

*Nurturing nature's abundance*

# Transition to Biological Farming: What we have learned to date

Burren Winterage School 24<sup>th</sup> October 2019

# Danú Farming Group

David Wallis, farmer: Team Leader

Dave Beecher, Engineer: Field Officer

John Mc Hugh, farmer: Coordinator

Alan Mooney, farmer & Vet: Coordinator

## Farmers:

Alfie Beattie, Dairy, Kildare

Michael Costello, Beef, Limerick

Norman Dunne, Tillage, Kildare

Jonny Greene, Tillage, Kildare

Graham Harris, Tillage/Sheep, Kildare

Stuart Rogers, Forage/Tillage, Meath

Andrew Bergin, Tillage, Kildare

Colman Deely, Dairy, Limerick

Colm Flynn, Tillage, Kildare

Nigel Gillis, Tillage, Kildare

Kenny Roberts, Dairy, Kildare

Donal Sheehan, Dairy, Cork

## Consultants:

Robbie Byrne, Precision Nutrition Ltd. Experienced Biological Farming Advisor.

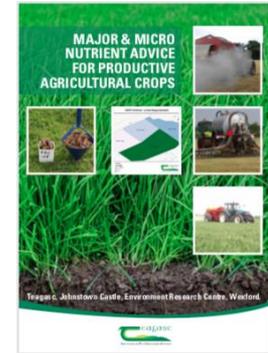
James McDonnell, Teagasc, Farm Financial Management Specialist.

Christine Jones, PhD, Australia. World Renowned Expert in Soil Carbon Sequestration.

# Trial Plots

All 12 farms have set aside 4 plots for the trials. Each plot will be monitored and evaluated over five years. Min plot size is 1Ha, max 2ha.

**Plot 1** **Control:** Teagasc Guidelines & Recommendations (“Green Book”) will be implemented over the 5 years of the trial.

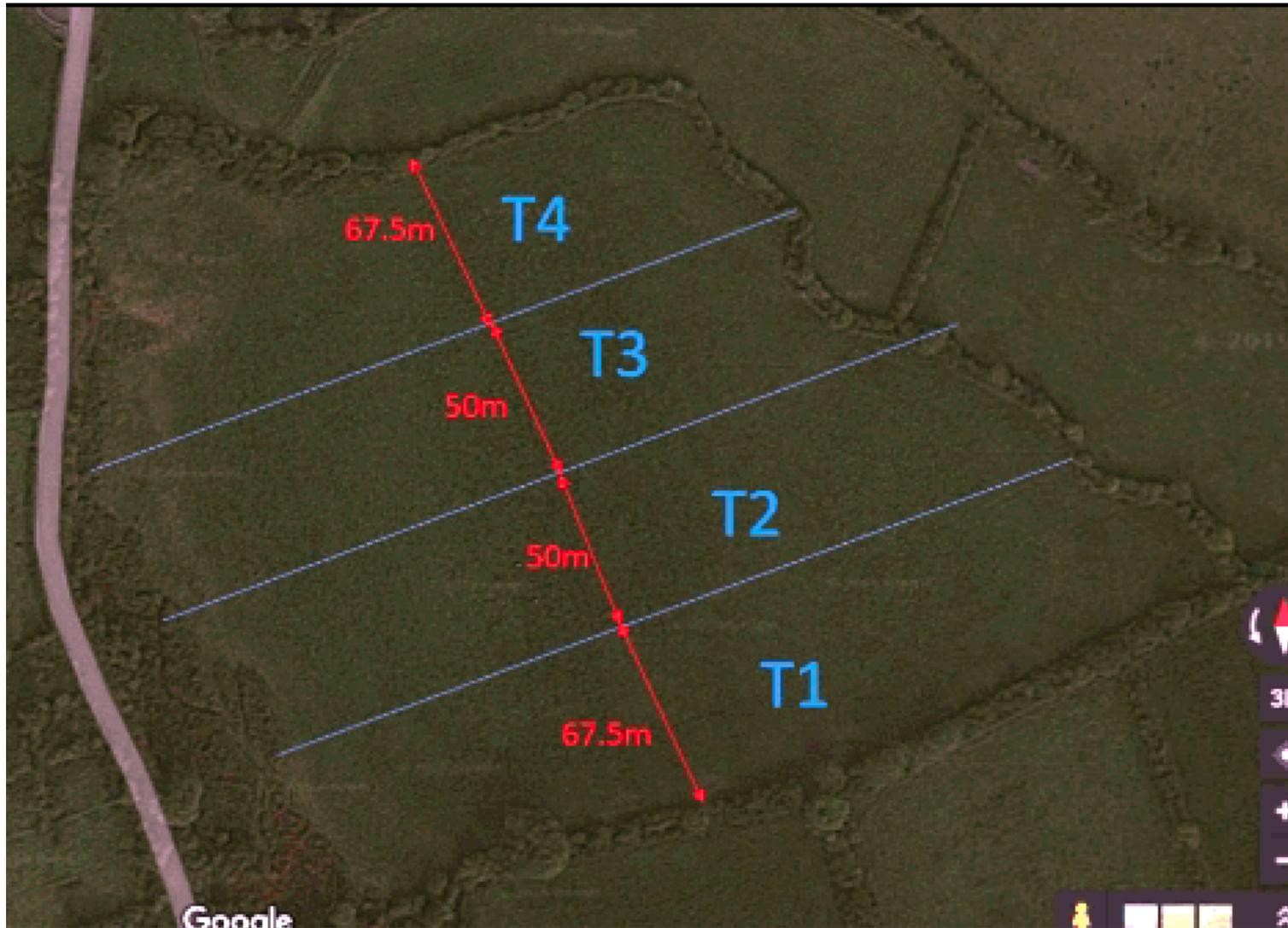


**Plot 2** As Control, But All Artificial Nitrogen & Acid Phosphate Buffered with a carbon source: Molasses, Humates, Sugar, Compost, Slurry, FYM.

**Plot 3** Full Mineral Balancing over the period of the trial. Strategic use of Foliars will occur when considered appropriate: this may be most immediately relevant for a soil that is very imbalanced.

**Plot 4** Full Mineral Balancing + Selected Biological Inoculants/Treatments and Nutrient Foliars over the period of the trial.

## C. Deely Trial Plots Layout



# Some Field Tools



## OBSERVATIONS



Root mat 10cm thick sitting on a 10cm gley layer\* (anaerobic smell). Subsoil light brown, sandy texture, very friable and free draining.



Iron oxide found around roots in all areas especially in T3.



Good Diversity of Earthworms

# OBSERVATIONS

Surface very sticky: looks like an oil slick after heavy rain.

Slugs and grubs in all areas. Good diversity of worms.

Water remained in most infiltration rings for 1 hr or more and just 9.5 mins in subsoil at a depth of 35cm in T4.

Docks sap was clear in colour and gave a very sharp line when viewed through the refractometer.

Grass sap dark green and faint line in refractometer, buttercup sap brown/green also faint line in refractometer.

Root mat 10cm thick sitting on a 10cm gley layer\* (anaerobic smell). Subsoil light brown, sandy texture, very friable and free draining.



# BASELINE DATA

Farm	Colman Deeley			Date	13/02/19	
Test	Units	T1	T2	T3	T4	Average
Soil Temp	°C	8.0	8.1	8.4	8.5	8.3
Air Temp	°C	10.0	10.5	11.5	9.5	10.4
BRIX PR Grass		5.5	5.0	5.2	6.0	5.4
BRIX Dock		3.0	4.0	5.0	4.0	4.0
BRIX Buttercup		6.0	6.0	6.2	7.0	6.3
Time	h.min	11.00	13.00	16.27	16.57	
Weather		Dull	Dull	Cloudy	Cloudy	
Root Mat Depth	cm	10	8	10	10	9.50
Topsoil Depth	cm	10	10	10	10	10.00
Subsoil Location*	cm	20	18	20	20	19.50
Root Mat VESS	No	2.0	2.0	3.0	2.0	2.25
Topsoil VESS	No	2.0	3.0	3.5	3.0	2.88
Average VESS	No	2.00	2.56	3.25	2.50	2.58
Earthworms (E)	No	12	8	8	11	9.75
Surface E	No	0	0	0	0	0.00
Root Zone E	No	9	6	7	9	7.75
Burrowing E	No	3	2	1	2	2.00
Juvenile E	No	14	22	15	10	15.25
Penetrometer						
200 psi	cm	9	8	10	10	9.25
300 psi	cm	24	21	20	18	20.75
Above 300 psi	cm	70	70	70	70	70.00
Water Infiltration:						
Bare Ground	minutes	90+	60+	60+	60+	67.5
Grass	minutes	90+	90+	51	60+	73.0
Docks	minutes	90+	120+	58	60+	82.0
Av. Infiltration	minutes	90+	90+	60+	60+	75.0

\*10cm gley layer below topsoil

# Permanent Pasture



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 9122781  
 Company Reg. No.: 9122781  
 VAT No. 194 9672 47

Client: Danu Farming Group  
 Contact: David Beecher

Date: 28/01/2019  
 Sample ID: SBL1958 Danu CD-T1  
 Crop: Grass

## Soil Microbiology Report

### Organism Biomass

Analysis	Units	Result	Guideline	Low	Optimal	High
Moisture content	%	40	15 - 55	[Progress bar]		
Active Bacteria	µg/g	32	30 - 150	[Progress bar]		
Total Bacteria	µg/g	694	300 - 600	[Progress bar]		
Active Fungi	µg/g	11	30 - 150	[Progress bar]		
Total Fungi	µg/g	324	300 - 600	[Progress bar]		
Hyphal Diameter	µm	3.0	>2.5	[Progress bar]		

### Organism Ratios

Analysis	Result	Guideline	Low	Optimal	High
Active/Total Bacteria	0.05	0.1 - 0.5	[Progress bar]		
Active/Total Fungi	0.03	0.1 - 0.5	[Progress bar]		
Active Fungi/Active Bacteria	0.34	1.0 - 2.0	[Progress bar]		
Total Fungi/Total Bacteria	0.47	1.0 - 2.0	[Progress bar]		

### Protozoa

Analysis	Units	Result	Guideline	Low	Optimal	High
Flagellates	No/g	9554	5000-100000	[Progress bar]		
Amoebae	No/g	2247	5000-100000	[Progress bar]		
Ciliates	No/g	231	0 - 500	[Progress bar]		

### Nematodes

Analysis	Units	Result	Guideline	Low	Optimal	High
Total Nematodes	No/g	6	10 - 20	[Progress bar]		
Nematode types	Fungal feeders 20%, Bacterial Feeders 63%, Predators 0%, Plant parasitic 10%, Juvenile 7%					

### Mycorrhizal Colonisation

Analysis	Units	Result	Guideline	Low	Optimal	High
Ectomycorrhizae	%	0	10 - 50	[Progress bar]		
Endomycorrhizae	%	9	10 - 50	[Progress bar]		

### Potential Nitrogen in Soil

Nitrogen (N)	kg/ha	63 - 94	Potentially cycled for a period of 3-6 months*			
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\*Please note that this value is related to the microbiological activity and is not a chemical measure of nitrogen.

# Tillage: Winter Cover Crop



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 VAT No. 194 9672 47

Client: Danu Farming Group  
 Contact: David Beecher

Date: 28/01/2019  
 Sample ID: SBL1910 Danu AB-T1  
 Crop: Cover crop

## Soil Microbiology Report

### Organism Biomass

Analysis	Units	Result	Guideline	Low	Optimal	High
Moisture content	%	21	15 - 55	[Progress bar]		
Active Bacteria	µg/g	42	30 - 150	[Progress bar]		
Total Bacteria	µg/g	949	300 - 600	[Progress bar]		
Active Fungi	µg/g	30	30 - 150	[Progress bar]		
Total Fungi	µg/g	260	300 - 600	[Progress bar]		
Hyphal Diameter	µm	3.0	>2.5	[Progress bar]		

### Organism Ratios

Analysis	Result	Guideline	Low	Optimal	High
Active/Total Bacteria	0.04	0.1 - 0.5	[Progress bar]		
Active/Total Fungi	0.12	0.1 - 0.5	[Progress bar]		
Active Fungi/Active Bacteria	0.72	1.0 - 2.0	[Progress bar]		
Total Fungi/Total Bacteria	0.27	1.0 - 2.0	[Progress bar]		

### Protozoa

Analysis	Units	Result	Guideline	Low	Optimal	High
Flagellates	No/g	7314	5000-100000	[Progress bar]		
Amoebae	No/g	217	5000-100000	[Progress bar]		
Ciliates	No/g	352	0 - 500	[Progress bar]		

### Nematodes

Analysis	Units	Result	Guideline	Low	Optimal	High
Total Nematodes	No/g	4	10 - 20	[Progress bar]		
Nematode types	Fungal feeders 23%, Bacterial Feeders 63%, Predators 0%, Plant parasitic 7%, Juvenile 7%					

### Mycorrhizal Colonisation

Analysis	Units	Result	Guideline	Low	Optimal	High
Ectomycorrhizae	%	0	10 - 50	[Progress bar]		
Endomycorrhizae	%	0	10 - 50	[Progress bar]		

### Potential Nitrogen in Soil

Nitrogen (N)	kg/ha	31 - 63	Potentially cycled for a period of 3-6 months*			
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\*Please note that this value is related to the microbiological activity and is not a chemical measure of nitrogen.

# Baseline Data: Soil Bioassay

# BASELINE DATA: COMPREHENSIVE SOIL NUTRIENT TEST

## DANÚ FARMING GROUP

Name	Colman Deely
Sample	T1
Sample Date	18/12/2018
Previous Crop	Grass
Current Crop	Grass
Soil Type	Loam
Dry Bulk Density	
% Sand, Silt, Clay	

TEC	12.24	Organic Matter %	12.5	6 to 10
CEC	9.00	Labile Carbon ppm	998	1200
pH	6.2	Total Carbon %	6.1	??
		Total Nitrogen %	0.389	??
		Total C : N ratio	15.7 to 1	10 to 12
		Nitrate N (ppm)	0.11	10 - 20 ppm
		Ammonium N (ppm)	1.96	10 - 20 ppm
		Estimated N Release: Kg/Ha	134 Kg N/Ha	

	Soluble ppm (Modified Morgans)			Available ppm (Mehlich 3)			Total ppm (Aqua Regia)
	Current	Index	Ideal	Current	Ideal	+/- Kg/Ha	Current
Phosphorus (P)	3.32	2	8	43	35 to 70		1084
Potassium (K)	99	2	120	209	#		593
Magnesium (Mg)	133	4	150	140	#		1771
Calcium (Ca)	1110	n/a	1000-2000	1435	#		2104
Sodium (Na)				37	#		161
Sulphur (S)				15	30 to 50		537
Boron (B)				0.4	1.5 to 2		2.86
Iron (Fe)				397	40 to 200		24900
Manganese (Mn)				53	30 to 100		324
Molybdenum (Mo)	(Total test) target is 0.7 to 1.2						1.19
Copper (Cu)				3.6	2.5 to 7		17
Zinc (Zn)				4.65	5 to 10		62
Cobalt (Co)				0.28	1.5 to 2		8.2
Nickel (Ni)	(Total test)						25
Chromium (Cr)	(Total test)						25
Aluminium (Al)				997	n/a		12200
Selenium (Se)				<0.01	??		0.92
Silicon (Si)	(Hot CaCl <sub>2</sub> extraction)			10.9	>50		
Molybdate	(Ammonium Oxalate extraction)			0.2	??		
Chloride (Cl)	(Water extraction)			323	1x to 2x of Na		
Iodine (I)	(Hot Water extraction)			< 0.01	??		

Base Cation Saturation Ratio %		
	Current	Ideal
Calcium	58.60	68.00
Magnesium	9.55	12.00
Potassium	4.38	3 to 5
Sodium	1.31	0.5 to 1.5
Hydrogen	26.15	10.00

RATIOS		
	Current	Ideal
(BCSR%) Ca to Mg ratio	6.1 to 1	5.67 to 1
(BCSR%) Mg to K ratio	2.2 to 1	3 to 1
(ppm) * K to Mg ratio	1.5 to 1	1 to 1
(ppm) * P to S ratio	2.87 to 1	1 to 1
(ppm) * P to Zn ratio	9.2 to 1	10 to 1
(ppm) * Fe to Mn ratio	7.5 to 1	< 2 to 1
(ppm) * Ca to B ratio	3,589 to 1	1,000 to 1

**Comments:**  
\* From Mehlich 3 "current" results. # Will be entered when soil dry bulk density figures available

# PLANT SAP ANALYSIS

Farm	CD	CD	CD	CD	CD	CD	CD	CD
Date	16/05/2019	16/05/2019	16/05/2019	16/05/2019	29/05/2019	29/05/2019	29/05/2019	29/05/2019
Location	P1	P2	P3	P4	P1	P2	P3	P4
Time	11.45	11.35	11.25	11.15	12.55	12.52	12.48	12.45
Weather	Sunny	Sunny	Sunny	Sunny	Light Rain	Light Rain	Light Rain	Light Rain
Crop	Rye Grass	Rye Grass	Rye Grass	Rye Grass	Rye Grass	Rye Grass	Rye Grass	Rye Grass
Growth Stage	1st leaf	1st leaf	1st leaf	1st leaf	2-3 Leaf	2-3 Leaf	2-3 Leaf	2-3 Leaf
Leaf Sampled	1st leaf	1st leaf	1st leaf	1st leaf	2-3 Leaf	2-3 Leaf	2-3 Leaf	2-3 Leaf
Air Temp (°C)	15.8	15.8	15.8	15.8	16.7	16.7	16.7	16.7
Soil Temp (°C)	14.3	13.9	14.1	14.1	14.7	15.1	15.0	14.9
Soil EC (mS/cm)	0.10	0.15	0.13	0.12	0.25	0.18	0.20	0.24
BRIX	3	3.5	2	2	3	3	4	3
Sap Colour	Pale green	Pale green	Pale green	Brown/green	Pale Brown	Pale Brown	Pale Brown	Pale Brown
Bubbles	No	No	No	No	No	No	No	No
Line	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Blue over?	Blue/white	Blue/white	Blue/white	Blue/white	Blue/White	Blue/White	Blue/White	Blue/White
pH (ppm)	6.14	6.07	6.22	6.13	6.04	6.02	5.95	6.06
NO <sub>3</sub> <sup>-</sup> (ppm)	210	190	190	190	270	250	300	260
Ca <sup>2+</sup> (ppm)	190	180	170	170	300	380	350	400
K <sup>+</sup> (ppm)	1,800	1,700	1,700	1,900	1,700	2,500	2,000	2,500
EC (mS/cm)	7.18	7.42	6.61	6.92	7.03	7.75	8.13	6.05
General Notes:								
Accuracy:	Sap (pH ± 0.01), (NO <sub>3</sub> <sup>-</sup> ± 10%), (Ca <sup>2+</sup> ± 20%), (K <sup>+</sup> ± 10%), (EC ± 2%)				Sap (pH ± 0.01), (NO <sub>3</sub> <sup>-</sup> ± 10%), (Ca <sup>2+</sup> ± 20%), (K <sup>+</sup> ± 10%), (EC ± 2%)			
Field Notes:	After 2nd grazing Drainage pipe installed across all plots				Going to seed Grass wet from rain, all samples dried with t-towel			



“Species Rich Herbal Mix finally going in today”.

C.D. 08/08/19



“Recent photo of Danú trial: Over-Seeding in the foreground, Disced next and Ploughed in the background”. C.D. 22/10/19

# Plant Sap Analysis P1

Plant sap sample 20190830 1027

Sample date: 29-8-2019

Name: Precision Nutrition Ltd.  
Address: 21 Ardee Business Park  
R92CA26 County Louth  
Ireland

Location/plot: Kerry Roberts  
Cultivation: Grass T1  
Crop: Grass  
Plant part: leaf (young)

Remarks

Mineral		Current level			
Total Sugars	%	0,3			
pH		7,8			
EC	mS/cm	27,4			
K - Potassium	ppm	6340			
Ca - Calcium	ppm	323			
K / Ca		19,65			
Mg - Magnesium	ppm	162			
Na - Sodium	ppm	109			
NH4 - Ammonium	ppm	807			
NO3 - Nitrate	ppm	468			
N in Nitrate	ppm	106			
N - Total Nitrogen	ppm	3231			
Cl - Chloride	ppm	2732			
S - Sulfur	ppm	412			
P - Phosphorus	ppm	186			
Si - Silica	ppm	37,9			
Fe - Iron	ppm	1,20			
Mn - Manganese	ppm	0,83			
Zn - Zinc	ppm	1,76			
B - Boron	ppm	0,30			
Cu - Copper	ppm	0,72			
Mo - Molybdenum	ppm	0,05			
Al - Aluminium	ppm	<0,50			

Consult your advisor for appropriate fertilizer recommendations.

01\_20\_01019

# Plant Sap Analysis P2

Plant sap sample 20190830 1028

Sample date: 29-8-2019

Name: Precision Nutrition Ltd.  
Address: 21 Ardee Business Park  
R92CA26 County Louth  
Ireland

Location/plot: Kerry Roberts  
Cultivation: Grass T2  
Crop: Grass  
Plant part: leaf (young)

Remarks

Mineral		Current level			
Total Sugars	%	0,6			
pH		7,2			
EC	mS/cm	19,9			
K - Potassium	ppm	6093			
Ca - Calcium	ppm	542			
K / Ca		11,25			
Mg - Magnesium	ppm	194			
Na - Sodium	ppm	240			
NH4 - Ammonium	ppm	832			
NO3 - Nitrate	ppm	25			
N in Nitrate	ppm	6			
N - Total Nitrogen	ppm	2197			
Cl - Chloride	ppm	3272			
S - Sulfur	ppm	481			
P - Phosphorus	ppm	256			
Si - Silica	ppm	38,3			
Fe - Iron	ppm	1,04			
Mn - Manganese	ppm	0,68			
Zn - Zinc	ppm	1,95			
B - Boron	ppm	0,33			
Cu - Copper	ppm	1,31			
Mo - Molybdenum	ppm	<0,05			
Al - Aluminium	ppm	<0,50			

Consult your advisor for appropriate fertilizer recommendations.

01\_20\_01019

## Plant Sap Analysis P3

Plant sap sample 2019 0830 1029

Sample date: 29-8-2019

Name: Precision Nutrition Ltd.  
Address: 21 Ardee Business Park  
A92CA26 County Louth  
Ireland

Location/plot: Kenny Roberts  
Cultivation: Grass T3  
Crop: Grass  
Plant part: leaf (young)

Remarks

Mineral	%	Current level		
Total Sugars	%	0,8		
pH		6,8		
EC	mS/cm	22,2		
K - Potassium	ppm	6801		
Ca - Calcium	ppm	641		
K / Ca		10,61		
Mg - Magnesium	ppm	325		
Na - Sodium	ppm	31,3		
NH4 - Ammonium	ppm	71,9		
NO3 - Nitrate	ppm	<20		
N in Nitrate	ppm	<5		
N - Total Nitrogen	ppm	186,7		
Cl - Chloride	ppm	470,9		
S - Sulfur	ppm	624		
P - Phosphorus	ppm	31,5		
Si - Silica	ppm	50,7		
Fe - Iron	ppm	1,88		
Mn - Manganese	ppm	1,09		
Zn - Zinc	ppm	2,14		
B - Boron	ppm	0,39		
Cu - Copper	ppm	0,81		
Mo - Molybdenum	ppm	0,08		
Al - Aluminium	ppm	<0,50		

## Plant Sap Analysis P4

Plant sap sample 2019 0830 1030

Sample date: 29-8-2019

Name: Precision Nutrition Ltd.  
Address: 21 Ardee Business Park  
A92CA26 County Louth  
Ireland

Location/plot: Kenny Roberts  
Cultivation: Grass T4  
Crop: Grass  
Plant part: leaf (young)

Remarks

Mineral	%	Current level		
Total Sugars	%	1,9		
pH		6,3		
EC	mS/cm	15,4		
K - Potassium	ppm	5779		
Ca - Calcium	ppm	965		
K / Ca		5,99		
Mg - Magnesium	ppm	332		
Na - Sodium	ppm	38,7		
NH4 - Ammonium	ppm	224		
NO3 - Nitrate	ppm	<20		
N in Nitrate	ppm	<5		
N - Total Nitrogen	ppm	171,3		
Cl - Chloride	ppm	2646		
S - Sulfur	ppm	826		
P - Phosphorus	ppm	566		
Si - Silica	ppm	37,0		
Fe - Iron	ppm	2,27		
Mn - Manganese	ppm	2,08		
Zn - Zinc	ppm	3,27		
B - Boron	ppm	0,58		
Cu - Copper	ppm	0,88		
Mo - Molybdenum	ppm	0,14		
Al - Aluminium	ppm	<0,50		



“P4 on left, P3 on right. First time I noticed a distinct colour difference”. C.F. 27/09/19



“Started harvesting Danú beans: batches out for weighing”. N.G.  
18/09/19



“I have a right selection of different fungi coming in P3 & P4. No edibles yet!” C.F.



“Ground under wheat is a mass of worm casts: moment of cheer in a grim harvest”  
A.B.

## FARMER COMMENTS

“Big changes for me on the farm this year: oats grown on trial plots showed what a different approach could achieve with a focus on soil balance and letting nature work. *Oats grown with No herbicide or fungicide, suppressed weeds on its own and didn't suffer disease problems.* There was a difference in yield between P3, P4 (higher) and P1, P2 due to recommendations”. [G.H.](#)

“OBSERVATION has being the key in last year.. There is generally more than one contributing factor when assessing a problem. Paying more attention to weeds and what signs they are telling us: compaction, excess nitrates, deficiencies etc Use of tools to measure readings (sap analysis, brix) and get ourselves trained up on those readings *so we can intuitively pick up on those results without the need of the tools*”. [N.D.](#)

“High Organic Matter/Humus means you can literally do what you like and you will get away with it. Compost is a special product and perfecting and tailoring this product will be the next step. *I hate slurry and we very quickly need to square the circle of doing something with it.* I reckon in 2 years time I will NOT apply any chemical N as I see it doing little or nothing for me”. [M.C.](#)

## FARMER COMMENTS

“What I’m learning is when planting a seed, soil temp has to be up and consistent. Inoculate the seed before or when planting, making sure seed gets good contact with soil ... mothers milk ... *if plant doesn’t get a good start in life , it is very hard to recover as it grows ....* also feeding soil with biology and oxygen is key to cracking the nut for me”. S.R.

“For me, Danú is about observing, examining, and questioning the Status Quo: identifying possible pathways towards a Healthier Ecologically based farm, and using our trials to find answers”. C.D.

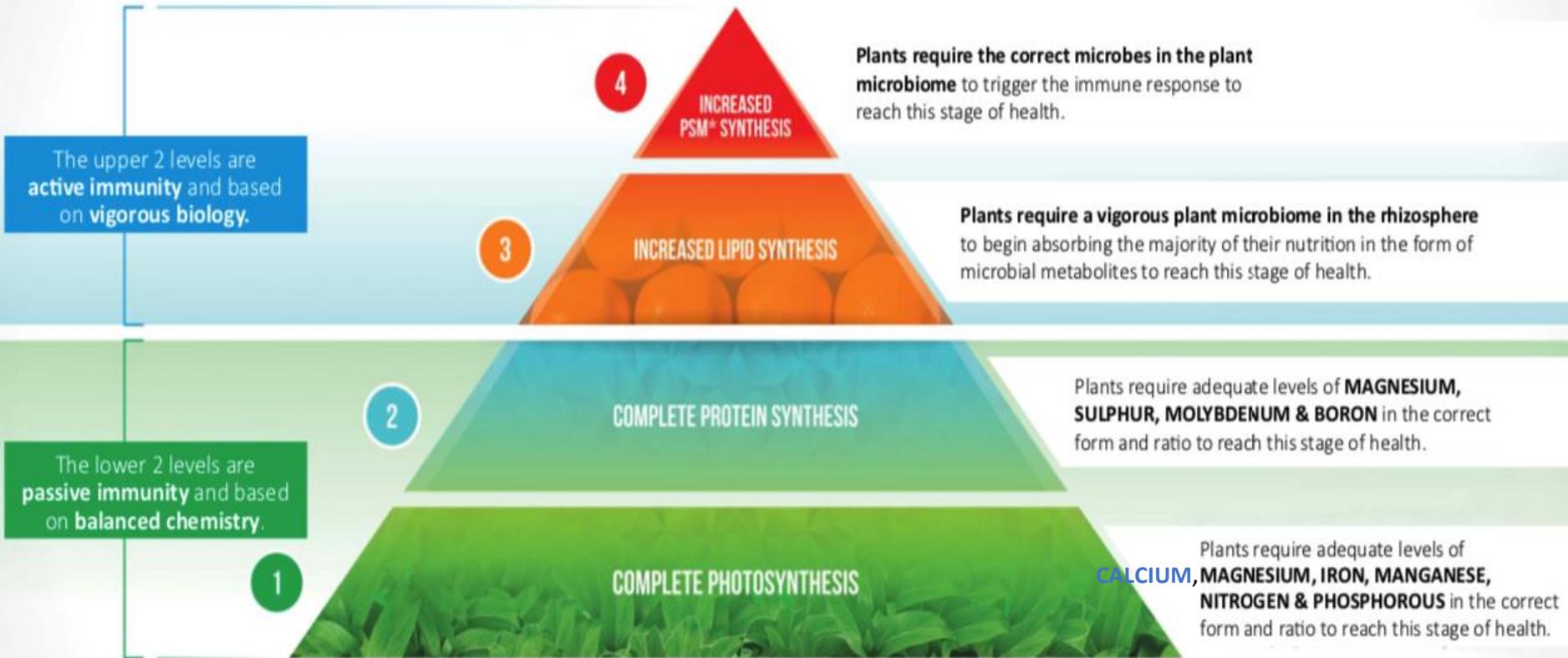
“My winter barley with 120 units N and targeted minerals, some N and P fixing biology yielded exactly the same as Green Book recommendations at 160 units N. **Targeted minerals will control Aphids and Mildew in peas.** Knowledge is key. Sharing it opens the door”. C.F.

“Fluid movement of ideas and creating a lot more feedback on Observation, Responses and Results during the growing season is a **1+1=3** type symbiotic relationship from the soil up”. R.B.

“In spite of problems getting sorted at the start, my bean plots have thrown up a couple of interesting observations: Docks seem to be much worse in plot 1 in spite of the fact that plot 1 looked by far the best in terms of yield, plot 3 beat it marginally, and with lower moisture content. Think margins will be about same ...oh yea.. *and beans yielded fine (1.8t) in a mass of weeds!*”. N.G.

“What I found is that even though my soils are high in Iron the plant sap pH reading is low due to the iron being in an oxidized state. When iron sulphate was applied it didn't make much of a difference but when it was chelated with fulvic acid readings started to significantly improve” K.R.

“Slowing Down and looking at soils and crops in minute detail is literally refreshing. *Collaboration in a challenging and constructive group is a great way to learn and expand horizons.* Some good laughs too”. A.B.



**“Healthy plants can become completely resistant to diseases and insects.”**

- John Kempf -

## Some Thoughts:

- 1... We need to be careful with the “Numbers”
- 2... “See What you Look At”. *Carey Reams*
- 3... “I can see very little change after the first year”
- 4... Is Biological Farming too Complicated?
- 5... The quickest way to improve Soil Biology: Species Diversity and Maintaining Green Covers
- 6... Its Complex and Simple at the same time!
- 6... **Output per Hectare v's Profit per Hectare?**

