Multi-species Cover Crops:

Grazing cover crops for Profit -

On farm trial 2017-2018

15th February 2018

Ardmona

Goulburn Murray Landcare

beyond soilcare




Australian Government | National Landcare Program

AGRICULTURE VICTORIA

Thank you to Fraser Pogue and family for hosting today's information session.

Gratitude to Graeme Hand & Colin Seis for travelling and generously sharing their vast knowledge of cover cropping with us.

Also Thank you to Doug at Murph's Roving Roast for our tasty lunch :)

Kind regards from Jo Doolan, Goulburn Murray Landcare & project partners.

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GRAZING COVER CROPS FOR PROFIT

A hay vs multi-species cover crop trial measuring soil health and profitability differences.

Background

Cover cropping refers to the technique of sowing a crop in between periods of regular cash crop production with the main purpose of creating a living groundcover to protect the soil surface, control weeds and improve soil health. The cover crop can also generate income through livestock grazing, cutting for hay and/or harvesting seed/grain.

Cover cropping can use annual crop species or perennial pasture species (known as pasture cropping). This trial is focusing on annual cover crops. Annual cover crops can comprise of a single crop species or multi-species mixes. Multi-species cover crops potentially have a number of benefits over single-species cover crops, these include:

- Increases plant diversity on the farm, which in turn increases food and habitat sources for beneficial insects.
- Addresses a broader range of problems, as different plant groups have different impacts (e.g. legumes, brassicas, grasses, warm season, cool season, etc.)
- Provide a food source for a broader range of soil biology.

Objective

The objective of this trial is to test whether growing and grazing multi-species cover crops prior to a summer corn crop increases soil health and profitability, compared to growing a hay crop.

Trial Location

Methodology

Trial treatments

Paired-paddock demonstration trial comparing two treatments:

1. A crop of oat and vetch, which will be cut for hay (control).
2. Multi-species cover crop, which will be grazed by cattle using planned grazing techniques.

Refer to Table 1 below for trial site characteristics and management practices.

Table 1:

Treatment	Hay Crop	Multi-species Cover Crop
Trial area	7 Ha	7 Ha
Site characteristics	Raised beds, sub-surface drip irrigation and Goulburn Loam soil type.	Raised beds, sub-surface drip irrigation and Goulburn Loam soil type.
Crop species mix	Oats and vetch.	Cereal rye, oats, wheat, barley, vetch, peas, Faba Beans, Spring canola, fodder beat, Tetila Ryegrass, Subterranean Clo-ver, Persian Clover and Balansa Clover.
Seed treatment(s)		
Sowing date	10/05/17	12/04/17
Sowing rate	*Oats - 40kg/ha Vetch 40kg/ha*	Cereal Rye 7kg/ha Oats - 7kg/ha Wheat 7kg/ha Barley - 7kg/ha Vetch - 15kg/ha Peas - 7kg/ha Faba Beans - 5kg/ha Spring Canola - 500g/ha Fodder Beet - 100g/ha Tetila Ryegrass - 6kg/ha Subterranean Clover - 1kg/ha Persian Clover - 1kg/ha Balansa Clover - 1kg/ha
Sowing technique	*John Deere single disc drill*	*John Deere single disc drill*
Fertiliser application(s)	*Guano 50kg/ha Urea 10kg/ha*	*Guano 50kg/ha Urea 10kg/ha*
Herbicide application(s)	*Glyphosate 450 - 2L/ha Oxyflurfen 75ml/ha*	*Nil*
Insecticide application(s)	*Nil*	*Nil*
Irrigation waterings	1.1ML/ha	1.9ML/ha
Harvest technique	Cut for hay.	Grazed by cattle using planned grazing* techniques.
Harvest date	21/10/17	Started Grazing 2/08/17 Finished Grazing 25/10/17 Cattle were in and out numerous times. Av. Number of cattle 83 for 32 days.
Crop to follow	Corn, sown 21/11/17	Corn, sown 21/11/17

*__Planned Grazing:__ a structured way of using animals to regenerate pasture (as utilised in Holistic Management systems) & to improve soil health & grazing profitability. Feed for livestock is balanced with feed for the soil.

Economics

One of the key aims of this trial was to look at the benefits of growing a cover crop vs a hay crop, and to look at the impacts on the yields of the subsequent summer cash crop (Maize). The aim was also to determine if grazing could make the cover crop economically viable in its own right. While we have yet to determine the effect of the cover crop on the yield of the maize, we have looked at the economics of the grazed multispecies cover crop vs the economics of the oat/vetch hay crop.

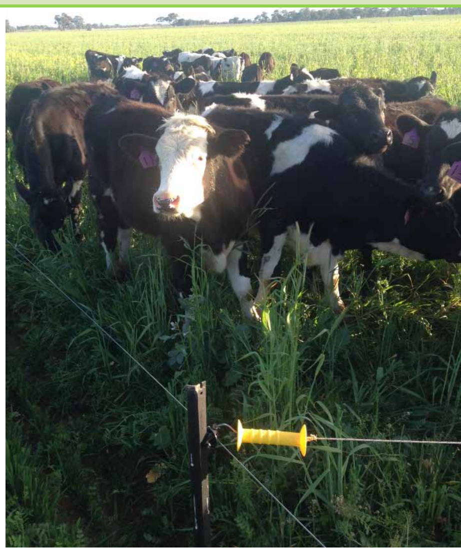
Oat/vetch yield was determined from the count and average weight of round bales produced on the trial area. The crop was assumed to be sold standing so there were no hay making costs. Price received was an estimate based on the regional seasonal conditions.

For the grazed multi-species cover crop cattle were weighed at the start and the end of the trial (average 89 days apart) to determine a daily cattle growth rate. Cattle were not on the trial for the entire trial period and while off the trial they received cereal hay (hay quality 9ME, 9CP). It is likely that growth rates would have been significantly reduced while off the trail with only the cereal hay available. Therefore, in this analysis 2 scenarios were investigated; 1. a worst-case scenario where weight gain was averaged over the entire time between weighing dates (0.96 kg/day); and 2. a best-case scenario where the weight gain over the trial period was all attributed to the time on the multispecies cover crop (1.61 kg/day). Price received was assumed to be $2.4 /kg.

In the worst-case scenario the grazed multispecies cover crop resulted in a similar economic return to the hay crop. In this scenario a cattle price of $2.50 was necessary for an identical return. In the best-case scenario the multispecies cover crop returned much more and only required a cattle price of $1.50 to equal the hay crop return. It is important to note that this analysis does not take into account other costs of each system (ie. differences in seed, fertiliser and chemical costs, labour costs which could vary substantially, or fencing, transport, selling and animal husbandry costs for the cattle).

Oats & vetch- Cut for hay		
Yield	Price standing	Gross return
t/ha	($/t)	($/ha)
10.1	90	**909**

Multispecies - Grazed				
Average no cattle	No days on trial	Daily weight gain	Price	Gross re-turn
		(kg/day)	($/kg)	($/ha)
83	32	0.96	2.4	**874**
		1.61		**1466**



Trial measurements

Measurement	Description
Soil tests	Chemical and biological soil tests conducted at the beginning of the project, in both the cover crop and maize crop, and after the maize harvest.
Landscape function assessment	Visual assessments conducted before, during and after crop growth to measure soil stability, infiltration and nutrient cycling. Assessments will be conducted using a Land Function Analysis* transect.
Animal performance	The number of grazing days, livestock numbers and animal weight gain.
Crop yield	Dry matter cuts taken before grazing on the multi-species cover crop and t/ha of hay cut measured from hay harvest. The subsequent corn yield and bulk density measured in both treatment areas.
Profitability	Weight gain at the current market price used to assess the profitability of grazing the multi-species cover crop. Income from hay and the subsequent crop compared on both treatment areas.
Water use	Sub-surface drip irrigation .

*__Landscape Function Analysis:__ Landscape Function Analysis (LFA) is a monitoring procedure developed by the CSIRO. It provides a rapid, reliable, and easily applied method for assessing and monitoring landscape restoration or rehabilitation projects. LFA examines the way physical and biological resources are acquired, used, cycled and lost from a landscape. For example, water is a landscape resource that can be stored in the landscape, providing for maximum benefits, or may run off and become lost from the system, often taking soil and other resources with it

Landscape Function

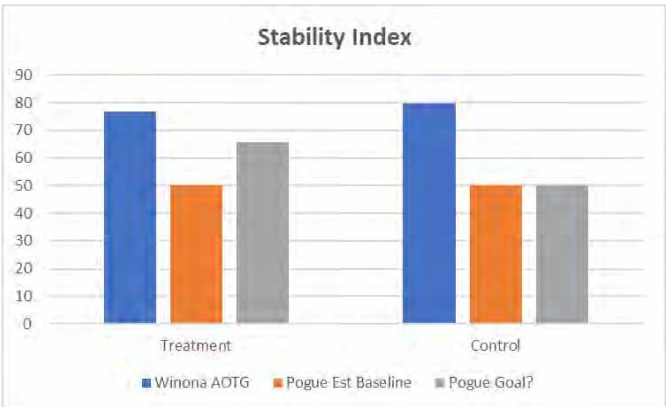
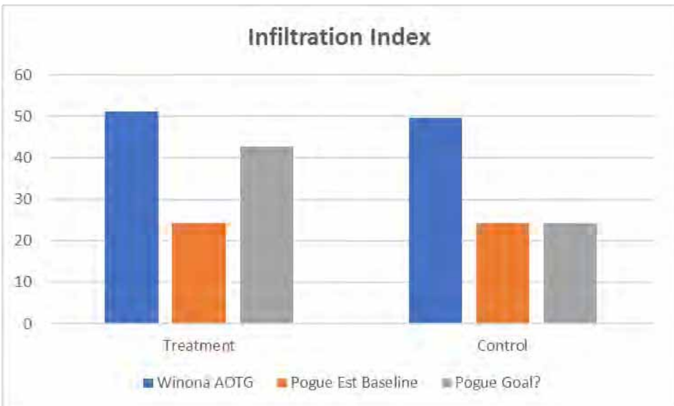
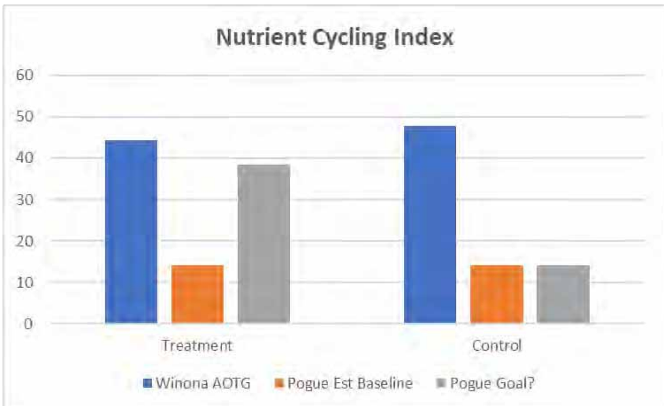


Figure 2 – Pre-sowing soil stability, infiltration and nutrient cycling results for the trial site (orange) compared to the landscape function goal for the property (grey) and a perennial grassland paddock from Col Seis' farm, Winona (blue). The treatment is the multi-species cover crop and the control is the hay crop.





Trial measurements

Penetrometer resistance

A cone penetrometer is used to measure soil strength and gives an indication of how hard plant roots have to works to explore the soil. As penetrometer resistance increases, measured in kilopascals, the soil is becoming stronger and more difficult for root to grow through. A penetrometer reading of 2000 kPa is considered to severely restrict plant root growth and productivity, while at 3000 kPa root growth is halted. Penetrometer resistance is influenced by soil water content, soil type and management practices.

In this study penetrometer resistance was measured on 5/5/2017 after both treatments had been pre-irrigated (figure 3), meaning soil water content was close to field capacity, which is ideal. Both treatments displayed similar penetrometer resistance profiles, with resistance reaching the 2000 kPa threshold at a depth of about 20 cm. This is approximately the depth to which the soil was cultivated for bed formation. Penetrometer resistance was similar to that measured under a pivot irrigator growing maize, and much lower than under maize grown on flood irrigation, both on a similar soil types (lemnos loam). Flood irrigation is much more destructive on soil structure which causes the higher soil strength.

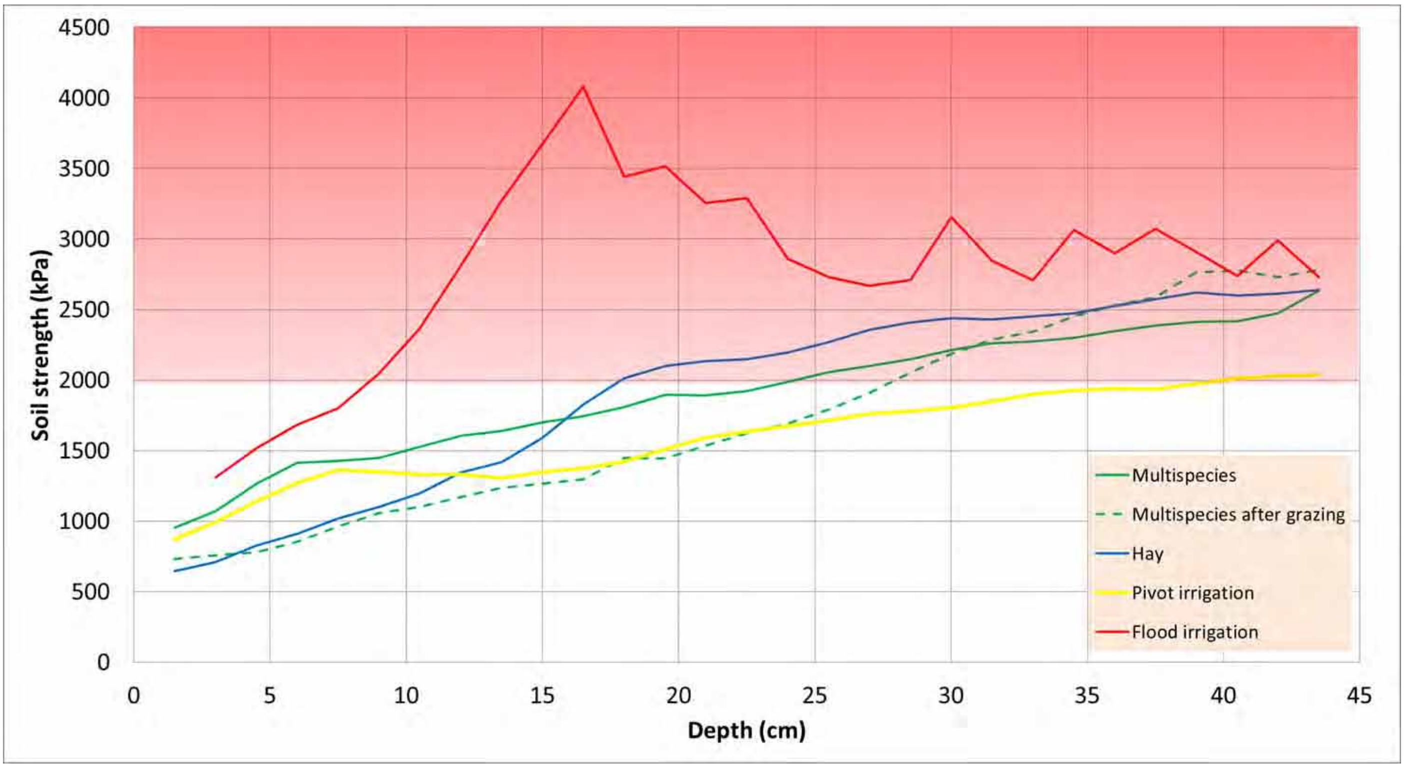


Figure 3: Soil strength using a core penetrometer, average of 27 insertions, for both treatments (mixed species & hay) in the current demonstration.

Trial measurements

Infiltration

Effective water infiltration into soil is important to maximise water use efficiency by reducing water loss by runoff and evaporation. Measurement of water infiltration can also be used as an indicator of soil porosity and structure, with infiltration rates higher on porous well structured soils. Infiltration curves are generally characterised by an initial rapid infiltration phase termed 'crack fill' (CF), followed by a reduction in infiltration rate when large pores are full and water movement is limited mainly to the soil matrix (i.e. through soil aggregates), termed 'steady state infiltration' or 'final infiltration rate' (FI). Figure 4 shows the infiltration curves at two locations in each treatment (hay and mixed species), as well as a classic infiltration curve for a lemnos loam and a lighter in textured Shepparton fine sandy loam. Crack fill in this demonstration was low because the soil was relatively wet having been pre-irrigated. The final infiltration rated at all 4 points in this study were higher than a classic lemnos loam soil, most likely due to the recent cultivation and good soil structure.

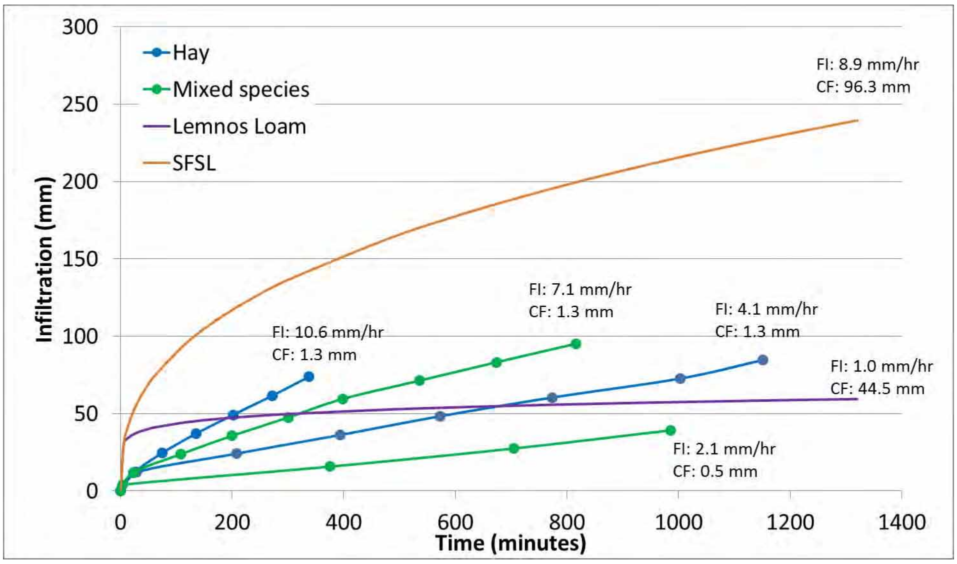


Figure 4 – Infiltration curves at two locations in each treatment (hay and mixed species), as well as a classic infiltration curve for a lemnos loam and a lighter in textured Shepparton fine sandy loam. CF refers to 'crack fill' and FI refers to 'final infiltration rate'.

Trial paddock, post corn sowing, (2/12/17), after 80mm rain.

3 days later (5/12/17), soaked in.

Trial measurements

Bulk Density

Measuring bulk density tells us how compacted soil is, which impacts plant root growth, water infiltration and soil aeration. A bulk density of 1.6 g/cm^3 or greater is considered to be restrictive to root growth on loam and clay loam soil types. In this study bulk density was measured at two depths, 0-10cm which had been cultivated and 20-25 cm which was below the cultivation zone.

Bulk density was measure before the cover crop was sown (5 May) and after it was harvested/grazed (1 November). Bulk density was higher in the 0-10 cm zone of the mixed species crop at both sample times, and in both treatments bulk density was higher at depth (figure 5). On both treatments bulk density increased in the 0-10cm zone between sample dates, most likely due to the consolidation of cultivated soil. Conversely, for both treatments bulk density decreased in the 20-25 cm zone between samples date, possibly due to improved soil structure caused by root growth and stabilisation.

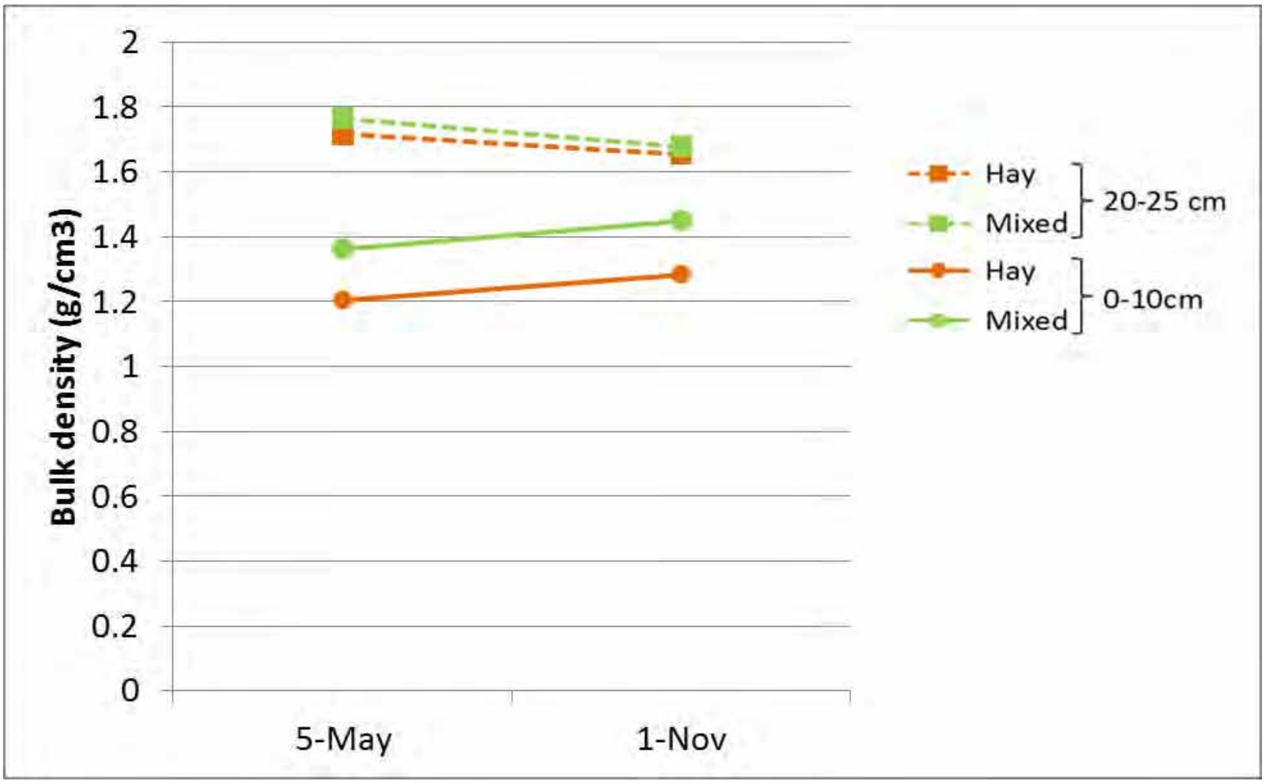
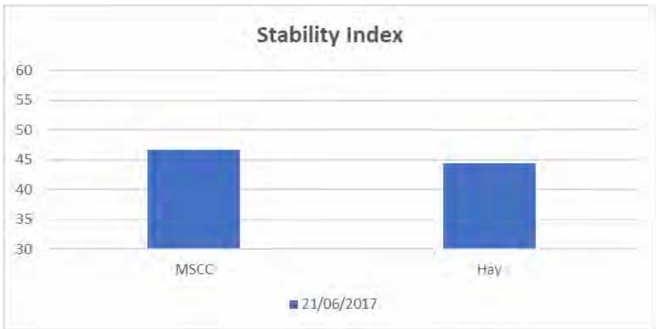


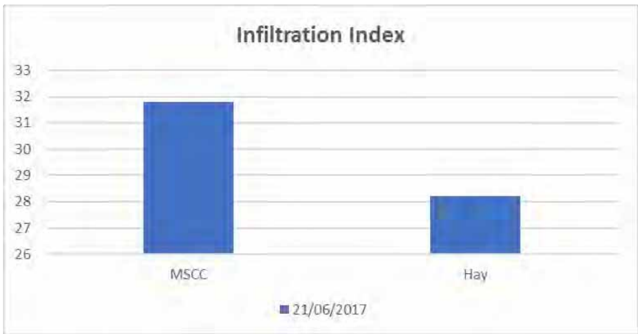
Figure 5 – Bulk density measured on the 5 May 2017 and 1 November 2017 for mixed species and hay treatments.

For each treatment 3 points were sampled at 2 depths (0-10 cm and 20-25 cm).

Trial measurements

Landscape Function





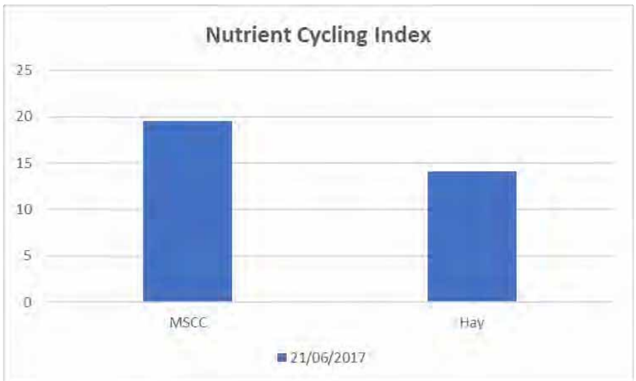


Figure 6– Soil stability, infiltration and nutrient cycling results of the multi-species cover crop compared to the hay crop on 21 June 2017.

Multi-species cover crop – 21 June 2017

**LFA assessments will continue through out the trial period.*

Trial measurements

Biomass

The biomass of the multi-species cover crop measured 1.16t/ha using dry matter cuts, samples taken 16 June 2017.

Dry matter cuts taken on 4 August 2017, showed the biomass of the multi-species cover crop measured 5.19 t/ha.

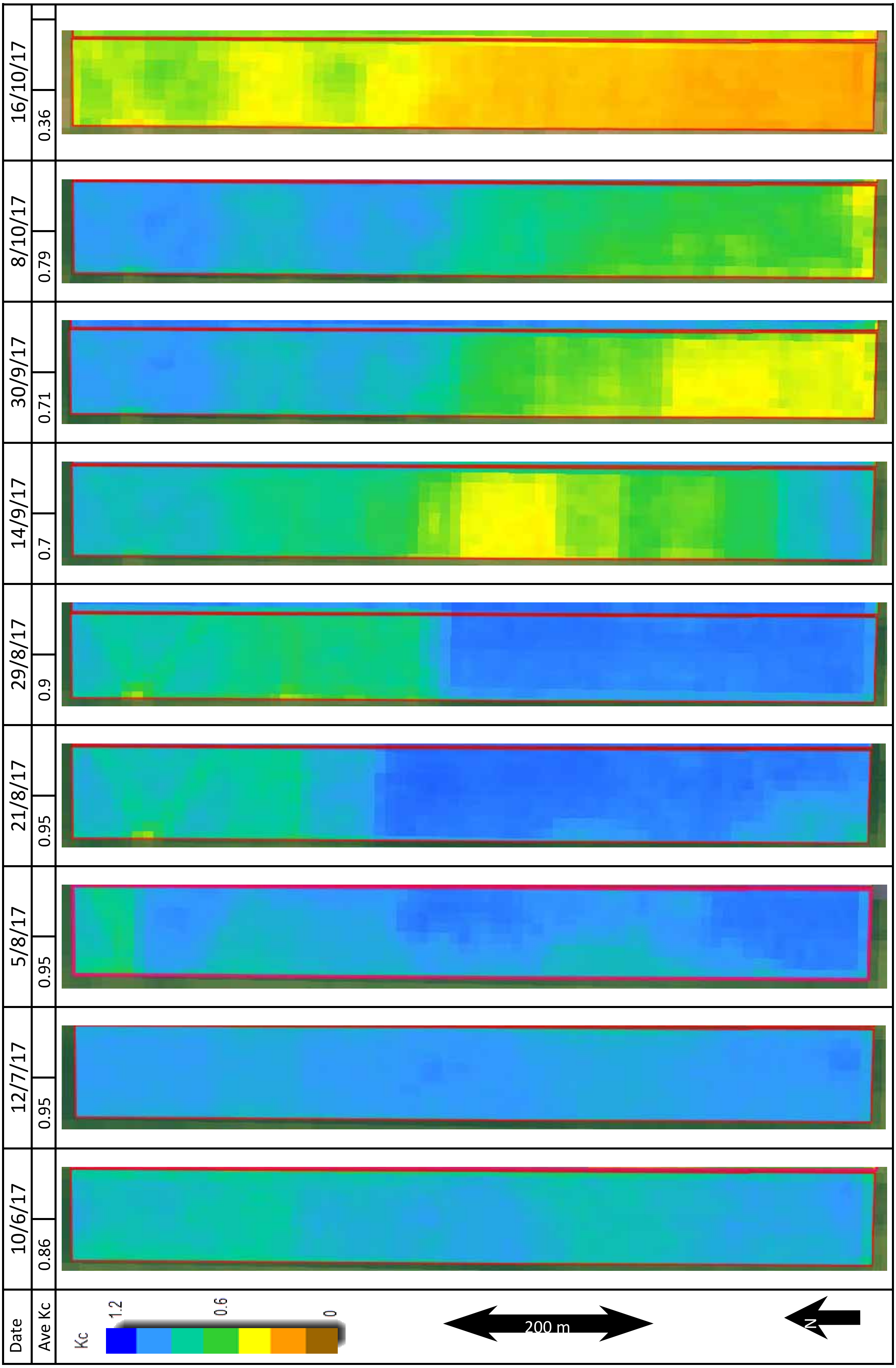
Organic matter returned from each system

An estimate of how much above ground dry matter was returned to the soil in each system was calculated. For the oat/vetch system it is assumed that approximately 10% of above ground plant material was left behind, meaning approximately 1 t/ha of organic matter was returned to the soil. For the multispecies cover crop system it was assumed that the cattle consumed 10 kg of dry matter per head per day and excreted 2.5 kg of dry matter per head per day. Average crop yield was estimated to be 10 t/ha, based on a second trial growing a similar multispecies mix on a similar soil type. For the multispecies cover crop it is estimated that approximately 7 t/ha of above ground organic material was returned to the soil.

Dry matter (DM)	t/ha
Est. DM yield of multispecies	10.0
Est. DM consumed by cattle	3.8
Est. DM excreted by cattle	0.9
Est. DM not consumed	6.2
Est. DM returned to soil (inc. dung)	7.1

Satellite imagery can show changes as the crop grows. The following images are recorded by the Sentinel 2 satellite (10 m pixel). The image on the next page shows the trial site (multi-species on the left, hay on the right) as it grew from June to October 2017. Progression of grazing and impact on vegetation cover is also evident. Blue indicates areas of best vegetation cover, green indicates intermediate vegetation cover and orange indicates poor or dead vegetation cover.

Satellite data can be accessed using Irrisat on the web https://irrisat-cloud.appspot.com/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0.71
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1.2
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200 m
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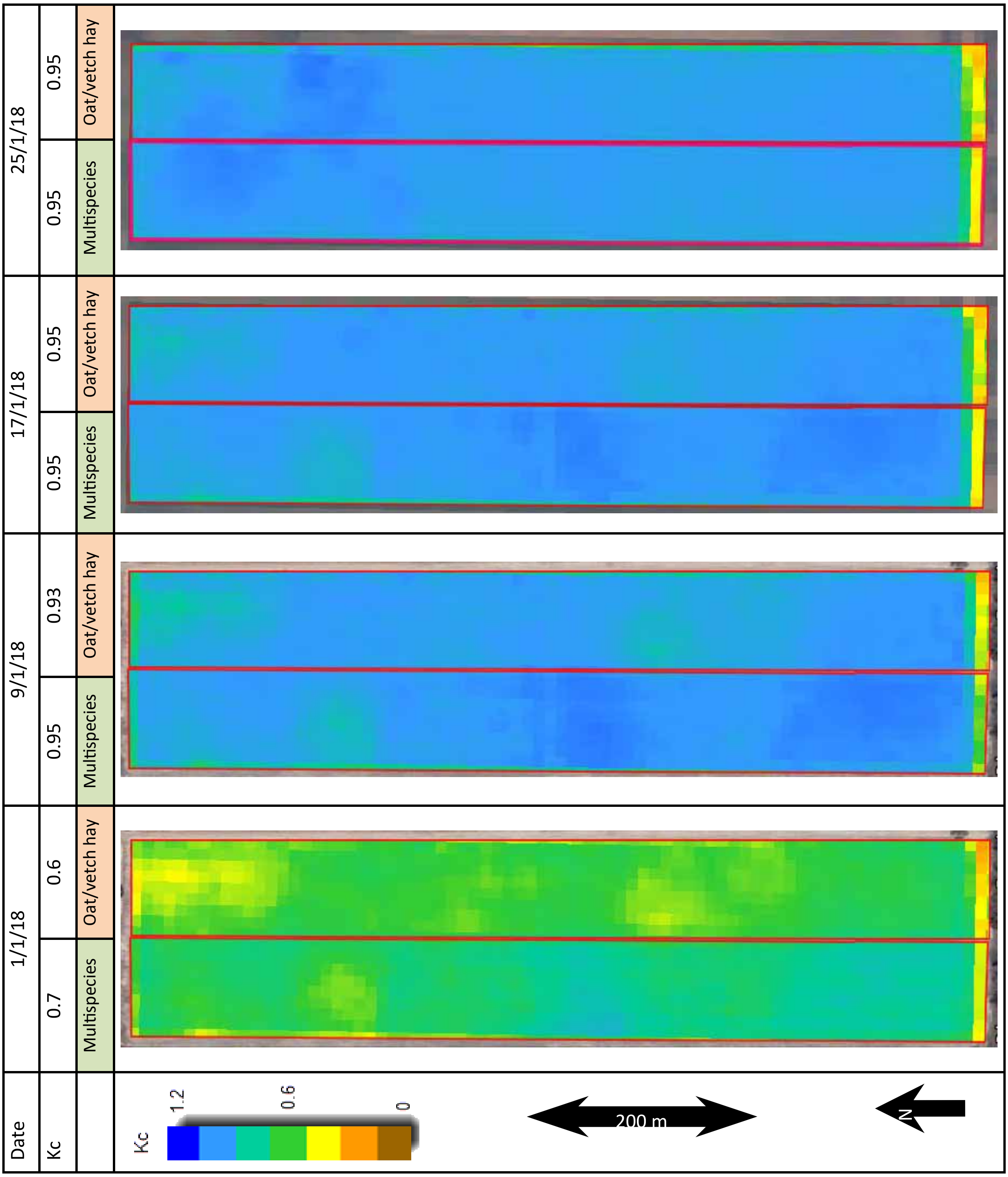
Crop development

Development of maize crop (**January 2018**) following multispecies cover crop (left) and oat/vetch hay crop (right), as recorded by Sentinel 2 satellite (10 m pixel). Blue indicates areas of best vegetation cover, green indicates intermediate vegetation cover and orange indicates poor or dead vegetation cover.



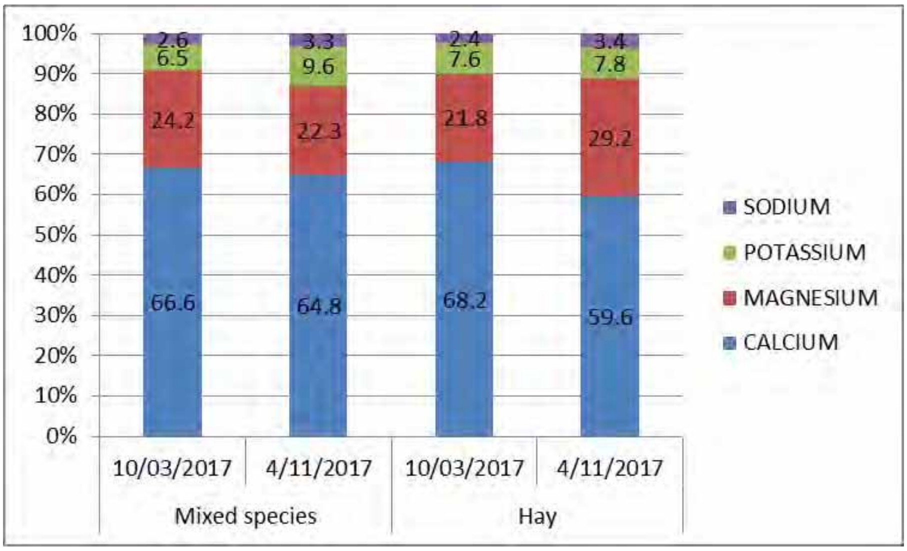
Trial measurements

Soil tests

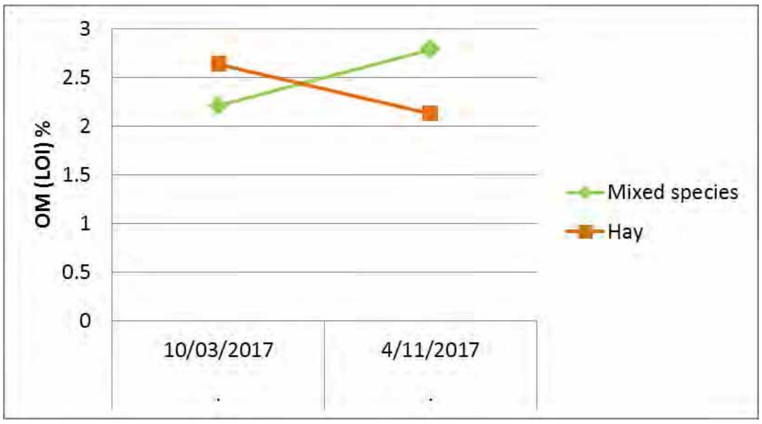
Chemical and biological soil tests were taken from both parts of the trial site in March & October 2017. Further tests will be taken through out the trial period.

Below are the graphed results so far.

Percent of base cations (Ca, Mg, K, Na)

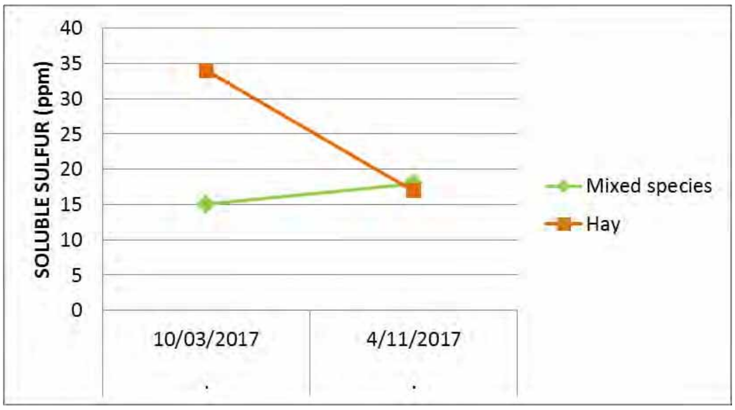


Organic matter (measured using Loss on Ignition)

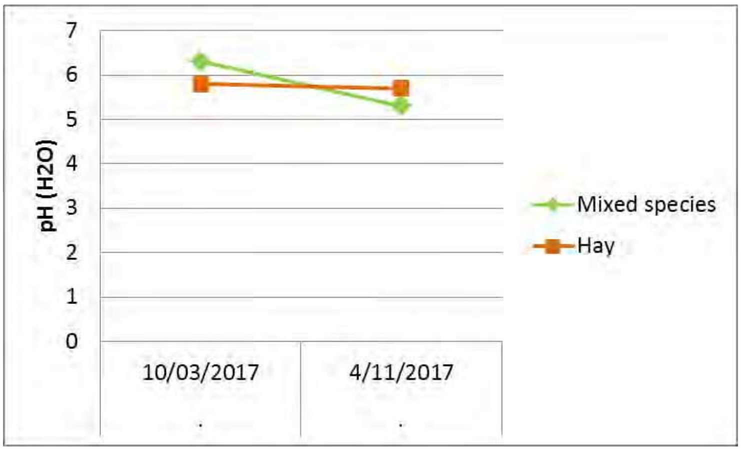


Estimated Nitrogen Release

Soluble Sulphur (ppm)



pH (1:5 water)



Colwell Phosphorus

Sum of base cations (cmol(+)/kg)

Further information

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Notes