RCS
Transforming Agriculture

Strategies and incentives for carbon sequestration in cropping and pastoral systems

Terry McCosker

Resource Consulting Services
1800 356 004
www.rcsaustralia.com.au

Agriculture flounders and mines its resources because consumers will not pay the full price of food

CARBON or ENVIRONMENTAL credits provide a mechanism to return additional income to landholders

The Linkages

- Profit = (f) Gross Margin
- Gross Margin = (f) Plant Productivity

- Plant productivity = (f) plant available water and nutrients
  - Plant available water and nutrients = (f) CeC
    - CeC = (f) Soil organic carbon (incl Humus)
    - Soil organic carbon = (f) biological activity
  - Biological activity = (f) food, shelter, water & air
  - Food, shelter, water & air = (f) plant productivity

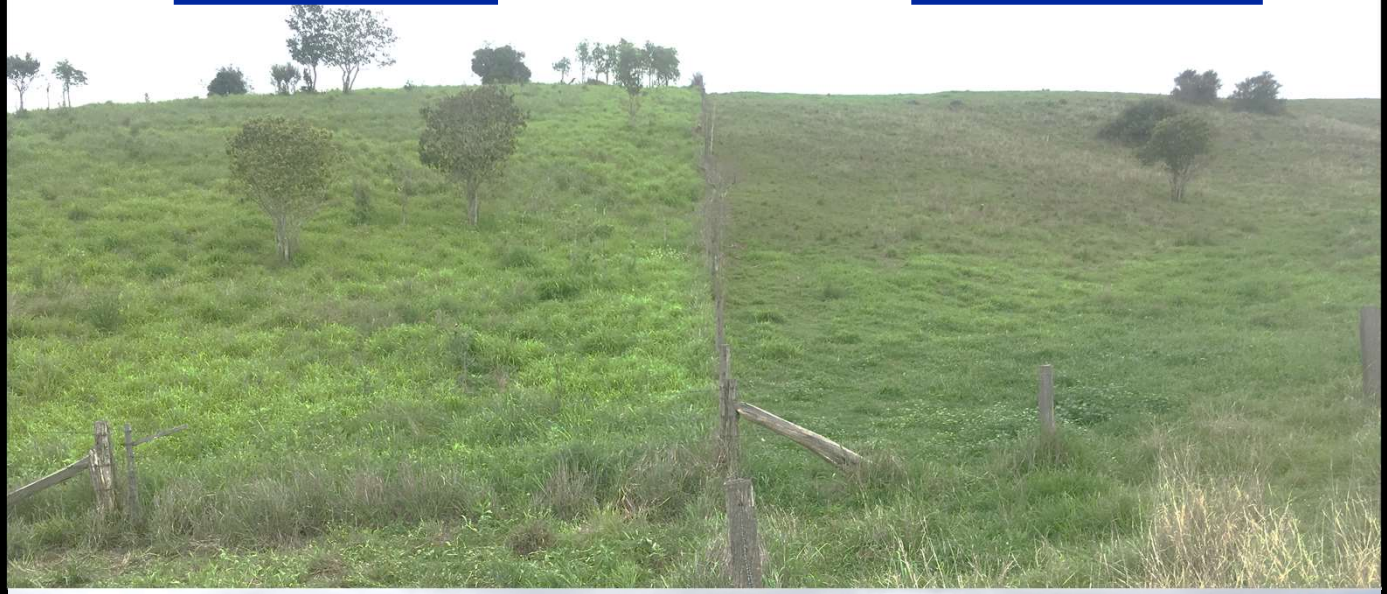
- Plant productivity = (f) plant available water and nutrients

Spiral up

Spiral down

Spiral up

40SDH/100mm October 2018 <20SDH/100mm



January 2019

Spiral down

6 PRINCIPLES of SOIL HEALTH

1. PLAN, MONITOR & MANAGE SOIL HEALTH
2. MAXIMIZE LIVING PLANT PRODUCTION
3. A FOCUS on BIOLOGY will REPAIR SOIL HEALTH
4. INTRODUCE BIODIVERSITY
5. MAXIMUM THICKNESS and AVAILABILITY of GROUND COVER
6. LIVESTOCK are NATURE's RECYCLERS

Planning

Harming soil biology V working with it

HARMS BIOLOGY	ALTERANTIVES
• Salt based Phosphorus (MAP, DAP, SSP)	• Guano, Soft Rock Phosphate
• Urea	• Mix with Carbon and reduce rates
• Glyphosate	• Alternate weedicides
• Fungicide Seed coats	• Trichoderma
• Neonicotinoid insecticides	• Brix level > 14 = no insects
• Fungicides	• Brix level > 14 = no disease
• Tillage	• Minimum or Zero Till

Ways to increase soil health

Biodiversity

CATALYTIC INPUTS

BIOLOGY

MANAGEMENT

(eg grazing/cover cropping)

Tools available

Management

- Grazing System
- Cover/Green manure Crops
- Crop rotations
- Continuous cropping
- Aeration
- Landscape Hydration

+ Biology

- Compost & Compost Extract (BEAM)

+ Fertilizer & Catalysts

+ Biodiversity

Sequestration Rates

Table 3: displays the adjusted mean sequestration rates for regenerative and conventional cropping practices with standard error in parenthesis, Upper confidence intervals and lower 95% BCa confidence intervals (controlling for soil depth (cm) and rainfall (mm)).

Cropping	Mean annual Carbon Sequestration rate t/C/ha	CI Lower	CI Upper
Regenerative	1.44 (0.14)	1.06	1.84
Conventional	-0.17 (0.29)	-0.90	0.34
Grazing			
Regenerative	0.93 (.14)	0.64	1.24
Conventional	-0.07 (.10)	-0.27	0.11

Regenerative GRAZING practices reported an average sequestration rate of 1.03t (v -0.07t) C/ha/year, but can range up to 3.8 tC/ha/year

Average expected annual soil carbon sequestration when implementing regenerative CROPPING activities are 1.46t (v -0.16t) C/ha/year, but can range up to 4.8 tC/ha/year

SOURCE: Carbon Link Internal Review

Sequestration Rates

	GRAZING		CROPPING	
Sequest Rate adjusting for Rainfall and Enterprise	**Sequest. Rate t/C/ha/year Regenerative**	**Sequest. Rate t/C/ha/year Conventional**	**Sequest. Rate t/C/ha/year Regenerative**	**Sequest. Rate t/C/ha/year Conventional**
Average	1.03	-0.07	1.46	-0.16
Min	-0.07	-0.52	-0.16	-4.40
Max	3.80	0.24	4.79	2.20
High rainfall >800mm				
average	1.17	-0.18	2.45	0.40
Min	-0.07	-0.22	0.05	0.00
Max	3.00	-0.13	4.79	1.15
Mid rainfall 500-800mm				
average	1.17	-0.08	1.59	-0.32
Min	-0.07	-0.52	-0.08	-4.40
Max	3.80	0.24	4.79	1.15
Low rainfall <500mm				
average	0.56	0.02 *	0.47	-0.18
Min	0.18	0.02 *	-0.16	-0.33
Max	1.60	0.02 *	2.00	0.00

SOURCE: Carbon Link Literature Review

4 Key Drivers of Return

1. Sequestration rate (tC/ha/year)

Projected outcomes at different sequestration rates			
Sequestration rate (tC/ha/yr)	1.00	1.5	2
Projected net abatement (tCO_2e)*	56400	84550	112750
Total cashflow over 25 years	$1,660,900	$2,608,000	$3,555,100
Annualised cashflow per hectare	$33	$52	$71
Net present value (25 years)	$1,042,000	$1,654,950	$2,267,850
NPV discount rate	3.00%	3.00%	3.00%
Projected internal rate of return	39%	51%	60%

*Includes the mandatory risk of reversal and 25yr permanence discounts, as well as Carbon Link's commission on ACCUs (18%). Based on 2,000ha and a 25 year carbon price of A$34/t CO2e, with a cost base of A$6/ha/annum.

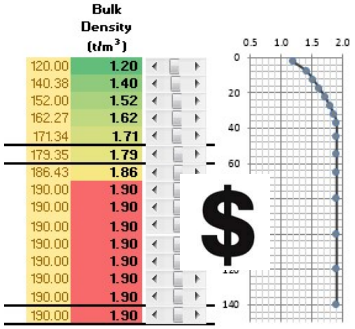
SOURCE: Carbon Link Limited Insights Calculator

4 Key Drivers of Return

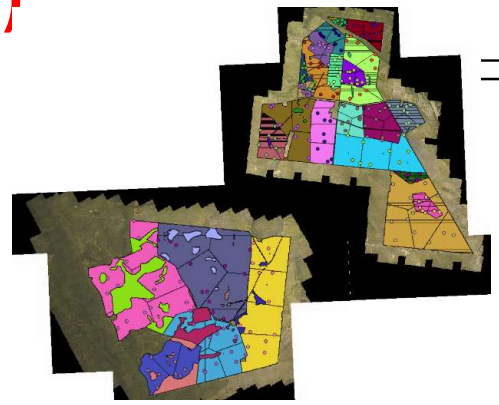
1. Sequestration rate (tC/ha/year)

2. Price of carbon ($/T CO2e)

3. Cost of measurement ($/ha)



4. Scale of project (ha)



Benefits of increasing Soil Carbon

- Improved soil health
- Increased carrying capacity & yield
- Increased water holding capacity
- Enterprise risk hedge
- Management of price and drought risk
- Increased ecosystem resilience
- Lower costs

IRR @ $34/t CO2e x varying scale and rate.

Scale (ha)	Seq Rate (t/ha/yr)	Initial Investment	IRR (%)	Nett Cashflow
500	1	$60,000	22	$346,100
	2	$60,000	38	$819,650
	3	$60,000	50	$1,293,200
2000	1	$105,000	39	$1,660,900
	2	$105,000	60	$3,555,100
	3	$105,000	74	$5,449,300
4000	1	$173,000	43	$3,388,400
	2	$173,000	65	$7,176,800
	3	$173,000	80	$10,965,200

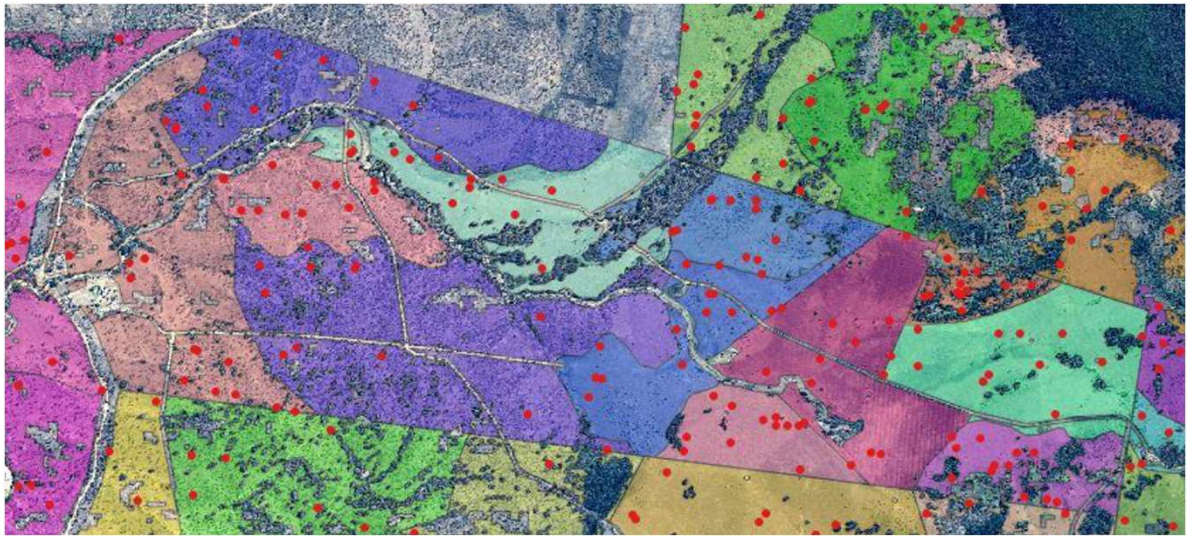
Notes: *Costs include two measurements & Audit. No capital included.*

Notes: *Income based on $34/t CO2e and current methodology.*

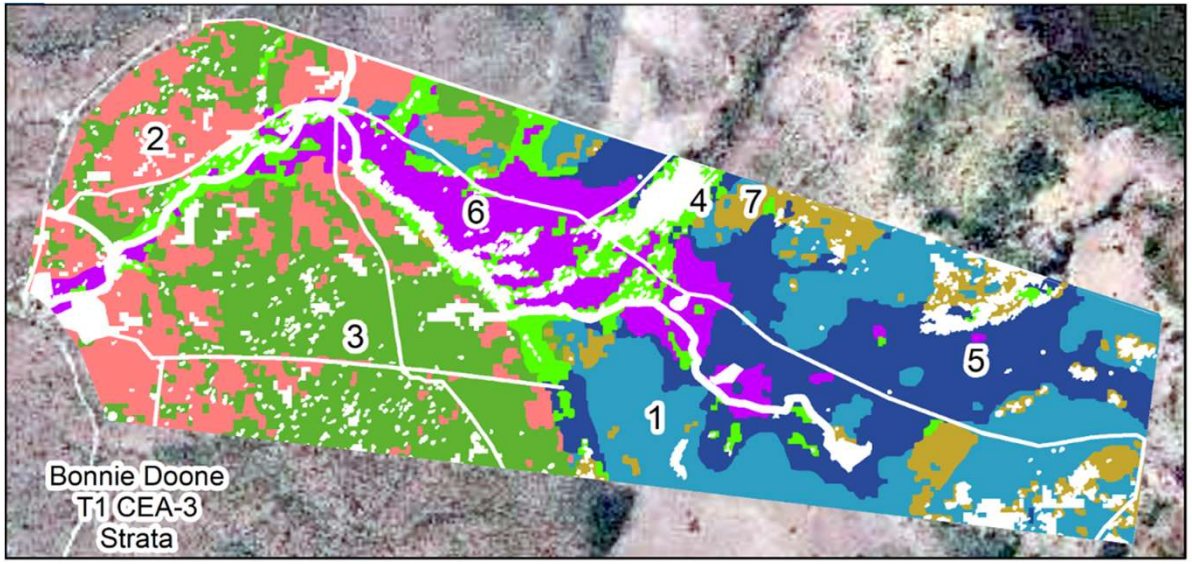
SOURCE: Carbon Link Limited Insights Calculator

Stratification on 1,167ha

2016 -12 strata



2020 – 7 strata



In 2016 the standard deviation of Topsoil Stock was ~12.5 tC/ha at this site, and ~10 tC/ha for all projects.

In our modelling a standard deviation under 5 tC/ha tends to detect creditable change after 5 years.

The 2020 results have reduced the CEA standard deviation to 1.07 tC/ha (range 0.98 to 4.00).

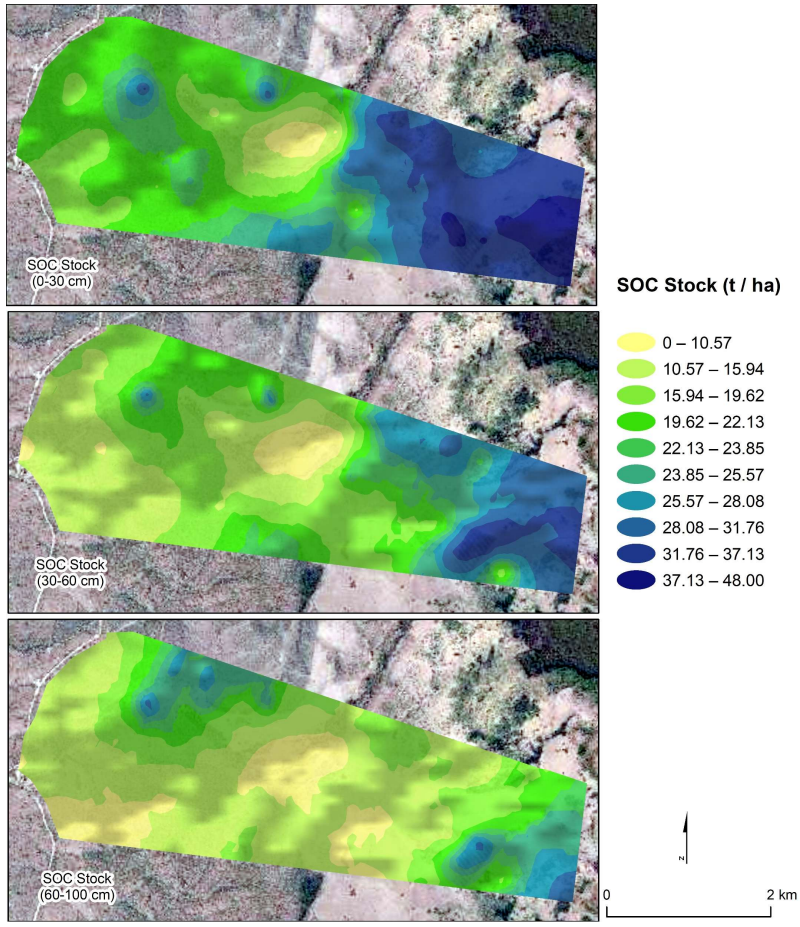
Strata

- 1
- 2
- 3
- 4
- 5
- 6
- 7

SOURCE: Carbon Link R&D

Stratification – Bonnie Doone

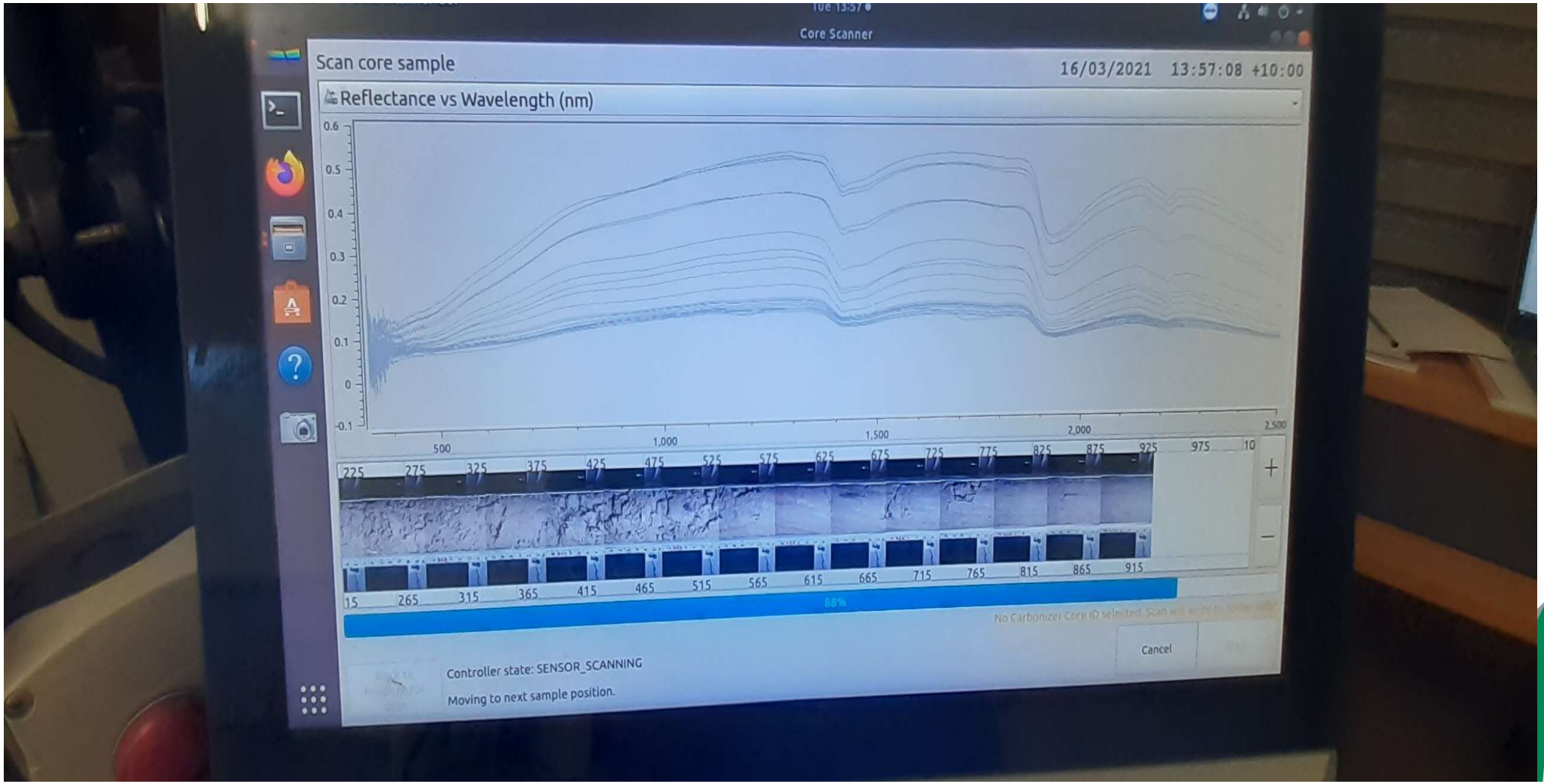
Strata	Area (ha)	Topsoil Stock (tC/ha)	Variance (tC/ha)	Standard Deviation (tC/ha)
1	237	44	9.26	3.04
2	189	29	0.96	0.98
3	278	31	1.33	1.15
4	78	35	16.03	4.00
5	205	51	15.18	3.90
6	115	38	7.34	2.71
7	65	52	12.80	3.58
CEA	1167	39	1.13	1.07



Soil Sampling

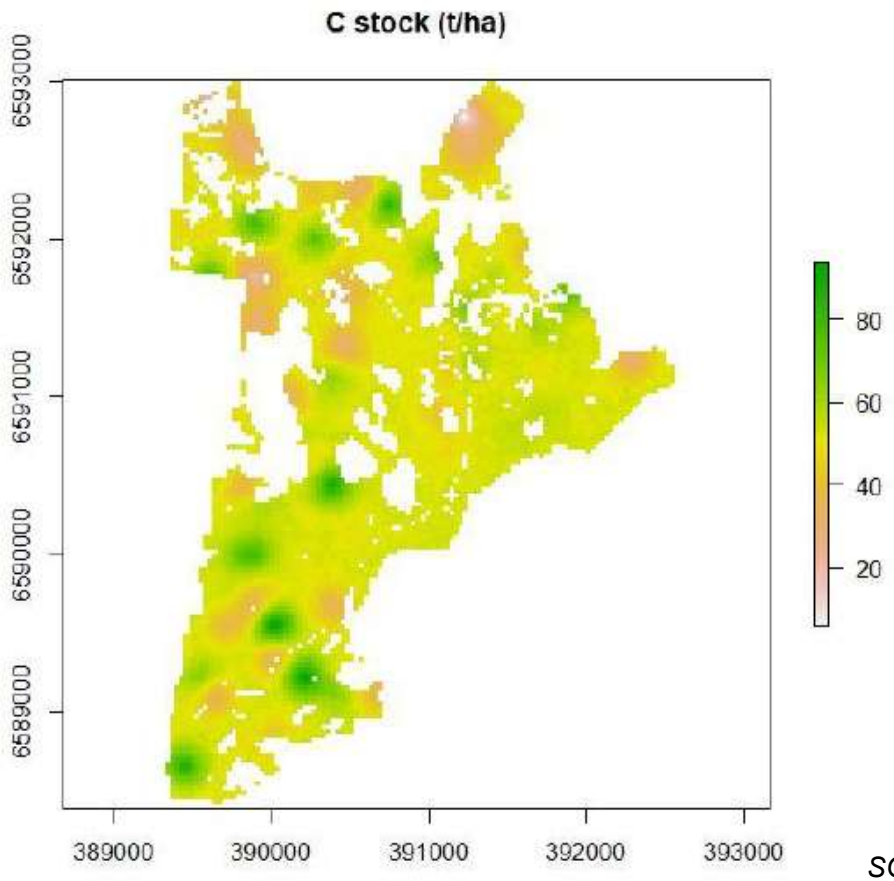
SCANS Unit – (Soil Condition Analysis System)

NIR spectra and core photograph



Change over 3 years with two years of drought.

ESTIMATED DISTRIBUTION of TOTAL SOIL ORGANIC CARBON STOCK (0-30cm)



Creditable Change					
Std Dev of Change	Ave SOC Change	Ave Gravel Change	Stock	Total Stock	Creditable Change
tC/ha	%	%	tC/ha	tC	tCO2-e
9.02	3.35%	25.20%	-14.54	-614	-2,251
5.88	22.15%	18.79%	5.32	1,077	3,949
3.92	19.66%	5.10%	4.51	387	1,419
7.34	2.34%	15.92%	-2.86	-271	-994
4.39	14.65%	16.28%	2.54	399	1,462
5.66	**15.17%**	**16.09%**	**1.68**	**978**	**3,586**

SOURCE: Carbon Link R&D

Net Abatement (after discounts) = **1,150t**

The MAGIC PUDDING

1 tonne of Soil Organic Carbon

=

3.67 tonnes of Carbon Dioxide

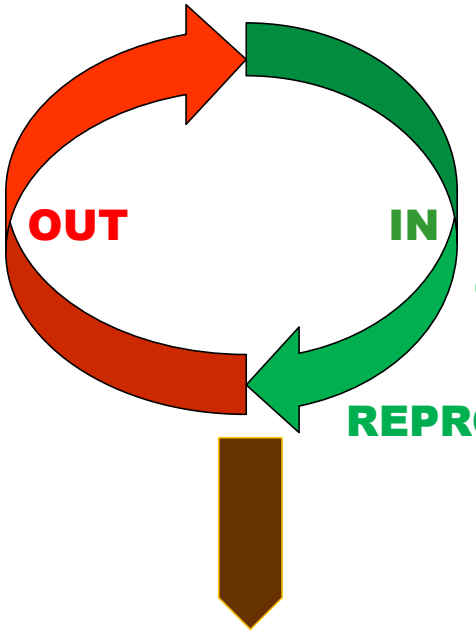
For SALE

The 375 million year old carbon cycle

OXIDATION

DECAY

DEATH

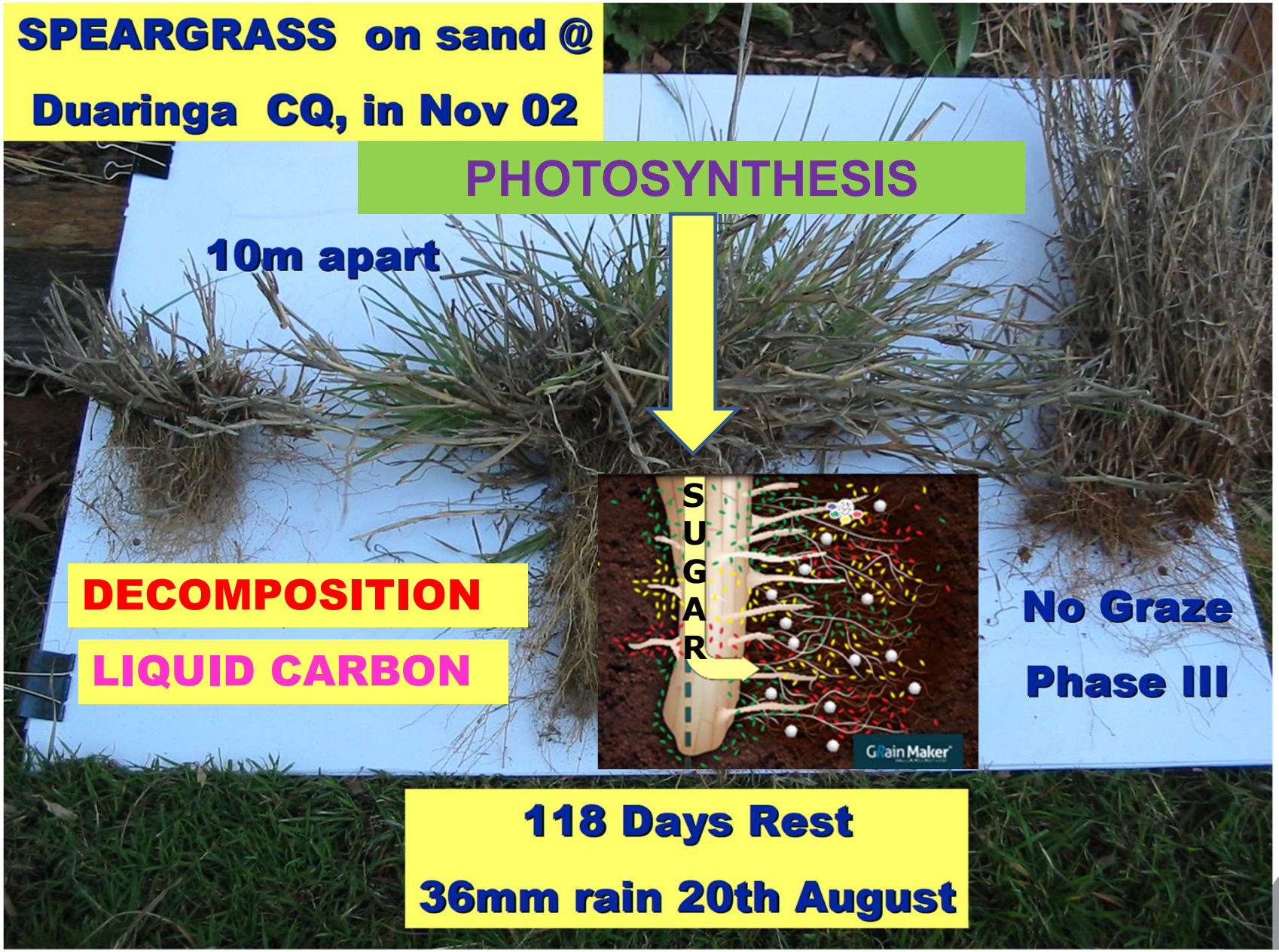


PHOTOSYNTHESIS

BIRTH

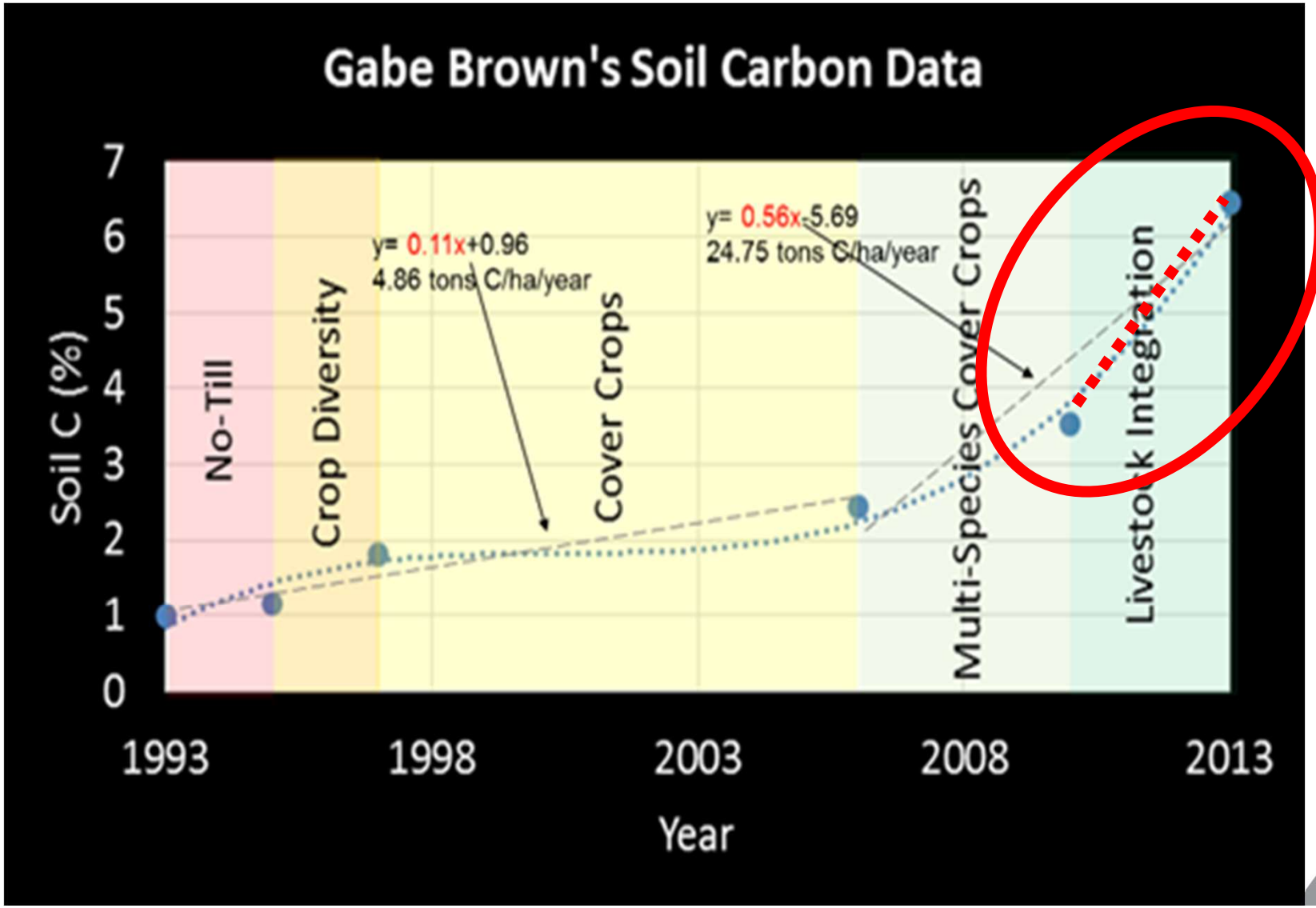
GROWTH

REPRODUCTION


SPEARGRASS on sand @
Duaringa CQ, in Nov 02
PHOTOSYNTHESIS
10m apart
SUGAR
DECOMPOSITION
LIQUID CARBON
No Graze
Phase III
GRain Maker
118 Days Rest
36mm rain 20th August

Cell grazing system, Uralla, NSW.

Annual cropping system - North Dakota.

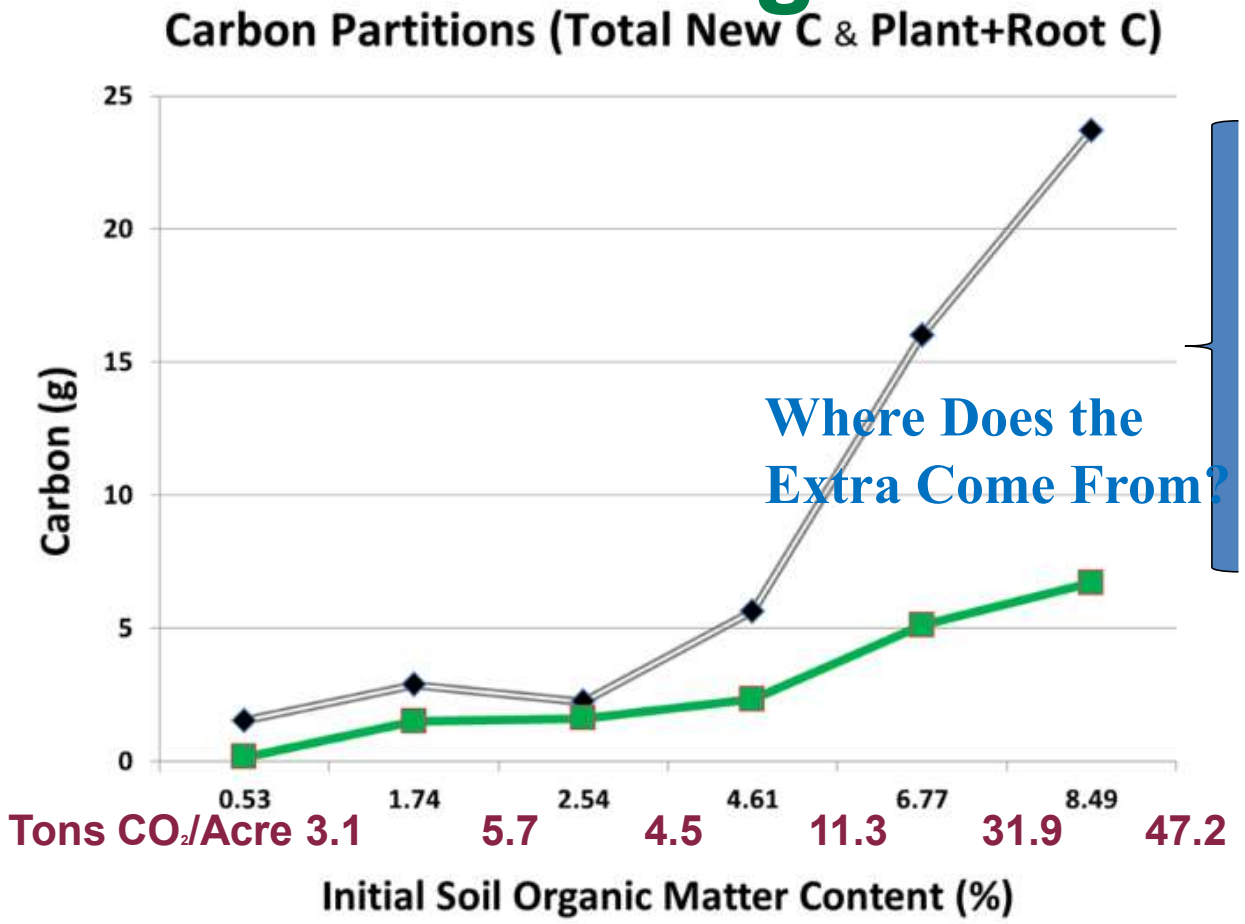


Had 460t SOC/ha to 1.5m by late 2020.

Source: Gabe Brown pers comm and Dr David Johnson, NMSU.

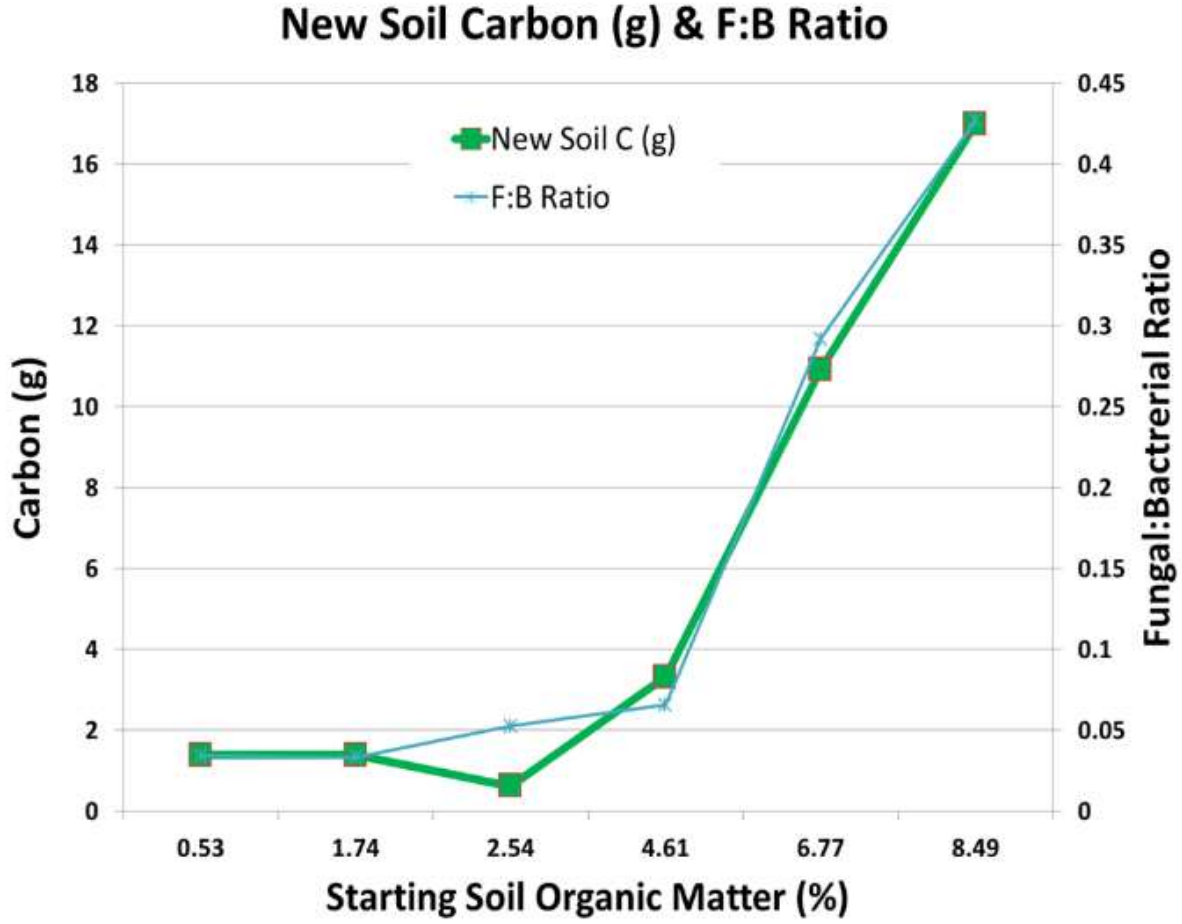
Sweet corn with dual purpose wheat or oats/cattle rotation at Dubbo. SOC has gone from 0.7% to 3.7% (top 10cm) in 2.5 years (Estimated 9.6t C added per ha/year) . Livestock grazed at 27 to 37 DSE/ha for 6 months per annum.

NEW Soil Carbon Accelerates above 3% Organic Matter



Johnson, D, Ellington, D and Eaton, W (2013) Institute for Sustainable Ag Research.

NEW Soil Carbon is correlated (R2=0.99) to the F:B Ratio



Johnson, D, Ellington, D and Eaton, W (2013) Institute for Sustainable Ag Research.

WHAT does that mean?

- **Photosynthetic CAPACITY measured at 11% in Industrial Agriculture.**
- **Photosynthetic CAPACITY measured at 56% in BEAM Crops.**
- **Nett PRIMARY PRODUCTION up 5 fold**

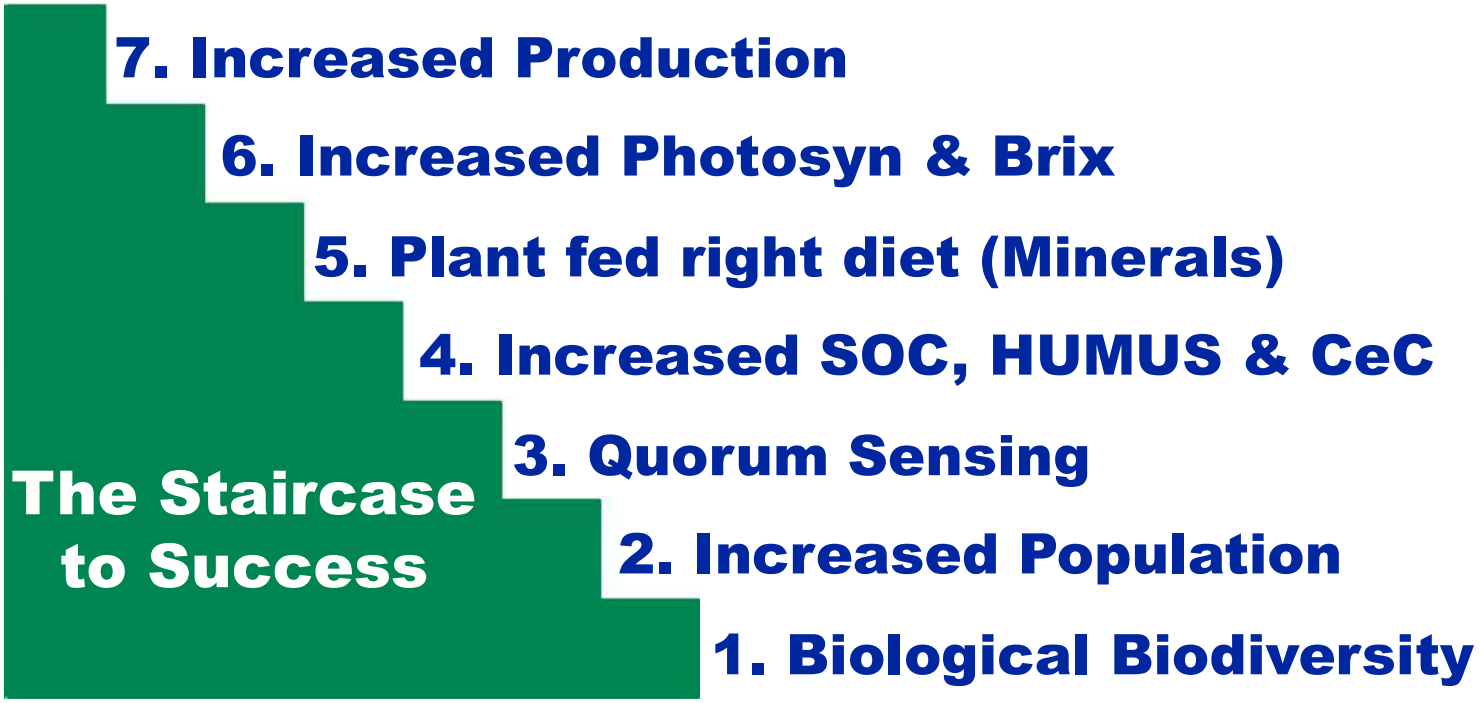
Changes in Soil Macro and Micro- Nutrients with "BEAM"

Months	0	6	8	15	19	Percent Increase	R^2	Regression
Manganese (mg/kg)	3.25	1.86	1.65	14.31	40.14	1135%	$R^2 = 0.969$	2nd Order
Iron (mg/kg)	4.89	4.12	2.66	27.01	59.19	1110%	$R^2 = 0.9892$	2nd Order
NO_3-N (mg/kg)	1.5	1.55	2.00	2.35	3.1	107%	$R^2 = 0.9847$	Linear
SOM (%)	0.75	1.25	1.22	1.49	1.41	88%	$R^2 = 0.7854$	Linear
Magnesium (mg/kg)	1.09	0.075	0.81	1.67	1.99	83%	$R^2 = 0.7954$	2nd Order
Calcium (meq/L)	4.09	2.82	3.00	6.07	7.19	76%	$R^2 = 0.6367$	Linear
Kjeldahl N (mg/kg)	633	719	739.00	752	1041	64%	$R^2 = 0.8244$	2nd Order
Phosphorus (mg/kg)	6.9	12.2	10.00	15.3	11.3	64%	$R^2 = 0.4624$	Linear
Zinc (mg/kg)	0.5	0.63	0.48	0.93	0.81	62%	$R^2 = 0.6652$	Linear
Copper (mg/kg)	1.17	1.1	1.04	1.74	1.64	40%	$R^2 = 0.6591$	Linear
Potassium (mg/kg)	30	33	32.00	42	41	37%	$R^2 = 0.8712$	Linear

20 month Study, 5 Sampling Periods

David C. Johnson- NMSU Institute for Sustainable Agricultural Research (ISAR) davidcjohnson@nmsu.edu

How?


7. Increased Production
6. Increased Photosyn & Brix
5. Plant fed right diet (Minerals)
4. Increased SOC, HUMUS & CeC
3. Quorum Sensing
2. Increased Population
1. Biological Biodiversity
The Staircase to Success