

FARM WOODLAND FORUM

Annual Meeting 30th June – 1st July 2011

Organic Agroforestry: Eco-functional Intensification

INTERNATIONAL PERSPECTIVES ON DESIGN OF TEMPERATE FODDER HEDGEROWS

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Outline

- 1) Inspiration – *Leucaena* hedgerows in Malaysia
 - a) Benefits
 - b) Constraints
- 2) Multiple forage shrubs – the *Enrich* project in Western Australia
 - a) Introduction and summary conclusions
 - b) Boost to whole farm profit
 - c) Forage shrubs as part of a mixture
 - d) Selecting shrub species
 - e) Plant attributes of selected forage shrubs
 - f) Grazing management with shrubs in mixed forage system
- 3) Some possible forage shrub species for UK
- 4) Additional suggestions from the floor
- 5) Design of possible UK systems

1. Inspiration - Leucaena hedgerows in Malaysia

1.1. Pastures from tropical rainforest



1. Inspiration - Leucaena hedgerows in Malaysia

1.2. Leucaena hedgerows with *Bracharia decumbens* – after two weeks grazing



1.2. Leucaena hedgerows - 2, 4, & 6 week's regrowth, and after 1 week's grazing



1. Inspiration - Leucaena hedgerows in Malaysia

Benefits

- 1) Vertical separation of C3 legume and C4 grass eliminates competition
- 2) Rhizobia nodules shed when Leucaena is browsed, making N available to grass
- 3) Deep roots of woody component allow:
 - minerals to be recycled from depth
 - extended growth into dry periods when grass component has lower protein.
- 4) Leucaena young shoots and leaves are highly palatable, and in hedgerow are grazed down to 1 metre height without allowing stems to grow out of reach
- 5) Leucaena leaves are high in crude protein with possible reduced degradability in rumen due to tannins
- 6) Bracharia extracts N from soil as it is released from rhizobial nodules, leading to rapid growth and availability of leafy fodder of high digestibility
- 7) The system supports 4 mature cows / ha each with 10 litres daily milk yield.

Constraints

- 1) If not correctly utilised, Leucaena grows beyond the reach of cattle:
 - Mechanical control is required
 - Leucaena will flower and produce pods / seeds, which can be invasive.
- 2) Leucaena contains the anti-nutritive compound (ANC) mimosine which can cause toxicity unless livestock are dosed with specific bacteria; however, at <30% of diet this is not a problem
- 3) Simple one tree / one grass mixtures are susceptible to pests and diseases:
 - A psyllid bug affects Leucaena around the world, and causes a 20% yield reduction
 - Bracharia is affected by both pests and diseases, especially in S. America

A more diverse system with multiple shrub and grass species is preferable
- 2) Additional areas or supplementary feed are required for grazing where the climate is seasonal.

2) Multiple forage shrubs – the *Enrich* project in Western Australia



Future Farm Industries CRC, June 2011

2) Multiple forage shrubs – the *Enrich* project in Western Australia

a) Introduction and Conclusions

Introduction

Livestock, with correct management, can cope and perform well with diverse plant mixtures, selecting a wide range of plants in their diets

Design for a ‘typical’ farm in the low-medium rainfall crop-livestock zones of **southern Australia**

- To show benefits of introducing forage shrubs into mixed farming systems where other perennial plant options (such as orchards and vineyards) are limited
- To help with selection of shrub species
- To demonstrate key principles of grazing management

Data are from the Enrich research project started in 2004 to:

- explore the potential of Australian native shrub species (some exotics) for grazing systems
- assess traits of many shrub species
- test different grazing management systems
- evaluate grazing of diverse mixtures of plant species

2) Multiple forage shrubs – the *Enrich* project in Western Australia

a) Introduction and Conclusions



2) Multiple forage shrubs – the *Enrich* project in Western Australia

a) Introduction and Conclusions

Summary conclusions:

Inclusion of perennial forage shrubs at 10 - 20 percent can increase whole-farm profit by 15 – 20 percent. Achieved by:

- reduced supplementary feeding during feed gaps (summer / autumn)
- deferring grazing of other parts of the farm at the break-of-season
- allowing better management and more pasture to be grown elsewhere

The shrub pasture acts as a **Fodder Bank** and as a **Buffer** for the whole-farm system

In most cases –

- the perennial shrubs complement rather than compete with cropping, and
- the perennial shrubs do not compete with pasture but are **in addition** to the existing feed base.

Perennial Australian shrubs, grown in a mixture, can:

- *provide out-of-season feed*
- *contribute to protein and mineral nutrition*
- *improve the efficiency of livestock digestion*
- *help control gut parasites*
- *provide shelter and shade.*

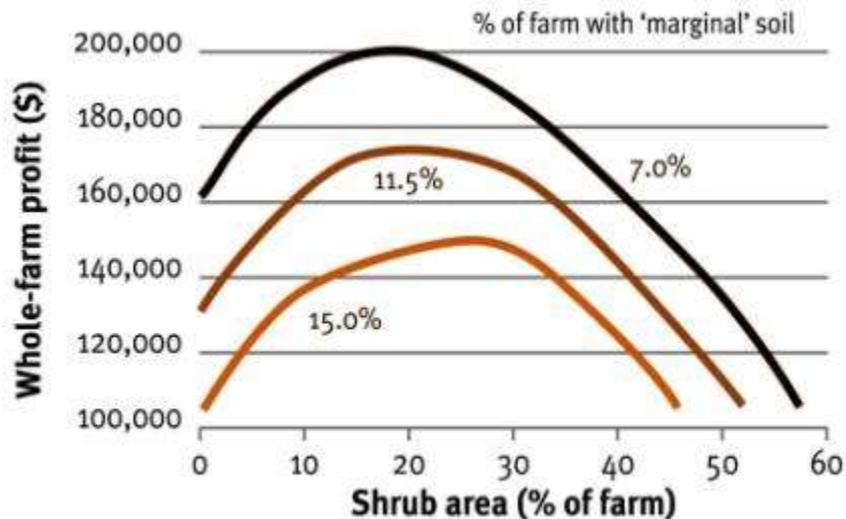
In addition shrubs can provide natural resource management benefits:

- *Control dryland salinity*
- *Control wind erosion*
- *Improve biodiversity*
- *[Increase and diversify feed sources for pollinators].*

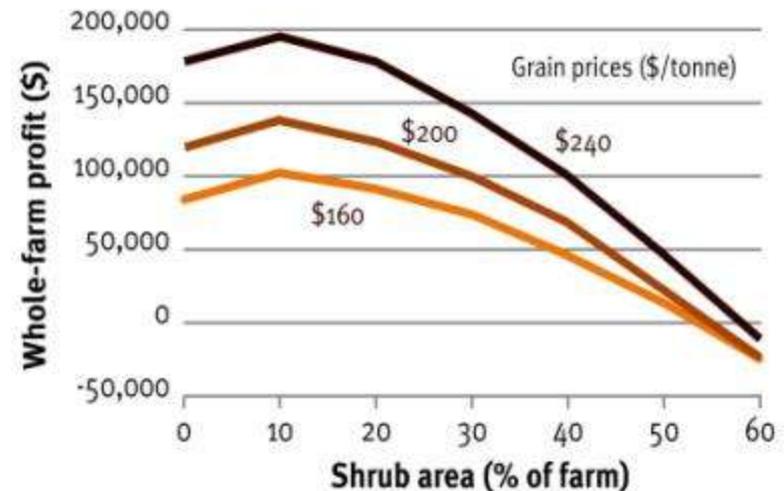
2) Multiple forage shrubs – the *Enrich* project in Western Australia

b. Boost to whole farm profit

Effect of shrub area on profit vs percent of marginal soils



Effect of shrub area on profit vs price of grain



How do forage shrubs boost whole-farm profit?

- i. Reduced supplementary feed in autumn, from \$13/ha to \$5/ha (half the profit increase)
- ii. Deferment of grazing of annual pastures in early winter (half the profit increase). This allowed better establishment of winter pastures and a higher stocking rate.

Evaluate the economic potential of forage shrubs on a whole-farm basis. Other benefits are in the summary.

2) Multiple forage shrubs – the *Enrich* project in Western Australia

c. Forage shrubs as part of a mixture

Forage shrubs (Australian)

× Not high quality edible biomass

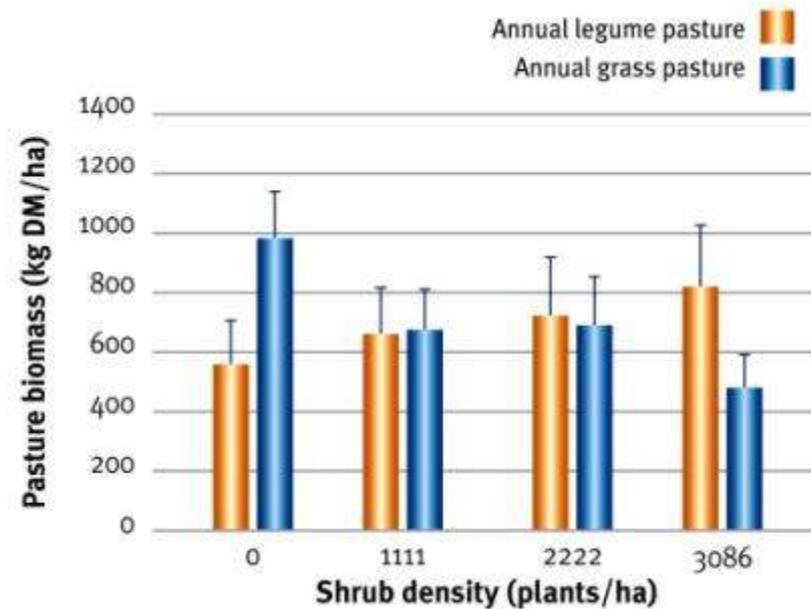
BUT

- ✓ Adapted to climate
- ✓ Resilient to tough conditions & drought

THEREFORE

- ADD forage shrubs to feedbase - DO NOT replace existing components
- Main fodder comes from productive inter-row pasture
 - At medium density <1000 shrubs/ha Loss of pasture biomass = gain in shrub biomass
 - Pasture legumes are happy alongside shrubs
 - Mineral contents of pasture legumes may be increased
 - Shrubs make up 1/4-1/3 of DMI of sheep
 - When pasture is poor quality, shrub intake increases to 1/2 of DMI

Shrub density on inter-row pasture biomass



2) Multiple forage shrubs – the *Enrich* project in Western Australia

d. Selecting shrub species

Selection process

KEY TO PROCESS

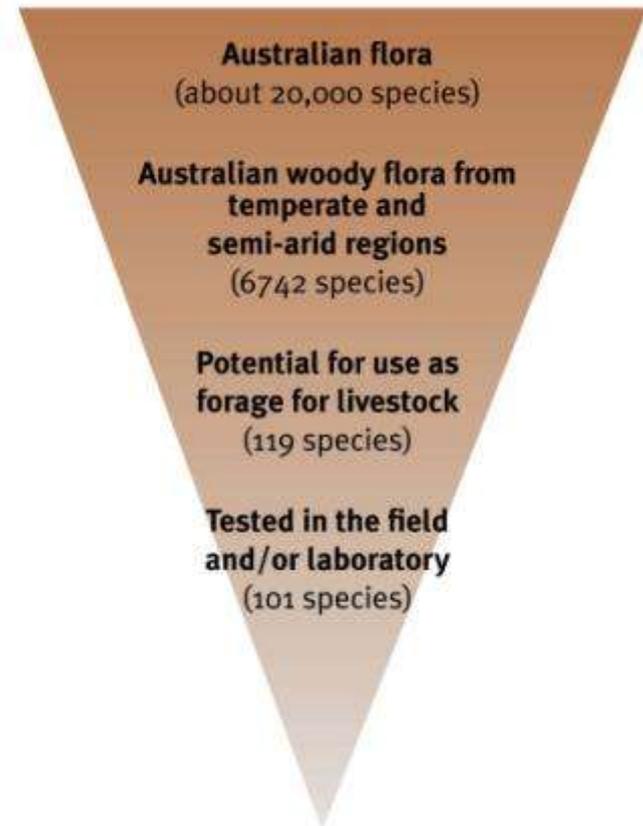
- Species selected to be part of a mixture
- Individual species doesn't need to meet all animal requirements
 - May be weak in some attributes but strong in others
 - As long as another species fill the missing attribute

THREE MAIN CRITERIA

- 1) Perennial life habit and woody growth form
- 2) Native to the locality
 - The traditional livestock/cropping zone (temperate), or
 - The southern pastoral zone (semi-arid)
 - Some exotic species included for comparison
- 3) Palatable

100 species identified and tested, 87 species grown in the field

The process



2) Multiple forage shrubs – the *Enrich* project in Western Australia

e. Plant attributes of selected shrub species

Data collected

- Edible biomass
- Plant growth over time
- Growth form and height
- Re-growth after grazing
- Animal preferences (palatability)
- Nutritive value (protein, fibre, minerals)
- Effects on rumen fermentation (gas production to indicate digestibility)
- Bioactivity – pattern of rumen fermentation end products including methane, ammonia, volatile fatty acids
- Bioactivity – anthelmintic properties

Invariably the top performers for any one trait were different to top performers for another trait – confirming the benefit of growing shrubs in mixtures

2) Multiple forage shrubs – the *Enrich* project in Western Australia

f. Grazing management with shrubs in mixed forage system

Achieve diet diversity and system sustainability through:

- 1) High stock density
 - Encourages animals to broaden their experience of different plants
 - With time animals will select a wide range of plant species
 - Learnt as young animals before weaning or even in utero through mothers feeding behaviour
- 2) Rotational grazing with small paddocks
 - Move animals to new paddocks before current paddock is overgrazed
 - Move before the understorey pasture runs out
 - Allows shrubs to recover and develop new shoots before the paddock is next grazed
 - Set-stocking can lead to the pasture being overgrazed before shrubs are selected
 - Set-stocking also allows more palatable shrubs to be repeatedly selected and killed
- 3) Animals in good condition and not stressed
 - Increases the chance of animals exploring new food sources in mixed shrub pasture
- 4) Experienced animals
 - Allow animals to develop experience of various forages through repeated exposure
 - Especially when grazing or browsing shrubs is new to them.



3) Some possible forage shrub species for UK Scotch Broom (*Cytisus scoparius* L.)

Benefits

- Local and adapted to climate
- Very hardy
- Legume
- 1 – 4 metres height
- Rapid growth
- Adapted to non-alkaline soils

Constraints

- Severely invasive – can form mono-specific stands with reduced biodiversity
- Noxious weed in many countries
- Toxic due to quinolizidine alkaloids sparteine and isospartine
 - Livestock poisonings reported in Europe, not US
- Host for several spp of *Phytophthora* - causing root rot which can spread to other species



3) Some possible forage shrub species for UK Tagasaste (*Chamaecytisus palmensis*)

Benefits

- Legume (from Canary Islands)
- Widely cultivated as a fodder shrub in Australia
- Adapted to sandy soils pH 5-7
- Evergreen shrub
- Deep rooted
- Heat tolerant

Constraints

- Establishment may be difficult due to small seed size
- Not cold tolerant below -9C
- Very susceptible to root rot fungi on poorly drained soils



3) Some possible forage shrub species for UK

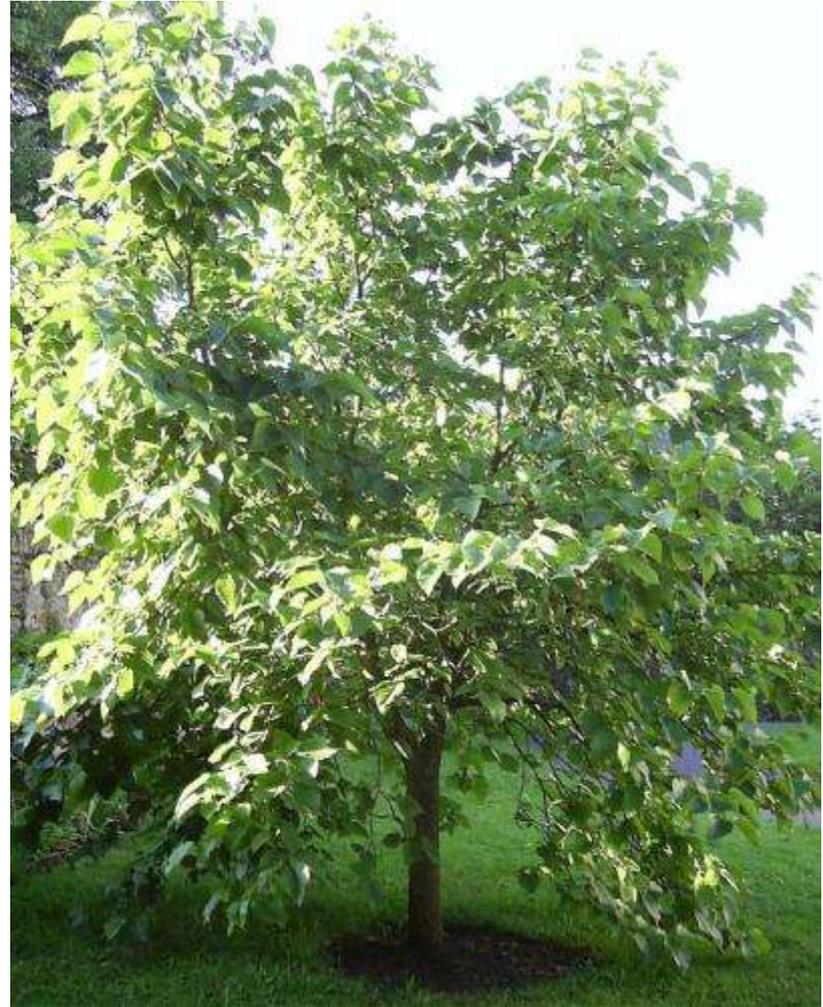
Mulberries (*Morus* spp L)

Advantages

- Long history of cultivation in UK, comes from N China so should be adapted
- Pruned as a bush, leaves used to feed silk worms
- Leaves cut for livestock (cattle, goats etc)
- Productive
- High digestibility
- Wide range of species
- Fruits are yummy, highly sought after by wasps,
- Medicinal uses of various plant parts

Constraints

- Ability to withstand browsing is unknown as normally used in cut and carry system



3) Some possible forage shrub species for UK Black Locust (*Robinia pseudoacacia*)

Advantages

- Introduced to Britain in 1636, with wide range of adaptation
- Legume with prolific flowering
- Major honey plant in US and France
- Dense timber of high calorific value
- Flavanoids in heartwood act as a preservative against fungal attack
- Coppices well

Constraints

- Toxic compounds, especially for horses, in leaves, pods and bark
- May become invasive
- Timber value degraded by locust borers (US)



3) Some possible forage shrub species for UK *Buddleja* spp (*Buddleja davidii* L)

Advantages

- 100 species, mainly shrubs
- *B. davidii* is naturalised in UK as a coloniser of dry open ground
- Evergreen and deciduous species
- Rapid growth and excellent regrowth and coppicing
- Classic pollen plant for butterflies and bees
- Fed as tree fodder in Nepal

Constraints

- Not fully hardy for UK
- Leaves contain ANC which causes blood disorders – but only if fed as sole diet

