Establishment and management of Grasslands Puna chicory used as a specialist, high quality forage herb

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Abstract

Between 8000 and 10 000 ha of Grasslands Puna chicory are now sown annually in New Zealand, largely as a high quality forage herb capable of finishing a range of livestock types including deer, sheep, and cattle. This paper details the specific establishment requirements of Puna, including: weed control, renovation rotation methods, cultivation techniques and sowing methods. Management requirements are also discussed with particular emphasis on grazing management, including optimum rotation length and post-grazing residual height. Maintenance fertiliser and herbicide requirements, and stock health issues are also covered, with reference to the use of Puna in various livestock systems and its effect on profitability.

Keywords: Cichorium intybus, establishment, Grasslands Puna, leaf proportion, pre-grazing height, post-grazing residual height, 'rotational block grazing', stem development, stem control

Introduction

Chicory (Cichorium intybus L.) is a perennial herb originating from Central Europe, where it has been used in pastures for more than 300 years. Chicory is also known as the leaf vegetable 'witloof' (George 1985). After selection and a breeding programme in the 1970s (Rumball 1986), Grasslands Puna chicory was released in 1985 as the world's first forage cultivar of chicory.

Puna chicory is a perennial forage herb of high nutritional quality, with an 8- to 9-month growing season (early spring to late autumn). Puna has a slightly raised crown producing leafy top growth from a thick, deep tap-root with excellent drought tolerance and mineral extraction. Puna requires soils of medium to high fertility, with good to moderate drainage.

Despite virtual winter dormancy (Lancashire & Brock 1983), growth rates are high, most regions being capable of averaging 15-18 t DM/ha/year, and daily yields over summer in excess of 150 kg/ha (Lancashire 1978; Matthews et al. 1990). Herbage is of a high digestibility (DMD 86.8%), has a variable crude protein level (CP 15.0-26%) (Terrill et al. 1992) and has high metabolisable energy (ME) values of 12.2% (Stevens et al. 1993).

Chemical analysis by Crush & Evans (1990) showed Puna to have higher concentrations of potassium, sodium, calcium, sulphur, boron and zinc than ryegrass and white clover pastures. All other elements, including phosphate, were similar. The high concentrations of zinc and sodium offer potential advantages for animal health and growth rate.

Some farmers are consistently recording lamb liveweight (LW) gains of 300-350 g/head/day, compared with ryegrass/clover pasture at 120-200. Fraser et al. (1988) reported on several growth rate trials based on Puna. One experiment showed a 44% growth rate advantage to lambs fed on Puna compared with Rangi rape (Brassica). Cruickshank (1986) showed spring lamb growth rates on Puna, white clover and ryegrass of 290, 320 and 227 respectively. Fraser et al. (1988) reported Friesian weaner bull calf growth rates of 0.9 kg/head/day (some 0.2 kg/head higher than expected on ryegrass) on an optimum allowance of 100 g/kg of LW/day.

These results indicate the considerable potential of Puna in livestock systems.

Domestic seed sales are now about 40 t/year, 60% into the South Island, with most of the North Island sales into the east coast (S. W. Ardagh, Challenge Seeds Ltd pers. comm.).

Puna chicory can be used either as a specialist perennial forage sown with clover, or as a summer-active component of a grass and clover mixture, e.g., ryegrass, cocksfoot and/or phalaris. Puna is particularly well suited to lamb and deer finishing, providing high quality summer forage when ryegrass/white clover pastures are low in quality.

This paper sets out the establishment and management requirements of Puna chicory as a specialist forage in animal finishing systems.

Establishment requirements

Paddock selection

Puna will tolerate a wide range of soil types including sand, peat and silt loams. Persistence on heavy clay loams tends to be poor because of potential crown damage and tap-root rots caused by Sclerotina spp. Soils
with significant pans, or seasonal underground aquifers, are generally not suitable. Medium (recent) silt loams with good summer water-holding capacity, moderate to good winter drainage and high natural soil fertility are most suitable. Crush & Evans (1990) suggested that *Puna* tolerates a wide range of pH, but was likely to perform best in the normal range of pH 5.6-6.0.

Paddock should be easily accessible and subdividable (i.e., temporary electric), with daily access to water. *Puna* tap-roots can block tile drains, although once identified, these lines can be sprayed out soon after establishment using 2,4-D @ 3 l/ha.

**Renovation rotation options**

The objective of these rotations is to ensure a weed-free seedbed at sowing. This is important given the limited range of post-establishment herbicides available, particularly for difficult thistles, e.g., nodding and winged (*Carduus nutans* and *C. tenuifloris*).

**Spring sowings should follow:**
- autumn-sown winter-active fodder crops (e.g., Italian ryegrass, oats)
- an early-spring spray cultivation and condensed spring fallow (Milne *et al.* 1993)
- an autumn spray cultivation and winter fallow.

**Autumn sowings should follow:**
- spring/summer cash or fodder crop, e.g., barley, maize or Nutrifeed (Panicitum spp.)
- spring/summer spray cultivation and fallow system (Hume & Lyons 1993).

To avoid problems with *Sclerotinia*, legume and brassica crops should not be used in the rotation before sowing *Puna* (Hare *et al.* 1990).

**Sowing date**

*Puna* establishes well from mid-spring (October) sowings, with the first grazing easily possible before Christmas. In cooler environments with good summer rainfall November sowings will be better. Early-autumn sowings are also possible, particularly in coastal districts which are autumn frost-free, and may be more reliable where early summer droughts can be expected.

**Paddock preparation**

**From cultivation**

Roller and air drills are the most accurate. Variations include the use of crop or direct drill, with down tubes removed as a broadcasting unit. The Aitchison direct drill, with its sponge pick-up mechanism, is ideal.

**Direct drilling**

This method is possible where paddock surfaces are level, soil structure is good, the drill type is very accurate in seeding depth and the resident pasture species are controlled adequately, i.e., spring/summer spray fallow (Milne *et al.* 1993). *Puna* tolerates a wide range of pH, but was likely to perform best in the normal range of pH 5.6-6.0.

Where a tilth of 3-5 cm is created from a spraying and shallow cultivation (e.g., power harrow), sowing should be by roller or air drill.

**Sowing depth**

Maximum consolidation before and after sowing is important for accurate sowing depth and even and rapid germination. This is difficult on low bulk density soils (e.g., peat, pumice and sands) where rolling with a weighted Cambridge roller and moist soil conditions are important.

Sowing depth is important. The optimum depth of 1-1.5 cm is achieved with the roller or air drill sowing systems. Roller drills should be checked for accuracy and to ensure that *Puna* and clovers are not being segregated. A neutral bulking agent mixed with the seed, e.g., dry lime, or sand, will prevent this. Neither of these problems occur when either the air seeder or Aitchison drills are used as broadcasting units, onto the preCambridge rolled seedbed.

**Herbicides and fertilisers**

To assist with weed control, the pre-emergence herbicides ethalfluralin (Soralan) and trifluralin (Treflan up to 1.6 l/ha a.i.) (Hare *et al.* 1990 1993) should be soil incorporated soon after application (e.g., power harrrows or tined cultivators set to 5-10 cm). Trifluralin will control fat hen, willow weed, docks, chickweed and summer grasses, etc, but not nightshade, thistles or shepherd’s purse. EPTC can also be used in this way (Hare & Rolston unpub. data).

After establishment, few herbicides are safe on seedling chicory. Exceptions include bentazone (Basagran) and asulam (Asulox). As soon as young plants reach 12-15 cm in diameter, Basagran @ 1.44 l/ha a.i. should be applied for control of some broadleaf weeds. If thistles are still a problem despite all efforts before sowing, 2,4-DB at up to 1.6 l/ha a.i. can be applied in the first winter, after the selective grazing of chicory and clover leaf (Hare *et al.* 1993). However, successive toppings, or the use of various wiping devices, are also effective in control of thistles.

In addition to any capital fertiliser required, a nitrogen-based compound fertiliser @ 30 kg N/ha (e.g., DAP @ 165 kg/ha) is recommended to be soil incorporated with the final chain harrowing just before sowing. For spring-sown pastures, a second application of N (@ 25 kg N/ha) can be made at, approximately 1-2 weeks from sowing. This will stimulate additional leaf canopy, further reducing potential weed competition.
Sowing mixtures and rates

The seed is small, light and rectangular with a 1000-seed weight of 1.44 g. As a minor component in a grass mixture, Punta is sown at 0.54 kg/ha for spring sowings and 1.15 kg/ha for autumn sowings (Punta is less competitive in autumn sowings than spring sowings). Specialist Punta mixes (Table 1) can be sown at 4.5 kg/ha, with a large-leaved white clover cultivar always included, and in most regions red clover also. Closers not only fix N but further enhance the nutritive value of the pasture and provide ground cover in winter.

Table 1  An example of a specialist, dryland Punta chicory pasture mixture

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Seed Sown (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grasslands Punta chicory</td>
<td>5.0</td>
</tr>
<tr>
<td>Grasslands Kopu white clover</td>
<td>4.0</td>
</tr>
<tr>
<td>Grasslands Colenso red clover</td>
<td>4.0</td>
</tr>
<tr>
<td>Total seed sown per hectare</td>
<td>13.0</td>
</tr>
</tbody>
</table>

First grazing

The first grazing should be when plants have reached a height of 12-15 cm and pass the pull test (i.e., plants pulled with thumb and forefinger with only leaf and stem able to be removed). The grazing should be fast and non-selective with young stock strip grazed and back-fenced.

Management requirements

Fertiliser

Little or no research has been done to determine nutrient requirements. However, despite its ability to forage for soil nutrients it is assumed that as a high yielding forage plant (i.e. up to 25 t DM/ha/year), standard target soil nutrient values apply, i.e., Olsen P 20-30, K 8+ and S 10+. Nitrogen is also an important nutrient, particularly at seedling development.

Maintenance rates will depend on soil type, stocking rate and fertiliser history, for example, but as a general guide, the following programme can be considered.

The main maintenance application should be in August: an N,P,K and S fertiliser, supplying 35 kg N, 35 kg P and K, and 20-30 kg S/ha. By early December a second application of N (e.g., urea) should be applied, providing 20-25 kg N/ha. In regions where autumn growth is good, depending on the season and growth rates to date, a third application of N in late February early March may increase yield.

Clark et al. (1990a) showed that spring response to 1 kg of nitrogen was 10.6 kg DM/ha (@ rates up to 50 kg N/ha), similar to that of ryegrass and white clover pasture. However, 60% of the response was in stem production. At 200 kg N/ha they found plant densities were halved from 21.3 (@ 50 kg N) to 10.4 plants/m².

Herbicides (maintenance)

As already stated, to minimise the need for weed control, extra care is needed both before and at establishment. However, if thistles continue to be a problem and control through topping is not possible, herbicides and weed wipers (e.g., glyphosate and Versatill) are recommended for selected control. Where grass and broadleaf weeds infest pastures over time, a mixture of simazine (0.75 l/ha a.i.) and gramoxone (0.4 l/ha a.i.) (Hare et al. 1990) can be applied after a mid-winter selective grazing for available chicory and clover leaf. For sustained thistle invasion (e.g., nodding thistle) 2,4 DB up to 1.6 l/ha a.i., or MCPB @ 1.2 l/ha a.i., can be used if winter pre-grazing management is the same. Note: simazine, and atrazine even more so, can temporarily suppress white clover. Other products (also without chicory registrations) which could be applied in a similar way include: Gallant, Fusilade, Sencor, Karnax and Kerb.

Grazing management

To achieve the potential stand life (5-7 years), correct grazing technique is vital. Unsuitable management such as prolonged and heavy set stocking, or grazing at high stocking rates during periods of heavy rain, are likely to reduce persistence.

In order to achieve optimum utilisation and animal performance by non-selective grazing animals (e.g., lambs and ewes), 'rotational block grazing' for limited periods (3-5 days), with a back fence, is recommended. Similar levels of efficiency can be achieved by set stocking with selective grazing animals (e.g., deer and yearling cattle), which can maintain a constant herbage height (10-15 cm) and appropriate leaf to stem ratio (spring 3:1) (Clark et al. 1990a).

Leaf and stem management

It is important to distinguish between immature and mature stands. Immature stands result from spring
sowings and will not develop stem until the following spring. Autumn-sown Puna will develop stem in the first spring, as this is triggered by vernalisation during winter (George 1985), Hare et al. (1987), Clarke et al. (1990b) and Matthews et al. 1990 all stressed that the key grazing management objective is to maximise leaf yield and minimise stem development, even though this would reduce total annual yield. Mature stands produce a hollow primary stem in mid October (photoperiod triggered), which if left ungrazed will thicken and harden substantially from a height of approximately 60 cm and continue to grow over 2 m tall (Hare et al. 1987).

The easiest way to minimise stem development is through two quick, hard grazings to ground level, the first in mid spring (i.e., mid to late October) and the second in November, 20-26 days later. If stem development is already well advanced before the first grazing, breeding ewes or yearling steers can be used to remove stem. If the first grazing is missed, another grazing, breeding ewes or yearling steers can be used, although successive topplings reduce plant numbers (i.e., for mature stands a target plant density is 18-24 plants/m²).

In spite of good spring control of primary stem, a finer more branched secondary stem may develop in early autumn. Often this is in response to an early or sudden drop in soil temperature, but the stem is not seen as a major problem limiting either quality or grazing control. Chicory, as a deep, tap-rooted plant, is very sensitive to fluctuations in soil temperature which will affect yield (Gianquinto & Pimpini 1989). East coast farmers in the North Island noticed reduced yields and acceptance, with fence line trekking and feed wastage likely.

Table 2 A guide to the grazing management of mature Puna chicory in a specialist lamb finishing system.

<table>
<thead>
<tr>
<th>Months</th>
<th>Rotation length (days)</th>
<th>Target pre-grazing height (cm)</th>
<th>Target post-grazing residual height (cm)</th>
<th>Estimated DMlha/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept-October</td>
<td>30-35</td>
<td>12-16</td>
<td>5</td>
<td>40-60</td>
</tr>
<tr>
<td>Oct.-November</td>
<td>20-26</td>
<td>10-16</td>
<td>2-2</td>
<td>w-75</td>
</tr>
<tr>
<td>Nov-December</td>
<td>2 2-26</td>
<td>12-16</td>
<td>0-2</td>
<td>80-110</td>
</tr>
<tr>
<td>Dec-January</td>
<td>26-32</td>
<td>14-18</td>
<td>2-5</td>
<td>70-95</td>
</tr>
<tr>
<td>Jan-February</td>
<td>34-36</td>
<td>16-22</td>
<td>0-5</td>
<td>50-70</td>
</tr>
<tr>
<td>March-April</td>
<td>36-45</td>
<td>16-24</td>
<td>0-5</td>
<td>35-55</td>
</tr>
<tr>
<td>April-May</td>
<td>45-55</td>
<td>16-24</td>
<td>5</td>
<td>35-35</td>
</tr>
</tbody>
</table>

Note: Rotation length (days) is an approximation only, as variation in seasonal rainfall and soil temperature mean that the farmer will have to modify these to suit actual growth rates. Pre-grazing heights provided and the aim of 70% leaf, may often be better guides to setting rotation length.

Conservation potential
G. Williamson (pers. comm.) recorded a DM yield (est. DM 30%) of 118 t/ha from a late-December silage crop wilted for 24 hours. However, because the high proportions of stem in this crop did affect silage quality, a cutting date no later than mid November is suggested. Stevens et al. (1993), in Southland indoor feeding trials, found the quality of Puna-based silage (fine chop, 40%/60 Puna and Grasslands Manawa ryegrass) to be very high relative to timothy/clover and ryegrass. Lambs on the Puna/Manawa silage had LWG of 125 g/head/day at 60% higher intake rates compared with ryegrass, which gave LWG of 7 g/head/day. Feed analysis of the Puna silage was: DM% 25-30%, CP 12.6%, DMD 74%.

Animal health considerations
Stock water requirements
If plenty of fresh water is not available, LW gains will
be reduced (particularly lambs on closed rotations), probably because of the high sodium levels in Puna (Crush & Evans 1990). On the block rotational system, movable troughs, or a permanent circular trough in the centre of the paddock, break and back-fences radiating out, can be used.

Nitrate poisoning
As with most rapid growing forage types which are nitrogen responsive, nitrate poisoning can occur under certain environmental conditions (i.e., excess plant nitrate levels, sudden growth, or overcast conditions). Under these conditions, a simple herbage nitrate test should be performed.

Pulpy kidney
As with clover dominance in ryegrass pastures, the high energy value of Puna chicory can result in pulpy kidney in lambs. Lambs should be revaccinated before grazing Puna for any length of time (i.e., closed rotations).

Bloat
Only traces of tannin have been found in Puna (Terrill et al. 1992), insufficient to protect animals from bloat. Cattle have been found to have a degree of rumen expansion without clinical bloat when grazing pure Puna (D.A. Clark unpub. data).

Pests and diseases
Little research has been done on Puna’s tolerance to common forage pests. However, field observations suggest good tolerance of diamond backed moth and aphids, but susceptibility to slugs and springtails. The fungi Sclerotina minor and S. sclerotiorum can reduce yield and persistence of Puna. S. sclerotiorum is the more widespread of the two and associated more with brassicas than S. minor. Both are soil borne and affect leaves, crowns and tap-roots, ultimately causing chronic degeneration and plant death (R. Skipp, AgResearch pers. comm.).

Uses for Puna chicory
Deer breeding and finishing systems
Puna’s high summer forage quality and yield tit perfectly the growth requirements of the breeding hind and fawn, when traditional dryland ryegrass/white clover pastures are low in quality and high in endophyte. In Manawatu farmlet trials (D. Clark and W. Thomas unpub. 1991) which included 20% Puna/clover and 80% grass/clover, Red deer fawn weaning weights were 26% higher (39.9 kg LW), despite a 17% greater stocking rate (11.7 hinds/ha), and 101 kg/ha (47%) more LWG was achieved on the Puna/clover pastures than on the grass/clover only farmlets.

On-farm trials in South Auckland (Hunt 1993) have shown 15% greater fawn weaning weights on Puna/clover compared with ryegrass. Hunt (1993) found that autumn direct drilling Grasslands Tama into Puna for winter/early-spring grazing maintained this advantage through to slaughter. By November, weaners on Puna/Tama were 20% heavier (stags +24%, hinds +15%) than those on ryegrass. With these growth rate advantages, the target LW of 90 kg was easily met by November (normally December/January), with the average stag LW of 92 kg achieved by August (Hunt 1993).

Lamb and cattle finishing
Farmers and some researchers have shown Puna to have advantages in cattle finishing systems (Fraser et al. 1988; P. Muir, AgResearch pers. comm.), but Puna has provided the most consistent advantage in lamb finishing. Most farmers will finish their heaviest lambs on Puna for 2-3 weeks before slaughter and replace these with the next heaviest mob. This ensures a constant supply of lambs for grazing Puna for most of the summer. Using this system, farmers can supply lambs at much higher carcass weights (i.e., 18+ kg CW) earlier in the season and take advantage of the associated market premiums. Later in the season when lambs have all been sold, Puna can be utilised by replacement hoggets, or as flushing feed for breeding ewes.

Based on recorded pasture and animal growth rates with lambs, Puna chicory has the potential to produce $35/week/ha gross income, from October to March (i.e., 25 lambs/ha @ LWG 270 g/head/day, 41% DO and $1.80/kg CW). Some farmers have recorded lamb gross incomes of $1000/ha in one season (P. Andrews, Agriculture NZ, pers. comm.).

Table 2 provides a guide to approximate pasture growth rates and rotation lengths.

Summary
1. Puna has very good potential for finishing deer, sheep and cattle in both summer moist and dryland environments, with animal growth rates similar to that on pure legumes.
2. For successful establishment, special consideration needs to be given to paddock selection, pre-plant weed control and seeding methods and depth.
3. The major grazing management objective in spring is to ensure a high proportion of leaf relative to
stem (i.e., 3: 1, or 70% leaf), rotation length and post-grazing residual height being the two critical factors.

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REFERENCES


