Future Forage Systems Project

Plantain and Oversowing Hub Updated Notes

Castlepoint Station, 19th February 2014

Background

The East Coast Future Forage Systems Project provides the opportunity to road-test a range of forage technologies such as lucerne, plantain and annual clovers – both as crops and on hill country. Where possible, this will consist of on-farm demonstrations where new options are benchmarked against existing farm practice. Once we understand how these alternatives perform locally, we can look at integrating them into farming systems.

The focus at Castlepoint Station is to improve the legume content of dry hill country by over-sowing a range of clovers

Current Trial Sites

Site 1 - Valley – 10.0 ha

Objectives:

- Evaluate success of over-sowing plantain and a range of annual clovers by aspect
- Seed set and hard seededness of annual clovers following different closing dates.
- Regeneration from seed bank (over several seasons).

Over-sowing seed mix:

- 5 kg/ha Tonic Plantain
- 7 kg/ha 'Arrotas' Arrowleaf clover – deep tap root well suited to summer dry
- 3 kg/ha 'Sensation' Red clover – tap rooted
- 3.5 kg/ha 'Bolta' Balansa clover – deeper and more extensive root system than white clover
- 3.5 kg/ha 'Enrich' Persian clover – tolerant of waterlogging
- 2 kg/ha 'Nomad' White clover

24 kg/ha Total

Fertiliser:

- 250 kg/ha Cropzeal 16N (NPKS 15.4, 8.0, 10.0, 9.6) at over-sowing
- Soil tests December 2012

pH	P	Ca	Mg	K	Na	SS	OS
5.7	15	7	83	13	16	4	6

Measurements

- Seed and fertiliser distribution
- Seedlings at 9 weeks/plant numbers before first grazing
- Plant numbers at closing
- Number of seed heads, seed set and percentage of hard seeds

Timeline

- **22 November 2012** – First spray and fallow – 3l/ha Roundup Transorb (glyphosate) + 40g/ha Granstar (tribenuron-methyl) in 100 l water /ha
- **26 March 2013** - Spot spray variegated thistles with 2 l Agritone (MCPA) in 100 litres water/ha
- **28 March 2013** – Second spray - 2.5 l/ha Roundup Transorb (glyphosate) + 100ml/100l Pulse + 40 g/ha Granstar (tribenuron-methyl) in 100 l water/ha
- **3 April 2013** - Fertiliser - 250 kg/ha Cropzeal 16 (NPKS 15.4, 8.0, 10.0, 9.6)
- **4 April 2013** – Seed over-sown by helicopter
- **10 April 2013** - Post over-sowing grazing and treading with 2100 hoggets chased around the paddock for four hours
- **9-11 June 2013** - Counts of clover seedlings along a transect. Exclusion cages placed on representative sites
- **28-30 June 2013** – First grazing with 800 hoggets
- **10 August 2013** – Dry matter cuts taken

- **29 September 2013** – Dry matter cuts taken
- **1 November 2013** – Dry matter cuts taken
- **13 December 2013** – Dry matter cuts taken
- **11 January 2014** - Dry matter cuts taken
- **12 January 2014 –** Flower counting and seed harvesting

Results:

Seed and fertiliser distribution – Collectors were placed at 6 metre intervals on a downhill diagonal 48 metres across north facing steeper country. Seed and fertiliser were sown on different days. There was a wide range in the sowing rates recorded in the collection buckets for clovers, plantain and fertiliser. Over a short transect the average sowing rate of clover seed (38 kg/ha) was twice the planned rate of 19 kg/ha (Figure 1). The average plantain sowing rate along the transect line was 8.4 kg/ha, nearly twice the planned rate of 5 kg/ha (Figure 2). There was a high correlation between clover seed and plantain seed in each collector, suggesting that the seeds were behaving similarly when being sown and that some areas were receiving more seed. Note – the individual seed weight for plantain is very similar to the average weight of the clover seeds sown.

Fertiliser along the transect averaged 294 kg/ha vs the target rate of 250 kg/ha. However there was a large range in the amount received by individual collectors, range 66-392 kg/ha (Figure 3). A low seed rate in one location will mean higher seed rates elsewhere. This appeared to be confirmed visually.

Seedling establishment – Clover and plantain seedlings were counted along 50 metre transects across a range of aspects (Table 1). Establishment of clovers and plantain was very good in all aspects other than on southern slopes and the easy tops. There was very poor, almost nil, establishment of seedlings in the moist flats between the two hills - this area was not counted. The reason for the establishment failure could be due to distribution, residual effects of MCPA (most likely suspect) or insect damage.

Figure 1 - Clover over-sowing rate along downslope transect 0=uphill end (Target rate = 19 kg/ha)

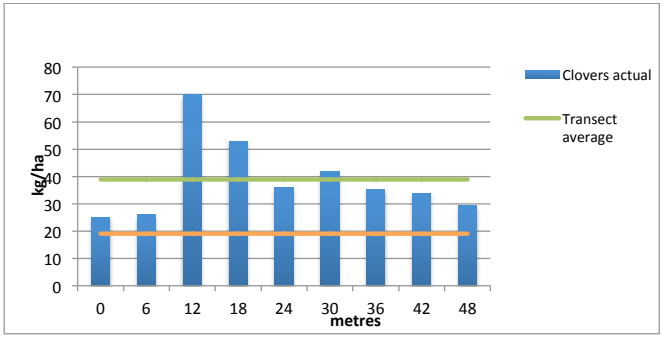


Figure 2 - Plantain over-sowing rate along downslope transect 0=uphill end (Target rate = 5 kg/ha)

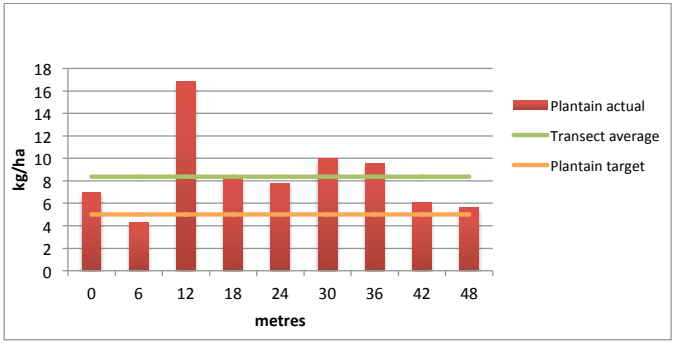
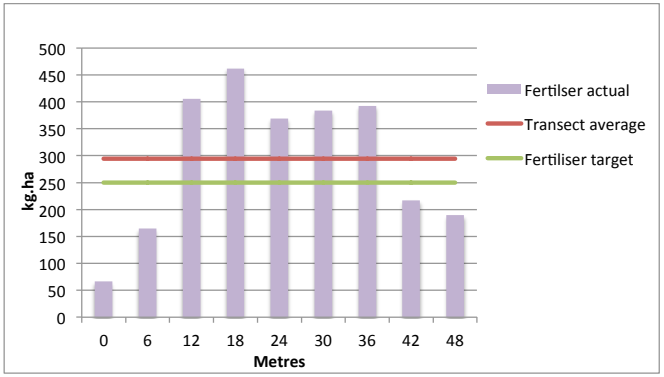


Figure 3 - Fertiliser application rate along downslope transect 0=uphill (Target rate = 250 kg/ha)



Establishment rates in excess of 100 clover plants per square metre were very good and reflect the high seeding rate used. The high establishment of plantain from over-sowing was very encouraging.

Table 1 - Seedling counts 9 weeks after over-sowing

Transect	Slope	Seedlings per m^2 Clover	Plantain
A	Dry north upper	114.2	77.8
B	Dry north lower	135.7	55.4
C	Moist flats	202.7	114.7
D	South slopes	50.2	46.5
E	Flat tops	53.1	27.5

Plantain and clover production - Cages were placed at 12 locations across a range of aspects in Valley. Dry matters were cut to 2 cm above ground on 10 August 2013 and thereafter to 5 cm above. After each cutting cages were shifted to representative areas that had been trimmed to 5 cm. Total dry matter (DM), growth rate per day and the proportion of grass, plantain, clovers, weed and dead matter were measured (Tables 2).

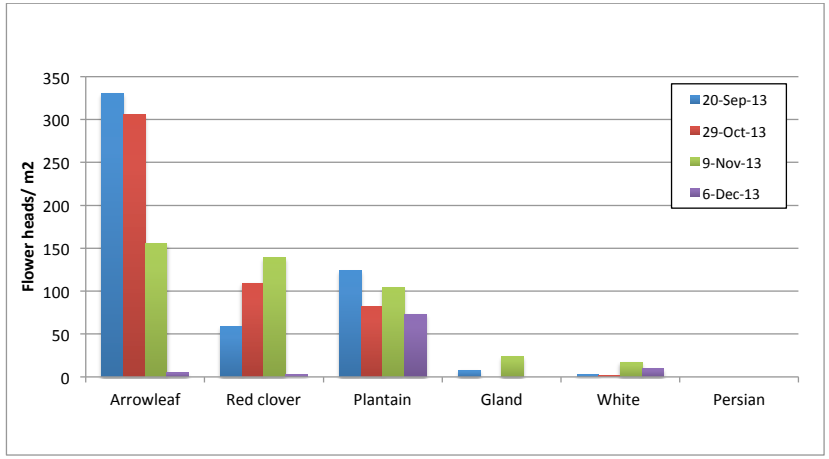
Table 2 – Production and pasture components from oversowing

Date	Land Class	kg DM/ha	Growth rate kg DM/day	% Grass	% Clover	% Plantain	% Weed	% Dead
10/8/13	Flat bottom	3406.7	26.4	16.7	5.2	73.0	1.1	4.1
	Flat top	2673.0	20.7	1.2	14.0	78.6	0.0	6.2
	Inter-track - North	2938.6	22.8	16.7	10.9	62.7	0.0	9.8
	Southern	719.0	5.6	2.9	11.7	76.7	1.7	7.0
	Eastern	1830.7	14.2	5.9	22.7	61.7	0.0	9.8
29/9/13	Flat bottom	1918.6	39.2	20.5	11.4	55.5	11.5	1.0
	Flat top	3409.2	69.6	12.2	17.3	70.1	0.5	0.0
	Inter-track - North	1778.4	36.3	1.4	11.8	84.7	0.7	1.3
	Southern	1470.5	30.0	13.0	21.4	62.6	1.3	1.7
	Eastern	2613.5	53.3	4.5	35.7	48.2	8.0	3.6
1/11/13	Flat bottom	3136.3	92.2	1.0	0.8	95.3	1.5	0.4
	Flat top	2503.8	73.6	22.0	8.8	38.4	28.4	2.4
	Inter-track - North	2405.6	70.8	5.3	20.8	71.1	0.7	2.2
	Southern	2343.5	68.9	14.4	31.1	49.6	4.9	0.0
	Eastern	1068.2	31.4	1.4	37.1	59.2	0.4	1.9
13/12/13	Flat bottom	2775.3	65.2	8.2	16.5	55.7	17.7	1.9
	Flat top	3708.7	71.8	65.0	9.7	19.4	0.0	5.8
	Inter-track - North	2590.5	39.6	7.9	24.3	55.0	1.4	11.4
	Southern	2365.9	64.2	37.9	14.9	41.3	1.0	5.0
	Eastern	2833.7	82.7	0.0	31.0	63.8	0.0	5.2
11/1/14	Flat moist	2472.7	58.9	4.9	11.3	75.0	0.0	8.8
	Flat top	2837.4	97.8	13.0	5.6	75.5	0.0	5.9
	Inter-track - North	1990.2	53.0	0.8	15.3	75.5	0.8	7.6
	Southern	1564.0	37.2	7.7	12.8	67.6	2.7	9.2
	Eastern	1527.5	36.4	1.5	14.8	71.9	0.0	11.9

On all sites there was a very high contribution of plantain to the total dry matter (range 48 to 87%). The contribution of clover ranged from 5 to 35%. The vigour of the plantain in the flat moist areas appears to have suppressed clover growth. Between sowing in early April and cuts made in August, the moist flats produced 26.4 kg DM/ha/day. However the north facing inter-track areas produced 87% of that grown on the moist flats. Total production averaged across all aspects in Valley was 11756 kg DM/ha between 4 April and 11 January.

Flowering & Re-seeding - From 20 September 2013 onwards, a 3 metre by 20 metre strip of north facing slope was fenced to exclude stock grazing. On 12 January 2014 the number of flowers for clover and plantain were counted for each date of closing (Figure 4). Closing date had a marked effect upon the numbers of flowers heads present in January for Arrowleaf clover. There were very small amounts of gland, white and Persian clovers following any closing date, suggesting it was grazed to extinction closing. There were flowers of Balansa clover present but it was not possible to count them as many had matured fully and disintegrated.

Figure 4 – Flower head numbers in January 2014 following closing at various dates



Lessons/observations to date:

- Fallow/double spray very successful - Good control of rats tail and rushes in particular
- Successful introduction of clovers and plantain into most aspects. Thatch preventing seedling establishment in some inter-track areas
- The sowing rate of plantain of moist flats was probably too high and 3-4 kg/ha would have been adequate.
- Seed/plant striping evident in some areas – less than ideal distribution of seed and fertiliser
- Large areas of moist country in middle flats with no seedlings – either not sown, spray damage or insect damage. However thistle spray may have had an impact as MCPA (Agritone) in the soil may temporarily inhibit seed germination/ plant growth.
- Poor seedling numbers on crest – desiccation of seedlings after over-sowing?
- Thistles require special attention. Thistle seedlings were providing large amount of competition on camp areas in August. By September thistles had become a problem in several areas of the paddock.

Grazing recommendations:

- Graze when plantain has 6 or 7 true leaves. True leaves must be fully or very near fully expanded.
- Grazing should be done to minimise pugging as plantain crowns are very susceptible to damage when ground is wet.
- The first grazing should remove no more than 2/3 of the existing herbage. Leave 6-8 cm behind.
- Subdivision with hot wires is likely to be necessary to achieve optimum grazing management with plantain.

Site 2 - Horse (16.6 ha) Oxen (11.2 ha) & Cob (10.9 ha)

Objectives:

- Directly improve the legume content of dry hill country (i.e. over-sowing without spraying) and obtain stock performance data if possible.
- Compare the effects of a sward suppressant spray on clover establishment
- Compare the effects of different closing dates on the ability of aerially seeding annual clovers to set seed and re-establish.

Over-sowing seed mix:

- 7 kg/ha 'Arrotas' Arrowleaf clover
- 3.5 kg/ha 'Bolta' Balansa clover
- 3.5 kg/ha 'Enrich' Persian clover
- 1 kg/ha 'Prima' Gland clover

  15 kg/ha total

Closing dates for re-seeding:

- Cob (right-hand side) – Control
- Horse – (middle) - Early close 1st November

- Oxen – (left hand side) - Later close 1st December
- Additional earlier closing dates within paddocks using cages.

Fertiliser:

- Nil at sowing – planned for autumn (not yet applied)
- Soil tests February 2011

pH	P	Ca	Mg	K	Na	SS	OS
5.6	18	9	79	28	13	11	9

Measurements:

- Seed and fertiliser distribution
- Seedlings at 9 weeks/plant numbers before first grazing
- Plant numbers at closing
- Number of seed heads, seed set and percentage of hard-seeds

Timeline:

- **Summer management** - Grazed as hard as possible over the summer with ewes and cows
- **26 March 2013** - Chemical top two swaths along fence line and where cover is thick prior to aerial sowing - 150 ml/ha Roundup Transorb X (glyphosate) in 100 litres water/ha to Oxen
- **4 April 2013** – Over-sown by helicopter.
- **9-12 April** - Treading with 2300 mixed age ewes for 2 days in each paddock
- **3-6 May** – Treading with 2300 mixed age ewes for 2 days in each paddock
- **7-10 June** – Treading with 2300 mixed age ewes for 2 days in each paddock
- **10 June 2013** - Total counts of clover seedlings down transect. Cages placed
- **10 August 2013** – Dry matter cuts taken
- **29 September 2013** – Dry matter cuts taken
- **1 November 2013** – Dry matter cuts taken
- **13 December 2013** – Dry matter cuts taken
- **11 January 2014** - Dry matter cuts taken
- **12 January 2014 –** Flower counting and seed harvesting

Results:

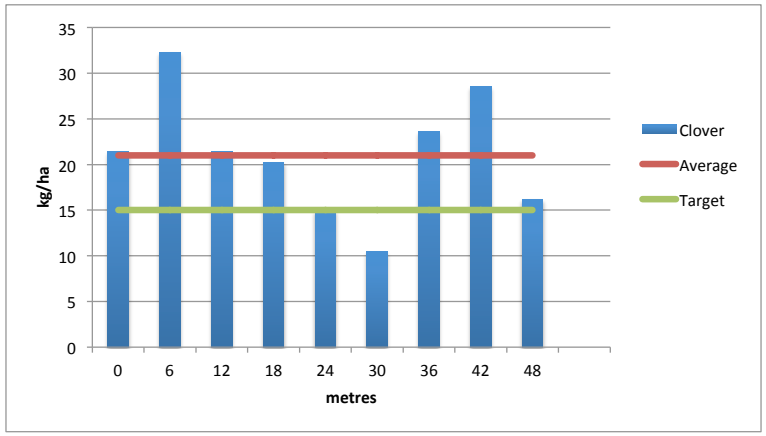
Seed distribution – Collection buckets were placed at 6 metre intervals straight down the slope for 48 metres to measure seed distribution. Over this relatively short transect the distribution was variable (10-32 kg/ha) with the average rate of clover seed being 21 kg/ha compared to the planned rate of 15 kg/ha.

It became clear after seed germination that there were seed distribution effects within both Horse and Oxen. Visual banding of clover seedlings was evident in many places within the paddocks. Some areas of the paddock received higher seeding rates at the expense of other areas throughout the paddock which must have received less, or possibly even no seed.

In order to further assess the distribution of seed throughout Horse on 11 August the number of 'new' clover seedlings were counted on 11 August in a 40 * 40 cm quadrat every 1 metre along a transect from the bottom of the hill to the top fence. Distribution of established seedlings was variable along the transect (Figure 5) and there were many instances of a bell shaped distribution over a 5-8 metre

distance with areas of no establishment in between. This provides further evidence for uneven seed distribution by helicopter. The effect is that area that received seed often had an effective sowing rate far higher that the desired rate at the expense of areas that received less or in many cases probably no seed.

Figure 5 – Clover over-sowing rate along downslope transect 0=uphill (Target rate – 15 kg/ha)



Seedling establishment – Clover seedlings were counted along 50 metre transects that covered a range of aspects (Table 3). Establishment of clovers and plantain was poor in all areas other than the sprayed steep northern aspect. While over-sown clovers were present throughout the over-sown areas their numbers were low and it appears competition from the existing sward has inhibited establishment.

Table 3 - Seedling counts 9 weeks after over-sowing

	Spray	No Spray	
	Steep North	Moist North	Steep North
Seedlings per m^2	130.8	36.8	26.3

Dry matter production - Cages were placed at locations showing good or very good clover establishment after oversowing in both sprayed and unsprayed areas. Cages were cut at 3 cm above the ground on 10 August 2013 and again on 29 September 2013 and approximately monthly thereafter. Total dry matter (DM), growth rate per day and the proportion of grass, plantain, clovers, weed and dead matter were measured (Table 4).

By the 10th August much of the clover present in unsprayed cages had disappeared (Table 4). After this cut, cages were placed on new 'good' areas of clover. By the 29th September there was more clover in the sward, suggesting that once the seedlings managed to become established they have persisted better as they got older (Table 5).

In August, swards in sprayed plots produced nearly 1.5 times more dry matter, mostly through the contribution of clover, which was 20 times that of the unsprayed areas.

At the September cut the growth in sprayed areas continued to exceed that of unsprayed areas. In December and January there was no differences in total dry matter production between the sprayed and unsprayed sites.

Table 4 – Production and pasture components from oversowing on good sites

			Growth rate	kg DM/ha			
Date	Treatment	kg DM/ha	kg DM/day	Grass	Clover	Weed	Dead
10 August	Spray	569.9	4.4	290.1	222.8	0.0	57.0
	No spray	364.9	2.8	329.4	10.7	0.0	24.0
29 September	Spray	2138.4	43.6	1022.3	971.6	0.0	144.4
	No spray	1262.9	25.8	561.3	701.6	0.0	0.0
1 November	Spray	1842.3	54.2				
	No spray	1414.5	41.6				
13 December	Spray	771.9	18.4				
	No spray	795.4	18.9				
11 January	Spray	715.1	17.0				
	No spray	775.9	18.5				

Table 5 – Pasture composition at cutting dates

Date	Treatment	% Grass	% Clover	% Weed	% Dead
10 August	Spray	50.9	39.1	0.0	10.0
	No spray	90.3	2.9	0.0	6.8
29 September	Spray	47.8	45.4	0.0	6.8
	No spray	44.4	55.6	0.0	0.0
13 December	Control	73.4	0.0	20.3	6.3
	Spray	71.6	11.9	3.0	13.4
	No spray	49.0	36.5	4.8	9.6
11 January	Control	50.7	0.0	30.1	19.2
	Spray	47.4	27.0	2.0	23.6
	No spray	35.9	30.3	9.0	24.8

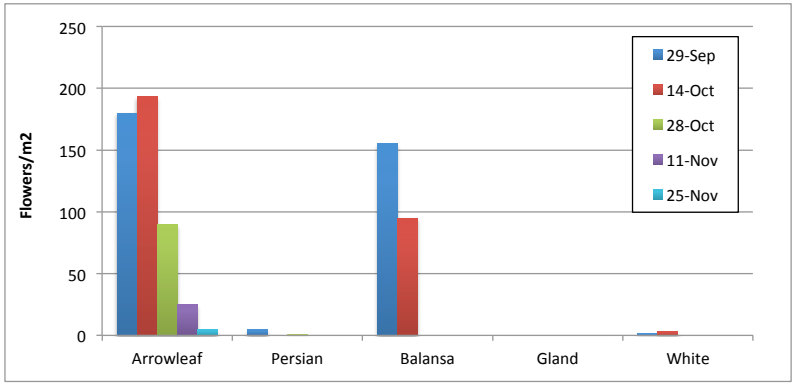
Reseeding – The area was set stocked with ewes and lambs on the 27 August 2013. On 29 September a 6 m by 7m area was excluded from grazing to allow plants to flower in the absence of grazing. Every two weeks after a further area of the same size was also fenced to exclude grazing. This continued to 25 November 2013. A ewe got into the area around the 16 October and ate all flower heads that were present - these were almost all Balansa flowers. Balansa flowering has been estimated from flower counts form photos of pasture cages and by observation.

Both Persian and gland clover had been grazed to near extinction by time of first closing (29 September). Grazing after 28 October removed all Balansa flower heads. There was negligible flowering from the small resident white clover population.

Lessons/observations:

- **Arrowleaf clover** – on 29 September stem extension had commenced in plants within cages though this had not begun on plants still being grazed. No flowering was evident.
- **Balansa clover** – on 29 September immature flower heads were appearing on plants within cages. No flowers were evident within the grazed paddock areas. No stem extension was noticed on Balansa plants. By 14 October flower heads were fully open and some florets fertilised. On 1 November almost no Balansa clover was evident within the paddock.

Figure 6 – Flower heads in January 2014 following closing at various dates



- **Gland clover** – following sowing it appeared that there had been quite a lot of inoculation failure on gland clover seedlings. Many appeared small, stunted and very yellow, while others grew vigorously. Healthy plants grew straight up. By 29 September Gland clover was in full flower in all cages and occasionally within the paddock. There appeared to be little Gland clover within in the sward suggesting it may have been grazed out. While showy due to its very early flowering, Gland clover was making a very small contribution to the sward.
- **Persian clover** – on 29 September the large leaved Persian clover was still evident within the paddock but there was visibly less Persian clover than in August, particularly on the easier slopes. By 1 November almost no Persian clover was evident within the paddock.
- Pre-grazing not hard enough? There was poor establishment where existing sward provided competition and better establishment where sprayed. 100 ml/ha Roundup Transorb did not provide enough suppression in moist areas
- Inoculation failure with some seedlings – gland clover?
- Contribution of gland clover to the sward is small.
- Over-sown large leaved clovers stood out quite well after two light grazings
- Some areas with good clover establishment but also very large areas with few plants.
- Seed striping was very evident in some places.
- Dry open northern sprayed areas can have high numbers of clovers.
- Significant competition in grassed areas.
- Flower heads are preferentially grazed by stock

Grazing recommendations:

- Post over-sowing – The challenge is to graze to reduce grass competition to give establishing clover plants a chance. Graze twice as frequently in rotation. Allow to grow to only ¾ normal pre-graze height and remove stock when twice the normal residual is left. i.e. much faster and laxer grazing than normal

Summary of Castlepoint results to date:

Dry matter production – The average growth rates for of all plantain/clover measurements and all oversown pasture measurements, together with the long term (2006-2011) average daily growth rate for Castlepoint Station is shown in Figure 7. Cumulative total dry matter production for each aspect is shown in Figure 8. Comparing just the northerly inter-track aspects, plantain/clover produced 11,950 kg DM/ha, nearly three times has much the oversowing trial's resident sward control (4,900 kg DM/ha) and nearly twice as much as the oversown resident sward (5,630 kg DM/ha) over the period April 2013 to January 2014. While the moister bottom and top flats produced over 13,000 kg DM/ha. The maximum growth rates 80-90 kg DM/ha/day were achieved on northern facing inter-tracks and on the flats. These are similar levels of production as measured over the last two years on flatter country at Te Aute and Te Mahanga.

What we know:

1. It is possible to introduce successfully clovers and plantain into moderately steep hill country on a small scale (10 ha).
2. Inoculation of new clovers is definitely required. Balansa appears it may be to use existing white clover rhizobia but in summer dry hill country these may be scarce.
3. Weed control in the lead up to oversowing is necessary as bare ground is created and germinating weed seedlings are more vigorous than establishing clovers.
4. Spring and autumn spays and summer fallow were ideal at Castlepoint. This resulted in a complete kill of rushes and ratstail. Neither has reappeared so far.
5. It is possible to introduce successfully clovers and plantain into moderately steep hill country on a small scale (10 ha).
6. Plantain and annual clovers is much more winter active on north facing slopes than the existing hill country existing sward.
7. The dates at which the cultivars and species used matured, as measured by appearance of flowers heads, was Gland, Balansa, Persian and Arrowleaf. Persian (Bolta) and Arrowleaf (Arrotas) had very long periods of flowering.
8. It is necessary to remove all competition from the existing sward to maximise productivity. Where the existing sward was left it competed vigorously with the establishing seedlings significantly reducing yield.

Figure 7 – Average growth rates of plantain/clover and oversown pasture together with the Castlepoint average growth rates (2006-2011)

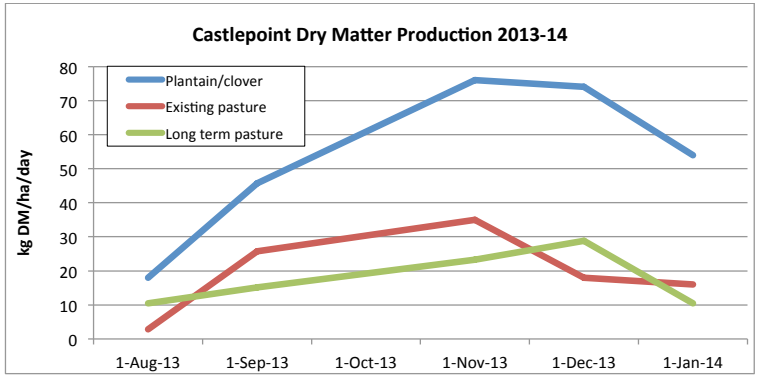
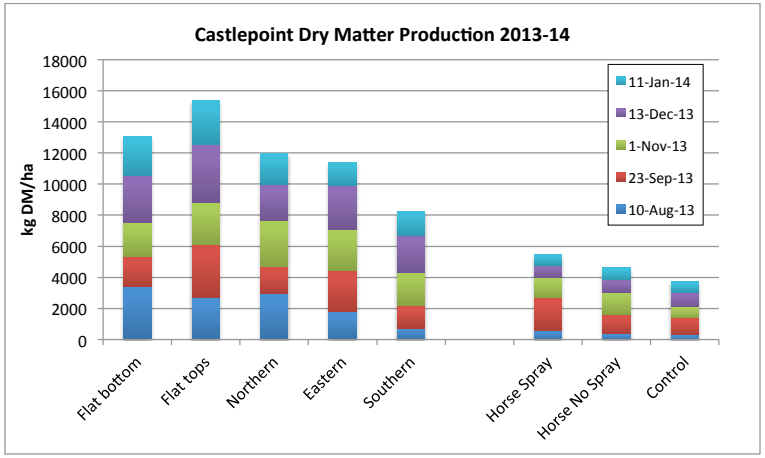


Figure 8 – Cumulative drymatter production from all sites and aspects



9. Spring and autumn spays and summer fallow were ideal at Castlepoint. This resulted in a complete kill of rushes and ratstail. Neither has reappeared so far.

10. Plantain and annual clovers is much more winter active on north facing slopes than the existing hill country existing sward.

11. Persian and gland clovers are rapidly grazed to extinction in a sward if set stocked.

12. Flowering and subsequent reseeding ability is greatly affected by closing date. Grazing Balansa after 14 October resulted in no flowers being set, while grazing after 28 October halved the number of flowers in Arrowleaf and grazing after 11 November resulted in almost no flowers.

13. The majority of the clover component in the plantain sward was annual clovers. Balansa and Persian clover appear well suited to growing with plantain as they are capable of sending up leaves into the top of the sward.

14. Arrowleaf clover is the most tolerant of grazing but it can be grazed to extinction if subjected to too much pressure.

15. Fencing for aspect is required to ensure that plantain and clovers are evenly grazed.

16. The area of bare ground 12 months after sowing has increased due to plant death and a decrease in the area occupied by dead thatch.

What don't we know:

1. How to achieve an even spread of clover and plantain seeds when oversowing using a helicopter bucket.

2. How to get annual clovers back into the sward for the following season. Would it be better to have a first year of annual clovers (possibly with plantain) but allow them to reseed and provide a seed reserve for future use? Is allowing these aerial annual clovers to re-seed a serious option.

3. If seed set is required, can the late flowering cultivars of Persian and Arrowleaf clover set viable seed before summer dry hits?

4. How much of the seed set for all clovers is hard-seeded and viable.

5. Can the current trial be repeated and up-scaled to a useful area at Castlepoint?

6. Can invasive grasses and weeds be controlled. Is spraying out invading grasses a workable option.

7. What is the longevity of the stand.

8. What stock classes should utilise the additional feed and when. What stock management changes would be required?

9. How do stock perform on clover and plantain on hill country.

The way forward for Castlepoint?

1. Over-sow Balansa, Persian and Arrowleaf clovers back into the sward after autumn rains and apply fertiliser at the same.

2. Subdivide the paddock using a cost effective form of electric fencing into 8-12 paddocks, rotationally graze stock and use it as learning how to do it in the future on this class of land.

3. Identify and prepare another paddock for oversowing in autumn 2015.

4. Model various scenarios to obtain financials over the life of the stand.

5. How much land would you need in plantain and clovers to make a step change.

Implications for future:

1. How to change management policies, year by year, if plantain and clover is to be introduced into the farming system.