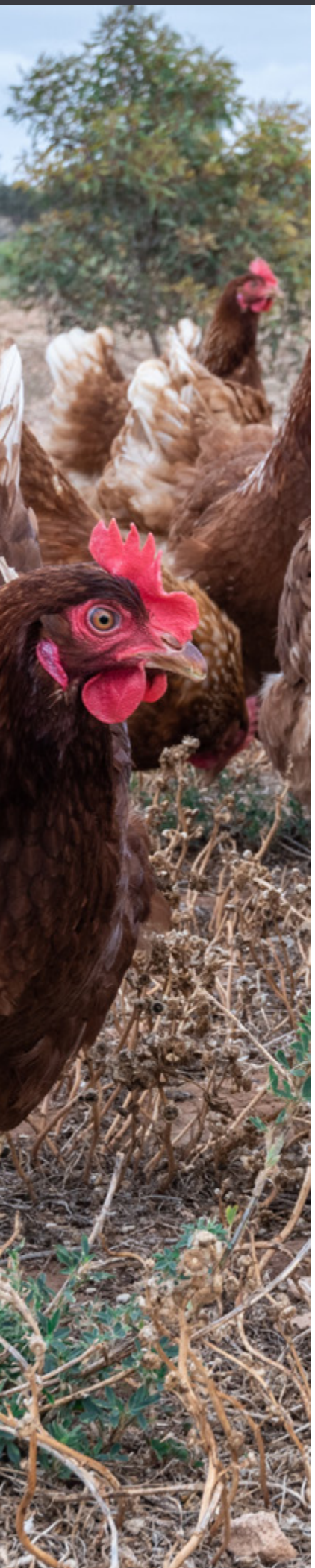
Pasture Selection and Management

A GUIDELINE FOR AUSTRALIAN FREE RANGE EGG FARMS

By Michael Wurst and Carolyn de Koning | 2021



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About the authors

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1 Introduction

This guide was developed to assist free range egg farmers to manage their outdoor ranges effectively through promotion of ground coverage and the provision of suitable forage species for hens.

Information is also provided on planting trees and shrubs for shade and shelter.

Additionally, case study farms provide examples of what some free range farms are planting and how they manage their range vegetation.

With the increased demand for free range eggs across Australia there has been a rapid shift in production to free range systems. Of the total volume of eggs produced, free range eggs represent 50% with cage eggs at 39%, and the remainder are barn laid and speciality eggs (Australian Eggs, Annual Report 2020).

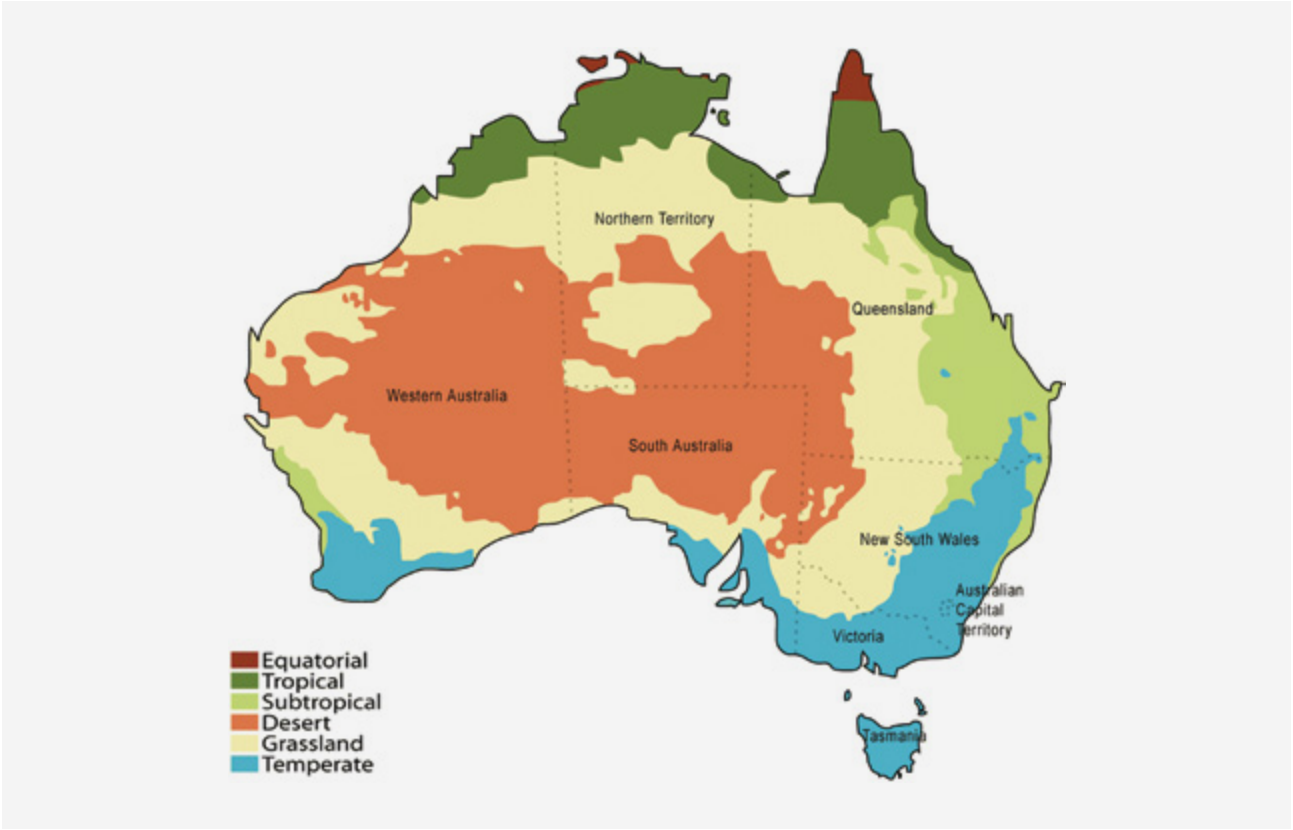
The National Information Standards (March 2016) on free range eggs requires that egg producers can only use the words “free range” on their egg cartons when laid by hens that:

- Had meaningful and regular access to an outdoor range during the daylight hours of the laying cycle.
- Were able to roam and forage on the outdoor range.
- Were subject to a stocking density of 10,000 hens or less per hectare and that outdoor stocking density is prominently displayed on the packaging or signage.

The Australian Competition and Consumer Commission (ACCC 2018) has produced “A guide for egg producers” to help egg producers of all sizes understand their fair-trading rights and obligations when promoting or selling eggs as ‘free range’.

However, the information and skills to manage large numbers of birds in free range systems has been limited and producers have needed to develop their own systems. In particular, there has been very little material available to free range farmers on the management of pastures and shrubs in free range systems.

Figure 1. Climate zones of Australia (Image: Martyman, Wikimedia Commons)



2 Australian Climate and Soils

SUMMARY

To identify the best pasture and tree species for the range it is important climate, rainfall and soil type are considered. Different plants and shrubs are suited to the 6 major climatic zones in Australia with average annual rainfall highest along the coastal regions and lower rainfall inland. **It is important to know your rainfall, soil pH, soil texture, nutrient status, soil depth and soil constraints before planting on the range**.

INTRODUCTION

Due to the diversity of climatic conditions and soil types across Australia, one size will not 'fit all'. In order to identify the best plant species for your range you need to consider your climate, rainfall and soil type. Different pasture types prefer different soil and climatic conditions and some varieties are better suited to certain conditions than others of the same pasture type.

AUSTRALIAN CLIMATIC ZONES

Figure 1 shows the 6 major climatic zones in Australia. Within each climatic zone there are further distinctions made based on temperature, humidity and rainfall patterns.

Equatorial
The temperature is high all year-round with a hot and humid wet season (summer) and dry winter.

Tropical
The temperature is high all year-round; no frost occurs; average annual lowest temperature is 15°C. It is distinctive for its monsoon or 'wet season' and 'dry season' with most rain occurring in the 'wet season', which corresponds to summer in southern Australia. The wet season is hot and humid with an average January maximum temperature > 30°C.

Subtropical
Low winter rainfall and reliable summer rainfall; high humidity from November to March; frosts are rare; average annual lowest temperature 10°C. Warm, humid, wet summer, average January maximum temperature < 30°C.

Desert
Very high summer temperatures; very high evaporation; a dry summer with prolonged drought is common. The northern part has a hot, dry summer and mild winter; the southern part a hot dry summer and cold winter with an average annual lowest temperature of -5°C.

Grassland

The northern part has very high summer temperatures and high winter temperatures with wet summer and very dry winter. The southern part has high summer temperatures and mild to cool winter temperatures with summer drought.

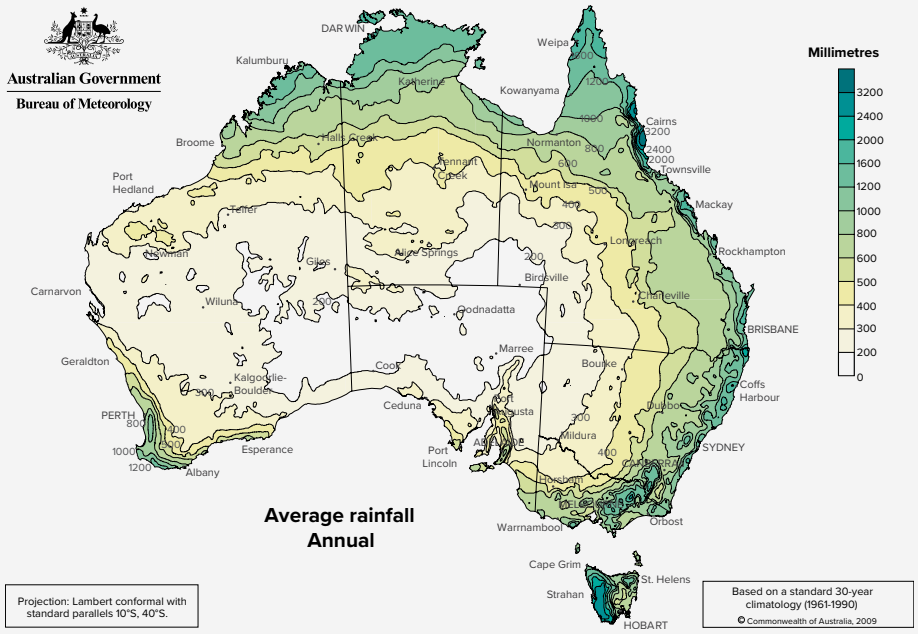
Temperate

Warm temperate
Cool winters with light frost, usually non-existent on the coast. The ocean moderates temperature allowing coastal zones in warm temperate zones to grow a range of plants including subtropical ones. The rainfall is reliable year-round; average annual lowest temperature 5°C. Warm summer, average January maximum < 30°C.

Mediterranean
Rainfall is predominantly in winter with low summer rainfall. The winter is cool, with light frosts and average annual lowest temperature of 5°C. The summer is warm, average January maximum < 30°C but with a low humidity.

Cool Temperate
Mild to warm summer and cold winter.

Figure 2. Australian average annual rainfall map



AUSTRALIAN AVERAGE ANNUAL RAINFALL

Average annual rainfall for Australia tends to be highest along the coastal regions grading to progressively lower inland (Figure 2). Recording your own farm rainfall will provide useful information on local growing conditions. The best rain gauges are those that allow for overflow collection into a larger outer cylinder in case you have a large rainfall event. A rainfall recording sheet can be downloaded from the Bureau of Meteorology site at:
www.bom.gov.au/watl/WATL-rainfall-log.pdf

Alternatively set up your own rainfall record sheet using a spreadsheet package.

SOIL CHARACTERISTICS

The most important soil factors that should be considered before sowing a pasture are:

- soil texture (sand, loam, clay) and pH (alkaline, neutral or acidic),
- rooting depth (depth to root limiting factors such as salinity, stone, compaction, sodicity etc.),
- potential for waterlogging (pasture species vary in their tolerance to waterlogging).

Soil pH can be quickly measured using off-the-shelf pH kits. They can be readily purchased from hardware stores and rural merchandise stores but ensure the best by date is checked. Consult your local agronomist to help you determine your soil texture and other soil attributes. A more detailed list of soil attributes can be found in Table 1, in the Glossary.

For further information on pasture types and soil suitability refer to:

www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/species-varieties

www.daf.qld.gov.au/plants/field-crops-and-pastures/pastures

www.agric.wa.gov.au/pasture-species

For further information on Australian soils refer to the ‘Australian Soil Resource Information System’:
www.asris.csiro.au/

KEY MESSAGES

- Where is your farm located on the climate and rainfall maps?
- Know your rainfall, soil pH, texture, nutrient status, soil depth and soil constraints and correct if possible, before sowing a pasture.
- Use the table below to fill in the attributes of your farm. This information is an important starting point in finding which pasture and tree species may be suitable for your farm.
- Talk with your local agronomist; they can assist you with soil testing and making plant species choices for your local area.

ATTRIBUTE	YOUR FARM
CLIMATE	
Climatic zone (use Figure 1)	
Temperature, both high and low (frost frequency)	
Length of growing season	
SOIL	
Soil pH (alkaline or acidic)	
Texture (clay content)	
Nutrient status	
Depth	
Water holding capacity and drainage	
Salinity	

3 Setting Up a New Range

Figure 3. Combination of artificial shelters and young trees on the range

SUMMARY

- Pasture plants come in a variety of forms; they can be annual or perennial, grass/legume or herb, native or introduced. It is vital to select pasture plants and trees best suited to your area.
- To assist with plant selection there are several factors to consider such as climate, soil, characteristics of the plants (e.g. growth habit, pattern of maturity), cost of establishment and expected life of the pasture.
- It is always helpful to seek professional advice from your local agronomist.
- Suitable plants need successful pasture establishment, which is reliant on 7 main steps.
- Consider irrigation to help with pasture establishment. However, be wary of biosecurity issues when using irrigation, like attracting wild ducks and do not use water from farm dams.
- Consider tree species with drought tolerance and be aware pastures may need resowing following a drought.
- Importantly when designing new ranges factor in fire preparedness of your property; create asset protection zones, bushfire buffer zones and have suitable fire extinguishers on hand.

INTRODUCTION

Setting up a new range is an opportunity to plan, plant and establish the range before introducing the hens. If possible, consult your local agronomist as they will know which species and varieties grow well in your district and common soil issues to look out for. You can plan different options using the information provided in the 'Case Study Farms', section of this guide. Other producers have tried a range of different plants and systems, you can learn from their experience and choose options which meet your needs.

RANGE DESIGN

In terms of range design, a combination of shelter areas (clumps of trees and shrubs) and more open areas sown to perennial pastures has proven successful. You can also incorporate artificial shelters consisting of a low frame with shade cloth on the top, and fences with shade cloth, to provide shelter and protection for foraging hens and encourage them to move further away from the shed. Ensure these structures are wind proof and well anchored down.

Hens on the range usually remain close to the shed and leave the area denuded of forage. It may be beneficial to leave the area close to the shed doors bare and cover this with gravel, to reduce the amount of dirt and mud that is brought into the shed. The gravel also helps with controlling nutrient runoff by slowing down surface water flow.

CATEGORIES OF PASTURE PLANTS

Pasture plants are categorised in multiple ways, the following is an overview of the categories and the characteristics of those groups.

Perennials

Regrow each year from root reserves. In areas of higher rainfall this gives them the advantage of already being established and able to respond when conditions are favourable.

Annuals

Grow from seed each year; need to be sown each year or may re-sow themselves, depending on species. In areas of lower rainfall this gives them the advantage of not having to survive a harsh winter or summer.

Biennials

Plants that take two years to complete their life cycle, or one in less favourable conditions.

Grasses and legumes

Grasses belong to the most widespread and successful family of plants, the Poaceae. Other terms are monocot and narrow leaf. Legumes, which include clovers and medics, are a family of broadleaf (or dicot) plants that can produce their own nitrogen. They do this with the help of Rhizobium bacteria, which live in nodules attached to the plant's root system. Rhizobia capture (or 'fix') atmospheric nitrogen and convert it into a form that is available to plants. In most cases, a pasture with both grasses and legumes is desirable.

Native and introduced grasses

Native grasses have evolved in Australia, whereas introduced, or exotic species have evolved elsewhere. Naturalised species are those that originate overseas but are now established in parts of Australia, where they persist without human intervention.

– C3 and C4 species

Temperate grasses and legumes and tropical legumes use the standard C3 biochemical pathway for photosynthesis whereas tropical grasses use the C4 pathway. C4 species have greater water use efficiency but for the same plant material (e.g. leaf) at the same stage of growth, they have higher fibre content than C3 species because of the energy needed to achieve this greater efficiency. High fibre content in grasses can cause crop impaction in hens, if too much is eaten.

– Year-long green

This term is sometimes used to describe C3 grasses which regularly grow year-round. However, both C3 and C4 perennials can grow throughout the year if conditions are favourable.

GRASS AND LEGUME NUTRITION

Pasture species and varieties can vary in crude fibre (CF) and crude protein (CP) content. Generally legumes are higher in CP while grasses tend to be higher in CF (Table 1). Hens eating too much pasture can create dietary imbalances and highly fibrous pasture species can cause crop impaction.

TYPES OF PLANTS UTILISED IN THE CASE STUDIES

TEMPERATE GRASS

COOL SEASON

C3 SPECIES

Figure 4. Phalaris

These grasses can grow in cooler conditions than tropicals and they tend to be of higher feed quality.

Most growth is in spring but they also grow in autumn and winter.

Perennial types can grow in summer if conditions are favourable (e.g. phalaris and cocksfoot).

TEMPERATE LEGUME

COOL SEASON

C3 SPECIES

Figure 6. Barrel medic

These plants produce their own nitrogen, in association with Rhizobium bacteria, and can grow in cool conditions.

Figure 7. Lucerne

Like temperate grasses, most growth is in spring but they also grow in autumn and winter (e.g. annual medic and subclover).

Perennial types can grow in summer, if conditions are favourable (e.g. Lucerne).

FORAGE SHRUB

Figure 11. Tagasaste

Figure 12. Oldman saltbush

These perennial woody plants are browsed by animals and can provide shelter (e.g. Oldman saltbush and Tagasaste).

TROPICAL GRASS

WARM SEASON

C4 SPECIES

Figure 5. Rhodes grass

These grasses tolerate hot and dry conditions better than temperate species.

Most growth is in summer and autumn.

Tropical species tend to grow very slowly in cool conditions (<15°C) and they are strongly affected by frost (e.g. Rhodes grass).

TROPICAL LEGUME

WARM SEASON

C3 SPECIES

Figure 8. Leucaena

These plants produce their own nitrogen, in association with Rhizobium bacteria, and tolerate heat better than temperate legumes.

Most growth is in summer and autumn.

They grow very slowly in cool conditions and are strongly affected by frost (e.g. Leucaena).

NATIVE GRASS

Figure 9. Blue grass

These may be tropical or temperate species.

Native grasses are well-adapted to their environment but their seed is expensive or difficult to obtain (e.g. Australian bluestem grass).

PASTURE HERB

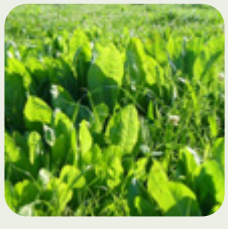


Figure 10. Chicory

These non-woody plants are a miscellaneous group of species that are neither grasses nor legumes.

They can be productive (e.g. chicory).

Table 1. Average Crude Fibre and average Crude Protein of fresh above-ground plant parts for different plant species

BOTANIC NAME	COMMON NAME	CRUDE FIBRE % DM	CRUDE PROTEIN % DM
Atriplex nummularia	Old man saltbush	20.1	14.7
Chichorium intybus	Chicory*	25.0	23.0
Chloris gayana	Rhodes grass	36.9	9.0
Cytisus proliferus	Tagasaste	14.8	22.2
Dactylis glomerata	Cocksfoot	29.7	16.3
Dicanthium sericeum	Blue grass	32.0	7.0
Leucaena leucocephala	Leucaena	19.9	23.3
Medicago polymorpha	Annual Medic	17.7	23.8
Medicago sativa	Lucerne	28.6	18.3
Phalaris aquatica	Phalaris	22.5	16.4
Trifolium subterraneum	Subclover	26.9	18.1

DM = Dry Matter, Source www.feedipedia.org, Chicory*= www.dairynz.co.nz

SPECIES/VARIETY SELECTION

To decide which pasture species to plant on the range, consider the farm factors you listed in the table on page 9, as well as:

Characteristics of species and varieties

1. Time of maturity
2. Pattern of growth
3. Growth habit (prostrate or erect)
4. Disease and pest tolerance
5. Regeneration (hardseed levels) of annuals
6. Drought tolerance

Economics

1. Cost of establishment
2. Life of stand (time to re-sowing)

For more information see MLA's 'Pasture selection' webpage: www.mla.com.au/research-and-development/Grazing-pasture-management/improved-pasture/pasture-selection

SEVEN STEPS TO SUCCESSFUL PERENNIAL PASTURE ESTABLISHMENT

Establishing your pasture properly will ensure it is productive and long lasting, making it a more worthwhile investment.

Perennial pasture seeds are generally small with seedlings that are delicate and slow growing compared to most crops and many weeds. Greater care and attention to detail is needed to establish perennial pastures successfully.

The following seven critical steps will help you achieve successful establishment and reduce the risk of failure.

Optimum sowing times and species will vary with regions but the principles of these seven steps will remain the same.

1 Select, assess and plan early – start at least 8-12 months before sowing

Key check: Assess the existing pasture, soil fertility, weed and pest risk

- Are the current pasture varieties well adapted and productive or should they be replaced?
- Is the soil pH and fertility level suitable for the proposed pasture? If not, reassess species, fertiliser and need for lime or gypsum.
- If spreading chicken litter to improve soil, it will require composting first. Hens should not be allowed to roam on the composted range for three weeks post-spreading. *Australian Eggs has a suite of factsheets on composting which you can find on the website.*
- Fertilising to address nutrient deficiencies is particularly important when establishing a range for the first time.
- Established farms should check soil fertility. *For more information on nutrient deposition on the range see the Australian Eggs 'Environmental management' webpage.*
- Are there wild birds and insect pests which could interfere with the establishment of seeds or seedlings?
- Consider all inputs when budgeting: sowing equipment, paddock preparation and sowing, herbicides, insecticides, seed and fertiliser.

2 Weed and pest control in preceding year(s)

Key check: Reduce weed seed reserves in the soil and insect pests by using techniques such as spray fallow, pasture-topping, spring fodder crops and integrated pest management procedures. This step must commence in the previous spring for autumn/ winter sowing to prevent annual weed seed set.

- What weed species are likely to be a problem? Competition from annual grasses is the major cause of poor pasture establishment and many pasture species have small seeds and seedlings are small and slow growing.
- It is important to control weeds before sowing, preferably control weeds the season before sowing to reduce weed seed levels in the soil.
- Slashing or mowing the area in the spring before sowing can reduce seed set of weeds, however if further rain is received weeds can recover and still set seed.
- If using slashing or mowing to control weeds keep in mind leaving the soil bare for long periods can expose it to wind and water erosion.
- Despite the issues with herbicides these are still often the best way to control weeds.
- A combination of knockdown herbicides (glyphosate plus spikes) and pre-emergent herbicides will give good control of a range of grass and broadleaf weeds. The type of preemergent herbicides that can be used will vary depending on the pasture to be sown.

3 Pre-sowing weed control

Key check: Manage the paddock for 3-4 months prior to sowing to reduce trash (dry plant residues) and maximise weed germination.

- If using conventional sowings – use cultivation in conjunction with herbicides.
- If using direct drill or surface sowings – spray with a knock-down herbicide at least three weeks before sowing to reduce root disease carry-over.

4 Absolute weed control – the most important factor for success

Key check: Allow full weed germination after the break of the season. Either cultivate or spray to control weeds while waiting for optimum sowing conditions.

- As a rule, don't sow on the first rain of the season (as subsequent weed germination is likely to be a problem).
- Identify what weeds are present or likely to be present and take action to eliminate them:
  - either use the appropriate herbicide at label rates, or
  - cultivate to achieve a firm, fine weed-free seedbed (NB. cultivation will stimulate further germination of weeds).
- The application of insecticide and fungicide seed dressings can reduce seedling damage and aid establishment. Care needs to be taken when these are applied in combination with rhizobium inoculants for legume pastures. Apply the rhizobia with glue first and coat with agricultural lime, before applying other seed treatments.

- Generally avoid dry sowing as it increases the risk of failure. Where sowing into a dry seedbed is the only practical option, good weed control in the previous season is essential.
- Preferably sow without cover crops – these compete with the young pasture for moisture and light just like weeds.

5 Adequate soil moisture – enough for quick germination and survival of the sown pasture

Key check: Moisture extending from the surface to at least 20cm depth in the soil profile.

- Provide a firm, moist seedbed, preferably using press-wheels. This allows close contact between the soil and the seed. Seeds can then absorb moisture, germinate and emerge more quickly and reliably.
- Sow when conditions are best for germination and survival.
  - temperate perennials: from autumn through to early spring (depending on the district).
  - sub tropical species: sow late spring to early autumn.
- For temperate species which can be sown in the cooler months, adequate soil moisture is more important than time of sowing.

6 Accurate seed placement – neither exposed nor buried too deep

Key check: For direct drill sowings of most small seeded species, 5% of seed/fertiliser should still be visible in the row; for ploughed seedbeds, soil cover over the seed should be no more than 1cm deep.

- Direct drilling
  - Average furrow depth 25mm, provided the furrow remains open, with 1-2cm of loose soil over the seed.
  - Press wheels will firm the soil and increase seed soil contact.
  - Don't use harrows or rollers.
- Conventional sowing
  - Beware of sowing too deep especially when the seedbed is loose and fluffy.
  - Rolling can improve seed-soil contact but beware of surface crusting in some soils.
- Use seed that is certified or quality assured wherever possible and check its germination and purity.
- Use sufficient seed to ensure a dense pasture.
- Be aware of specific requirements of some species; e.g. Rhodes grass, lovegrass and wallaby grass require very shallow sowing.
- Be aware that some soil types such as heavy cracking clays can lose moisture quickly after sowing while other clays are prone to surface crusting.
- Ensure legume seed is inoculated with the correct strain of rhizobia and where necessary, lime pelleted. *For further information on pasture legume inoculation see the Department of Primary Industries and Regional Development website – 'Inoculating pasture legumes' page:* www.agric.wa.gov.au/pasture-establishment/inoculatingpasture-Legumes
- Provide good nutrition – Apply adequate phosphorus, sulphur and trace elements (e.g. zinc, copper and molybdenum) at sowing time. Check for other potential deficiencies such as potassium, particularly on deep sandy soils in medium to high rainfall areas.
- Use nitrogen fortified (compound) fertilisers for direct drill sowings (maximum rate, 20kg N/ha).
- Banding phosphorus fertiliser near the seed is four times more efficient than broadcasting.

7 Monitor weeds & pests regularly after sowing

Key check: Look for pests and weed seedlings at 10-14 day intervals after sowing. This check is most often overlooked.

- Check pastures for pests regularly. For earth mites this may require close inspection on hands and knees and using reading glasses if needed. Treat young pastures immediately if mites are found – many mites will probably not be seen.
- The likelihood of insect pests being present is generally greater in direct drilled than conventionally sown new pastures.
- In direct drilled pastures under warm, moist spring conditions, slugs may be a problem. Slugs can be detected by placing wet paper under bags or boards at several sites. A registered insecticide is available for use at or after sowing if they pose a significant threat.

Table 2. An example of basic indicative costs (year 2019) associated with establishing a new pasture.

VARIABLE COST	RATE/HA	$/HA
Seed		
Cocksfoot	4 kg @ $5.00/kg	20.00
Subclover	10 kg @ $5.50/kg	55.00
Inoculant for subclover (peat based)	–	5.00
Fertiliser		
Superphosphate	100 kg @ $360.00/t	36.00
Freight fertiliser	$20.00/t	2.00
Fertiliser spreading (contractor)	–	8.50
Chemicals – Herbicides		
Knockdown year prior sowing – Glyphosate 540g/L	2L @ $6.00/L	12.00
Knockdown before sowing – Glyphosate 540g/L	2L @ $6.00/L	12.00
Ground spraying x 2 times (contractor)	@ $10.00/ha	20.00
		TOTAL 220.50

PASTURE ESTABLISHMENT COSTS

The cost of establishing a pasture will be relatively small compared to the total investment in the business, therefore it is important to achieve good establishment the first time to avoid the need to re-sow in the short term.

The cost of pasture establishment will vary, depending on existing plant species and the type of pasture to be established. A basic example with indicative costs is shown for establishing a cocksfoot + subclover pasture in *Table 2*. It shows most of the costs to consider but does not include lime or gypsum application.

An indication of costs for a number of pasture types can also be found at:

www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/establishment-mgmt

pir.sa.gov.au/consultancy/farm_gross_margins_and_enterprise_planning_guide

farmstyle.com.au/news/pasture-development-small-farms

IRRIGATION

Where irrigation is available this could be used to establish perennial pastures. However, irrigation can attract wild ducks, which can spread diseases, for example Avian Influenza. Irrigation with untreated surface water (from dams, rivers and reservoirs) is not recommended.

DROUGHT – MANAGEMENT OF PASTURES

During extended dry or drought conditions perennial pasture species will have limited growth and will be more susceptible to over-foraging. In these situations perennial pastures are likely to be thinned or even die out totally. This may leave the range relatively bare, with only unpalatable weeds remaining.

In the following year sections of the range may need to be re-sown with suitable pasture to increase ground cover. These areas will need to be fenced-off for several months to allow the pasture to become well established, before allowing hens to forage.

DROUGHT – TREE AND SHRUB SELECTION

By planting local native species or drought tolerant species these trees and shrubs should be able to survive periods of drought, once they have become well established.

When looking after trees during a drought, make sure the root area is well protected from scratching damage by using rocks or netting.

FIRE PROTECTION

When planning to establish a new range or area of vegetation on the property, consider how this could impact your bushfire risks. Asset Protection Zones and Bushfire Buffer Zones can be created to enhance the property's fire preparedness.

Asset Protection Zones (A-Zones)

An Asset Protection Zone (APZ) surrounds or is adjacent to residential buildings, feed silos, poultry sheds etc. and are designed to reduce fire spread, intensity, radiant heat and direct flame contact to an asset. They generally contain highly modified vegetation, such as a cultivated area, gravel or mown grassland areas that will reduce the radiant heat impact during a bushfire. The location of an APZ should include areas such as existing cleared areas, roads and driveways which already have low fuel levels.

Asset Protection Zone's provide a defendable space to allow residents and firefighters some degree of safety before, during and after the passage of the fire front.

Management of vegetation within an APZ alone cannot provide complete protection during a bushfire and should be accompanied by other measures to maximise your safety in bushfires. These can include:

- implementation of Bushfire Buffer Zones to further reduce fuel loads and minimise ember attack,
- appropriate building location, design, construction and maintenance,
- use of appropriate building materials, and
- installation and use of sprinklers.

Bushfire Buffer Zone

A Bushfire Buffer Zone (BBZ) is intended to provide strategically located fuel reduced areas that decrease the potential for large bushfires to develop across the landscape. The goal for a BBZ is to have strategic firebreaks of sufficient width and continuity to provide a substantial barrier to the spread of bushfire. Bushfire Buffer Zone's should be located around houses and sheds to complement APZ. Where possible, BBZ's should include agricultural land that has been managed to reduce fuel loads during the bushfire season. The area surrounding the poultry shed is often bare through hen activity, this can create a fire break.

KEY MESSAGES

For establishing new pastures:

- Select, assess and plan early
- Weed and pest control in preceding year(s)
- Pre-sowing weed control
- Absolute weed control
- Adequate soil moisture to at least 20cm deep
- Accurate seed placement in soil, don't sow too deep
- Monitor weeds and pests after sowing
- Plant native trees and shrubs, as once established many are drought tolerant
- Pasture areas on the range may need re-sowing following drought
- Have a fire protection plan
- The longer you can keep hens away from newly sown pastures the better. If hens can easily pull up seedlings, roots and all, the pastures are not ready for foraging by hens.

4 Regenerating a Current Range

SUMMARY

Several techniques are available to improve pasture composition that are simple and inexpensive, without the need for total pasture replacement. This may involve mowing, slashing, applying fertiliser, over-sowing and selective spraying. In addition, mown areas also help with biosecurity by reducing grass seed set, making them less attractive to wild birds and rodents and minimising the risk of hen crop impaction.

TECHNIQUES TO IMPROVE PASTURE COMPOSITION

Techniques aimed at improving pastures range from simple and inexpensive options to total replacement. Although some management options might take several years to achieve the desired result, they may result in the largest return on investment. The following options and combinations of these may improve pasture composition and productivity sufficiently to avoid the need for costly re-sowing.

1. Fertiliser

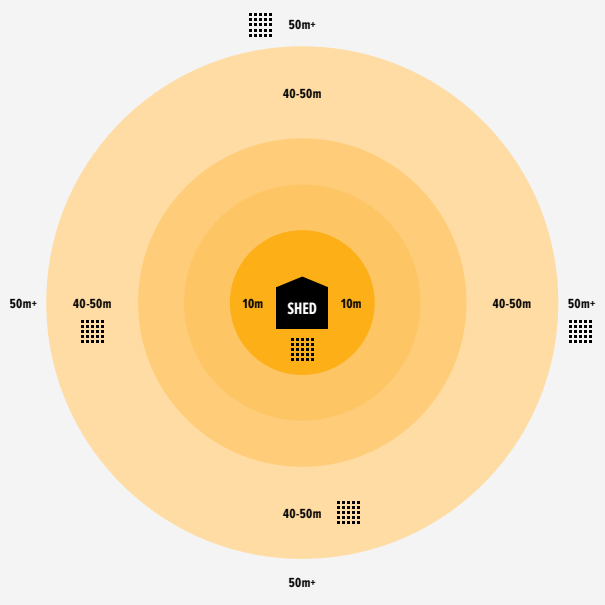
Deficiencies of nitrogen (N), phosphorus (P), sulphur (S), potassium (K) and molybdenum (Mo) are common in many pastures. Fertilising to address nutrient deficiencies will ensure that desirable pasture species grow to their potential.

In low fertility situations, useful pasture species tend to decline and low production weed species, such as *Vulpia* species, catsear/false dandelion (*Hypochaeris radicata*) and sorrel (*Acetosella vulgaris*), can invade and dominate.

Check soil fertility by undertaking soil tests, starting close to the shed and sampling at various distances from the shed. Take a sample within the 10m zone around the shed, another sample 40-50m from the shed and a third sample on the outer range greater than 50m from the shed. Each sample is comprised of numerous plugs of soil taken in a grid pattern. Talk with your local agronomist for further advice on how to take soil samples.

A vigorous, effectively nodulated legume component will provide N to the grass component and improve the persistence of the pasture. Your soils may require

Figure 13. Soil testing diagram



N fertiliser if there is not a legume component, in order for grasses to produce to their potential. Legumes have a higher requirement for P, S and Mo than grasses.

2. Over-sowing an existing pasture

Many degraded pastures can be improved or rejuvenated by sowing new species into the existing pasture. This non-destructive approach can be the best option when you want to increase the proportion of the desired legumes or useful perennial grasses, but do not want to re-sow.

Legume and grass seeds can be broadcast or direct drilled into existing pasture. The success of such a technique is mixed and broadcasting legume seed often results in lower establishment compared with drilling the seed into the soil. See page 15 – 'Accurate seed placement' for more information.

Depending on the situation, before over-sowing appropriate herbicides can be used to suppress the already established, useful species. Seek advice from an agronomist before using this technique and also check withholding periods before selling eggs.

3. Selective weed control

Unwanted species such as Vulpia (Silver grass) or Paterson's curse (Echium plantagineum) can be

removed using appropriate herbicides. Before using herbicides, it is important to assess the current species composition of the area to determine the most appropriate herbicide option and the likely impact of removing the target weeds on ground cover. More details on weed management options are presented on pages 14-15.

Herbicide treatment may result in bare ground once the target weed/s are removed and make the pasture susceptible to weed re-invasion. If the pasture is made up of a large proportion of target weeds, herbicide use is best combined with another management strategy, such as over-sowing.

4. Pasture management

Assessing your management strategy may give clues as to why some species have thinned or disappeared from your pasture. Knowledge of phenology of the species (i.e. seasonal growth and development) is important in order to understand how your management affects different pasture plants (both perennials and annuals) and how they respond to mowing or slashing throughout the season.

5. Re-sown pasture areas

Pastures can be sown in a clearing, where there are no or minimal trees or shrubs, with only a portion of the range being re-sown to pasture at any one time. The area of newly sown pasture will need to be fenced off from the rest of the range to protect the young seedling plants from the hens.

It may take six months or more before the plants are well enough established to allow hens to enter the newly established pasture. Outdoor stocking densities need to be maintained while re-sown areas of the range are excluded from hens. Some farms have made their range areas 30% larger than required so they can renovate 30% of the range at any time while upholding outdoor stocking densities.

BIOSECURITY

There are increased biosecurity risks when operating a free range poultry system, due to exposure to potential sources of disease and food safety pathogens. Some of the greatest biosecurity risks to a free range operation are wild birds and animals, rodents and airborne infection. Keep grass

and pasture on the range area short and don't let it seed as long grass can attract wild birds and rodents. Mown grass also minimises the risk of hen crop impaction.

For further information on poultry biosecurity visit the 'Biosecurity' section of the Australian Eggs website, or the 'Eggs' section of the Farm Biosecurity website:

www.australianeggs.org.au/for-farmers/biosecurity
www.farmbiosecurity.com.au/industry/chickens

KEY MESSAGES

- Have a good look at what is already growing across the range.
- Your local agronomist should be able to help you identify pasture plants and weeds.
- You may only need minor changes without having to re-sow the whole area.
- Use security cameras, wildlife cameras or video recording devices to see whether hens are using the range, where they are going and what they are doing while on the range.

5 Establishing Trees and Shrubs on the Range

SUMMARY

Trees and shrubs do more than just provide shade and protection for the hens. They can also serve as windbreaks and control odour. A combination of trees and artificial structures are often necessary to attract hens out onto the range. Artificial structures can take the form of low horizontal shade structures and vertical fences. Selection of well-adapted trees and shrubs suited to the area is a good starting point, but it is essential to plan for planting and be prepared for after planting care of trees and shrubs.

INTRODUCTION

Forage shrubs and trees can provide valuable shade and protection during extreme or inclement weather events and will provide cover to enable hens to forage further away from the shed. Trees are best planted in clumps and rows to provide areas for hens to forage with a clearing (open area) sown to perennial pasture. However it is important that vegetation (e.g. planted trees for shade, vegetation buffers and shelter belts) minimise attraction of wild birds.

A range of different shrubs and trees can be used, depending on soil type and rainfall. Nonetheless, native shrubs and trees have proven to be easy to establish and hardy, requiring minimal management once established.

SHRUB AND TREE SELECTION

Local tree and shrub species can be sourced through "Trees for Life" (www.treesforlife.org.au), however it is important to know how quickly and how high the different species will grow.

A range of tree and shrub species are commercially available and the decision regarding which types to plant should be based on soil characteristics, plant structure, fire susceptibility, as well as the availability and cost of the seedlings.

Acacia species (wattles) are broadly adapted with a large range of different species suitable to different climates and soil types. However many of these are relatively short lived (10-15 years), compared to some other shrub species.

Hop bushes (Dodonaea sp.) are native to many parts of Australia with some species widely used in revegetation projects. **Saltbushes** (Atriplex sp.) are also widely adapted. These shrubs tend to grow low to the ground and may require wire netting around the base to stop hens nesting underneath but still allow some browsing of leaves.

A range of **exotic tree species** have been planted in poultry ranges, including commercial tree species, such as olives, nuts and fruit trees. Biosecurity needs to be considered if planting olives, nuts and fruit trees as they will attract wild birds and insects. The harvesting of these crops also needs to be factored into range and farm management.

Trees such as olives can be planted close to the shed, as they have a high requirement for fertiliser and would be more tolerant of high nutrient loads. Where produce is to be harvested from trees for human consumption the produce cannot have direct contact with the ground to avoid contamination with hen litter.

Ground cover outcomes will be maximised through the incorporation of a perennial pasture rather than annual pastures. Producers have had good success in improving ground cover with **lucerne** (Case study farm 1) and also perennial native grasses (Case study farm 3).

Forage shrub species such as **Creeping saltbush** (*Atriplex semibaccata*) which has a lower growing habit than most forage shrubs will provide additional ground cover.

A mix of trees, shrubs and perennial pastures is more likely to attract a greater diversity of insect and other species.

Two shrubs which have performed well in layer ranges are **Old-man saltbush** and **Tagasaste**. You can use the information below to see if they are a suitable choice for your ranges.

Old-man saltbush (*Atriplex nummularia*)

Old-man saltbush is a large shrub, up to 3m high, and up to 4-5m across if left unmanaged.

Leaves are grey-green 2-4cm long, with seed ripening in mid-summer.

There are currently three varieties of Oldman salt bush: 'Eyres Green', 'De Koch' and 'Anameka'.

Oldman saltbush is being commercially produced in large quantities, making it relatively cheap to purchase as seedlings or speedlings. See Case study farms 3 and 5 for further information on saltbush used on free range farms.

Other characteristics:

- Drought tolerance
- Fire retardant
- Tolerant of saline soils
- Good survival (~72%)
- Provides good shelter for livestock/poultry
- High salt content
- Not tolerant of water logging

Tagasaste (*Cytisus proliferus*)

Tagasaste or tree lucerne is an evergreen deeprooted, perennial legume shrub or small tree growing to a height and crown diameter of about 5m, often with long, drooping, leafy branches.

Other characteristics:

- As a small plant it can be frost sensitive with young leaves burnt by frost.
- Mature tagasaste trees provide good shade and if grown in closely planted hedgerows, form an excellent windbreak.
- Tagasaste prefers a temperate or mediterranean climate with a rainfall of at least 350mm but tolerates drought, wind and poor fertility soils.
- Adapted to a range of soils with pH 5 to 7, preferring the more freely drained ones, but does not do well on low lying sites subject to waterlogging.

PLANNING TO PLANT

A range of factors need to be considered when planning and designing a range with trees or shrubs including:

- Plant spacing
- Spacing between forage shrub plants (i.e. in row)
- Row spacing
  - Width between rows of forage shrubs
  - Width for inter-row pasture
  - The width of farm machinery needs consideration when determining distance between forage shrub rows.
- The species of forage shrub
- The species of Inter-row pasture
- Timing of planting

Plant spacing

When planning spacing between shrubs (i.e. along rows) find out how big/ wide the mature shrub will be.

As a rule of thumb, 3m spacing between shrubs has been used with good success for Old-man saltbush. Other species with a smaller growth habit (Creeping saltbush, Ruby saltbush) will need to be planted closer together along the row (2-2.5m apart).

Row spacing

Forage shrubs, particularly Oldman saltbush are often planted in dense blocks with rows 2.5-3m apart, providing dense shrubbery. However, this results in low productivity of the inter-row pasture through heavy plant competition. Densely planted rows can also provide attractive egg laying sites.

As a result, forage shrubs are now commonly planted in multiple rows (generally 2-3) with a much larger gap for inter-row pasture.

The design will depend on a range of factors including the planting area and size of machinery available for planting.

Site preparation

Most forage shrub species are poor competitors as seedlings so good site preparation for the planting of seedlings is essential and substantial deaths of up to 50% of shrubs can occur without good site preparation.

Chemically fallowing the planting area, 1-2m around the spot the seedlings will be planted 8-12 months before planting is recommended. This allows for moisture conservation for the seedlings and a reduction in weed competition with seedlings. Use pre-emergent herbicides at planting to help reduce competition in the year of establishment.

When selecting herbicides ensure that if a residual chemical is used it will not affect forage shrub seedlings or the inter-row pasture and that there is sufficient ground cover to prevent erosion.

Mechanical weed control through scalping creates a V shaped furrow to funnel moisture to seedlings located in bottom of the V.

Hard pan, heavy clay soils, dry saline land or rock sites should also be ripped or worked to a depth of approximately 20cm to allow greater moisture penetration. Rip lines will need to settle for a few months before planting into them. Sometimes large soil clods and air pockets are created from ripping and water just disappears beyond the new seedlings' roots (Case study farm 5).

For well-structured deeper soils, ripping is not required with plants placed in non-ripped ground having greater root penetration and development than those in ripped ground.

Seedlings and speedlings

Shrubs and trees can be grown in a home nursery or are available from a limited range of commercial nurseries in a number of different forms. These include:

- Seedlings or tubestock which are grown in small tubes usually 50 x 120mm to be transported to site. These seedlings will need to be guarded to avoid damage.
- Speedlings are grown in plastic trays of 100-250 plants depending on the tray size, the root volume is usually 20 x 50mm. These plants are small and will require tree guards for 12 months or more before they can be removed.
- Young trees/bushes. Although these are more expensive they can be planted out into a range without the need for guards. On Case study farm 2, they were growing seedlings to 1m tall in their own on-farm plant nursery. The young 1m-tall trees were then planted on the range without the need for guards.

PLANTING TECHNIQUES

Hand planting

Hand planting of forage shrubs can often be quicker than machine planting depending on the size of the site. Shrubs are generally planted quickly and accurately using a range of tree planters (e.g. Potti Putki or Hamilton).

Machine planting

A range of three-point linkage seedling planters are suitable for planting large numbers of trees and shrub seedlings/speedlings. Generally, two people are required to operate the planters – one to drive the tractor and the other to plant the forage shrubs, seated on the back of the planter.

On some sites it may be necessary to check plants after machine planting to ensure they are correctly planted with good soil contact around the roots. Plants can be partially buried to reduce moisture loss from the root ball and leaves.

Alternatively a number of contractors will also plant seedlings.

Time of planting

The best time to plant seedlings is after opening rains or after crop seeding, when adequate soil moisture is available so that plants can establish before summer. Plants will grow slowly over winter, with rapid growth in spring and early summer.

Planting at this time minimises the need for hand watering. Insect pests are also less active. Plants may need to be hand watered if rainfall is not received in spring to increase plant survival over the summer.

Post planting management of seedlings/speedlings

Control of weeds after planting, particularly in spring and summer, will improve the survival of seedlings and increase shrub growth.

Producers have had good success with spraying weeds on either side of trees and shrub plants, protecting shrubs with a spray shield. It is practical to use weed mat circles as a non-chemical alternative, but there is a need to evaluate the cost.

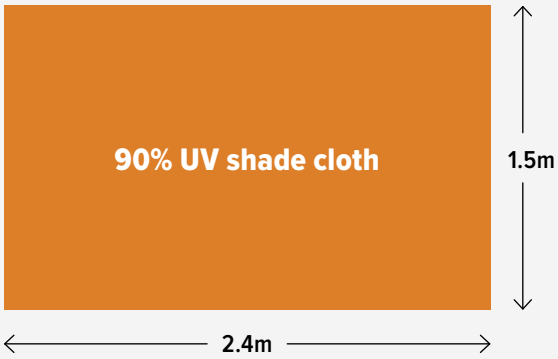
The use of tree guards is essential, to protect young seedlings from hens, while they are getting established. Once they grow above the tree guards they can generally tolerate some foraging by the hens. Closely monitor any damage and change the guards if required to avoid the hens attempting to roost and causing serious damage to young plants.

Wire netting around the base of plants may be necessary to avoid damage and stop hens dust bathing and laying eggs underneath the shrubs. Rocks may need to be placed around the roots of trees and shrubs to protect them from scratching damage by hens.

OTHER SHELTERS

Alternatives to trees on the range are structures covered with shade cloth or shade sails giving birds overhead cover where they can feel safe from birds of prey. These structures can be relatively low (less than 1m high) and open on all sides, to allow hens to shelter or move in safely. Placing these structures close to the sheds should encourage hens to move further away from the shed. Long narrow structures will provide safe passage corridors between the shed and pastures and shrubs, further out into the range. This should encourage hens to safely forage in pasture and shrubs further away from the shed.

Figure 14. Shade cloth density and dimensions of the most effective vertical fence used by Rault et al. 2013.



SHELTERBELTS FOR ODOUR CONTROL

A shelterbelt is a vegetative belt, generally made up of trees planted in a row. Ideally shelterbelts are planted in a way that provides a windbreak. Air quality issues are becoming an increasing concern in agriculture with continued urban encroachment into previously rural, agricultural areas.

Shelterbelts offer one method for producers to take proactive steps to address the issue; demonstrating consideration for social and environmental impacts by buffering odour, dust and noise emissions from their facilities while improving farm aesthetics and property values. The source of animal odours is near the ground and tends to travel along the ground, shelterbelts can intercept and disrupt the transmission of these odours. Shelterbelts also reduce the release of dust and aerosols by reducing wind speed near production facilities. Wind tunnel modelling of a three-row shelterbelt quantified reductions of 35% to 56% in the downwind transport of dust. However, shelterbelt density determines the degree to which dust and aerosols are reduced. For more information see references for Takle, 1983; Heisler and DeWalle, 1988 and Thernelius, 1997 in the 'Further Reading' section.

SHELTERBELTS FOR PROTECTION

The area sheltered is generally proportional to the height (H) of the shelterbelt. For example a 5m high shelterbelt on the boundary of the enclosure may provide wind protection of up to twenty times its height (20 x H); that is 100m from the shelterbelt.

The extent of the protection depends on the positioning of the shelterbelt in the landscape and the porosity of the shelterbelt. A shelterbelt on a ridge will provide more shelter further out into the range than one on a flat and more again than one at the base of a slope.

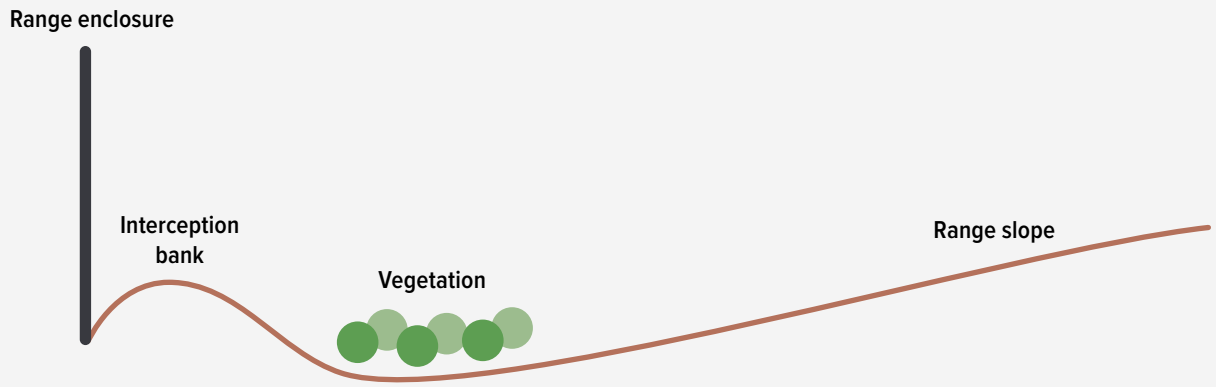
A tree and shrub canopy that is reasonably open with about 30 to 50% porosity will give the maximum protection distance. More dense shelters will give better protection but for shorter distances. A mix of taller trees and shrubs will give full protection.

KEY MESSAGES

- Look around your local district to see what trees and shrubs grow well.
- Native species are very hardy and drought tolerant once established.
- Prepare tree/shrub planting areas well before planting by good weed control and deep rip if needed.
- Consider setting up an on-farm nursery to grow trees to larger sizes that don't require guards when planted out (see Case study farm 2).
- WATER, WATER, WATER to ensure the best possible survival of your trees and shrubs.
- Protect tree roots with rocks or mesh from scratching damage by hens.

6 Managing Nutrient Run-off

Figure 15.



SUMMARY

A vital part of range management is controlling water run-off to prevent nutrient contamination of nearby watercourses. Many factors determine the level of water run-off. Where there is a high risk of water run-off interception banks with vegetative cover are required to slow and capture water flow.

WATER RUN-OFF

Water run-off from the range needs to be managed to avoid contamination of nearby water courses and steams. The amount of water run-off will depend on:

- Rainfall amount and intensity
- Ground cover
- Soil type
- Range slope

On sandy soils with minimal slope and adequate ground cover the water run-off will be minimal and will not require significant management, however on soils with a moderate to high clay content and slight to moderate slope, run-off may be significant following extended period of wet weather or high intensity rainfall events.

INTERCEPTION BANKS

Where there is a high risk of water run-off, water interception banks (Figure 15) will be required to slow water flow and capture any run-off into water courses. By planting the base of these banks with suitable plants, nutrients will be filtered from the water.
A range of perennial plants could be used depending on soil type and rainfall, including Rhodes grass or kikuyu grass. In higher rainfall areas a reedbed may be necessary to filter large volumes of water.

For more detail regarding effluent management requirements, consult your local government authority.

KEY MESSAGES

- Assess your level of water run-off risk based on rainfall amount, rainfall intensity, ground cover, soil type and slope.
- High-risk water runoff areas will need interception banks.
- Interception banks will require vegetative cover and protection from hens.

7 Poisonous Plants

SUMMARY
A simple definition of a poisonous plant is one that contains chemical substances that can harm or kill animals eating it. Poisonous plants affect hen welfare and can potentially contaminate eggs. As a result, removal of poisonous plants from the range is required.

WHAT IS A POISONOUS PLANT?

A poisonous plant contains chemical substances in amounts that can harm or kill animals eating it. However it is the amount and type of chemicals they contain, the type of animal eating them, the amount eaten in relation to body weight, the time taken to eat that amount and the state of chemical processing in the animal's body that together determines if poisoning is likely to happen or not.

A plant that poisons one animal species does not necessarily poison another species. Listed on pages 26-27 are known poisonous plants for poultry. It is important to refer to plants by their botanical names rather than common names alone. Common names can be different across Australia for the same plant species.

EGG CONTAMINATION

Eggs may be contaminated by pyrrolizidine alkaloids if free range hens eat plants containing them or if fed grain contaminated by weed seeds containing these toxins. No cases of poisoning from pyrrolizidine alkaloids in eggs are known but there is a risk (McKenzie, 2012). Plants that contain these alkaloids include Patterson's curse (*Echium plantagineum*), camel bush (*Trichodesma zeylanicum*), *Amsinckia* species, rattlepods (*Crotalaria sp.*), helioptropes (*Heliotropium sp.*), fireweeds and ragworts (*Senecio sp.*) and comfreys (*Symphytum sp.*).

BIRD HEALTH

Poultry and birds are quite different from mammals in their susceptibility to different plant toxins. Poultry are more susceptible to pyrrolizidine alkaloids than other domestic livestock, except pigs. They are dangerous toxins because they are cumulative; building up over months or even years until the damage they cause is severe enough to show up as disease.

LEGISLATION

Under state government legislation, persons in charge of animals have a duty of care to protect their welfare. Theoretically this extends to the prevention of poisoning.

Occupants of private land are required by legislation in all Australian states and territories to control declared plants on their land. Almost all legislation on declared plants, noxious weeds or proclaimed plants is enacted at the state or territory level but enforced at the local government level. Local governments may have subsidiary legislation that applies only within their particular jurisdiction.

LIST OF POISONOUS PLANTS

There are a range of plants, both weeds and commercial plants that can be toxic to poultry. (See Table 3)

KEY MESSAGES

- Get any unknown plants growing on the range identified to make sure they are not toxic to hens.
- Removal of poisonous plants from the range is required.

Table 3. List of Poisonous Plants

COMMON NAME	BOTANICAL NAME	DISTRIBUTION	TOXIC PARTS
Gidee-gidee	***Abrus precatoris***	Native in tropical areas of Australia	Seeds highly toxic but need to be broken to absorb toxin
Monkshood	***Aconitum napellus***	Garden plants	Roots, leaves, flower & seeds
Horse chestnut	***Aesculus hippocastanum***	Garden tree	Seed, leaves, bark & flower
Onion	***Allium cepa***	Commercial vegetable	Can cause off-flavoured eggs.
Careless weed	***Amaranthus species***	Most are weed species; naturalised coastal QLD, northern NSW, NT. Cultivated species used for leaf, pseudo-grains and ornamental	Roots, leaves, stems. (fresh and dried)
Bishop's weed / Queen Anne's lace	***Ammi majus***	Present in all states	Leaves and seeds low toxicity. Can contaminate feed grain
Ironweeds Yellow burr weed	***Amsinkia species***	Widespread & common – Vic Limited distribution but locally common – WA, SA, Tas & NSW	All above ground parts and seeds moderately toxic. Seeds may contaminate grain.
White moth plant	***Araujia sericifera***	Naturalised and weedy growing on waste land, along roadsides, fencelines and edges of scrubs – SE Qld, NSW, Vic & Tas.	Leaves and seeds highly toxic
Mexican poppies	***Argemone species***	Widespread & common – NSW & Qld Widespread – WA & SA Rare or uncommon – Vic & Tas	Seeds contaminate feed; green plants unpalatable. Moderately toxic
Corncockle	***Argostemma githago***	Naturalised in NSW, Tas & SA	All parts
Horse radish	***Armoracia rusticana***	Garden vegetable	All parts, leaves and roots
Milkweed	***Asclepias species*** ***Asclepias curassavica***	Widely naturalised across Australia, most common eastern parts of Australia.	Leaves contain the most toxin, but all plant parts are toxic.
Rape, kale, turnip	***Brassica species***	Kale and turnip are commercially grown in isolated areas	All above ground parts but flower and seed-heads most toxic
Bryony	***Bryonia species***	Considered environmental weed	All parts, especially berries
Mother of Million	***Bryophyllum species***	Garden escapee and weed, Eastern Australia, NSW & QLD, small infestations in Vic	All parts; flowers 5 times more toxic than other plant parts
Green cestrum	***Cestrum parqui***	Commonly around towns, farm buildings and along fencelines and water courses – SE Qld, NSW, Vic & SA.	All parts highly toxic
Hemlock	***Conium maculatum*** **(similar appearance to Ammi majus)**	Widespread & common – SA & Tas Widespread – WA Limited distribution but locally common – Qld, NSW & Vic	All parts of the plant are toxic with flower heads and fruit the most toxic
Lily of-the-valley	***Convallaria majalis***	Grown in gardens in temperate regions of Australia.	All parts highly toxic.
Rattlepods	***Crotalaria species***	Native and widespread in tropical and subtropical areas	All above ground parts and seeds moderately toxic. Seeds may contaminate grain.
Thornapple	***Datura species***	Prefer fertile soils growing on river flats and stockyards. Widespread – Vic; Limited distribution but locally common – NSW & Qld; Rare – WA, SA & Tas.	Seeds, leaves and flowers moderately toxic. Crushed seeds more toxic.
Pattersons curse	***Echium plantagineum***	Widespread and common in WA, SA, NSW & Vic Widespread in Tas.& southern Qld	All above ground parts and seeds moderately toxic.
Cotton	***Gossypium species***	Grown commercially in Qld, NSW & Ord irrigation district in WA	Seeds (whole cotton seed). Poisoning usually occurs after weeks or months of eating a diet rich in cotton seed or cotton seed meal. Low toxicity

COMMON NAME	BOTANICAL NAME	DISTRIBUTION	TOXIC PARTS
Blue Heliotrope	***Heliotropium amplexicaule***	Limited distribution but locally common – NSW & Qld; Rare – SA & Vic; Unknown – WA & Tas	All above ground parts and seeds moderately toxic.
Common heliotrope	***Heliotropium europaeum***	Widespread as a summer growing plant in WA, SA, NSW and Vic.	All above ground parts and seeds moderately toxic. Seeds may contaminate cereal grains.
Native heliotrope	***Heliotropium ovalifolium***	Native to tropical areas of Australia	All above ground parts and seeds moderately toxic
Small flowered mallow	***Malva parviflora***	Naturalised and weedy in the southern two-thirds of Australia, mainly around farm buildings and roadsides and in stockyards.	Mainly seeds. Hens produce eggs that discolour during storage. Low toxicity
Oleander	***Nerium oleander***	Sparsely naturalised in all Australian states. Commonly grown in gardens.	All parts highly toxic
Avocado	***Persea americana***	Cultivated as a fruit tree	All plant parts moderately toxic, except seed.
Black locust	***Robinia pseudocacia***	Grown in gardens and streets in temperate Australia.	Bark is the most toxic but leaves and seeds can also cause poisoning. High toxicity
Azaleas	***Rhododendron species***	Garden plants	All parts
Ragwort / Fireweeds	***Senecio jacobacea*** ***S. linearifolius*** ***S. madagascariensis***	Varies between species but one or more species present in WA, SA, Vic, NSW, Tas and southern Qld S. linearifolius native	All above ground parts moderately toxic
Potato	***Solanum tuberosum***	Cultivated as vegetable	All above ground plant parts and berries. Sprouted or green tubers. Moderate toxicity
Blind grass	***Stypandra glauca***	Grows on or near granite rocks. Native and widespread in south west WA, NSW and Vic.	Both young green shoots and flowering plants highly toxic
Comfrey	***Symphytum species***	Sparsely naturalised in south eastern Australia as garden plant	All above ground parts have low toxicity
Noogoora burr	***Xanthium strumarium***	Limited distribution but locally common – Qld, NSW & Vic Rare or uncommon – WA, SA & Tas	Cotyledon leaves and burrs only are highly toxic.

8 Case Study Farms

These case study farms helped the authors understand the plants in use in Australian free range egg farms and provided insight on which plants worked well and which didn't.

The farms were fixed range free range farms, the focus was on what was planted/growing on the range and how the farms managed ground cover and trees.

The case study farms were located in different climatic zones and were visited up to twice per year corresponding with flocks in peak lay and mature flocks prior to depopulation. Five farms were visited during 2018 and 2019.

On two of the case study farms (Farm 1 and 2), flocks were selected that had started ranging.

The case studies include information about the farm (such as climate, soil type and time of establishment) as well as what's growing on the range and observations of the hens during the authors visits.

You can use this information to see how farms similar to yours have managed their range and the outcome.

Farm 1

Temperate climatic zone (Mediterranean)

AVERAGE ANNUAL RAINFALL & RAINFALL PATTERN

470mm, winter dominant rainfall pattern.
Rainfall total 2018 = 250mm.
Rainfall total 2019 = 252mm

SOIL TYPE

Typically, red-brown earths have a topsoil of sandy loam to light clay loam overlying a clay subsoil.
Soil pH* at the following depths was:

At 0-30cm: 6.6-7.0

At 30-60cm: 7.6-8.0

At 60-100cm: 8.1-9.5

*measured in $CaCl_2$

LENGTH OF TIME THE FARM HAS BEEN OPERATING

The farm has been running free range layers for over 50 years as part of a broadacre cropping-livestock enterprise. The case study flocks' range area and shed is approximately 5-6 years old.

SHED AND RANGE DESIGN

The shed is located in the centre of a square shaped range area that caters for up to 1,500 hens per hectare. The range area is subdivided into four sections.

Orientation of shed
East-West.

Shed type (1-sided or 2-sided pop-holes)
The shed was sub-divided down the middle lengthwise and each sub-flock had access to their own range area. The entire lower half of the north and south facing sides of the shed open to allow hens access to the range.

Additional structures (eg. shade shelters, hay bales) on the range
Shade shelters are located 5m from the shed on the north and south side of shed.

FLOCK

Total flock 5,000 Hy-line Brown hens divided into two sub-flocks of 2,500 hens each. Two flocks were observed, Flock A and Flock B.

OUTDOOR STOCKING DENSITY

Up to 1,500 hens /ha.

CONDITIONS AND OBSERVATIONS ON FARM VISITS

Case study visits in 2018 were made when Flock A were 32 and 65 weeks old. In 2019, Flock B were 25 and 41 weeks old during visits (Flock B).

2018
In December strong SW winds meant that most hens outside chose to forage and dustbathe on the northern side of the shed.

In May most of the hens on the range were on the shady southern side of the shed.

The maximum percentage of Flock A outside during the case study visits was 12.5%.

GROUND COVER SPECIES ON THE RANGE

Sown

- **Lucerne (*Medicago sativa*)** had been sown extensively on the range areas of Farm 1 (Figure 16).

Pre-existing

- A naturalised annual form of saltbush, **lagoon saltbush** (Atriplex suberecta) was growing closest to the shed, but very well grazed down by the hens.
- At 40m from the shed **Lucerne** was dominant with no weeds at this distance.
- At 20m from the shed, lucerne and lagoon saltbush were growing in combination.

Weeds

- Very few weeds were found and they grew 10m and 20m from the shed.
- Weed species included **wild mustard** (*Sinapis arvensis*), **marshmallow** (*Malva parviflora*) and **wire weed** (*Polygonum aviculare*).

CONDITION OF THE GROUND COVER VEGETATION ON THE RANGE

2018
Drought conditions during 2018 had a significant impact on Lucerne growth. However, if not for the lucerne and the lagoon saltbush, there would not have been any green ground cover.

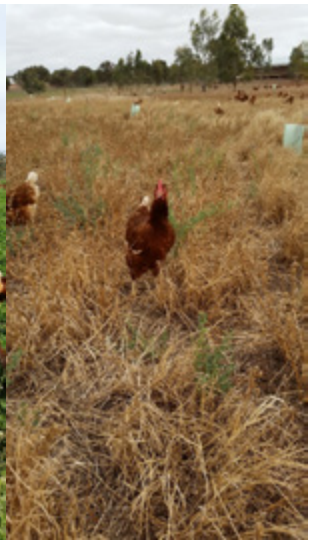
Pasture height was taller furthest from the shed. As hens had been foraging away from the shed

Figure 2

Range in autumn 2018 when hens 32 weeks old.

Early summer 2018 showing Lucerne when hens 65 weeks old.

July 2019 – The range had at least 90% green ground cover at 40m from the shed.



November 2019 – Annual plants have died off leaving green Lucerne plants and an average green ground cover of 18%.

the height of Lucerne had decreased from 25cm tall at 32 weeks to 15cm at 65 weeks at a distance of 40m. The range area surrounding the shed was bare out to around 10m.

July 2019

The area rested during 2018 was opened for flock B during 2019. Green ground coverage was high in July 2019, except at 10m were there was 14% cover. At 20m and 40m there was 84% tand 90% cover respectively.

November 2019

- Green ground coverage had dropped dramatically by November 2019, at 10m there was only 8% green cover, 20m= 11% green cover and 40m= 18.5% green cover.
- This was largely due to the annual plant species dying off at this time of the year; a normal occurrence for Mediterranean climatic areas.
- Lagoon saltbush had made an appearance again in November and was mostly found at 10 and 20m from the shed. In July Lagoon saltbush was not seen.
- By November Lucerne was the most dominant species and remained green while the annual plant species (marshmallow, annual ryegrass and Shepherd's purse) had died off (Figure 16).
- Lucerne was not dominant in July, other species were present such as **marshmallow**, **annual ryegrass** (*Lolium rigidum*) and **Shepherd's purse** (*Capsella bursa-pastoris*).
- The area rested during 2019 had more green ground cover at 20m (20% cover) and 40m (31% cover) from the shed in November 2019 compared to the area that had been ranged throughout 2019 (11% and 18% for 20m and 40m respectively).

TREES ON THE RANGE

Eucalyptus was planted on the range.

Type: Locally adapted Eucalyptus tree species.

Number: at least 60 established trees from 1m to 6m tall and 200 younger trees less than 1m tall.

Placement: 5 rows running parallel to the shed, within the rows the trees were planted around 5m apart. Rows are adjacent, 10m, 25m, 40m and 55m from the shed and run the full length of the range area.

Source: Trees were sourced from "Trees for Life".

Care: Newly planted trees are protected with 40cm tall green corflute tree guards.

RANGE MANAGEMENT

- The range area is subdivided so there is the ability to rotate between 2 paddocks for each sub-flock.
- Sown Lucerne is given 12 weeks to establish before hens are introduced to the range.
- Lucerne survived the drought conditions, however older Lucerne stands on the range had to be re-sown.

FARM 2

Temperate climatic zone (Cool)

AVERAGE ANNUAL RAINFALL & RAINFALL PATTERN

Average annual rainfall is 610mm, uniform rainfall pattern throughout the year.

2018 Rainfall total = 635mm. (Spring was drier than usual.)
2019 Rainfall total = 432mm.

SOIL TYPE

Acidic loam with less acidity at depth.
Soil pH* at the following depths was:

At 0-5cm: 5.6-6.0

At 5-15cm: 4.9-5.5

At 15-60cm: 5.6-6.0

At 60-100cm: 6.1-6.5

*pH measured in $CaCl_2$

LENGTH OF TIME THE FARM HAS BEEN OPERATING

6 years.

SHED AND RANGE DESIGN

Square range of 19,000m^2. The northern range is twice the size of the southern range. There is no eastern range area.

Orientation of shed
East–West.

Shed type (1-sided or 2-sided pop-holes)
Pop-holes are located along the north and south facing sides of the shed.

Additional structures (e.g. shade shelters, hay bales) on the range

- There were 10, steel framed shade structures (5 x 5m) with shade cloth. These were located close to the shed when the flock was young and moved progressively further from the shed as the flock matured.
- Hay bales had been placed on the range, particularly when the green ground cover had disappeared. The hens scratch through the hay breaking it down into smaller pieces potentially adding organic matter to the soil.

FLOCK

Throughout the research project 2 flocks were housed in the shed. In 2018 there was a total of 14,880 Hy-line Brown hens in the flock (Flock C).

In 2018 case study visits were made when Flock C were 42 and 72 weeks old. During 2019 only one visit was made when Flock D were 68 weeks old.

OUTDOOR STOCKING DENSITY

Up to 10,000 hens /ha.

CONDITIONS AND OBSERVATIONS AT FARMS VISITS

2018
Weather conditions at the time of the visits was cool, partly cloudy with a light breeze. 14% of Flock C were outdoors at the time of the visits. Hens were found across all parts of the range with at least 50% of those hens outdoors beyond 10m from the shed.

2019
Weather conditions were sunny, no breeze and 21°C. At least 50% of Flock D was outdoors. Of the hens outside, 80% were away from the shed in the wattle groves and under the cypress pines along the perimeter fence. There were very few hens using the constructed shelters adjacent to the shed.

GROUND COVER SPECIES ON THE RANGE

Wire weed (*Polygonum aviculare*) had been the main ground cover plant on the first visit in March 2018, with almost total cover except for bare ground within 5m from the shed.

CONDITION OF THE GROUND COVER VEGETATION ON THE RANGE

2017
The flock had attacked the newly established pasture species of perennial ryegrass (Lolium perenne), red clover (Trifolium pratense) and white clover (Trifolium repens) in the dry season (503mm annual rainfall).

2018
Due to the dry season and over grazing, wire weed dominated. By October green ground cover had been denuded from the range by the time Flock C was at 72 weeks.

2019
The range was lightly cultivated and re-sown in March with biennial ryegrass (Lolium multiflorum), oats (Avena sativa) and white clover in preparation for

Figure 17. Farm 2 plant nursery used to grow trees to a larger size before planting on the range.

Figure 18. Farm 2 wattle planted (1 year since planting) on the range with rocks around the base to protect the roots.

Figure 19. Wattle groves with trees at least 3m tall after only 2 years since planting on the range of Farm 2, groves are being highly utilised by hens.

Flock D placement in March 2019. Weather conditions were dry and the hens soon targeted the palatable ryegrass.

TREES ON THE RANGE

New trees

- Trees planted on farm 2 are locally adapted native species and were sourced from a local nursery as seedlings.
- Seedlings are grown on into larger pots (up to 30cm diameter) in the farm's own simply constructed plant nursery (Figure 17).
- When the trees reach 1m tall they are planted out onto the range. At this height, they don't require tree-guards.
- Tree planting is usually done from March to November, with around 114 newly planted trees in the last 12 months on the range.
- In total the farm has over a 1,000 newly planted trees. On other range areas, trees have recently been planted in twin rows that start near the shed and extend to the outer range to help encourage hens to move further out from the shed.

EXISTING TREES

Cyprus trees

Furthest from the shed along the northern fence line is a row of mature **cypress trees**. This area of the range has been well utilised by the hens, to the extent that the trees needed their root zone protected with large rocks.

Silver wattles

- Young **black and silver wattles** (*Acacia mearnsii* and *A. dealbata*) planted on the range were growing particularly well and had reached over 3m tall in 2 years.
- Wattles had been planted in circular shaped groves consisting of 18 wattles spaced 3m apart with a slower growing **flowering gum** (*Corymbia ficifolia*) in the centre. In total there are six wattle groves planted on the range situated approximately 40-60m from the shed.
- Hens were observed utilising the groves for dustbathing, sheltering and resting (Figure 19). Tree roots remain well protected from hen activities, with large rocks placed at the base of the young trees (Figure 18).

RANGE MANAGEMENT

- Some underutilised range areas on the farm require regular mowing (fortnightly) as they contain fast growth of grasses such as **cocksfoot** (*Dactylis glomerata*), **perennial ryegrass** and **prairie grass** (*Bromus wildenowie*).
- There is also a background of **subclover** (*Trifolium subterraneum*). The farm was an ex-dairy property and the grasses and the subclover are the result of what was a well-maintained dairy pasture.
- Grass dominant ranges have been over sown with pasture legumes such as lucerne, red and white clover.

Farm 3

Sub tropical climatic zone (summer dominant rainfall)

The information presented on farm 3 is based on two visits with no specific flocks followed. Three systems of free range production are being run on the farm; fixed range 1,500 hens/ha, fixed range 10,000 hens/ha and organic mobile sheds at 1,500 hens/ha.

AVERAGE ANNUAL RAINFALL & RAINFALL PATTERN

Regional rainfall average = 626mm, summer dominant pattern.
Rainfall total for 2018 = 544mm.
Rainfall total for 2019 = 169mm.

SOIL TYPE

Clay and heavy loam soils.
Average soil pH at the following depths was:

At 0-10cm: 6.2

At 10-30cm: 7.1

At 50-60cm: 8.8

LENGTH OF TIME THE FARM HAS BEEN OPERATING

At least 10 years.

SHED AND RANGE DESIGN

Organic production. Rectangular shaped range with the shed in the middle, each range is 3ha (1.5ha each side of the shed). Another range area the same size is adjacent, this is used in rotation every 60 weeks. The organic shed is designed to be moved to the adjacent location with every new flock.

Orientation of shed
East-West.

Shed type (1-sided or 2-sided pop-holes)
2-sided with pop holes on southern and northern sides.

Additional structures (e.g. shade shelters, hay bales) on the range
Long rectangular shade shelters are placed near pop holes (8-12 shelters per shed).

FLOCK

Hy-line Brown and Isa Brown, 4,500 hens per flock.

OUTDOOR STOCKING DENSITY

Organic flock = 1,500 hens/ha.

CONDITIONS AND OBSERVATIONS AT FARMS VISIT

Not assessed on the first visit in 2018. On the day of the second visit in November 2019, it was hot and sunny day with a maximum temperature 36°C. Some hens in all free range systems had left the shed but did not venture far onto the range and remained close to the pop-holes or sheltered under the ramps and shade shelters adjacent to the sheds.

GROUND COVER SPECIES ON THE RANGE

Sown

- **Lucerne** had been sown on some of the ranges.
- **Kikuyu** (*Pennisetum clandestinum*) had been trialled in the past but was too reliant on irrigation to keep it looking good and growing.

Pre-existing

- The main perennial grasses growing on the ranges are **Rhodes grass** (*Chloris gayana*), **Creeping blue grass** (*Bothriochloa insculpta*), **African lovegrass** (*Eragrostis curvula*), **African star grass** (*Cynodon plectostachyus*) and un-improved native grass pastures.
- Mostly **Rhodes grass** is resilient to hens (Figure 5), but it can be killed by hens if they are allowed too soon onto new regrowth following mowing. Although another species of Rhodes grass, **"Feathertop Rhodes grass"** (*Chloris virgata*) has become an issue on some 1,500 hen/ha ranges. It is considered a major weed of broadacre farming enterprises and is a tufted annual that grows to 1m tall that can readily set and reproduce from seed and competes strongly with more desirable species.

Weeds

- None noted

CONDITION OF GROUND COVER ON THE RANGE

2018

Despite most ranges being well covered (except closest to the shed) most flocks didn't venture much further than 20-30m from the shed. It was noted by the farm manager the hens do not like moving through tall grass. To encourage hens out, corridors were mown through long grass however this still had minimal effect on encouraging more hens further out.

2019

Drought conditions had impacted pasture growth severely whereby there had been no new growth at the time of the visit in November 2019. Ranges stocked at 1,500 hens/ha had maintained standing dry grass further away from sheds.

TREES ON THE RANGE

- Trees and shrubs are all locally adapted.
- Wattles are not being planted because of potential weediness concerns as the farm is located close to native bushland.
- Newly planted trees on the range are protected with wire mesh guards, not to prevent hen damage but to protect against corellas that nip out growing tips and strip the leaves from young trees.
- Mulch pads are also used around the base of newly planted trees. They reduce weeds and are designed to funnel light rain and dew onto the root zone and reduce evaporation from the root zone (Figure 22).
- Recent tree plantings have been arranged in rows radiating out from the shed onto the range, it's anticipated that this will encourage more hens further away from the shed.

Planting Oldman saltbush (Atriplex nummularia)

– Oldman saltbush (Atriplex nummularia) variety "De Kock" was planted during 2019 on the ranges of the 10,000 hens/ha sheds and some organic sheds ranges.

Planting

– Planting rows were firstly deep ripped, then a planting hole was made with an auger.

– Fertiliser was also added to the planting hole.

– The area planted to saltbush starts 5m from shed out to the first row of trees approximately 30m away in a 3 x 3m configuration. It is the zone on the range that normally doesn't grow much.

– The saltbush on the organic shed ranges were planted in twin rows inside the range boundaries and also at right angles from the shed to the outer saltbush boundary.

Care

– Under the dry weather conditions of 2019 the saltbush was watered weekly.

– The saltbush area is fenced off from hens on the 10,000 hens/ha sheds while the saltbush establishes (Figure 23).

– When the saltbush reaches at least 1m tall the area will be opened up for hens to access.

Outcome

– Saltbush grew very well with the tallest saltbushes already 40-50cm high after 4 months post planting. Saltbushes closest to the tree line are shorter due to competition effects from trees.

– Saltbush was also responding very well to fertiliser, particularly nitrogen.

RANGE MANAGEMENT

- The organic system rotates the range area every 60 weeks.
- Usually fixed range areas of 1,500hens /ha require regular mowing of the outer range areas (Figure 21), except during 2019 as there was very little growth due to dry conditions.
- Fixed range 10,000 hens/ha range areas usually require re-sowing. However, free range accreditation schemes stipulate that only one-third the area at any one time can be fenced off and re-sown.
- In light of this, the farm may consider placing a 10,000 hens/ha flock under barn production for one production cycle to allow the pasture on the range to be totally renovated.

Figure 20. Farm 3 – Rhodes grass clumps on a range stocked at 10,000 hens/ha.

Figure 21. Farm 3 – Naturalised perennial grasses and young trees (planted) on the range stocked at 1,500 hens/ha.

Figure 22. Farm 3 – Fluted mulch pad that collects rain and dew and redirects water to root zone.

Figure 23. Farm 3 – Saltbush planted in the 5-30m zone of a 10,000 bird/ha shed. Growth at 3 months old.

Farm 4

Temperate climatic zone (no dry season with a warm summer)

AVERAGE ANNUAL RAINFALL & RAINFALL PATTERN

Average annual rainfall is 1066mm, uniform rainfall pattern.
2019 Rainfall total = 617mm.

SOIL TYPE

Heavy textured clay soils, highly acidic through much of the profile. Soil pH* was:

At 0-60cm: 3.0- 4.8

At 60-100cm: 5.6- 6.0

*Soil pH is measured in $CaCl_2$.

LENGTH OF TIME THE FARM HAS BEEN OPERATING

The farm has been running poultry since 1997 and the case study shed is 7 years old.

SHED AND RANGE DESIGN

The shape of the range is roughly square and subdivided into 4 paddocks. Each subdivided paddock is one hectare.

Orientation of shed
East-West.

Shed type (1-sided or 2-sided pop-holes)
2-sided with pop holes on southern and northern sides.

Additional structures (e.g. shade shelters, hay bales) on the range
No shade structures on the 10,000 hen/ha range as there are plenty of trees.

FLOCK

30,000 Hy-Line Brown, 40 weeks old at the time of the visit (July 2019).

OUTDOOR STOCKING DENSITY

10,000 hens/ha.

CONDITIONS AND OBSERVATIONS AT THE FARM VISIT

At the July 2019 visit the weather was sunny, 14-17°C, light breeze, slightly damp soil. Approximately 4,000 birds were outside. An estimated 300 hens were foraging on the outer extremities of the range area with a majority of the hens dustbathing under trees by the shed.

GROUND COVER SPECIES ON THE RANGE

Sown

- **Blue couch (Kentucky bluegrass)** was growing well on the range (Figure 25). This was harvested from other parts of the farm and transplanted on the range area. Initially the couch runners needed to be buried to protect from hens.
- Sowing Kentucky bluegrass seed was considered but seed is extremely expensive at $300/kg. Turf type grasses can be useful for the range but expensive seed will be an issue on large range areas. Therefore farm management are considering buying a second-hand turf harvester for transplanting their own couch.
- **Perennial ryegrass** and **red clover** have been sown on some of the ranges. Although the clover is the first to be picked out by the hens.
- Lucerne has also been trialled but was not successful.

Pre-existing

- **Pin rush** (*Juncus usitatus*) is growing in some places with couch in between (Figure 24), however pin rush can be destroyed by hens, they can trample through and flatten it to the ground.
- **Kikuyu** is growing in some areas on the range, however hens will eventually dig up the runners. Kikuyu is an issue on the farm, as the property also raises cattle. Nitrite poisoning and a fungal disease that infects kikuyu can cause toxicity in cattle.

WEEDS

- Common weed species on the range are **stinging nettle** (*Utrica dioica*), **marshmallow** (*Malva parviflora*), **fat hen** (*Chenopodium album*), **Paddy's Lucerne** (*Sida rhombifolia*). The hens do not eat the stinging nettle and they use the Paddy's Lucerne for shelter.
- Weed control is via mulching, especially weeds such as marshmallow.

TREES ON THE RANGE

Type, placement and condition

- At least 10 native tree species which include sheoaks and callistemon were planted 8 years ago.
- Wattles were originally planted on the range but these were removed due to processionary caterpillars (Ochrogaster lunifer) that lived on the wattles. Processionary caterpillars were a major problem due to their noxious hairs that irritated livestock including the hens.
- The closest group of trees are located 10-20m from the shed.
- Some trees have their roots exposed from hen activity, particularly those growing on steep slope areas.
- Some trees closest to the shed are dying and this may be due to high nutrient loads.
- Trees have also been planted on the downside of contour banks.

Range management

- The subdivision of the range into 4 areas enables rotation with one area re-sown and rested at a time.
- The area requiring renovation is firstly cultivated to level out the surface from dust bathing divots.
- The overall range is sloping with contour banks. The contour banks have been fenced off from hens.
- Connecting passageways have been constructed through contour banks to enable hens to move to the lower slope areas of the range. These passage areas have tyres and mesh to protect soil from digging birds and allow water movement.

Figure 24. Couch grass area with pin rush and trees below contour bank.

Figure 25. Couch grass on the lower slope of case study farm 4.

Farm 5

Temperate climatic zone (Mediterranean)

PLANTING SALTBUSH ON THE RANGE

This case study farm specifically tested the viability of planting saltbush on the range.

INTRODUCTION

Trees and shrubs on the range are highly beneficial as they:

- Provide shade and shelter for hens.
- Encourage hens to go outside and explore.
- Add to the aesthetics of the range.
- Buffer odour, dust and noise emissions.

Even though the case study describes planting saltbush, the information presented is applicable for planting most tree or shrub species and includes the pitfalls encountered during this research project.

Oldman saltbush (*Atriplex nummularia*) was chosen for this research because it is well adapted to the region where the case study farm is located.

Free range farms in **high rainfall areas** with **acidic soils** could consider other fast growing species such as Tagasaste (*Chamaecytisus palmensis*) and wattles (Acacia species).

AVERAGE ANNUAL RAINFALL & RAINFALL PATTERN

Average annual rainfall for the farm is around 360mm, with cool wet winters and hot dry summers.
2017 Rainfall total: 355mm.
2018 Rainfall total: 170mm.
2019 Rainfall total: 221mm.

SOIL TYPE

Soils are moderate to highly calcareous gradational clay loams with moderate fertility. Alkalinity increased with depth. Soil pH* was:

6.6-7.0 at 0-15cm

7.1-7.5 at 15-60cm

7.6-8.0 at 60-100cm

– Boron toxicity issues can be found at depths 50-100cm which cause foliage to brown in susceptible plant species and varieties.

* measured in $CaCl_2$

Figure 26. Small leaf bluebush (*Maireana brevifolia*) on the range of the case study farm 5.

LENGTH OF TIME THE FARM HAS BEEN OPERATING

The farm was established from 2015 to 2017 and most trees and shrubs had been planted within 50m from the sheds.

SHED AND RANGE DESIGN

The range area is 4 hectares orientated east-west in a rectangular shape with the shed located centrally at the eastern end. The range area 50m beyond the shed on the western side had very few trees, although there are scatterings of native small leaf bluebush (Maireana brevifolia) (Figure 26). Range areas are relatively flat.

Orientation of shed
East-West.

Shed type (1-sided or 2-sided pop-holes)
Sheds (16.5 x 132m) with pop-holes down both long sides of the shed.

Additional structures (e.g. shade shelters, hay bales) on the range
None noted.

Flock and outdoor stocking density
Individual flock sizes on the farm are 30,000 hens stocked at 10,000 birds/ha.

SALTBUSH PLANTING

Why Oldman saltbush was chosen

Suitability to area

- Oldman saltbush is very well adapted to the area with a plantation block for sheep production situated only 1km from the farm.
- Once Oldman saltbush is established it will be tolerant to dry conditions including drought and another bonus it is a fire retardant. In summer when annual pastures have dried-off, saltbush will provide green forage on the range.

Figure 27. Left – PottiPutki planter in action. Middle – planter with beak mechanism in closed position ready for inserting into soil. Right – beak mechanism open ready for planting. The seedling is dropped down the hollow tube section of the planter and then the planter lifted up out of the way. Soil around the seedling is compacted by the operator's feet.

Quick growing
Oldman saltbush grows relatively fast under favourable conditions and can reach a height of 1m by 12 months of age.

Cost-effective
Seedlings are relatively cheap at 40 cents each for an order of 1,000 seedlings.

Availability
The saltbush nursery had already exposed the seedlings to outdoor conditions which is an essential step before planting. TIP: *If planning on planting Oldman saltbush yourself it is important to ask the nursery, are the seedlings ready to plant and hardened to climatic elements?*

Preparation

- Two range areas of two separate flocks were selected for planting saltbush.
- The areas to be planted were sprayed 20 days before planting (on the 7/09/2017) with Roundup Powermax® (Glyphosate at 3L/ha) and planting rows were deep ripped three days after this (on 11/09/2017).

Figure 28. Saltbush seedling in corflute guard.

- This was done well before the hens commenced ranging.
- Deep rip lines had worked well on one range area but in the other area had created large clods of soil.

PLANTING

- In 2017 saltbush was planted during the driest month of that year (September total: 3.2mm) and soil conditions were dry on the planting days (27 to 28/09/2017).
- Saltbush planting was done too soon after ripping as the range with clods caused problems with physically planting seedlings between soil clods and then watering, water disappeared between soil clods beyond the root zone of the newly planted saltbush.
- Another planting of saltbush was made in 2018 (24/08/2018 and 7/09/2018) to fill in some of the gaps due to poor survival from the 2017 planting.

Method

1. Oldman saltbush variety "De Kock" was used, which came in seedling trays holding 150 seedlings.
2. Just prior to planting, seedlings were popped out of the tray and placed into a 9L bucket with a mixture of 3L water and Seasol®. The bucket could hold at least 50 seedlings.
3. Planting was done using a PottiPutki (Figure 27) which is an ergonomically designed manual tree planter.
4. Planted seedlings were protected with green corflute 40cm high triangular guards (Figure 28) and watered after planting.

Placement

- Four twin rows of saltbush were planted per range 16m apart.
- Rows started at least 50m from the western end of the shed and were 250m long.
- Twin rows of saltbush were 4m apart and within a row saltbush was spaced at 4m (Figure 29).
- This gave the option to thin out if necessary in later years. The plan was to also sow new pastures between the saltbush rows; this did not eventuate as conditions were far too dry.

OUTCOME – SALTBUSH SURVIVAL RATES

- In 2017 a total of 1,000 seedlings were planted (500 per range) and a further 500 (250 per range) in 2018 to fill in the gaps due to seedling deaths in 2017.
- In hindsight this was too many seedlings to look after, given conditions at planting were so dry and it meant a lot of follow-up watering.
- Despite the dry conditions the survival was 41% and 51% for the two range areas in October 2019. This level of survival was only possible through strong commitment from farm staff watering the saltbush every fortnight.

Figure 29. Oldman saltbush rows in late summer on the case study Farm 5, 6 months after planting, the dark green low growing shrubs on the range are small leaf bluebush.

Figure 30. Hens foraging and dustbathing around Oldman saltbush on the case study farm 5 during winter 2019.

Figure 31. Mid spring in 2019 the inter row annual pasture species have died off and hens are using the saltbush for shade.

HEN INTERACTIONS WITH SALTBUSH

- Research has shown hens are attracted to saltbush and will eat up to 5% saltbush in their diet (de Koning *et al*. 2019). Some of the saltbush plants from the 2017 planting had grown to at least 1m tall by October 2019 and hens were using the saltbush to rest and dustbathe under (Figures 30 & 31).
- Similarly, small leaf bluebush that naturally occurs on one range area was also attracting hens for dustbathing and sheltering. Wildlife cameras were placed near the saltbush to see how frequently the hens used the area.
- Interestingly, similar numbers of hens visited the saltbush areas closest to the shed (at least 70m from shed) as those saltbush areas further away from the shed (at least 120m from shed). Although, those cameras 70m from the shed were triggered 3 to 5 times more often by hen activity than the more distant cameras at 120m.

KEY MESSAGES

- Choose tree/shrub species adapted to your area, consult your local nursery and agronomist.
- Plant into damp soil, not dry.
- If deep ripping, allow deep rip lines to settle before planting, particularly if large clods are formed from ripping.
- Look at the long term weather forecast. If prolonged dry conditions are predicted, ask yourself is it worthwhile to plant? Alternatively delay planting and/or reduce the number of trees planted.
- Look after your seedlings immediately after planting by watering well and protect with guards.
- Water regularly (weekly or fortnightly) throughout the first summer or prolonged dry periods.

Reference

De Koning, C., Barekatain, R., Singh, M. and Drake, K. (2019) Saltbush (*Atriplex nummularia* and *A. amnicola*) as potential plants for free-range layer farms: consequences for layer performance, egg sensory qualities, and excreta moisture. Poultry Science, 98(10); 4555 – 4564.

9 Glossary

Table 1. Soil attributes and their significance for pasture production (Source: McKenzie et al. 2012)

ATTRIBUTE	SIGNIFICANCE
Aggregate stability	Guide to soil physical fertility. Potential for clay dispersal and adverse impacts on water quality.
Bulk density	Indicates suitability for root growth and guide to permeability. Necessary for converting gravimetric estimates to volumetric.
Cation exchange capacity	Guide to nutrient levels. Indicates the degree of weathering. Guide to clay mineralogy (when used with clay content).
Clay content	Affects texture.
Coarse fragments	Affects water storage and nutrient supply.
Depths to A1, B2, impeding layers	Used to calculate volumes of water and nutrients (e.g. plant available water capacity, storage capacity for nutrients and contaminants).
Electrical conductivity (salinity)	Presence of potentially harmful salt. Indicates the degree of leaching.
Exchangeable sodium percentage (sodicity)	Indicator of dispersive clays and poor soil physical properties.
pH (acidic, neutral or alkaline)	Controls nutrient availability and many chemical reactions. Indicates the degree of weathering.
Plant available water capacity	Primary control on biological productivity and soil hydrology.
Saturated hydraulic conductivity	Indicates likelihood of surface runoff and erosion. Indicator of the potential for water logging. Measure of drainage.
Sum of exchangeable bases	Guide to nutrient levels. Indicates the degree of weathering.
Texture	Affects most chemical and physical properties. Indicates some processes of soil formation.
Volumetric water content (–10 kPa)	Used to calculate water availability to plants and water movement.
Volumetric water content (–1.5MPa)	Used to calculate water availability to plants and water movement.

Agronomy/Agronomist
The science of cultivation of land, soil management, and crop production.

Bulk density
Weight of soil in a given volume. Soils with a bulk density higher than 1.6 g/cm3 tend to restrict root growth. Bulk density increases with compaction and tends to increase with depth. Sandy soils are more prone to high bulk density.

Calcareous
Soils that contain high levels of calcium carbonate.

Cannibalism
Eating the flesh of one's own species.

Conductivity (ionic)
A measure of a material's ability to conduct an electric current through ionic charge carriers (salt, water etc.).

Conventional cultivation
Two or three full cut cultivations before sowing.

Direct drilling
Single pass sowing without prior cultivation.

Hardseed levels
Mechanism of seed dormancy that allows formation of a persistent seedbank; as a result of an impermeable layer in the seed coat that prevents water uptake by the seed.

Foraging
Animals/birds searching widely for food.

Inoculant
Formulation that contains rhizobia; they can consist of peat, clay and peat granules, freeze-dried cultures and liquid cultures.

Pyrrolizidine alkaloid
Amongst the most important toxins affecting livestock in Australia and the world. Their properties can directly damage human and domestic animal health and consequently they can strongly affect national and international trade in grain and livestock products.

Rhizobia
Bacteria that fix nitrogen (diazotrophs) after becoming established inside root nodules of legumes.

Waterlogging
Saturation of soil with water in a plant's root zone, which decreases the oxygen available to roots.

10 Further Reading

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The Australian Government. The Treasury, *Decision Regulation Impact Statement – Free Range Egg Labelling*, Consumer Affairs Australia New Zealand, March 2016.

11 Useful Websites

Pastures

www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/species-varieties

www.daf.qld.gov.au/plants/field-crops-and-pastures/pastures

www.agric.wa.gov.au/pasture-species

www.mla.com.au/research-and-development/Grazing-pasture-management/improved-pasture/pasture-selection

Pasture establishment costs

www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/establishment-mgmt

pir.sa.gov.au/consultancy/farm_gross_margins_and_enterprise_planning_guide

farmstyle.com.au/news/pasture-development-small-farms

Environmental management

www.australianeggs.org.au/for-farmers/environmental-management

Biosecurity

www.australianeggs.org.au/for-farmers/biosecurity

www.farmbiosecurity.com.au/industry/chickens

Feedstuff nutritional value

www.feedipedia.org

Bureau of Meteorology

www.bom.gov.au

Australian eggs