about five litres per head per day; however, they should always have access to drinking water.

Saline feeds and water supplies will increase the water consumption of all stock.

The amount of water that sheep need varies with the time of year.

(Source: Eliott-Lockhart 2013)

FAST FACTS

Water consumption depends on the use:

- Human consumption is about 125 to180 litres per day.
- Stock consumption varies with the species and the time of year – cattle use about fifty litres per head per day, year round; sheep five to ten litres per head per day in the summer but very little in winter.
- Plant water use varies and is largely governed by evapotranspiration, although differences in usage patterns also exist between species.
- Use mulch and/or wetting agent on soils to ensure that water is used most effectively.
- If salinity is a problem, use perennial plantings to maximise water use.
- If irrigating, try to use an efficient system, e.g. drip irrigation and look out for an irrigation course to learn more.

PLANT WATER USE

Over 90 per cent of the water used by plants is drawn through the roots and transpires through the leaves. Only a small amount of the water taken up by plants is actually used to produce plant tissue. Water use varies widely from plant to plant and is largely governed by evapotranspiration, or the amount of water moving through the plant. Evapotranspiration is the water loss occurring from the processes of evaporation and transpiration. Evaporation refers to water lost from plant or soil surfaces as vapour, whereas transpiration refers to the water lost through the leaves of plants.

In many circumstances, on a small block, your aim will be to preserve water and use it as sparingly as possible. It is often useful to follow the principles of waterwise gardening and use mulch on soil surfaces to reduce evaporation, and to use soil wetting agents to increase the efficiency of water infiltration.

However, occasionally, you will be faced with an excessive recharge problem, and risk soil salinisation. This occurs when excess water (not used by plants) moves through the soil profile, picks up salt on the way down, and causes salinisation of the groundwater. In these cases, you may need to use plant species that will use all the available soil water so that excessive recharge is not an issue. Many trees and shrubs, as well as perennial pastures (both grasses and lucerne), will utilise soil water all year round and reduce recharge problems.

IRRIGATION

Irrigation of gardens and orchards can be made more efficient by utilising some of the newer technologies developed by irrigation specialists. The approximate application efficiencies of different systems are reported as the following:

- **Surface (e.g. furrow):** 60 per cent efficient.
- **Sprinkler:** 75 per cent efficient.
- **Drip:** 90 per cent efficient.

Time of day and duration of watering is a big influence on efficiency but the more focused the application system, the more efficient it is. Installing drip irrigation pipe sub-surface will increase efficiencies by reducing evaporation. Surface drip pipe is still a more efficient way of irrigating than are sprinklers.

For many trees, the majority of the roots are at the drip line – an imaginary line around the tree where water drips off the edge of the foliage. The tree line changes as the tree grows and some good systems have been developed that use a loop of drip irrigation pipe placed around the tree at about its drip line to target these roots. This also helps you to target the major roots for nutrition if you are using liquid fertiliser.

If you are irrigating, then it is well worth enquiring about the availability of an Introduction to Irrigation or a Waterwise on the Farm course, as these can be very helpful and informative.

FOLLOW UP

Read this chapter in conjunction with these other Water chapters:

- Farm Water Sources.
- Water Quality & Testing.

As well as:

- See noteworthy 19 on water supplies for the small rural holding (in this *Guide*).
- *Saving Water in your Garden*, WA Department of Water www.watercorporation.com.au/w/waterwise_gardens.cfm.
- *AgGuide, A Practical Handbook: Farm Water;* Jennifer Laffan, NSW Dept. of Primary Industries www.dpi.nsw.gov.au/aboutus/resources/bookshop/farm-water-book.

LIVESTOCK

FEEDING LIVESTOCK

FEEDING BASICS

The idea of keeping livestock holds an attraction for many small landholders. Horses, sheep and cattle are commonly kept, while more exotic animals like alpacas, ostriches, rabbits and goats may also hold an interest.

The Livestock section of this *Guide* covers the basics of feeding livestock. Different animals process feed differently, so there are separate chapters covering some the basics of ruminant digestion (sheep, cattle, goat and alpacas), as well as digestion in the hindgut fermenters like horses and rabbits.

Understanding the differences in digestion is important, as these differences will drive what types and levels of supplementary feed are required by different animals.

Green feed is what grows in paddocks during the winter months and dry feed is the residue left over that has died off. Hay is green feed that has been cut off at the base and left to dry in the sun. This is better quality feed than dry feed as the nutrients have not been transferred to seeds but are left in the cells as the plant tissues have dried out.

In the NAR, most supplementary feeding is done with lupin grain, with hay (usually oaten hay, but lucerne hay is also common) or with oats and other grains that may be available. This *Guide* will cover some of the main livestock issues, but you should discuss animal husbandry issues with a vet or experienced person.

DRY SHEEP EQUIVALENTS (DSE)

Animals can be described as a small or large stock unit (SSU or LSU) or more commonly, a dry sheep equivalent (DSE). As a large amount of variation exists in all biological systems, there is not really a set amount that a sheep or cow will eat. The amount consumed will depend on what is available and how much the animal requires to fulfil all its dietary needs.

The DSE is a common way of describing the quantity of feed required, and this unit makes it easy to compare different types of animals. The DSE is based on the amounts that a dry sheep would need and are then extrapolated to approximate the amount of feed that each type of animal requires, or the amount of grazing that certain soil types can carry.

The standard DSE is equivalent to a sheep that is:

1. Not lactating.
2. Weighing a live weight of 45 kg.
3. In reasonable condition (not too fat or skinny).
4. Grazing enough pasture to maintain weight.
5. Drinking relatively fresh water (< 1,000 mg/l TDS).

FAST FACTS

Different types of livestock have different digestive systems and it is worth understanding the differences so that you can supply the appropriate feed requirements.

Sheep, cattle, goats and alpacas are ruminants; horses and rabbits are hindgut fermenters.

Dry Sheep Equivalents (DSEs) are useful units for assessing the feed requirements of different animals.

DSEs are based on the amounts a dry sheep would need; requirements will differ depending on the type of animal and its physiological state.

Different types of animals or animals in a different physiological state will have a different DSE score. For example:

- A dry cow is about 10 DSE.
- A ewe pregnant in its last trimester is about 1.7 DSE.
- A six month old lamb is about 0.7 DSE.
- A ewe with a lamb at foot is about 2.5 DSE.

These figures clearly show that the age, weight and physiological state of the animal has a big bearing on what DSE number is generated. Horses that are grazing in paddocks will be about the equivalent of a large stock unit or similar to cattle in their DSE equivalents.

In the NAR, stocking rates are about 2.0 to 4.0 DSE/WGha (winter grazed hectare). Good graziers can run them at 6.0 to 7.0 DSE/WGha. However, they will generally have large areas of stubbles (residues left after crops have been harvested) to run animals in the summer.

For example, a five acre (2 ha) paddock on the Greenough flats can run approximately eight DSE, equivalent to one horse, with some supplementing of dietary intake and taking into account trampling. However, on the sandy hills nearby, the figures are about half this.

Splitting the paddock into two will have the benefit of reducing the amount of trampling in any one paddock and thus better use of the available feed.

Before you decide to get involved in a livestock enterprise, it is always a good idea to have as much information on the habits and lifecycle of an animal as possible. The health and welfare of the animals will be your responsibility. Understanding how the animal converts food to growth and maintenance will help you to determine when supplementary feeding is needed and at what periods the animal has a higher requirement for food.

In all cases, it is important to have your veterinary clinic's phone number and to call a qualified person to discuss any problems you may have with your livestock.

FOLLOW UP

Read this chapter in conjunction with these other Livestock chapters in this *Guide*:

- Ruminant Nutrition.
- Horses: Hindgut Fermenters.
- Livestock Problems.
- Fences & Feeders.

As well as:

- noteworthy 5: Cattle Ownership.
- noteworthy 13: Branding and Moving Stock.
- noteworthy 18: Livestock Husbandry.
- noteworthy 31: Horse Keeping.

Also see the References chapter at the end of this *Guide* for further information.

RUMINANT NUTRITION

FEATURES OF RUMINANTS (SHEEP CATTLE, GOATS, ALPACAS)

A ruminant is an animal that has a large stomach-like organ called a rumen which has four chambers or areas where different sized particles are processed or digested. The rumen is a large fermenting vat full of 'good' bacteria. The food that is ingested helps support this ruminant bacteria population, which is important in the fermentation processes.

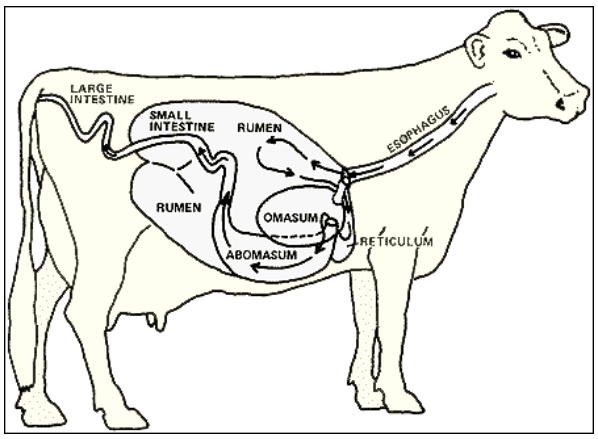
The rumen of sheep and goats has an approximately 15 to 20 litres capacity and cattle about 150 to 200 litres or around 25 to 30 per cent of the animal's live weight. The by-products of microbial degradation in the rumen are what provide nutrition to the animal. The resultant nutrients, including the dead bacteria themselves are then passed out of the rumen into the intestines and nutrients are absorbed into the bloodstream. The fermenting vat of the rumen is able to utilise very poor quality feed and convert it to quite high quality nutrients that the animal can use.

However, sometimes dry feed is so nutrient-poor that that even the bacteria is unable to utilise it well enough and supplementary feeding needs to be started before the animal loses too much condition.

Sudden changes to the diet will cause scouring (diarrhoea) and poor growth rates, until the rumen bacteria have adjusted to the new feed. Different bacteria work on different feeds and until the normal rumen bacteria are at optimum levels, all sorts of by-products can be made and some of these can be toxic. Similarly, if the animals have been on poor quality feed and you want to supplement their diet, it is better to start with a small amount of the supplement and build it up to the required rate over about seven to ten days. Feeding a smaller amount of a supplement out every two to three days is better for rumen function than a larger amount once a week.

In the NAR, many farmers grow lupins as they are easily sourced, are high in nutrition and are good value for money. Most supplementary feeding is done with a combination of hay and lupins for sheep and the smaller ruminants, and mainly hay for cattle. These feeds are generally very safe to feed to these animals, as are oats.

However, note that excess feeding of some grains can be very detrimental and can lead to a serious condition called acidosis. See the Livestock Problems chapter in the Livestock section for more information. In general, lupins and oats are quite safe, but you need to introduce grains such as wheat, barley and triticale very gradually into the diet to avoid acidosis in ruminants.



Representation of digestive system in ruminant (University of Waikato, 2011).

Ruminants also cough up material from the rumen and then chew it up again to break it down to smaller particles. This is known as chewing the cud for cows or ruminating in sheep. This action breaks down the harder fibrous vegetation to smaller particles that are easier for the bacteria to work on. This material in most other mammals gets passed through as undigested fibre.

The major differences between ruminants are in the agility of the mouthparts and the shape of the rumen. Sheep can graze closer to the ground, and utilise short pastures more effectively than can cattle. There are also differences in their ability to deal with whole grains or very poor quality feed and the ability to pick up small seeds off the ground.

As a general rule, goats are better at finding and utilising feed than are sheep, but some of the newer breeds of sheep in Australia, such as Dorpers, reportedly have a better feed conversion than other sheep breeds. Of the ruminants, in general, cattle are the least able to pick up seeds off the ground and have trouble digesting whole grains.

FAST FACTS

Sheep, cattle, goats and alpacas are all ruminants, and use a rumen (or large many chambered stomach) to digest food via microbial fermentation.

Feeds vary in their usefulness for ruminants. Be careful about the safety of some grains fed in large quantities.

Feed On Offer (FOO) must be assessed, together with digestibility and metabolisable energy, and matched to the physiological requirements of the animals at any particular time.

If paddock feed is insufficient to meet the requirements, then supplementary feeding will be necessary.

FEED AVAILABILITY: FOOD ON OFFER (FOO)

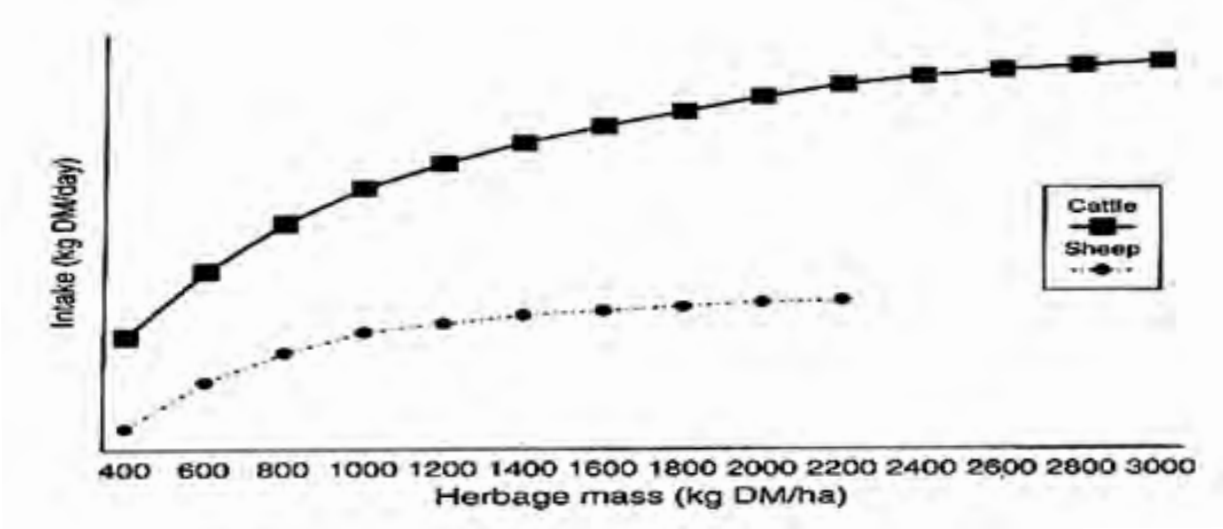
Food availability for animals (Feed On Offer (FOO)) is measured by kilograms of dry matter per hectare (kgDM/ha). The animal's food intake per day is used to assess how much food the animal needs to maintain all its bodily functions (kgDM/day). The quality of the dry matter (DM) affects the ability of the animal to meet its needs. A general rule is that an animal will eat about three to four per cent of its bodyweight per day.

If we apply this in a practical way, the smaller ruminants will start to get enough to eat with about 500kg/ha of FOO and will generally be fine with 700kg/ha FOO. Larger ruminants will start to get some nutrition at 700kg FOO and will be able to get a good mouthful at about 1,000kg/ha FOO. This equates to feed at about three to four centimetres high for 500kg and about five to six centimetres high for 800kg. Ankle high feed is between 800kg and 1000kg/ha (see figure). At the start of the season, this feed is generally high quality, with 14 to 18 per cent protein and ten to 12 Mega-joules of energy.

Good ground coverage and actively growing pasture are also important. The ability of the animal to get enough bulk of food is important. When pastures are low, animals have difficulty maintaining sufficient gut fill, so they will spend a considerable amount of energy looking for food.

A 50kg ewe needs between 1.5 and 2 kg/DM to feel full. With good quality feed, she may be able to fulfil all her needs with 1kg, but she will still graze to feel full and thus lay down the extra energy as fat. Once there is adequate material on the ground, animals will spend some time during the day camped up and re-chewing their food.

Intake with FOO at different levels (Dept of Primary Industry, NSW, 2006).



DIGESTIBILITY & ENERGY

The tables on this page and the next show differences in required intake as digestibility declines (which can occur as plants start to 'dry or hay off'). The decrease in quality may mean that the animal consumes its full intake of 2kgDM/day but this cannot supply all of its requirements for maintenance. Maintenance amounts are required to ensure the animal does not lose weight and is able to maintain all its body functions. These include pregnancy and milk production as well as the distance it may have to graze or walk for water. The intake of metabolisable energy (ME) and/or crude protein (CP) can also be used to assess various feed sources. The digestibility of the food source has an impact on how much the animal has to eat to get its required level of nutrition (see figure on next page).

Sheep Class	Pasture Digestibility		
	75%	68%	60%
Dry sheep	400	600	1200
Pregnant ewes:			
Mid pregnancy	500	700	1700
Last month	700	1200	ns
Lactating ewes:			
Single	1000	1700	ns
Twins	1500	ns	ns
Growing stock (per cent of potential growth)			
30% (75 g/d)*	400	700	1700
50% (125 g/d)	600	1000	ns
70% (175 g/d)	800	1700	ns
90% (225 g/d)	1600	ns	ns

*Predicted growth rates in brackets are based on a weaned four month old crossbred lamb of approximately 32 kg from a ewe with a standard reference weight of 55 kg. ns = not suitable; that is, at these digestibility's, no matter how much pasture is available, dry or pregnant stock are unlikely to maintain weight, lactating stock are likely to experience an unacceptable level of weight loss, and growing stock will not be achieving the targeted weight gain.

Minimum herbage mass (kg green DM/ha) to maintain satisfactory production levels in sheep (NSW Dept of Primary Industry 2006).

Cattle Class	Pasture Digestibility		
	75%	68%	60%
Dry cow	700	1100	2600
Pregnant cow (seven to eight months, not lactating):			
	900	1700	ns
Lactating cow (calf two months):			
	1100	2200	ns
Growing stock (per cent of potential growth)			
30% (0.39 kg/d)*	400	700	1700
50 % (0.61 kg/d)	600	1000	ns
70 % (0.85 kg/d)	800	1700	ns
90 % (1.12 kg/d)	1600	ns	ns

*Predicted growth rates in brackets are based on a weaned 13 month old steer of approximately 320 kg from a cow with a standard reference weight of 500 kg. ns = not suitable, that is, at these digestibilities, no matter how much pasture is available, dry or pregnant stock are unlikely to maintain weight, lactating stock are likely to experience an unacceptable level of weight loss, and growing stock will not be achieving the targeted weight gain.

Minimum herbage mass (kg green DM/ha) to maintain satisfactory production levels in cattle (NSW Dept of Primary Industry 2006).

The following graphs show the effects of digestibility on energy available to the animals. Dry pasture with less leaf area and more stalks has less energy available to livestock. Once pastures have dried off, there can be a dramatic reduction in both the usefulness of feed and also in the physiological state of the animals.

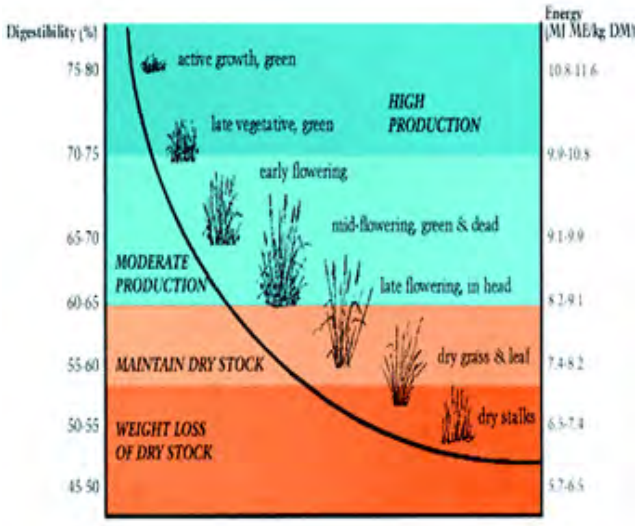
A good mixture of ryegrass and clover (called a mixed sward) that has 'hayed off' is much better than a capeweed/brome grass pasture as the protein and energy levels are better. Green feed is better quality than dry feed; making sub-tropical perennial pastures extremely useful. Perennial pastures grow well in this region over summer, and are excellent at capturing any moisture, including dew. They have been measured at about nine to ten per cent CP with about 9 to 10 MJ/ME and about 60 to 70 per cent digestibility, so depending on growth patterns they can provide excellent summer and autumn feed.

Once the CP, ME and digestibility of the feed source are known and it is correlated with the requirements of the animal, then decisions can be made about the need for supplementary feeding.

Of course, the exact figures that exist in all paddocks are unknown, so it is important to monitor the feed levels available for all stock. If stock look like they are losing condition it is important to start supplementing as soon as possible. Rain on dry feed degrades the feed quality, so if it is a wet summer/early autumn then it will be important to supplement early as feed quality will plummet. This is the time when livestock have a high demand for good feed, as they are often at late pregnancy or early lactation.

Supplementary feed may be necessary, particularly in our dry summers, if animals are not maintaining condition.

(Source: Eliott-Lockhart 2013)



Effects of pasture growth on digestibility and metabolisable energy during the season (NSW Dept of Primary Industry 2006).

FOLLOW UP

Read this chapter in conjunction with these other Livestock chapters in this *Guide*:

- Feeding Livestock: Introduction.
- Horses: Hindgut Fermenters.
- Livestock Problems.
- Fences & Feeders.

As well as:

- noteworthy 5: Cattle Ownership.
- noteworthy 13: branding and moving stock.
- noteworthy 18 : Livestock Husbandry.
- noteworthy 31: Horse keeping.
- A very good reference, which has been used in developing this chapter is the *Pasture Assessment and Livestock Production*, Prime Fact 323, NSW Department of Primary Industry, 2006 www.dpi.nsw.gov.au/agriculture/livestock/nutrition/feeds/pasture-assessment-livestock-production/pasture-assessment-and-livestock-production.pdf.

Also see the References chapter at the end of this *Guide* for further information.

HORSES: HINDGUT FERMENTERS

A LARGE CAECUM, NOT A RUMEN

Hindgut fermenters (for example horses, rhinos, rodents and rabbits) have a similar digestive system to all mammals, but have a large organ called the caecum. This is similar to the rumen in that it is a fermenting vat and the microbes help break down organic matter that cannot be digested by the typical mammal stomach. It is not the sole source of nutrition for the animal but it will assist the animal to break down poorer quality feed to obtain more nutrients from grazed plant material.

Most horse owners will supplement their feed before any problems appear. If you are interested in owning a horse, then discussing nutrition needs with a qualified person before you start is the best strategy.

The information about Crude Protein (CP), Metabolisable Energy (ME) and Food On Offer, and Digestibility – discussed in the chapter on Ruminant Nutrition – applies to all grazing animals. However, small variations occur in the ability of different animals to graze short pastures or utilise poorer quality feed. Horses and cattle, being large animals, do need taller pastures to effectively get a mouthful. Because of the structure of their digestive system, grass and hay are the most appropriate feed for horses and they should be allowed to forage as much as possible.

At least one per cent of the horse's body weight is required in roughage to aid digestion. Therefore, roughage should be approximately 50 per cent of the ration. The equine digestive system is very efficient if horses are mainly fed grass and hay, but too much grain can be a problem.

The high starch content in grain is difficult for a horse to digest. Digestion of starch can also produce excessively acidic conditions in the hindgut due to the production of lactic acid via bacterial breakdown. This may result in low pH conditions, which cannot be tolerated by the important fibre-digesting bacteria, which then die and release toxins into the hindgut. Colic may then occur, or even 'founder' (or laminitis), a foot inflammation that can be brought on by inappropriate feeding.

The table on page three of this chapter gives some very detailed data on the energy and protein requirements for different categories of horses. As with all animals, the nutritional demands will vary greatly for young and older animals, and pregnant and lactating mares.

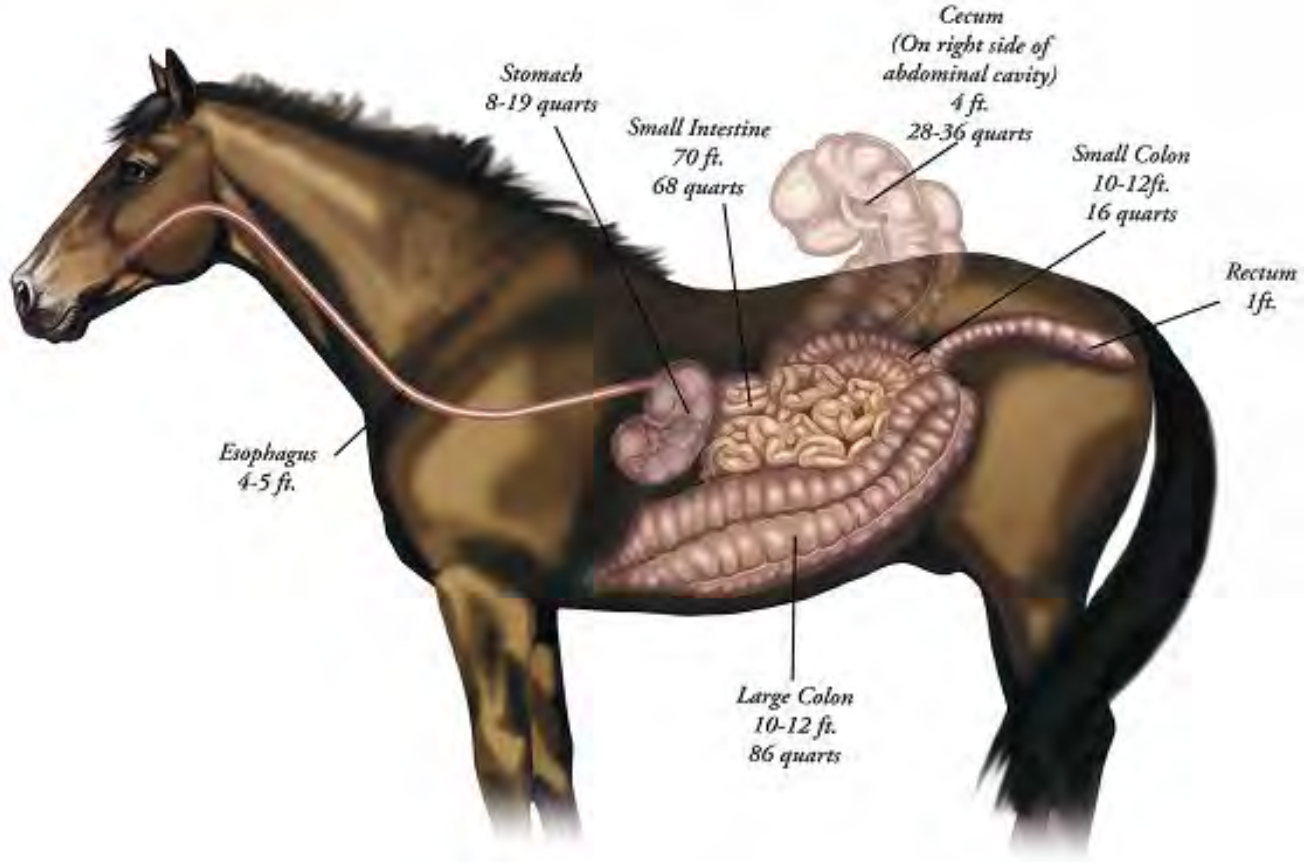
FAST FACTS

In hindgut fermenters such as horses, microbial fermentation occurs in an enlarged caecum, not in a rumen.

Roughage such as hay is very important for horses and should constitute 50 per cent of feed.

Feed grain carefully to horses, as they have a limited ability to digest starch and excessive consumption may cause problems.

As with other animals, the digestible energy and protein requirements of horses will vary considerably, depending on the different physiological stages of the animal.



Representation of a horse digestive system
(Copyright © Veterinary Online, 2014)

FOLLOW UP

Read this chapter in conjunction with these other Livestock chapters in this *Guide*:

- Feeding Livestock: Introduction.
- Ruminant Nutrition.
- Livestock Problems.
- Fences & Feeders.

As well as:

- noteworthy 5: Cattle Ownership.
- noteworthy 13: Branding and Moving Stock.
- noteworthy 18: Livestock Husbandry.
- noteworthy 31: Horse keeping.

The following were accessed in developing this chapter:

- *Equine Nutrition in the 21st Century*. All About Feed website www.allaboutfeed.net/Nutrition/Diet-Formulation/2010/8/Equine-nutrition-in-the-21st-century-AAF011661W/. *Drought feeding & Management for Horses*. Rural industries Research and Development Corporation, David Nash, 1999. http://questequinewelfare.org/attachments/article/53/Drought%20Feeding%20and%20Management%20for%20Horses.pdf.

Also see the References chapter at the end of this *Guide* for further information.

Daily energy and protein requirements for different categories of horse (Nash, 1999).

Type of Horse	Mature Weight (kg)	Daily Gain Live Weight (kg/day)	Digestible Energy (MJ)	Crude Protein (g)
Weanling (six months, moderate growth)	400	0.55	54.0	643
	500	0.65	62.8	750
	600	0.75	71.1	850
Yearling (12 months, moderate growth)	400	0.40	65.3	700
	500	0.50	71.9	851
	600	0.65	95.0	1023
Two years old	400	0.15	64.0	650
	500	0.20	78.7	800
	600	0.30	98.3	998
Maintenance	400		56.1	563
	500		68.6	656
	600		81.2	766
Pregnant mare (11 months)	400		67.4	708
	500		82.4	866
	600		97.5	1024
Lactating mare (foaling to three months)	400		95.8	1141
	500		118.4	1427
	600		141.0	1711
Lactating mare (three months to weaning)	400		82.4	839
	500		101.7	1048
	600		120.9	1258

LIVESTOCK PROBLEMS

MAJOR LIVESTOCK PESTS & DISEASES

Some of the more common issues for livestock are listed below, but in all cases it is better to seek qualified help if a problem occurs. Some ailments are common to all livestock, whilst some species are prone to specific conditions.

LUPINOSIS

Lupinosis, also called phomopsis or staggers, is caused by the Phomopsis Fungus (Diporthe toxica formerly Phomopsis leptostromiformis) growing in the stalks of old lupin plants after summer rain. It primarily occurs in the summer and late autumn when stock are grazing the stubbles of Narrow-leaf lupin (the main type used for grain production in this region) or Blue or Sandplain lupin (a common grazing type on the coastal plain).

The toxins formed from the fungus can affect the livers of all animals, but sheep, particularly young sheep, are the most sensitive. Young sheep are not as adept as older sheep at picking lupins off the ground, so they're more likely to chew on the stems and become affected.

Most modern lupin varieties have some level of Phomopsis resistance and this has reduced the risks, but not eliminated them. Mild damp summers favour the development of the fungus and the toxins that it produces, but the presence of the fungus alone is not a great indicator of the problem.

Lupin stubble should always be grazed before cereal stubbles, to reduce the risk of toxin development. Ideally, sheep should be put into lupin paddocks as soon as the paddocks are harvested. It is usually better to defer grazing cereal stubbles and put up with some loss in stubble quality than to defer grazing lupin stubbles and suffer increased risk of lupinosis (see the DAFWA bulletin on Lupinosis).

To be sure the problem is not occurring, monitor the condition score of the animals and check for yellowing of the eyes. Remove the mob from that paddock if they are losing condition or if they show any adverse signs. High stocking rates of young sheep increases the risk, so managing grazing is important.

FAST FACTS

Important livestock problems you may encounter are listed below. Make sure you know the signs and how to deal with them if they occur.

Lupinosis – from grazing phomopsis infected lupins over summer.

Pregnancy Hypocalcaemia & Toxaemia – with similar symptoms, but different causes and remedies.

Colic – especially in horses.

Laminitis or founder – in horses.

Alkaloid poisoning – from grazing; e.g. Blue lupins or Paterson's curse.

Acidosis from starchy grains.

Flystrike and lice – particularly in woolly sheep (and goats) in warm moist weather.

Worms – a good worming program is essential.

PREGNANCY HYPOCALCAEMIA & TOXAEMIA

Hypocalcaemia is caused by a calcium deficiency in the bloodstream, which can be the result of a deficiency of calcium in the animal's diet (e.g. ewes feeding on poor quality pastures or grain diets without added calcium). Hypocalcaemia is most often seen in the last six weeks of pregnancy and the first three months of lactation, when the female is providing calcium for young bone development and milk production. Death is fairly quick and can happen within six to 24 hours; however, some cases may only last a few days.

Pregnancy Toxaemia occurs when females have a lack of energy in their diet in the last trimester of pregnancy. It is worse in females carrying twins or if they have been on a good plane of nutrition that suddenly drops. This can occur from rain affecting pasture or the more nutritious feed being eaten out.

It is normally brought on due to some other stress factor, like mustering or bad weather. The extra movement or lack of grazing time is enough to use up the last of the energy reserves of the animal and death occurs over a five to seven day period.

Both of these diseases can occur in conjunction with each other and can have similar symptoms. However treatment is very different. Hypocalcaemia can be treated by injections of calcium and sugar into the bloodstream and recovery can be very quick (between one and 30 minutes).

Treating Pregnancy toxaemia is a lot more difficult and prevention is the best course of action. As stock get closer to giving birth, look closely at pastures and stock conditions. If it looks like animals are struggling for enough nutrition (lots of feed but poor digestibility), then supplementary feeding may be necessary to maintain healthy animals. All animals can suffer from these diseases.

To avoid problems, make sure all mobs have continual access to a lick (loose licks are good) containing minerals, especially calcium. Also make sure that animals are kept on a good plane of nutrition, with adequate energy in the feed, from early pregnancy to weaning.

COLIC IN HORSES

This is one of the most serious diseases of horses and can cause death. It is like a stomach ache, and it can be brought on by a number of factors. Generally the animal will start to behave in a stressed manner and this may get progressively worse until death occurs. Occasionally, the animal may recover naturally. It is very difficult to detect the cause and to ensure that colic does not reoccur.

Colic is mainly avoided by good management practices, such as making sure there are no toxic weeds in the paddock, providing adequate fresh water, reducing any stresses, and avoiding sudden increases of grain in the diet. Many paddocks that have sandy soils and Paterson's curse in them become very bare and sandy as the Paterson's curse dies off and this sand can be ingested and also cause colic. Gradually changing the diet and monitoring the change in the animal is also very important. If colic is suspected, then call for veterinary advice immediately.

LAMINITIS OR FOUNDER IN HORSES

A very serious disease in horses, laminitis is caused by a number of factors, from excessive weight or carbohydrate intake to endocrine dysfunction and some management factors, but all seem to reduce blood flow to the hoof, usually in the forefeet. The horse is usually in some pain and will try and take the weight off its affected hooves. In severe cases, the hoof, and the bone that it is attached to, separate and the leg appears to fall into the hoof. This gives rise to the name founder – from the old English word meaning 'to sink'.

ALKALOIDS

Many pasture species contain alkaloids or other organic compounds that can be toxic to all livestock; chief amongst these are Paterson's curse and Blue lupins. The alkaloids do not kill the animal directly but affect its liver or can be broken down in the digestion process to residues that can cause photosensitivity and leave the animal susceptible to other diseases and conditions.

Sometimes signal grass can produce alkaloids that can kill stock, but alkaloid poisoning is more commonly related to previous grazing on Blue lupin or Paterson's curse pastures. Deaths from signal grass have been sporadic and have mainly occurred when hungry sheep have been moved from grazing old pastures with plentiful Blue lupins and Paterson's curse into paddocks that have young fresh shoots of signal grass that is then moisture stressed.

Reducing the populations of any alkaloid-producing plants will help improve the pasture as well as improve the profitability of the paddock. Some pasture species are more prone to causing photosensitivity in stock. This is a sunburn-type of effect seen generally on the nose, eyelids and ears of affected animals. If this symptom is spotted, then remove animals from the paddock and contact your local veterinary office.

ACIDOSIS

Acidosis can be a big problem for ruminants when supplementary feeding of grains occurs. Lupins and oats are quite safe but if you start to add wheat, barley or triticale to the diet, then you run the risk of causing acidosis. Acidosis is caused when the microbes start to produce lactic acid from the starch in the grain instead of volatile fatty acids (VFAs). As more lactic acid gets produced, the pH of the rumen falls and this produces an ideal environment for more acid-producing bacteria.

In mild cases, acidosis causes scouring. As it worsens, the scours get runnier and more foul-smelling and animals walk like they have hot feet. The concentration of acid can then start to strip the lining of the rumen. It can cause death in serious cases. If acidosis is detected in time, drenching with Bicarbonate of Soda solutions can help. However, once the lining of the rumen is stripped, then the animal's ability to absorb nutrition from its rumen is affected for the rest of its life. For small landholders, it is generally easier to access the safer feeds for supplementing over the summer.

FLYSTRIKE

Blowflies can cause breech (rear), body (shoulders and back) and poll (head around horns) strike. Flystrike is the laying of eggs on the fleece and the hatching of maggots that burrow under the skin and start to eat healthy and rotting flesh. When struck, sheep will move away from the mob and may bite or scratch at the affected area. Flies are very active in autumn and spring; this is also the time that pastures change composition and are more likely to cause scouring (diarrhoea) in sheep.

Wool that is damp from scouring and urine is the main attraction, so wet springs and autumns are prime times for fly outbreaks as the moisture and nutrition provides an ideal environment for egg laying. Crutching and shearing prior to these times can help reduce the incidence of fly strike. Wool sheep are the main animals affected by fly strike. Sheep breeds with little or no wool (e.g. Damaras and Dorpers) are almost never flystruck, and if so, it is usually only a minor issue.

Check your sheep regularly – especially animals away from the mob – and if one has been struck, then you will need to catch it, clip about five centimetres of the wool away from the affected area and use an appropriate treatment. Talk to your vet or local agricultural supplier.

Cattle are unlikely to have a problem with flystrike unless they have an open wound.

Flystrike is a problem in wool sheep.
(Photo: www.woolisbest.com)

LICE

Lice live in the fleece of sheep and goats and cause discomfort by biting. They are mainly spread by roaming animals. A light infestation can reduce fleece weight by 0.2kg/head and a heavy infestation can reduce it by over 1kg/head. Lice die quickly when removed from the body, so after shearing is the best time to apply a lousicide to the whole flock. Talk to your Vet or local agricultural supplier about an appropriate chemical. The lice from one animal that is missed or has developed resistance to your treatment is enough to reinfest your flock much quicker than if they have all been treated.

WORMS

All animals can get worms. A good worming program is essential and should be discussed with a vet or local agricultural supplier.

Many areas with extensive livestock history may have problems with worms resistant to drenches. Make sure you rotate the type of chemical you use for treatment to avoid the development of resistance. This can be difficult with small flocks and the standard containers, but if you can obtain supplies from a neighbour or share a drum with them, it may help.

Monitoring worm burdens by faecal egg counts will help identify worms and give you an accurate idea of when treatment should be conducted. Your local vet, or the Department of Agriculture and Food, Western Australia (DAFWA), can perform faecal egg counts for you and give you further advice.

Drenching a young sheep for worms
(Copyright © Veterinary Health Research 2000)

FOLLOW UP

Read this chapter in conjunction with the other Livestock chapters in this *Guide*:

- Feeding Livestock: Introduction.
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- Horses: Hindgut Fermenters.
- Fences & Feeders.

As well as:

- noteworthy 5: Cattle Ownership.
- noteworthy 13: Branding and Moving Stock.
- noteworthy 18: Livestock Husbandry.
- noteworthy 31: Horse keeping.

The following documents, all available online, contain more detailed in information:

- *Equine Laminitis*: *Current Concepts*, by Chris Pollitt. A RIRDC publication. www.rirdc.infoservices.com.au/downloads/08-062.
- *Colic Fact Sheet* www.ed.ac.uk/polopoly_fs/1.18068!/fileManager/dvepfactsheet-colic.pdf.
- *Animal Health Welfare and Biosecurity*. Meat and Livestock Australia. www.mla.com.au/Livestock-production/Animal-health-welfare-and-biosecurity.
- *Sheep 201: A Beginners Guide to Raising Sheep* www.sheep101.info/201/diseasesa-z.html.

Also see the Reference chapter at the end of this *Guide* for further information.

FENCES AND FEEDERS

FENCES

Good fences are required by law and help to prevent the spread of some pests and diseases. Many different types of fencing are available and the manufacturers of fencing materials are always looking for ways to make a cheaper, easier fence for the market.

Broadly speaking, there are three types of fencing. Talk to your local agricultural supplier about the style of fence that you wish to build and they can suggest the latest equipment and technology that will suit.

Post and rail

These are constructed of rigid materials, with uprights spaced at even distances. Rails are made from a rigid material and spaced as high as considered necessary. These fences can be quite expensive and are usually used only for yards, entrances, or for enclosing horses.

(Source: Eliott-Lockhart 2013)

Ringlock or netting fencing

These use star pickets as uprights or may be constructed using wooden posts, with the netting attached to each upright. Many different styles and strategies are used, depending on what you wish to keep in or out. These can also incorporate electric hotwires and other parts of the electric fencing systems. Generally, 7-90-30 netting is used and this denotes that there are seven horizontal wires 90 centimetres high with vertical wires are spaced 30 centimetres apart.

The horizontals are typically closer together at the bottom. This type of fence may have barb or plain wires on the top and/or bottom. Netting or ringlock fencing is not suitable for horses.

(Source: Eliott-Lockhart 2013)

FAST FACTS

There are three sorts of fences:

- Post and rail – highly visible and low impact – often used for horses.
- Ringlock or netting – the most common.
- Electric – extremely useful for strip grazing and very versatile, but less useful for sheep than for cattle.

Fencing is often useful to contain feed in a structure, to save on wastage and avoid health risks.

Simple structures can be erected e.g. on fences.

More sophisticated feeders – e.g. Lick Feeders – can be purchased.

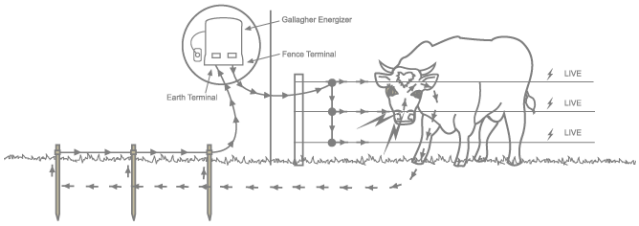
Hay should also be contained, if possible, to avoid trampling.

Small farms can often use a simple, inexpensive form of water trough such as a bath.

Electric fences

Electric fences come in lots of different styles. Some are permanent and some are mobile, some run from mains power and some energisers can be driven by batteries and solar panels. These fences are very versatile and if you are thinking about perennial pastures and cell grazing, then some form of electric fence system will be very useful. Sheep are less easily controlled with electric fences than other animals as their wool insulates them when it is long. Electric fencing can be very suitable for horses or cattle.

Essentially, an electric fence is a simple electric circuit on a large scale. The fence terminal (positive) is connected to insulated wires, and the earth terminal (negative) is connected to galvanised metal stakes driven into the ground. The animal will receive a short, non-harmful, but memorable 'shock' if it completes the circuit by touching the wire.



Electric fence diagram from Gallagher (supplier).
(Source: Eliott-Lockhart 2013)

FEEDERS

When supplementary feeding is necessary over the summer and autumn, it is often wise to prevent both wastage and animal health problems by providing the feed in some sort of structure. This does not have to be complicated or expensive. For example, a simple mesh sling attached to a fence can be an excellent way to feed out grain, particularly with small flocks or herds.

The DAFWA bulletin *Feeding and Managing Sheep in Dry Times,* has some excellent practical suggestions for constructing inexpensive feed troughs, and it also describes different types of self-feeders. If you prefer not to make your own, some excellent commercial feeders are available.

A recent innovation in Australian agriculture has been the development of the Lick Feeder, which is used to feed supplementary grain or pellets. The feeders are designed with a narrow (and adjustable) horizontal gap at head height, to allow the animals to get only a small amount of grain at each feeding. The quantity they can get is governed by the flow of their saliva; for example, sheep reportedly usually have enough saliva for about five minutes of continuous feeding. Sheep will go to the feeder about six times a day. This means that supplementary feeding might be more efficient, with the animals accessing more stubble or hay in between using the feeder.

Lupins are an excellent type of grain to use in a Lick Feeder. Some of the feed companies (e.g. Milne Feeds) also have pellets specifically designed for Lick Feeders.

Several brands of Lick Feeders are available in WA and all are very similar – for example, Advantage Feeders, EZEfeeders and Universal Feeders.

It may also be useful to provide structures for feeding out hay – many different types are available. These are generally a metal frame that prevents the animals from trampling the hay.

A typical Lick Feeder.
(Source: advantagefeeders.com.au)

WATER TROUGHS

While many types of water trough are on the market, small landholders may find it useful to avoid buying costly structures and instead improvise. For example, at the local hardware shop you can probably buy plastic or fibreglass baths that are very cheap and will do an admirable job. Ideally, you will have an automatic refill system from a tank, but for a small property you may find it satisfactory to just fill them manually. However, remember to keep them full (and free of algae, which can be poisonous) over the summer, as stock will have a larger demand for water at this time, and losses via evaporation will also be high.

FOLLOW UP

Read this chapter in conjunction with the other Livestock chapters in this *Guide*:

- Feeding Livestock: Introduction.
- Ruminant Nutrition.
- Horses: Hindgut Fermenters.
- Livestock Problems.

As well as:

- noteworthy 2: First Time Fencing.
- noteworthy 5: Cattle Ownership.
- noteworthy 10: Supplementary Feeding.
- noteworthy 13: Branding and Moving Stock.
- noteworthy 18: Livestock Husbandry.
- noteworthy 31: Horse Keeping.

Other useful sources of information:

- *Rural: A Handbook for Small Landholders*, Bernie Webb. This has some excellent practical information on fencing.

Commercial Fencing Information:

- www.gallagher.com.au/what-is-electric-fencing.aspx.

Commercial Lick Feeder Information:

- Advantage Feeders www.advantagefeeders.com.au.
- Universal Feeders www.universalfeeders.com.au/universal-feeders.
- EZEfeeder www.ezefeeder.com.au.

Also see the References chapter at the end of this *Guide* for further information.

PLANTS

PLANTS

ORCHARDS & TREE CROPS

The chapters on plants will focus on the types of agricultural plants common to the soil types in the NAR, as discussed in the previous Soils section in this *Guide*. Species not mentioned may also grow well, so discuss your interests with a nursery or agronomist.

IRRIGATED ORCHARDS

Orchard trees that have been grown with success in the NAR are olives, mangoes, carobs, grapes (both table and wine), almonds and avocados. Citrus trees are very suitable, with various types being grown locally, in particular mandarins, oranges, lemons and limes. Orchard trees prefer reasonable soil types but can be grown on most soils, provided that the water and nutritional requirements are met. Hostile subsoils will affect tree growth and are some of the harder issues to fix, so adequate soil testing both on the surface and at depth to assess suitability is a good place to start.

Although our sandy soils have poor nutrient levels and water holding capacity, ironically, they are perfectly suitable for most orchard trees. This is mainly because the sandy soils do not obstruct root development, also water and nutrients can be easily added via irrigation. Mulching is advisable on sandy soils, to reduce surface temperatures over the summer, and also to reduce the loss of soil water by evaporation. Simple straw or hay mulches are suitable, but leave a gap between the mulch and the trunk to avoid disease issues.

Fertiliser and water requirements of the individual crops will change depending on the stage of growth of the trees. Fertiliser can be applied through the watering systems and this is referred to as fertigation. It is most important to get your fertigation or fertiliser regime right. Discuss the requirements with a qualified agronomist or industry based person.

For irrigated orchard crops, the most important issue is whether you have sufficient water of appropriate quality. Underground water is the most common source of irrigation in this region, but quality can vary a lot. Bores are expensive, so it is **most** important to properly investigate water issues before setting up an orchard. In particular, if your orchard is intended to be more than just a domestic garden, you will need a water licence from the Department of Water. Water in your area may already be fully allocated, and a licence may be difficult to obtain, so do your homework first.

FAST FACTS

A wide range of orchard trees can be successfully grown in the NAR.

With good water and fertiliser regimes, even sandy soils can be productive.

Water quantity and quality are most important if irrigating.

A water licence will be necessary, and may be hard to obtain, if you wish to market your produce.

Harvesting and marketing can be expensive aspects of the venture.

Plantation trees can also be grown successfully in different parts of the NAR – for example Oil Mallees, Pine, Brushwood, Sandalwood and bushfoods.

Organic production is an option, but can have complicated requirements if you wish to become certified organic.

MARKETING YOUR PRODUCE

If you are growing a crop to sell, then you also need to consider how you will harvest and market your produce. If you are serious about the venture, then be warned that harvesting and marketing can be the most expensive parts of your project, especially if you require labour to assist you, or if the market demands a particular form of packaging. For small landholders, an excellent avenue for selling produce are the farmers markets – these are now available in Geraldton (Saturday and Sunday morning), and for those closer to Perth, there are markets in several suburbs (e.g. in Wanneroo, Stirling, Subiaco and Claremont).

PLANTATIONS

In this region several tree species are grown in plantations for various purposes. For example, Oil Mallees are now common in the eastern parts of the region, on heavier soil types. Interest is increasing in the possibility of Oil Mallees being suitable for power generation and/or for biochar production. Maritime Pines (for wood) are grown in some of the more western parts of the region; for example, around Moora Gingin and Dandaragan; and plantations of Sandalwood (for wood or nuts) or Melaleuca Uncinata Brushwood (for fence materials) also occur in several places. A range of other species are being planted by some innovators; for example, Native Limes, Bush Tomato, Quandong and Wattleseed.

Some trees may also be planted as wind breaks or shelter belts for livestock, or sometimes just for beautification. Many native trees and shrubs can be excellent for this purpose. A good tip is to look around at other farms nearby and choose something that is already growing well in your area. Remember that even native trees may need to be watered over the first summer in this environment. Weed and insect control in the early stages of establishment will also help with survival rates.

ORGANICS

Some small landholders are very keen to grow produce organically. However, with careful management, you can reduce your use of chemicals without compromising the quality of your produce, and without going to the extent of becoming certified organic. Certification may be part of your plan, but it can be very onerous, sometimes with unusual demands about the procedures or products you can use. For those interested in organics, some excellent noteworthy notes can be found – one in this *Guide*, and others available online.

FOLLOW UP

Read this chapter in conjunction with these other chapters in this *Guide*:

- Plants and Soils chapters.
- Declared Plants.
- Water Quality & Testing.

As well as:

- noteworthy 29: Going Organic.
- noteworthy 48: Business Planning.

Other useful information:

- *DAFWA's website www.agric.wa.gov.au*
- Australian Farmers Markets www.farmersmarkets.org.au/markets.
- *Native Foods. New Crop Industries Handbook*. RIRDC This can be downloaded at https://rirdc.infoservices.com.au/items/08-021.

Also see the References chapter at the end of this *Guide* for further information.

VEGETABLE GROWING

Even in our relatively harsh climate there is a vast array of vegetables that can be grown for your home consumption – and having your own super-fresh veggies is a definite plus for all the family. In this region there are also many vegetables produced under irrigation on a large commercial scale, some of these are: tomatoes, eggplant, potatoes, lettuces, broccoli, cabbage, cauliflower, celery, onion, garlic and various pumpkins.

Because this topic is covered adequately in many other publications, this is a very brief chapter, partly to provide the opportunity to include the planting guide that locals Julie Firth and Dan Clarke have developed for the Geraldton area. Dan has a small block in the Moresby Ranges and he is the subject of a case study later in this *Guide*. The case study has lots of good tips on developing a sustainable garden.

TOP TIPS FOR VEGGIE GROWING

Know your soil

The pH will affect what vegetables are best, or whether you need to lime (very unlikely in the sandy soils of our coastal strip).

If it is sandy, use organic matter and manure to reduce leaching and retain nutrients; if water doesn't soak into the soil it may need treating with a wetting agent; if soil is very heavy, raised beds may help drainage.

Select a good site

Veggies like sunlight, so make sure the beds have a northerly aspect and are not too shaded by buildings or structures. Align any rows north/south to get the greatest benefit from the sun.

Protect from evaporation and wind

This region can be harsh particularly in relation to wind, heat and evaporation.

While veggies like sunlight, they don't like dry roots caused by evaporation from the soil surface … so mulch around the plants.

Provide windbreaks – this might just be a fence or you could plant trees or baña grass – or edge with taller crops such as corn.

Plant at the right time of year

See the local planting guide overleaf.

Rotate your crops

Do not plant like on like – to avoid disease problems, rotate different types of vegetables from one season to the next.

Fertilise, weed, and water well

Vegetables don't like water stress or weeds (which rob them) and they will perform better with good nutrients – so don't neglect them – treat them kindly!

FAST FACTS

You can grow a big variety of vegetables – just get started.

Top tips are to know your soil, plant at the right time of the year (see over), mulch well, provide wind protection, rotate crops, and water and fertilise regularly.

FOLLOW UP

Read this chapter in conjunction with these other chapters in this *Guide:*

- Know Your Soil.
- Soild Classification.
- Soil pH.

As well as:

- There are many publications that can advise you on how to grow vegetables. Get one! DAFWA has developed a good one for WA, *Vegetable Growing: A Guide for Home Gardeners in Western Australia*.

January	February	March	April	May	June	July	August	September	October	November	December
Garlic Chives, Oregano, Rosemary, Rue, Tansy, Wormwood											
			Calendula, Rocket, Nasturtium								
			Coriander ***(Chinese)***			Motherwort					
			Basil ***(East Indian Clove)***								
				Parsley ***(Egyptian)***							
				Catnip							
				Chamomile, Dill, Fennel, Fenugreek, Mint, Parsley ***(Italian)***				Basil ***(Sweet Giant-leaf)***, Feverfew			
			Beetroot								
			Asparagus *(Mary Washington)*								
			Tomato, Sweet Potato								
		Asian Greens ***(Bok Choi)***						Asian Greens ***(Bok Choi)***			
			Leek, Mustard Lettuce, Radish					Cucumber, Watermelon, Zucchini, Spring Beans ***(Black Valentine, French Epicure, Seven Year Highworth, Snake, Staley's Surprise, Tropical Lima, Yellow Wax)***			
		Broccoli, Cauliflower		Carrot, Celtuce, Chard / Silverbeet, Lettuce							
			Garlic, Onion, Beans *(French Epicure)*	Asparagus Pea, Brussels Sprouts, Potato	Broad Bean			Capsicum, Corn, Cowpea, Eggplant, Gourd, Jews Mellow, Luffa, Melon, Pumpkin, Chilli ***(Banos Red, Inferno, Poblano, Red Thai Long, St Helena Orange, Yellow Peruvian)***	Chilli ***(Habanero)***, Ceylon Running Spinach		
			Edible Chrysanthemum, Cabbage, Winter Bush Beans ***(Black Valentine, Staley's Surprise, Hawkesbury Wonder, Yellow Wax)***								
				Celery, Pea, Scorzonera, Snowpea							

Geraldton Planting Calendar

This calendar is a guide to help you get started. After a few seasons, you will be able to vary your planting times to adapt to the yearly seasonal variations such as early or late rains, cooler or warmer seasons.

Acclimatised seeds of these heirloom varieties are grown at the Drylands Permaculture Farm in Geraldton and are available from www.yilgarnseeds.com.au

developed by:

MATCHING PASTURES & SOIL TYPES

GOOD QUALITY PASTURE IS IMPORTANT

If you are producing livestock, then it is most important that you have good quality pasture to feed them with. Most unimproved pastures in this region are of very poor quality, often consisting of plants such as Capeweed, Bromegrass, Lovegrass or other species which are little more than weeds. An ideal pasture will have a mixture of grasses as well as legumes such as Clover or Serradella.

It is most advisable to put some effort into improving your pastures, by planting species that are suitable for your soil types and fertilising them so that you get the maximum benefit from them. A problem with improving your pastures is that it often entails restricting grazing while the pastures are young. A good technique for a small landholder to follow is to methodically plant a small area each year. Then the effort is not a burden, but there is continual improvement. Good pastures will also enhance the value of your property.

In this chapter, pasture species are discussed in relation to the main local soil types to which they are most suited. Also refer to the Know Your Soils chapter in the Soils section for more information on the soils and their distribution.

In relation to grazing management, it is useful to assess when maximum production will occur. In our environment, most annual pastures will produce abundant growth in the spring. It is also useful to use pastures such as sub-tropical perennials (which grow over the summer), to utilise fodder shrubs or fodder crops, or to produce or buy in hay, to fill in the feed gaps which may occur in the summer and autumn.

FAST FACTS

Match your pasture to local soils

Deep grey coastal sands:

- Sub-tropical perennial grasses: Rhodes Grass and Gatton Panic.
- Serradellas: various yellow or pink varieties, some hard-seeded.
- Medics: Barrel, Burr, Strand and Disc.

Deep pale yellow and yellow sands:

- Subterranean Clover.
- Arrow Leaf Clover.
- Oats sown as pasture.
- Annual Ryegrass.

Yellow sands with clay or gravel:

- Species as above.
- Pasture Cropping.
- Biserrula.
- Balansa Clover.

Yellow or red loamy sands:

- As above, with background levels of Sub-Clovers and Ryegrass.

Yellow/red and red loamy clays:

- As above; also Gland Clovers.

DEEP GREY AND COASTAL SANDS

These sands are well suited to perennial grasses and Serradella as a legume.

Sub-tropical perennial grasses

Sub-tropical perennial grasses are popular in the NAR, following promotion by the Evergreen Group, an organisation of committed farmers with strong local links. They have developed the Northern Sandplain mix, which you can purchase locally and which contains seeds of several of the most productive and suitable species. The composition can vary, depending on new information or seed availability.

The Northern Sandplain mix comprises species that grow in the warmer weather and go dormant in the winter. In areas north of Eneabba, very little dormancy occurs in winter, and if there is enough moisture, the plants will keep growing all year. However, most pasture bulk in winter is generated by annual species, so the inclusion of a good base of annual pasture species can help with the winter productivity of these pastures. Common annual species to include are Ryegrass, Serradella or Clover. Blue lupins can also provide good winter feed as part of a sub-tropical perennial pasture.

There have been some instances where animals grazing on sub tropical pasture species have shown some photosensitivity and alkaloid issues; this is covered in the previous chapter on Livestock Problems. Recent work suggests that most of the problem is associated with Signal grass, so this species is no longer included in the common mixes. In addition, the problems are generally transient. A mixture of species reduces the problems as it reduces the dependence of the animals on one plant type.

The main sub-tropical grasses now recommended for this region are Rhodes grass and Panic grass.

Rhodes grass (Chloris gayana)

Rhodes grass spreads by above round runners, and depending on the variety, it can be upright or prostrate. If it has not rooted down, then it can be chewed off by stock. Rhodes grass is excellent for providing soil cover during the summer, and allowing healthy soil biology to develop, but its feed quality is not as good as the bunch grasses. A good interwoven stand of Rhodes grass runners can provide a firm surface, even in the loosest soils. After a while, Rhodes grass can start to die out of a sward, but in good seasons it will regenerate from seed and runners.

Green or Gatton panic (Megathyrus maximus)

Panic is a bunch grass that can develop to about 50 centimetre diameter. It is highly palatable and also provides excellent feed quality. Panic can perform well on even the lightest sands when well managed, but in thin stands, the sand can move near the base creating some very rough areas to move over.

Other species

Bambatsi panic (Panicum coloratrum): good on heavier soils.

Setaria (Setaria sphacelata): can have issues for horses due to oxalate content.

Digitaria species (Digitaria eriantha and Digitaria milanjiana): minor species; adds to diversity but may not add to productivity.

Signal grass (Urochloa decumbens): good on lighter soil types, but linked with some animal health issues and no longer recommended.

You can buy bags already packed with a seed mix, or make your own. Grower mixes are now usually 80 per cent Green panic and 20 per cent Rhodes. Sow at about three to five kg/ha in August. All species prefer a rising soil temperature over about 15°C, so the further north the property is located, the earlier planting can occur. Around Geraldton, this is early August or the last week of August at Gingin.

Sub-tropical perennial grasses on the coastal sandplain (with a stand of tagasaste in the background).
(Source: Eliott-Lockhart 2013)

For good establishment and production, preparation of the paddocks is essential. Paddock preparation is primarily about weed control, as these species do not handle competition during establishment. These pastures do not cope well with set stocking as the plants have no rest period and plant numbers will be lost quickly under this regime.

Cell grazing is recommended. This involves dividing the paddock up into smaller areas, known as cells, and then grazing each of these in turn at a very heavy stocking rate. This optimises utilisation and gives the plants time to rest before being grazed again. It is also important to spell the paddock after seeding for up to a year.

Depending on the season, a light graze in March after seeding should be the only utilisation of that area for about nine months. Grazing hard too early will pull out some of the plants and not give them sufficient period to get established.

Serradella species

Serradella is an annual pasture legume very suitable for light sands, partly because it is very deep rooted. Two types of Serradellas are used, differentiated by the colour of the flowers: pink (French) and yellow. Serradellas can be hard-seeded or soft-seeded. Hard-seeded refers to the fact that a proportion of the seed will remain in the soil after planting and will not germinate until the next or subsequent years. This is a type of risk strategy and can sometimes be used to advantage in pasture management. Soft seeded Serradellas will germinate in the year they are planted. It is important that you understand this concept, and the nature of the variety you have chosen, as it has important management implications.

Serradellas can be used as a stand-alone legume in an annual pasture mixture or they are good for winter/spring production in a perennial pasture system.

Establishing a hard-seeded Serradella the year prior to sowing perennial pastures will ensure that you have a legume in the system to improve the protein levels in the pasture and to provide nitrogen back to the grasses. Due to the hard seeded nature of the legume, not many will establish in the perennial seeding year but a good stand should emerge the following year.

All Serradellas are prone to Helicovera (budworm) attack and should be monitored when flowers first appear. In the first few years, try to build up the seed bank by sweep netting pastures and spraying when grub numbers exceed the threshold of one grub in ten sweeps. As these species are aerial seeders, grazing during seed set will reduce seed returned to the seed bank.

Yellow Serradellas

All varieties are hard-seeded.

Santorini: Moderately hard seeded; well adapted to coastal and medium rainfall areas.

Charano: Slightly quicker to flower than Santorini and may produce slightly less bulk in some seasons; slightly harder seeded than Santorini.

Yelbini: Quick growing and acid tolerant; suited to lower rainfall areas and acid soils.

Pink Serradellas

Cadiz: Soft-seeded and shows very little persistence after about two to three years, but well adapted to sandy soils.

Erica: A hard-seed selection from Cadiz; its prostrate form can be useful, although this also makes seed harvesting more difficult, resulting in more limited availability.

Margurita: Another hard seeded selection from Cadiz; flowers for a longer period than Erica.

Eliza: The most recent release; also hard-seeded, and developed from Cadiz; its ability to flower earlier means more reliable seed production and less dependency on favourable spring conditions.

Pink Serradella.
(Source: Eliott-Lockhart 2013)

Medic species

On the high pH limestone ridge country, Medicago species will outperform the serradellas. Knowing the pH of your soils will help in your selection of the most suitable variety. Medics are very hard seeded legumes and can be very prolific in their growth. Their main limitation is very poor herbicide tolerance, which leads to difficulty controlling common weeds such as Doublegees. These weeds grow flat on the ground and are not generally grazed, so they can be very prolific seeders. Their spiny seeds can affect an animal's ability to walk around and graze.

Barrel Medic (Medicago truncatula)

Caliph: pH above 5.8 and heavier soil types 400+ millimetres annual rainfall.

Burr Medic (Medicago polymorpha)

Serena: Short season, suitable for 200 to 350 millimetre rainfall zone.

Santiago: slightly longer season than Serena with similar characteristics, 350 millimetre+.

Strand Medic (Medicago littoralis)

Herald: 350 millimetre+.

Angel: 350 millimetre+ has some group B herbicide tolerance, which can be useful for out of season Doublegee (Spiny emex) control.

Disc Medic (Medicago tornata)

Toreador: Short season 200 to 350 millimetre; pH 5.0.

Sphere Medic (M. sphaerocarpos)

Orion: 450 millimetre+ zone pH 4.8, tolerant to Redlegged earth mite (RLEM) at the seedling stage.

DEEP PALE YELLOW & YELLOW SANDS

These will also grow the sub-tropical perennial grasses and Serradellas very well, but are too acidic for the Medicago species. The better of these soils will grow Subterranean clover (sub clover) and Ryegrasses in a mixed sward. These are very productive, and with some management, can give five to ten years before needing rejuvenation. The original sub clover varieties that were released were named after towns in WA. Wimmera Ryegrass was spread widely in the 1960s and 70s.

Sub clover (Trifolium subterranean)

Older stands of Subterranean clover in the region are a mix of the varieties Geraldton, Nungarin and Dalkeith. Dalkeith was released in the 1980s as a replacement for Geraldton. Due to the decline in wool prices and rise in the area cropped over the last 20 years, little new pasture was sown. New varieties that are replacements are:

- Izmir (for Nungarin) for the 250 millimetre+ zone.
- Urana (for Dalkeith) for the 350 millimetre+ zone.

Setting seed under the ground makes sub clovers quite tolerant of herbicides and grazing during seed set. Hard grazing at that time will reduce seed set by about 30 to 40 per cent. This is due to low bulk and grazing of flowers but is a lot less than the aerial seeded clover varieties. These varieties are the bulk of good legume-based pastures due to their hardiness and tolerance to hard grazing.

Arrow leaf clover (Trifolium vesiculosum)

Cefalu or Zulu are the two main varieties of arrow leaf clover. They grow well on sands with clay underlying as long as long periods of waterlogging or a parched water table do not occur. The arrow leafed clovers do not like inundation, but in the NAR area, production can be extended for one to two months if the right area is selected.

Oats sown as pasture

Oats can be sown for hay or grazing (also see Fodder chapters). They are a cheap way to thicken up pasture stands and are very safe as seed or green feed. Other cereals (e.g. wheat) can be planted for grazing but take care once seed forms as ingestion of excess wheat grain may cause acidosis. Also be aware that oaten hay can transmit Annual Ryegrass Toxicity (ARGT), as it is difficult to exclude Ryegrass from oats.

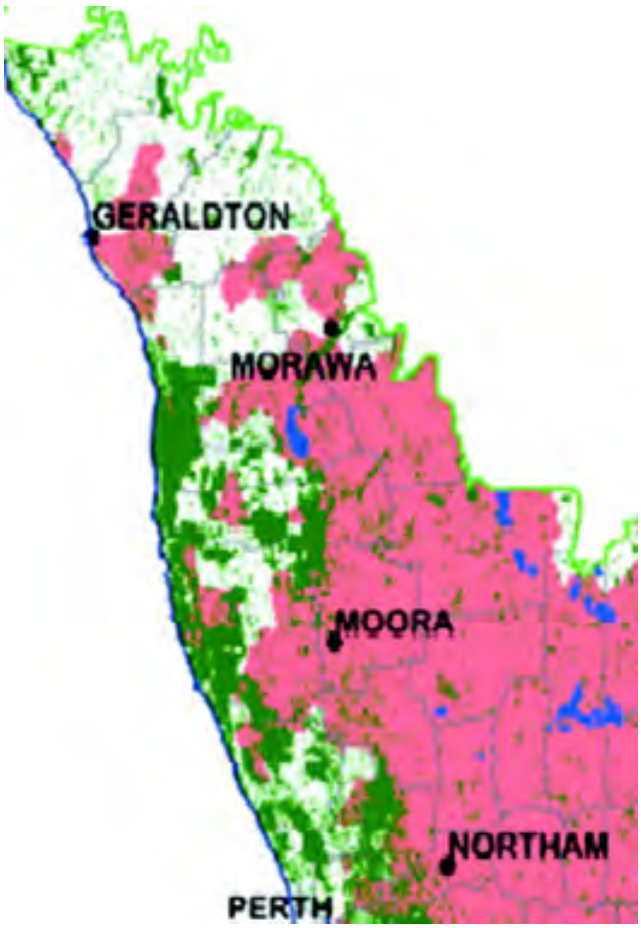
Cefalu arrow leaf clover.

Annual Ryegrass (Lolium rigidum)

Ryegrass grows rapidly on most of these soils and its high quality makes it an excellent feed for stock. However, parts of the NAR are prone to ARGT, which is a big issue for grazing and hay production.

This problem is caused by toxins produced by a bacteria carried by a nematode into the heads of annual ryegrass. These bacteria form galls that contain toxins. Background populations of Ryegrass are based on Wimmera ryegrass due to its season length - this is also the perfect season length for ARGT formation. Safeguard is another variety of the same season length that can help with ARGT and is quite productive. It does this by stopping the nematodes from entering the seed heads. The twist fungus is a biological control agent that can be spread on affected paddocks to control the problem. If your property falls in a pink zone on the following map, you will need to be aware of this problem and take necessary action.

Mature Annual Ryegrass.
(Source: Eliott-Lockhart 2013)



Ryegrass toxicity risk: The pink areas show the known areas of ARGT infection as of Feb 2010.

Some Ryegrass varieties are also tetraploid. Tetraploid grasses have four pairs of chromosomes, bigger cells and a greater cell content to cell wall ratio. This makes them much more productive, with an associated capacity to be very competitive. Wimmera and Safeguard are diploid and have two pairs of chromosomes, like most living organisms. Tetraploid grasses do not form viable seed, so they are planted for one year for maximum production and to provide better quality feed. This can make it a lot more expensive to establish. A rotational grazing system for younger stock, with the paddock divided up into cells and the stock rotated through at very high stocking levels (25 to 50 DSE/ha), will generate as much live weight gain as possible.

YELLOW SANDS WITH CLAY OR GRAVEL AT DEPTH OR AT THE SURFACE

These sands will grow all the pasture species mentioned above, depending on the pH of the soils. If you are considering cropping some of the areas, then the annual pasture species tend to fit better with this system. In addition to the ones mentioned previously, several other legume pastures can be used in this area; for example, Casbah biserrula or Balansa clover. Pasture cropping is also an interesting option on this soil type.

Pasture cropping

Pasture cropping has been trialled over the last few years in the NAR and is showing promising results. This is where a crop is sown into a paddock where a stand of perennial grass pasture has already been established. Results to date have been variable, with some lupin and hay trials showing success but cereal grain crops showing less promise. To fill grain, moisture is needed at the end of the season, but this coincides with the start of active growth of the summer-growing pasture and can cause constraints for a grain crop. However, a crop introduced into a perennial pasture can provide excellent winter grazing.

Generally, the crop is introduced into the pasture with low disturbance machinery to minimise damage to the perennials. Combine seeders and culti-trash equipment may cause too much disturbance of the perennials and careful consideration should be given to appropriate machinery.

Biserrula (Biserrula pelecinus)

Casbah Biserrula fits well into these soil types and is a very hard seeded variety that shows good persistence once established. It can make a good companion to perennial pastures as well. Paddocks that have a mix of soil types will support Biserrula growth and so it is worthwhile in a seed mix. Saline white-grey clays under breakaways can be hard to grow legumes on but Biserrula is a good fit. Biserrula has been linked to photosensitivity in sheep, when sheep have been grazing quite pure stands (>70 per cent) in the spring. Stock can also preferentially graze the non-Biserrula components in pastures, leading to iserrula dominant pastures. The best method of reducing the risk is to allow livestock access to other paddocks and to monitor the stocking rate.

Casbah Biserrula.
(Source: Ballard Seeds WA).

Balansa clover (T. michelanium)

Frontier is a shorter season variety than Paradana and is recommended in all areas that are suitable for Balansa clover. It has good waterlogging tolerance and mild salinity tolerance, so it will grow well in wet, slightly salt affected areas.

YELLOW OR RED LOAMY SANDS

These soils support all of the previously mentioned improved pastures and will usually have background levels of sub clovers and Ryegrass.

YELLOW/GREY OR RED LOAMY CLAYS

These soils support all of the previously improved pastures and will usually have background levels of sub clovers and Ryegrass. A lot of moisture may be required to germinate pastures. While these soils resist wind erosion, they can still lose significant amounts of topsoil if left bare. In many cases, these can be subjected to transient waterlogging during winter if large amounts of rain fall in a short period, and this can affect pasture composition. The clovers that are more suited to these areas will be the Balansa and Gland species.

Gland clovers (T. glandulifeium)

This is a small aerial seeded species that has good pest and disease tolerances for the better quality soil types. Prima gland is the variety name and it has a reasonable tolerance of transient waterlogging. It has higher hard seeded levels that sub clovers and is less prone to seasonal fluctuations. Because of this, it may be very useful in pasture mixes.

These soils are some of the best for hay making as they are very fertile and can produce large biomass during the season.

Repeated cutting in one season or over many years of the same paddock will reduce seed set and can be a useful method of weed control in these areas, except for prostrate weeds.

FOLLOW UP

Read this chapter in conjunction with these other chapters in this *Guide*:

- Fodder Crops.
- Know Your Soils.
- Livestock chapters.

As well as:

- noteworthy 10: Supplementary Feeding.
- noteworthy 12: Pastures ready... set... grow.
- noteworthy 34: Productive Pasture Management.

Other useful information:

- *Perennial Pastures for Western Australia*, Geoff Moore et.al. DAFWA Bulletin 4690.
- *Characteristics of Perennial Grasses*, Trevor Lacey & Geoff Moore, DAFWA, 2007.
- *Your guide to Perennial Grasses in the Northern Agricultural Region*, Mingenew Irwin Group (MIG), 2007.
- *Annual Ryegrass Toxicity-current Situation*, David Kessell DAFWA Farmnote 417/2010.
- *Cefalu arrow leaf clover*, Richard Snowball et.al. DAFWA Farmnote 38/2005.
- *Frontier* – an early maturing Balansa clover for the wheatbelt, Clinton Revell et.al. DAFWA Farmnote 3/2001.
- *Urana* – a hardseeded subterranean clover with excellent winter vigour, Phil Nichols & Martin Barbetti DAFWA Farmnote 31/2005.
- *Izmir* – a new subterranean clover for low rainfall cropping situations, Phil Nichols & Brad Nutt DAFWA Farmnote 114/2006.

Also see the Reference chapter at the end of this *Guide* for further information.

PASTURE PESTS

REDLEGGED EARTH MITE AND LUCERNE FLEA

All pastures can be susceptible to Redlegged earth mite (RLEM or Halotydeus destructor) and Lucerne flea (LF or Sminthurus viridis). These pests can attack most germinating pastures and cause significant damage and death early in the season. Due to their differences in laying eggs, RLEMs occur on sandier soils and LF on the heavier soil types.

CUTWORM AND WEBWORM

Cutworm (Agrotis spp) and Webworm can also affect pasture establishment. These are grubs that emerge from eggs laid by moths at the break of the season. If large numbers of grey/brown moths appear around windows and lights in May and June, then assessing pasture establishment is important. A lack of soil cover created by poor emergence or patchiness can indicate any or all of these pests. Poor emergence and patchiness will also lead to reduced productivity and increase the risks of wind erosion. When soil starts to move in small areas, this sandblasts the cover downwind and can lead to larger areas being affected.

The links under Follow Up include photos of the pests that can be found. The *Ute Guide* from GRDC and *Topcrop* is also recommended. It has laminated pages and can fit in the vehicle glovebox.

Diagnosis of pests can be carried out by an agronomist or by sampling bugs found, and taking the samples to your local DAFWA office or agricultural supplier.

Major pests of pasture

Redlegged earth mite.
(CSIRO Entomoology website)

Lucerne flea.
(Photo: Tony Servitude)

Cutworm.
(Photo: Quilchena Gold and Country Club)

FAST FACTS

The major pests of pasture are:

- RedLegged earth mite and Lucerne flea.
- Cutworm and Webworm.

(The above affect very young plants)

- Native Budworm – affects the seeds.

Look out for pests, learn to identify them, intensively graze, or control if necessary.

NATIVE BUDWORM

Many of the aerial seeding varieties (seeds are formed in a seed head borne in the air) are susceptible to hard grazing at seed production time and Native Budworm (Helicoverpa spp) can also have the same effect by eating the seeds. This reduction in seed production will affect the plants' ability to regenerate as a pasture in the following season.

Sub clover sets its seed below the ground but most other legumes set seed in the air, allowing stock and grubs to eat it before it reaches the ground. The reduced seed set can affect pasture density in the following year, so monitoring and easing grazing pressure is the most effective way of dealing with these issues.

Budworms are best detected with the use of a sweep (butterfly) net. Sweeping susceptible pastures from the start of flowering through to haying off will be important if growers are trying to build up the seed bank of that species.If you detect a pest but are not sure what it is, then DAFWA has an excellent tool on its website which will help to identify the pest and provide some information about its lifecycle and control measures.
See http://agspsrv34.agric.wa.gov.au/ento/pestweb.

Native Budworm.

CONTROLLING PESTS

It is not always economical to actively control pests in pasture. Take advice about this. Intensive grazing can sometimes be effective and it also has the advantage of being low cost, and avoids chemicals. However, several proprietary insecticide sprays do a good job and can often be used strategically to break the life cycle and give relief over several years. Get advice from your local agribusiness advisor or reseller.

FOLLOW UP

Read this chapter in conjunction with these other chapters in this *Guide*:

- Matching Pastures & Soil Types.
- Fodder Shrub.

As well as:

- noteworthy 34: Productive Pasture Management.

Other useful information:

- *Crop Insects: The Ute Guide*, Western Grain Belt Edition, compiled by Rob Emery, Peter Mangano and Phil Michael, DAFA & GRDC, March 2005 www.grdc.com.au/Resources/~/media/977F9C82D6D40198F115324C58053F6.pdf Catalogue no. GRDC 209.

Also see the References chapter at the end of this *Guide* for further information.

FODDER CROPS

Fodder is a term that is often applied to conserved roughages, but it can also refer to standing green crops that are used for grazing. In this chapter, various livestock feeds derived from plant material other than pastures are described. You may choose to grow them yourself, or you may prefer to buy them. For instance, hay bales are a frequently purchased item by small landowners who run livestock.

HAY CROPS

Hay is made by cutting, drying and baling pasture or crop, and it is one of the major ways to even out the feed supply in our Mediterranean environment. Most of our feed is grown in winter and spring and then it slowly breaks down in the summer. We usually experience a feed gap over summer and autumn, when supplementary feeding is necessary. This will frequently be in the form of hay.

The most common type of hay is oaten hay. However, other types – meadow, lucerne or vetch hay – can also be cut if they are grown. Meadow hay refers to cutting whatever is growing as pasture. Frosted or failed crops of a grain crop such as wheat may also be cut for hay.

Oaten hay is usually made from a crop grown specifically for hay production. Seek advice on the best variety to use: several newer varieties are available. For your purposes, you may find one of the older varieties, which are likely to have cheaper and more available seed (such as Winjardie or Swan), may be quite satisfactory.

Lucerne and vetch are both bulky legumes that can be cut for better quality (higher protein) hay. Lucerne is a perennial species that can be grown under either dryland or irrigation systems. With irrigation, you may be able to produce multiple cuts each year. The cost associated with growing hay is similar to growing a crop, but extra expense arises in getting someone to cut and bale it, especially if the bulk is not there.

Hay is cut when there is maximum biomass and quality of feed in the paddock. This is at flowering time for the grasses but it may be different depending on what is growing.

Paddock selection and responding to seasonal conditions are the best way of dealing with poor growth. Hay removes about 10 to 15kg/ha of potassium for every tonne that is removed, so growing hay on lighter soil types can cause significant nutritional issues and is not recommended unless you are vigilant about fertilisation and soil nutrition. Ideally, the paddock should produce greater than 4t/ha of biomass to make cutting and baling profitable.

FAST FACTS

Various forms of fodder can be useful for supplementary feeding in our Mediterranean climate.

Oaten hay is most common, but lucerne hay is also produced locally, and hay can be made from any other crop or pasture.

Cereal and lupin crops are also often grown as standing fodder for grazing, or their stubble is grazed after harvest.

Remember that straw is far inferior to hay in terms of livestock nutrition.

STRAW

It is important to understand that there is a big difference between hay and straw. Hay is cut when the plants are at peak growth, whereas straw is the dry stalks remaining after the grain is harvested. Most types of straw have high levels of indigestible material, are low in protein and other nutrients and are usually only useful to provide roughage for livestock.

SILAGE

Silage is fermented, high moisture fodder developed from various field crops. It is generally of higher nutritional value than the corresponding hay. However, the machinery, time and cost of making, storing and feeding out silage is usually beyond the scope of the small landowner. However, if the opportunity arises, it is worth considering.

STANDING FORAGE AND STUBBLE

It is also common to grow crops for the express intention of grazing them. This can be a useful tool for a small landowner, who can scratch in a small area of seed of, for instance, lupins, oats or wheat, which can then be used for grazing. Cereal crops (such as wheat or oats) can often be grazed early in the season and will then recover to produce a grain crop, or at least be grazed again. Lupins, however, will not recover from early grazing as they have terminal growth only.

The stubble remaining after grain crops are harvested is also commonly used for grazing in this environment. Lupin stubble is particularly good nutritionally, although it is important to graze lupins immediately after harvest and to monitor the grazing to avoid lupinosis.

Baling oaten hay.
Source: Eliott-Lockhart 2013

FOLLOW UP

Read this chapter in conjunction with these other chapters in this *Guide*:

- Matching Pastures & Soil Types.
- Livestock chapters.

As well as:

- noteworthy 10: Supplementary Feeding.

Other useful information:

- *Fodder*, by Roy Butler and John Milton. In *The Good Food Guide for Sheep*. DAFWA, 2001, Bulletin 4473.

FODDER SHRUBS

The two main types of fodder shrubs used in Western Australia are Tagasaste, which is grown mostly on pale deep sands, and Saltbush, which is grown mainly on salt-affected land. A number of other fodder shrubs are also planted. The native Acacia saligna has been tried as a fodder shrub, but poor palatability and short lifespan have limited its use. There is also some local interest in Rhagodia. While not strictly speaking a shrub, we have also included Lucerne in this section because of its perennial nature and the fact it can be used in a similar way.

The information summarised here has relied heavily on various chapters of the DAFWA bulletin *Perennial Pastures for Western Australia*. For substantially more information refer to this publication, which you might also consider purchasing for future reference.

TAGASASTE

Tagasaste (Chamaecytisus palmensis), or tree Lucerne, is a woody perennial legume that originated in the Canary Islands off the coast of Africa. It is a productive, drought-tolerant perennial especially suited to pale, deep sands where the growth of annual crops and pastures is poor. More than 100,000 ha of Tagasaste are currently planted in WA, mainly in this region.

Tagasaste plantations on deep sands in the West Midlands have had a major impact on improving farm viability. Tagasaste provides good quality feed in the autumn break and can reduce the need for supplementary feeding. It is also useful for grazing all year round. It is now grown on many farms throughout the western parts of the region.

In recent droughts, Tagasaste proved to be very resilient and spectacularly useful: farms with Tagasaste were able to maintain a high carrying capacity while many others were forced to sell stock.

Features of Tagasaste

- Drought-tolerant fodder shrub.
- Well suited to deep sandy soils, with very deep roots able to explore the profile.
- Can replace extra feeding in autumn, although animals will only maintain weight.
- Feed quality and animal production in winter and spring are similar to that in annual pastures.
- Can be grazed continuously by cattle, but sheep for not more than six weeks at a time.
- Requires hard grazing or cutting in the first half of the year to prevent flowering.
- Intolerant of waterlogging, salinity, acidity or high aluminium levels.
- Requires at least one metre of well drained soil to persist and be productive.
- Fine-textured soils can restrict root growth and are vulnerable to winter waterlogging.

Slashing Tagasaste. (Source: NACC)

FAST FACTS

The main fodder shrubs in WA are Tagasaste and Saltbush. Both are resilient and very useful particularly in relation to the autumn feed gap. However, monitoring is important.

Tagasaste is very suited to the pale deep sands of the coastal plain and is now extensively grown in the west of the NAR.

The various forms of halophytic shrubs or Saltbush are suited to saltland mainly in the east of the region.

Lucerne, while not a shrub, has many similar attributes and the additional advantage that it is a very high value and palatable feed.

Young Tagasaste seedlings are susceptible to attack by insects, grazing animals or rabbits in their first year. Newly emerged seedlings are at risk from Redlegged earth mite, Lucerne flea and a range of caterpillars. Wingless grasshoppers can be a problem in coastal areas.

Livestock disorders

The feed value of Tagasaste is affected by the presence of phenolic compounds (tannin-like compounds), which are produced by the plant in response to stress. These are at highest levels in summer and autumn. Phenolics can interfere with the microflora in the rumen of sheep and cattle, but this can be overcome by supplementary feeding of lupins. Other disorders may also occur, so grazing Tagasaste needs to be monitored carefully.

SALTBUSH

Salt-tolerant shrubs are grown in Western Australia both to use productively and to rehabilitate land that has become too saline and wet for cropping. In WA, over one million hectares are now severely salinised and up to 4.5 million hectares of land have a high risk of secondary salinity. About half of WA's saltland is suited to various kinds of saltland pasture. The remainder is too saline and should be fenced to allow it to revegetate naturally with samphire (Halosarcia species) and salt and waterlogging tolerant trees like swamp sheoak (Casuarina obesa).

The halophytic shrubs, Saltbush or Blue bush (various species of Atriplex or Maireana), are commonly grown on saltland. Rhagodia preissii, which is referred to as Mallee Saltbush, has also been planted by some local farmers over the last few years. Other saltland pastures include halophytic perennial grasses such as Puccinellia (Puccinellia ciliata) and Tall Wheat Grass (Thinopyrum ponticum). Some annual legumes, such as Balansa and Persian clover and Burr medic, and also Annual Ryegrass, have some salt tolerance and may be grown on mildly salty areas. This section will focus on Saltbush, in particular the Atriplex types.

Many plantings of halophytic shrubs in the wheatbelt remain productive after 40 to 50 years, so these must have reached equilibrium in terms of their salt and water balance. Saline soils affect the growth of plants mainly because of high concentrations of dissolved sodium and chloride ions in the soil. These shrubs can utilise saline water and lower the watertable, which can assist in the growth of other understorey species of higher feed value after the newly dried soil is occupied with fresh rainwater. This seems to be the reason for some of the grazing benefits than can be achieved from saltland pastures. Several species of saltbushes and climatic conditions should be taken into account for the choice of Saltbush to be planted. These shrubs do not tolerate long-term continuous grazing and should be allowed to recover after grazing.

The benefits of growing halophytic shrubs include:

- Increased production on moderately salt affected and waterlogged land.
- High protein forage available to meet the autumn feed gap and provides a source of vitamin E.
- Increased evapotranspiration, so recharge and saline groundwater are used. This makes productive use of as much water as possible and can lower the watertable, so that understorey species of higher productivity and nutritive value can be grown.
- Sequestration of Co^2.
- Control of wind and water erosion.
- Shelter for stock in severe weather conditions.
- Reduced shedding of water, salt, soil and nutrients.
- Improved sustainability in the long-term.
- Increased biodiversity and improved wildlife habitat.

The importance of mixtures

Saltbush has reasonable nutritional qualities, but the high salt concentration is a major limitation to feed intake. Thus Saltbush leaf, on its own, is at best a maintenance diet for sheep. The key to the use of saltbush fodder is to mix it with feeds with complementary characteristics, such as stubble. Alternatively, plant an understorey of tolerant annual legumes and grasses with the Saltbush.

Saltbush with pasture inter-row. (Source: NACC)

LUCERNE

Lucerne is a deep-rooted, perennial legume which is suited to a wide range of soils, but is not adapted to acid, waterlogged or saline soils. It is the only perennial legume available to address rising water tables and associated salinity in pasture crop rotations.

Lucerne provides additional green feed at the start and end of the normal winter growing season and has the ability to respond quickly to summer rainfall. The quality of feed remains relatively constant throughout the year while it is active. It requires rotational grazing for long-term persistence.

A difficulty with Lucerne is getting good establishment; however, with persistence, this can be achieved on most soil types. The perennial nature of Lucerne, and its high feed value, makes it a very valuable pasture. Once established, Lucerne has good drought tolerance and can help manage herbicide-resistant weeds with its competitiveness and tolerance of some broad-spectrum herbicides. With careful grazing, and direct weed management if necessary, Lucerne can be an excellent choice as one of your suite of pastures. It can be managed as a pure stand, or can be a mixture with other pasture species. Livestock may selectively graze Lucerne, so pastures containing Lucerne need rotational grazing and careful monitoring to avoid losing it from the mixture.

Features

- Drought tolerant, herbaceous perennial legume.
- High palatability and feed quality.
- Very responsive to out-of-season rainfall.
- Suited to a wide range of soils (although not waterlogged, saline or very acid soils).
- Susceptible to a range of pests and diseases.
- Requires rotational grazing for long-term persistence.

Lucerne. (Source: NACC)

FOLLOW UP

Read this chapter in conjunction with these other chapters in this *Guide*:

- Matching Pastures & Soil Types.
- Fodder Crops.
- Pasture Pests.
- Livestock chapters.

As well as:

- noteworthy 10: Supplementary Feeding.

There are many useful chapters in the following publications:

- *Perennial Pastures for Western Australia*, DAFWA Bulletin 4690 compiled by Geoff Moore, Paul Sanford and Tim Wiley.

Other useful information:

- *Perennial fodder shrubs providing profitable and sustainable grazing*. Key practical findings from the Enrich project, Dean Revell, CSIRO and Future Farm Industries CRC. Search on "Enrich" at www.futurefarmonline.com.au.

DECLARED PLANTS

WEEDS

A weed is a plant growing where it is not wanted. For example, ryegrass can be a weed in a lupin crop and clover is a weed in a rose bed. Because of the many different scenarios that can arise with weed control – depending on what you are trying to grow – we have not included a general section on weeds. We recommend that you refer to a reference that is specifically designed for your situation.

DECLARED PLANTS

Declared plants are weeds for which there are Government regulations to ensure their control in part or all of the State. The Government restrictions are implemented and enforced by the Department of Agriculture and Food's Invasive Species Program. This program is responsible for the management of biosecurity risks associated with serious noxious weeds in Western Australia, by means of declared plants policies and regulations and the provision of research and technical advice on weed issues (www.biosecurity.wa.gov.au).

Depending on the significance of the weed, different categories of control are identified in the Biosecurity and Agriculture Management (BAM) Act 2007 including:

- **Biosecurity and Agriculture Management Act 2007** (www.biosecurity.wa.gov.au).
- **C1 category (Exclusion)** Pests or weeds that are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
- **C2 category (Eradication)** Pests or weeds that are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
- **C3 category (Management)** Pests or weeds that are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

What this means is that legislation is currently in place that requires landholders to control or eradicate the weed when it grows on their land.

The major declared plants in the Northern Agricultural Region (NAR) are:

- **Skeleton Weed** C3 management in the Shires of Yilgarn and C2 for the rest of state.
- **Stemless thistle** C3 management in the Shires of Chapman Valley, Greater Geraldton, Irwin and Northampton.
- **Paterson's Curse** C3 management in the Shires of Chittering, Dandaragan, Dalwallinu, Gingin, Moora & Victoria Plains.
- **Thornapple (Datura wrightii)** C3 management in the Shires of Chapman Valley, Greater Geraldton, Irwin and Northampton.

Other declared plants in the NAR include: Salvinia (C2); Bathurst Burr (C3); Camel Thorn (C1); Parkinsonia (C3); Mexican poppy (C3); Saffron Thistle (C3); Variegated thistle (C3).

For more information on declared plants visit the BAM's website www.biosecurity.wa.gov.au. On the following page you will find photos of some of the declared plants in the NAR as well as information on plant appearance, biology, and control measures.

FAST FACTS

A weed is a plant growing where it is not wanted. A declared plant is a weed for which there is Government regulation that requires landholders or others to control or eradicate them.

There are three categories of declared plants: C1, C2 and C3, each with a different level of control required.

This chapter contains pictures of many of the main declared plants in this region. Learn to recognise them.

Some of the main problems are: Skeleton Weed, Bathurst Burr, Parkinsonia, Salvinia, Camel thorn, Arum lily, Mexican poppy, Patersons curse, Saffron thistle, Stemless thistle, Thornapples, Variegated thistle.

Skeleton weed (Chondrilla juncea): Major pest found in all areas; P1, P2. (Copyright © Western Australian Agriculture Authority)

Water weeds: These escape from garden ponds and make their way into rivers. There are 16 different varieties, with Salvinia probably the major one in this region. P1 and P2, or P3 for the whole state. (Copyright © Western Australian Agriculture Authority)

Bathurst burr (Xanthium spinosum): Found in the Nangetty area P1, P2. (Copyright © Western Australian Agriculture Authority)

Camel thorn (Alhagi maurorum): P1, P2. (Copyright © Western Australian Agriculture Authority)

Parkinsonia (Parkinsonia aculeata): Found in the Pastoral areas, but some plants have been found in Mullewa and Morawa shires, P1 for the whole state. (Copyright © Western Australian Agriculture Authority)

Arum lily (Zantedeschia aethiopica): P1, P4. (Copyright © Western Australian Agriculture Authority)

Mexican poppy (Argemone ochroleuca): P1, P3. (Copyright © Western Australian Agriculture Authority)

Stemless thistle (Onopordum acaulon): P1 P3 for Chapman Valley, Greater Geraldton, Irwin and Northampton. (Source: Hussey et al 2007)

Patersons curse (Echium plantagineum): P1 for whole state, P3 for Chittering, Dandaragan, Dalwallinu, Gingin and Moora, P4 for areas of Carnamah and Coorow west of the Midlands Rd. (Source: CRC – ScienceAlert)

Thornapples (Datura wrightii) (Copyright © Western Australian Agriculture Authority).

Saffron thistle (Carthamus lanatus): P1 and P3 for Carnamah, P4 for Chittering, Dandaragan and Gingin. (Copyright © Western Australian Agriculture Authority)

Variegated thistle (Silybum marianum): P1 and P2 for the whole state except Chapman Valley, Greater Geraldton, Irwin, Mullewa and Northampton where it is a P3. (Copyright © Western Australian Agriculture Authority)

OTHER PLANTS THAT MAY NEED TO BE CONTROLLED

Onion Weed (Asphodelus fistulosus): Found from Greenhead to Geraldton, livestock do not graze this plant and it is quite tolerant of most common herbicides. (Source: Eliott-Lockhart 2013).

Golden Crownbeard (Verbesina enceloides): Found from Perth to Geraldton, toxic to stock and humans. Also known as Dongara Daisy. (Source: Eliott-Lockhart 2013).

This is not an exhaustive list and if you find other plants that you are not sure of, get them identified so that appropriate control measures can be put in place.

FOLLOW UP

Read this chapter in conjunction with these other chapters in this *Guide*:

- Matching Pastures & Soil Types.
- Fodder Shrubs.

As well as:

- noteworthy 1: Spray Safe, Stay Safe.
- noteworthy 15: Finding the Right Advice.
- noteworthy 34: Productive Pasture. Management.

Other useful information:

- *Western Weeds: A guide to the weeds of Western Australia*, by B.M.J. Hussey et al.
- Weeds in Australia website www.environment.gov.au/biodiversity/invasive/weeds/.
- Weeds Australia website www.weeds.org.au.

Also see the References chapter at the end of this *Guide* for further information.

ENVIRONMENT

REMNANT VEGETATION

The NAR has a wide diversity of native flora and parts of it (for example, the West Midlands area) are world renowned as an international biodiversity hotspot. As well as in some excellent national parks, many areas of pristine vegetation still remain on private properties.

REMNANT VEGETATION IS IMPORTANT

If you are fortunate enough to have some areas of native bush remaining on your property (remnant vegetation), it is likely you will want to preserve it.

Remnant vegetation plays an important role:

- In conserving the remaining biological diversity in the region.
- In providing habitat for many animals, including birds, lizards and other creatures.
- In balancing the soil water profile by using soil water and preventing recharge and reducing the development of salinity.
- In protecting vulnerable soil types, particularly sands, from wind erosion.
- In protecting other non-arable areas such as shallow rocky or gravelly soils.
- In softening the harshness of the dry landscape with a swath of green.
- In providing immense aesthetic pleasure to many people.

If you want to maintain the viability of your remnant vegetation, it will be best to actively manage it. At the very least, you should fence it off to protect it from grazing animals that can degrade it by causing physical damage, and most importantly, that will spread weeds.

FAST FACTS

Remnant vegetation plays an important role, not only in conserving biodiversity, but also in protecting soils and landscapes, as well as providing a source of enjoyment.

The most important conservation measure you can take is to fence it off. Other actions include the control of weeds and feral animals, and strategic revegetation.

Source information and get to know your local species.

Seek advice from your local NRM officer.

Join Land for Wildlife – a voluntary scheme run by DEC, which provides expert support.

TAKE ACTION

Some of the actions you might take are:

- Fence off the area to exclude grazing and vehicle tracks.
- Avoid burning as much as possible. While burning is a natural phenomenon in the Australian bush, it should not be done more often than every seven or eight years or it could increase weed problems and cause other degradation issues.
- Actively control problem weeds.
- Bait for feral animals, particularly foxes and cats.
- Strategically revegetate with trees and/or understory if it is warranted.
- Take advice! Many people will be happy to help you (for example, see the following section on the Land for Wildlife program).

LEARN ABOUT YOUR LOCAL SPECIES

It is not possible in a brief chapter to do justice to the vast array of native species – plants, animals, birds and others – that you might be lucky enough to find on your property. There have been, and continue to be, many studies of our biodiversity. You may find it very satisfying to be able to recognise your local species, and it is imperative that you are able to do this if you plan to do any revegetation. So source some of the excellent reference materials, or make contact with an NRM officer from your local landcare or catchment group, or join the Land for Wildlife scheme.

LAND FOR WILDLIFE

Land for Wildlife is a voluntary scheme that aims to encourage and assist private landholders in Western Australia to provide habitats for wildlife on their property, even though the property may be managed primarily for other purposes.

If you wish to protect or create wildlife habitats on your property, the Land for Wildlife scheme can offer advice and assistance - whether you manage a farm, a bush block, a Shire reserve or a roadside.

Land for Wildlife is run by the WA Department of Environment and Conservation (DEC) and has very supportive coordinators in many locations across the state. Participation in the scheme is entirely voluntary. Registering with Land for Wildlife will not change the legal status of your property in any way.

Remnant vegetation on sandplain near Lancelin. (Source: Rural Solutions WA).

FOLLOW UP

Read this chapter in conjunction with these other chapters in this *Guide*:

- Revegetation.
- Native Gardens.

As well as:

- noteworthy 1: Spraying.
- noteworthy 2: Fencing.
- noteworthy 20: Being Firesmart.

Other useful information:

- Land for Wildlife scheme in WA www.dec.wa.gov.au/management-and-protection/conservation-on-other-lands/land-for-wildlife.html or contact Fiona Falconer (Coorow) fiona.falconer@dec.wa.gov.au.
- Bibliography of books on WA flora, Wildflower Society of Western Australia http://members.ozemail.com.au/~wildflowers/ebooks-sorted.html#Native%20plants%20in%20gardens.
- *The value and benefits of healthy farm bush*, by Colin Holt. DAFWA Farmnote 141/2000.
- *Vegetation buffer zones*, by Mark Ocktman and Colin Holt. DAFWA Farmnote 38/2000.
- *Weed control for successful revegetation*. DAFWA Farmnote 47/98.

Also see the References chapter at the end of this *Guide* for further information.

REVEGETATION

You may decide that you want to revegetate an area of your property with native species. There can be many reasons for doing this, and it is important to plan according to your purpose. For example, you may want to revegetate for conservation purposes; to provide shelter for livestock; to reduce the risk of salinity, waterlogging, and wind or water erosion; for a cash crop; or for carbon credits.

As well as deciding on your aim, you need to choose, assess and prepare the site carefully. Several issues will affect the success of your project, the most important being soil type and depth, water availability, exposure to wind, weed burdens and pest damage. Good establishment conditions are essential, and management of young plants is advisable. Plants are particularly susceptible to water stress, weed competition and pest attack during the seedling stage. DAFWA has some excellent *farmnotes* on site issues – see the Information section for reference details.

Another key issue is to choose plants that suit the soil type and climate. Almost any site, irrespective of soil type, can be revegetated – after all, it probably carried native vegetation in the natural state. The trick is to choose plants carefully and manage establishment.

The soil frequently (although not always) contains a significant seed bank of native species. If you fence off an area and/or exclude grazing, native vegetation will likely return naturally to a site without you needing to do much at all – although weeds may need to be monitored and controlled.

FAST FACTS

Revegetation may be for:

- Nature conservation.
- Erosion or salinity control.
- Livestock shelter.
- Cash crop.
- Carbon credits.

For nature conservation, use local provenance, collect seed and don't neglect the understorey.

For landcare or commercial plantings be clear about your purpose. Local choices include Oil Mallee, Sandalwood, Maritime pine, Broombush or native foods.

REVEGETATION FOR CONSERVATION

If your aim is nature conservation, you will be keen to preserve the local biodiversity. In this case, you should only plant local species. Some local nurseries specialise in native plants (e.g. at Muchea, Kalannie, Mingenew, Geraldton and Wongan Hills – see reference list) and staff members will be able to give you good advice on what to plant.

Apart from the wonderful diversity in our flora, and the stunning wildflowers, a key reason for using local species is that they will provide habitat for, and enable you to attract and nurture, the local fauna and birds.

Acacia saligna seedlings at Kalannie nursery. (Source: NACC)

A major revegetation project is being implemented in the Moresby Ranges near Geraldton. (Source: NAAC)

Local provenance

If you are keen to regenerate for conservation reasons, then use local provenance. Although a particular species may occur naturally across different areas, localised populations may differ because they become specifically adapted to individual habitats. Different populations containing local genetic variations are called provenances. It is important to preserve these different provenances, as each is unique and has the benefit of having evolved with the local soils and climate. These plants are likely to require less maintenance than plants from other locations. If you collect seed yourself, you can be sure that it is local – see the farmnote on seed collection for more information.

Understorey species

Overleaf is a list of tree species that can be useful in different soil types in this region. However, remember that for conservation planting the understorey, including small and medium bushes and groundcovers is also important. The understory plays an important ecological role as well as significantly contributing to the landcare benefits, such as soil protection and stabilisation.

REVEGETATION FOR LANDCARE

Many good reasons to revegetate are related to landcare or outcomes other than nature conservation. In these cases, choose the species that most suits your purpose. You have many different choices and they may or may not be natives. For example, Sandalwood, Broombush, Oil Mallees and Maritime Pine (non-native), and some native food species, are all grown in this region for multiple benefits, including the use of areas less suited to cropping or livestock, salinity and erosion control, risk management and diversification, and future income. Local landcare groups are well acquainted with the issues, so contact them for advice.

FOLLOW UP

Read this chapter in conjunction with these other chapters in this *Guide*:

- Remnant Vegetation.
- Native Gardens.

As well as:

- noteworthy 1: Spraying.
- noteworthy 2: Fencing.

Other useful information:

- Land for Wildlife scheme in WA www.dec.wa.gov.au/management-and-protection/conservation-on-other-lands/land-for-wildlife.html.
- *Trees & Shrubs for the Midlands and Northern Wheatbelt,* DG Wilcox et al 1966.
- DAFWA farmnotes on site management:
  - *Site Assessment,* Farmnote 36/98.
  - *Site Preparation,* Farmnote 37/98.
  - *Weed control,* Farmnote 47/98.
- *Collecting Native Seed* by Barbara Jennings. DAFWA Farmnote 44/1992.
- Revegetation Association of WA website (RIAWA) http://riawa.com.au/wordpress/.

Also see the References chapter at the end of this *Guide* for further information.

TREES SUITABLE FOR THIS REGION

Scientific Name	Common Name
Deep grey sands and coastal sands	
Acacia rostellifera	Summer scented wattle
Acacia saligna	Orange or golden wattle (will grow on many soil types)
Banksia prionotes	Acorn banksia
Eucalyptus erythrocorys	Illyarrie
Eucalyptus gomphocephala	Tuart
Eucalyptus obtusiflora	Dongara mallee (on limestone)
Deep pale yellow to yellow sands	
Eucalyptus camaldulensis var obtuse	Red river gum
Eucalyptus cladocalyx	Sugar gum (SA)
Eucalyptus cladocalyx var nana	Dwarf sugar gum (SA)
Eucalyptus eudesmioides	Malallie
Eucalyptus jucunda	Yuna mallee
Eucalyptus leptopoda	Tammin mallee
Eucalyptus leucoxylon var rosea	Red flowering gum (NSW)
Eucalyptus subangusta	Mallee wandoo
Eucalyptus todtiana	Coastal blackbut
Yellow sands with clay or gravel at depth or at the surface	
Eucalyptus accedens	Powder bark wandoo
Eucalyptus arachnea	Black marlock or black stemmed mallee
Eucalyptus camaldulensis var obtusa	Red river gum
Eucalyptus leucoxylon var rosea	Red flowering gum (NSW)
Eucalyptus sideroxylon	Red ironbark (NSW, Qld)
Eucalyptus stowardii	Fluted horn mallee (eastern wheatbelt)
Eucalyptus salicola	Salt gum (saline areas)
Eucalyptus subangusta	Mallee wandoo

Yellow/grey or red loamy clays	
Acacia acuminata	Jam (wattle)
Eucalyptus arachnea	Black marlock or black stemmed mallee
Eucalyptus brachycorys	Cowcowing mallee
Eucalyptus dundasii	Dundas blackbutt (WA Eastern wheatbelt /Goldfields)
Eucalyptus horistes	Mallee (rough bark) (also oil mallee – syn E. kochii)
Eucalyptus loxophleba	York gum (also oil mallee)
Eucalyptus salubris	Gimlet
Eucalyptus salmonphloia	Salmon gum
Eucalyptus torquate	Coral gum (Eastern Goldfields)
Melaleuca uncinata	Broombush (mallee floors)

This list has been sourced from an article by Pat Ryan (1966) in the booklet *Trees and Shrubs for the Midlands and Northern Wheatbelt*. This is not an exhaustive list, but is a sample of suitable trees. Not all the above plants are native to this region, although most are. If you go to the Florabase website at http://florabase.dec.wa.gov.au/ , you can find detailed information about WA plants. A good way to search is to click "Browse the WA Flora" under the "Find" tag at the top of the page.

STREAMS & WETLANDS

We are not a region of vast waterways, but many properties do have wetlands or streams, and some even have river frontage. If you are in this fortunate position it is likely you will want to preserve the integrity of the area and hopefully even conserve it as an environmental asset. Unfortunately, many of our wetlands have been degraded, particularly by livestock.

WETLANDS

A wetland is an area saturated with water, either permanently or seasonally, and may take the form of a fresh or salt water lake, a soak or just a wet area of ground. Whatever its form, in its natural state, a wetland contains a very diverse ecosystem with a wide range of native plants, small animals and micro-fauna. Wetlands also frequently support a rich bird life. Many of our wetlands are used as summer pasture, which is a legitimate use, but one which will degrade the ecosystem. Therefore, if you wish to preserve the biodiversity of your wetland, you need to fence it off and exclude grazing.

FAST FACTS

A wetland is an area with permanent or seasonal water saturation, with a diverse natural ecosystem.

The riparian zone is the land immediately next to a waterway.

Our wetlands, waterways and riparian zones are often degraded, with livestock being a primary cause.

Managing stock access is important; this may be by fencing and/or by watering stock remotely.

Direct weeding of riparian areas may be necessary, with the best method often being manual removal.

The Hutt River – Shire of Northampton. Photo from Western Australian Rivers website. (Source: NAAC)

WATERWAYS: STREAMS AND RIVERS

Preserving waterways involves three key issues:

- **Riparian vegetation**
  The riparian zone is the area of land bordering a watercourse. It includes the bed, banks and adjacent land. Its width will vary – it may be much wider in a valley floor than in an upland stream. In this region, where streams are often seasonally dry, the riparian zone may be difficult to define. Nevertheless, preservation of the riparian vegetation is critical to the health of the waterway.
- **Water quality and flow**
  Both chemical pollutants (e.g. herbicides and fertilisers leaching from surrounding land) and rubbish dumping can cause serious degradation of waterways, so manage these elements carefully.
- **Bank stability**
  Removing native riparian vegetation, either through deliberate clearing, or by stock grazing and/or fire, can result in unstable banks and lead to erosion, sedimentation of waterways and flood problems.

STOCK MANAGEMENT

Uncontrolled access of livestock to riparian land, or to water, can result in excessive run off, bank erosion, loss of productive land, loss of important habitat, weed invasion, soil compaction, direct pollution of the waterway and reduced water quality. Even if you wish to continue using the stream for stock water, it is wise to directly manage livestock access by the erection of fences to restrict movement of stock, both within the riparian zone and up and down the stream.

If possible, provide an alternative form of water for your stock. If stream water is essential, then you may be able to pump it (e.g. using a solar pump) into a trough outside the riparian zone.

Ideally, you will exclude stock completely, but it this is not feasible, do as much as you can to preserve the stability of the ecosystem – and encourage your neighbours to do likewise. From time to time, opportunities arise to access funding to assist you in fencing off riparian zones – take advantage of this!

Arum lily infestation at Gingin Brook. (Source: Rural Solutions WA).

WEED CONTROL

Weeds are serious problems in riparian zones. Conditions are ideal and they will often spread and become almost uncontrollable. An example of this is the Arum lily along the banks of Gingin Brook, but many of our waterways have weed problems, particularly where they abut farmland. Weeds will displace native vegetation, increase fuel loads and fire risks and increase stream pollution. Weeds are one of the most important reasons to exclude stock as much as possible from riparian zones.

While it can be laborious, in many cases, manual removal by pulling or slashing is the best method of weed control. Depending on the type of weed and its spreading mechanism, you may need to make sure that you remove the crowns and even the roots and not just the vegetative tops. Herbicides can also be useful, and wipe methods can often avoid unnecessary drift. Be careful to use a frog friendly formulation, as some herbicide carriers can cause problems. For woody weeds, you may find that stump injection with a herbicide is useful.

FOLLOW UP

Read this chapter in conjunction with these other chapters in this *Guide*:

- Remnant Vegetation.
- Revegetation.
- Water Quality & Testing.

As well as:

- *Water Notes*, Department of Water. For a wide range of fact sheets on rivers and wetlands see the series *Water Notes* at www.water.wa.gov.au/Managing+water/Rivers+and+estuaries/Restoring/Water+notes/default.aspx.
- Rivers of Western Australia www.rowa.org.au.

Also see the References chapter at the end of this *Guide* for further information.

NATIVE GARDENS

Gardens are a wonderful source of pleasure and relaxation and they also have a cooling effect on the environment. However, in our climate, gardens face a constant struggle against the harsh elements, with our hot dry summers and strong winds. Our soils also present many challenges, such as high alkalinity on the coastal limestones to saline soils inland. If you are near the coast, you may also have the problem of salt spray and sand blasting.

ADVANTAGES OF LOCAL NATIVE PLANTS

Native plants can provide many advantages over exotics because they are adapted to our environment, and local natives are even more so. Some of the advantages are:

- High drought tolerance.
- Low maintenance.
- Minimal watering requirements.
- Minimal need for fertilisers and pesticides.
- Providing habitat for animals and birds.
- Suitability to many landscaping styles.
- Striking, unique foliage and flowers.

Some native garden enthusiasts are purists and are dedicated to planting only natives. However, this is your choice. Native plants can also be very effectively mixed with exotic species to provide a very varied garden. The trick to mixed gardens is to group plants of similar types, as natives can have different water and fertiliser requirements from exotics (usually much less).

FAST FACTS

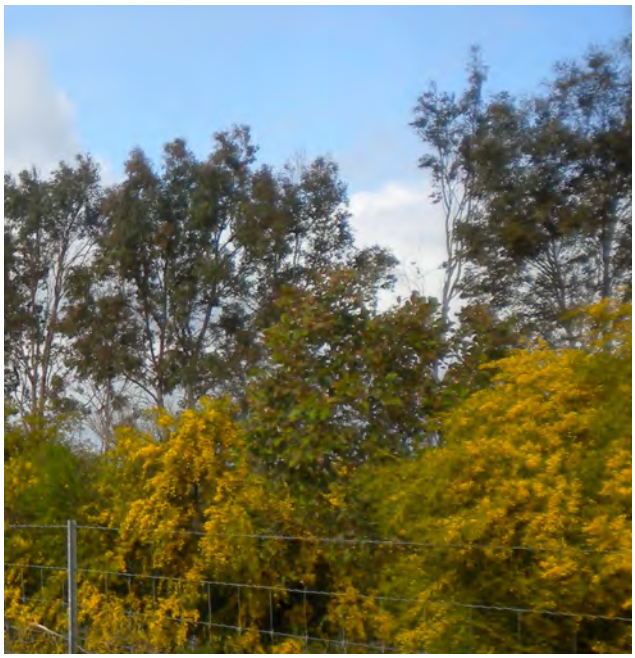
Native plants have many advantages, especially types sourced locally.

They are drought tolerant, low maintenance and provide habitat for animals and birds.

Get copies of NACC's Native Garden Guides – there are separate guides for coastal and inland locations and they're FREE!

Start your garden with some of the common types, particularly those growing well in gardens near you.

Plant early in winter to ensure good establishment before summer.



Border planting of Acacia saligna (orange wattle), Corymbia citriodora (lemon scented gum) & C. calophylla (marri). (Source: Rural Solutions WA).

GET A NACC NATIVE GARDEN GUIDE

Recently, NACC, in association with other NRM groups across the country, has developed two *Native Garden Guides*: one for coastal situations and another for inland locations. These guides are excellent – they provide information on:

- Suitable plants (trees shrubs, ground covers, climbers, grasses and sedges, etc).
- Various garden designs and how to implement them.
- Plants to avoid – ones that will escape and become environmental weeds.
- How to grow and maintain a native garden.

Grevillea thelemanniana (spider net Grevillea) and Eremophila glabra (prostrate emu bush). Photo's from the Geraldton Drylands Permaculture Nursery and DEC Florabase websites.

SUITABLE PLANTS

Many native plants are easy to grow and make stunning additions to a native garden. Some species are also more difficult to domesticate. If you are new to native gardening, look around your locality and start with some types that are already growing well in garden situations. Local nurseries stock many suitable natives.

The choice of plants will depend on your soil type and local climate, but in this region, some good types to start with will probably be:

Trees

- Corymbia citriodora (lemon scented gum).
- Corymbia ficifolia (red flowering gum).
- Grevillea robusta (silky oak).
- Agonis flexuosa (native peppermint).
- Eucalyptus erythrocorys (illyarie).
- Eucalyptus caesia (gungurru).
- Eucalyptus leucoxylon rosea (red flowering yellow gum from SA but well suited to local calcareous coastal soils).
- Acacia saligna (orange wattle) – also many other wattles

Note that many eucalypts now have the genus name Corymbia.

Shrubs

There are many suitable species of the following – both small and large shrubs:

Callistemon	Acacia
Grevillea	Hakea
Eremophila	Melaleuca

Groundcovers, prostate forms or climbers

- Kennedia prostrata, K. coccinea or K. Nigricans.
- Grevillea spp.
- Eremophila spp.
- Hardenbergia violacea.

There are many other choices. The above are just a quick start guide.

When to plant?

Each spring, nurseries are full of a seductive array of plants in full bloom. However, because of our harsh summers, you are wise to plant earlier and give your plants special attention in the first year. June to August is a good planting time, after the opening seasonal rains and before any hot weather commences. This will allow the plants to get their roots down and establish under good conditions and will avoid the necessity of too much maintenance over summer.

FOLLOW UP

Get your own free copy of the NACC *Native Garden Guides*:

- *Inland Native Garden Guide.*
- *Coastal Native Garden Guide.*

The Australian Native Plants Society and the Wildflower Society of WA both have websites with a lot of information at http://anpsa.org.au and http://members.ozemail.com.au/~wildflowers/draftlist.htm.

Another excellent source of information on Western Australian flora is on DEC's Florabase website at http://florabase.dec.wa.gov.au.

The Water Corporation of WA has information on waterwise gardens, with sections on plant selection, mulching and watering, at www.watercorporation.com.au/w/waterwise_gardens.cfm.

Also see the References chapter at the end of this *Guide* for further information.

CASE STUDIES

CASE STUDY

BOOKARA GOAT DAIRY

GREENOUGH

It is easy to have a passion for your work when the product is as luscious as the goats cheeses made by Bookara Goat Dairy. Following a lot of planning and research, Cate and Mark Weston have achieved their dream of developing a commercial rural enterprise.

After moving to the Mid West from Queensland ten years ago, they have experienced several parts of the region while Mark was employed first as a teacher at the WA College of Agriculture in Morawa, then as a Project Manager with the Northern Agricultural Catchments Council (NACC). They tried a bit of share farming on the north coast, and have even been involved in the cray industry. The adventurous family now farm a 150ha block on the coastal flats 40km south of Geraldton, not far from Dongara. Mark's background as an agricultural scientist helped map out their venture, and his knowledge of farm management techniques is useful in implementing the plan. However, it is teamwork that drives the venture, and Cate's input is invaluable.

As well as goats, the Weston's run a few beef cattle and horses. With three young boys to keep active it is good to have variety, and the attractive country – on a hill near the coast, with some remnant bush still intact – is an ideal place for children to grow up. The goats are very friendly in nature, which is also important with young children.

Mark Weston and his son with a Bookara goat.

In starting a new venture there are lots of decisions to make. Cate and Mark were keen to work on a small property and the idea of goats appealed to them. "We wanted to work on an intensive agricultural project and were attracted to the idea of controlling all aspects – from paddock to plate," Mark said. There are few goat dairies in Western Australia, which presented challenges in getting information and equipment, but also opportunities to fill a market niche. "We were lucky to find some suitable equipment in a cow dairy in the south of the state and we have also been all over the country talking to goat dairy operators so that we could learn as much as possible."

Cate overcame some of their initial lack of knowledge by attending a week long course at Regency TAFE in Adelaide. "The course was fantastic and gave me much more confidence to experiment so that we could create our own unique products," Cate said. "We started with just milk, but now various processed products are an important part of our business." As well as goats milk (both pasteurised and unpasteurised), well known for its health benefits, the Bookara product range now includes haloumi and ricotta cheeses, natural yoghurt and goats curd.

There is a lot of local interest in the product range, with Geraldton restaurants now boasting delicious dishes such as "Grilled Bookara haloumi with watercress and crusty bread," or "Ravioli with Bookara goats ricotta and spinach," even a pizza with "Bookara goats cheese, asparagus and prosciutto". The Weston's are also keen supporters of the Geraldton Greenough Farmers Market which is held every Saturday morning in Maitland Park in Geraldton. Mark is kept even busier as the Deputy Chair of the market.

The local enthusiasm is encouraging, but Mark and Cate are very conscious that continuity of supply is important for a business, so they are keen not to expand too quickly. "We have just started promoting our products, but we are treading gently at first," Mark said. "We want to be able to continue to supply our customers on a regular basis, and while we are keen to expand, we plan to do it in a gradual and sustainable way."

Preliminary planning and research have been very important in developing the business. Mark's previous agricultural experience is invaluable. He has successfully implemented improved pasture, including sub-tropical perennial grasses which are suited to the soils of the region's coastal fringe, and provide valuable feed in summer. "Some of the soils on our place are challenging to work with," Mark ventured. "We have both cracking clays, and high pH black wattle sands, but we manage them carefully and we have been able to develop good pastures and grow a few crops. A dairy produces all year round, so it is particularly important to have a continuous supply of feed for the goats, particularly in the dry summer months."

The Weston's are a fantastic example of how you can develop a new farm project from scratch. Cate and Mark had some ideas, but they didn't rush in – first they thought about the various options and did a lot of research. Choosing the goat breeds, learning about goat husbandry and milk and cheese production, as well as developing appropriate pastures and feed supplies have all been important steps. Marketing also presents special challenges, but Cate and Mark are now confident they have the bases covered, and have created a sustainable value-added intensive enterprise to be proud of.

Inspiring ideas

- You can develop a new enterprise from scratch – just start!
- Follow your passion, form a plan, then work on information and skills.
- Ask questions – speak with other operators.
- Love your product – others will love it too!
- Develop gradually to make sure you have continuity of supply.
- Projects go well with a family team approach.
- Being able to support a family with your enterprise brings special rewards.

Bookara goats.

CASE STUDY

RURAL LIFESTYLE

MOORA

Andrew Hill and Rachel Walmsley.

Natural Resource Management Officer (NRMO) for the Moore Catchment Council (MCC), Rachel Walmsley is putting her knowledge of trees and shrubs native to Moora into practice on her own property. With partner Andrew Hinton, she is developing their 1.5ha block south of Moora into a rural haven.

Rachel and Andrew arrived in the region from Dorset in the south west of England in 2007, where Andrew worked in the mushroom industry and Rachel in the environmental side of commercial waste management. Andrew is now the Orchard Manager at Moora Citrus. Their house and land initially came as part of the job, but they have since bought it for themselves. The couple had never owned a property before and wanted to transform it into a place to suit their relaxed lifestyle. At first it was very sparsely planted so they were particularly keen to do something about the bare paddocks. New plantings of a variety of native trees and shrubs around the property provide aesthetics, privacy and wind protection, while attracting wildlife. (See the following box for details of the selected tree and shrub varieties)

Rachel said they first planted trees in rip lines along the boundaries, and then pockets in the paddocks to create a parkland effect. "We have particularly enjoyed seeing the transformation in only a few years. The trees have attracted a lot of birds and make the property much more enjoyable," she said. Carnaby's Black Cockatoos use the trees and eat the grevilleas. Recently a breeding pair has moved in and are using a big Salmon Gum at the back of the property to feed they also drink from a rainwater collector most nights. The property is also home to lots of Honeyeaters, Magpies, Magpie larks, Willy Wagtails and Butcherbirds.

Rachel and Andrew have a menagerie of domestic animals – nine chickens, two roosters, two dogs and two cats. The chooks are particularly useful because of the abundant eggs they produce. Rachel is a keen gardener so they also grow their own vegetables. She has developed three veggie patches over the years and describes it as a bit "hotch potched."

"The last one I built had a bit of planning – a raised bed with a good mix of clay, sand and homemade compost. I also included horse and pig poo. We are careful to rotate the plantings so it is really successful in producing heaps of veggies for us."

Andrew and Rachel try to be as sustainable as possible. In 2012 they put in a 2.5kw solar power system which creates about 13 to14 kw per day in the summer months. "We are very pleased so far and we will put in more panels in the future," Rachel said. Future plans also include installing a rainwater tank soon so they can also use water more sustainably.

Some of the trees & shrubs that Rachel and Andrew have planted:

- Casuarina obesa (Salt Water Sheoak) .
- Eucalyptus erythroneama (Red Flowering Mallee).
- Eucalyptus salmonophloia (Salmon Gum).
- Eucalyptus salubris (Gimlet) .
- Melaleuca hamulosa (Creek Honey Myrtle).
- Melaleuca nesophila (Western Honey Myrtle).
- Melaleuca thyoides (Salt Water Tea Tree).
- Eucalyptus loxophleba (York Gum).
- Calothamnus quadrifidus (Netbush) .
- Eucalyptus citriodora (Lemon Scented Gum).
- Eucalyptus torquata (Coral Gum).
- Acacia acuminata (Jam Wattle) .
- Eucalyptus camaldulensis (River Red Gum).
- Eucalyptus macrocarpa (Rose of the West).
- Eucalyptus woodwardii (Lemon Flowered Gum).
- Melaleuca lateritia (Robin Red Breast).
- Atriplex nummularia (Old Man Saltbush).

Rachel misses some aspects of England – particularly walking in the English countryside. "I am disappointed that the climate and bush are a bit harsh here and it's not easy to enjoy a walk. However, we do love the climate in Australia – we hated the poor weather in the UK. The sense of community, the access to lots of sports (I play hockey), and the friendliness of the people here is wonderful," she said.

The pair first came here on holiday, but liked it enough to return to live and work. "We did have to get used to this type of rural living ... and living like an Australian!" Rachel said. "There were a few surprises, like not having the post delivered, but in terms of the quality of life, and financially, we are better off here. I sometimes reflect that I would never have had my own house and land and swimming pool in the UK, or played hockey, or been involved so much in community activities. "

Andrew and Rachel both work in jobs that help them manage their block, but there have still been many challenges. One of the biggest is deciding what to do. Now they have developed the trees and the veggies and installed solar power, they are starting to think about other projects including the possibility of a few sheep.

The clay soil has also been a challenge. Understanding how to match production to the climate and soil has been a steep learning curve. "We have learned lots of tips and tricks," said Andrew, "like ripping and timing, and tree guards to protect the seedlings from the white cockatoos". Other challenges have been learning about fence maintenance, fire issues as well as weed identification and control. Like many people new to managing a small property accessing suitable tools and equipment has also been challenging.

They still have many adventures ahead on this block, but Rachel and Andrew can now relax and be proud that they have contributed to maintaining and improving the local environment.

Inspiring ideas

- Put your knowledge and skills into practice – Rachel and Andrew both work with landcare and trees but enjoying it together at home gives another dimension.
- Create your own relaxing rural space only a few kilometres from your 'day job' and also give your pets plenty of space to enjoy.
- Planting native trees can bring lots of benefits – wind protection, privacy, but especially bird life.
- Having enough space for a veggie patch and chooks means lots of home produce.

Carnaby's breeding pair.

Rachel and Andrew's block in January 2013.

CASE STUDY

SANDY LAKE FARM

MUCKENBURRA, GINGIN

Reg and Veronica Beale farm 64ha at Muckenburra to the west of Gingin: it is not just a farm, but also a farmstay that attracts tourists from all over the world.

Reg purchased Sandy Lake Farm in 1998 and has worked constantly ever since to improve the pastures and the several different wetland areas on the property. Originally from Perth, Reg had a long career as CEO of the Fire Brigade (now "Police and Nurses") Credit Union. Veronica was involved in real estate and executive administration in Mandurah. She also ran a herd of Angus cattle on a Boddington property for 13 years. Reg moved to Sandy Lake Farm in 2003 and Veronica joined him in 2007. Upon completion of the large homestead in 2009 they began Sandy Lake Farm B and B, and in their very first year they won state and national awards for "Country Getaway Accommodation". They have since expanded the accommodation options. There is still the 'Bed and Breakfast' in the main homestead where you can have a beautiful view of the lake or garden. If you prefer to be independent, 'Abbeys Cottage', provides self-contained facilities for up to six people. The venture now also includes short stay sites for self-contained caravan owners.

There are several livestock enterprises on the property – some small Galloway cattle as well as some mixed breeds (Angus and Murray Grey) – some sheep and a few goats. The sheep are the 'easycare' Dorper meat breed which have little wool so don't need shearing, crutching or mulesing which is a great bonus to a small landholder. Reg and Veronica are happy to show the cattle and sheep at feeding times, and the four goats may be spotted in the back paddock. In addition they are blessed with many birds and native animals, particularly a resident family of kangaroos, which are of great interest to guests, and very tame.

Abbeys Cottage and some of the beautiful trees.

Reg has put a lot of effort into improving the pastures. The farm is divided into nine paddocks of various sizes. Natural wetlands support summer pastures providing more natural feed in the warmer months than many other parts of the region. Establishing perennial pastures is a special focus for Reg who says small landholders shouldn't be put off by the establishment costs. "The effort is worth it in the end," he said.

Inspiring ideas

- If you enjoy your lifestyle, and enjoy people, share your passions with others!
- Knowing where to begin a farmstay project can be challenging, but once you start each step presents itself.
- A farmstay is a mixture of lots of different projects – developing the farm, running well-oiled accommodation, maintaining the environment, providing a variety of activities, and above all, being charming and even entertaining! It can be very rewarding.
- A farmstay can work two-ways – clients are often very skilled and happy to share their knowledge with you.

One of the great benefits to Reg and Veronica of running a farmstay is many of the guests have talents or knowledge they are happy to share. They have had bike and model plane enthusiasts and expert photographers. "I love to take photos," said Veronica, " I really appreciate the help that many of the astro, landscape and animal photographers have given me when they visit." The reason for the astro interest is twofold: the farm is very close to the Gravity Centre and Gingin Observatory, both premier regional attractions that many regular customers value. In addition, the night skies are very clear and dark with no light pollution and the night viewing is fantastic. "Overseas visitors in particular are amazed by our wonderful starry nights," Veronica said.

Reg enjoys flying model planes and encourages guests to bring their models and enjoy the ample space to fly in the paddocks or near the lake. He is also a natural entertainer and enjoys sharing a song with the guests.

Sandy Lake Farm is a very pretty spot. It is in an area of natural wetlands on the Swan Coastal Plain, and the property has several very attractive environmental features. It is mainly cleared land, but there is some bush that has been fenced off to protect it from the livestock. Australian gum trees and mature pine trees line the perimeter boundary resulting in special sunsets filtered through the pines. There is a large ephemeral soak in one paddock that is often filled with water and at other times dry. It has its own special ecology which is very interesting to some guests. Most spectacular however is the lake (see picture below) which is a prized feature of the property. The lake was re-dug in 2010 to remove silting and it is now back to a repaired state of pristine beauty. A stroll out to the lake, or a walk around its 3.5km perimeter are both great ways to enjoy the environment. Black Butt, Paper Bark and Tea Trees surround the water adding to the beauty.

The spectacular lake at Sandy Lake Farm.

Reg showing his Dorper sheep to some interested guest.

The Gingin area is becoming known for its fabulous products such as blueberries, citrus, mangoes, avocados, olives, passionfruit, lettuces, tomatoes, jams and honeys, to name just a few. It is also developing a vibrant community atmosphere. Reg has been an elected member of the Gingin Council for several years, and is also Chair of the Moore Catchment Council; he enjoys giving back to the community. Reg and Veronica are proud of their achievements on their farm, but as well as enjoying the challenge and rewards of developing a small property and farmstay, they like the benefits that the local rural community brings.

CASE STUDY

HOWATHARRA WEEKENDER

NORTHAMPTON

Cris Babbage has a busy life as a physiotherapist, wildlife carer and mother of three children, and she finds it a real bonus to be able escape occasionally from Geraldton to the family's Howatharra lifestyle block. Cris and her husband, pharmacist Ross McKay, recently bought the block and they are still deciding how to manage it. In the meantime it is proving to be a boon for the whole family.

View from the Babbage family's Howatharra lifestyle block in Northampton.

The girls in the family are very keen on horses while the boys are into tractors, bikes and archery and are in the process of building their own field archery course. There are now five horses on the block – two belong to friends who share the daily trip out to feed. This has been a godsend for Cris with all her time commitments and to cover holidays. They find it wonderful to be able to have their own block to run the horses on, and they are fortunate to also have a neighbour who is passionate about horses and restoring her land back to native bush.

It is only a short trip to the farm from their house in the northern suburbs of Geraldton, so is very easy to go back and forth for a ride, to check the animals, or just to relax, and having a house on the property is very convenient.

Half of the 40 hectare property is covered in native bush, and with a creek, hills and breakaway country. The neighbouring farmers have been excellent in allowing them to ride over their land too, so it provides a wonderful place, and plenty of space, to ride and enjoy the environment.

For the past 20 years, Cris has cared for wildlife in her spare time. She has provided a temporary home for literally hundreds of animals and birds over the years. Last Christmas she had an extra 26 mouths to feed, all of them 'feathered friends' or of the 'marsupial kind'! Most commonly people bring her birds, but her particular passion is owls, with frogmouths being her favourite. The most entertaining animal she has ever cared for was a juvenile seal that had been caught up in a boat propeller. Firstly Cris and a fellow carer had to convince the police that this object wrapped up in a blanket that they had to rugby tackle on the beach in the middle of the night was **not** a dead body. It then had to live in the back of her hilux for a couple of days (entertaining on school runs!) until it could be taken to Perth where an emergency medical and television crew were waiting to perform surgery. It was even featured on the news and eventually released.

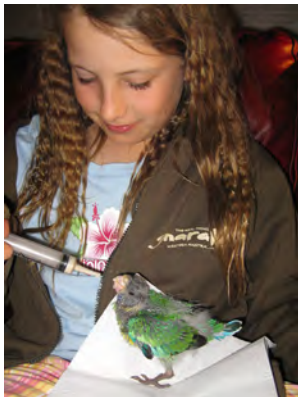
Archery is a favourite family activity that takes place on the block.

Inspiring ideas

- Escape from the hassles of the working week at a rural retreat.
- A mix of cleared land and remnant bush is a great combination on a small block.
- As a wildlife carer a small property is ideal for releasing animals and birds back into the wild.
- If you have a passion for horses then enjoy them on your own block!
- A mango orchard is a bonus: great eating, happy friends and some pocket money.

Cris finds having a property of their own, especially one with so much natural bush, is a real plus for her wildlife caring service as it gives her the opportunity to safely release animals and birds back into the wild.

As a totally voluntary service, wildlife caring can be both time-consuming and expensive, but Cris has occasionally been fortunate to receive small grants to assist her. In 2012 she was grateful to receive $500 as an individual fauna rehabilitator under the WA Government's Environmental Community Grants scheme, to build a dual purpose release aviary for both birds and kangaroos.



Rehabilitating a bird.

Cris also has a Masters in Animal Therapy and finds that her knowledge of human and animal physiotherapy is very valuable when caring for animals, both their own and those of others. Her physiotherapy practice even boasts the slogan "for two legs and four", and is a "comprehensive physiotherapy service for all aspects of musculo-skeletal and neurological problems in both humans and animals". Performance, working animals and even pets often require treatment, just like humans. Injured animals also benefit enormously from specialised knowledge about the best methods of physical rehabilitation.

When Cris and Ross bought the property, it came with a grove of about 300 mango trees already planted. They are not planning to be commercial orchardists, but they are very keen to nurture the plants and make sure they are healthy and bear fruit. This has involved learning about irrigation and fertilising, and Cris has used the expertise of other local mango growers to help with advice.

The Babbage girls after a horse ride.

Family horse amongst the orchards.

"Overall, I am not intending to use these mangoes as a source of income but an excuse for a good mango party and maybe for the kids to make some pocket money," Cris said.

Cris has several friends with small blocks around the Geraldton area, many of whom also have an interest in horses, and she finds that sharing experiences and ideas with them can be very helpful.

She would be very interested in being part of a network of small landholders to share information and knowledge and learn from each other's mistakes and triumphs. Being new to managing a block she has found that there are many challenges. "Finding enough time is probably one of the biggest problems, but learning how to control vermin such as rabbits, cats and foxes, as well as weeds, have been big issues. We are fortunate to have a very knowledgeable and helpful neighbour, who has helped us to develop a management plan, which I feel is essential," she said.

In 2012 Cris was part of a focus group on Small Landholders with the Northern Agricultural Catchments Council (NACC). She is really keen for a group like NACC to help local small landholders by providing information, coordinating workshops, and facilitating a community network. Most of all she just wants to be able to have enough time to enjoy the block with her family.

CASE STUDY

MORESBY HAVEN GERALDTON

NORTHAMPTON

Dan and Coral Clarke and their four children live on a two hectare block in the Moresby, hills behind Geraldton. They previously lived in the Northern Territory but came to the region for Dan's previous job as the Principal of Strathalbyn Christian College. He now works part time four days a week at the College as a sustainability educator with both primary and secondary students. Part time work provides the mental and physical space to do some of the activities which accompany any garden or land.

Dan says that he and Coral both care about the art of living, saying that many of society's obsessions with accumulating more stuff and being busy is not where they are at. In a globalised world where actions and transactions have a moral ripple far beyond the front gate, they try to live in a manner which is authentically rooted in their Christian faith. This also compels Dan and his family to have a deep connection with ecology, justice, health and community.

Dan is very interested in permaculture, organic farming and sustainable living. Having his own property gives him the opportunity to put his ideas into practice. He also soaks up the knowledge from anyone else he can find. One local treasure has been Julie Firth of the Drylands Permaculture Nursery. Together with Julie, Dan has developed a *Vegetable Planting Guide* which you can find in the Vegetable Growing chapter of this *Guide*.

With Coral's passion for cooking healthy food, super-fresh vegetables are a great plus. They have a large garden, and grow a wide range of vegetables. Dan says that in Geraldton the biggest issues are wind, temperature and soil. To limit the harsh wind, the vegie garden sits alongside the house, shed, and water tank and a recycled fence also provides protection. Inverted roof trusses covered with shade cloth keep the sun's heat off the soil during the growing season and irrigation using brown dripper hose is used to reduce evaporation losses. Dan likes to hand water so that he can get to know the plants better but timers ensure there is consistent watering when other things in life intrude on watering times.

Micah, Coral and Abigail in their corn.

The soil is mostly non-wetting sand, but it has been built up with a variety of organic materials such as straw, chicken manure and lots of free horse manure (from the local race track) and is now quite productive.

The garden should be a pleasing place to be. If the garden is too far away, or not in your daily routine then it easily becomes neglected. Dan's garden is literally 'just out the door'. However even with his passion, he says there are times when the business of life simply means the garden gets neglected.

Inspiring ideas

- Build a sustainable lifestyle at home – grow your own vegies, eggs and other produce.
- Enjoy the haven of a family retreat and the pleasure of having your horses and other animals close by.
- Revel in the challenge of making your dreams come true on your own block.
- Follow your words with actions. As a teacher of sustainability, Dan loves putting his lessons into practice.

Human ploughing technique.

The children each spend at least an hour a week in the garden. Often this is a wonderful family time where everyone works at a communal task. This sense of community, of sharedness, and of connection is important and is linked to a common vision and having a role to play.

The family enjoy being able to have fresh eggs every day, but their chooks not only produce eggs – there is a mutually beneficial arrangement between the chooks and the garden. The task of weeding is made much simpler by fencing off sections of the garden and allowing the chooks to roam freely: scratching, weeding and fertilising. During summer they have free range of most of the garden, and both garden beds, and chooks benefit. The family started with some Isa Brown hens and have since added a few lovely Indian Runner ducks. The little ducklings and chickens are loved by all the family. Coral looks after the sitting ducks and chooks and has an array of cages and spaces to house them.

The family also has two horses. Growing up with horses in Victoria, Coral wanted to be able to share the joy of riding with the children, but she finds the extremely sandy conditions provide some new challenges. "Colic (from eating sand) and keeping the soil from becoming bare weren't things we had to worry about over east," Coral said. Dan has some reservations about the environmental footprint of horses, he finds providing appropriate pasture and sufficient cover on the soil challenging. However, he is happy to support the family with their own passions. They have recently fenced four separate paddocks to enable easy rotation of the horses, allowing regrowth and pasture care.

Dan and Coral have found owning their own property in the harsh climate of WA especially challenging. Dan says while the wind, heat, poor soil, and increasing numbers of rabbits and weeds are all big challenges, he still loves it. "Most challenging is having the time, the machinery, and the knowledge to make our dreams for this little sandy block come true," he said.

Dan sometimes gets frustrated that things take so long to complete and that they haven't done more. One of the issues is knowing how to develop a good property plan and he is disappointed he has not been able to source assistance with this. Dan believes there is a lot of potential to share information, tools and knowledge with others with similar issues and interests.

Like many other small property owners, he is interested in the idea of developing a "Small Farmer Network" and is hopeful that the Northern Agricultural Catchments Council and their friendly staff might be able to assist with this.

Veggie garden.

Dan and Coral know they are amazingly privileged and feel both the immense joy and responsibility of caring for some land. Although the different demands of work, family and community mean that life is sometimes hectic, Dan is encouraged by the many local people who are doing amazing things with their little bits of land. He believes environmental stewardship and an urge to reconnect with the fundamental things of life are becoming more important to more people and that's a great thing.

Abigail, Marley the horse, and Coral.

CASE STUDY

MOOLIABEENIE HORTICULTURE

EAST GINGIN

Tony and Jenny Maddern have a long experience with horticulture production, especially tropical fruits, and many stories to tell about previous exploits. For several years they enjoyed a New Guinea adventure together while Tony managed plantations and Jenny worked at Government House, coping with a wide range of tasks including entertaining visiting dignitaries. The couple then lived in Katherine in the Northern Territory where Tony had a technical role with the Government research station. However, Tony and Jenny have always maintained close links with Western Australia, and in 2005 they moved here to work with the local company Westralian Fruits. They now also have their own horticulture venture on a 60ha farm to the east of Gingin. Although it can sometimes mean long hours in the orchards for both of them, they enjoy working on this project together.

Mangoes and avocados are the main crops. The combination works well as the fruiting seasons are at different times of the year, making managing harvest much easier. In this region mangoes are picked in February / March and avocados for a longer period, with the peak in September / October.

Left: Tony Maddern.
Right: Bounty from the olive oil harvest.

Recently 500 navel oranges and 150 passionfruit have been added to the venture. The citrus and passionfruit harvests will be in the middle of the year at a time less critical for mangoes and avocados.

Commercial production means many boxes of fruit – a wonderful bonus for friends and family – but sometimes challenging in relation to picking, packing and marketing. Their best turn out so far has been 15,000 trays of mangoes and 7,000 trays of avocadoes. They usually use a local labour hire company to help provide pickers during harvest season, but most of the year they do it all themselves. Tony says it's hard work sometimes. "But it is very rewarding to produce our own fruit. It's a good feeling to see the trays of fruit on the truck and later in the supermarket," Tony said.

Marketing is a challenge for horticulturalists. While there is now a lot of interest in farmers markets, they mainly cater for small producers. Anyone with a lot of fruit, like Jenny and Tony, will usually deliver to the central market in Perth. Requirements for fruit quality and size and tray presentation are very demanding. Most products also require post-harvest ripening, and it is critical that this is done appropriately to prevent spoilage. Tony is always on the front foot working with the wholesalers to make sure that product is marketed in the very best condition.

Inspiring ideas

- Horticulture can be demanding, but it's very satisfying to grow your own produce.
- Marketing is as challenging as growing.
- Sharing experiences with other growers is very helpful.
- Nothing beats hard work and persistence!
- Working on projects together is rewarding in lots of ways.
- The peace and independence of rural life bring special benefits.

There are many production challenges, and Tony and Jenny have found that a great way to learn is to share ideas and experiences with other growers. They are active members of several production groups, and Tony is President of the Southern Mango Growers Group (SMANGO). They also both work at Westralian Fruits on irrigation management and are experts on all manner of issues related to pipes, pumps, sprinklers, quality and flow. Irrigation is a critical issue for fruit growers, avocados in particular use a lot of water. Fortunately the Gingin area has good underground water and Jenny and Tony have a water licence that they are careful to use very responsibly.

Jenny and Tony are both keen gardeners and have developed a beautiful oasis of plants around their farmhouse. As well as many different flowering plants, both native and exotic, they also grow a wide range of vegetables and other fruit. Jenny is a wonderful cook and produces many interesting pickles, jams and other luscious things. The couple's Olive Grove provides the raw ingredients needed to produce a wonderful range of oil and pickled olives. Each year they generously share this produce with friends and family.

Jenny comes from a family of sheep farmers and her brother, who is a merino breeder near Broomehill, recently gave her a small flock of sheep. The sheep are intended to be used for weed control however the couple are also looking forward to eating their own lamb. Currently a very cooperative arrangement with a neighbour allows them to share the running of sheep flocks. Due to the hassle of mulesing, crutching and shearing Jenny and Tony are thinking of using an 'easy care' breed of ram in the future in order to develop a flock with fewer time demands.

Many rural people like the sense of community, and also the relative tranquillity, that country living brings. Jenny and Tony are no exception. Perth is only an hour drive from the farm and while they are often there for short times for business or family reasons it is always pleasing to be home. They have a wide circle of friends and family and enjoy entertaining them or sharing the company of other local producers. Jenny is very artistic and loves to work with fabrics, ceramics, various crafts, even felting. She has been involved in many art and craft courses over the years, in Moora, Gingin and Perth, and thoroughly enjoys the change of pace that this brings, as well as the creative buzz. Among other community activities Tony is very involved with the local Fire Brigade and is a Fire Control Officer for their district. The couple are not just producers but also part of the rhythm of rural life.

Hosting a mango growers meeting.

INFORMATION

REFERENCES

In each of the chapters in this *Guide* we have included a box labelled Follow Up. All the references in those boxes are repeated below. In addition there are a few other references here that we didn't have space for earlier. The references have been grouped under the heading of each section, although note they will frequently apply to more than one of the sections. The references are not in alphabetical order.

There is a lot of information available on the web if you search on key words. For DAFWA farmnotes search on "farmnote xx/xxxx" (eg farmnote 61/2005) to access digital copies.

SOILS

- *Soil Guide: A handbook for understanding and managing agricultural soils* (DAFWA, compiled and edited by Geoff Moore). Originally released in hardcopy as Bulletin 4343, dated 2004.
- *My Soil*: *A diagnostic tool designed to improve identification of soil types* (DAFWA). This is an online resource which summarises thousands of soils into 15 broad soil types, and takes you through a simple step by step process to help with identification. There is also a video clip to explain the process.
- *Soil acidity: A guide for WA farmers and Consultants*, by Chris Gazey and Stephen Davies. DAFWA Bulletin 4784, 2009.
- *Soil Matters: managing erosion on your property*, DAFWA noteworthy 11, 2009. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Australian Soil Fertility Manual*, Fertiliser Industry Association of Australia, 2003. Published by CSIRO. This is a manual on the safe use and handling of fertilisers. It can be purchased from many outlets. See www.publish.csiro.au/pid/5338.htm.
- *Soil and Land Survey Field Handbook*, National Committee on Soil and Terrain, 2009. Published by CSIRO. This specifies methods and terminology for soil and land surveys. It can be purchased from several outlets. See www.publish.csiro.au/pid/5230.htm.
- *Soil Testing – accurate samples yield better results*, noteworthy 9, 2008. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Soil Matters – managing erosion on your property*, noteworthy 11, 2009. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Soil Textural Triangle:* McDonald, RC, Isbell, RF, Speight, JF, Walker, J and Hopkins, MS, Australian Soli and Land Survey: Field handbook, 2nd Ed, 1990, Inkata Press, Melbourne.
- *Soil pH ranges:* 'Glendinning, 2003. Australian Soli Fertility Manual. Collingwood: CSIRO, 2003.
- *Soil Erosion (susceptibility rating table):* Moore, G.2004. Soil Guide - A handbook for understanding and managing agricultural soils. Bulletin 4343. DAFWA, 2004, South Perth.

WATER

- *AgGuide, A Practical Handbook: Farm Water,* by Jennifer Laffan, NSW Dept. of Primary Industries. This book is for anyone who wants the best from their water supplies in a rural area. It gives an introduction to the technical problems involved in domestic and livestock water supplies, but is written in non-technical language. To purchase go to www.smallfarms.net/xcart/home.php?cat=283.
- *Water Quality Critical for Livestock*, noteworthy 7, 2008. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- A good explanation of salinity and EC, and comparisons with Total Dissolved Solids is given on the Apps Laboratory website. See www.appslabs.com.au/salinity.htm.
- *Water Supplies for the Small Rural Holding*, noteworthy 19, 2009. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Water, Sufficient Summer Supplies Saves Lives*, noteworthy 8, 2008. See www.agric.wa.gov.au under Small Landholder Information Service.
- *Calculating Dam Capacity*, noteworthy 47, 2011. See www.agric.wa.gov.au under Small Landholder Information Service.
- *Waterwise irrigation big benefits for small properties,* noteworthy 41, 2011. See www.agric.wa.gov.au under Small Landholder Information Service.
- *Rural Land uses and water quality*, a community resource document, developed by the Agricultural and Resource Management Council of Australia and New Zealand 2000. See www.environment.gov.au/water/publications/quality/pubs/rural-land-uses-paper9.pdf.
- *Irrigation water quality-salinity and soil structure stability*, Qld Department of Enviroment and Resource Management, 2009. See www.derm.qld.gov.au/factsheets/pdf/water/w55.pdf.
- *Irrigation Insights*. This is a series of notes on a range of sustainable irrigation topics. They can be accessed from the old Land and Water Australia website. See http://lwa.gov.au/taxonomy/term/6309.
- *Saving Water in your Garden*, WA Department of Water. See www.watercorporation.com.au/w/waterwise_gardens.cfm.

LIVESTOCK

- *Pasture Assessment and Livestock Production,* NSW Department of Primary Industry, Prime fact 323, 2006. See www.dpi.nsw.gov.au/agriculture/emergency/drought/planning/strategies/audit/pasture-assessment-livestock-production.
- *The ruminant digestive system*, University of Waikato. 2011. See http://sci.waikato.ac.nz/farm/content/animalstructure.html#ruminant_digestive_system.
- *Grazing weaner sheep on phomopsis resistant lupin stubbles*, by Keith Croker et al, DAFWA Farmnote 61/2005.
- *Photosensitization in sheep grazing Biserrula*, DAFWA Agnote 396, Jan 2010.
- *Annual Ryegrass Toxicity-current situation*, Kessell, David. DAFWA Farmnote 417/2010.
- *Animal Health Welfare and Biosecurity*, Meat and Livestock Australia. See www.mla.com.au/Livestock-production/Animal-health-welfare-and-biosecurity.
- *Feeding and Managing Sheep in Dry Times*, Bulletin 4697, DAFWA 2006. See www.ruralrdc.com.au/WMS/Upload/Resources/FeedManSheep06.pdf.
- *Supplementary Feeding, keeping livestock healthy during summer*, noteworthy 10, 2008. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Livestock husbandry for love and money* noteworthy 18, 2009. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Livestock identification and movement: sheep and goats,* DAFWA Farmnote 519 / 2012 (replaces Farmnote 223).
- *Owning Livestock: brands identification and movement*, noteworthy 13, 2009. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Horse digestive system*. All About Feed website, 2010. See www.allaboutfeed.net/.
- *Drought feeding & Management for Horses,* by David Nash, 1999. Rural industries Research and Development Corporation. See http://questequinewelfare.org/attachments/article/53/Drought%20Feeding%20and%20Management%20for%20Horses.pdf.
- *Colic Fact Sheet*. See www.ed.ac.uk/polopoly_fs/1.18068!/fileManager/dvepfactsheet-colic.pdf.
- *Equine Laminitis: Current Concepts*, by Chris Pollitt. A RIRDC publication. See https://rirdc.infoservices.com.au/downloads/08-062.
- *Laminitis and Founder in horses*. Recovery EQ website, 2011. See www.recoveryeq.com.
- *Equine Nutrition in the 21st Century*. All About Feed website. See www.allaboutfeed.net/Nutrition/Diet-Formulation/2010/8/Equine-nutrition-in-the-21st-century-AAF011661W/.
- *Sheep 201: Sheep Diseases A-Z A Beginners Guide to Raising Sheep*. See www.sheep101.info/201/diseasesa-z.html.
- *Cattle ownership is a serious step*, noteworthy 5, 2009. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Horse keeping on small properties*, noteworthy 31, 2010. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Rural: A Handbook for Small Landholders*, Bernie Webb. This is a WA publication that has some excellent practical information on fencing, as well as many other topics. See www.redgumrural.com.au.
- Commercial Fencing Information. See www.gallagher.com.au/what-is-electric-fencing.aspx.
- Commercial Lick Feeder information:
  - Advantage Feeders. See www.advantagefeeders.com.au/.
  - Universal Feeders. See www.universalfeeders.com.au/universal-feeders/.
  - EZEfeeder. See www.ezefeeder.com.au/.

PLANTS, PRODUCE AND PASTURE

- *Your guide to Perennial Grasses in the Northern Agricultural Region*. Minginew Irwin Group (MIG), 2007.
- *Perennial Pastures for Western Australia*, Geoff Moore Paul Sanford and Tim Wiley. DAFWA Bulletin 4690.
- *Characteristics of Perennial Grasses*, Trevor Lacey and Geoff Moore, DAFWA, 2007.
- *Annual Ryegrass Toxicity-current Situation*. Kessell, David. DAFWA Farmnote 417/2010.
- *Cefalu arrow leaf clover,* by Richard Snowball et.al. DAFWA Farmnote 38/2005.
- *Frontier* – an early maturing balansa clover for the wheatbelt, Clinton Revell et.al. DAFWA Farmnote 3/2001.
- *Urana* – a hardseeded subterranean clover with excellent winter vigour, Phil Nichols & Martin Barbetti. DAFWA Farmnote 31/2005.
- *Izmir* – a new subterranean clover for low rainfall cropping situations, by Phil Nichols & Brad Nutt DAFWA Farmnote 114/2006.
- *Fodder,* by Roy Butler and John Milton. In the *Good Food Guide for Sheep*, DAFWA Bulletin 4473, 2001.
- *Saltland Pastures,* by Ed Barrett Lennard and Geoff Moore. In *Perennial Pastures for Western Australia*, DAFWA Bulletin 4690. See above.
- *Perennial fodder shrubs providing profitable and sustainable grazing*. Key practical findings from the Enrich project, Dean Revell, CSIRO and Future Farm Industries CRC . Search on "Enrich" at www.futurefarmonline.com.au.
- *Lucerne*, by Christopher Loo, Perry Dolling, and Soheila Mokhtari in *Perennial Pastures for Western Australia*, DAFWA Bulletin 4690.
- *Pastures ready ... set ... grow!* noteworthy 12, 2009. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Productive Pasture Management,* noteworthy 34, 2010. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Crop Insects: The Ute Guide*, Western Grain Belt Edition. Compiled by Rob Emery, Peter Mangano and Phil Michael, DAFA & GRDC, March 2005. See www.grdc.com.au/Resources/~/media/A977F9C82D6D40198F115324C58053F6.pdf. Catalogue no. GRDC 209.

FOOD CROPS

- Australian Farmers Markets. See www.farmersmarkets.org.au/markets.
- *Native Foods, New Crop Industries Handbook,* RIRDC. See https://rirdc.infoservices.com.au/items/08-021.
- *Going Organic: what you need to know,* noteworthy 29, 2010. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.

DECLARED PLANTS

- Biosecurity and Agriculture Management Act 2007 (www.biosecurity.wa.gov.au)
- Declared Plants list can be found in DAFWA website www.agric.wa.gov.au .
- *Western Weeds: A guide to the weeds of Western Australia,* by B.M.J. Hussey et al.
- Weeds in Australia website. See www.environment.gov.au/biodiversity/invasive/weeds/.
- Weeds Australia website. See www.weeds.org.au.

REVEGETATION & REMNANT VEGETATION

- *The Value and Benefits of Healthy Farm Bush*, by Colin Holt, DAFWA Farmnote 141/2000.
- *Vegetation Buffer Zones*, by Mark Ocktman and Colin Holt, DAFWA Farmnote 38/2000.
- *Weed Control for Successful Revegetation*, DAFWA Farmnote 47/98.
- *Trees suitable for soil types,* by Pat Ryan, D.G.Wilcox, E.C.Lefroy, T.C.Stoneman, N.R.Schoknecht and E.A.Griffin. *Trees and Shrubs for the Midlands and Northern Wheatbelt*, 1996.
- Florabase website. See www.florabase.dec.wa.gov.au/.
- *Biodiversity Summary for NRM Region, Northern Agricultural, Western Australia*. See www.environment.gov.au/heritage/anhat/summaries/wa/pubs/summary-wa-northern-agricultural.pdf.
- *Site assessment for successful revegetation: for agricultural regions with less than 600 mm rainfall,* by David Bicknell, Avril Baxter and Ryan Denham, DAFWA Farmnote 36/98.
- *Site preparation for successful revegetation: for agricultural areas with less than 600 mm rainfall,* by David Bicknell, Avril Baxter and Ryan Denham, DAFWA Farmnote 37/98.
- *Collecting Native Seed,* by Barbara Jennings, DAWA Farmnote 44/1992 (reviewed 2005).
- Oil Mallee Australia website. See www.oilmallee.org.au/.
- Revegetation Association of WA website (RIAWA). See www.riawa.com.au/wordpress/
- *Revegetation Planting Standards: Guidelines for establishing native vegetation for net gain accounting,* Victorian Department of Sustainability and Environment (2006).
- See www.dse.vic.gov.au/__data/assets/pdf_file/0005/97349/NativeVeg_Reveg.pdf.
- Land for Wildlife scheme in WA. See www.dec.wa.gov.au/management-and-protection/conservation-on-other-lands/land-for-wildlife.html or contact Fiona Falconer (Coorow) fiona.falconer@dec.wa.gov.au.
- Bibliography of books on WA flora, Wildflower Society of Western Australia. See http://members.ozemail.com.au/~wildflowers/ebooks-sorted.html#Native%20plants%20in%20gardens.

NATIVE GARDENS

- *Waterwise Plants for the Central West*, Water Corporation of WA. See www.watercorporation.com.au/w/waterwise_plants_central_west.cfm.
- Native plant fact sheets and case studies. See www.abc.net.au/gardening/factsheets/native.htm.
- *Coastal Native Garden Guide,* Northern Agricultural Catchment Council (NACC).
- *Inland Native Garden Guide,* Northern Agricultural Catchment Council (NACC).
- Wildflower Society of WA, bibliography of books on WA wildflowers. See http://members.ozemail.com.au/~wildflowers/ebooks-sorted.html#Native%20plants%20in%20gardens.
- *What to Grow,* Wildflower Society of WA. See http://members.ozemail.com.au/~wildflowers/draftlist.htm.

LOCAL NATIVE PLANT NURSERIES

- Greenoil Nursery, Midlands Rd, MINGENEW, WA 6522 (08) 9928 1470 (Ian Pulbrook).
- Kalannie Tree Supplies, Lot 50 Pithara East Road, KALANNIE, WA 6468 (08) 9666 2131 (Angela Waters).
- Muchea Tree Farm, Lot 214 Archibald Street, MUCHEA, WA 6501 (specialise in natives) 08 9571 4090 www.mucheatreefarm.com.au/.
- The Drylands Permaculture Nursery, 333 David Rd Waggrakine, GERALDTON, WA 6530 (natives and exotics) 08 9938 1628 www.permaculturenursery.com.au/ (Julie Firth).
- Wongan Trees, 6 Avon Road, WONGAN HILLS, WA 6603 (08) 9671 1979 (Denis and Ellen Mitchell).
- Yetna Tree Farm, Yetna Springs Chapman Valley Rd, GERALDTON, WA, 6530 (08) 9923 3827.

WATERWAYS

- *Managing our rivers: a guide to the nature and management of the streams of south-west Western Australia,* by Luke Pen, 1999 (editor, June Hutchison) Water and Rivers Commission of WA.
- *Revegetation: Revegetating riparian zones in south-west Western Australia,* Water and Rivers Commission August 1999 Report No. RR 4.
- *Water Notes*, Department of Water. These are a wide range of fact sheets on rivers and wetlands, some of the more useful ones are:
    - *Wetland vegetation.*
    - *Livestock management: Fence control and grazing control.*
    - *The values of the riparian zone.*
    - *Identifying the riparian zone.*
    - *Protecting riparian vegetation.*
    - *Livestock management: Watering points and pumps.*
    - *River and estuary landscape appreciation and protection.*
    - *Sediment in streams.*
    - *Weeds in waterways.*
    - *Herbicide use in wetlands.*
    - *Monitoring and evaluating river restoration works.*
    - *Wetlands and weeds.*
    - *Wetlands and fire.*
    - *Wetlands as water bird habitat.*
    - *The ecology of wheatbelt lakes.*

PDF versions are available at www.water.wa.gov.au/Managing+water/Rivers+and+estuaries/Restoring/Water+notes/default.aspx.

- Rivers of Western Australia. See www.rowa.org.au/. This has some simplified information on how rivers work, including an illustration and some descriptions of the Hutt River system near Northampton.
- River Landscapes publications, Land and Water Australia. On the old lwa website (the organisation has been disbanded) there is still access to a wide range of publications including information on river systems. For example, if you search on Rip Rap you will find a series of *Rip Rap* magazines with a wide range of articles on waterway management. See http://lwa.gov.au/products/list/3364.

PLANNING & BUSINESS

- *Finding the right advice,* noteworthy 15, 2009. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Got a small property? You need a property plan!* noteworthy 24, 2010. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *What to consider when leasing,* noteworthy 40, 2011. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Business Planning: being successful is not about luck,* noteworthy 48, 2012. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *The Land is in Your Hands: A practical guide for owners of Small Rural Landholdings in Western Australia*. See www.agric.wa.gov.au. There is also a copy of this booklet in this guide.
- *Tips for Purchasing Small Rural Landholdings*, DAFWA, June 2011.

PRACTICAL TASKS

- *Spray Safe, Stay Safe*, noteworthy 1, 2008. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *First time fencing unravelled*, noteworthy 2, 2008. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Chainsaws for the small landholder,* noteworthy 4, 2008. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- *Be fire smart this summer,* noteworthy 20, 2009. See www.agric.wa.gov.au under Small Landholder Information Service. There is also a copy of this *Note* in this *Guide*.
- Other Publications from the DAFWA Small Landholder Information Service (SLIS). For the full list of publications produced by SLIS, contact your local DAWFA office.

GENERAL

- *Rural: A Handbook for Small Landholders*, Bernie Webb. This is a WA publication especially designed for the small landholder, by someone who has lived through it. It is easy to read, is well laid out, and has some excellent practical information on a wide range of topics. You can purchase it locally or online. See www.redgumrural.com.au.

GLOSSARY & ACRONYMS

As much as possible in this *Guide* we have tried to avoid using acronyms, although we have regularly used NACC (Northern Agricultural Catchments Council), DAFWA (Department of Agriculture and Food, Western Australia) and DEC (WA Department of Environment and Conservation). Unfortunately acronyms are inevitable. Below is a list of common abbreviations. Not all of them have been used in writing this *Guide*, but you may come across them.

ACRONYMS, PARTICULARLY OF ORGANISATIONS

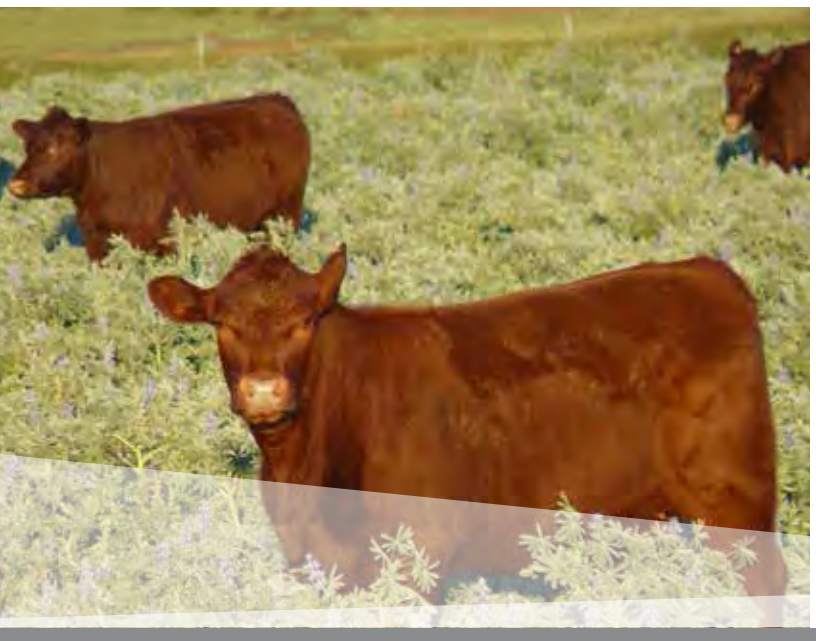
- CSIRO Commonwealth Scientific and Industrial Research Organisation
- DAFWA Department of Agriculture and Food, Western Australia
- DEC WA Department of Environment and Conservation
- GRDC Grains Research and Development Corporation
- LWA Land and Water Australia (a federal organisation which has now been disbanded)
- MIG Mingenew Irwin Group
- MCC Moore Catchment Council
- NACC Northern Agricultural Catchments Council
- NAR Northern Agricultural Region
- NRM Natural Resource Management
- RIRDC Rural Industries Research and Development Corporation
- WA Western Australia
- WMG West Midlands Group
- YYCMG Yarra Yarra Catchment Management Group

TECHNICAL TERMS

- ARGT Annual ryegrass toxicity
- CP Crude protein
- DM Dry matter kg/DM/ha = kilograms of dry matter per hectare
- DSE Dry Sheep Equivalents
- FOO Food on offer (used to assess pasture)
- g gram kg = kilogram
- l litre l/hd/day = litres per head per day
- ME Metabolisable energy (energy is measures in MJ – megajoules)
- mg/l milligram per litre
- mS/m millisiemens per metre – a measure of water quality / conductivity / salinity (may also be expressed as ppm (parts per million) or gr/gal (grains per gallon)
- pH A measure of acidity
- ppm parts per million
- TDS total dissolved solids

CONTACT US

P (08) 9938 0100
F (08) 9938 0166
A 201 Lester Avenue, Geraldton WA 6530
P PO Box 7168, Geraldton WA 6531
E nacc@nacc.com.au
www.nacc.com.au



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