TITLE OF PROJECT:

An Investigation into the use of natural compost vs Slurry and synthetic fertilisers in a community garden.

By : Aine O’D, Lucy M, Emma C and Jenna H

Judges Page

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Abstract/executive summary

Ireland has a large agricultural community. Overuse of cattle slurry and synthetic fertilisers is causing a significant pressure on our water systems, impacting over 1000 of our water bodies. This is caused by runoff from the land (EPA.ie).

Last March, the Biodiversity Officer in our local Community Garden approached us with a problem. The soil tests showed potassium was greatly depleted, also the vegetable garden area had no worms. He did not want to use slurry or synthetic fertilisers. We were keen to research this problem and find the most natural solution. We are living in an agricultural area so we hope our research will encourage local farmers to adopt natural ways to nourish their land.

This is the location of Pairc a Tobar

We decided to set up 4 test beds last March using horse manure, seaweed compost, a biological compost, and a mixture of all 3. A control bed was left untreated. Horse manure gave the best growth for onions, potatoes, carrots, and beans. All composts improved potassium levels. We won an award for our project in May at the Globe Ireland National Competition and presented the findings at the European Globe Student Conference in Prague. We want to extend the study now to research the runoff water

quality of each natural fertilizer. We will also compare this with slurry and synthetic runoff in soil from the same source.

We wanted to discover which natural compost a) gives the best growth of vegetables, b) increases Potassium most efficiently and c) is best at encouraging worms

We set up four test beds -horse manure compost, seaweed compost, biological compost, and a mixture of all three. A control bed was left untreated. We divided the bed into four areas and

planted beans, potatoes, carrots, and onions. We monitored growth over the next 16 weeks and recorded soil temperature and pH.

We also set up an apparatus to test the runoff from the soil that was used with our fertilisers vs slurry.

We wanted to bring this soil back to life as Pairc an Tobar, our community garden is fundamental in our small community of Rosscarbery. In rosscarbery, we are surrounded by nature. There are many local farmers, and farming is at the core of our local economy and community. We made contact with many local farmers and discovered that many of them used slurry or synthetic fertilisers as their fertilisers. This concerned us as we are aware of the environmental dangers of these synthetic chemicals.

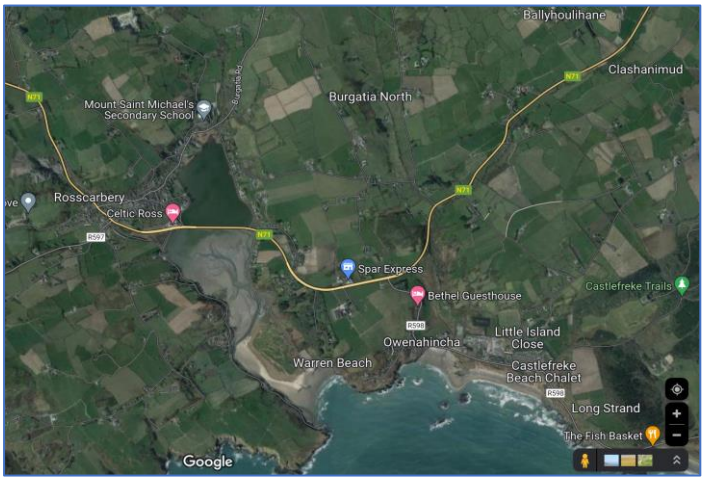
We believed that we could prove that these chemicals were not necessary to restore the soil in the community garden and wondered if these principles could be applied on a wider scale.

We entered our initial project in the Globe Competition and went to Prague to participated in the Globe student conferrence, where we shared our ideas on how we could play our part in helping the planet, while learning how we could apply our innovative ideas in Rosscarbery.

The results of our soil bed test in Pairc an Tobair showed that while different vegetables grew best in different composts, we

discovered Horse manure compost gave the best all-round results in growth.

Introduction



Our school is situated in West Cork. Rosscarbery is a seaside village with a strong agricultural economy. Our local biodiversity officer was looking for some TY students to help with a project in our local Community Park. We volunteered and are so grateful that we got this opportunity.

We met with our TEAGASC advisor John Crowley who suggested we should test samples of the soil in our community garden as crop quality was poor last year. We discovered that the soil is low in potassium. The local Biodiversity Officer, John O'Callaghan also reported a lack of worms in the soil where the vegetables were to be cultivated. This was problematic as the community garden is a major source of pride in Rosscarbery and the lack of success in farming can lead to the people involved losing motivation.

We decided to investigate natural composts to find which is best to improve potassium content and encourage worms to colonise the beds.

We chose natural composts as we are aware that there are many negative environmental effects associated with artificial fertilisers, and most significantly we did not want to pollute our local waterbodies.

Pairc a Tobair is located just up the hill from the lagoon, which has been frequently infected with E. coli. We spoke with Christopher O Sullivan TD who is FF spokesperson for Coastal Communities. He told us he is working to improve the conditions of the waterbodies. This, along with the Globe online webinars and discussions we attended at the Rosscarbery Heritage Launch really helped to shape our understanding of the importance of clean waters, and we made the realisation that unnatural fertilisers make a negative effect.

This inspired us to extend the study to look at soil runoff from our natural fertiliser and compare it to Slurry runoff.

The lack of potassium in the beds concerned us as we are aware that potassium is necessary for disease resistance, regulation of

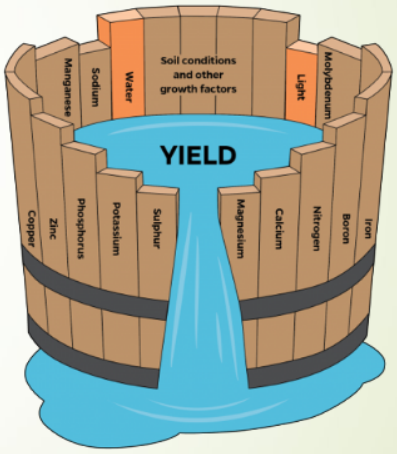
transpiration and to improve the overall quality of plants and fruits, which is vital in a vegetable garden.

We are aware of liebegs law of the minimum

Liebigs Law Of The Minimum

Liebig's law of the minimum states that if one of the essential plant nutrients is deficient, plant growth will be poor even when all other essential nutrients are abundant.

As our soil is currently lacking potassium, plant growth will be poor even if all other nutrients are sufficient, as they are.



We know that the soil is foundation of all plant life and therefore human life, and it must be sufficient in the nutrients it contains. With climate change, world hunger and loss of biodiversity catastrophe looming, new practices must be developed if the earth is to survive for future generations.

Literature review

While researching and carrying out our project we understand the importance of having the presence of worms and potassium in our soil while also using natural fertilisers e.g. biological manure, rather than synthetic fertilisers or slurry.

To expand our knowledge of soil and its ecosystem we did a lot of research using several sources. We used websites, read books and textbooks, spoke to our Teagasc advisor and local gardeners from Pairc an Tobar, and watched documentaries.

Fiona Brennan, Teagasc Senior Research Officer, explains that soils harbour an incredible diversity of life. "In fact, soil is the most biodiverse habitat on the planet, with recent estimates indicating that it is home to 59% of biodiversity. This biodiversity underpins our food production systems and is vital for the delivery of a range of essential ecosystem services. The more we learn about this reservoir of biodiversity the more we understand its incredible importance for addressing the major societal challenges of our times." - TEAGASC news articles- A Worm Welcome 03/02/24

As for the worms.

Earthworms in soil

By their activity in the soil, earthworms have many benefits: increased nutrient availability, better drainage, and a more stable soil structure, all of which help improve farm productivity.
Worms feed on plant debris (dead roots, leaves, grasses, manure) and soil. Their digestive system concentrates the organic and mineral constituents in the food they eat, so their casts are richer in available nutrients than the soil around them. Nitrogen in the casts is readily available to plants. Worm bodies decompose rapidly, further contributing to the nitrogen content of soil.
New Zealand research shows that worm casts release four times

more phosphorus than surface soil. Worms often leave their nutrient-rich casts in their tunnels, making a good environment for plant root growth. The tunnels also allow roots to penetrate deeper into the soil, where they can reach extra moisture and nutrients. Earthworm tunnelling can help incorporate surface applied lime and fertiliser into the soil.

The extensive channelling and burrowing by earthworms loosens and aerates the soil and improves soil drainage. Soils with earthworms drain up to 10 times faster than soils without earthworms. In zero-till soils, where worm populations are high, water infiltration can be up to 6 times greater than in cultivated soils. Earthworm tunnels also act, under the influence of rain, irrigation and gravity, as passageways for lime and other material.

Earthworm casts cement soil particles together in water-stable aggregates. These are able to store moisture without dispersing. Research has shown that earthworms which leave their casts on the soil surface rebuild topsoil. In favourable conditions they can bring up about 50 t/ha annually, enough to form a layer 5 mm deep. One trial found worms built an 18-cm thick topsoil in 30 years.

Research into earthworms in New Zealand found earthworms introduced to worm-free perennial pastures produced an initial increase of 70–80% in pasture growth, with a long-term 25% increase: this raised stock carrying capacity. Researchers also found that the most productive pastures in the worm trials had up to 7 million worms per hectare, weighing 2.4 tonnes. There was a close correlation between pasture productivity and total worm weight, with some 170 kg of worms for every tonne of annual dry matter production.
We saw how earthworms mix and improve soil structure in an experiment to show the activity of earthworms in a soil. A wormery, filled with layers of sand, soil, clay chalk and leaf litter

were made, and we collected worms that were introduced to the wormery. We saw how the layers mixed over weeks and so introduced air and mixed minerals.
Earthworms are best suited to moist, warm soils (above 12°C) rich in organic matter and a pH close to neutral.
To conclude, it is crucial to have worms and other micro-organisms present in the soil. Soil with microorganism activity has an increased nutrient availability, better drainage, and a more stable soil structure, all of which help improve farm productivity. For this reason we will include a biological compost in our study.

Mineral Nutrients in Soil

Nutrient	Source	What it does
Nitrogen (N)	Bacterial action in plant residues (nitrification) produces ammonium or nitrate 2 Bacterial actions in root nodules on legumes produces soil nitrogen	Basis of plant proteins -helps plants to grow quickly and healthily
Phosphorus (1)	1 Mainly from phosphate fertilisers 2 Organic manures but not readily available as the soil holds P tightly to itself.	Produces vigorous growth and sturdy roots in seedlings Stimulates seed formation and flowering in mature plants
Sulphur (5)	Micro-organisms convert organic matter into sulphates which are available to plants 2 Weathered rock material is oxidised to produce sulphates	Component of plant amino-acids and proteins
Potassium (K)	Igneous parent rocks, such as granite. The nutrient is: 1 dissolved in the soil solution 2 loosely held on soil particles by electrical attraction	Promotes disease resistance Improves the quality of seeds and fruits Helps regulate transpiration

Nitrogen

Nitrogen is a key nutrient for growth and is available naturally in the soil. However, we normally supplement soil nitrogen with fertiliser nitrogen and/or by adding organic matter. Vegetables vary in the amount of nitrogen they require. Some of the legumes

such as peas and broad beans can fix their own nitrogen and do not require any.
Nitrogen levels were not tested as "Nitrogen is not normally tested for as the amount in the soil is very variable – its natural availability depends on biological processes and is also prone to leaching."

Magnesium

When our soil in Pairc an Tobar was initially tested in February 2024 we found that it had sufficient magnesium levels (213 mg/l). Magnesium is used in the plant as part of the chlorophyll molecule and can cause chlorosis of lower plant leaves if it is found to be deficient.

Phosphorus (P)

The soil in Pairc an Tobar had sufficient phosphorus levels (31.2 mg/l) in February 2024.Phosphorus is the second most important macronutrient, after nitrogen. Phosphorus is needed for optimum growth and reproduction, it is involved in the energy transfer in the plant, production and development of new cells, transfer of dna to new cells and seed formation and development. Phosphorus uptake is heavily dependent on pH of the soil, which is optimum for phosphorus uptake between pH 5 and pH 7.5. outside of these levels the phosphorus forms compounds that are insoluble in water and unavailable to plants. Our test results show that the soil pH was pH 6.4 which is within the optimum range.

Potassium levels (K)

Potassium is essential in all processes needed to sustain plant growth and reproduction. Plants deficient in potassium are less resistant to drought, excess water, and high and low temperatures. They are also less resistant to pests and diseases.

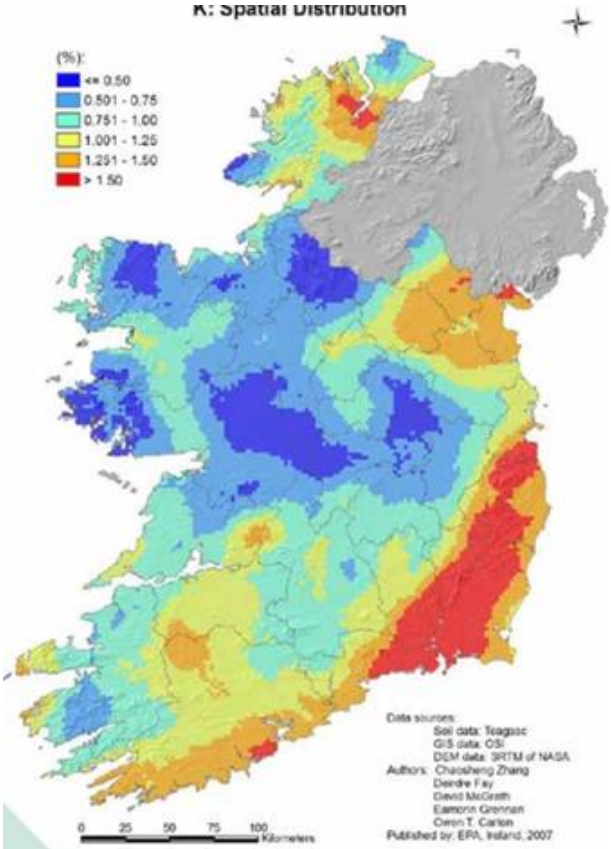
Note: potash is another word for potassium. It comes from plant ashes soaked in water in a pot, the primary means of manufacturing the potassium rich fertilisers before industrialization. (Fertiliser association of Ireland Feb. 2020)

Potassium is important in plants to carry out:

- Protein synthesis (the process where cells make proteins)
- Translocation of carbohydrates (translocation is the movement of materials from one area to another. In plants, plant translocation involves the movement of sugars from sources to sinks.)
- Regulation of plant stomata and water use
- Promotion of disease resistance
- Activation of plant enzymes

Potassium deficiencies can cause reduced crop yields, the scorching of leaves along leaf margins, slow growth, poorly developed root system, weak stalks, low sugar content in fruit and chlorosis (yellowing of leaves)

Potassium map of Ireland:



igure 1:- Total soil K map of Ireland (Source: - Geochemical Atlas of Ireland).

Our area is in the orange section 1.251-1.5 % which is adequate. Our soil is depleted, maybe due to a previous crop.

When potassium (K) is deficient, several processes are impaired. Low K inhibits enzyme activation, making plants more susceptible to fungal attack.

Impaired stomatal activity results in poor control over gas exchange, impacting on photosynthesis and water control, making plants more susceptible to stresses from drought, frost, water uptake, and soil salinity.

Low K also impairs proton exchange across membranes in chloroplasts, resulting in worsening symptoms under higher light intensity, according to the PDA.

Transport of photosynthates can also be impaired, resulting in a build-up of sugars (potentially worsening aphid attacks) and a reduction in protein and starch synthesis, lowering the plant's dry weight.

Potassium deficiency may first appear as deep green plants with shorter and fewer internodes and smaller leaves, flowed by the rapid development of necrotic spots along the margins and across leaf blades of recently matured leaves.

Potassium deficiency can cause changes in both individual plant organs and, collectively, the crop canopy. When leaf tissue becomes chlorotic or necrotic, it no longer reflects light the same way it did when it was healthy.

Visibly, leaves change from green to yellow or brown but changes also occur outside the visible spectrum.

These changes can be identified by measuring the reflectance of the crop using specific wavelengths which can then be linked back to the potassium status of the plants.

Runoff

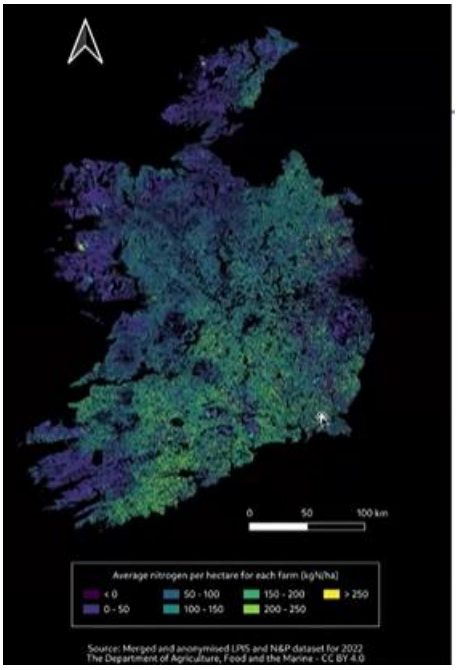
Our soil runoff tests were inspired by the problem of the water quality in Rosscarbery and the surrounding areas, which has resulted in many inconveniences, like the closure of the Warren strand in Rosscarbery during peak tourist season multiple years. We knew fertilisers like urea and pastural sward are popular among the farming community here, which is prominent in our rural community of Rosscarbery. We felt that these chemical fertilisers may have played a part in the infection of our rivers and sea and decided these runoff tests would be an integral part of the investigation.

Runoff occurs when there is more water than the land can absorb. The excess liquid flows across the surface of the land and into nearby creeks, streams, or ponds. Runoff can come from both natural processes and human activity

Soil runoff can carry exceptionally fine soil particles, nutrients, pesticides or manures to water bodies. This can cause pollution and harm to water-based habitats. Runoff can move directly from a field into water, but it can also travel towards water in other ways, such as through yards.

Poorly designed drainage systems and inappropriate use of fertilisers and pesticides can lead to an increase in losses of nutrients and chemicals to waters.

Map showing the level of fertiliser in the soil in various parts of Ireland Autumn 2023. The green parts have more fertiliser. In areas where agriculture is predominant there is a lot of fertilisers used.



Courtesy of Dr. C Rocha TCD

Background to the chemical test for nitrate

Nitrate + Sulphuric acid + Phosphoric acid + 2 propanolol ⟶ 4 nitro2,6,dimethyl phenyl nitrate

This complex is what is measured. (Hard water analysis handbook, 3rd

edition)

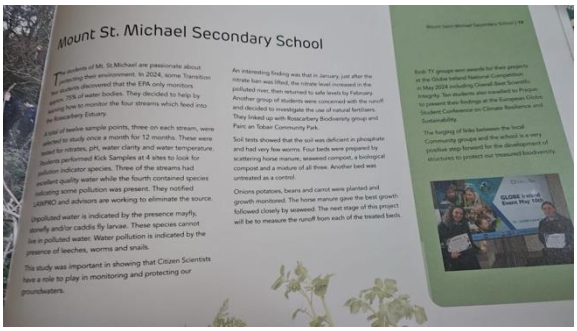
There is a new nitrate sensor out which is portable so in field studies give immediate results. It is accurate to 0.02 mg/l NO^3-N

Raising Awareness : Locally, Nationally, and Internationally

We flew to Prague to share our results with students internationally in the GLOBE Student Conference in April 2024

and to the national conference in Dublin where we won an award for scientific integrity

We also contributed to a *Streamscapes* publication '*Rosscarbery Estuary Project: Protecting Our Heritage*' and presented our project at the Awareness Day for the Project Launch.



Our debating class invited our local councillor, Mr. Christopher O'Sullivan to school. We told him about our project and he shared his interest in biodiversity and bird watching with us.

Further collaboration was with Tidy Towns for a grant application. We wrote a summary of our project for the Chairperson to include in the grant submission. This is in the Appendices.

A copy of our power point presentation is included in the Appendices

Methodology

For the initial study we entered for the Globe Competition March-June 2024.

To test the effects of natural fertilisers on potassium deficient soil

Hypothesis: different fertilisers will raise the potassium levels different amount and therefore be more nutritious for the plant being grown and produce better yield

Prediction: if the potassium levels are raised, then yield will be improved

Variables:

Independent: the fertilisers used (five test beds- bed 1 horse manure, bed 2 seaweed fertiliser, bed 3 biological fertiliser, bed 4 a mixture of all three fertilisers, bed 5 left fallow for control.)

Dependent: the potassium levels in the beds at the end of our tests, worms found, crop yield

Controlled: bed size (4.3m sq.), time between tests, vegetables planted

Type of fertiliser	**Nitrogen**	**Phosphorus**	**Potassium**
Seaweed Compost	3.5%	1.5%	2.5%
Farmyard manure	2.7 units/tonne	2.4 units/tonne	12 units/tonne
Horse manure compost	0.5%	0.36%	0.09%

Apparatus: five 4.3m sq. beds in Pairc an Tobar, measuring tape, gardening gloves, seaweed fertiliser, horse manure fertiliser,

biological fertiliser, teagasc soil tests, seeds or seedlings of vegetables (Broad beans, carrots, potatoes, onions,) project diary to record results, weighing scales

Method:

1. We sent soil to Teagsc to test the soil in Pairc a Tobair to find the potassium levels. This was what our experiment was based on.
   Soil analysis 17/ February /2024
   Sufficient levels of magnesium (213.0 mg/l)
   and phosphorus (31.2 mg/l) in the soil.
   Medium pH levels (pH 6.4)
   Low potassium levels (79.2 mg/l)

2. We also tested the soil Type through sedimentation. We found it had a silty loam type, as in 1755 an earthquake in Portugal caused a tsunami in Rosscarbery , that brought silt to the land.

Soil Profile:

On March 22nd 2024, we conducted a test for soil profile by sedimentation.

Sedimentation is a process that occurs when particles of a material (in this case soil) settle to the bottom of a container of liquid. The largest particles settle at the bottom with smaller particles making layers above them.

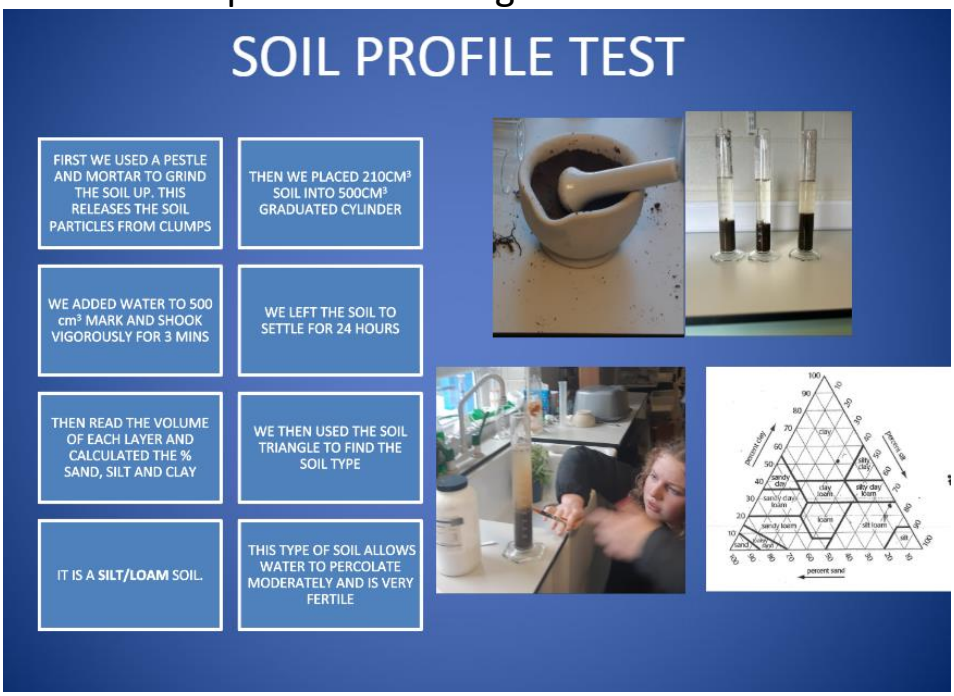
We predicted that we would have sandy soil as we are located near to Warren beach, Rosscarbery

Apparatus: soil samples, beaker, stirring rod, graduated cylinders, water, stopper, sieve

Method:

1. We put a sample of sieved soil in a beaker of water and mixed it thoroughly
2. We poured 100ml of the mixture into the graduated cylinder.
3. We put a stopper on the cylinder and shook it to again mix the soil and water thoroughly.
4. We repeated this three times with soil samples all from the same place to make sure we had a control.
5. We let it to settle overnight
6. We saw the layers that formed in the graduated cylinder. Sand at the bottom, then silt, and clay at the top. The water rose above all soil layers.
7. We recorded the amount of each layer and found our soil texture.

Our results show that we have a silt loam soil. This soil means that water can percolate through at a sustainable rate.



We were surprised to find that it was a silty loam soil, so we asked Clodagh from the Rosscarbery heritage group, who told us that an earthquake in Portugal in 1755 caused a tsunami in Rosscarbery that

made the lagoon. This tsunami brought in a lot of silt with it, and the results of it can still be felt.

3. We spread our fertilisers evenly in the beds. We spread 500g horse manure, 250g biological, 700g seaweed and a mixture made of a third of each fertiliser. One bed was left as a control without any fertiliser.

Bed (4.3 m squared)	Fertiliser used 20/3/24
1	Horse manure (Gee up peat free fertiliser) 500g per sq. metre 2.5 kg for bed in total (4.3metre sq.) Spread evenly and raked into soil
2	Seaweed fertiliser (fast grow seaweed plant fertiliser) 700g pellets spread in bed 1 150g per metre squared Broadcasted (spread evenly through soil) and raked into soil Used 150g prior to planting, will use 50g every 6-8 weeks per metre squared
3	Biological fertiliser (soil renew farmyard manure) 250g used on the 4.3sq metre bed Broadcasted and raked in Apply once a year/twice a year for vegetables
4	1/3 of each fertiliser required- 750g horse manure 83g bio manure 230g seaweed Mixed and spread evenly throughout the soil. Raked through.
5	Control plot. No fertiliser used in this plot but was raked.


SOIL
RENEW


FAST
GROW
SEAWEED
PLANT
FERTILISER


Gee-up
Golden Nourishment for Flowers,
Vegetables, Trees and Shrubs.

4. We raked these in and let them sit to mix with the soil for 5 days


5. We next planted the broad beans. These were sourced from Pairc an Tobar and allowed for our use. An even number of these were planted in each bed, parallel to each other


6. We next planted potatoes, onions, carrots, and parsnip. The same method was used for these. Note- when seedlings were used their height was recorded when planting.

7. We monitored the growth of these plants over the next weeks.
8. We kept note of the growth and compared the growth between the different beds and since planting the plants. We also monitored the prescence of worms, which hadnt been present prior to our tests. We found worms after just a week of the fertilisers being spread.

9. We tested the soil to find the level of potassium and how it increased.

Conclusion: the fertiliser was the best to raise levels of potassium, but we found best growth with the Horse manure fertiliser. The horse manure fertiliser bed was the only bed that's potatoes were not affected by blight.

Impact: the Horse manure compost will now be used in Pairc an Tobair to make the vegetables grow the best.

Our Extension study –October 2024

To test the water runoff of different fertilisers in comparison to conventional fertilisers like slurry.

Hypothesis: different fertilisers would have different levels of nutrients leached.

Prediction: if the fertiliser had high concentrations of nutrients eg nitrogen, runoff would be high in that nutrient eg nitrate

Variables:

Independent: The fertilisers used (seaweed, biological, horse manure, slurry)

Dependent: the nitrate and phosphate levels in the runoff

Controlled: mass of soil used, amount of runoff tested, amount of water used, Certified laboratory protocols used

Apparatus:

5 retort stands, electronic balance, beakers, water, sieved soil, fertilisers, 5 reused water bottles, notebook to record results, ruler

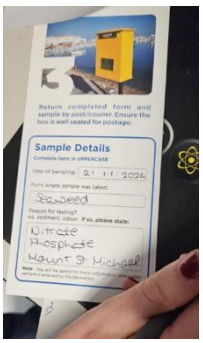
Method:

1. We cut reused water bottles and put them in the retort stand, set up with a beaker underneath.

2. We sieved the soil and weighed out 5x 400g of soil. We put these in the bottles.
3. We weighed out our fertilisers.
   50g seaweed, 15g biological, 175g horse manure, 100ml slurry.
   We added them to the soil, mixed it in and let them sit in the soil untouched for 5 days.

4. After 5 days we returned to the lab and ran our tests. We added 400ml of water to the soil, 100ml at a time. We timed how long it took for the first drop of water to come through each soil sample (percolation) and how long it took for our 350ml runoff sample to come through.

5. We put our runoff samples into bottles provided by Acorn laboratories in Bandon and visited their lab to deliver them.

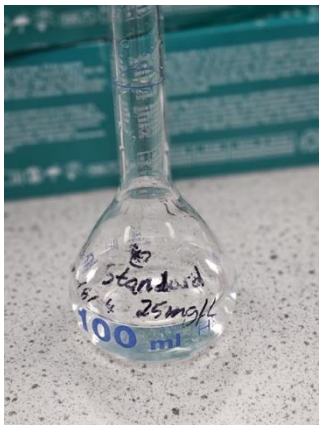


6. Here they demonstrated how our tests would be carried out and showed us how to test a sample ourselves. We conducted nitrate and e-coli testing ourselves. This was interesting and gave us insight into life in a lab.

Method for testing Water for Nitrate

<u>To make up the Nitrate standard.</u>

Pipette 2.5 ml of the nitrate standard into a 100ml volumetric flask and make up to the mark with deionised water. This was 25mg/l standard.



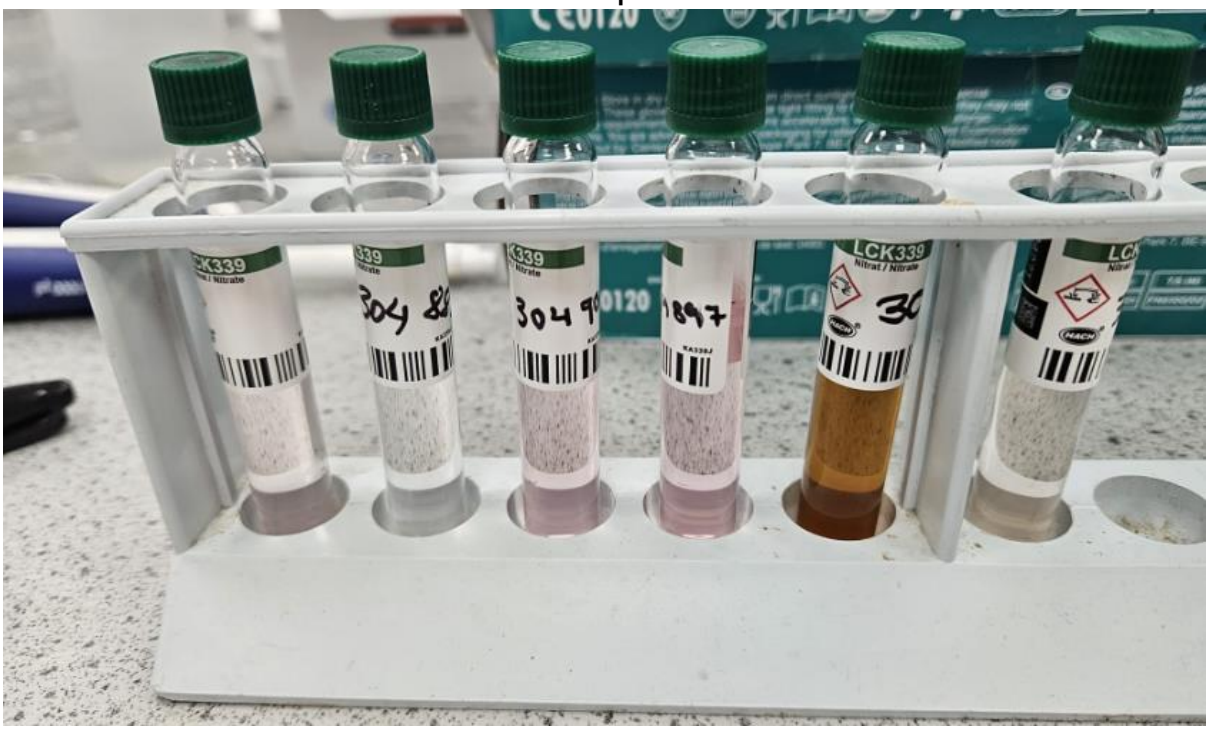
<u>To prepare the sample</u>

Add 5 ml of 33% phosphoric and 60% sulphuric acid solution into the tube.

Pipette 1 ml of sample into the tube. Pipette 0.2 ml of 2-propanolol into the tube.

then stopper and mix

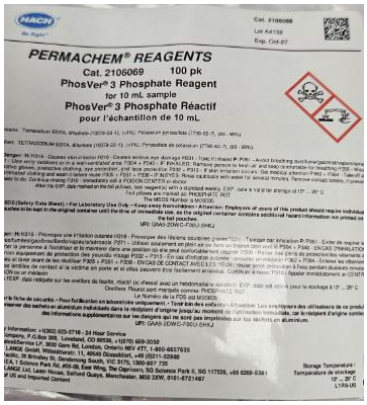
This is what our samples looked like when ready to measure in the Spectrometer. The standard is on the right. The brown coloured one is the seaweed sample.



The Spectrophotometer was a Hach DR3900 Spec. It is used for water tests in Acorn. We set itat 345 nm as this is the wavelength that the nitrate complex in the test tube absorbs at.

It was zeroed with deionised water first. Then we measured the standard to calibrate with. We read the absorbance of each of our samples and recorded the result.

Phosphate Test.



This test takes several hours as it has to be heated so we just saw how to prepare the sample and looked at the old spectrophotometer (a Hach DR2010) it is measured on. The sample is added to 3% sulphuric acid to digest it. Then placed on a heat block at 105oC for 3 hours. Before measuring the absorbance, NaOH is added to bring the pH back up. The colorimeter was set at 800nm as this is the wavelength orthophosphate absorbs at.

To count ecoli the water sample is mixed with 1 dextrose containing an enzyme. It forms an enzyme substrate complex and incubated at 35°C for 18hours. The colour change is viewed under a UV bulb which causes the colonies to fluoresce, and they can be counted.

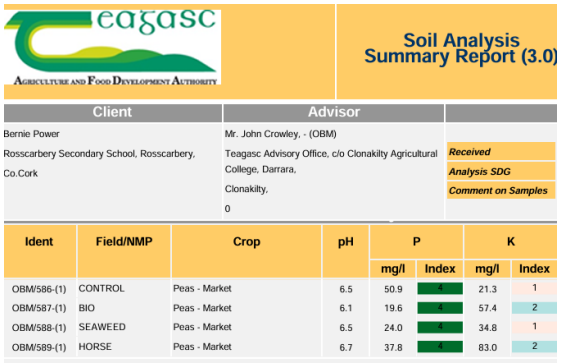
6. The Lab manager reran the tests to ensure accuracy, and we received our results for the tests a week after they conducted official tests. We took note of these and compared them to the results of our other tests.

Results

Soil Profile Result: Sandy/Loam

Visual Assessment

Table 1: Potassium levels in our test beds before treating and 6 months after.

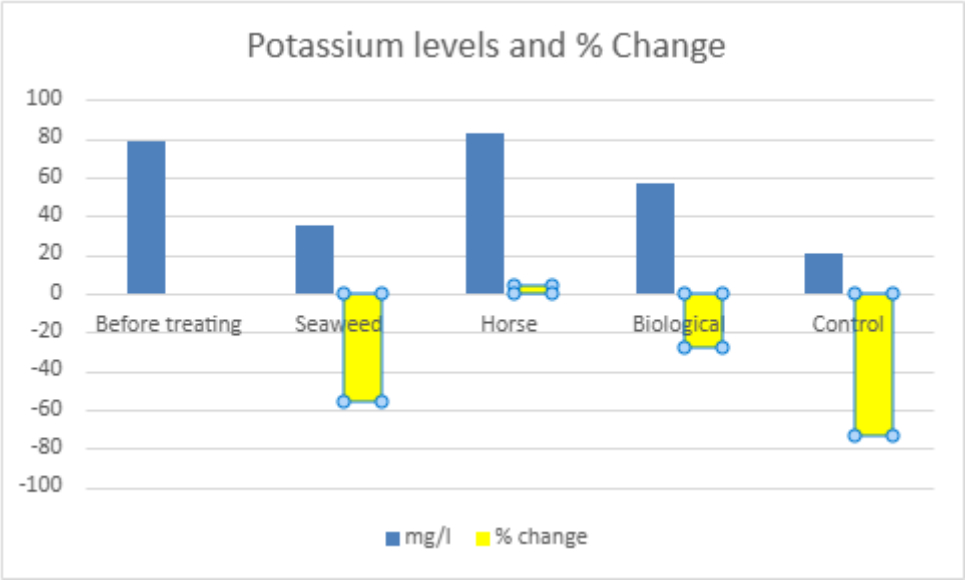


Soil Analysis Summary Report (3.0)

Client	Advisor	
Bernie Power Rosscarbery Secondary School, Rosscarbery, Co.Cork	Mr. John Crowley, - (OBM) Teagasc Advisory Office, c/o Clonakilty Agricultural College, Darrara, Clonakilty, 0	*Received* *Analysis SDG* *Comment on Samples*

Ident	Field/NMP	Crop	pH	P		K	
				mg/l	Index	mg/l	Index
OBM/586-(1)	CONTROL	Peas - Market	6.5	50.9	4	21.3	1
OBM/587-(1)	BIO	Peas - Market	6.1	19.6	4	57.4	2
OBM/588-(1)	SEAWEED	Peas - Market	6.5	24.0	4	34.8	1
OBM/589-(1)	HORSE	Peas - Market	6.7	37.8	4	83.0	2

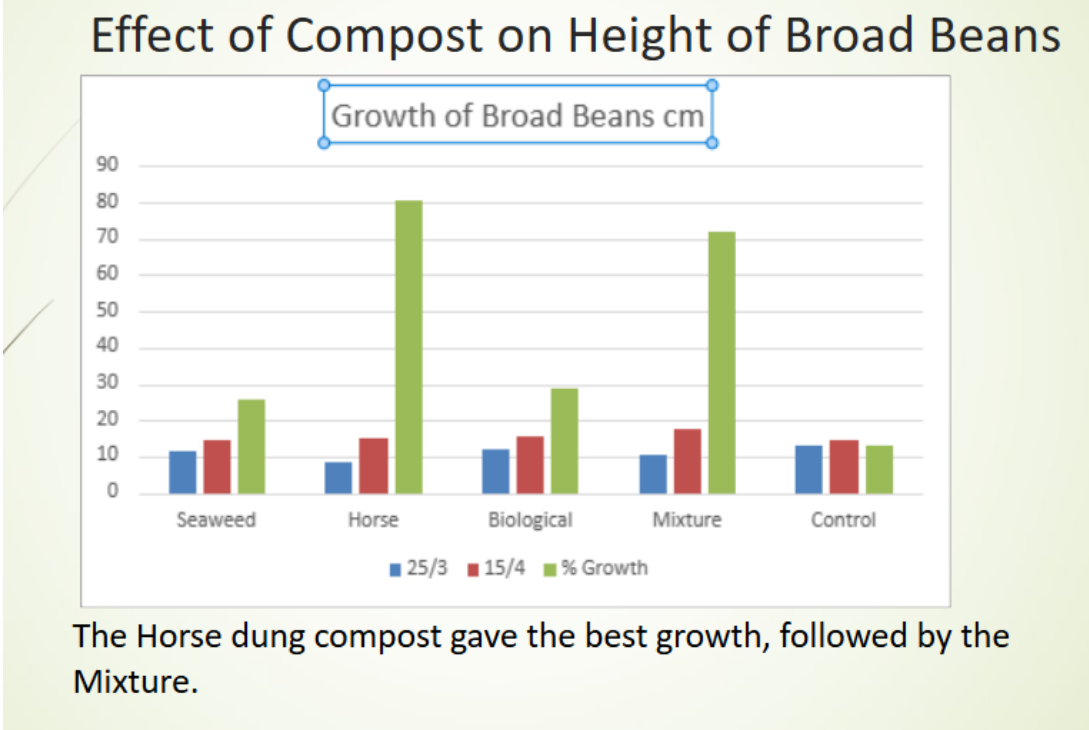
Potassium	mg/l	% change
Before treating	79.2	
Seaweed	34.8	-56.06
Horse	83.0	4.80
Biological	57.4	-27.52
Control	21.3	-73.12



The horse compost was the only fertiliser to raise the potassium levels. Potssium levels fell in the other beds. The biggest % decrease was in the control bed.

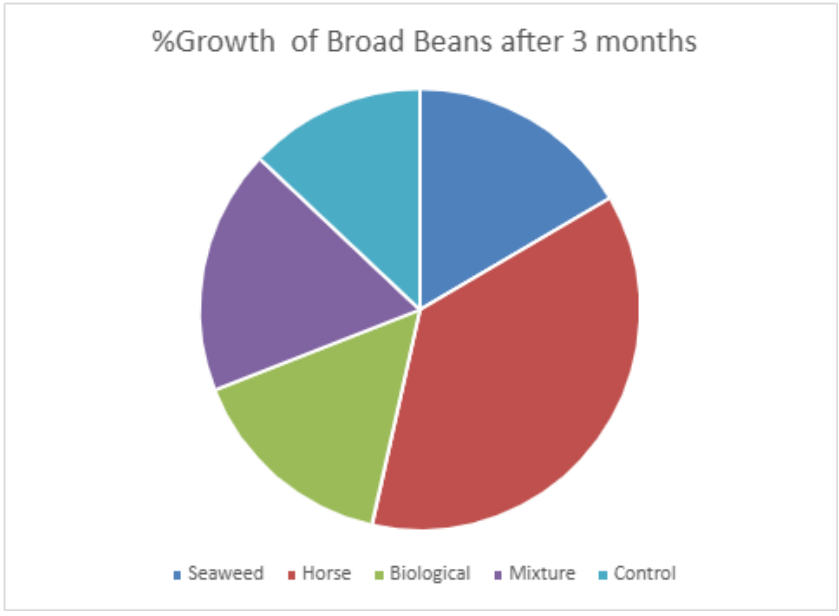
Results of Initial Study Effect of Different Natural Composts on Broad Beans, Onions, and Potatoes

Graph 1: Bar Chart on Broad bean height after 3 weeks



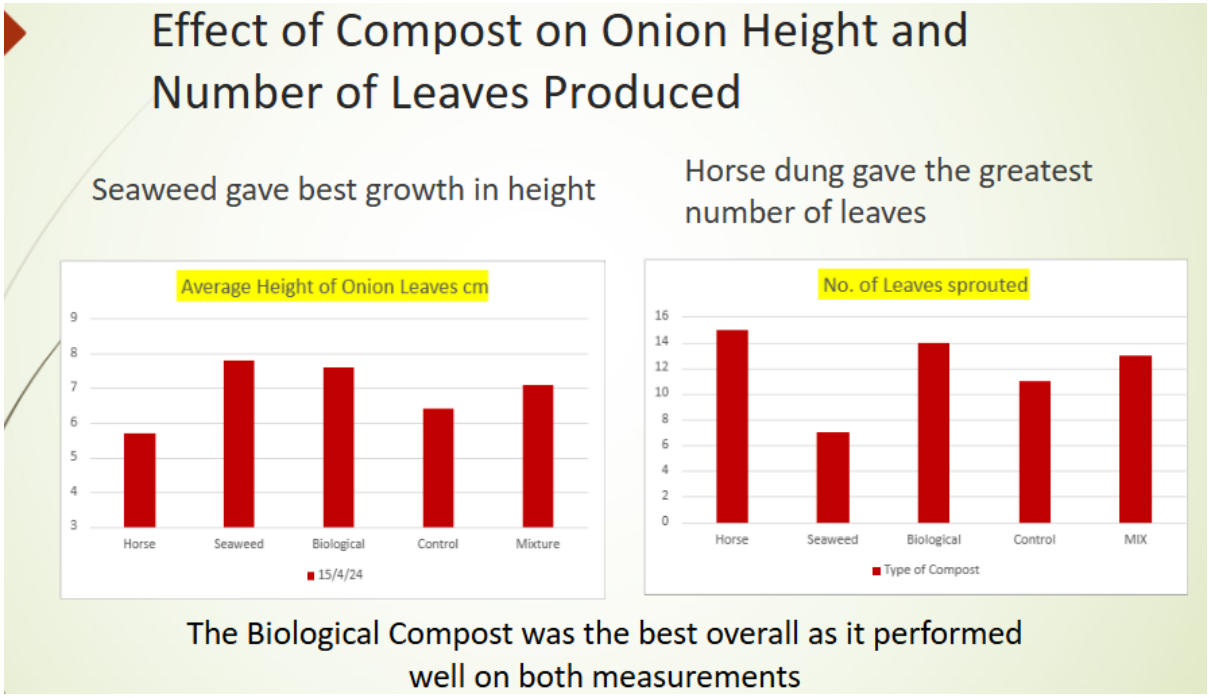
The Horse dung compost gave the best growth, followed by the Mixture.

Graph 2: Pie Chart on height of same Broad Beans after 3 months

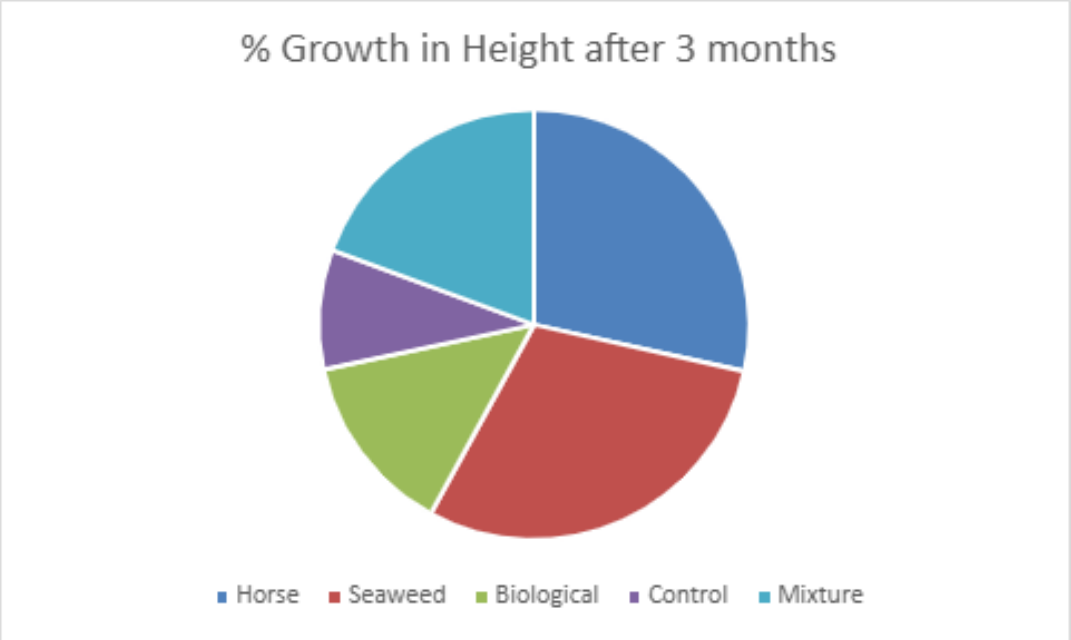


After 97 days of growth the beans were near ready to harvest. The Horse manure produced 10.3 % more height than the untreated control plants.

Graph 3 and 4: Bar Charts of Averaged Data after 3 weeks



Graph 5: Average Height of Onion plants after 97 days



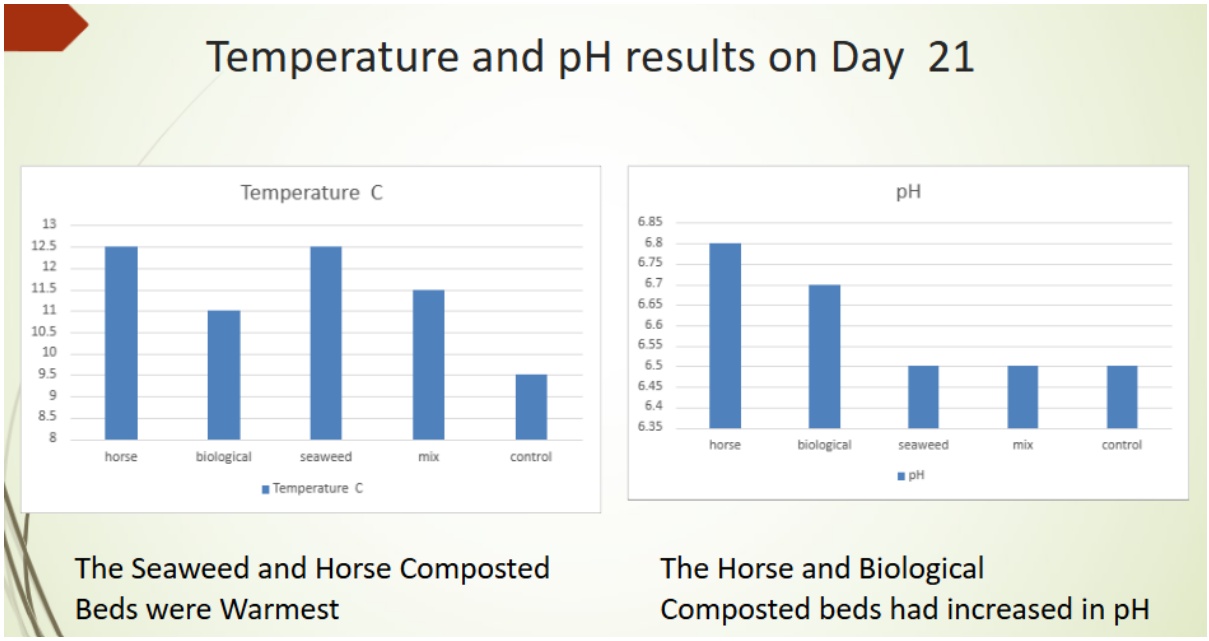
While the biological compost plants performed well in the first 3 weeks, the horse and seaweed treated plants both overtook the biological compost plants by 3 months.

Table 1: Height of Potatoes after 3 months

Potatoes	Heght after 3 months
Horse	45
Seaweed	Blight
Biological	24
Control	Blight
Mixture	Blight

The horse manure treated potatoes did best and did not get blight even though the bed was beside the others. The biological treated plants got blight later than the control and mixture plants.

Graph 6: Temperature 5cm depth and Graph 7: pH of soil 3 weeks after compost added



Result of Study Extension

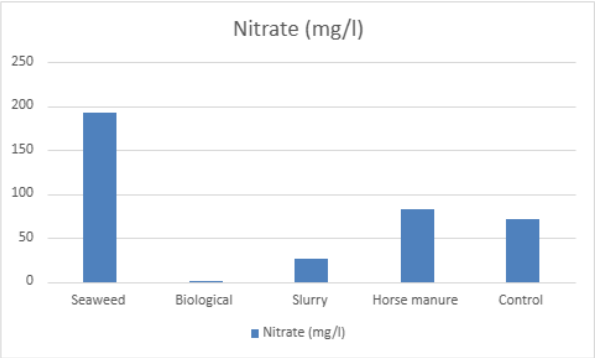
Chemical Tests and Microbial Test on Runoff from soil with Natural Fertilisers, including slurry, added.

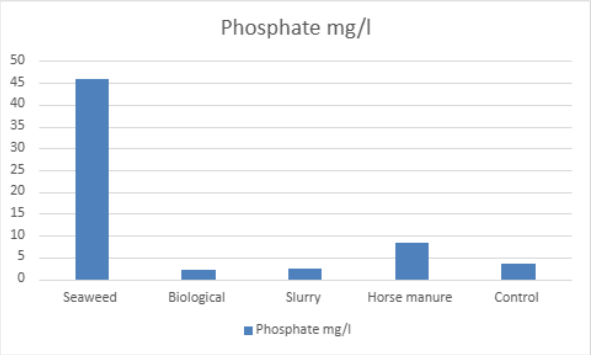
Table 2

	Seaweed	Biological	Slurry	Horse manure	Control
Nitrate (mg/l)	193	>1	26.7	82.8	70.7
Phosphate	46	2.04	2.34	8.4	3.6
Ecoli (Cfu/100ml)	406	30	1300	75	0

Graphs of the nitrate and phosphate results are below. The control had no ecoli and biological had very few compared to the other beds. The slurry was by far the highest showing how polluting it is to our waterways and drinking wells. It was interesting to note that horse manure has much less ecoli than slurry.

Graph 7 level of nitrate and Graph 8 level of phosphate as shown in Table 2 above





Seaweed seems to be an excellent source of nitrate and phosphate for plants. We were not expecting it to have high ecoli though and cant find an explanation for this.

Summary of Results

Pairc a Tobair has sandy/loam soil which is fertile and drains well. Worms found their way into our beds quickly. We did not do a population study as it was during our summer holidays, but the horse manure bed seemed to have more by the end of the study.

The horse compost treated bed stood out from the other fertilisers. It performed well with broad beans, onions, and potatoes. The soil temperature was warmer when compared to the control bed and pH had increased. Nitrate and phosphate levels were good.

The horse was the only bed that increased in Potassium. A revelation was that the potatoes did not get blight!! This definitely is a project for next year.

Seaweed fertiliser had both the highest phosphate and highest nitrate levels so it would be good for replenishing the soil after a crop is harvested. Biological fertilisers had the lowest levels of both of these.

Our control sample was the only sample where e-coli was not detected. The highest levels of ecoli was found in the slurry by over 800cfu/100ml.

Collecting slurry:

Impact of ecoli in slurry: clearly the slurry was the highest in ecoli, which is the bacteria that closed local beaches and the lagoon activity centre during the tourist season. Significantly, slurry is spread

on almost all pastures and fields in the Rosscarbery area. We have made local farmers aware of our results and discussed alternatives. They are not convinced

When we shared our results in school, another Young Scientist group had been monitoring the local rivers and found e coli in all four, but not at levels that would result in beach closures. A third group looked at the Estuary and found the ecoli may be coming from the sewage treatment plant.

Sources of error

- We punched our own holes in the bottles for our runoff tests. These holes might have been varied sizes in the different bottles which may have affected the particles that sifted through the runoff and made our results obscure. If we did this test again, we would use a specially made funnel.
- Accurate measurement of plant height was difficult, particularly for beans and potatoes. Our measurements are only accurate to + or – 1cm.
- Study of the Watercycle tells us that in fact, rain percolates through the soil and can spend time filtering through the bedrock before running into streams and lakes. Our experimental design did not account for this. If we were to do it again, we would design a filter bed and put the fertilised soil on top of this. In this study we were interested only in runoff from the land through the upper layers of soil.
- The location and the plants that were grown in the beds in Pairc an Tobar last year may have affected what nutrients are in the beds this year. We started with the same mixed soil in each bed but as this was done before our first day on site, we cant be sure so this may have affected the test results
- Fertilisers take a few years with consistent use to make a difference to the soil composition. This means that the fertilisers did not make a proper change to the soil after this one year and should be continued for the next few years.
- We do not have results for carrots as they seeds didnt sprout. We think they may have been dead.

Discussion

The results of our soil fertiliser tests have shown an increase in the levels of potassium only occured in the Horse compost treated bed. Potassium levels fell in the other beds. The final potassium level is still low (Index 1). We have learned from yhis that Natural fertilisers have to be used regularly.As the plants grow they are removing nutrients from the soil.

In our next study we will have to establish a regular treatment rota.

Earthworm activity was increased.

These were our main aims when beginning our research and we are delighted that we have had this result. As we have previously discussed the success in farming in Pairc an Tobar is crucial in our community of Rosscarbery. The natural fertilisers used have proved to be useful which will undoubtedly make a difference to the environment in our area.

Our results have shown that all our fertilisers gave different results depending on which plant we were measuring. This makes sense as all plants need diverse levels of nutrients and is important to note that there can be no best fertiliser.

We did most monitoring in the months March, April, and May as we could most easily track growth during the early stage of growth, and we were in school to visit the Pairc together.

Onions: seaweed gave the best growth of height of stalks (quality), while the horse manure gave us the greatest number of

stalks (quantity). Comparing averages, the biological fertiliser gave us the best results overall as it did well in both areas.

Broad beans: the horse manure gave us the best B-road beans, followed by the mixture of all three fertilisers.

Quality: the most significant note on the quality of the vegetables was how the potatoes in all beds were affected by blight except for the horse manure bed.

Environmental discussions: our investigations were conducted with our impact on the environment in mind throughout. The idea of using organic fertilisers in the beds in Pairc an Tobar was made because of this. Our local area of Rosscarbery is all too aware of water pollution, with our waterbodies being infected with disease. For example, the Rosscarbery lagoon, home of the lagoon water park, was infected with E. coli, leading to its closure in peak summer months. The warren strand in Rosscarbery has also been closed during summer months due to unclean water. This has taken a toll in numerous ways, particularly economically as Rosscarbery is a tourist destination and tourism employ many people here.

The EPA.ie states that "*Irelend has a large agricultural community. Overuse of cattle slurry and synthetic fertilisers is causing a significant pressure on our water systems, impacting over 1000 of our water bodies. This is caused by runoff from the land."* This statement summarises the significance of different fertilisers on not only the crop that we are trying to cultivate, but also the knock-on effect onto our waterbodies.

Approximately 75% of the pressures on water quality are from diffuse losses of Nitrogen (N), Phosphorus (P) and Sediment (Data

from ASSAP). Soil type, rainfall and land management all contribute to these losses to waters at a field or farm scale.

How farmers manage the physical land area they farm can impact water quality. Many routine farming activities such as fertilizer/slurry application, pesticide application, reseeding, etc. can impacts on water quality. In most of these activities following good practice guidelines can mitigate against adverse effects on water quality and the environment.

Diffuse nitrogen losses:

Nitrogen (N) loss typically occurs on soils that have high permeability. These are 'light' free draining soils and water can quickly permeate through these soils.

Where excess Nitrogen fertiliser is applied above crop requirement, this N is not utilised by the grass or tillage crop and is left in the soil. N does not bind tightly to soil like P and therefore when there is heavy rainfall, the water leaches N away to groundwater, streams, and rivers. The natural biological processes in the soil increase the N available, particularly in autumn. This requires careful management to minimise N losses at that time of the year.

Diffuse phosphorus losses:

Phosphorus (P) loss typically occurs on soils that have low permeability. These are poorly draining soils and get quickly saturated with rainfall. When there is heavy rainfall on these saturated soils this leads to the water staying on the surface of the soil. This in turns leads to overland flow of water, particularly on fields with slopes.

The overland flow of water across fields carries phosphorus in soluble form. It also washes off soil particles that have P attached to them. P binds tightly to soil particles. The soluble P and soil particles can then be washed into the drainage network and streams located in the farm and end up impacting on the quality of water in the streams.

Critical Source Areas (CSA's) are areas that are at highest risk of impacting a water body. These are often low-lying parts of farms where runoff accumulates in high concentration. Runoff from CSA's carries sediment and nutrients to waterways.

Identification of these areas on a farm is necessary to reduce nutrient sediment and pesticide losses. It is important that appropriate farm management practices are applied on these areas.

The critical source areas (CSAs) often coincide with hydrologically interconnected areas where overland and/or shallow subsurface water flows and transfers nutrients from the land to rivers and streams.

These CSAs vary across individual catchments and sometimes even within individual fields. As a result, effective measures to reduce nutrient losses will require differing levels of management that are appropriate for different areas of farmland within individual catchments. We have identified that our point at Pairc an Tobar is at the lagoon which is 100m from our test area.

Natural fertilisers provide more efficient plant production and improved ecosystem. The soil can support more life thus increasing biodiversity, less pollution of waterbodies and increasing plant production means less carbon dioxide will be in the air and more oxygen will be produced.

Conclusion

Our results have shown that natural fertilisers are effective for managing soils to make the plants grow and have a successful crop yield. However, soil requires regular treatment during the growing season. Cultivating our soils encouraged macro-organism presence and burrowing behaviour. This has a positive effect on the community, and we consider our investigation a success.

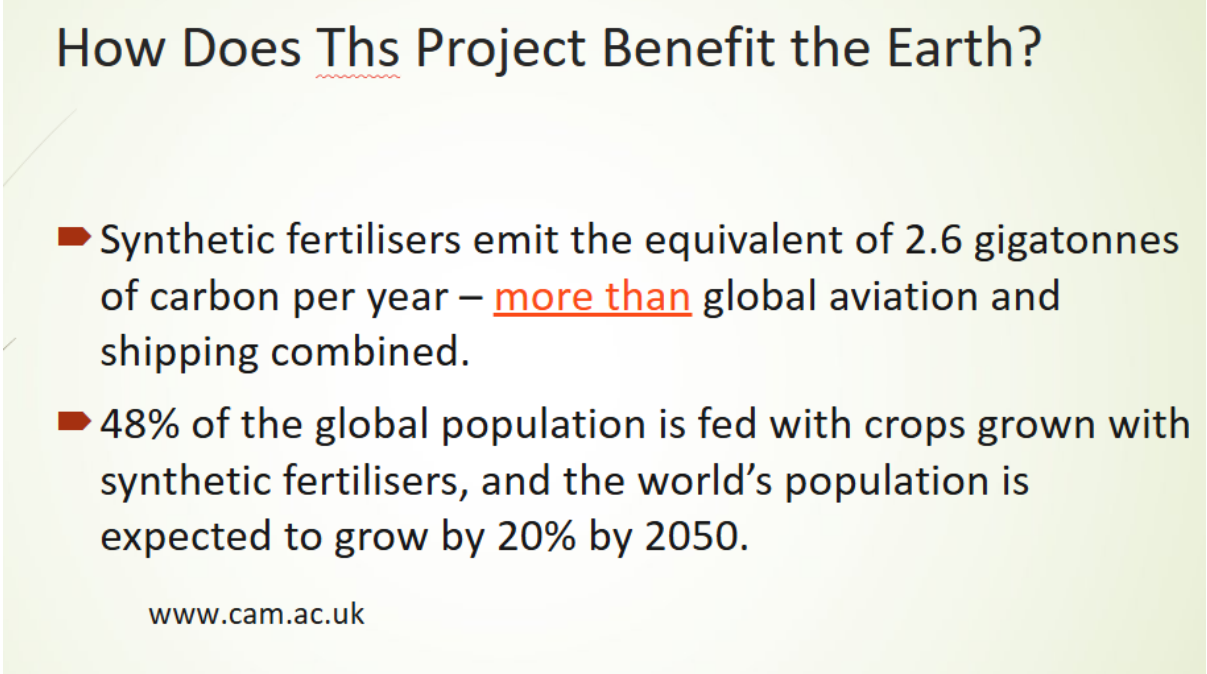
We would like to retest our runoff and monitor the growth of plants in Pairc an Tobar as fertiliser must have continued use and will not alter the soil structure for a few years.

Going forward we would like to share our findings with more of the community in Rosscarbery. We have presented our findings at the annual heritage meeting in Rosscarbery and have organised meetings with local farmers. We contributed to the Rosscarbery Biodiversity plan.

Two of our school Globe groups contributed to the development of the **Rosscarbery Biodiversity Plan.** This is us with the LAWPRO educational co-ordinator for West Cork at the launch of the plan.

The community involved in Pairc a Tobar have decided to use natural fertilisers full time in the garden and we are staying connected with them to keep up with what is going on there. Aine is studying Agricultural Science for her Leaving Certificate and is looking forward to extending this research study for her final year project.

Discovering the Globe Community has opened horizons for us we never thought possible. We have conquered the many challenges and grown in confidence on the journey. We have developed a deep understanding of the scientific method and had lots of fun along the way.



Appendices and Sources

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- "How spongy is our school?" – investigation by Global Citizenship class in our school 2023-2024 for the Globe Campaign. Garden mulch absorbed the most water as it was the most porous and prevents water logging
- "The Plant Nutrition Manual" by J Benton Jones. Average concentrations of mineral nutrients in a plant.
- Our teagasc advisor John Crowley. Met on several occasions and discussed the importance of lacking nutrients and what could be done to improve the situation.
- John O Callaghan, gardener, and Biodiversity Officer in Pairc and Tobar. Met often and assisted us with planting and planning the practical work
- Clodagh from Rosscarbery Biodiversity group, volunteer in Pairc aTobar. Along with John O Callaghan gave us great insight into how the balance of nutrients is effective in practice
- Kiss The Ground – Documentary. Gave us inspiration into the significance of the quality of soil on crop yield.
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