
Not Just Dirt
A Hidden Ecosystem Forum
Kevin R. Elmy, PAg

Healthy Soil

What is healthy soil?

- Functioning during different environmental conditions
  - Producing healthy plants, animals and humans
- Diversity of life above and below ground
- Drive more carbon into the soil than taking out
  - Water follows carbon

Measuring Health

How do you know if your soil is healthy?

- How much inputs do the plants require to produce
- How much minerals do animals require to stay healthy
- How much water infiltrates into the soil and stays in the root zone
- How easily does the soil erode
- How much wildlife do you see

Enlist
TM
ADV
How would you
measure soil health?

Measurements

- Start with baselining
  - Compaction
    - Penetrometer
  - Plant photosynthetic function
    - Refractometer
  - Microbial function
    - Soil respiration
  - What weeds are growing

Measurements

- Depth of A horizon
- Rooting depth
- Soil smell
- Soil feel
- Soil aggregate stability
- Soil microaggregate stability
- Drone NDVI camera

Measurements

- Soil test
  - Mineralogical test
  - Traditional chemical extraction
- Microbial survey
  - PLFA
  - Microscope
- Tissue testing
- Sap testing


What goals do you have from attending this workshop?

Where to start?

- Need to develop goals
  - What do you see as broken?
    - What do you not like?
  - Not necessarily “yield”
    - Need to think “profit”
      - Not a 4 letter word

Cover Crop Needs Assessment

Name **Paddock**
Hectares

Conventional Organic

Grain Mixed Farm Livestock

Moisture

Dry OK Moist

Soil Texture

Sandy Soil Loam Clay Soil

Soil Fertility Level

Low Medium High

End use:

Hay Rotational Grazing Stockpiled Grazing Green manure

Ground Cover Soil Improvement Intercrop

Issues (rated):

Hard Pan Poor aggregation Slow

infiltration Weeds Low

N Erosion Low OM Low

fertility Grazing Hay/Silage Salinity

Seeding date:

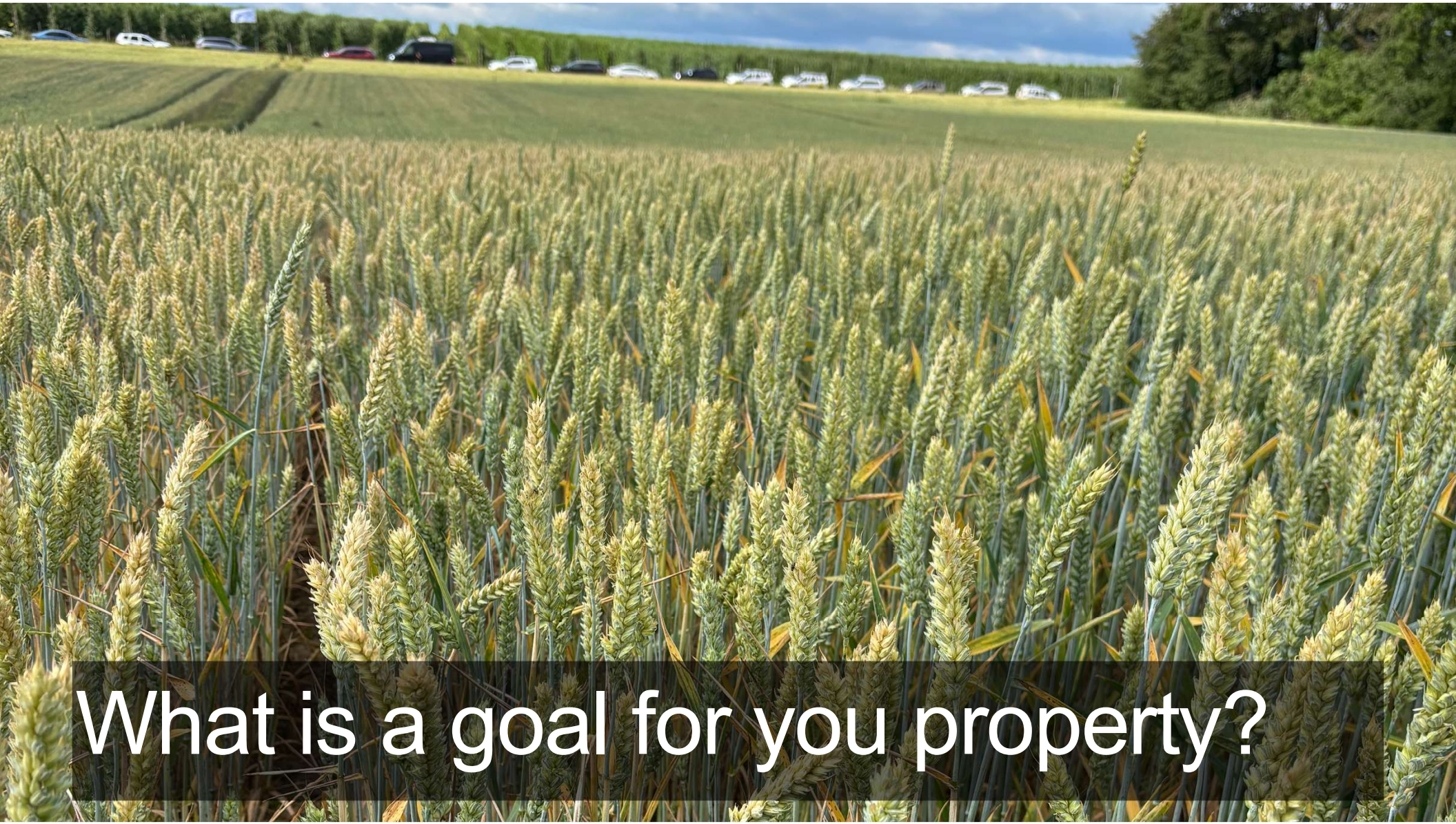
Early spring Late spring Early summer summer Early fall

Seeding method:

Broadcast Drilled

Termination:

Cultivation Herbicide Over summer Grazing/Hay Tillage/crimp


What is a goal for you property?

Cause vs Symptom

- Need to identify if problem is a symptom or the cause
  - Symptom - reappears after “curing” problem
  - Cause - creates the symptoms
    - May have more than one symptom or causes

Tackling Causes

- Will take some experimentation
  - Climate may mask failure
    - Or other issues
- Reflect on soil health principles
- Speed of repair
  - Depends on climate, budget, patience, tools, complexity of the solution


What problem you need to tackle?

Compaction

- Symptoms
  - Poor root growth
  - Low water infiltration
  - Poor fertiliser responses
  - Poor plant growth
  - Erosion

Compaction

- Causes
  - Over application of nitrogen
  - Low calcium flux rates
  - Traveling on wet soils
  - Low fungal populations
  - Low plant diversity
  - Excessive tillage

Soil Health Principles

1. Have a plant in the vegetative stage for as many days possible
2. Increase functional plant group diversity
3. Reduce tillage
4. Reduce reliance on synthetic inputs
5. Properly incorporate livestock

Vegetative plants

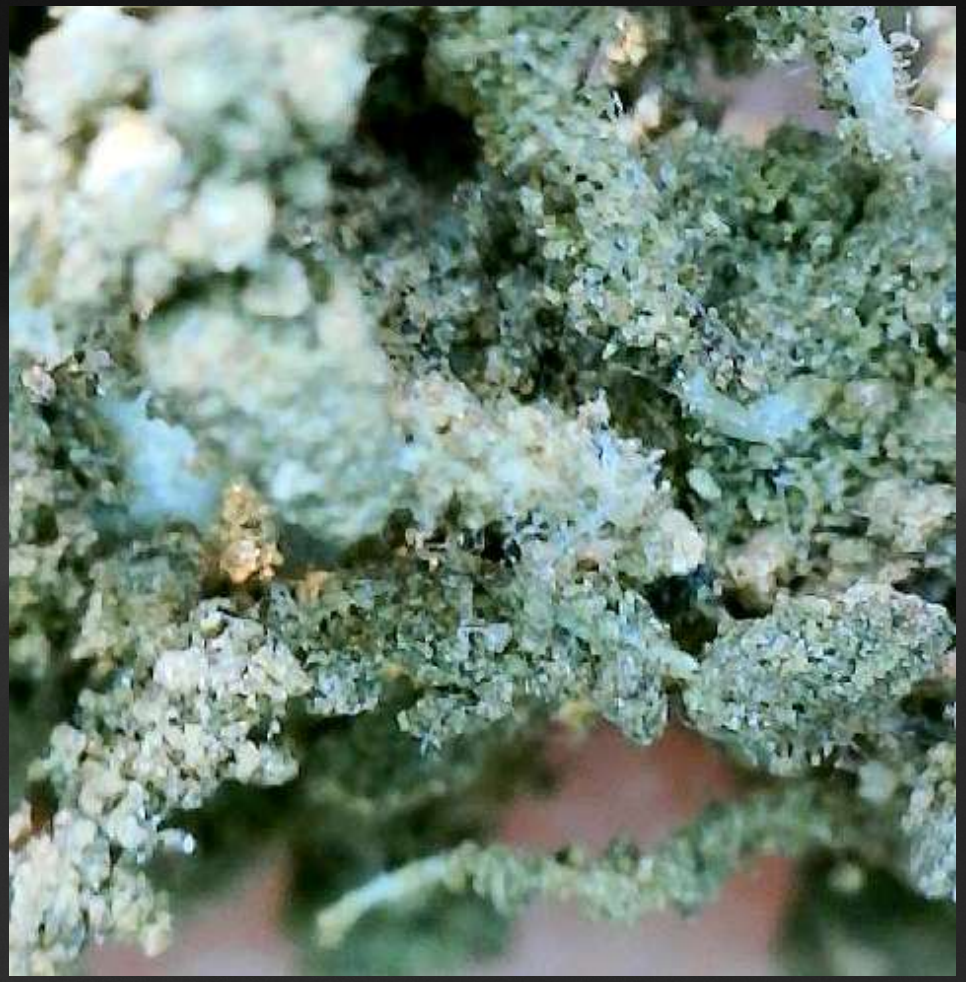
- Important to build soils
  - Vegetative plants
    - Release up to 80% of photosynthesis as root exudate
    - Cycles nutrients
    - Builds mycorrhizal fungi
    - Protects the soil
    - Aids microwater cycle

Vegetative plants

- Important to build soils
  - Vegetative plants
    - Reduces evaporation
    - Suppresses annual weeds by minimizing excess soil nitrates
    - Increased grazing potential
    - Helps break down excess dead plant residues

Vegetative plants

- Important to build soils
  - Root exudates as the seasons change are used by microbes to stabilize soil aggregates
  - Need soil armour to protect from UV degradation and erosion
  - Keeps microbes active
    - Annual crops only feed the soil microbes for 30-40 days



Functional plant diversity

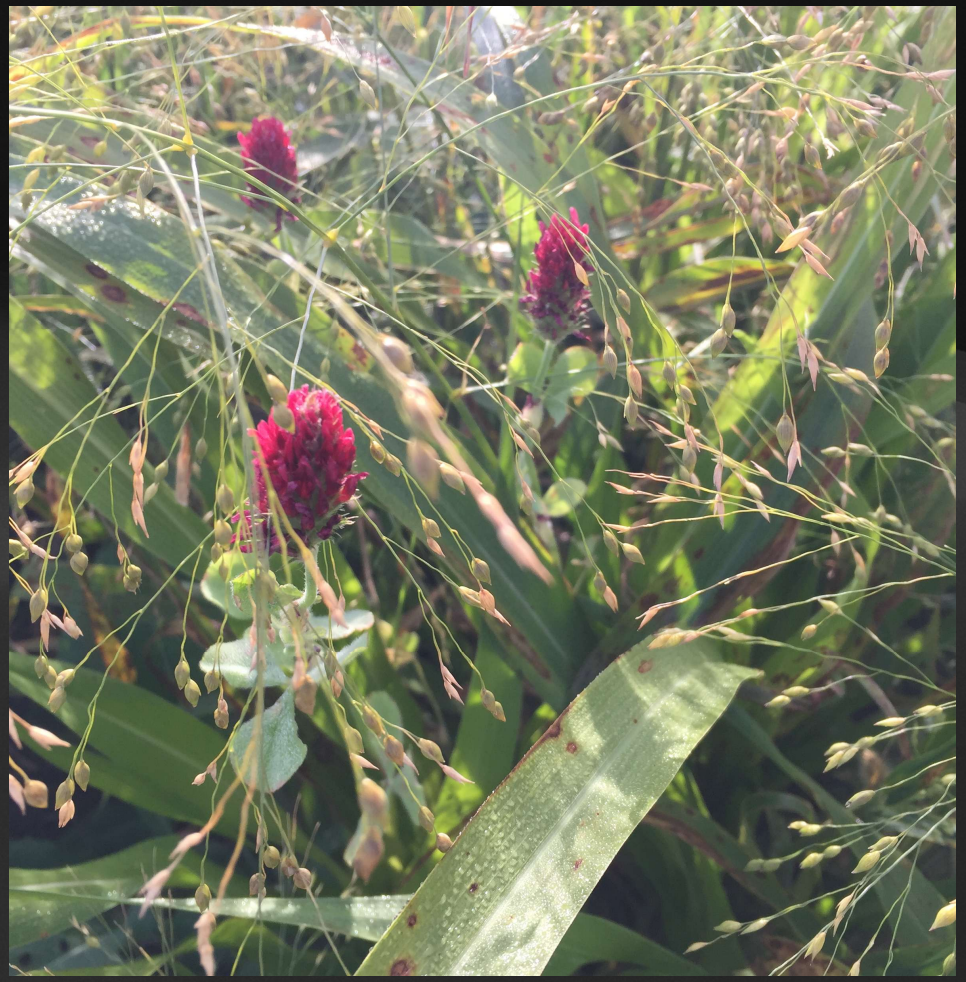
- Different functional plant groups have different ecological function
  - Different microbiomes
- Need either in mix(es) or in rotation
- Nature does not work as individuals
  - Teams and cooperation

Functional plant diversity

1. Grass
2. Legume
3. Brassica
4. Non Brassica Broadleaf
5. Forbs

Summer and winter actives

Annuals, biennials, perennials



Reducing tillage

- Tillage oxidises soil carbon
  - Reduces soil organic matter
  - Causes about 50 mm moisture loss per hectare per pass of moderate tillage
  - Damages fungi hyphae
    - Promotes more bacteria
- Tillage can play a positive reaction when goal driven

Reducing tillage

- Strategic tillage
  - Minimal disturbance with goal achieved
  - SoilKee
  - Add carbon with each pass
  - Retain soil armour
- Tillage is not necessarily a bad thing, it depends on what happens during or after

Reducing tillage

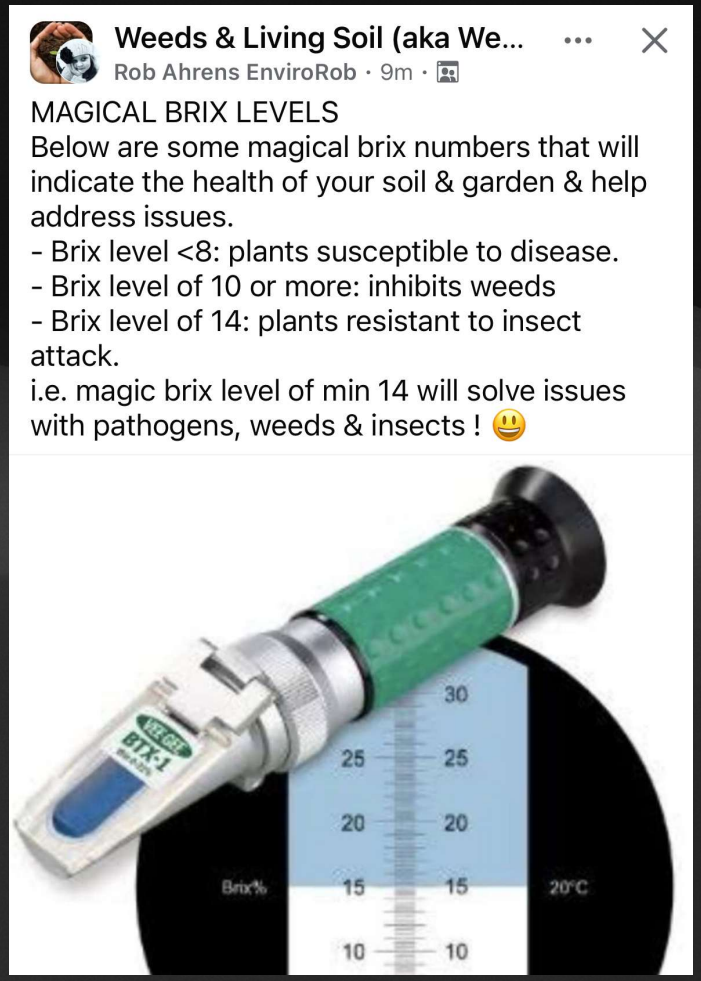
- Damage relates to
  - Intensity
  - Duration
  - Frequency
  - Repairs to the system
- Tillage actually increases weed pressure

Synthetic inputs

- Synthetic inputs are a convenience for us
  - Fixes a “problem” quickly
  - Traditionally agronomy fixed them
    - Takes knowledge, time, not always 100% effective
- Synthetic fertility takes jobs away from microbes

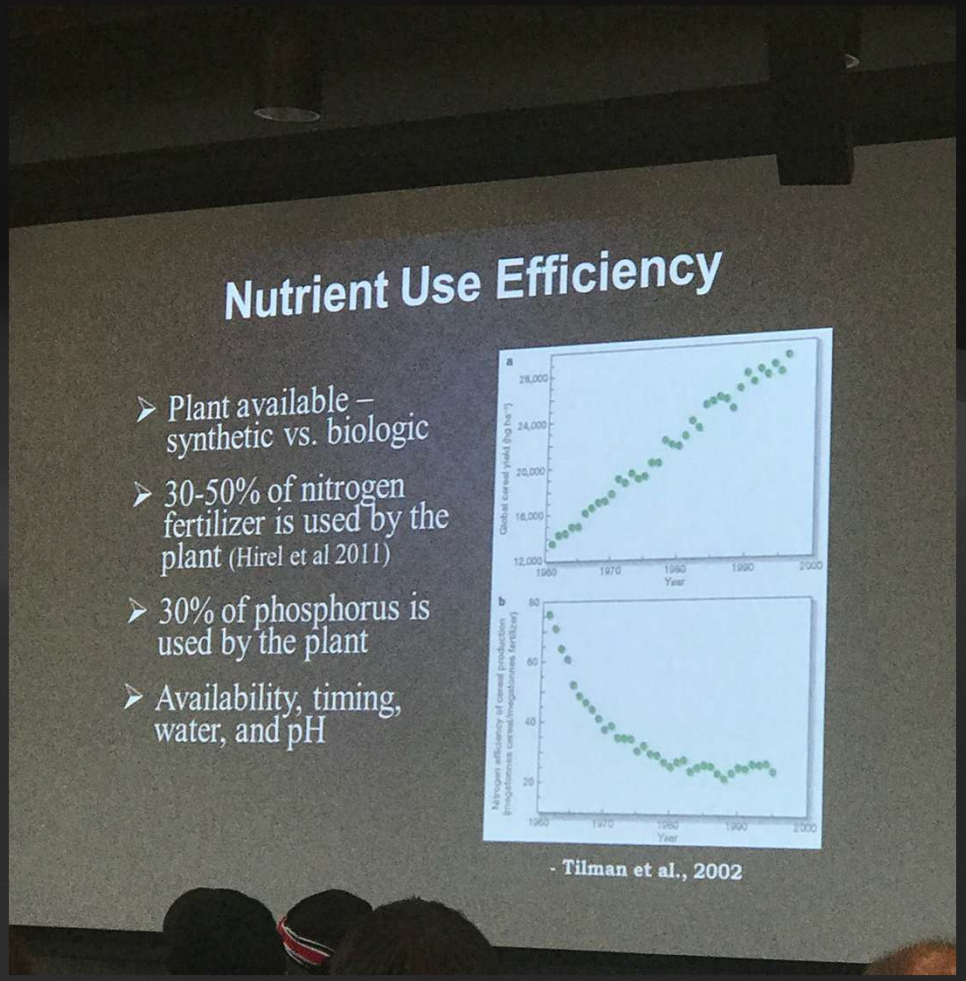
Synthetic inputs

- Biocides mask the cause of the issues
  - Spraying without changing management will allow the problem to reoccur
    - Weeds, disease, insects
- Application of biocides will drop Brix of our cash crop in almost all cases
  - Creates a weaker plant



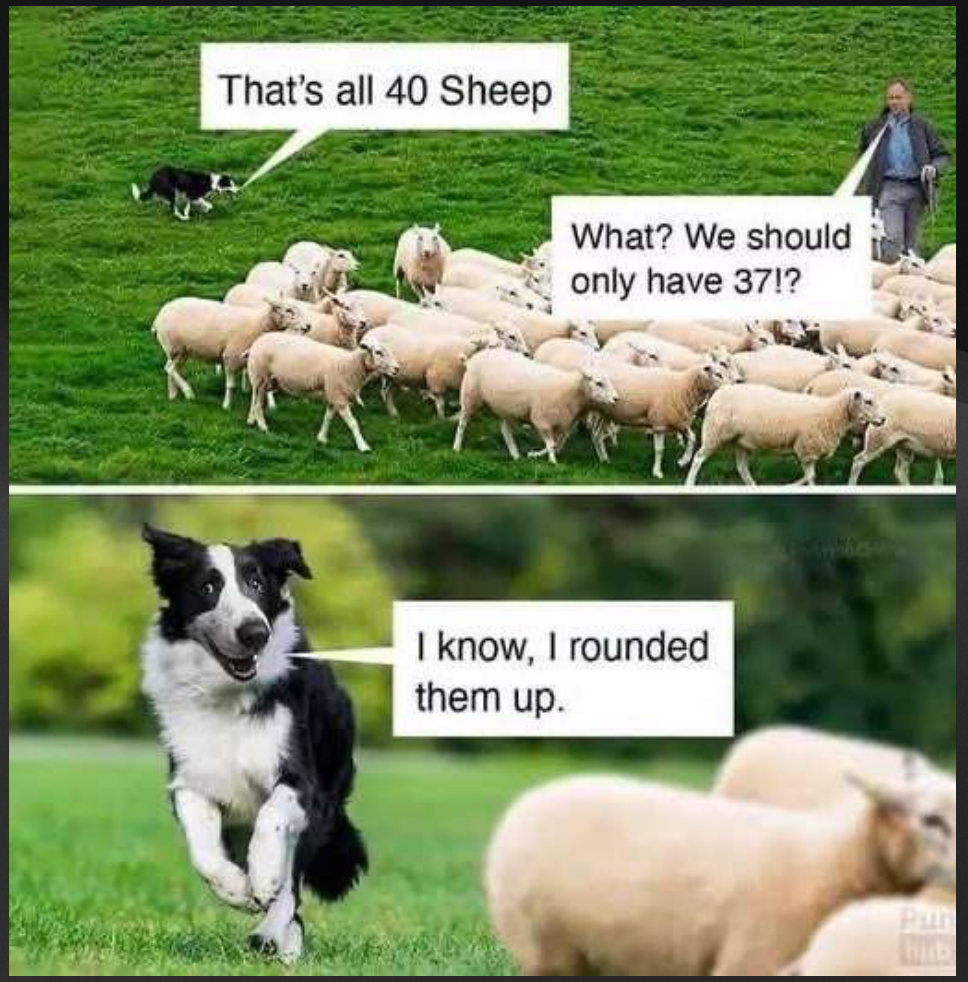
Fertiliser

- At best plant will use
  - synthetic N is 50%
  - P is normally under 15%
- Natural fertility - Rhizophagy (Dr. James White)
  - Identified in Univeristy of Queensland 2010
  - Plants prefer to take up 85+% nutrients this way



Incorporating livestock

- Dr. David Montgomery “Dirt: The Erosion of Civilizations”
  - Researched the fall of major civilizations through time
    - Absentee landowners
    - Use of high nutrient requiring crops for export
    - Reliance on capital assets
    - Large farms
    - Improperly managing livestock



Incorporating livestock

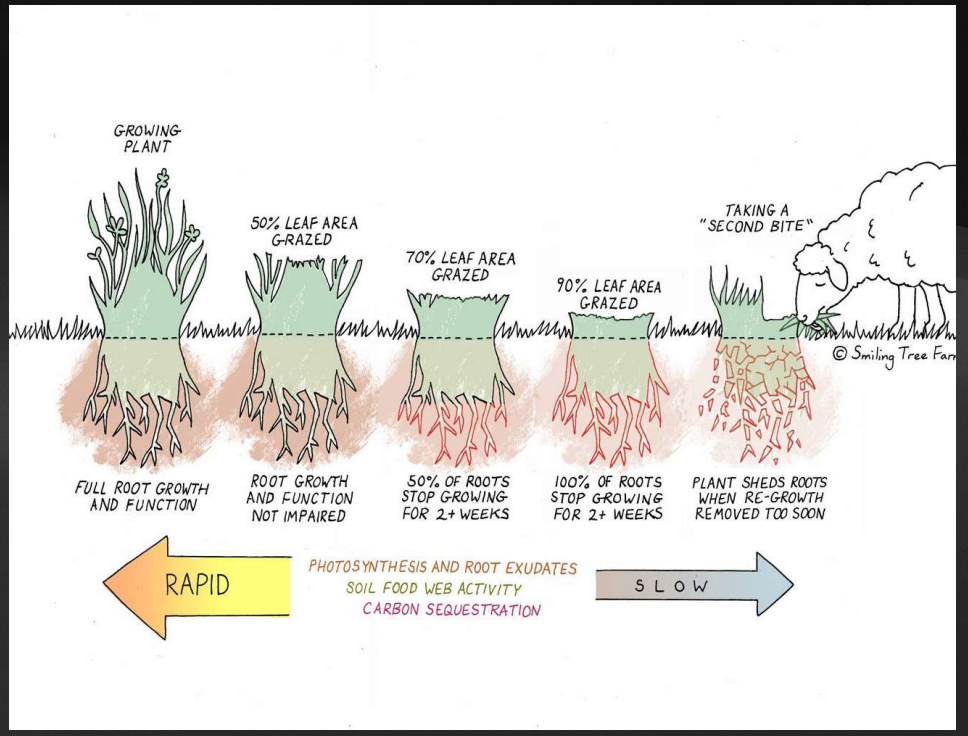
- Key: use the livestock as a tool to manage the grass
  - Graze or cut at a time the forage is ready
    - Allow plant rest and recovery
    - Still have high animal impact for short durations during plant growth

Incorporating livestock

- Set stock grazing
  - Animals will pick forage they like
    - Avoid non desirables
      - Allows those species to increase in density

Incorporating livestock

- Understand plant dormancy
  - Leave perennials as they are preparing for dormancy
    - Building nutrient reserves in their root systems
  - If grazed or cut during this time, reduces future productivity



Incorporating livestock

- Change thinking
  - Using animals to manage the grass growth stage
    - Adaptive grazing
    - Reduce the risk of over grazing
    - Able to maintain proper grazing pressure

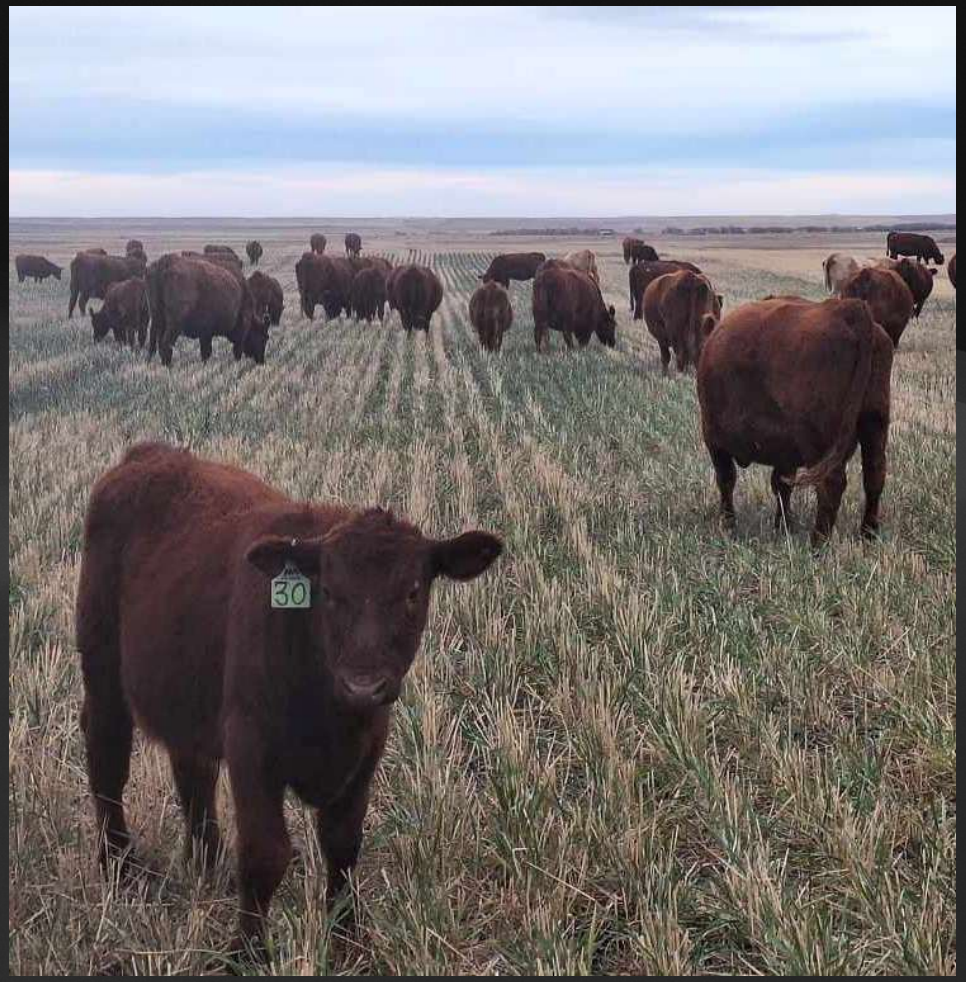
Incorporating livestock

- Utilise the best part of the plant
  - Top 1/2
    - Best gains
  - Bottom 1/2
    - High lignin
    - High nitrates
    - High sulphates

Cover Crop Feed and Forage Report			
Menoken Farm			
19-Sep-16			
Specie	**Crude Protein**	**RFV**	**TDN**
Annual Ryegrass - Top/half	15.67%	110.81	61.88%
Annual Ryegrass - Bottom/half	8.02%	109.05	60.12%
Cowpea - Top/half	14.79%	218.90	69.38%
Cowpea -Bottom/half	4.35%	103.72	58.94%
Hairy Vetch - Top/half	14.75%	126.74	60.78%
Hairy Vetch - Bottom/half	6.07%	85.59	52.08%
Pearl Millet - Top/half	9.77%	83.95	59.18%
Pearl Millet - Bottom/half	1.77%	86.91	57.79%
Radish - Top/half	10.74%	105.20	56.08%
Radish - Bottom/half	6.54%	75.30	48.09%
Soybean - Top/half	17.90%	190.15	67.95%
Soybean - Bottom/half	11.76%	114.08	59.10%
Sudan - Top/half	7.83%	83.93	58.21%
Sudan - Bottom/half	7.52%	84.78	57.56%
Sunflower - Top/half	10.38%	193.66	65.57%
Sunflower - Bottom/half	6.06%	123.83	58.30%
Sweet clover - Top/half	24.53%	228.51	72.25%
Sweet clover - Bottom/half	12.62%	97.47	55.15%
Cool Season Cover Crop Mix (fall seeded)	26.79%	208.43	71.32%
Source: Dairyland Laboratories, Inc.			

Incorporating livestock

- Rest perennials when heading into dormancy
  - Replace with annual cover crops
  - Strengthens perennial long term
  - Can dormant graze perennials



Picture: Calvin Gavelin

Incorporating livestock

- Cropper?
  - Partner with a livestock producer
    - Do not need to own the livestock
  - Create a win-win partnership
  - Great way to utilize crop rescues
  - Income diversity

Picture: Ed Sharko


How do you rate each
principle on your property?

Cover cropping

- Definition: growing plants to protect and improve the soil
  - Directed by goals
    - Solve problems
- Colin Sies - No kill pasture seeding
  - Winter actives into summer active perennials

Are you using any cover crops?

Cover cropping

- Create mixes to foster synergies between functional plant groups
  - Watch antagonisms
  - Watch future contamination
    - Create new problems
- Identify holes in feed calendar
  - Summer slump
  - Late spring

Cover cropping

- Cropper
  - Intercropping
  - Relay cover cropping
  - Full season cover
  - Post harvest

Cover cropping

- Livestock
  - Full season
    - Rotational graze
    - Stockpile graze
    - Cut and graze
  - No Kill Pasture Seeding (Seis)
  - Relay cover crop

Cover cropping

- Fodder
  - Goals. Goals. Goals.
  - Type of livestock
  - When seeding
  - When feeding
  - Feed shortage windows

Legacy effect

- Dr. Christine Jones
- Soil has a microbiome
- Plants have their own microbiome
  - Populates the soil via rhizosheath
- Roots with different microbiomes will intermingle, sharing their microbiome with other plants as needed
  - Triggers gene expression

Legacy effect

- Seed harvest will have a microbiome more suited to the past year's growing conditions
- Roots will follow old root channels
  - Accessing old rhizosheaths and past plant microbiomes
  - More tillage, herbicides/biocides and lower plant diversity, less old microbiome availability


What cover crops are used?

Designing blends

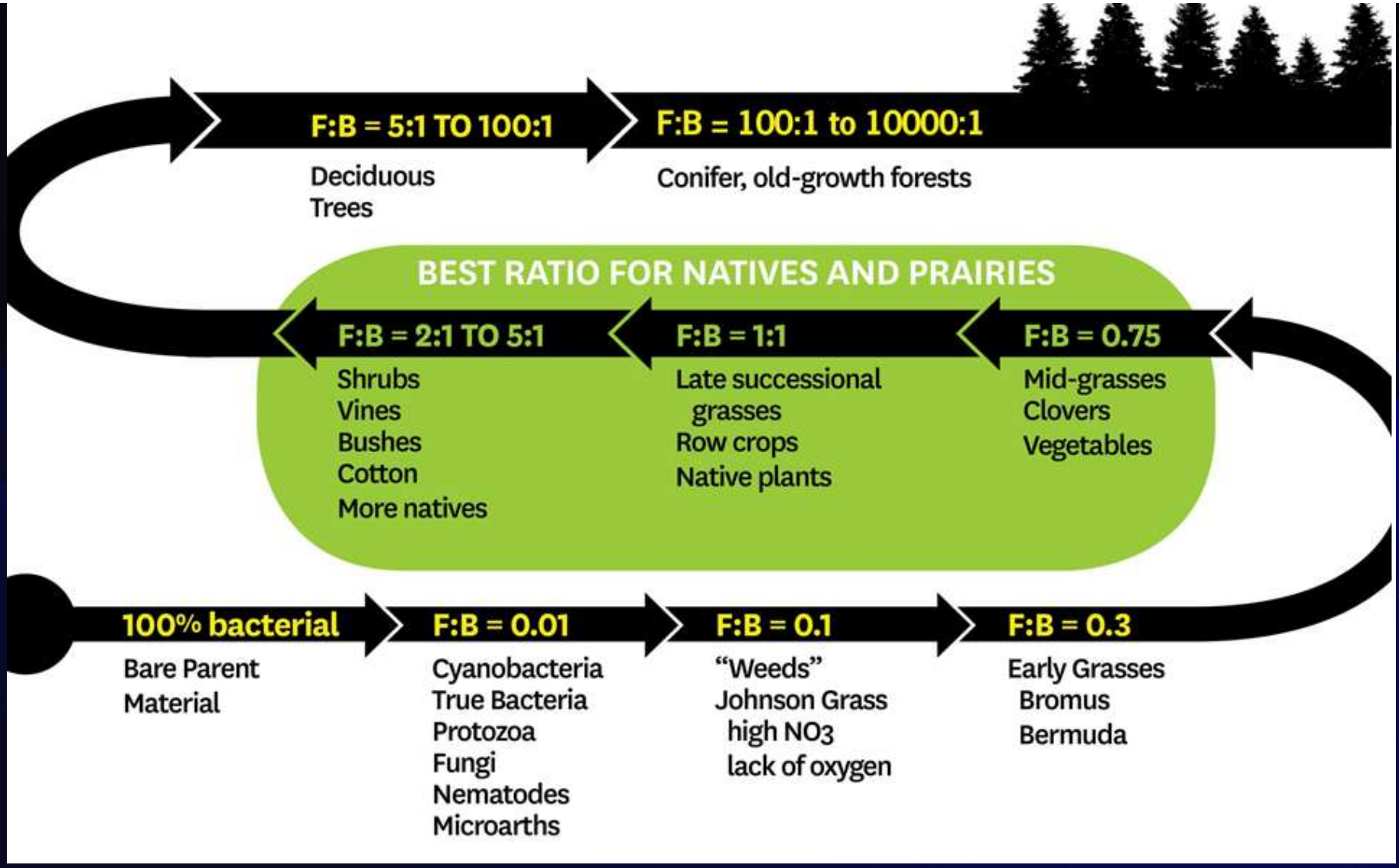
- Goals
- Need to understand role of functional plant groups
  - Which will address goals?
- Plant diversity —> Microbe Quorum (Dr. Christine Jones)
- Excess diversity for the sake of diversity
  - Might dilute species that are important in the mix

Designing blends

- Grasses
  - Tonnes
  - Fibrous root
  - P accumulators
- Legumes
  - N fixer
  - Protein

Designing blends

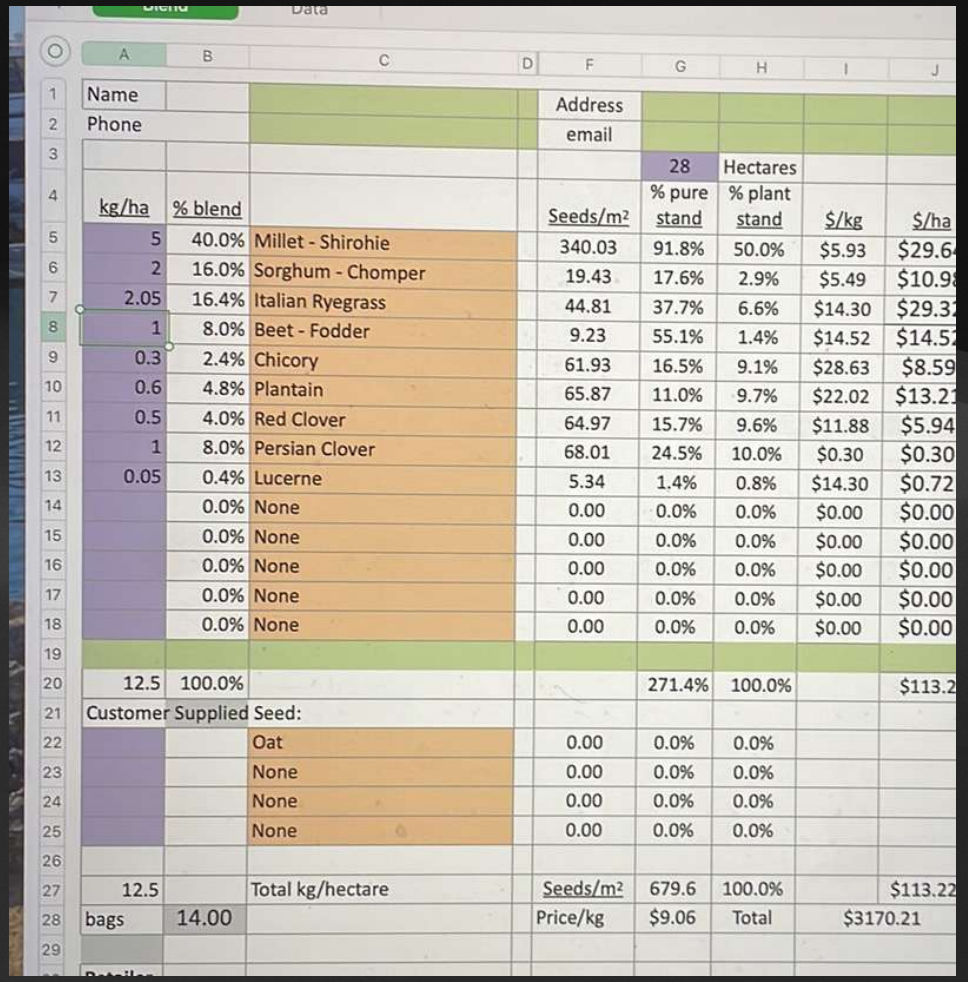
- Brassicas
  - Scavengers - non mycorrhizal
  - Protein
- Non Brassica Broadleaf
  - Various roles
- Forbs
  - Flowering herbaceous plants
  - Secondary plant metabolites



https://sustainablegrowthtexas.com/sgtx-custom-blends-follow-road-map-to-match-biology-with-desired-plant-growth/

Blend ideas

- Need to know
  - Seed size (#/kg)
  - Monocrop seeding rate
  - Your plant density target
    - Total
    - Species



	A	B	C	D	F	G	H	I	J
1	Name				Address				
2	Phone				email				
3						28	Hectares		
4	kg/ha	% blend			Seeds/m²	% pure stand	% plant stand	$/kg	$/ha
5	5	40.0%	Millet - Shirohie		340.03	91.8%	50.0%	$5.93	$29.6
6	2	16.0%	Sorghum - Chomper		19.43	17.6%	2.9%	$5.49	$10.9
7	2.05	16.4%	Italian Ryegrass		44.81	37.7%	6.6%	$14.30	$29.3
8	1	8.0%	Beet - Fodder		9.23	55.1%	1.4%	$14.52	$14.5
9	0.3	2.4%	Chicory		61.93	16.5%	9.1%	$28.63	$8.59
10	0.6	4.8%	Plantain		65.87	11.0%	9.7%	$22.02	$13.2
11	0.5	4.0%	Red Clover		64.97	15.7%	9.6%	$11.88	$5.94
12	1	8.0%	Persian Clover		68.01	24.5%	10.0%	$0.30	$0.30
13	0.05	0.4%	Lucerne		5.34	1.4%	0.8%	$14.30	$0.72
14		0.0%	None		0.00	0.0%	0.0%	$0.00	$0.00
15		0.0%	None		0.00	0.0%	0.0%	$0.00	$0.00
16		0.0%	None		0.00	0.0%	0.0%	$0.00	$0.00
17		0.0%	None		0.00	0.0%	0.0%	$0.00	$0.00
18		0.0%	None		0.00	0.0%	0.0%	$0.00	$0.00
19									
20	12.5	100.0%				271.4%	100.0%		$113.2
21	Customer Supplied Seed:								
22			Oat		0.00	0.0%	0.0%		
23			None		0.00	0.0%	0.0%		
24			None		0.00	0.0%	0.0%		
25			None		0.00	0.0%	0.0%		
26									
27	12.5		Total kg/hectare		Seeds/m²	679.6	100.0%		$113.22
28	bags	14.00			Price/kg	$9.06	Total	$3170.21	
29									

Cover Crop Blender

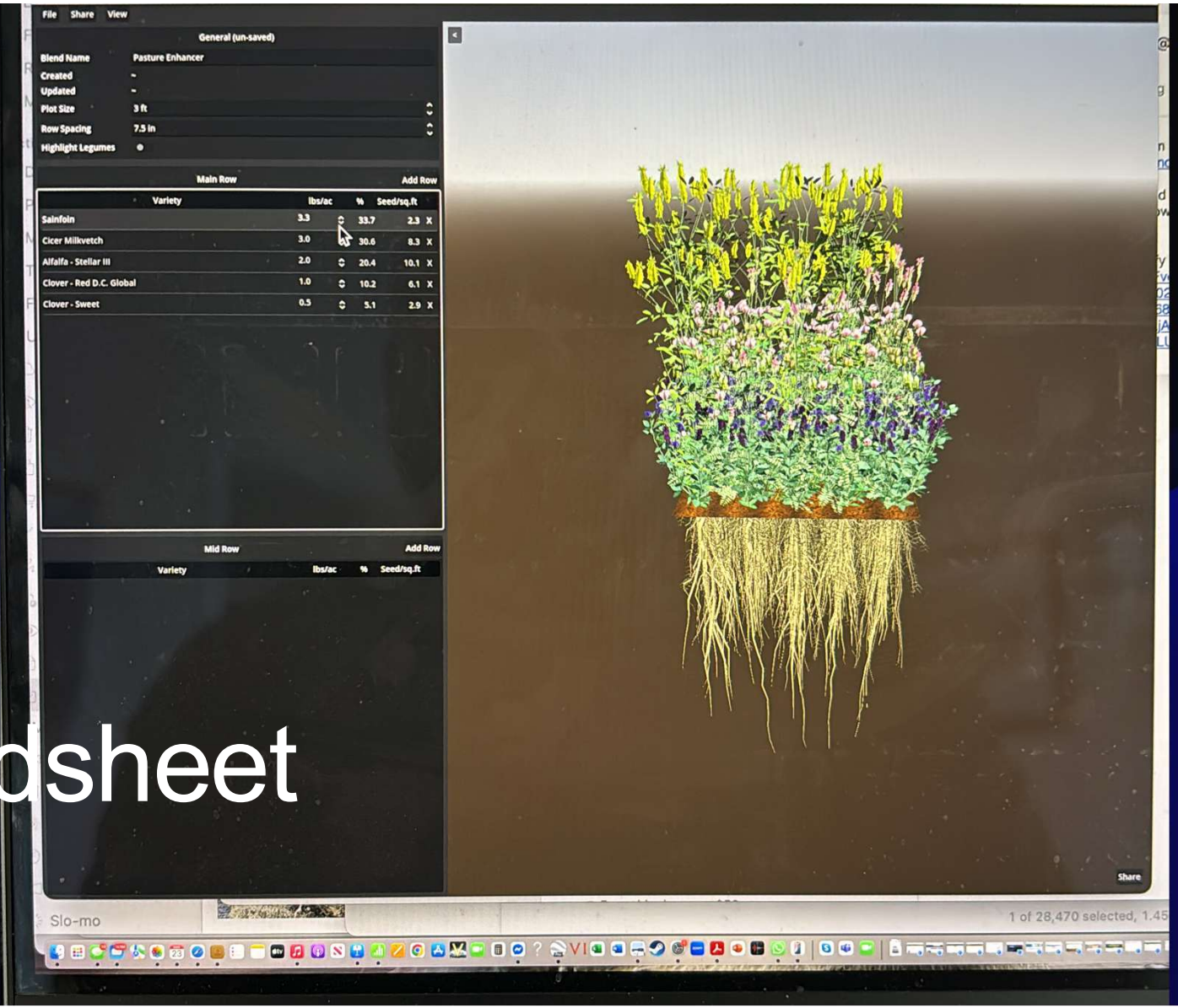
Name				Address							
Phone				email							
					150	Hectares					
kg/ha	% blend			Seeds/m²	% pure stand	% plant stand	$/kg	$/ha	Type	Total kg	$/blend
0.33	2.3%	Teff		87.28	8.3%	19.2%	$0.00	$0.00	WSG	49.50	$0.00
4.3	30.1%	Cow Peas		6.45	53.8%	1.4%	$0.00	$0.00	WSL	645.00	$0.00
2.65	18.6%	Lablab		1.46	33.1%	0.3%	$0.00	$0.00	WSL	397.50	$0.00
0.5	3.5%	Sunflower		8.82	6.3%	1.9%	$0.00	$0.00	WSB	75.00	$0.00
1	7.0%	Buckwheat		3.09	1.7%	0.7%	$0.00	$0.00	WSB	150.00	$0.00
1	7.0%	Millet - Shirohie		68.01	18.4%	14.9%	$0.00	$0.00	WSG	150.00	$0.00
2	14.0%	Sorghum Sudan		19.43	17.6%	4.3%	$0.00	$0.00	WSG	300.00	$0.00
2	14.0%	Crimson Clover		106.87	36.7%	23.5%	$0.30	$0.60	CSL	300.00	$90.00
0.5	3.5%	Balansa Clover		154.28	110.2%	33.9%	$0.00	$0.00	CSL	75.00	$0.00
	0.0%	None		0.00	0.0%	0.0%	$0.00	$0.00		0.00	$0.00
	0.0%	None		0.00	0.0%	0.0%	$0.00	$0.00		0.00	$0.00
	0.0%	None		0.00	0.0%	0.0%	$0.00	$0.00		0.00	$0.00
	0.0%	None		0.00	0.0%	0.0%	$0.00	$0.00		0.00	$0.00
	0.0%	None		0.00	0.0%	0.0%	$0.00	$0.00		0.00	$0.00
14.28	100.0%				286.0%	100.0%		$0.60		2142.00	$90.00
Customer	Supplied	Seed:									
		None		0.00	0.0%	0.0%					$90.00
		None		0.00	0.0%	0.0%					
		None		0.00	0.0%	0.0%					
		None		0.00	0.0%	0.0%					
14.28		Total kg/hectare		Seeds/m²	455.7	100.0%		$0.60	/ha		
bags	85.68			Price/kg	$0.04	Total		$90.00			
Retailer											

Cover Crops Canada

www.covercrops.ca

Version 3.22.2022b

Blend spreadsheet



Management

- Seeding
  - Drill
    - Tine
    - Disk
  - Broadcast
  - Modified
    - SoilKee


LEMKEN


New Holland


A.E.
WALKER


Partner 2800 HT
HORSCH
CASE
AXIAL-FLOW
8240

Weed control

- Weeds indicates what/what is not happening in the soil
  - Weeds are trying to fix the problems in the soil
    - Ecological advantage
- In the year of weed expression
  - Leave them (if not toxic)
  - Control them
  - Address the issue

Weed control

- After weed expression
  - Pick cover crop species with similar ecological function
  - Seed at different times of the year
  - Add soil supplements
    - Nutrition
    - Compost/compost extract

Weed control

- Killing weeds without changing management
  - Weeds come back
- Need to understand what triggers weed growth
  - Low calcium flux
  - Excess soil nitrate
  - Bacterial activity without plant activity

Perennial forages

- Rest perennials at critical periods
  - Sacrifice cover crop
- Plan cover crops for feed holes
- Create feed diversity
  - Stimulates growth and health
- “Wasted” feed
  - Feeding livestock in the ground

Fire

- Ideally some summer active plants are included that will be vegetative when the rains stop
  - Millet
  - Sorghum
  - Teff
  - Cow peas
- Even if in strips across the paddock
- Green plants do not burn well

Drought

- Multi species is about diversity
  - Does not have to be at high plant densities
- Cropper
  - Plants below cutting height
- Livestock
  - Grazing opportunity?

Drought

- Green leafy plant
  - Leaves cool faster than air
    - Moisture condenses on leaf surface
      - Rolls off
      - Plant absorbs the moisture
        - Eventually released as root exudate

Drought

- Tap rooted plants
  - If mycorrhizal
    - Shares nutrients and water with other plants
  - During rain events rain is funnelled down roots to hydrate soil deeper

Seeding next year

- Managing residue
  - Relates back to carbon:nitrogen ratio
    - Tighter ratio -> faster breakdown
  - Longer residue causes issues with tine drills
    - Wrapping
  - Add legumes, brassicas, vegetative plants


Other issues?

Healthy systems

- Healthy systems
  - Low or no external inputs
  - Stable soil aggregates
  - Plant diversity replaces weeds
  - High Brix plants
  - Low mineral consumption by livestock
  - Water cycle functions

Helping soils repair

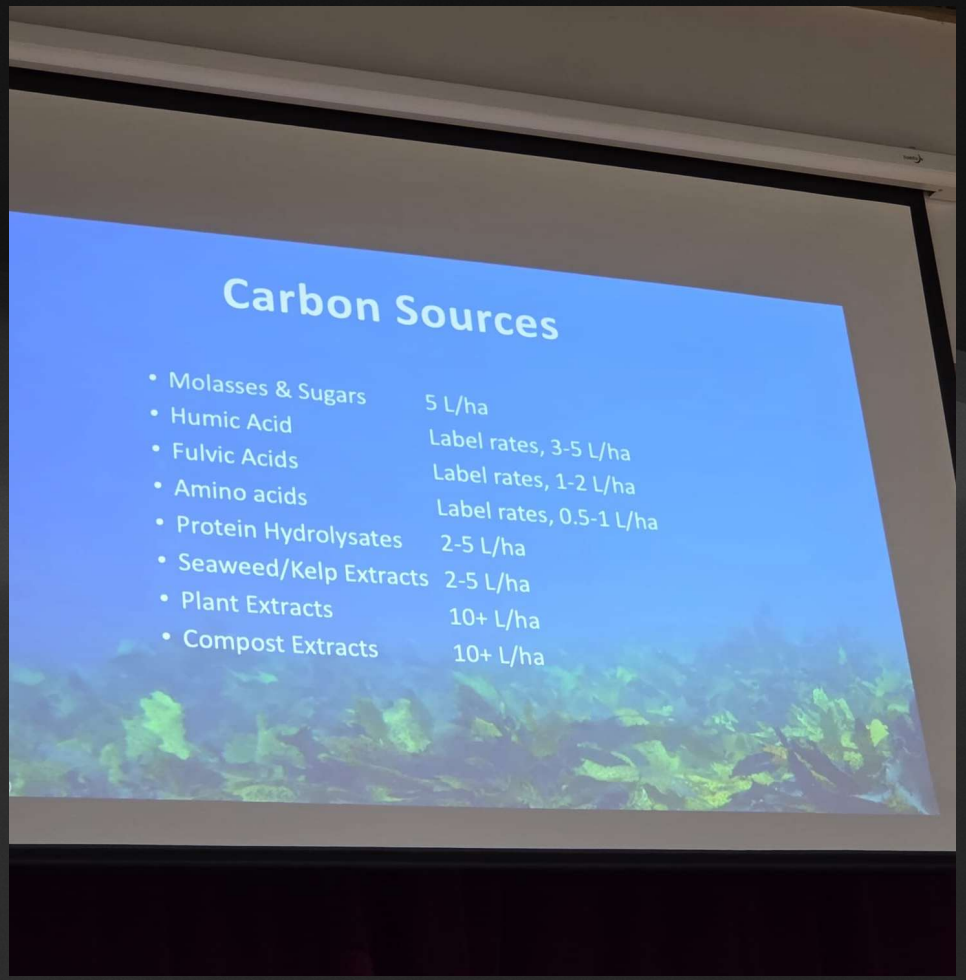
- Compost
  - Broadscale
  - On seed
- Compost extract
  - On seed
  - In furrow
  - Foliar

Helping soils repair

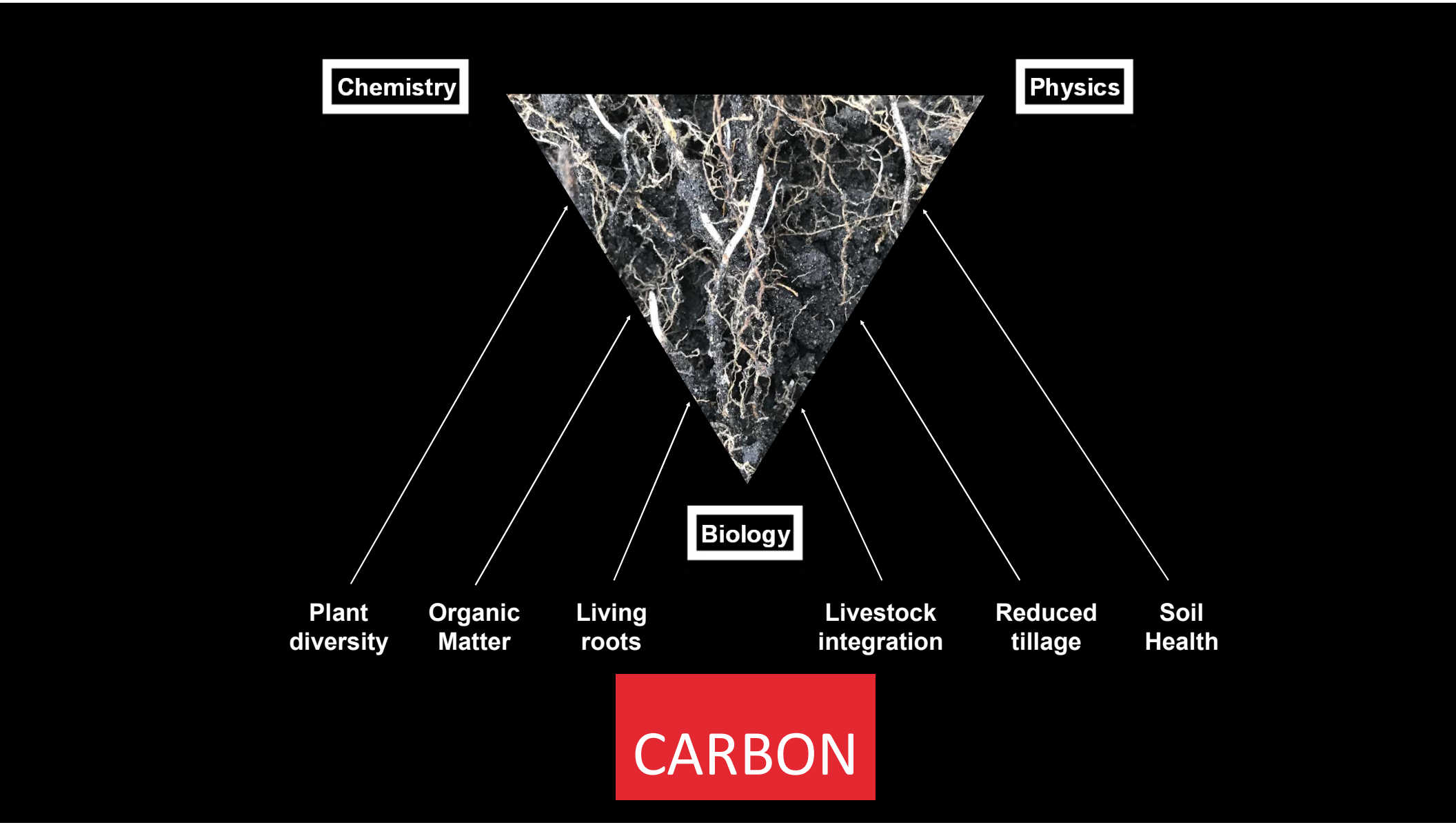
- Carbon based fertility
  - Feed pellets
- Kelp
- Molasses
  - Non sulfonated
- Sugar
- Wood chips
  - May need to be aged

Helping soils repair

- Support soil health principles
- Increase liquid carbon cycle
- Improve water cycles
- Work within constraints
- Work within context
- Reduce reliance, increase resilience



Your situation…..


Chemistry
Physics
Biology
Plant diversity
Organic Matter
Living roots
Livestock integration
Reduced tillage
Soil Health
CARBON

Kevin R. Elmy, PAg

WhatsApp 1-306-621-8784

kevin@covercrops.ca

Social Media @KevinElmy

www.covercrops.ca