Using Chicory and Plantain in Beef and Sheep Systems

Better Returns Programme

Information provided by Dylan Laws and Dr Liz Genever of AHDB Beef & Lamb.

Key messages

- Chicory is best suited to light soils and areas where its drought tolerant attributes (deep tap root) can be exploited.
- A stand-alone crop should persist for three to five years. A reduction in plant population of approximately 30% per year can be expected.
- Due to its nutritional qualities chicory is well suited to finishing lambs or carrying ewes and lambs during lactation.
- Chicory has been proven to reduce faecal egg counts in lambs and could reduce the use of anthelmintics.
- Chicory and plantain's plant growth pattern is not the same as grass so it requires different management.
- Chicory and plantain have a shorter growing period than PRG.
- Chicory and plantain are not legumes and require a source of nitrogen.
- Rotational or strip grazing is essential to see the benefits of chicory or plantain as a stand-alone crop or as part of a mixed sward.
- The crops can be ensiled as a last resort.
- Plantain is adapted to a wide range of soils but does not tolerate waterlogged soils or deep sands.
- Annual yields of plantain have been known to reach around 17t DM/ha (6.8t DM/acre).

Keywords:

Chicory, Plantain, Forage herbs, Perennial forage crops, Chicory for sheep, Chicory for cattle

Contents

Introduction

There is growing evidence that herbs, such as forage chicory and plantain can be high yielding and a beneficial source of highly palatable and nutritious feed for grazing livestock. Using species like this within a system can reduce reliance on concentrate feeds, especially for finishing which reduces production costs.

Although chicory has been used in agriculture for some time, its use as a modern forage crop for livestock is relatively new. Much like chicory, plantain has only recently established itself as a viable forage crop for livestock production and very few fields have been grown in England to date.

Most evidence of the potential of these plants lies in the southern hemisphere, where modern varieties of both forage chicory and plantain have been developed. A better understanding of its agronomic and management requirements and potential benefits, are needed to determine its suitability for English systems.

Both chicory and plantain have large tap roots, which increases their tolerance to dry conditions, which may become increasingly important if climate variability continues.

Chicory

History

Chicory plant at florette stage

Chicory is a perennial herb, native to Europe and many parts of Asia, Africa and America. The plant is grown commercially as a leaf vegetable or salad green in Europe and to produce high fructose (sugar) syrups. Its roots are often used as a coffee substitute. Its 'wild-type' plant was previously discounted as a forage crop due to its lack of persistence and poor productivity in the 1950s.

Family	Asteraceae
Latin name	*Cichorium intybus L.*
Alternative names	Blue sailors, succory, coffeeweed

Chicory was re-assessed as a potential forage crop in the mid-1970s in New Zealand. After ten years of breeding the world's first forage variety of chicory became commercially available in 1985. A range of different cultivars is now used worldwide.

Although varieties of forage chicory continue to be released, most of the research on herbage production and animal performance to date has been on the Puna varieties.

The majority of forage chicory currently being used and researched in the UK is of the Puna II type. It was bred in New Zealand specifically as a forage crop for sheep and beef systems, selected for its tolerance to Sclerotinia fungus, long growing period and uniformity.

Bolted chicory plants

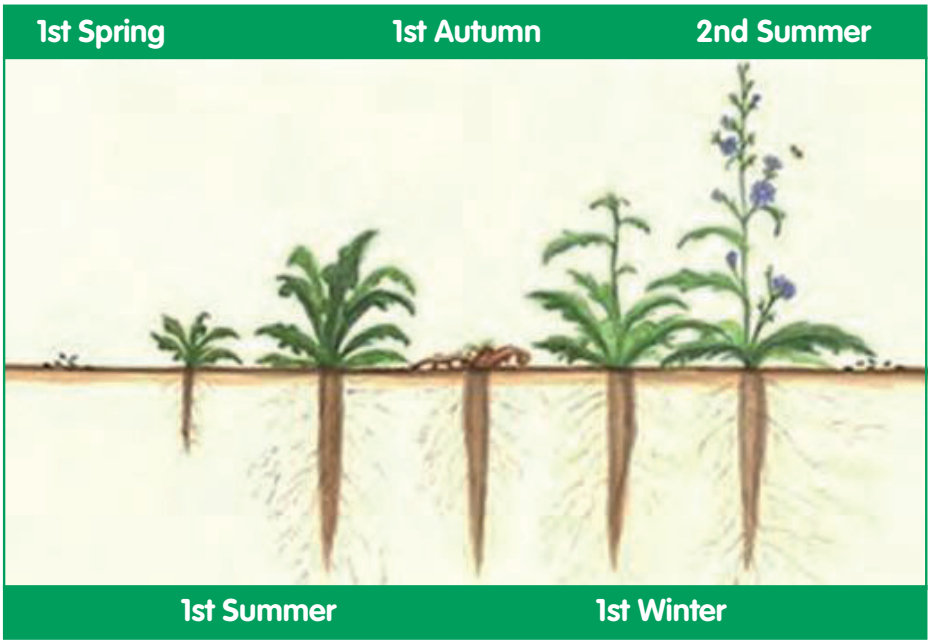
Characteristics

Chicory is a biennial rosette plant carrying broad flat leaves in winter and more erect leaves when it is warmer. The plant usually has one intact crown which produces a flowering stem (a bolt) in late spring/early summer the year after establishment.

This hollow primary stem thickens and hardens substantially, growing from approximately 60cm to 2m tall if not controlled. In late summer/autumn the crown splits to produce secondary stems (shoots). The flowers are 2cm to 4cm wide and usually bright blue.

Chicory flower

Figure 1: Growth stages of a chicory plant 18 months after a spring sowing



Chicory possesses a deep tap root which can extract moisture from great depths in the soil. These deep roots also draw up minerals into the plant. If over-grazed, the top of the tap root can become exposed and damaged which reduces the crop's persistency.

Crop requirements

Chicory has a long, thick tap root

Chicory grows best in well-drained soils with medium to high fertility. Much like any other productive forage species, the plant needs a high artificial nutrient input to sustain high levels of production, especially on soils with poor fertility.

Waterlogged and heavy clay soils limit its persistence and soils with significant pans or seasonal underground aquifers are generally not suitable. The crop can tolerate a wide range of pH (4.8–6.5), but grows best at pH 5.6–6.0.

Soil Type	Well drained, medium to light soils
pH	5.6–6.0
Soil temperature	Above 10°C (growth stops below 8°C)

Yield and growth rate

Under optimum management and growing conditions, chicory produces a high yield of high quality forage (Table 1). A forage yield of 6–9 tonnes DM per hectare (2.4–3.6t/acre) is common in pure chicory stands for the first two or three years under grazing conditions. One study in New Zealand reported a yield in excess of 15t DM/ha (6t DM/acre).

Under optimum management and growing conditions, chicory produces a high yield of high quality forage.

The plant exhibits rapid growth in optimal growing conditions (usually in late spring to mid-summer) and growth in excess of 150kg DM/ha per day has been reported. This rapid growth means the crop requires different management to grass-based pastures, so different 'rules' need to be followed to maintain sward life and productivity.

Chicory thriving in drought conditions

What is kg DM/ha?

Kilograms of dry matter per hectare per day (kg DM/ha/d) is a way to measure and describe growth and yield. It provides a number that can be used to calculate and predict feed availability.

A plate meter or calibrated sward stick can be used to assess kg DM/ha in grass swards, but will not be as accurate in chicory dominated swards.

For more information see BRP Manual **Planning grazing strategies for Better Returns**

Figure 2: Growth rate of chicory, plantain, and perennial ryegrass (PRG) on an Australian dairy farm, 2010/11 (Dairy Australia 2012)

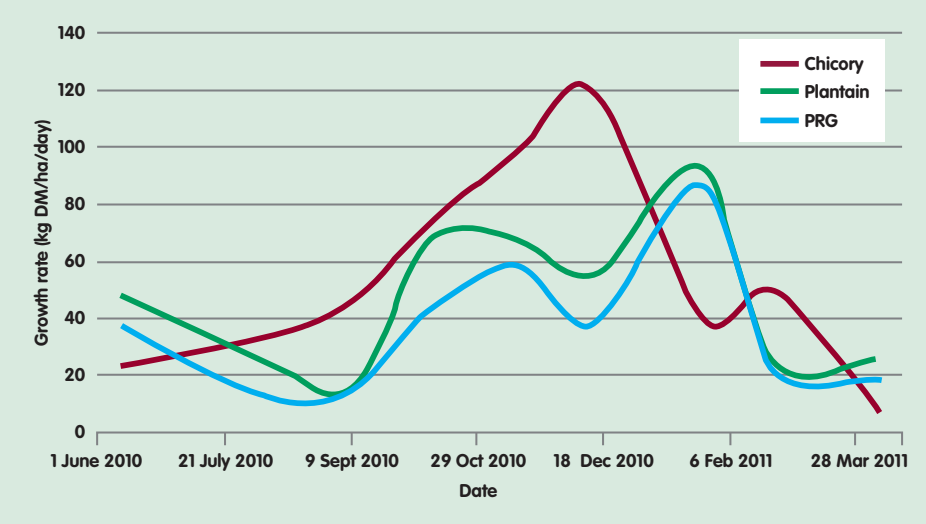


Figure 2 shows the growth pattern of chicory and plantain in comparison to perennial ryegrass (PRG) in Australia. Although not directly applicable to the UK, it does show the length of the growing season for chicory and plantain compared to grass, their shut-down during winter (July/August) and how they outperform grass in the autumn (January/February).

Table 1: Chicory yields from trial plots in Great Britain (GB) and other countries

Date	Origin	Crop	Seed Rate (/ha)	Management	Yield (t/DM/ha)
2003	USA	Pure chicory	4.5kg	Cut every three to five weeks	Year 1 = 6–8.2 Year 2 = 7.6–4.7
2008	USA	Pure chicory	3.4–5.7kg	Varied harvesting schedules	Year 1 = 5.8
2008	Aus	Pure chicory	N/A	N/A	Year 1 = 5.2–10.1 Year 2 = 2.6–4.2
2008	NZ	Pure chicory	4–6kg	Grazed or cut	Year 1 = 8.5–13.4 Year 2 = 9.4–11.4
N/A	GB	Pure chicory	N/A	Rotationally grazed	Year 1 = 2.6 Year 2 = 5.5–7.5

Nitrogen

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Chicory is a herb and not a legume, so additional nitrogen is essential for growth. Clover is a good companion crop. Applications need to be applied later than on grass, due to its growth pattern. Little and often generates the best response.

Persistency

The persistency of chicory can vary between two to five years.

The persistency of chicory can vary between two to five years, with losses of about 30% of the plant population each year. Anecdotal evidence suggests that if well managed, it can last for longer.

Its persistency is likely to be increased as a stand-alone crop compared to being part of a mixed sward. One of the initial problems encountered with the first commercial variety was that the plant died out of a field after two years, due to the differences in plant requirements. This has been improved through breeding and can be reduced through management techniques such as rotational grazing and topping.

Nutritional value

The nutritional value of a sward can vary depending on plant growth stage, crop condition and its environment. Any analysis must take this into account when being compared with an alternative crop PRG.

For instance, a crop like PRG with a high leaf to stem ratio will have a low DM % but high digestibility (D-value), metabolisable energy (ME) and crude protein (CP) values.

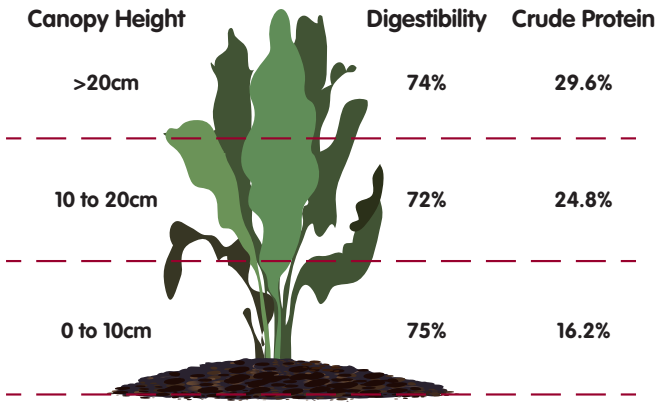
The AHDB Beef & Lamb **Home-Grown Forages Directory** suggests that chicory possesses similar D-value, ME and CP to PRG (Table 2). However nutritional analysis of chicory conducted in research work has suggested the D-value and CP can be higher.

Table 2: The nutritive value of chicory in comparison to other forage species
***1 D-value unit = ME of 0.16**

	Chicory	40% Chicory with red and white clover	Grazed grass	Grazed grass with high white clover content	Lucerne
CP (% in DM)	18	20	17	19	17-22
D-value*	68.8	75.0	71.9	75.0	62.5
ME* (MJ/kg DM)	11.0	12.0	11.5	12.0	10.0

Source: AHDB Beef & Lamb Home-Grown Forages Directory

Figure 3: Nutritive values of different parts of a chicory plant (from McCoy et al. 1997) nutritive values



Chicory is rich in minerals due to its deep tap root which can absorb minerals that are inaccessible to shallower rooted plant species. In general, most of the macro-minerals in chicory are similar, or exceed those found in grasses and legumes (Table 3).

Table 3: Macro mineral contents (g/kg DM) in chicory at vegetative state vs perennial ryegrass (PRG)

Mineral Content (g/kg)	Chicory	PRG
Calcium (Ca)	14.9	6.6
Phosphorous (P)	3.4	3.6
Sodium (Na)	2.1	0.8
Potassium (K)	36.4	25.5
Magnesium (Mg)	2.8	1.8

Source: Barry, 1998

Palatability

Chicory leaves are very palatable to grazing livestock. However, the flowering stems that develop when the crop bolts are far less palatable and have a lower nutritive value than the leaves. It is likely that animals will not consume these unless grazed tight.

Case study

Nigel Spinney, Bartestown Farm, Dorset

+ Nigel runs a herd of 100 organic Aberdeen Angus cows with followers.

"We started including chicory in our red clover and ryegrass leys in 2010 to increase mineral levels to our grazing animals. The plant has definitely helped keep up the mineral intake in our organic system. We do not currently feed any mineral supplements or hard feed.

"Keeping on top of plant growth is essential as it soon goes to head. The crop coped well with the wet weather, but we made an effort not to poach it too heavily."

Establishment and management

Varieties

There are currently very few varieties of chicory available to grow in the UK.

Chicory can be grown as a stand-alone crop or as part of a mixed sward. Various studies have reported positive responses in animal performance for both options (see Tables 8, 9 and 11).

The benefit of growing chicory in a mixture is that its rapid growth in summer, drought tolerance and relatively high protein content, complement the shortfalls in the other species. In general, chicory does combine well with other grasses and clovers. However, the density of plant populations can decline significantly in mixed swards if not managed properly.

The benefit of growing chicory in a mixture is its rapid growth in summer, drought tolerance and relatively high protein content.

Publications from the southern hemisphere suggest growing chicory with a companion clover results in a highly nutritional lamb finishing crop, requiring lower levels or no nitrogen applications. A persistent variety of medium to large leaf white clover is recommended to compete with the vigorous growth of chicory during establishment. The persistency of chicory/clover swards is usually between two to four years.

Sowing

The seed rates from research studies for a stand-alone sward vary between 4–9kg/ha (1.6–3.6kg/acre), although 5–6kg/ha (2–2.4kg/acre) is generally the most recommended rate (Table 4).

As part of a mixed sward, seed rates in trials vary between 0.8–7.5kg/ha (0.3–3kg/acre) depending on the companion species and target population. Some of these seed rates may be high to guarantee plant establishment, as the performance of seed rate was not evaluated during the trial. Recommended inclusion rates are usually between 0.5–2.0kg/ha (0.2–0.8kg/acre) in seed mixtures including PRG and clover.

Table 4: Recommended range of sowing dates for chicory and companion species

	Recommended Range		
	Chicory	Clover	PRG
Pure chicory	4–6kg/ha (1.6–2.4kg/acre)		
Chicory and clover mix	3–5kg/ha (1.2–2.4kg/acre)	8–9kg/ha (3.2–3.6kg/acre)	
PRG, clover and chicory	4–5kg/ha (1.6–2kg/acre)	3–4kg/ha (1.2–1.6kg/acre)	20–22kg/ha (8–9kg/acre)

Sowing in late spring is recommended, as growth is limited when soil temperature is less than 10°C. It can be sown up to mid-August as part of a mixed sward depending on soil conditions.

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The challenge is to establish the crop and graze it before soil temperatures fall below 8°C and winter dormancy occurs. It is essential to control broad-leaved weeds pre-sowing as herbicide options are limited post-emergence. Slug pellets can also be used to enhance establishment.

For conventional re-seeding, the seed can be broadcast or drilled to a maximum depth of 10mm due to the small seed size, into a firm, reasonably fine seed bed. Creating good soil-to-seed contact is essential for germination, so harrowing followed by rolling is recommended. After sowing the seed bed should be rolled at least twice, once in either direction.

For direct drilling, spraying the current pasture with glyphosate to kill it before direct drilling chicory, has been found to increase yield by over 2t DM/ha (0.8t DM/acre), increase plant density and reduce weed populations, compared to broadcasting onto an existing pasture.

In this trial, the additional cost of spraying and drilling in comparison to just broadcasting was justified, as the increase in yield was produced at less than half the cost of purchasing its equivalent in bought-in feed (Table 5).

Table 5: Cost benefit of spraying off existing plants and direct drilling forage chicory

	Spray off and direct drill	No spray and broadcast	Difference
Yield (t DM/ha)	+2t DM	-	2t DM
*Spray costs (£/ha)	12.50	-	12.50
Glyphosate (£/ha)	30.00	-	30.00
*Sowing costs (£/ha)	30.00	20.50	9.50
		Total additional cost:	£52.00
Value of 2t DM of an alternative 18% CP and 11 MJ ME concentrate			**£500**

*Costs calculated using NAAC contracting charges 2012/13

Nutrient requirements pre-sowing are similar to grass – a soil pH of between 5.8 and 6, phosphate (P) and potash (K) indices of 2, along with good nitrogen (N) levels.

Applying 50kg/ha N, 25kg/ha P and 25kg/ha K at sowing, and regular applications of 30–40kg/ha N after each grazing during the growing season, is recommended for chicory crops that do not include clover. For swards with high clover content, N may only need to be applied at around 50kg/ha to stimulate initial plant growth at the start of the growing season. Applying additional N throughout the season is not likely to increase the response in growth rate.

The crop should be ready to graze from eight weeks post-establishment. The aim is for a sward height of 10–16cm and a good stand will have 45–60 plants/m². Once plant density falls below 25 plants/m² it is worth considering re-seeding.

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Grazing intensity and frequency

Rotational grazing (using more than one paddock) or strip grazing (with a back fence), must be employed when grazing, especially when the sward has a high proportion of chicory.

Continuous grazing can result in a significant decline in plant density in the sward, compared to rotational grazing systems. In general, the crop requires short, intensive periods of grazing with sufficient rest/recovery periods in between.

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Under-grazing (mature crops in particular) will allow the crop to bolt, resulting in the production of an unpalatable main plant stem and subsequent reduction in nutritional value and utilisation.

The aim with any grazing system should be to take the crop down to around 7cm as soon as possible, without damaging the crop. It should not be grazed below 4–5cm in autumn/winter.

The first two grazings should be quick and hard with pre-grazing heights of 10-16cm and around three weeks apart. This maximises leaf space and minimises primary stem development, which is essential to maintain optimum crop quality. Thereafter, a pre-grazing height can gradually increase as the season goes on, but at no time should it exceed 20cm. If the crop exceeds this height, primary stem development is likely to inhibit leaf production (Table 6).

Allowing the crop to flower once in autumn and encouraging the development of secondary stems/shoots has been shown to increase persistency. However, it needs to be grazed carefully afterwards to ensure it is re-set before the spring .

Table 6: Sward height targets for crops with high levels of chicory

Time of season	Pre-grazing target (cm)	Post-grazing targets (cm)
Late spring	10–16	5
Early summer	12–18	5
Late summer	14–18	5
Autumn	16–20	5–7

Stocking rates and rotation length will vary depending on field conditions, stock type and crop growth rate. Studies have shown that rotational grazing for one week followed by five weeks of rest resulted in higher yields and increased crop density.

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Avoiding poaching and subsequent damage to the crown is essential to maintain yields in following years. Management is particularly difficult in periods of prolonged wet weather (Table 7).

Table 7: Stocking rate and rotation decisions depending on prevailing conditions

Situation	Action
Wet conditions	Reduce stocking rate or increase rotation speed, eg less days in each paddock. Paddocks may need to be sub-divided.
Prolonged wet weather	Reduce stocking rate significantly or avoid grazing, then follow with topping or mob-stocking when weather permits
High plant growth rate	Increase stocking rate, increase post-grazing target height and/or increase rotation speed

Crop growth should be checked at least once a week particularly during stem development in its second spring. A good crop should support 70, 35kg lambs or five 500kg steers per ha for 14 days (assuming available forage of 1400kg DM/ha).

Grazing at the end or after the growing season should only be considered if conditions are dry to minimise crown damage, and sward height targets are met.

When chicory gets out of hand

If the crop does exceed 20cm and develop a thick primary stem, yield will fall. The priority should be to remove the primary stem. This can be achieved by mowing, topping or grazing.

Mowing can let rainwater penetrate the hollow stem which can kill the plant if it sits there. It can be better to graze it with cattle at high stocking rates, as they are less selective grazers than sheep. The cattle will initially remove the nutritious leaves before removing the fibrous stems. Therefore it is best to initially graze the crop with growing animals with higher dietary needs, and then stock the field with animals requiring just enough feed for maintenance, such as dry cows. Good fences may be needed as strip grazing is likely to be most effective method. To maintain sward persistency for following years, the timing of stock removal is key to prevent crown damage.

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Case studies

Martyn Greenfield, Norton Barn Farm, Leicestershire

+ Martyn runs 1000 Mule/Texel cross ewes on around 96ha (235 acres) of grass leys on a medium clay loam.

"We introduced three-year-grazing leys containing red and white clover with chicory or PRG, white clover and chicory in 2008. The leys were sown in May with a pneumatic seed drill into a traditionally ploughed seed bed and top-dressed with nitrogen in June. They were ready for grazing in July.

"Because of the tap root, chicory continues to grow well during dry weather. Initially, one of the problems was keeping on top of it, but we have now established a rotational block grazing system, with each block providing two or three week's grazings at a time.

"Through our direct lamb sales, we've also found that lambs grazed on chicory have a very good flavour.

"The chicory performed particularly well in 2011 when it was very dry, providing feed at the end of the season when there was nothing else."

Growing and finishing lambs

The influence of chicory on lamb growth rates varies depending on the management and subsequent quality of the crop. Growth rates from chicory trials vary from 178g to 300g per day. However growth rates of 300–400g are possible with good crop and animal management.

In general, lambs grazed on chicory have similar growth performance to those grazing forage legumes and better growth than those grazing grass-based pastures.

A study carried out by EBLEX in 2008 found that including chicory in a mixed sward increased lamb growth by 20%. Subsequently 53% of lambs were finished directly off the chicory compared with 18% off the grass-only sward (Table 8).

A study carried out by EBLEX in 2008 found that including chicory in a mixed sward increased lamb growth by 20%.

Another study found that lamb growth rates can be 70% higher when grazing chicory in comparison to a standard grass sward.

Table 8: Compilation of studies measuring the effect of chicory on the performance of growing lambs

Date	Origin	Crop	Seed rate (/ha)	Animal	Stocking/ allowance	Lamb growth rate
1998	Aus	Chicory and clover	3kg chicory and 6kg clover	WL	n/a	264g/day
2006	UK	Pure chicory	N/A	PL	9 ewes/ha for 18 weeks	264g/day
2007	UK	Chicory with plantain	9kg chicory, 0.9kg plantain	WL	43, 35kg lambs/ha for 4 weeks	300g/day
2008	UK	Grass mix with chicory	0.8kg chicory, 14kg PRG and 1kg white clover	PL	12 ewes/ha for 6 weeks	178g/day
2009	UK	Pure chicory	N/A	PL/WL	17 ewes/ha for 3 weeks then 33 lambs/ha for 6 weeks	203g/day
2009	UK	Pure chicory	N/A	WL	10 lambs/ha	197g/day
					8–60 lambs/ha	219g/day
WL = Weaned Lambs, PL = Pre-weaned Lambs						

Lamb grazing on chicory

Grazing lambs on chicory appears to have no adverse effects on carcase traits in terms of fatness and weight.

An EBLEX-funded trial over two seasons found that lambs grazing chicory in both set stocking (25 lambs/ha) and rotational grazing (8–60 lambs/ha) systems had a higher killing-out percentage, in comparison to those grazing a PRG sward (Year 1 = 39.9% vs 37.2%, Year 2 = 46.8% vs 44.6%).

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Case study

John Newman, Farm Manager at Abbey Home Farm, Gloucestershire

+ The 650ha mixed organic farm runs 700 Lleyn ewes and 60 suckler cows.

"Chicory is now a common feature in our grazing leys. Much of the farm is down as a three-to-five year white clover, chicory and ryegrass ley. Ewes and lambs are grazed on swards from turnout to weaning. This year's lambs will average 250–300g/day from birth to slaughter with no creep.

"We use faecal egg counts to monitor worm burdens, but only had to treat sixty lambs last year.

"We planted around 55ha of grass leys incorporating chicory in 2012, and the wet weather had no impact on growth rates or yields."

Ewes

Grazing lactating ewes on grass and chicory has been found to maintain ewe body condition score in comparison to those grazing a standard grass sward which lost condition (Table 9).

As of yet no research has been conducted into the benefits of chicory on ewes at other stages in the production cycle.

Table 9: Compilation of studies measuring the effect of chicory on the performance of lactating ewes

Date	Origin	Crop	Seed Rate (/ha)	Animal	Stocking/ Allowance	Ewe performance
2008	UK	Grass mix with chicory	0.8kg chicory, 14kg PRG and 1kg white clover	Ewes with twin lambs at foot	11.7 ewes/ha for six weeks	Ewe maintained body condition
2009	UK	Pure chicory	N/A		16.6 ewes/ha for three weeks	Ewes gained weight
2012	NZ	Pure chicory	6kg/ha plantain, 4kg/ha white clover, 6kg/ha red clover	Ewes with lambs at foot	4.5kg DM/day (to simulate ad-libitum conditions)	Ewes gained 7.2kg on average during lactation

Growing and finishing cattle

Growing steers grazing a chicory based sward

Chicory does not appear to have the benefits of increased growth rates in growing cattle as it does in lambs.

EBLEX funded a two-year trial, where a chicory and PRG sward was compared to a PRG sward. Six groups of six steers (18 per treatment) were stocked at three steers per hectare (1.2/acre) and rotationally grazed in a four paddock system for 18 weeks in the first year, and 21 weeks in the second. Protein levels were significantly higher in the chicory sward.

Steers grazing the chicory and PRG swards gained an average of 1.05kg/day in comparison to 1.11kg/day for those grazing PRG. This study also identified no significant differences in carcase characteristics including conformation, fat grade, killing out % and carcase weight (Table 10).

Table 10: Carcase characteristics of grazing beef steers

	Ryegrass	Chicory/ryegrass
Conformation (% R/U grade)	85.0	92.8
Fat grade (% 2/3 grade)	52.8	61.2
Slaughter weight (kg)	638	632
Killing out %	0.55	0.56
Carcase Weight		
Right side hot (kg)	178.1	176.8
Right side cold (kg)	174.1	175.6
Total cold (kg)	350.9	353.7

Similar results were identified in a study carried out in the United States in 2012, where no significant difference was found in the daily liveweight gain (1.17kg vs 1.18kg) of steers grazing a pure chicory sward, in comparison to a variety of annual ryegrass, even though the crop was deemed to possess a higher D-value (71.5 vs 68.1) and crude protein levels (20.6 vs 15.4).

In this study, four groups of five steers (10 steers per treatment) were rotationally grazed (14 days grazing, 14 days rest) in either annual ryegrass or chicory paddocks (0.81ha), for 56 days a year over a period of three years. The chicory paddocks were grazed at a pasture mass of approximately 3500kg DM/ha (Table 11).

Table 11: Compilation of studies measuring the effect of chicory on the performance of growing cattle

Date	Origin	Crop	Seed Rate (/ ha)	Animal	Stocking/ Allowance	Growth rate
1990	NZ	Pure chicory	N/A	Friesian bulls	4.2-12.5kg DM/head/ day	0.39-0.67kg /day
2012	UK EBLEX	PRG and chicory	7.5kg chicory 22.5kg PRG	Steers	Six steers/ ha for 2 weeks	1.00-1.09kg /day
2012	US	Pure chicory	8kg chicory	Steers	10kg DM/ head/day	1.17kg /day

Cows

Trials with dairy cows in the southern hemisphere and from the US, have shown that grazing chicory can increase milk solid yields in comparison to more common grass types. No studies currently exist on the effects of chicory on suckler cow performance.

Meat quality

A study carried out by EBLEX in 2010 into the carcase quality of lambs grazing chicory, concluded that it had no detrimental effects on meat sensory eating quality, in comparison to lambs grazing a grass and clover sward.

A study carried out by EBLEX in 2010 into the carcase quality of lambs grazing chicory, concluded that it had no detrimental effects on meat sensory eating quality, in comparison to lambs grazing a grass and clover sward.

This agreed with previous research that found no differences in pH, meat colour, tenderness and flavour in lamb fed chicory in comparison to lucerne (alfalfa). The EBLEX trial did find that chicory fed lamb was found by a trained taste panel to be slightly juicier.

Similar results have been observed in cattle. An EBLEX trial investigated the effect of including chicory in the diet had on sensory carcase quality of beef steers grazing either a chicory and PRG sward, or grazing PRG only.

The steers were finished on one of the crops for 21 weeks over spring and summer. Measures of meat quality were taken from slaughter through to a taste panel. This included pH analysis post-slaughter, fatty acid composition and mechanical analysis of colour over the two week maturation period, along with eating quality. No significant differences were found in any of the measures taken.

Worm control benefits

Chicory has the potential to reduce the adverse effects of internal parasites, which can reduce anthelmintic use. Although chicory grazing has been shown to have little impact on controlling worms in adult sheep, it can result in lower egg counts in lambs, which may improve performance.

It has been shown that lambs grazing chicory had fewer adult abomasal worms than lambs grazing ryegrass/white clover. For example, SAC trials have shown that a pure stand of chicory can reduce worm burden by 40% over a short term, so it will save costs and the labour of drenching.

SAC trials have shown that a pure stand of chicory can reduce worm burden by 40% over a short term, so it will save costs and the labour of drenching.

The reason for the apparent lack of anthelmintic effect on mature ewes in comparison to lambs is not known. Drenched ewes on chicory have been found to be in better condition than un-drenched ewes, suggesting that chicory cannot provide the required level of nutrients for ewes facing a parasitic challenge in early lactation.

The mechanism of how chicory impacts on worm population is not fully understood.

One thought is that the sward or plant structure of chicory affects the development, survival or migration of worms, reducing the number of worms that are ingested by the animals. Dietary forage has been shown to alter the percentage of nematode parasite larvae that reach the infective stage in the faeces of parasitised sheep.

Also, different forages may produce a microclimate in the sward environment, or possess a sward structure which interferes with the lifecycle of these parasites, so reducing their ability to infect grazing livestock.

Plots of chicory and birdsfoot trefoil (a perennial herb similar in appearance to some clovers), treated with ovine gastro-intestinal parasite eggs, were found to have significantly less larvae in comparison to PRG plots. This strongly suggests that plant structure has a significant effect on larval ingestion in sheep.

It is hypothesised that structures on the surface of chicory, called trichomes, interfere with larval migration. However it needs to be remembered that many factors, such as diet, voluntary feed intake and environmental interactions, could be responsible for the effects of chicory on parasites.

Another theory is that this effect is due to something the plant produces. The presence of secondary metabolites, organic compounds that are not essential for the basic function of the plant, such as sesquiterpene, lactones, chicoriin and chicoric acid, could be acting directly on the nematodes in the gut to reduce their efficacy. These substances, which are part of the plant's defensive system, may have a role in worm control by inhibiting the growth of infective larvae. Both chicoriin and chicoric acid have been known to act as deterrents to feeding activity in insect larvae.

Another suggestion is that the superior nutritional properties of chicory in comparison to PRG, increase the immunity of lambs and enhance their tissue repair mechanisms, reducing the damage caused by worms.

These possible mechanisms for reduced Faecal Egg Counts (FEC) in lambs may act separately, or in combination.

No anthelmintic benefits have been identified in cattle grazing chicory. This is based on the findings of an EBLEX-funded study carried out at IBERS comparing steers grazing a PRG sward with additional chicory against a PRG-only sward. This may have been due to the fact that the diet/sward did not consist of sufficient chicory to affect FEC results, or that the cattle did not receive a sufficient challenge to identify any benefits.

Other health benefits and issues

One advantage of chicory in cattle is that it does not cause bloat as clover can, as it contains condensed tannins.

Due to the high sodium mineral levels in chicory, providing access to plenty of clean fresh water is essential. Failure to do so will result in reduced growth rates. In a paddock rotation system, water provision is a priority and may need infrastructure investment.

As with grazing pastures with high clover dominance, pulpy kidney can occur in lambs grazing chicory due to its relatively high energy value. Vaccination is therefore recommended.

If high levels of nitrogen are applied without adequate timing before grazing, nitrate poisoning can occur when grazing chicory. It is recommended that growing lambs have access to grass or an alternative low protein forage, eg hay or silage, when first introduced to a pure stand of chicory.

It is recommended that growing lambs have access to grass or an alternative low protein forage, eg hay or silage, when first introduced to a pure stand of chicory.

As chicory is considered highly digestible, lambs will probably need dagging pre-slaughter. Ewes may also need dagging before grazing chicory.

Conserving chicory

The focus for using chicory should be on grazing, but ensiling can be used if necessary.

Chicory can be ensiled as part of a mixed or stand-alone sward. This can be a useful option when peak mid-season growth rates cannot be controlled through grazing (Table 12).

Table 12: Silage analysis results from EBLEX chicory silage trial at IBERS, 2012

%	100% PRG	100% Chicory		25% chicory / 75% PRG	25% chicory / 75% PRG and red clover
	Without inoculant	With inoculant	Without inoculant		
DM	30.3	13.9	14.4	27.1	24.5
CP	16.3	17.6	18.8	16.8	20.6
pH	4.55	3.37	3.60	3.55	3.61

Good quality silage can be achieved, but good timing and management are essential.

The low DM of chicory appears to be the main issue and it is not as a good a crop to ensile as PRG. Despite wilting for 48 hours, chicory DM contents can still be low. This can increase the fermentation rate, which can lead to a build-up of butyric acid. This results in a fishy odour and a slimy sticky texture, which can have low palatability and reduced animal intakes.

Good quality silage can be achieved, but good timing and management are essential.

A low DM% can also lead to animals not being able to eat enough to meet their needs, so more concentrate feed may be required.

However in the trial conducted at IBERS, there appeared to be a good fermentation process with a low protein breakdown.

Tips for ensiling chicory swards

+ Only carry out if the crop cannot be grazed
+ A mower conditioner is essential to speed the wilting process
+ Target a DM of above 20%
+ An acid additive will be needed to encourage a rapid fall in pH and to improve the quality of fermentation

Chicory and clover silage

A trial has been carried out in Denmark to investigate the effects of ensiling and feeding baled chicory and white clover to dairy cows, in comparison to other alternative forages. The silage was fed *ad-lib* as part of a total mixed ration (TMR). The chicory and white clover silage was deemed competitive with the other legume based forages, but had a lower crude protein content (Table 13 overleaf).

Table 13: Quality of silage from four different sward types and the effect on milk production

	Silage type			
	White clover	Red clover	Lucerne	Chicory
Silage				
DM%	42	22	39	26
D-value	78.0	76.0	79.6	79.9
CP%	23.2	24.0	22.0	18.2
TMR				
CP%	16.7	20.0	17.7	16.7
Dry Matter Intake, kg cow	25.3	21.9	27.1	24.5
Milk Production				
Milk, kg	30.2	31.5	29.3	31.5
Protein, g	980	982	983	1030
Feed conversion (kg energy output/kg DM silage)	2.2	3.0	1.9	2.6

Tips for managing chicory

- Chicory is best suited to light soils and areas where its drought tolerant attributes (deep tap root) can be exploited. However it can grow in a wide range of environments
- Chicory's growth pattern is not the same as grass and requires different management
- There is a short intense growing period, which PRG does not have. Plant growth is limited at below 10°C but growth rates can exceed 150kg DM/ha per day in summer
- A stand-alone crop should persist for three to five years. A reduction in plant population of approximately 30% per year can be expected
- If grown as part of a mixed sward, excellent management is required to maintain plant populations
- Chicory is not a legume and requires a source of nitrogen. Artificial N applications are recommended after every grazing, if the plant is not grown with clover
- Due to its nutritional qualities, chicory is well suited to finishing lambs or carrying ewes and lambs during lactation
- It has been proven to reduce faecal egg counts in lambs and could reduce the use of anthelmintics
- Chicory can be used as a feed for cattle, but does not have significant benefits over PRG in terms of growth rates or worm burdens
- Rotational or strip grazing is essential to see the benefits of chicory, when grown as a stand-alone crop or as part of a mixed sward. A short intense period of grazing followed by sufficient recovery time is recommended
- Dagging or crutching grazing ewes and/or lambs may be required due to the potentially high digestibility of the plant
- Grazing in late autumn and winter and during prolonged wet weather, will damage the crown and reduce persistency
- The crop can be ensiled as a last resort. However, a significant wilting process is essential and the addition of an acid additive will probably be required to produce silage of sufficient quality

Plantain

History

The plantain plant

Narrow-leaf plantain or ribgrass is a perennial herb with a broad distribution in the native grasslands of the temperate world. It was once and in some situations still is, considered a weed.

However, in New Zealand in 1987, an attempt to identify native plants, collected mostly from roadsides, with high seed-producing potential as well as vegetative yield, led to the development of 'Grasslands Lancelot' in 1993. This was the first-ever plantain cultivar to be bred for pasture use.

The crop is now used as a stand-alone crop and as part of a sward for ruminants across the world.

Family	Plantaginaceae
Latin name	*Plantago lenceolota L.*
Alternative names	Ribgrass

Characteristics

Narrow-leaf plantain is a deep-rooted, smooth-leaved perennial herb with a rosette growth form. The leaves are lance shaped and scarcely toothed with three to seven strong parallel veins to a short stalk. Compared to its more native counterparts, the forage varieties of plantain are more uniform and more erect, with a higher number of vegetative shoots.

Description

- Basal rosette of leaves which are lance-shaped
- Dense upright foliage with leaves about 25cm long, and flowering stems 60-90cm long
- Deep tap root which provides some drought tolerance
- Flower is a brown cylinder 3–6cm long, with a mass of creamy-white stamens

A plantain flower

Plantain is adapted to a wider range of soils than chicory, but does not grow well in deep sands or waterlogged soils. It requires an annual rainfall above 500mm.

Unlike chicory the crop is winter-active. However growth rates are still lower than those of PRG. The plant is also moderately tolerant to drought and frost.

It has no specific P and K requirements and is commonly found in soils low in these elements. However recent anecdotal reports from New Zealand suggest that good P, K and sulphur (S) fertility is required.

It can tolerate a wider range of pH (4.2–7.8) than chicory, but 5.8 is considered optimum.

Yield and growth rate

The growth pattern of plantain is similar to that of PRG, exhibiting low to medium growth in winter, with the main growth periods occurring in spring and autumn. See Figure 4.

Under certain conditions plantain can yield up to 20t DM/ha, although 8–9 tonnes DM/ha (3.2–3.6t DM/acre) may be more likely in the UK. Reports from New Zealand suggest that the growth rate for plantain mix pastures can vary between 30 and 75kg DM/ha/day (12–30kg DM/acre/day). See Table 14.

Under certain conditions plantain can yield up to 20t of DM per ha, although 8–9t DM/ha (3.2–3.6t DM/acre) may be more likely in the UK.

Like chicory, plantain can be highly responsive to N when actively growing. This can be applied to the crop or supplied by sowing it with clover.

Figure 4: Seasonal DM production of plantain in comparison to PRG on four NZ farms over a four year period (Moorehead and Piggot, 2009)

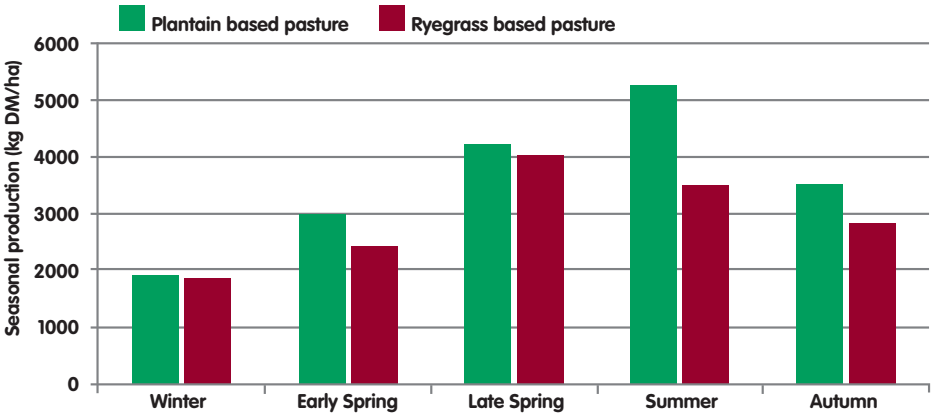


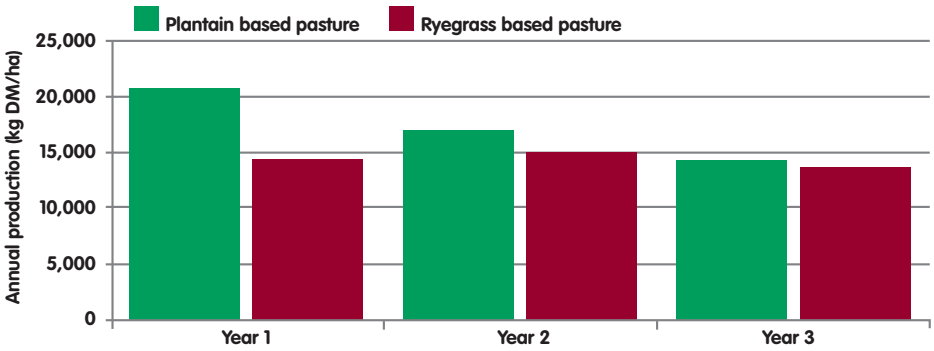
Table 14: Plantain yields from trial plots in New Zealand and USA

Year	Country	Crop	Sowing	Growth rate	Yield
2006	NZ	Pure plantain	15 row cone seeder, 6–8kg/ha	30–75kg DM/ha	16.9t DM/ha
2012	NZ	Plantain mix	n/a	70kg DM/ha at peak growth	n/a
2003	USA	Pure plantain	Drilled to 10mm (1cm) at 11kg/ha	n/a	6.3t DM/ha
2009	NZ	Plantain based pasture	2kg Plantain, 5kg clover and 10kg PRG /ha	n/a	17.6t DM/ha (6 farms over 4yrs)
2009	NZ	Pure plantain	n/a	69–72kg DM/ha	n/a

Persistency

A study where a plantain dominant sward was compared to a PRG-based mixture on six farms in New Zealand, showed significant variation between farms in the persistency of the plantain-based sward over the first three years. These ranged from 18.5–22.3t DM/ha (7.5–9t DM/acre) in year one, to 10.6–20.6t DM/ha (4.2–8.3t DM/acre) in year three. This suggests that under the right environment and management, the persistency of plantain based swards can be maintained for a minimum of three years.

Figure 5: Annual yields of plantain vs PRG over three consecutive years (Moorehead and Piggot, 2009)



Spraying off the existing pasture using a glyphosate-based herbicide, followed by direct drilling plantain, resulted in higher yields and plant establishment compared to broadcasting into an existing pasture.

Spraying off the existing pasture using a glyphosate-based herbicide, followed by direct drilling plantain, resulted in higher yields and plant establishment compared to broadcasting into an existing pasture.

Although early papers recommended growing plantain varieties as part of mixed swards, more recent evidence suggests that the plant's persistency and subsequent value to the sward is severely reduced. This is due to the competitiveness of other sward species and weeds.

Trampling, increased fertiliser applications and herbicide treatments will provide a greater competitive advantage to grasses and some clovers, leading to lower persistency in the plantain within the sward.

After a series of trials carried out in the North East of the USA, an author concluded that plantain had not lasted more than two years in simple, or complex mixtures with grasses and legumes.

The persistency of plantain in a mixed sward will benefit from rotational grazing, selecting less competitive companion species, a dry climate and generally lower soil fertility.

If there are plenty of nutrients in the soil, deep rooting is less of an advantage and light is the competitive factor. Grasses win in this situation due to their leaf shape and size.

Nutritional Value

As with chicory, the nutritional value of a sward can vary depending on plant growth, health status and its environment. In general, plantain has a higher CP value than PRG and is similar to that of white clover. Its D-value is similar to PRG, and lower than that of clover (Table 15).

Table 15: Nutritional values given to plantain in various research papers

Paper	Country	CP %	D-value
Fulkerson et al 2008	Australia	28.1	60
Glassey et al 2012	Australia	19.8	68
Moore et al 2006	Australia	Leaf = 23.5 Stem = 13.8	Leaf = 72 Stem = 59

Plantain is rich in minerals due to its deep tap root, which can access nutrients less available to more shallow-rooted crops such as grasses and clovers.

Plantain is rich in minerals due to its deep tap root, which can access nutrients less available to more shallow-rooted crops such as grasses and clovers (Table 16).

Table 16: Macro mineral contents (g/kg DM) in plantain vs PRG

Mineral content	Plantain	PRG	Approximate req. of a 40kg lamb gaining 100g/day
Calcium (Ca)	16.6	3.0	2.9
Phosphorous (P)	2.8	3.6	2.0
Sodium (Na)	8.1	4.3	0.7–0.9
Potassium (K)	16.1	28.6	5.0
Magnesium (Mg)	3.2	2.0	1.2

Palatability

Plantain is highly palatable and many studies have shown that in a mixed pasture animals will selectively graze it. This may be another reason why the plant struggles for persistency in a mixed sward.

Plantain is highly palatable and many studies have shown that in a mixed pasture animals will selectively graze it.

Seed heads will develop in the first year but this should be less than 10% of the available feed. Quality can be maintained by grazing before flowering, while the stems are still soft and palatable. One advantage over chicory is that most of the plant remains palatable at flowering. This means it is a little more forgiving if the crop cannot be managed to stop flowering.

Plantain that has bolted

Varieties

Plantain used to be added predominantly to a mixed sward. However recent reports from New Zealand suggest the crop is best utilised as the dominant species or the only species in a sward.

Two varieties of plantain currently exist globally. Grasslands Lancelot, the first pasture variety of plantain, was selected for its erect bushy growth habit and ability to tiller strongly under close grazing.

Ceres Tonic is the most current and most common variety used globally as a forage crop. When compared to Grasslands Lancelot it has larger leaves, flowers six days earlier (under New Zealand conditions) and has better autumn and winter production.

Sowing

Recommended seed rates are 8–10kg/ha (3.2–4kg/acre) for a stand-alone crop and 1–3kg/ha (0.4–1.2kg/acre) in mixed swards.

However recent work from South America recommends sowing at rates of 11–12kg/ha (4.4–4.8kg/acre) in stand-alone and 6kg/ha (2.4kg/acre) in mixed swards, in cold and temperate sub-humid regions where the average soil temperature at planting is around 11.7°C. Sowing plantain at a high seed rate (3–6kg/ha – stand-alone, 1.5–3kg/ha – mixed) increased seedling establishment by 28% over that of medium and low sowing rates.

Similar to chicory, late spring sowing is recommended in the UK, as growth is still limited at low soil temperatures. Sowing in the autumn as part of mixed sward is likely to lead to poor establishment of plantain, as other sward species are likely to out-compete it and dominate the sward.

Sowing in the autumn as part of mixed sward is likely to lead to poor establishment of plantain, as other sward species are likely to out-compete it and dominate the sward.

The seed can be broadcast or drilled to a maximum depth of 10mm due to the small seed size, into a new seed bed or into a killed-off pasture. Direct drilling and spraying off the existing pasture with a glyphosate herbicide increased yields by approximately 2.2t DM/ha (0.9t DM/acre), compared to broadcasting with no seed application (Table 17).

Table 17: Cost benefit of spraying off existing plants and direct drilling forage plantain

	Spray off and direct drill	No spray and broadcast	Difference
Yield (t DM/ha)	+2t DM	-	2t DM
*Spray costs (£/ha)	12.50	-	12.50
Glyphosate (£/ha)	30.00	-	30.00
*Sowing costs (£/ha)	30.00	20.50	9.50
		Total additional cost:	£52.00
Value of 2t DM of an alternative 18% CP and 11 MJ ME concentrate			**£500**

*Costs calculated using NAAC contracting charges 2012/13

Weed control pre-emergence is essential as plantain does not tolerate phenoxy-based herbicides (eg 2,4-D, MCPA). Publications from the southern hemisphere also suggest that if necessary, the crop can also be sprayed three weeks after planting.

Slug pellets are also recommended in medium to high risk areas.

For optimum performance soil P and K indices should be 2 as with grass. However as part of a mixed sward optimum growing conditions for companion species will result in a reduction in plantain populations.

Similar to chicory, applying 60kg/ha N, 25kg/ha P and 25kg/ha K at sowing and applications of 30–40kg/ha N after each grazing during the growing season, is recommended for plantain crops that do not include clover.

To ensure optimum utilisation, nitrogen applications rates following grazing can be adjusted to match predicted requirements.

The crop should be suitable to graze in about 12 weeks if sown in spring. The plant should possess at least six fully developed leaves before the first grazing. This usually occurs at a height of 20–30cm (2500–3000kg DM/ha).

However recent studies have suggested grazing from 10cm down to 5cm results in optimum utilisation. The aim should be to maximise leaf to stem ratio.

Recent studies have suggested grazing from 10cm down to 5cm results in optimum utilisation. The aim should be to maximise leaf to stem ratio.

Grazing intensity and frequency

Although some literature suggests that plantain can endure some levels of set stocking, a rotational grazing system is needed to fully utilise the crop's potential. Continuous grazing of mixed or pure swards leads to poor levels of utilisation and reduced yields.

Set stocking with low stocking rates can result in decreased plantain populations within mixed swards. Cattle have been found to select out plantain leaves in white clover and ryegrass swards.

As with chicory, plantain requires short, intensive periods of grazing with sufficient rest/recovery periods in between. Rotation length should not exceed four weeks – aiming for an optimum of three weeks, but can increase alongside reductions in plant growth.

Reports from New Zealand recommend leaving a residual height of 5–8cm to optimise utilisation and liveweight gain. Grazing to a residual height below 5cm can reduce growth rates and leaving a residual above 8cm leads to poor utilisation.

At peak growth, the crop should be able to sustain 80 lambs/ha gaining 200g a day for 14 days (assuming 1600kg DM/ha of available forage).

During the second year it is essential that plant height does not exceed 25cm to limit stem seed head development and maintain feed quality.

The crop should not be grazed in winter. Allowing the crop to rest for these months has been shown to increase yield by over 50% the following spring and summer.

The crop should not be grazed in winter. Allowing the crop to rest for these months has been shown to increase yield by over 50% the following spring and summer.

Case study

John Downes, Lognor, Shropshire

+ Milking 260 organic dairy cows on a forage based system

"We have been including plantain in our four-year grazing leys seed mixtures at around 0.5kg per acre.

"The main reason we use the crop is for its ability to draw up minerals, due to its deep tap root. It also provides a good source of forage in dry times.

"In peak growth conditions, the plant is difficult to control, even with rotational grazing."

Growing and finishing lambs

Reported growth rates of lambs on plantain swards vary widely, however they are dependent on management.

There are reported growth rates in lambs in the past ten years of between 200–350g/day where the crop has been rotationally grazed. In general growth rates are better than those of lambs on grass-based pastures, but slightly lower than those grazing forage legumes.

There are reported growth rates in lambs in the past ten years of between 200–350g/day where the crop has been rotationally grazed.

The advantages of plantain are exhibited better when evaluating production per ha (kg of lamb/ha), as plantain can sustain higher stocking densities than grass-based swards.

Studies measuring the performance of plantain in grass-based pastures on lamb growth rates have shown some positive effects. However, these studies recommend that to maintain optimum swards, plantain plants must be fully grazed. Due to the combination of varying plant growth rates and selective grazing, this can be difficult to achieve in some systems (Table 18).

Table 18: Compilation of studies measuring the effect of plantain on the performance of growing lambs

Date	Origin	Crop	Seed rate (/ha)	Animal	Stocking/ Allowance	Growth rate
1996	NZ	Pure stand plantain	8kg/ha plantain	Weaned lambs (22–23kg)	2kg DM/day	84–141g/day
2009	NZ	Pure stand plantain		Ewes with twin lambs during lactation till weaning	2.5kg DM/day	222g/day
2012	NZ	Plantain with white and red clover		Wethers weighing an average of 41.3kg	10 wethers/ha	346g/day

Ewes

Much of the research into plantain is based upon the performance of weaned lambs for finishing, due to the crop's nutritional values. However there is significant interest in the crop's attributes as a feed for lactation.

A trial conducted in New Zealand in 2009 found that plantain significantly increased lamb and ewe weight gain during the lactation period, in comparison to PRG (Table 19).

A trial conducted in New Zealand in 2009 found that plantain significantly increased lamb and ewe weight gain during the lactation period, in comparison to PRG.

Table 19: Performance of ewes with twin lambs grazing PRG or plantain

	PRG	Plantain
Weaning %	197	187
Lamb LWG (g/d)	309	346
Total weaning weight (kg/ha)	574	635
Ewe liveweight change (kg/ewe)	-2.3	7.2
Magnesium	2.8	1.8

Source: Judson et al, 2009

Growing and finishing cattle

No data on the effects of plantain on the growing and finishing of beef cattle could be found.

Meat quality

A New Zealand study found no difference in lambs fed plantain to those fed PRG that could be attributed to the pasture species, in terms of carcase and meat quality.

Lambs grazing plantain did have significantly higher kidney weights. This may have been due to the presence of active diuretics in the plantain.

Effects on health

Along with chicory, plantain has also been found to significantly reduce FEC in sheep, potentially reducing the number of anthelmintic treatments needed.

In New Zealand, lactating ewes with twin lambs, grazing plantain exhibited a 48% reduction in FEC compared to PRG. At weaning the FEC for ewes grazing plantain were three to four times lower than those grazing PRG.

Research conducted by SRUC has identified both chicory and plantain as bio-active forages that can reduce the need for worming.

Research conducted by SRUC has identified both chicory and plantain as bio-active forages that can reduce the need for worming.

Some research has recommended including plantain in a pasture mixture purely to meet the animals' mineral requirements, as PRG cannot do this on its own. Copper (Cu) imbalances, in particular, may occur due to the low Cu and high molybdenum (Mo) contents in grass.

Plantain has been found to have high levels of Cu, iron (Fe), zinc (Zn), selenium (Se), calcium (Ca) and magnesium (Mg), whilst also having low levels of other minerals, namely Mo and K.

Although the high level of active diuretics in plantain does not appear to affect animal health, it is recommended that plenty of clean, fresh water is available to lambs at all times. Increased water intake has been observed in lambs grazing plantain swards.

Increased water intake has been observed in lambs grazing plantain swards.

Conserving plantain

Only one study could be found investigating the quality of plantain as a conserved forage. The research was conducted in Australia where plantain hay bales were compared with those of PRG and lucerne (Table 20).

Table 20: The quality of hay made from PRG, plantain and lucerne

	PRG	Plantain	Lucerne
CP%	8.2	9.5	16.5
D-value	61.7	56.3	61.2
NDF* (g kg DM)	57.7	50.8	44.7
WSC** (g kg DM)	9.2	10.5	6.4
ME (MJ/kg DM)	9.0	8.1	9.0
DM%	53.0	57.9	54.2

** NDF is a measure of the fibre content*

*** Water soluble carbohydrate*

The quality of the plantain silage was deemed to have sufficient nutritive value to meet the maintenance requirements of weaned lambs, but not of ewes in early lactation.

The relatively poor quality of the plantain hay was deemed to be attributed to the late cutting date, suggesting there was a low stem to leaf ratio when the forage was cut.

Tips for managing plantain

- Plantain is adapted to a wide range of soils but does not tolerate waterlogged soils or deep sands. It is best suited to areas where its drought tolerant attributes (deep tap root) can be exploited
- It possesses a shorter growing period than PRG. However its growing period is longer than that of chicory
- Growth rates can reach above 70kg DM/ha per day in summer. Annual yields have been known to reach around 17t DM/ha (6.8t DM/acre)
- Plantain's plant growth pattern is not the same as grass so it requires different management
- A stand-alone crop can maintain sufficient yields for a minimum of three years if well managed
- As part of a mixed sward, excellent management is required to maintain plant populations
- Plantain is not a legume and requires a source of nitrogen. Artificial N applications are recommended after every grazing if the plant is not grown with a companion clover species
- Due to its nutritional qualities, plantain is well suited to lactating ewes with lambs or finishing weaned lambs
- It has been proven to reduce FEC in lambs and can reduce the use of anthelmintic treatments
- Rotational or strip grazing is essential to see the benefits of plantain as a stand-alone crop or as part of a mixed sward. A short intense period of grazing, followed by sufficient recovery time is recommended
- Grazing over late autumn and winter and during prolonged wet weather will damage the plant. Allowing the crop to rest over winter has been shown to increase yields by 50% the following spring and summer
- The crop can be conserved as a last resort, and has been shown to make sufficient quality hay. However, there is no evidence of its potential as silage

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