Trees and shrubs for fodder

Introduction

Trees and shrubs can supplement the quantity and quality of pastures for grazing livestock. They are an effective insurance against seasonal feed shortages or the risk of drought.

Fodder or browse production from trees and shrubs is one of the benefits of agroforestry. Fodder agroforestry systems can be designed to deliver additional benefits such as shelter, soil conservation, rough timber and habitat.

The first step in designing a fodder agroforestry system is to clearly determine your farming objectives. Figure 25 identifies various options for fodder agroforestry available to you.

Objectives

The following questions may help you decide your fodder agroforestry system objectives.

- Do you have a fodder shortage at a particular time of year? How long does this period last? How often do you expect an atypical shortfall in a ten year period?
- Is the problem due to annual variability of supply because of seasonal drought such as in a climate with wet winters and dry summers?
- Is your fodder shortage due to the quantity of feed, or its quality?
- Is it sufficient to just maintain your animals during the period of shortage, or are you expecting them to grow or gain weight?
- Is your aim to save money through your fodder project?

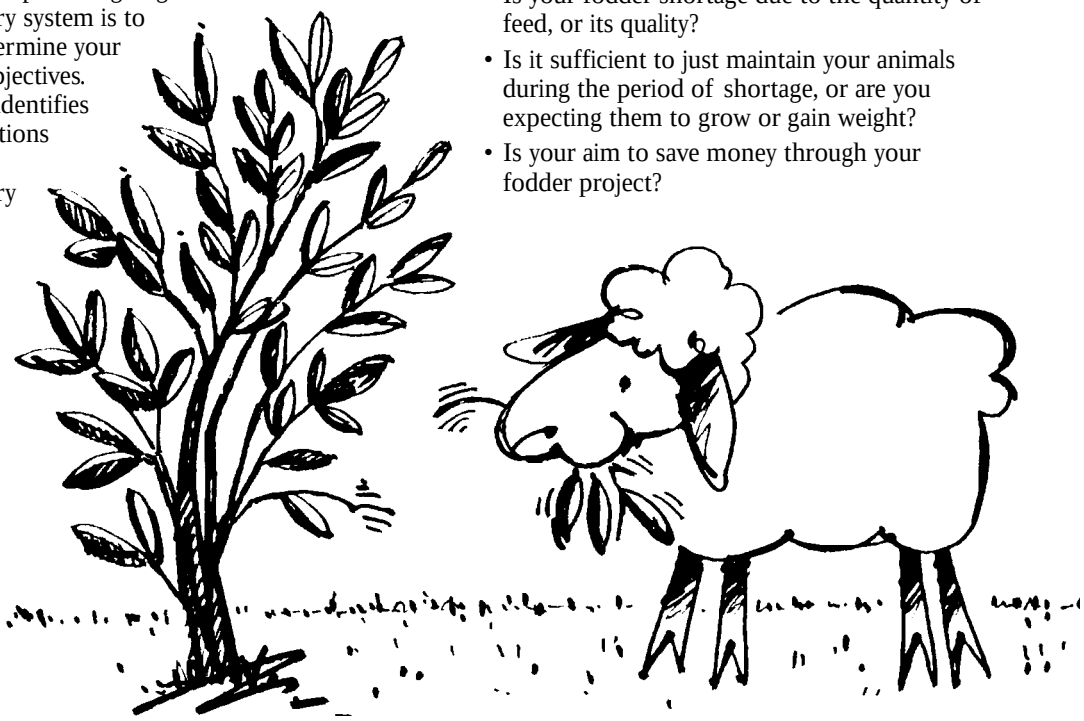
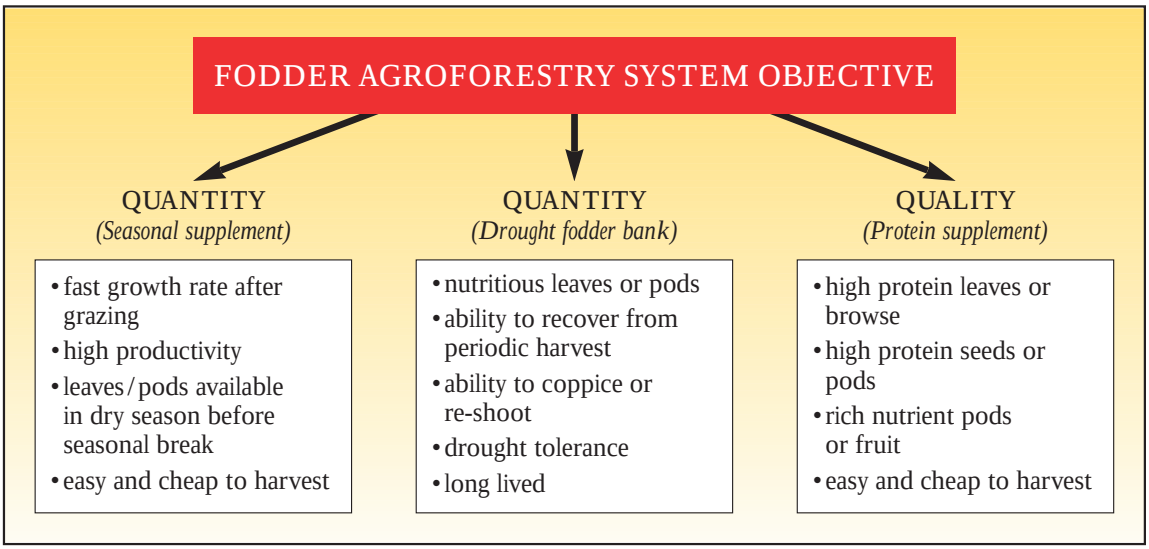


Figure 25:
Fodder agroforestry options



- Are you expecting the fodder agroforestry system to increase the quantity of feed available to livestock?
- Are you expecting the fodder agroforestry system to increase the quality of feed available to livestock?

Design principles

Design principles are rules of thumb to help guide you through the many choices that can be made as you design your fodder agroforestry system. These principles help to guide your decisions about:

- quantity and quality of forage production;
- consumption, nutrition and animal production;
- layout of plantings;
- what species of trees and shrubs to plant;
- the costs and benefits of alternative fodder agroforestry options; and
- additional benefits because of interactions with other activities.

It is worth remembering that some fodder trees or shrubs can suppress pasture growth, although there are others which will stimulate pastures. The quality of fodder produced by trees and shrubs is usually different from that of pasture feed.

You may need to take the change in the seasonal distribution of fodder quality into account.

For example, by planting fodder shrubs you may be replacing some of the output of high quality spring feed with a supply of higher quality summer feed. This could have implications for stocking rates or stock management.

Potential of fodder agroforestry systems

Figure 26 shows typical seasonal feed production by annual pastures, perennial pastures, autumn fodder agroforestry crops and summer fodder agroforestry systems.

The aim of planting a fodder agroforestry system is usually to overcome the effects of the troughs or to insure against the risk of drought or fire.

Figure 26 demonstrates the potential for summer and autumn fodder trees and shrubs to balance out the seasonal feed shortages which occur with annual and perennial pastures.

The right fodder trees and shrubs for the job are the ones which produce feed during the troughs or accumulate feed which can be used after a disaster such as drought or fire. Because most trees and shrubs have more extensive root systems than grasses and forage legumes they are able to maintain growth during seasonal dry periods and the early period of droughts.

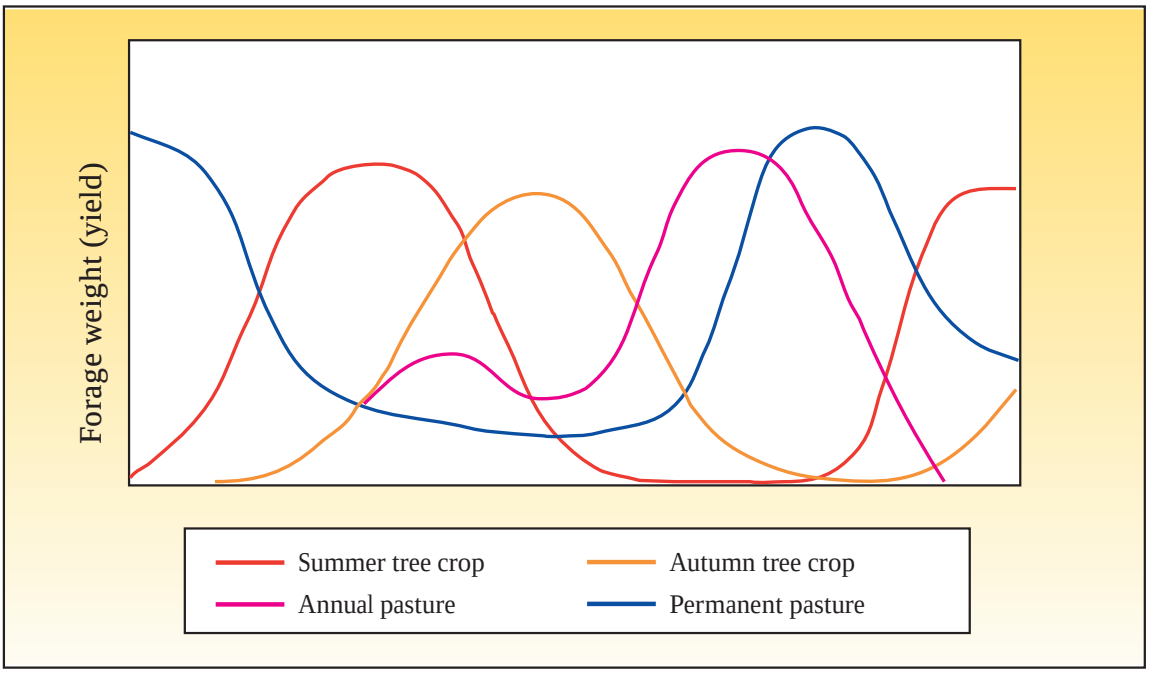
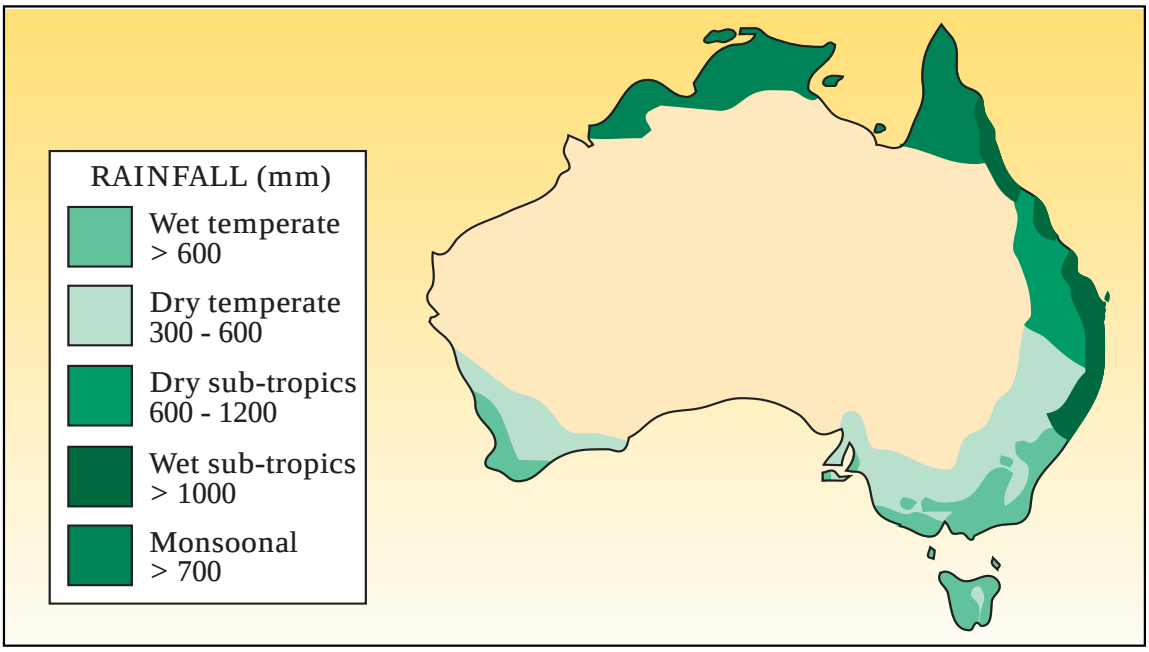


Figure 26: The potential for fodder from various systems

Figure 27: Agroecological zones of Australia



Typical feed problems which can be managed with fodder agroforestry systems in each agroecological zone include:

- Wet temperate zone (>600 mm) – *quality* protein supplements in late autumn just before or after the autumn break to give a boost to pregnant ewes and cows;
- Dry temperate zone (300–600 mm) – *quantity* (seasonal supplement) to provide additional feed during the dry season and *quantity* (drought bank) to provide a long-term feed reserve to maintain stock for the first year of a drought
- Dry sub-tropics (600–1200 mm) – *quality* protein supplements in late autumn just before or after the autumn break to give a boost to pregnant cows and *quantity* (drought bank) to provide a long-term feed reserve to maintain stock for the first year of a drought;
- Wet sub-tropics (>1000 mm) – *quantity* (seasonal supplement) to provide additional feed during the dry season and *quality* protein supplements just before the end of the dry season to give a boost to pregnant cows or finish off live cattle before export; and
- Monsoonal (>700 mm) – *quality* protein supplements just before the end of the dry season to give a boost to pregnant cows or live cattle before export and *quantity* (drought bank) to provide a long-term feed reserve to maintain stock for the first year of a drought.

Based on the principles illustrated in Figures 26 and 27, Table 2 shows some examples of the potential for fodder trees and shrubs to meet the needs of livestock producers.

Agroecological Zone	Fodder Species	Fodder Production	Animal Production
Dry and wet sub-tropics	*Leucaena leucocephala*	Supplies high quality feed April to October when pasture quality is low. Rainfed or irrigated.	Cattle gain 200–300 kg/ha/yr. Under irrigation, gains of 1000 kg/ha/yr have been achieved.
Monsoonal	*Leucaena leucocephala*	Rainfed regrowth estimated at 500 kg/ha/yr edible dry matter in the late dry and 4400 kg/ha/yr in the early wet.	Cattle gains of 5.6 kg/head/day from irrigated fodder.
Dry temperate	Tagasaste *(Chamaecytisus palmensis)*	Needs 500 mm of rain or more to produce a significant forage reserve. Prone to high mortality rates in dry years.	
Dry temperate	Saltbush *(Atriplex, Maireana* species*)*	Supplies summer and autumn shortfall.	Can maintain summer and autumn condition, but best fed in combination with grass or hay due to high salt content.
Dry temperate	Tagasaste *(Chamaecytisus palmensis)*	Supplies autumn and early winter shortfall. Produces 3 t/ha/yr of edible dry matter on 450 mm rainfall, and up to 9 t/ha/yr on 1100 mm. A combination of shrubs and inter-row pasture produces 1 t/ha/yr per 100 mm of rain.	On 450 mm of rain sheep have been maintained at the same or better condition than animals on dry annual pasture with grain supplement. Wool production was better, but quality was inconsistent. Mass gains of 500–600 g/day have been achieved for cattle, but sheep appear to be only maintained.
Dry temperate	Willow (*Salix* species)	200 kg of fresh leaves and fine stems harvested on one occasion from one tree.	Weaners and hoggets fed a sole diet of 0.94 kg/head/day of foliage and stems gained 1.9 kg/head over 6 weeks.
Dry temperate	*Acacia saligna*	Has produced 4 t/ha/yr of edible dry matter.	Digestibility is reported to be low.
Wet temperate	Willow (*Salix* species)		Gains of 43 g/day reported over a six week period for young sheep when willow was the sole feed.
Wet temperate	Tagasaste (*Chamaecytisus palmensis*)	12–17 t/ha/yr of edible dry matter at 100 mm rainfall over 3 years.	Leguminous leaves have high digestible protein content.
Wet temperate	Honey locust (*Gleditsia triachanthos*)	100 kg/tree/yr of leguminous fruit pods reported.	Legume pods drop in autumn prior to seasonal break and provide high energy feed when paddocks are bare.
Dry temperate	Carob (*Ceratonia siliqua*)	100 kg/tree/yr of fruit reported from trees after 10 years in areas with 400–650 mm rainfall.	Legume pods drop in autumn prior to seasonal break and provide high energy feed when paddocks are bare.

Table 2: Examples of fodder production rates and animal responses

The following sections identify species for the three key objectives of fodder agroforestry systems.

Quantity – seasonal supplement

Many regions of Australia experience seasonal dry periods each year when paddock feed stops growing and livestock production relies on dry paddock feed or forage conserved from periods of high pasture growth. Options available to livestock producers for managing seasonal feed shortages include:

- **managing livestock breeding cycles** – sheep and cattle breeding can be managed to coincide with the growing season with weaners being sold early in the dry season;
- **managing livestock stocking rates** – the number of sheep or cattle carried can be managed so that there is enough standing paddock feed at the beginning of the dry season to maintain stock until the next growing season;
- **feeding conserved forage** – paddock feed harvested during the peak growing season as hay or silage can be fed to livestock during the dry period;
- **seasonal agistment** – livestock can be agisted off the property during seasonal dry periods; and
- **use of fodder trees and shrubs** – fodder trees and shrubs are less affected by seasonal dry conditions because of their more extensive root systems and longer life-span.

Conventional techniques for management of seasonal dry periods often result in regional peaks and troughs in the number and class of livestock being sold. This often depresses prices and means that conventional but sustainable management may not lead to the best returns.

Using conserved feed or fodder agroforestry systems to maintain stock during seasonal dry periods increases the marketing and management choices available to livestock producers.

Table 3 gives examples of tree and shrub species which can provide seasonal supplement fodder for each agroecological zone.

Quantity – drought fodder bank

Drought is a risk which needs to be managed by all livestock producers. The extent of the risk and the amount of effort which is sensible for managing drought varies with location. Options available to livestock producers for hedging against the risk of drought include:

- **conservation of paddock feed** – storing hay and silage made on the property during good seasons or buying it to maintain breeding stock through a drought;
- **feeding grain** – feeding grain to maintain breeding stock through a drought;
- **agistment** – moving breeding stock to areas not affected by drought to maintain breeding stock through a drought; and
- **growing drought fodder banks** – establishing blocks of fodder trees and shrubs, perhaps as shelter belts or erosion control plantings, which can be selectively harvested during a drought.

Fodder from any one tree and shrub species in isolation is unlikely to contain sufficient energy, protein and nutrients to meet the maintenance needs of livestock.

A mixture of fodder trees and shrubs is more likely to provide an effective drought bank.

Mixing leguminous trees such as acacias, tagasaste or *Leucaena leucocephala* with other trees such as kurrajongs, sheoaks or willows is likely to provide the best fodder balance.

Table 4 gives examples of seasonal fodder tree and shrub species which are suitable for hedging against the risk of drought for each agroecological zone.

Table 3: Fodder tree and shrub species which can provide seasonal supplement

Agroecological zone	Fodder tree or shrub	Comments
Wet temperate (>600 mm)	Willow *(Salix* species*)*	Fast recovery from harvest
	Poplar *(Populus* species*)*	Less vigorous than willow
Dry temperate (300–600 mm)	Tagasaste *(Chamaecytisus palmensis)*	Requires careful browse management for high production
	Salt bush *(Atriplex* species*)*	May not be easily digested by sheep and cattle
	Mulga *(Acacia aneura)*	Highly palatable
Dry sub-tropics (600–1200 mm)	Kurrajong *(Brachychiton populneum)*	Best harvested on 3–5 year rotation
	Leucaena *(Leucaena leucocephala)*	Marginal in drier areas but effective for finishing store cattle
Wet sub-tropics (>1000 mm)	Leucaena *(Leucaena leucocephala)*	Fast growth rates, may be attacked by sucking insects
Monsoonal (>700 mm)	Sesbania *(Sesbania grandiflora)*	Moderate recovery from cutting or browsing
	Gliricidia *(Gliricidia sepium)*	High digestibility and palatability

Quality – protein supplement

The quality of forage depends on the nutrient and energy content of the feed and its digestibility. Most feed types are not sufficiently digestible or nutritious to meet all an animal's needs in isolation. This is why pastures typically mix legumes such as clover or stylo with grasses such as ryegrass or panic.

During the dry season or southern summer, paddock feed usually has poor digestibility because dry grass is rich in fibre (cellulose and lignin) and poor in sugar and protein. Providing protein and energy supplements helps animals, especially cattle and sheep, make use of dry season pastures. In this way supplements increase the quality of dry pastures.

Protein supplements to improve the quality of dry pastures can be provided in the form of:

- **high protein conserved feed** – such as lucerne hay;
- **manufactured high energy/high protein supplements** – such as urea/molasses licks; or
- **quality fodder banks** – managed as part of a fodder agroforestry system.

Conserved feed and manufactured supplements are expensive and can have hidden costs such as weed seeds in hay or urea poisoning in stock from too much lick. Quality fodder banks, on the other hand, can be established as fodder agroforestry systems with a relatively low cost per unit of protein or extra energy produced.

Agroecological zone	Fodder tree or shrub	Comments
Wet temperate (>600 mm)	Drooping sheoak *(Allocasuarina verticillata)*	Coppices well, moderate growth rate
	Willow *(Salix* species*)*	Fast recovery after harvest
	Poplar *(Populus* species*)*	May sucker
Dry temperate (300–600 mm)	Belah *(Casuarina cristata)*	Moderate growth rate
	Saltbush *(Atriplex* species*)*	Some species have poor digestibility
	Tagasaste *(Chamaecytisus palmensis)*	Highly palatable and digestible
	Mulga *(Acacia aneura)*	Moderate protein
	Whitewood *(Atalaya hemiglauca)*	Palatable but has low digestibility
	Supplejack *(Ventilago viminalis)*	Readily browsed by cattle, good protein
	Kurrajong *(Brachychiton populneum)*	High protein and good digestibility
	Wilga *(Geijera parviflora)*	High available protein
Dry sub-tropics (600–1200 mm)	Mulga *(Acacia aneura)*	Readily browsed by cattle
	Kurrajong *(Brachychiton populneum)*	High protein and good digestibility
	Wilga *(Geijera parviflora)*	High available protein
Wet sub-tropics (>1000 mm)	Leucaena *(Leucaena leucocephala)*	Fast growth rates, may be attacked by sucking insects
Monsoonal (>700 mm)	Sesbania *(Sesbania grandiflora)*	High digestibility and palatability
	Gliricidia *(Gliricidia sepium)*	High digestibility and palatability

Table 4: Fodder tree and shrub species which can provide drought bank

Quality protein supplements are most likely to come from high protein trees and shrubs such as legumes.

These produce:

- high energy and protein seed pods – which normally ripen and fall in late summer or autumn before the break of season when there is typically a shortage of paddock feed and pregnant stock are nearing lambing or calving or starting lactation; or
- high protein leaves – which can be fed or grazed whenever additional protein is needed.

Table 5 gives examples of fodder tree and shrub species useful for quality supplements in each agroecological zone.

Table 5: Fodder tree and shrub species useful for quality supplements

Agroecological zone	Fodder tree or shrub	Comments
Wet temperate (>600 mm)	Tagasaste *(Chamaecytisus palmensis)*	Leaf dry matter is about 24% crude protein
	Honey locust *(Gleditsea triacanthos)*	Pods fall in autumn, 20–30 kg per tree, providing 17% protein, 60% carbohydrate and 7% fat
Dry temperate (300–600 mm)	Tagasaste *(Chamaecytisus palmensis)*	Leaf dry matter is about 24% crude protein
	Carob *(Ceratonia siliqua)*	Pods fall in autumn, 20–50 kg per tree, providing 5% protein, 70% carbohydrate and 3% fat
	Acacia saligna	Leaf dry matter is about 15% crude protein
Dry sub-tropics (600–1200 mm)	Gliricidia *(Gliricidia sepium)*	High digestibility and palatability
	Leucaena *(Leucaena leucocephala)*	Moderate growth rates in areas with 800–1200 mm rainfall
Wet sub-tropics (>1000 mm)	Leucaena *(Leucaena leucocephala)*	Fast growth rates, may be attacked by sucking insects
Monsoonal (>700 mm)	Sesbania *(Sesbania grandiflora)*	High digestibility and palatability
	Gliricidia *(Gliricidia sepium)*	High digestibility and palatability

Designing fodder agroforestry systems

Layout

There are three commonly used layouts for fodder agroforestry systems:

- rows or alleys – where rows of fodder trees and shrubs are planted across a paddock to form alleys for grazing or cropping;
- widely-spaced trees – where individual trees are widely spaced across a paddock to allow cropping or grazing in between the trees; and
- blocks – where a particular paddock or area is fully planted as a fodder reserve.

Your decision will be affected by whether you intend to cut and carry fodder from a protected plantation. You might do this if you are trying to redistribute soil nutrients (see chapter on trees for soil conservation), or if the animals are damaging your fodder plants. This can be time consuming. If animals are to feed directly from the fodder plants, you should also consider the effects of spacing on the efficiency of foraging. You also need to consider access to all sides of each plant.

The most important consideration, though, is the influence of trees on shelter.

Fodder trees can provide shade or shelter for stock and reduce wind erosion. They will affect pasture growth too, sometimes negatively and sometimes positively, depending on species, site and distance from tree. In general, the wider the spacing the greater the amount of grass that will grow between rows. Examples of spacings are presented in Table 6 below. They are not necessarily optimal.

What species or provenance?

Criteria for the selection of species depend on your objectives. Some of the factors you might take into account are presented in Table 7.

Table 6: Examples of spacings of fodder shrubs

Agroecological zone	Species	Spacing used (not necessarily optimum)
Sub-tropics	*Leucaena leucocephala*	Rows 5–10 m apart under rainfed conditions or 2 m apart under irrigation. Sometimes pasture grasses such as panic planted between rows
Dry temperate	Tagasaste *(Chamaecytisus palmensis)*	Rows 5–10 m apart, 1000–2000 stems per ha
Dry temperate	*Acacia saligna*	Rows 10 m apart
Wet temperate	Poplar *(Populus deltoides)*	300 stems per ha

Financial benefits and costs

The calculation of financial benefits and costs is discussed in detail in a later chapter. Some financial benefits of trees and shrubs for fodder are:

- the net change in the value of livestock output, remembering that some output is lost because of the suppression of pasture;
- the value of any sales of fodder to other consumers; and
- any other benefits expected (eg salinity control, soil conservation). These other benefits are discussed in the interactions at the end of this chapter.

Cash flow may be an important consideration. You need to estimate the time to first use – there will be no fodder benefits in this period. Calculations should be carried out over the expected life of the project – a convenient time horizon might be the expected life of the fodder plants.

Risk and uncertainty

Fodder trees and shrubs can reduce drought risk. They have access to water from deeper in the soil profile and may be able to obtain water for longer periods than grasses. They can therefore often supply survival feed. The danger of land degradation may be increased if animals do not die during drought, so care must be taken that in the long term providing drought feed is not detrimental to the land.

Financial risk and uncertainty may be reduced because fodder trees and shrubs supply home grown feed, removing the need to purchase during times of high cost. If a surplus is produced it can be sold, further reducing financial risk and uncertainty.

Warning

Australia has a major problem with woody weeds. The attributes of rapid growth and ease of establishment that characterise some fodder plants are also properties of weeds.

Table 7: Considerations in the selection of species

Forage value	Financial benefits and costs	Conservation	Other considerations
Accessibility to livestock Palatability Dry matter digestibility (in vitro) >55% for supplement or maintenance; >70% as main feed or for production Energy, protein and mineral content Toxicity Quantity of annual production Seasonal variations in quality and quantity relative to animals' needs Variability between plants and over time in all these factors Ease of storage	Establishment cost Management cost Time to first use Rotation time Cash flow Complementary and competitive indirect effects Net present value compared with options	Erosion Nutrient cycling Addition of nitrogen and carbon to soil Effect on soil structure Water use for salinity control Effects on microclimate Risk of becoming a weed	Suitability to local climate and land Reliability of information on which I am making my choice. Am I pioneering, and do I want to be? Ease of obtaining planting material Can I provide necessary labour at the right times? Does it fit with existing enterprises? Persistence under browsing Riskiness (fire, disease, pests, climatic change etc)

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Capturing benefits in addition to fodder

Fodder trees can often be economically viable when planted over a considerable percentage of the farm and thus could give significant salinity, waterlogging and soil conservation benefits. With careful design, some shelter and nature conservation benefits could also be captured.

Other benefits to capture	Opportunity	Things to look out for
Wood	Some fodder species in northern Australia also have timber potential	Management for fodder could be in direct conflict with timber production
Salinity and waterlogging	The rooting depth of fodder trees generally exceeds that of pastures giving a positive impact on rising water-tables An alley crop layout for fodder trees gives a wide spacing of trees over the landscape which is a compatible design for salinity management	Not all fodder species are tolerant of waterlogged or saline soils
Soil conservation	Belts of fodder shrubs or an alley crop design are compatible with designs to reduce wind and sheet erosion	Grazing would need to be managed carefully to reduce damage by stock
Shade and shelter	Belts of fodder shrubs or an alley crop design are appropriate designs for shelter	Heavy grazing or lopping would reduce effectiveness
Nature conservation	Strips of trees will increase habitat diversity and act as corridors for some species	Restricted choice of species reduces nature conservation value Constant livestock impact will reduce habitat quality
Scenic quality	Careful design layout can have a positive impact on scenic quality	Exotic and/or heavily grazed shrubs and geometrically shaped plantings can be visually obtrusive in the landscape, especially in foreground areas