

Narrow-leaved Plantain (*Plantago lanceolata*)

Description and distribution

- Perennial herb species that in a ‘wild state’ is widely found in older temperate pastures throughout New Zealand.
- Features erect, ‘lance-shaped’ narrow and strongly ribbed leaves connected to the crown by short fibrous stems.
- In the early 1990’s New Zealand plant breeders released two commercial cultivars ‘Grasslands Lancelot’ and ‘Ceres Tonic’.
- Particularly drought tolerant species drawing on a deeply placed, coarse fibrous root system. Plantain also enjoys relatively wide pest tolerance including grass grub.
- Does not require high soil fertility to persist (ie. low phosphorus, nitrogen and SOM with a wide pH range of 4.2-7.8), but is not well suited to water-logged or saline soils.
- In its leafy state plantain is a palatable herb with very good acceptability to a number of ruminant species including deer, sheep and cattle.



Figure 1: Tonic plantain sown with Endosafe ryegrass and clovers



Figure 2: plantain’s erect habit & coarse fibrous root structure

Table 1: Comparative features on NZ plantains

Feature	Lancelot	Tonic	Wild type
Origin	NI ‘wild type’ collection & selection	Portuguese collection	Introduced by first European settlers
Growth habit	Semi-erect	Very-erect	Prostrate
Leaf size	Med-large	Very large	Small-med, hairy
Tiller number	High	Medium	Med-high
Winter growth	Low	High	Very low
Summer growth	High	High	Low

Ref: AV Stewart, 1996

Productivity



Figure 3: Deer finishing pasture (Tonic plantain, Advance tall fescue, Gala grazing brome, red and white clover)

- As a pure stand grown in optimum conditions plantain can give an annual yield of 20t, less than that of ryegrass at 24t DM/ha.
- Typically plantain is sown as a herb component of a grass and legume mix, often partnering chicory with sowing rates of this small seed ranging from 0.6 to 1.5kg/ha.
- Contribution to yield will be subject to the type of companion grass species used, with ryegrass the resulting in the lowest plantain yields and tall fescue or brome species (eg. Gala grazing brome), the highest yield.
- After year 3 in grass and clover mixes ‘Tonic plantain’ rarely contributes more than 20% of total DM yield in the summer. In winter this can reach 35% of yield (ie. Mediterranean origin) which can be an invaluable contribution in most NZ livestock systems.
- Plantain can also be added to multi-graze brassica crops such as Pasja and Goliath increasing total yields by 15-25%.

Table 2: Yield results from 4 year dryland Canterbury cutting trial

Forage Species	Annual Yield kg DM/ha	Summer yield (relative to ryegrass)
Tonic plantain	8,362	107
Lancelot plantain	7,582	105
Kara cocksfoot	9,862	126
Roa tall fescue	9,327	92
Gala grazing brome	10,759	128
Perennial ryegrass	9,961	100
LSD 5%	961	30.1

Ref: AV Stewart, 1996

Nutritional value

- In a leafy vegetive state plantain has a lower proportion of cell wall, less cellulose and fibre, but also lower soluble carbohydrates levels than ryegrass.
- **Table 3** shows comparable feed quality characteristics with the popular forage herb chicory. Plantain has been shown to retard digestion by slowing microbial activity in the rumen which can lead to a temporary depression in appetite resulting in reduced liveweight gain (LWG) potential.
- During the reproductive phase (ie. around flowering) plantain significantly increases cellulose and hemi-cellulose content in both leaf and stem.
- As expected the increase in both these components impacts negatively on plant digestibility and consequently lamb intake further impacting on LWG over this period.
- **Table 3** shows digestibility difference between leaf and stem, with late-summer and early-autumn plantain pastures comprising of up to 60% stem.

Table 3: Comparative feed quality of plantain (Lancelot) and effects on lamb intake

Quality Analyte	Chicory	Plantain (leaf)	Plantain (stem)	White clover	Ryegrass
Digestibility %	84.8	80.4	58.7	83.0	80.2
Crude protein %	24.3	20.2	13.8	28.0	20.1
Hemicellulose %	2.34	7.48	14.6	5.2	24.5
Cellulose %	11.3	11.9	22.6	15.3	18.3
Lignin %	3.3	2.9	5.0	2.7	1.8
Intake (kg DM/head/day)	1.94	1.44	-	1.77	1.03

Ref: TJ Fraser & Rowarth, 1996

- In **Table 4** we see the classic LWG's advantages associated with both chicory (+76%) and white clover (+107%) over that of plantain. *Lotus corniculatus* advantage largely results from its condensed tannins, which boost animal's protein utilisation.
- I visited this trial on two occasions and would suggest that 'Tonic' plantain would have given more favourable results than the selected trial cultivar 'Lancelot'.

Table 4: Lamb liveweight gains (LWG g/head/day) on different forage types (fasted weights)

Year	Chicory	Plantain	White clover	Lotus Conic.	Ryegrass (LE)
1993	182	141	219	-	128
1994	181	84	225	175	98
1995	214	102	233	239	136
Mean	192	109	226	207	121

Ref: TJ Fraser & Rowarth, 1996

- In summary, there are very few instances where I would advocate ‘Grassland Lancelot’ over **Ceres Tonic**. Two situations might include low fertility, low rainfall hill and high country and coastal sand country. I believe these to be very different performing cultivars with Tonic having a definite qualitative and quantitative advantage over Lancelot in most NZ environments.



Figure 4: Far Northland dairying Tonic plantain & chicory used for summer nutritional boost in coastal sand country

Mineral composition

- When compared to ryegrass plantain contains higher concentrations of key macro and micro elements (eg. Ca, Mg, Na, P, Zn, Cu, Se and Co).
- **Table 5** provides some evidence of key micro-nutrient accumulation in livestock grazing mineral rich herbs. In this trial liver analysis from lambs grazing sole diets of either ryegrass or ‘Tonic’ plantain were compared. The result was significant advantages occurring for copper and selenium liver concentrations on plantain.

Table 5: Lamb micro nutrient liver analysis following plantain diet

Forage	Liver B ₁₂ (nmol/kg/FW)	Liver Cu (µmol/kg/FW)	Liver Se (umol/kg/FW)
‘Tonic’ plantain	620	2250	671
Ryegrass	571	716	380
Sig.	NS	P<0.01	P<0.01

Ref: HG Judson, pers. com

Unique chemical properties

- For many centuries plantain has been widely used in traditional medicine around the world. Researchers have looked at its anti-microbial properties and more recently identified the iridoid glucoside *aucubin* and its derivatives as important bio-active compounds.
- Subsequently a number of effects from these compounds have been identified; tissue growth promotant, laxative, non-steroidal anti-inflammatory, promotion of liver protection, weak anti-oxidant and uric acid excretion stimulant.
- Plantain contains high levels of **aucubin** (<3% DM) subject to plant genotype and soil fertility, with concentrations increasing with leaf age and summer moisture stress.
- *Plantago* species are also widely know as a source of **mucilage** (polysaccharide hydrocolloids) (0.8% DM) which with hydration forms a viscous gel with both laxative and purgative properties throughout the digestive system (eg. mucilage is used to control calf scours).
- Plantain also contains phenylpropanoid glycoside *verbascoside* (<9% DM) another bio-active compound which has anti-microbial, anti-fungal and anti-tumoral effects. **Verbascoside** acts as a strong ‘superoxide scavenger’ and antioxidant with anti-hypertensive and anti-tremor activity.
- In *Plantago* the sugar alcohols *sorbital* (2% DM) and *mannitol* act as major osmotic regulators while in grasses this performed by the amino acid *proline*. **Sorbital** has 60-70% the sweetness of sucrose and therefore potentially increases plantain’s palatability to livestock.
- Plant **condensed tannins** (CT’s) have been measured in *Plantago* at 0.4 and 1% concentrations. CT’s are known to reduce protein degradation in the rumen thereby increasing crude protein (CP) utilisation by assimilation in the small intestine and directly into the blood stream.
- Some forms CT’s can also provide anthelmintic properties which suppress internal parasite development. NZ experiments to date have not found this with grazing livestock on plantain.

Main reference publication:

Stewart, A.V. 1996. Plantain (*Plantago lanceolata*) a potential pasture species. *Proceedings of the New Zealand Grasslands Conference* 58: 77-86.