Future Northland Pastures: 3. Potential woody forages for Northland

Katherine TOZER[1*], Grant DOUGLAS[2], Grant RENNIE[1] and Jim CRUSH[1]

[1]*BSI - AgResearch Group, Ruakura Research Centre, Hamilton, New Zealand*
[2] *GBDScience, Palmerston North, New Zealand*
*Corresponding author: katherine.tozer@agresearch.co.nz

Abstract

Woody vegetation can provide numerous benefits on-farm, such as shade and shelter for livestock, erosion control, livestock forage, vista enhancement and fodder for honeybees and other pollinators. Research on woody species for forage has occurred in the South Island and in the central and lower North Island for exotic species such as tagasaste, saltbush, poplar and willow. We located no information on woody forages for Northland. This review identifies woody forage species with potential for use in Northland's pastoral systems, drawing on New Zealand and international literature. Ten candidate species were selected, including leucaena, tagasaste, saltbush, and others, based on drought tolerance, nutritional traits, and adaptability. Although not woody, bananas were also included due to their potential as a forage crop, particularly on effluent treatment areas. The findings highlight the need for regional trials to evaluate establishment, management, and livestock responses.

Keywords: woody forages, bananas, Northland region

Introduction

On New Zealand farms, woody forages are best thought of as an addition to pasture rather than as a replacement and sole diet. Pastures are generally of higher nutritive value than the woody forages. However, shrubs and trees can provide valuable forage when pasture growth is inadequate or of poor quality such as during a drought or at the end of winter/early spring when pasture growth is slow. The woody legumes have the advantage of nitrogen (N) fixation, so less fertiliser is required, and having their own source of N enables them to stay greener in a drought.

Woody vegetation can provide numerous benefits on-farm, such as provision of timber, shade and shelter for livestock, erosion control, livestock forage, vista enhancement and fodder for honeybees and other pollinators (Pollock 1986; Wills et al. 1990; Butz Huryn 1995; Hawke & Dodd 2003; Papanastasis et al. 2008; Swaffield & McWilliam 2013). Research on woody species for forage has been done in the South Island and in the central and lower North Island for exotic species such as tagasaste (*Cytisus proliferus*), saltbush (*Atriplex halimus*), poplar (*Populus* spp.) and willow (*Salix* spp.) (Townsend & Radcliffe 1990; Wills & Begg 1992; Douglas et al. 2003; Charlton 2007; Tozer et al. 2023b; Tozer et al. 2023a). However, we could find no information on research on woody forages in Northland.

There has also been very little research on the suitability of native species as woody forages, although species such as mirror bush/Taupata (*Coprosma repens*), Karamu (*Coprosma robusta*), Cabbage tree/ti kouka (*Cordyline australis*), Karaka (*Corynocarpus laevigatus*), broadleaf/kapuka (*Griselinia littoralis*), lacebark/houhere (*Hoheria populnea*), whitey wood/mahoe (*Melicytus ramiflorus*), and Karo (*Pittosporum crassifolium*) may be suitable for livestock forage (Tozer et al. 2021a; Wangui et al. 2024). However, before any of these native species are trialled as potential forages, they will need to be screened for compounds that might compromise animal health or cause off-flavours in products.

Recent investigation into banana plants as a perennial crop for cattle feed has shown promising results in the region (Rennie 2021). Banana could be a low N, high carbohydrate summer green feed with potential to complement Northland pasture systems and play a part in effluent recycling on dairy farms. Bananas require high amounts of N and potassium and have been estimated to grow 15 to 20 t DM/ha total biomass accumulation as a permanent summer crop. Tropical and subtropical banana production shows significantly higher DM production for further potential in a warming climate (Watts et al. 2023). Research is required on nutrient cycling, grazing/harvesting management and feeding systems utilising bananas.

This paper identifies and reviews candidate woody forage species for Northland, drawing on both New Zealand and international research. The objective is to inform future on-farm trials and integration strategies for woody forages in pasture systems.

Methods and Results

The New Zealand and overseas literature were searched to identify woody forage species that might have utility under current Northland climates. Ten species were selected as potential candidates for field testing, based

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on prior evidence that they are palatable and not toxic for livestock, are present in New Zealand with easily accessible seed (either in New Zealand or in Australia with only basic biosecurity import requirements), and are suitable for growing in Northland based on their environmental tolerances. While bananas are not woody species, they were included in this review due to their potential forage value and suitability for integration into effluent management systems in Northland. The production potential, problematic issues, establishment processes, management methods and growing conditions tolerances for each species are summarised in Table 1.

Discussion

Establishing woody forages in pastures is often difficult from seed. Firstly, many of the species produce seeds with a hard seed coat which results in low germination unless they are scarified. For example, to establish tagasaste from seed, it is recommended that seeds be placed in boiling water which is then removed from the heat source and allowed to cool overnight. This promotes cracking (physical scarification) of the seed coat, allowing water to be absorbed with consequent swelling of the seeds. The swollen seeds are then sown into root tubes.

Secondly, woody species grow much more slowly than herbaceous species and are very vulnerable to competition during establishment. Transplanting seedlings of woody forages rather than sowing seed is much more likely to result in successful establishment. Competing pasture species, such as kikuyu, must be controlled during establishment. There may also be some benefit in pruning the seedlings to develop a multi-stemmed shrub to reduce the risk of irreparable damage from livestock to a single leader growth form.

Reducing competition from pasture species during establishment may involve using weed-mats at the time of planting, release chemicals and / or grazing livestock. Grazing livestock must be managed to prevent ring-barking and severe damage. Pest animals, such as rabbits, hares, goats, possums, pigs and deer, can also damage seedlings. Provided the woody forages are afforded some protection from grazing, sheep can be used with care to graze the surrounding pasture.

Once the woody forages are a few years old, they can be grazed intermittently for short intervals by sheep or cattle, but always with care to avoid damage to the main stem. Woody forages can be incorporated into farm systems in a variety of ways:

- as wide-spaced trees
- in stands for direct browse
- a feed bank from which leafy branches can be cut and carried to the livestock or cut and dropped and fed in the vicinity of the parent plants. This may be a good option on areas of the farm where direct access by stock is not practical.
- a multi-purpose system in which trees or pods can be browsed but also grown on for timber as is the case for honey locust (Papanastasis et al. 2008).

Many woody forages – particularly tropical shrub legumes (Beauchemin et al. 2008) contain phenolic compounds such as condensed tannins (CT). These compounds have potential anthelmintic properties which may reduce the requirement for drenching (e.g., willow, Diaz Lira et al. 2008), but this depends partly on the CT concentration and individual CT chemistry. Higher-growing woody forages also have negligible or no parasitic worm egg populations. Condensed tannins present in low concentrations (such as occurs in saltbush (e.g., 2-4% of DM)) can increase the absorption of amino acids in grazing stock. Conversely, when present in high levels (4-10% of DM), CT can reduce palatability, voluntary intake of forage, digestibility of the forage, and the availability of protein (Honeysett 2004). Woody forages containing CT can also reduce methane emissions which is a potentially valuable additional benefit (Beauchemin et al. 2008). Research is required to determine the optimal content of CT-containing woody forages in livestock diets to balance the methane-reducing benefits with the potential intake and digestibility penalties.

Some woody forages such as Leucaena produce chemical compounds like mimosine. This compound can cause loss of hair and liveweight in grazing stock. Gradual introduction of stock to Leucaena allows the animals to adapt to the compound and avoid adverse reactions (Dalzell et al. 2012).

Both Leucaena and tagasaste have become problem weeds in some overseas locations, including in some Australian environments (Paynter et al. 2003; Sharma et al. 2022). The weed potential for both species in Northland is uncertain. It would be prudent not to plant Leucaena near any waterways as it has become weedy in riparian areas in some countries (Walton 2003). For tagasaste, planting should be avoided near shingle riverbeds where grazing pressure may not be adequate to control the plants.

Recommendations

Based on the information summarised in Table 1, we suggest that the best potential woody forages for on-farm trials in Northland are: (i) tagasaste, (ii) saltbush, (iii) golden wattle, (iv) hairy canary clover, (v) Robinia and vi) hybrid willow. Bananas also merit further investigation, especially on effluent disposal sites. All these species can be sourced in New Zealand, most of them are available as seedlings and there are scientists / rural professionals who have worked with these forages and can provide advice on their

establishment and management. Basic research on optimal establishment and management techniques for Northland farming systems is required. For example, determining the optimal age and size for transplanting, different methods to protect them from ring-barking (e.g., individual tree guards or clumps and types of fencing), weed control (especially kikuyu), pest control (hares, rabbits, possums, goats, deer), and how to manage them for grazing. Basic information is lacking on how often and to what extent they should be grazed and their production potential for Northland pasture-woody forage systems. Enablers and barriers to adoption should also be ascertained to understand what support landowners need in establishing and growing these woody forages.

In summary, woody forages offer a promising strategy to build resilience in Northland's pasture systems, particularly in the face of climate variability. However, local research is needed to refine establishment practices, evaluate grazing strategies, and ensure these species fit within practical farm systems.

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Table 1 Production advantages, issues, establishment and management tips and growing conditions for a range of woody forages potentially suitable for Northland.

Production potential	Issues	Establishment	Management	Growing conditions	Further reading
Leucaena (*Leucaena leucocephala*)					
• High protein tropical legume for cattle • Can live for decades • Beef production increased by 2.5-fold on leucaena-grass pastures than grass only, in Queensland • Can reduce methane emissions • Fixes N	• Mimosine in leucaena can cause weight loss and hair loss; introduce stock to forage gradually so they adapt • Has been weedy in some countries; don't plant near waterways. Given temperature requirements for establishment and growth, it is unlikely to be weedy in NZ • Northland is currently only region where it can grow, where it is only marginally suitable for leucaena (as this plant is best suited for a tropical environment)	• Can easily obtain MPI sign-off to import Australian seed • Prepare the seedbed as for a crop (as described below) • Remove resident vegetation • Plant when soil temperatures >18°C and soils are moist • 2 kg seed/ha • Sow in strips at least 4 m wide to allow for double rows • Row spacings 6-12 m • Thin to 5-10 plants/metre of row • Takes a few years to establish • Fence to protect from grazing during establishment • Control broadleaf weeds and grasses after emergence	• Once established, rotationally graze; avoid continuous grazing • Periodic intense grazing to keep it leafy with multiple branches and to stop it growing too tall • https://www.leucaena.net/	• Drought tolerant • Frost-free is best; light frost can cause leaf fall and heavy frost can kill stems • Well drained soils • Optimal growth in fertile soils (Olsen P >20 mg/kg, S >5 mg/kg)	(Walton 2003: Shelton et al. 2021;
Golden wattle (*Acacia saligna*)					
• Can provide browse during droughts and maintain weight gain • Potential to reduce methane production due to condensed tannins • Fixes N	• High tannin concentrations reduce digestibility, protein availability and intake • Needs to be managed to prevent it growing tall and out of reach of sheep	• Can easily obtain MPI sign-off to import Australian seed • Scarify seeds before sowing as they are hard-seeded (as for tagasaste)	• Can be coppiced • Direct graze / browse as part of a mixed diet	• Drought tolerant • Frost tolerant • Grows on a range of soil types from sand to clay • Shade tolerant but grows best in sun	(Degen et al. 1995; Johnston 1996; Beauchemin et al. 2008)

Tagasaste (*Cytisus proliferus*)					
• Valuable late summer-early autumn drought feed • Potential to reduce methane production due to condensed tannins • Provides food for bees • 8-14 t DM/ha • Fixes N	• Can be weedy on shingle river-beds and dry hill faces where there is no grazing pressure • Tannins may reduce protein availability • Susceptible to lemon tree borer • Susceptible to disease when planted in poorly drained soils • Relatively short lived (<15-20 years)	• Available from a number of NZ nurseries • The weeping tagasaste cultivar is available in small amounts from Palmerston North • Collect fresh seed • Boil water, add seeds (up to 1 minute), then allow to cool and leave overnight. Repeat if required • Grow in pots and transplant when >25 cm tall • Inoculate with Bradyrhizobia (same as used for *Lotus corniculatus*) • Control weeds in planting area and during establishment • Trim the young plant to form a multi-stemmed shrub to reduce risk of ring-barking • Protect from weed competition, hares and rabbits	• Direct graze multi-stemmed shrubs 3-5 times per year with sheep or cattle with short periods of grazing • Heavy stocking pressure for long periods can ring-bark and over-graze trees resulting in tree losses • Browse single-stemmed taller shrubs • Cut-and-carry is a preferred option	• Drought tolerant • Frost-free area required for seedling establishment; tolerant of light frosts once established • Well-drained soils • Part – full sun • Tolerates coastal conditions • Short-lived on wet soils	(Townsend & Radcliffe 1987; Lambert et al. 1989; Borens & Poppi 1990; Townsend & Radcliffe 1990; McGowan & Mathews 1994; Douglas et al. 1996; Douglas et al. 1998; Dann & Trimmer 2003; Stace 2003; Tozer et al. 2021b; Tozer et al. 2022; Tozer et al. 2023b; Tozer et al. 2023a)
Hairy canary clover (*Dorycnium hirsutum*)					
• Up to 2 m high, regrow from the crown after cutting • Produced up to 5.6 t edible shoot DM/ha in the second year of growth, in a trial at Palmerston North • Moderately palatable to livestock but poor digestibility • Fixes N • Potential to reduce methane production due to condensed tannins	• Potentially high condensed tannins (e.g., 19% of leaf DM) depending on environment; leads to reduced digestibility (e.g., 60%) • Difficult to maintain in a vegetative state • Susceptible to competition during establishment • Needs specific rhizobium strain	• Seed available in small quantities from Kahikatea Farm, Hawke's Bay • Seed requires scarification • Emergence poor if not scarified (e.g., <30%) • Direct drill into rows at a depth of 10 mm • Use seedling transplants • Seedlings susceptible to competition • Manage weeds	• Provides browse when pasture supply is low (e.g., early spring, during summer, in a drought) • Rotationally graze or cut • Needs ca. 8-week recovery period between grazings; avoid overgrazing. • Trim to keep it green and leafy (develops woody stems if neglected)	• Drought tolerant • Frost tolerant • Well-drained soils • Can grow in low-fertility soil • Salt tolerant	(Wills et al. 1989; Douglas & Foote 1994; Bell et al. 2005; Beauchemin et al. 2008; Bell et al. 2008)

Tree medick (*Medicago arborea*)					
• 9 t/ha of edible DM over three years when cut once each year in early summer in a Mediterranean environment • 3-4 m high • Moderate forage value (crude protein >18%) • Fixes N	• Short lived • Relatively poor survival and poor production in wet hill country (50% died within two years at Ballantrae) • Needs specific rhizobium strain	• Seed available in small quantities from Koanga Gardens near Wairoa • Early autumn or early spring • Scarify seed using boiling water treatment (as for tagasaste) • Germinate seedlings in soil-filled trays and transfer germinated seed into small pots • Transplant into 1 L pots once 5 cm tall • Transplant into the paddock once 50 cm high	• Browse • Probably best suited to rotational grazing • Does not grow beyond reach of grazing livestock, so no topping required	• Drought tolerant • Frost tolerant • Well-drained soils • Full sun	(Mastrorilli 1993; González-Andrés & Ceresuela 1998; Amato et al. 2004; Papanastasis et al. 2008; Corleto 2011)
Hybrid willow (*Salix matsudana x alba*) clone 'Tangoio'					
• Supplementary feed for summer/autumn drought • 0.1 – 2.3 t DM/ha/yr at densities of 4000-6900 stems/ha of which 30-50% edible • Nutritive value usually higher than that of pasture during drought • Contains condensed tannins in edible foliage which may have nutritional benefits • Can enhance understorey pasture composition through site-drying • Deciduous	• Limb fall can damage farm infrastructure; debris tends to degrade slowly • Need to trim to keep vegetative growth within reach of livestock if direct grazing • Can break down and block waterways	• Readily available in NZ • Vertically plant cuttings (e.g., 1-1.2 m lengths of willow) and bury in the ground up to 30% of total length • Above-ground portion should be >0.5 m in height • Control surrounding vegetation to reduce competition (herbicides / grazing) • Vulnerable to drought during establishment	• Cut-and-drop or cut-and-carry leafy branches for feeding livestock during drought • Direct graze • If direct grazing in late summer/early autumn with sheep, follow with cattle in late autumn to reduce stem height, manually top to the desired height, and graze with sheep during winter/ early spring to control surrounding vegetation	• Drought tolerant (relative to many other willows) • Tolerates very wet soils • Wind tolerant • Dormant during winter so avoids frosts	(Charlton 2003; Douglas et al. 2003; Charlton 2007)

Poplar (*Populus deltoides x nigra*)					
• Similar production potential to willow at wide spacings • Range of different clones and productivity • Leaves and small branches palatable and rich in trace elements • Leaf quality similar to that of pasture in summer and autumn • Deciduous	• As for willow	• Readily available in NZ • Can be established using cuttings, stakes or poles, depending on application; as for Tangoio willow.	• As for willow, but more likely to use cut-and-drop, or cut-and-carry options	• Some clones might be less tolerant of saturated soil conditions than willow	(Kemp et al. 2001; Charlton 2003; Douglas et al. 2003; Charlton 2007)
Saltbush (*Atriplex halimus*)					
• 2 m tall × 4 m wide • Forage supply for early spring, summer droughts • Little growth during winter when temperatures drop below 13ºC and optimum growth occurs 30-35ºC • 4000 kg DM/ha (2000 plants/ha) in Central Otago • Lower protein and higher fibre contents than lucerne or willow • ME of 11.9-12.4 MJ/kg DM in South Island (SI) trials; lower in Australian studies (8-11 MJ/kg DM) • SI work was focused on sheep • No negative impacts on sheep meat	• High levels of chlorine, sodium, other minerals and oxalic acid - use for browse in combination with pasture	• Can easily obtain MPI sign-off to import Australian seed • Can be difficult to establish from seed; intolerant of competition • Transplant at densities of 500 (5 m x 5 m spacing) to 1500 (1.5 m x 4 m spacing) per hectare • Can plant closely within rows leaving space for stock movement between rows • Use stock or herbicides to remove competition with pasture	• Fence off in blocks • Rotationally graze • Manage weeds (grazing / herbicide) • One or two grazings per block per year • Graze to keep leafy and stop plants from getting too tall	• Drought tolerant • Frost tolerant • Well-drained soils • Full sun • Grows well in soils with high levels of sodium and calcium but poorly on alluvial soils • Tolerant of windy conditions	(Wills et al. 1990; Wills & Begg 1992; Honeysett 2004; Moreno et al. 2015; Heuzé 2019)

Thornless honey locust (*Gleditsia triacanthos* var. *inermis*)					
• Fixes N and has edible seed • Can grow up to 20 m • Deciduous • Deep tap-root does not compete with grass/legume shallower roots • Pods, young seedlings and coppice regrowth are edible • 20-75 kg pods/tree within 8 years • Lower DM yield than robinia • Seedlings can produce 7 t DM/ha • Coppice regrowth has high protein and low lignin levels (16-18% protein and 22-25% acid detergent fibre) • Pods provide browse during winter • 8.8 to 9.9 MJ ME/kg DM • Rich in condensed tannins	• Avoid the thorny variety of this species which is avoided by livestock and can become weedy • A small percentage may revert to the thorny variety • Brittle branches • Pods are not easily digested by cattle but whole pods are suitable for sheep	• Available from NZ nurseries • Easily transplanted • Slow establishment	• Cut-and-carry • Direct browse • Coppice to maintain leafy vegetation (Can grow >20 m high)	• Drought tolerant • Frost tolerant • Tolerates a wide range of soil conditions once established • Not well-suited for coastal conditions • Full sun (does not tolerate shade well) • Tolerates high levels of sodium • Branch drop may occur with strong winds but it is used in wind-breaks • Grows in tropical and Mediterranean environments	(Burner et al. 2005; Heuzé 2018)
Robinia (*Robinia pseudoacacia*)					
• Fixes N • Deciduous • High levels of condensed tannins which can reduce digestibility and intake • Higher yielding than honey locust and can provide drought feed at the end of summer • Poorer quality than pasture but sufficient for / exceeds livestock maintenance requirements • Provides a browse option during drought • 20% protein during spring • Digestibility 53-66% • Nutritional value of leaves similar to lucerne • Up to 30 m high within 3 decades • Can live 40-50 years • 5.5 – 6.1 t DM/ha	• Thorny • Spreads vigorously by suckers which are grazed by livestock • Brittle branches • Toxic if consumed in large quantities and especially for horses; OK for sheep and cattle for browse • Susceptible to borer species in the USA; no data are available on borer damage of robinia in NZ	• Available from NZ nurseries • Seeds require scarification otherwise germination percentages are low • Easily transplanted • Control competition from other species during establishment • Transplant when 50 – 200 cm in height • Propagate by root cuttings • Better establishment and tolerance of sheep grazing than honey locust • Seeds disperse close to the parent tree • Suckers easily • Can plant in rows, with 2.5 – 3 m between rows • Protect with tree guards or fencing during establishment • May need to re-establish after 3-5 cycles of coppicing	• P fertiliser application improves yield • Yield greater when pollarded at 50 or 100 cm than 5 cm • Cut-and-carry / cut-and-drop • Direct graze as part of a rotation • In a pasture-tree system, can integrate: coppicing (cutting to the ground), pollarding (cutting above browse height) and allow some to grow for timber / shade / shelter	• Drought tolerant • Frost tolerant (w.r.t. Northland) • Tolerates nutrient-poor soils • Grows best on deep, nutrient-rich, well-drained soils • Tolerant of humidity • Not tolerant of frequent water-logging and compacted soils • Can be brittle on exposed sites	(Burner et al. 2005; Papanastasis et al. 2008; Gabriel 2018; Halasz et al. 2021)