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Evaluating new forage systems for East Coast dryland

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Abstract

Dry matter production and animal performance on plantain and erect annual clovers were monitored on four demonstration sites from 2012 to 2014. These studies confirmed plantain's potential for increasing both the quantity and quality of forage produced on cultivated and un-cultivable hill country. Newly sown plantain produced more dry matter than newly-sown ryegrass over winter and spring. Across three sites, plantain pastures had more clover (32%, 45% and 45%) in October. Lambs grew faster on plantain and had higher dressing-out percentages. Plantain appears less competitive than ryegrass and the grazing management it requires suits erect annual clovers (e.g. Balansa, Persian, Arrowleaf). Because these clovers are aerial seeders, achieving seed set is challenging under grazing. Until management systems can be developed to allow seed set, these clovers are destined to be an annual crop producing a bulk of high quality spring feed in suitable micro-climates. Plantain and erect annual clovers offer a promising alternative to ryegrass-based systems on dryland. However, there is much to learn about the best place for each species and how they fit within a farm system. As with lucerne, plantain and erect annual clovers need to be rotationally grazed to prevent damage to the crown and growing points. The success of these alternative forages in dryland will depend on farmer willingness to embrace new grazing management techniques.

Keywords: forages; plantain; Arrowleaf clover; Persian clover; Balansa clover; over-sowing; lambs; live weight gain; dressing out percentage

Introduction

Climate change and an increasing frequency of droughts led to a search for more robust farming systems for dryland areas. Lucerne combined with a complete change in management has been a success story for the Avery family in drought prone Marlborough (Avery et al. 2008). Developing more robust dryland systems is about maximising farm production during the times of the year when moisture is not limiting, rather than producing more feed during the drought. On the East Coast, this means producing more, better quality feed in winter and spring, so that more stock are finished before the onset of drought. The current project evaluated a range of alternative forage systems and their fit within farming systems suitable for dryland East Coast. Forages evaluated included lucerne (*Medicago sativa*), plantain (*Plantago lanceolata*) and new, erect annual clovers such as Persian (*Trifolium respinatum*), Balansa (*Trifolium michelianum*) and Arrowleaf (*Trifolium versiculosum*). This paper focuses on plantain and annual clovers.

Plantain is an upright perennial herb which is becoming popular as a specialist crop or in a pasture mix. It has a shallower tap root than lucerne, chicory or red clover, which means it is less tolerant of drought. Plantain requires careful management (rotational grazing) to optimise production and persistence (Charlton & Stewart 1999). Industry sources suggest that 5,000 ha of plantain was planted in 2011, and this has increased rapidly to an estimated 20,000 ha in 2013. Data on dry matter yields of

plantain are limited, particularly in East Coast dryland. Sheep performance appears to be better on plantain than traditional pastures. Judson (2008) found the lambs on lactating ewes lambs grew at 370 and 270 g/d, on plantain and ryegrass respectively. Kemp (2012) found that plantain-based pasture produced 408 kg carcass weight/ha compared with 306 kg/ha on a ryegrass based pasture – mainly as result of a 33% higher stocking rate on plantain.

Erect annual clovers are relatively new to New Zealand farming and have promise in summer-dry areas, where white clover does not persist. A number of varieties with different flowering dates have been bred in Australia and are adapted to temperate climates with annual rainfall of 350-800 mm. These clovers grow vigorously during spring, are aerial seeders (seed heads produced at the growing tip) but, with the exception of Persian clover, produce significant amounts of hard seed. Whilst Arrowleaf, Persian and Balansa have all been historically tested within New Zealand research institutes (Sheath et al. 1984, Hyslop et al. 2003) the transition to commercialisation was not made. In 2011, a demonstration at Clarence Bridge reported that Persian, Balansa and Arrowleaf clovers produced 8.3, 7.2 and 6.9 tonnes DM/ha, respectively, between sowing on 26th March and harvest on 31st August (Anon 2012). The following year, 'Arratas' Arrowleaf clover was measured growing at 153 kg DM/ha/day at Lincoln (Evans & Mills 2008). These reports led to these annual clovers being incorporated into the Future Forage Systems project. This project has the objective of road-testing a range of forage

technologies and benchmarking them within existing farm situations.

Site Outline – Establishment and Results

A number of plantain and annual clover swards were established in summer-dry areas of the Hawkes Bay and Wairarapa. Sward growth rates were recorded and, where possible, benchmarked against conventional pastures. In most cases, animal performance was also measured.

Fertiliser (125 kg/ha DAP) was applied at drilling and again by air on 18 June (90 kg/ha Urea) and 12 August (200 kg DAP 13S). Each paddock was subdivided with three wire electric fences and rotationally grazed.

Pasture production. Pasture growth rates were measured at approximately monthly intervals using three exclusion cages per farmlet. In Year 1, the plantain/clover farmlet produced 29% more dry matter than the other two ryegrass based farmlets (10,660 vs 8,216 kg DM/ha; Figure 1). To date in Year 2, the plantain/clover continued to out-produce

Table 1 Area and sowing rates of three farmlets at Te Aute.

	Black Tank	North hill	Duck pond
Treatment	Ryegrass/clover	Ryegrass/plantain/clover	Plantain/clover
Area	7.8	5.8	5.4
Sowing rates (kg/ha)			
Ryegrass - Extreme AR37	20	20	
White Clover – Nomad	2	2	2
White Clover – Tribute	1	1	1
Red Clover – Tuscan	2	2	2
Sub Clover – Denmark	6	6	6
Plantain – Tonic		2	6
Weight kg seed/ha	31	33	17
Cost of seed/ha \$a	287	309	181

1. Te Aute - Plantain/clover on cultivatable hill country

Establishment. Three 6-7 ha farmlets were sown on a sandy loam soil on steep but cultivatable hill country at Te Aute Station near Hastings. Prior to establishment, pastures had been planted in a summer brassica crop and then fully cultivated and sown with a Great Plains disc drill on 24 March 2012. Three seed mixes were used where ryegrass and plantain content varied but clover mix remained the same (Table 1).

ryegrass/clover by 29% (12,423 kg DM/ha vs 9,599 kg DM/ha). In both years, winter growth from the plantain/clover was greater than ryegrass/clover. Production peaked at 70 kg DM/ha/day in September in both years. Plantain/clover pasture consistently had a lower dry matter percentage (~14%) than the ryegrass-based pastures (~20%), making visual estimates of pasture dry matter difficult. In spring of Year 1, the plantain/clover pasture had 32% clover (on a DM basis), whereas the two farmlets where ryegrass was sown had only 13.6% clover - in spite of the

Figure 1 Dry Matter production (23/5/2012 – 11/11/2013) from three farmlets at Te Aute.

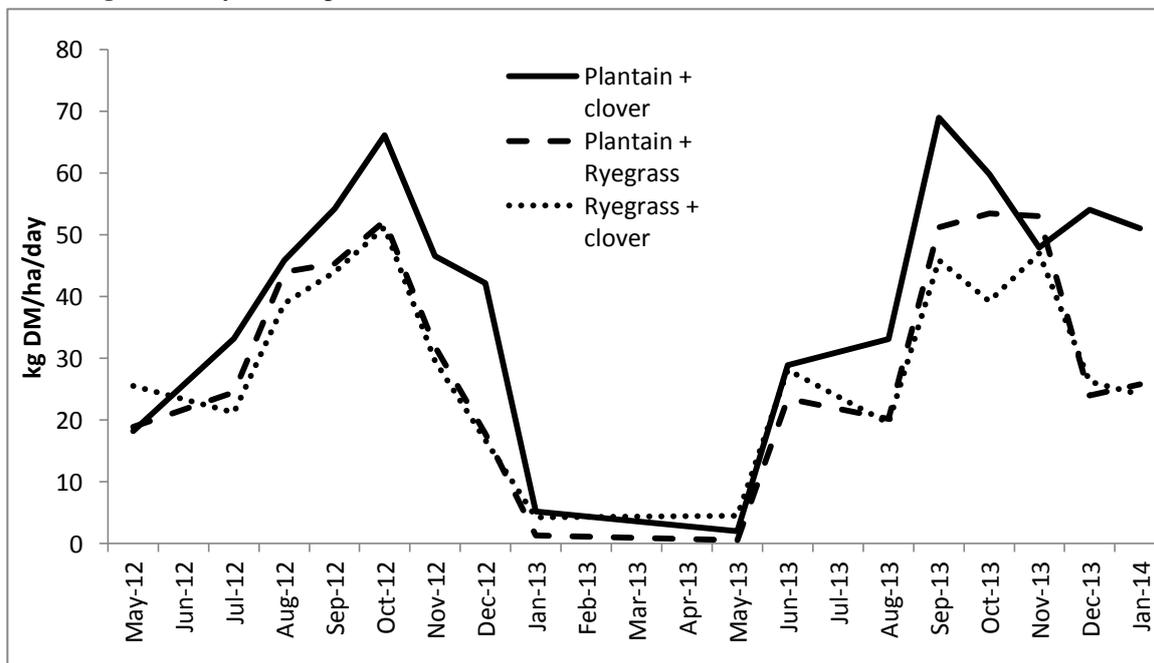


Table 2 Lamb performance at Te Aute for a 75 day grazing period from 18/7/12 and 1/10/12.

		Ryegrass/clover	Ryegrass/plantain/clover	Plantain/clover
18/7/12	Lambs at start	93	67	63
10/8/12	Lambs added	81	62	57
5/9/12	Lambs added	109	89	88
14/9/12	Bulls added	10	6	10
Grazing days (number/ha)		1734	1741	1722
Stocking rate (lambs/ha/day)		23.1	23.2	23.0
Lamb growth rate (g/d)		233	205	273
Total lamb LWG/ha (kg)		403	357	471
Average dressing out %		45.0	43.9	47.2
Average carcass weight (kg)		22.3	21.8	23.5
Increase in carcass value/ha (\$)		997	862	1223

original clover sowing rate being identical across the farmlets (Table 1). Where plantain was sown only with clover, it made up 65% of the sward dry matter, whereas when it was sown with ryegrass, plantain only comprised 10% of the sward dry matter. To what extent this was a result of competition from ryegrass, or preferential selection by lambs is not clear.

Animal performance. A lamb grazing trial was run between 18 July and 1 October 2012. Lambs with an average liveweight of 33.4 kg were drenched, tagged and allocated to farmlets. To control pasture growth, additional lambs were added on 10 August and 5 September, and yearling bulls on 14 September (Table 2). Lambs over 48 kg were drafted for slaughter on the 5 September and 1 October, and all lambs scored for dags. The criterion used was “would they have to be dagged if they were being sent for slaughter?”. Lambs grazing plantain/clover appeared to have fewer dags, with an average of 22% classed as dirty, compared with 32% of lambs grazing the ryegrass-based blocks. Over the 75 day trial period, lambs on plantain grew at 273 g/d compared with 220 g/d for the ryegrass-based blocks. As a result, more lambs were drafted for slaughter. Lambs off plantain had a higher dressing out percentage (47.3%) than lambs off ryegrass-based pastures (45.5%). This resulted in lambs on plantain having significantly heavier carcass weights (Table 2). Over the trial, the combination of higher liveweight gains and higher dressing-out percentage meant that lambs on plantain/clover produced 222 kg of carcass weight/ha compared with 181 kg for lambs on ryegrass/clover and 156 kg/ha for lambs on ryegrass/plantain/clover. At \$5.50 per kg carcass, this was an advantage of \$291/ha for plantain/clover pastures over the ryegrass based farmlets.

2. Te Mahanga - Plantain and clovers on flat land

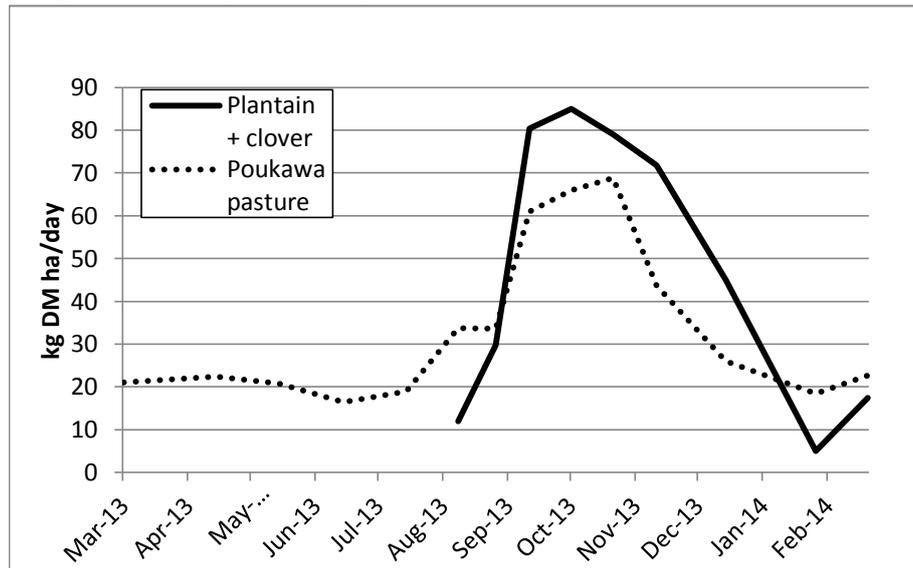
Establishment. A 38.2 ha flat land block at Te Mahanga Station near Hastings was fully cultivated after being in annual ryegrass and sown with a roller drill on 19 April 2013 and 150 kg/ha DAP was

applied. The sowing mix was ‘Tonic’ Plantain (6 kg/ha) plus 12 kg of clover seed - 3 kg/ha of ‘Bolta’ Balansa, 3 kg/ha of ‘Lightning’ Persian, 3 kg/ha of ‘Tuscan’ Red, 1.5 kg/ha of ‘Nomad’ White and 1.5 kg/ha of ‘Tribute’ White clover. Balansa and Persian clovers were chosen as they had been the outstanding performers in an annual clover demonstration near this site. The intention was to provide a boost in feed quality in Year 1, with red and white clovers forming the clover content of the sward in subsequent years. The soil type is a clay loam with an impervious pan, resulting in the block being winter wet and, generally, regarded as a low producing area of land. The block was subdivided into 12 paddocks with three wire electric fences.

Pasture production. Pasture growth rate was measured by mowing using a 7cm pre-trim. The late sowing combined with a wet winter resulted in slow post establishment growth rates of 12 kg DM/ha/d through late autumn and winter (Figure 2). From 8 August to 8 September, plantain/clover growth rates were 30 kg DM/ha/day. From 8 September to 8 November, growth rates were 70 – 85 kg DM/ha/day. By 8 January, dry summer conditions meant that pasture growth rates had declined to less than 5 kg DM/ha/day. Over the period from 19 April to 26 February, 10,670 kg DM/ha of utilisable feed was produced. Clover content was 19% of total DM in August and 45% of total DM in October.

Animal performance. The poor pasture growth rates post-establishment meant that first grazing was delayed until 8 August. Two mobs of 432 and 533 winter-finishing lambs were initially rotated around the 12 paddocks, but as the feed on offer increased, additional lambs were added as required. Grazing management aimed for best practice for the plantain. This meant that grazing occurred when the plantain was approximately 15-25 cm high and lambs removed at a residual of approximately 7-10 cm. This often meant shifting the lambs every day or second day. Wet underfoot conditions in early spring meant some paddocks were skipped until they dried out. Lambs

Figure 2. Plantain and Annual Clover production at Te Mahanga (2013-14) compared with long term average for the district.

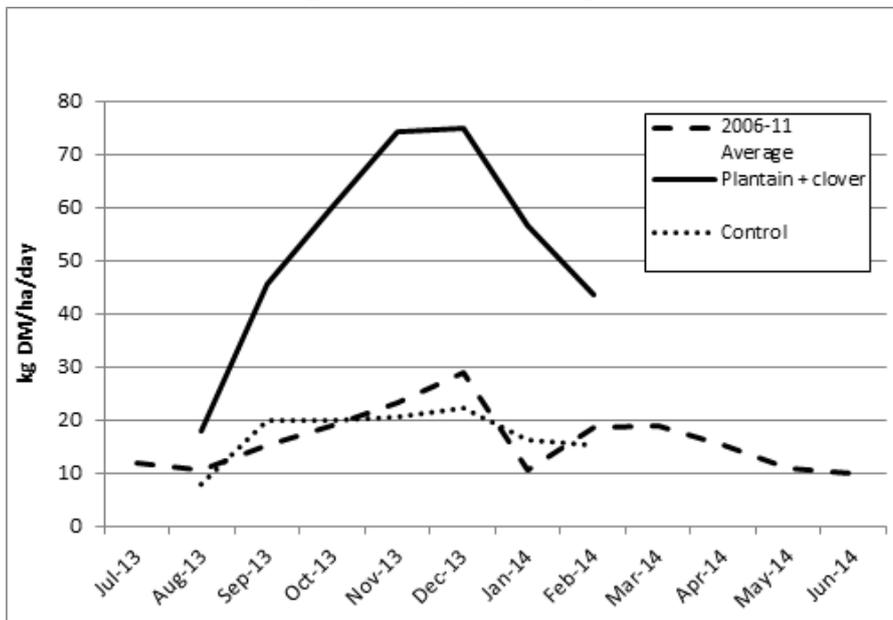


entered the block at approximately 30 kg live weight and were drafted for slaughter at 40 kg. Indicator lambs were weighed and tagged within each mob and replaced with new weighed, tagged lambs as the indicator lambs were slaughtered. Between 8 August and 11 November 2013, 4,716 lambs (79,880 lamb grazing days) were finished on the block. Lamb growth rates averaged 298 g/day and resulted in 613 kg of lamb LWG/ha. Dressing-out percentages were 48.4% (based on a farm weight) and were consistently 1-2% higher than other similar lambs on the same property finished on annual ryegrass (Moata). This meant that over the 95 day trial period, the increase in carcass weight was 297 kg/ha. At \$5.50/kg, this meant an increase in lamb carcass value of \$1,633/ha. Lambs finished on plantain/clover also had fewer dags, with

20% of lambs requiring dagging prior to slaughter. The comparable figure for lambs off Moata on the same property was approximately 50%.

was re-sprayed with 2.5 l/ha Roundup Transorb and 40 g/ha Granstar. Fertiliser (250 kg/ha Cropzeal 16N) was applied aerially on 3 April and the following day, seed was oversown by helicopter. The seed mix was ‘Tonic’ plantain (5 kg/ha) and a mix of clovers – ‘Arratas’ Arrowleaf (7 kg/ha), ‘Bolta’ Balansa (3.5 kg/ha), ‘Enrich’ Persian 3.5 kg/ha), ‘Sensation’ Red (3 kg/ha) and ‘Nomad’ White (2 kg/ha). Immediately after sowing, 2,100 hoggets were moved around the block to facilitate treading and seed/soil contact. The first grazing occurred on 28 June 2013 with 800 hoggets and subsequent grazings with a range of sheep classes occurred approximately monthly.

Figure 3 Pasture growth rate of plantain/clover and resident pasture on similar contoured land and the long term Castlepoint average.



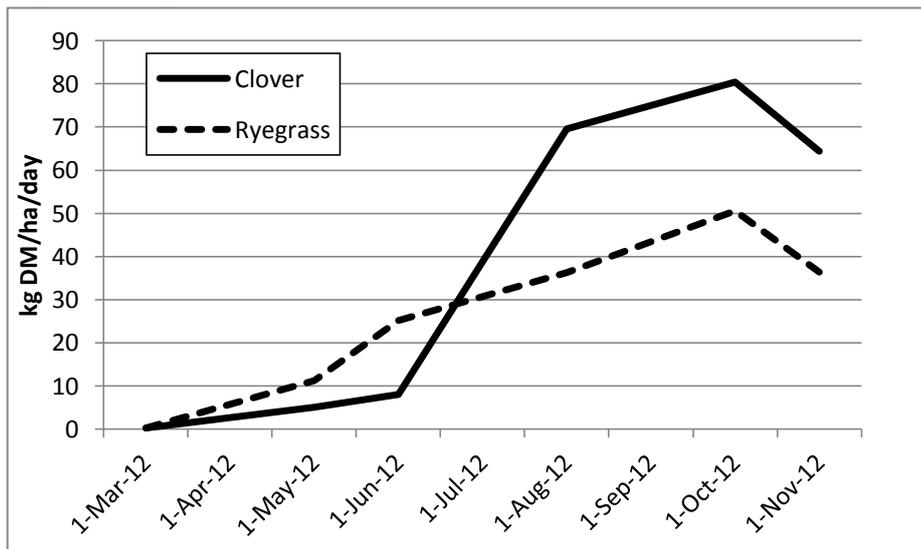
Pasture production. Pasture growth rates were measured using 14 exclusion cages across a range of topography. The growth rate of old pasture was also measured using 5 exclusion cages in an area of similar contour and aspect. Plantain/clover averaged 53.9 kg DM/ha/day between 1 August to 11 December (Figure 3). Clover content was 13.8% in August and 23.1% in December. By comparison, control pastures grew at 19.1 kg DM/ha/day over the same period and had less than 1% clover in August and December. Over the measurement period to date, 10 August 2013 to 11 January 2014, the over-sown plantain/clover block produced 11,768 kg DM per ha, 3.16 times the 3,715 kg DM per ha produced by the control block.

4. Poukawa – Annual clovers (Persian) as a crop

Establishment. This site compared the performance of Persian clover as a one-off annual crop with annual ryegrass (Moata) on a silt loam soil at the Poukawa Research Farm. An area that had been in annual ryegrass was sprayed with Roundup and disced prior to sowing with a rotary cultivator/air drill. Fertiliser (150 kg/ha DAP) was applied prior to sowing. Three 1.5 ha paddocks were sown in ‘Turbo’ Persian clover at 5 kg/ha and three paddocks were sown in Moata at 25 kg/ha on 29 March 2012.

Pasture production. Pasture growth rate was measured using the difference technique by mowing 1.5 m² within exclusion cages. Annual ryegrass pastures were grazed as necessary. Persian clover grew slowly through winter and thus remained un-grazed until early September. By the end of August, annual ryegrasses had been grazed three times and had produced 3,545 kg DM/ha, while the ungrazed Persian clover had produced 3,000 kg DM/ha. Most of the growth in Persian clover occurred during August (~ 70 kg DM/ha/day). Persian clover grew strongly through spring, with growth rates of 65-80 kg DM/ha/day, while Moata performed poorly with peak growth rates only of 50 kg DM/ha/day (Figure 4). Persian clover yields to 19 Nov were 8,300 kg DM/ha, while Moata yields were only 6,500 kg DM/ha – well below normal expectations and may have been a function of a wet late winter and/or a lack of nitrogen.

Figure 4 DM production of Persian clover and Moata at Poukawa.



Animal performance. A mixture of late lambing ewes and hoggets were allocated to the Persian and Moata blocks and rotationally grazed from early September. Lambs were mostly multiples, with ewes on annual ryegrass rearing 165% lambs, and ewes on Persian clover rearing 168% lambs. The intention was that ewes and lambs would not be limited for feed to determine potential lamb growth rates. More ewes and lambs were added to the Persian clover mob as required and stocking rate averaged 11 ewes/ha.

Stocking rate on the Moata averaged 7.5 ewes/ha. Over a 54 day grazing period, lambs on Persian clover grew at 349 g/d (lambs reared by ewes 380 g/d and lambs reared by hoggets 294 g/d) whereas lambs on annual ryegrass grew at 276 g/d (lambs reared by ewes 290 g/d and lambs reared by hoggets 246 g/d). Ewes on the Persian clover put on weight and were 5 kg heavier than their counterparts on the Moata. Ewes and lambs had to be removed from the Moata on 16 Nov because of deteriorating feed quality.

Discussion

These studies confirm plantain's potential to increase both the quantity and quality of forage produced. The greatest benefits were observed at Castlepoint Station, where an intensive development schedule of double spray, summer fallow and over-sowing established a plantain based pasture which, in only 9 months production, produced 3.16 times more dry matter than similar areas of resident pasture. Winter and spring production is critical in a summer dry environment and plantain at Te Aute out-produced newly sown ryegrass over winter and spring for two years. Whilst stocking rates were similar at Te Aute, the extra dry matter enabled higher feed intakes and better liveweight gains. At all sites, plantain-based pastures had high clover contents in October (Te Aute 32%, Te Mahanga 45%, Castlepoint 45%), so it seems that the growth habit of plantain encourages clover growth, whereas ryegrass suppresses clover growth, particularly during spring. It is not clear to what extent the lamb growth rate advantage on plantain is a result of the plantain *per se*, or to the higher clover content of plantain based pastures. Lower faecal egg counts in lambs grazing plantain pastures may also play a role in improving growth rates (Fraser & Rowarth 1996; Turner 2002) as both Te Aute and Te Mahanga reported lower dags in finishing lambs.

The results obtained in the present study have been combined with the available data from published studies on plantain (Table 3). In the eight studies where both plantain and ryegrass have been compared, average lamb growth rates on plantain have been 25% higher than on ryegrass. In addition to faster lamb growth rates, is the improvement in dressing-out percentage (1-2% advantage) observed at both Te Aute and Te Mahanga. This was presumably the result of more digestible feed and faster rumen transit times and provides a double benefit to the

Table 3 Comparative lamb liveweight gains on plantain and ryegrass mixtures*.

Site		Growth rate		Significance	
		Stocking Rate	Plantain g/lamb/day		Ryegrass g/lamb/day
Lincoln^a	Post-weaning		84 – 141	98 – 136	Not available
Canterbury^b	Pre-weaning	Diff	376	296	Low sign
Canterbury^c	Pre-weaning	Same	346	309	High sign
Canterbury^d	Post-weaning	Diff	222	135	Non sign
Canterbury^e	Pre-weaning	Same	370	270	Not available
Massey^f	Post weaning	Diff	214	154	Not available
Massey^f	Post weaning	Diff	231	188	High sign
Bennydale^g	Post weaning		260		Not applicable
Te Aute	Post weaning	Same	273*	233	
Te Mahanga	Post weaning		298*		Not applicable

^a Legumes, herbs or grass for lamb performance - only higher on plantain in Year 1 (Fraser & Rowarth 1996)

^b Ewes at different stocking rates 15.1 ryegrass and 10.4 plantain. Weaning weight 785 kg/ha on ryegrass vs 618 kg/ha on plantain (Judson et al. 2009)

^c Twin-bearing ewes at similar stocking rates - 9.5 ryegrass and 10.4 plantain (Judson et al. 2009)

^d Different stocking rates with 8-week old lambs - 27.2 lambs/ha on plantain and 37.3 lambs/ha on ryegrass. No significant difference in weight gain per hectare from Dec – Mar, although growth rates much higher on plantain. High endophyte ryegrass may have contributed to lower liveweight gains (Moorhead et al. 2002)

^e Judson (2008)

^f Kemp (2012)

^g Lambs over 96 day period and 0.9 kg carcass weight heavier than grass fed (Anon 2011).

farmer - higher growth rates and higher carcass weights at the same liveweight.

Whilst plantain based pastures look very promising, they have failed to persist in a number of East Coast situations. Whilst the individual reasons for lack of persistence are unknown, it is clear that ryegrass management techniques should not be applied to plantain. Set stocking, repeated hard grazing, pugging in winter, failure to spray out grass weeds will all reduce plantain plant numbers and the life of a stand. Optimum management is grazing from 12-25 cm down to a grazing residual of 8 cm (Kemp 2012). For most farmers, this will require a change in thinking – i.e. managing the forage to optimise its performance rather than managing for animal performance. Experiences on flat land at Te Mahanga are that even a set rotation is difficult to achieve. Plantain pastures need regular checking and overgrazing must be avoided even if it means removing animals from the plantain. The requirement for rotational grazing and regular monitoring provides a serious complication on hill country where set stocking is often the norm. It also means establishing enough area that it can be rotationally grazed or undertaking expensive subdivision on the over-sown area. However, plantain pastures are free-seeding and if permitted, seed set can exceed 400 kg/ha (Rowarth 1990). This means that allowing plantain pastures to set seed is likely to rejuvenate a stand.

The role of the erect and aerially seeding annual clovers in dryland areas is less clear. Their slow winter growth rates mean either a change in stock policy or growing other supplements (e.g. greenfeed oats) to compensate for the feed shortfall on farm. However, these annual clovers grow rapidly in spring and are capable of high yields from relatively low amounts of seed. Persian clover at Poukawa provided a bulk (8,000 kg DM/ha) of high quality feed through a very difficult and dry spring. A Hawkes-Bay farmer is having considerable success growing Arrowleaf clover (current plantings 70 ha) as a specialist crop. In addition, Persian, Arrowleaf, and Balansa clovers performed well in demonstration blocks at Poukawa. A combination of results led to annual clovers being incorporated with plantain and perennial clovers at Castlepoint and Te Mahanga. Visually, the inclusion of Persian and Balansa clover made a large contribution to the 45% clover content in the sward at Te Mahanga. At Castlepoint, when annual clovers were sown with plantain, clovers contributed 13.2% in August, 23.1% in November and 12.9% in January to the sward with plantain contributing most of the rest, with weeds and grasses contributing less than 10% at any cut.

When grown with plantain, Balansa and Persian clover are capable of contributing large amounts of quality dry matter. Both clovers appear to occupy space that the plantain does not. While their very erect growth habits pose management challenges under set stocking, they are promising companion clovers when

sown with plantain and grazed to residuals no greater than 8 cm. Because these clovers are aerial seeders, achieving seed-set under grazing poses difficulties, as erect flower heads are readily consumed. A long seed maturation period means to achieve effective seed-set, stock grazing may have to be avoided for several months and if seed is set, hard-seededness in the case of Balansa and Arrowleaf may mean that seed germination is at least 12 months away. Until development of management systems for these new annual clovers, it is likely that their role is as one-off companion plants producing high quality feed within a plantain stand, or as annual crops in specific micro-climates.

Plantain and annual clovers offer a promising alternative to ryegrass based systems in dryland. However, there is much to learn about the best place for each species and how they fit within a farm system. There is a need to better understand weed control, grazing management and ways to optimise stand longevity – particularly in the case of annual clovers. As with lucerne, plantain and erect annual clovers need to be rotationally grazed to prevent damage to the crown and growing points. The success of these alternative forages in dryland will depend on farmer willingness to embrace new grazing management techniques.

Acknowledgements

The authors gratefully acknowledge the assistance of Cameron Lane of Brownrigg Agriculture and Tom Bush of Castlepoint station. Noel Smith and Kay Ward for willing measurements and Peter Swinburn and members of the Beef + Lamb Farmer Council for their over-sight and direction of the project. This work was funded by MPI's Sustainable Farming Fund (Grant 11/104), Beef + Lamb NZ and the Hawkes Bay Regional Council.

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