

Carbon Positive Project

Milestone Two Report

Due 1 February 2023



Date: 1 February 2023	Milestone 2
Milestone description	Year 1 Planning Completed
STOP / GO	MPI approval of Annual Science Plan
Target Outcome	Scientific knowledge of regenerative agriculture principles and transition.
Activities undertaken	<p>TAG to develop and submit Annual Science Plan</p> <p>Crops sown.</p> <p>Annual Project Plan drafted and PSG review,</p> <p>Development of Terms of Reference including roles, responsibilities, and project structure. Identify farming groups and other influential stakeholders for project involvement. Understanding of existing trusted communication pathways and plan appropriate communication material is required.</p> <p>Key information shared by processors outlining their vision, current worldwide regen work and/or accreditation criteria for future supply. Seek permission to use this information within the project</p>
Deliverables / evidence of completion / achievement of Outcome	<p>MPI approved Annual Science Plan (with milestones).</p> <p>PSG approved Annual Project Plan (with milestones)</p> <p>Provide additional information (above) from processors.</p> <p>PSG and TAG meeting minutes. Terms of Reference.</p>
MPI Funding amount	\$137,020
Co-Funding contribution	\$58,726
Total	\$195,746

Year 1 Sampling and Crop Establishment: Milestone 2

The below table details activities to be completed as part of milestone 2, with start/finish dates or approximate completion dates. Further details on each activity can be found below.

In addition to the listed activities, considerable time has been spent consulting with a wide range of people/groups on what practises we should be considering for each of our 3 treatments. We have been working with:

- Growers across the regenerative spectrum
- Regenerative advisors
- Quorum Sense
- Processors
- Contractors
- Landcare Research Manaaki Whenua
- Massey University
- AgResearch
- Outside Agronomists
- Bio-Stimulant Advisors

We have consulted with this group on principles and philosophies, groundwork, agrichem use, seed treatments, fertiliser use, other soil amendment use, foliar applications, crop monitoring requirements etc. to make sure we have effective, practical, and safe practices and processes that meet the desired outcomes. As part of this process, we are starting to build a framework for how we make management decisions within the philosophies of each treatment.

Activity	Completion Date	Details	Date Started	Date Finished
Year 1 Planning Completed	1/02/23	Year 1 Planning Completed		
Collect soil cores for C&N stocks	30/11/22	8 x 42mm cores to 90 cm split 4 depths	17/11/22	5/12/22
Collect cores for labile C,P&N	30/11/22	8 x 42mm cores to 300mm split 2 depths	17/11/22	5/12/22
Samples to Hills Lab	30/11/22	Combine each plot into two samples for each depth	21/11/22	8/12/22
Determine dry bulk density	30/11/22	Weigh, oven dry, back calculate BD each core	20/11/22	10/12/22
Collect samples for soil texture analyses	30/11/22	8 x 42mm cores to 90 cm split 4 depths	17/11/22	5/12/22
Samples to Hills Lab	30/11/22	One combined sample each quadrant each depth	14/11/22	14/11/22
Visual soil assessments	30/11/22	4 samples per plot as VSA guidelines	15/11/22	17/11/22
Worm counts	30/11/22	4 samples per plot, group by worm type, count, weigh	15/11/22	17/11/22
Aggregate stability	7/12/22	Collect from VSA samples, apply SLAKE 9 aggs/plot	TBC	
Aggregate stability calibration	7/12/22	Send 1 sample/plot to MWLR	TBC	
Soil prep as agreed OAG	7/12/22	Likely strip till all, powerharrow conventional	10/12/22	14/12/22
Plant sweetcorn crop	14/12/22	McCain sweetcorn, target pop 60,000/ha	23/12/22	23/12/22
Record applied nutrients	30/11/22	Fert rate determined after soil testing	Ongoing	
Record any agrichem applications	14/12/22	Seed treatment, selective herbicides	Ongoing	
Monitor emergence	23/12/22	Count plants in 5m row, 4 rows/plot	4/1/2023	9/1/2023
Measure soil N pre-side dressing	23/01/23	8 cores per plot to 30cm, Nitrate Quick test 2 depths	30/12/2023	Ongoing
Apply side dressing as required	30/01/23	Rate determined by testing and OAG advice	25/1/2023	
Monitor canopy size pre-closure	30/01/23	Canpoeo app, 10s video scan at waist height, 2 per plot	9/1/2023	Ongoing
Note any pests/diseases/weeds	30/01/23	Agronomic walks/records	30/12/2023	Ongoing
Irrigation	30/01/23	By linear as required according to monitoring, all treatments same	When required	If the rain stops!

Activities Completed

Collect soil cores for C & N stocks

Soil cores for carbon sampling was completed between 17 November and 5 December. Eight cores were taken per plot to a depth of 900mm. Overall this process was relatively seamless with a team of three.



Figure 1 Extracting soil core from 90 cm sampler

Collect cores for labile C, P & N

The same soil samples used for measuring carbon and nitrogen stocks were used to measure labile carbon, phosphorus, and nitrogen.

Samples to Hills Lab

Each 900mm soil core was split into four depths (0-150 mm, 150-300 mm, 400-600 mm, 600-900 mm). Samples were passed through a 4 mm sieve then split, with half being dried for bulk density assessment and half sent to the laboratory for analysis.

For each plot, the four western and four eastern cores were combined for each depth. The eight resulting samples per plot (32 per treatment, 96 in total) were submitted for analysis.

The tests used for measuring carbon and nitrogen stocks are 'Total C by Dumas Combustion' and 'Total N', as determined by the TAG. The tests used for measuring labile nutrients were 'Hot Water



Figure 2 Sieved soil samples split for drying and submission to laboratory

Extractable Carbon', 'Hot Water Extractable Nitrogen' and 'Olsen P'. These tests have been completed by Hill Labs.

Determine dry bulk density

Samples for bulk density calculations were weighed, and then dried at 105°C for 17 hours. The samples were then reweighed.

Preliminary Carbon Results

Laboratory analysis has now been completed for the submitted samples. To determine amount of carbon in each sample, dry bulk density is calculated for each core, at four depths. An average of these bulk densities has been used, as well as Total Carbon Percentage, to calculate how much carbon is present, this is expressed as tonnes of carbon per hectare (Carbon T/ha). Further analysis is yet to be completed.

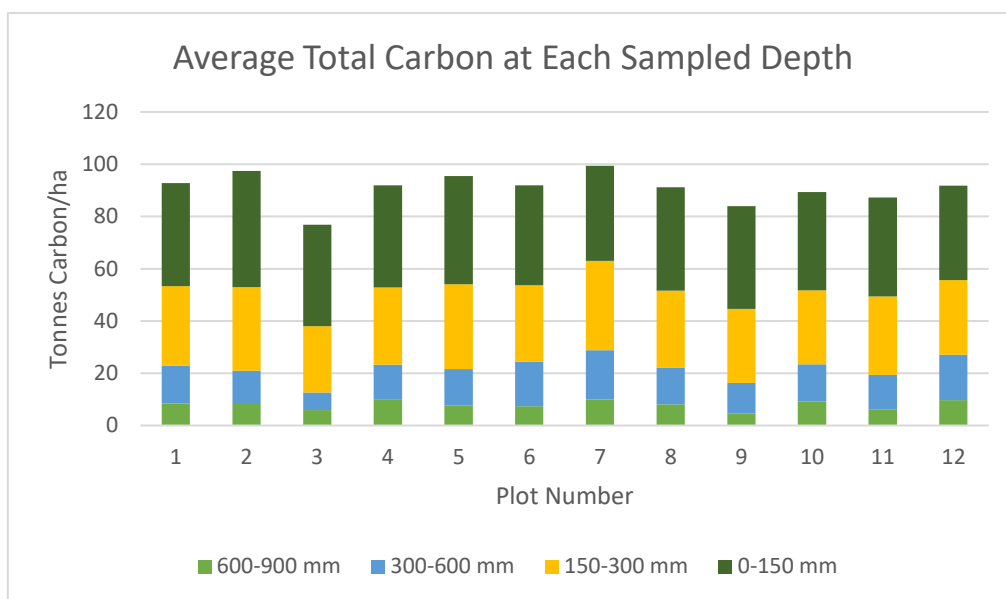


Figure 3 Average Total Carbon at each of the four sampled depths.

Collect samples for soil texture analyses

Subsamples for soil texture analysis were taken from the oven dried bulk density samples. Soil texture is a one-off test and will not change over time. The samples were grouped together by quadrant (see below) at each depth. From each bulk density sample, 2 tablespoons were taken to



Figure 4 Quadrant layout diagram for soil texture combined samples.

make up the combined subsample. In total 16 samples were submitted to Hill Laboratory's for soil texture analysis.

Laboratory results included below.

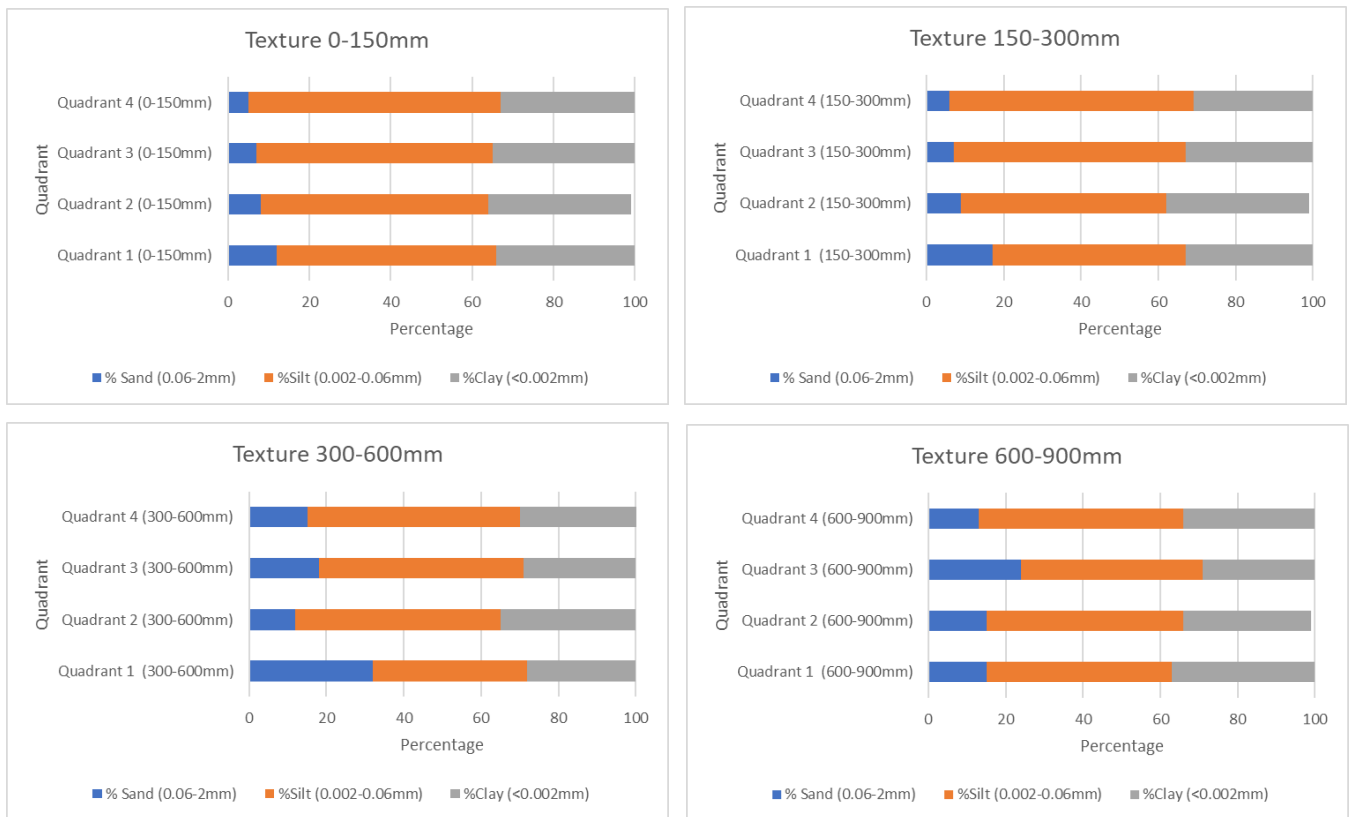


Figure 5 Soil Textures at four depths

Visual soil assessments

As mentioned in Milestone Report 1, Visual Soil Assessments (VSA) were made across the site. Four samples were completed in each plot and additional earthworm counts made (see below notes on earthworms).

Using the *Visual Soil Assessment. Volume 1. Field guide for cropping and pastoral grazing on flat to rolling country, 2000*, by Graham Shepherd, the VSA assessments showed the soil condition in the trial plots to be "good"; neither "excellent" nor "poor" (**Error! Reference source not found.**). VSAs taken from the fence line show soil in better condition (**Error! Reference source not found.**). From this, we might assume there is opportunity for management over the next five to six years to either regenerate or further degrade soil condition.

We will complete VSA's before each crop is planted, the next between sweetcorn harvest and cover crop planting.



Figure 7 Example of VSA soil layout shows surface cloddiness, but soil in generally good condition



Figure 7 VSA taken at fence line shows soil in better condition, with a higher carbon content, better structure, and higher worm population

Earthworm counts

As an extension to the VSA we sought advice from Dr Nicole Schon (AgResearch) on methods for counting and identifying earthworms. From our VSA spade spit we collected all earthworms that we could find in a 5-minute period (both immature and mature worms). We then washed, weighed, and identified the earthworms where possible. We used the Great Kiwi Earthworm Survey identification card to help identify the worms. We found a high number of immature worms, which were difficult

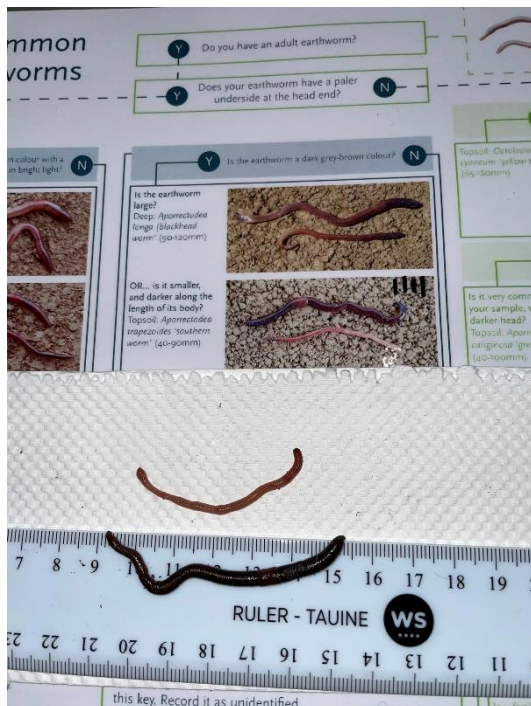


Figure 7 Identifying Earthworms (Southern Worm)



Figure 8 Identifying Worms (Grey Worm)

to identify, so aimed to identify just those that were adults. We will complete detailed earthworm counts when we complete next VSA's in April/May.

Aggregate stability

Aggregate stability has not yet been completed. This testing required the purchase of additional equipment and confirmation of methodology before sampling can be completed. Samples will be taken before canopy closure, for Slake Test and Manaaki Whenua independent testing to get underway.

Aggregate stability calibration

To be completed after sampling, and results are back.

Soil prep as agreed OAG

To determine what practices were suitable for each treatment we consulted with processors, growers, contractors, and other advisors. Our plan was then approved by the OAG. All plots were ripped to 450mm to break up hard crust on soil surface (on contractors' advice). All plots were then strip tilled, as this was most practical for machinery. The conventional plots were then rotary hoed. It was planned to roll all plots to break up clods on soil surface, unfortunately some wet weather came through which meant this wasn't completed.

Treatment	Practice	Date Completed
Conventional	Ripper	10/12/22
	Strip Till	14/12/22
	Rotary Hoe	14/12/22
Hybrid	Ripper	14/12/22
	Strip Till	
Regenerative	Ripper	14/12/22
	Strip Till	

Plant sweetcorn crop

The McCains sweetcorn crop was planted by Nicolle Contracting on 23rd December 2022, in a small window between weather events, and timed with other sweetcorn planted in the region. This was one of the last sweetcorn crops planted for McCains for the year.



Figure 9 Sweetcorn Planter in strip tilled plot



Figure 9 Sweetcorn Planter in fully cultivated plot

Record applied nutrients

Nutrient applications are being recorded as applied. Nutrient management decisions are made with advice from OAG. A base application was applied across all treatments to apply sulphur to all plots (very low in base soil test). All treatments had mineral starter fertiliser applied with the seed at planting. The regenerative treatment received a lower rate but also had nitrogen applied via Horticultural Grade compost.

Application	Conventional	Hybrid	Regenerative
Base	150kg lime/30kg SP90/10kg Boron ✓	150kg lime/30kg SP90/10kg Boron ✓	150kg lime/30kg SP90/10kg Boron ✓ 25m ³ /ha Horticultural Grade Compost
Starter	200kg/ha Cropzeal 20N ✓	200kg/ha Cropzeal 20N ✓	150kg/ha Cropzeal 20N ✓

Record any agrichem applications

Agrichem use is being recorded when applied. This is being recorded online in ProductionWise. As with fertiliser applications, decisions are made after consulting widely, adopting the practices and philosophies that go alongside each treatment. Additional to conventional agrichem being applied, we also have some alternative products being applied to the regenerative plots, for instance soluble humates/bio-stimulants. These applications are also being captured. Figure 10 shows spray application using 12m spray boom over a regen plot.



Figure 10 Tractor applying humates over regen plot

Conditions at planting were perfect, which meant the crop emerged very quickly and it wasn't possible to apply the intended pre-emergence spray. As far as herbicides are concerned, the below table shows intended pre emerge, and the applied post emerge herbicide for each treatment. This program was developed with the advisory group, as well as a crop walk with McCains agronomist to get timing right.

	Conventional	Hybrid	Regenerative
Pre Emerge Herbicide (planned)	Rustabout (Acetochlor)	Rustabout (Acetochlor)	Nil
Post Emerge Herbicide	Atrazine + Arietta (Topramezone)	Arietta (Topramezone)	Arietta (Topramezone)

Monitor emergence

Emergence was monitored from 29th December (after Christmas break). Plant population was counted every 1-2 days to estimate total population in each plot. In most plots population stayed the same or increased over the following 10 days, we do have the odd plot where population is declining due to damage from Pukeko.



Figure 11 Sweetcorn emergence five days after planting

Crop Development

Crop development measurements are taken from four 5 m lengths of row within each plot. Measurements include emergence, population, tasselling and silking, and harvest data. The rows were measured out across our existing testing transect and captured every second planter row (1,3,5,7) in case there are any differences in seeding rate between planter units. At time of reporting the crop is around the 8-9 leaf stage and progressing well.



Measure soil nitrogen pre-side dressing

Soil samples from the transect are taken weekly. Initially sampling only in the top 150mm, as the crop grows samples are taken further into the profile. Currently samples are being taken in the top 300mm. Nitrate Quick Tests showed high levels of plant available N present across all plots. We will start taking samples to depth as the crop gets bigger, and roots go down further.

Apply side dressing as required

The sweetcorn was side dressed on the 25th of January. Initially the plan was to broadcast the nitrogen application, however to get more accurate rates, a contractor was used to apply urea next to the plant. This allowed for different rates of urea to be applied to each treatment.



Figure 12 Side Dresser being calibrated before application.

The table below details rate of urea applied per treatment, as agreed to by the Operational Advisory Group. The conventional treatment had the recommended rate applied as per *Nutrient Management for Vegetable Crops in New Zealand*, the hybrid treatment as slightly lower rate, and the regenerative treatment a minimal rate. The regenerative treatment will additionally have a liquid mix applied before the end of January.

	Conventional	Hybrid	Regenerative
Kg/ha Urea	250kg/ha✓	200kg/ha✓	100kg/ha✓
Kg/ha Nitrogen	115kgN/ha	92kgN/ha	46kgN/ha

Monitor canopy size pre-closure

Canopy cover is being captured weekly as part of ongoing crop monitoring using the Canopeo App. This app captures images of the crop at waist height, identifies green area and estimates canopy cover (Figure 13). One image is taken per 5m sample row (4 per plot). The Canopeo measurement is affected by weeds, which account for most of the canopy cover differences measured in the first weeks post crop emergence.

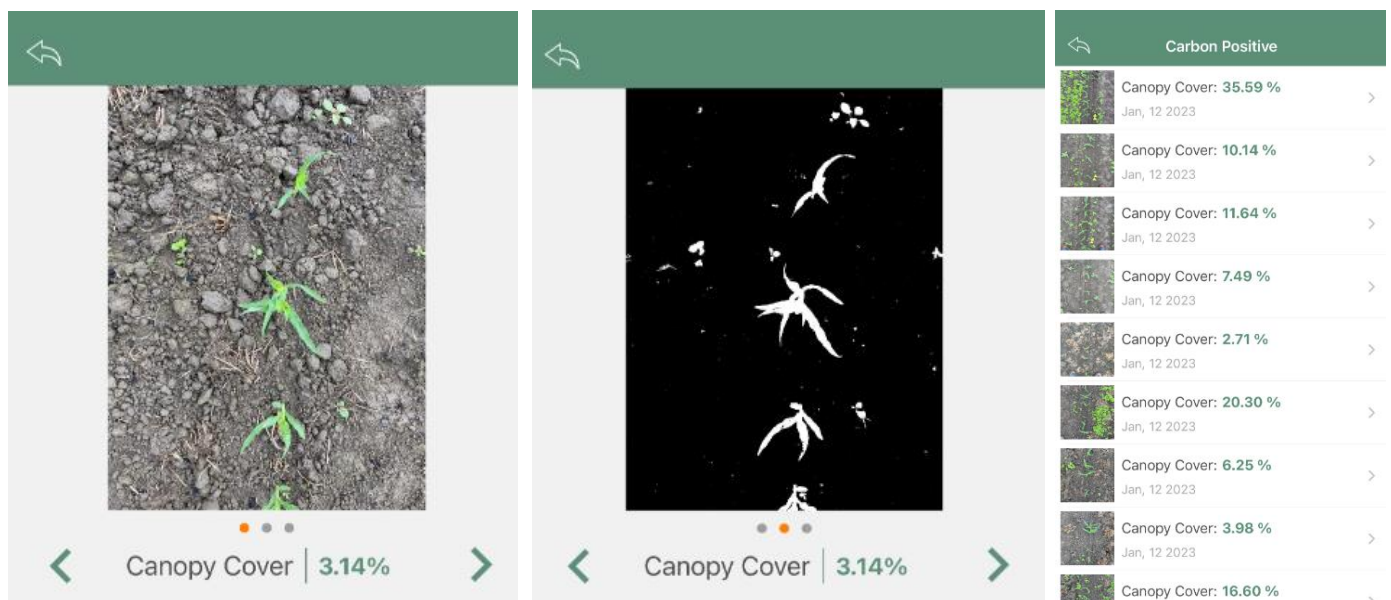


Figure 13 Canopeo App Screenshots showing how we are measuring canopy cover

Note any pests/diseases/weeds

All plots are monitored at least weekly for pests and weeds with photos taken. As mentioned above the crop emerged very quickly so a pre-emergence spray was not applied. Control of weeds has been with the post emerge spray. Figure 14 shows a selection of the weeds present in the crop before the post-emergence spray is applied. The post emerge spray was applied at the 6 leaf stage and has been effective at controlling most weed species.

Pest damage is assessed weekly, and the number of plants with damage recorded. In the early stages of the crop, we had a slug problem, mainly in the strip tilled plots where there was grass residue for slugs to proliferate. After discussions with Allan Machakaire (McCain Foods agronomist) and Phil Schofield (Regen Advisor), it was decided to apply slug bait to all plots to minimise damage. This was extremely successful. A small amount of cutworm damage was also identified.



Figure 14 Range of weed species present in the sweetcorn crop

The crop has been under attack by pukeko, who pull the plant out of the ground for fun. We have installed a bird laser as a deterrent and have an external company setting traps to hopefully prevent further damage.



Figure 16 Pukeko damage- plants pulled straight out of the ground



Figure 16 Cutworm found in crop

Irrigation

To date no irrigation has been applied. Hawkes Bay has had an uncharacteristically wet season, so far there has been no need for irrigation.

Planning Ahead

Milestone 3 due 1 March 2023

Date:1 March 23	Milestone 3
Milestone description	Year 1 Progress as per planned milestones
Target Outcome	Scientific knowledge of regenerative agriculture principles and transition.
Activities undertaken	PSG Meeting to review milestone reports, Year 2 summer process crops established, crop monitoring, outreach Field Day. Further activities as per Annual Project Plan and Annual Science Plan.
Deliverables / evidence of completion / achievement of Outcome	PSG and TAG meeting minutes. Deliverables as per milestones within Annual Project Plan and Annual Science Plan.
MPI Funding amount	\$83,303.55
Co-Funding contribution	35,601.52
Total	\$119,005.07

Key actions for Milestone 3 include:

1. PSG Meeting to review milestone reports
2. Year 2 summer process crops established, crop monitoring, outreach Field Day.
3. Further activities as per Annual Project Plan and Annual Science Plan.
4. PSG and TAG meeting minutes.
5. Deliverables as per milestones within Annual Project Plan and Annual Science Plan, including:
 - Continued agronomic observations
 - Weekly crop walks, noting weeds, pests, and diseases
 - Irrigation
 - By linear as required according to monitoring, all treatments same