Crops and horticulture projects

on the demonstration network

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Foreword

Horticulture and cropping opportunities in Wales have increased over recent years, meeting a growing demand for locally grown and sourced food. The Farming Connect demonstration network has implemented a number of projects across a range of sites to investigate horticulture and cropping good practice, with the aim of providing advice and guidance to farmers across Wales who may also be interested in trying them on their farms. The projects and topics outlined in this booklet provide practical examples of what improvements can be made in these systems, improving the profitability of the business.

Helping to develop the skillsets required to grow commercially, knowing how to adapt production systems to cultivate crops profitably in Wales and being able to add value to better meet the demand of the market are all topics covered under the Farming Connect programme.

Reducing costs in the sector, and utilising home produced resources better, such as manure and compost materials are examples of topics shared with horticultural and cropping producers. Using home produced soil conditioners with the aim of reducing the requirement for chemical inputs into vegetable production is another example of innovation in the sector.

Working with high value niche crops has been a priority for the programme, trialling new ways of working at a vinery and orchards in Wales. These high value products contribute to Wales' food provenance, celebrating and promoting high value food with strong environmental and heritage credentials.

This booklet is an illustration of the wide range of projects that took place between 2016 and 2019, and the outcomes that have been demonstrated to farmers. They highlight the potential for achieving more from less to help develop sustainable horticulture and arable enterprises in the future.

For updates on projects and trials at all the sites in the Farming Connect demonstration network, visit our website at **www.gov.wales/farmingconnect**

Dewi Hughes
Technical Development Manager, Farming Connect
Summer 2020

Farming Connect - helping you drive your business forward

Eligible businesses registered with Farming Connect can tap into a wide range of Farming Connect support services, guidance and training.

Many services are fully funded, others are subsidised by up to 80%.

Visit our website to find out how you can:

- benefit from subsidised business support, tailored to your business needs
- reduce outputs and increase efficiency across all areas of your business
- benchmark your performance and work towards progress and growth
- identify areas for improvement and find solutions to problems
- develop your skills as part of our continuous professional development/lifelong learning programme
- keep up to date with the latest innovations in technology through industry developments and the latest research projects
- share best practice and benefit from the knowledge of other farmers, industry experts and academic research
- be inspired by new ideas and find more efficient and innovative ways of working

The value of nutrient management planning for horticulture

The value of a Nutrient Management Plan (NMP) on horticultural farms is often overlooked. Nutrient management planning enables growers to improve crop production where soil results indicate deficiencies or incorrect nutrient ratios. Within a field vegetable system, a significant amount of vegetable waste is often created, and the nutritional value of this waste, although recognised, is often not utilised to its full potential. The Fruit Farm focus site at Llanvihangel Crucorney, near Abergavenny is a mixed horticultural farm currently producing field vegetables and fruit, farming to organic principles, although not certified organic. Working with Farming Connect the farm investigated alternative ways of managing this vegetable waste, with a view to reusing it for its nutritional value.

In addition to focussing on good practice associated with nutrient management planning, the farm trialled vermicomposting (a worm composting system) to process the crop waste, with the intention of producing a useful source of compost to return to the land.

Project results

- Soil sampling results varied across the farm, indicating the value of taking a crop requirement approach to inputs, with regular soil testing.
- Vegetable crops were performing well but certain fruit crops particularly raspberries, were underperforming due to soil nutrient deficiencies.
- The farm was shown to be producing low levels of valuable organic manures. The importation and use of organic approved fertilisers was recommended to improve the nutrient status of the field crop plots.
- Leaf and fruit analysis was recommended to diagnose nutritional disorders and storage potential of the plant before fertiliser application.
- Establishing the vermicomposting system over a longer time period, perfecting the composting conditions required by the worms and ensuring a stable aerobic environment should provide a valuable compost and soil conditioner.

Recommended soil indices for field crops at Llanvihangel Crucorney

pH (acidity)

- Optimum soil pH is vital in maximising the uptake of nutrients.

Target: pH of 6.5

Phosphorus (P)

- Essential macronutrient.
- Plants require large amounts of P.
- Transfers energy from one reaction which drives another reaction.
- Adequate P stimulates early plant growth and hastens maturity.
- **Target: index 2 for fruit and index 3 for vegetables**

Potassium (K)

- Essential nutrient for plant growth.
- A macronutrient.
- Large amounts are absorbed from the root zone in the production of most agronomic crops.
- Associated with the movement of water, nutrients and carbohydrates in plant tissue.
- **Target: 2+**

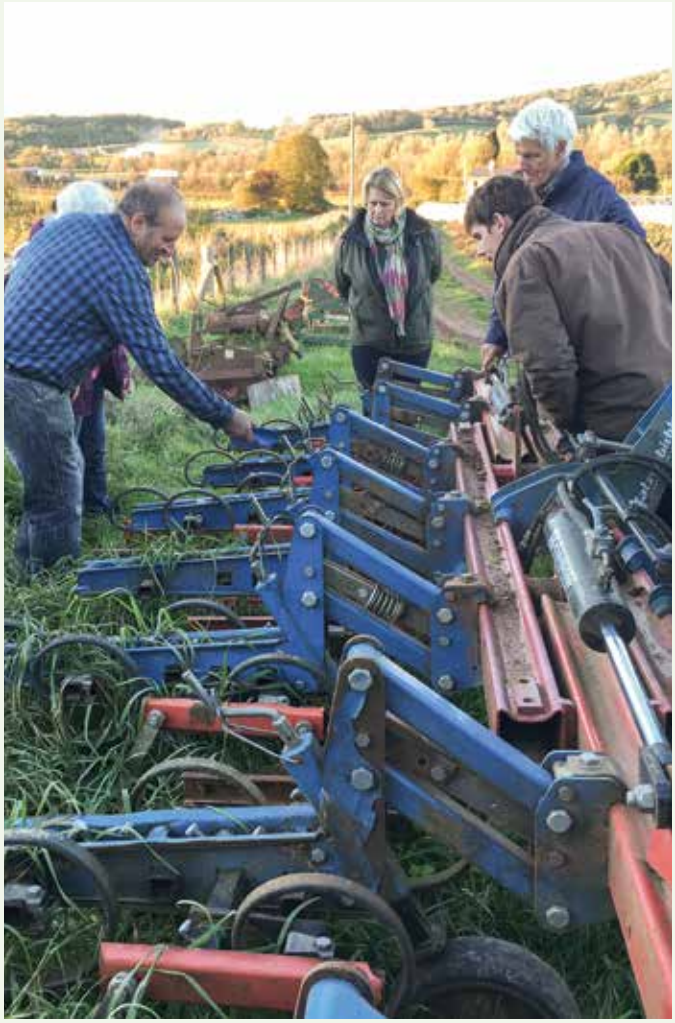
Magnesium (Mg)

- Mg deficiency results in poor and stunted plant growth.
- Helps to activate specific enzyme systems.
- **Target: 2**

Key messages

Nutrient management

- Undertake soil sampling every 3-5 years across the whole farm.
- Source organic certified fertilisers to improve crop production.

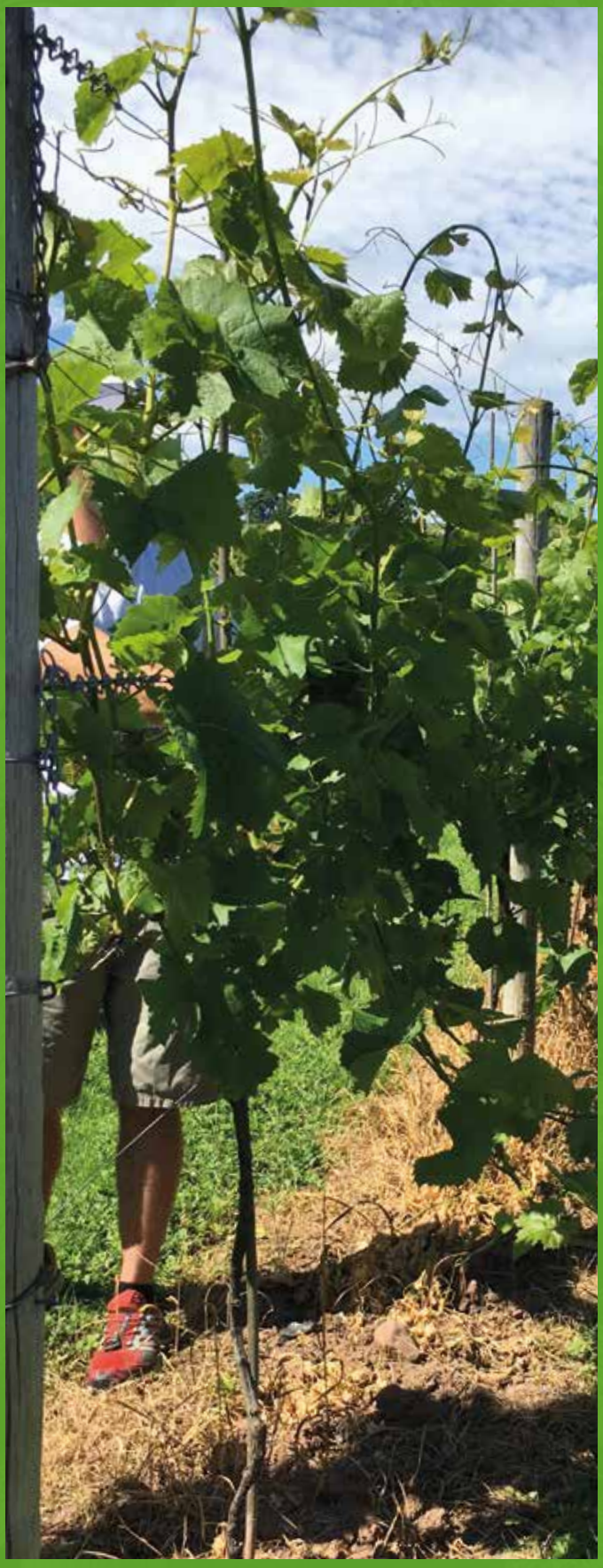


- **Routinely analyse leaf and fruit samples to assess nutrient requirements.**
- Essential in making fertiliser choices.
- Helps diagnose nutritional disorders.
- Leads to targeted fertiliser applications.
- Improves crop quality, financial and environmental efficiency.

Vermicomposting requirements

- Temperatures between 10°C and 30°C.
- Moisture content of 60-80%.
- Aerate compost through manual turning.
- Reduce material size by shredding the fruit and vegetable waste.
- Darkness is essential for the worms to thrive.

Optimising grapevine vigour by winter pruning and nutrient management



White Castle vineyard near Abergavenny consists of 5,000 vines including Pinot Noir, Regent, Rondo, Seyval Bland, Phoenix and Siegerrebe vines. The first vineyard harvest took place in October 2011, with productivity increasing over subsequent years. This focus site has investigated both nutrient management planning and winter pruning, sharing knowledge and expertise with other members of the Welsh Wine Association via events and factsheets.

Event attendees learnt how different soils can affect the growth of vines, with site and rootstock selection being essential as a result. One event covered macro and micro nutrients and their effect on vine development, problems associated with limited or excess nutrients and how other factors impact on vine and berry growth.

Winter pruning of grapevines was the subject of a practical workshop; this is considered to be the most important task carried out during the year, as vine pruning technique significantly affects lifetime productivity.

Nutrient management

- Grapes will tolerate a pH range of 4.5 – 8.6 but yields and wine quality will be affected as pH influences nutrient availability.
- 6.0 - 7.5 is the optimum pH for grape production.
- Regularly monitor pH, tailoring nutrient inputs to ensure optimum crop growth.
- Nutrient needs are directly related to crop off-take. For example: 1.3-1.6 kg N will need to be replaced per tonne of fruit harvested.

Application timing is critical for nitrogen inputs

One month after bud break and post fruit set are good times to apply N, when uptake and demand are high. Applying outside of these timings causes excessive top growth increasing the canopy density and decreasing sunlight penetration, causing mildew growth.

Introduce the vines into cropping gradually to ensure productivity long term

Years 1-3 are vitally important for the young vines, as they concentrate on growing the root system needed to produce fruit over the coming years.

Growers often attempt to force the vine to produce too much fruit too early. Allowing vines time to establish and mature will result in higher levels of productivity over their lifetime.

Deficiency in magnesium (Mg) can be an issue, when the soil potassium to magnesium ratio is greater than 5:1.

Remedy this by applying Epsom salts spray.

Undertake leaf analysis to determine nutrient deficiencies

Leaves are good indictors of nutrient deficiencies and leaf analysis should be undertaken on a leaf opposite the first buds at flowering.

Visible signs of deficiencies present	
N	Yellowing of young and old leaves
Mg	Green veins but yellowing of leaf between veins first seen on older leaves
K	Crisp burnt edge of leaves
Iron (Fe)	Young leaves anaemic, can be prevalent on chalky soils
Manganese (Mn)	Yellow leaves, (rare in the UK)

Establishment phase pruning

Winter of year one (entering season two) – cut the vine back down to a two bud stub.

Winter of year two (entering season three) – forms the trunk of the vine. Allow three to four shoots to grow from the top of the trunk during season three. This will generate a small first crop, and allow the vine to continue growing its roots while building up a reserve of carbohydrate energy.

How many buds to leave at pruning time - charge counting

Once vines are established, the simplest way to gauge how many buds to leave when pruning is to count the number of strong shoots which have grown the previous season. This is the best indicator of the vine's capacity for growth.

If you can count 10 strong shoots on your vine, then aim to grow 10 shoots again during the next season – as this is what the vine is showing it has the capacity to produce. This requires approximately 12 buds to be retained – allowing for some being removed during shoot thinning in early summer.

Avoid calculating bud numbers which involves a 'blanket treatment'. By leaving the same bud number on all vines, the weak vines will get weaker and the stronger vines will become over vigorous, which will impact on productivity.

Exploring the use of wood chip mulch for weed control in organic vegetable production

Pictured (left to right): Will John, RSK ADAS and Rob and Ryan Whittal, Square Farm

Wood chip is often considered a waste by-product by tree surgeons. However, the chemical and physical diversity of waste wood chip resists compaction unlike commonly used weed suppressants such as sawdust and bark. Arborist wood chip is often available free of charge, making it economically practical.

Square Farm focus site, near Monmouth trialled the use of wood chip and its potential to suppress weeds in organically planted vegetables. Square Farm wanted to assess whether the use of waste wood chip from local tree surgeons could be used to suppress weed growth in organically planted vegetables, comparing it against plots that were manually weeded only. The project investigated whether wood chip could contribute to improved production via increased moisture retention, temperature moderation and weed control, whilst reducing costs and contributing to the farm's environmental credentials.

Crops chosen were purple sprouting broccoli (PSB) and celeriac. PSB is a strong competitor against weeds whereas celeriac is much less competitive. Three metre long plots were established and replicated three times across the field. Wood chip was applied to a depth of 50mm on the treatment plot and no wood chip was applied to the control plot. The wood chip was applied by hand from a telehandler bucket for the purposes of the trial but on a larger scale this could easily be mechanised using a rear discharge manure spreader.

Records were taken of the % weed cover, the weed species and the effect on crop vigour, the latter on a 1-5 scale with 1= Poor and 5= Strong. In order to get some guidelines on likely cost savings timed hand hoeing was carried out.

What is wood chip mulch?

Arborist wood chip includes bark, wood, and often leaves. The chemical and physical diversity of these materials resists the compaction often found with the use of sawdust and bark mulches.

Advantages of arborist wood chip

- Promotes better performance, due to:
  - Moisture retention
  - Temperature moderation
  - Weed control
- Sustainability.
- Often available free of charge making it economically practical.
- Resistant to environmental disturbance.

Project results

Savings of up to **£524/ha**, primarily via a reduction in labour requirements

Crop vigour was higher and weed cover lower in the mulched plots

The mulch did not appear to compete with the current crop for nitrogen

The mulch visibly increased soil moisture in what was a dry year

Higher levels of worm activity and fungi colonisation was observed in the mulched plots in comparison to the control

Weed cover and crop vigour in mulched and control plots of celeriac - results

	September 2018		October 2018	
	% Weed Cover	Crop Vigour	% Weed Cover	Crop Vigour
Mulch	5	3	20	3
Control	13.2	2.3	73	2.3

Key messages

- Wood chip mulch is considered to increase biological activity, including earthworms and fungi.
- Carry out mulching directly following transplanting work to create an effective weed control.
- For annual crops, the mulch was incorporated with the crop trash after harvest, improving soil organic matter.
- Action would be required to ensure subsequent crop vigour does not reduce due to competition for nitrogen between the crop and the mulch.

The value of compost in horticultural cropping

Sustainable nutrient management is a priority for horticultural systems in Wales, reducing costs and reusing/recycling valuable on-farm fertiliser resources. This was the focus for a project at Caerhys focus site near St David's, a community run organic horticultural unit on a mixed livestock farm.

The project examined how to increase the efficiency of composting home produced livestock manure from straw bedded cattle to provide higher quality nutrition for vegetables, including crops in polytunnels. The manure was stored in small stacks 2m high and 3m wide at the base, and the trial stack was turned with a tractor and front end loader when the temperature dropped below 50°C. The stacks were covered with a silage sheet to prevent leaching of nutrients and N losses through ammonia release. The temperature was recorded using electronic tags in the heaps with the information downloaded to a computer.

Alongside analysis of the two manure stacks a comprehensive assessment of the nutrients available both in fields and polytunnels on the farm was also undertaken, in order to make better use of applied manures, compost and fertilisers.

Project results

Comparison of the nutrient value from the trial stack versus the control stack

- Potash value was doubled.
- Phosphorus levels were 33% higher.
- Magnesium levels were 28% higher.
- Worm activity seemed to be much higher in the trial stack, with a band of intense activity in the top 30cm.

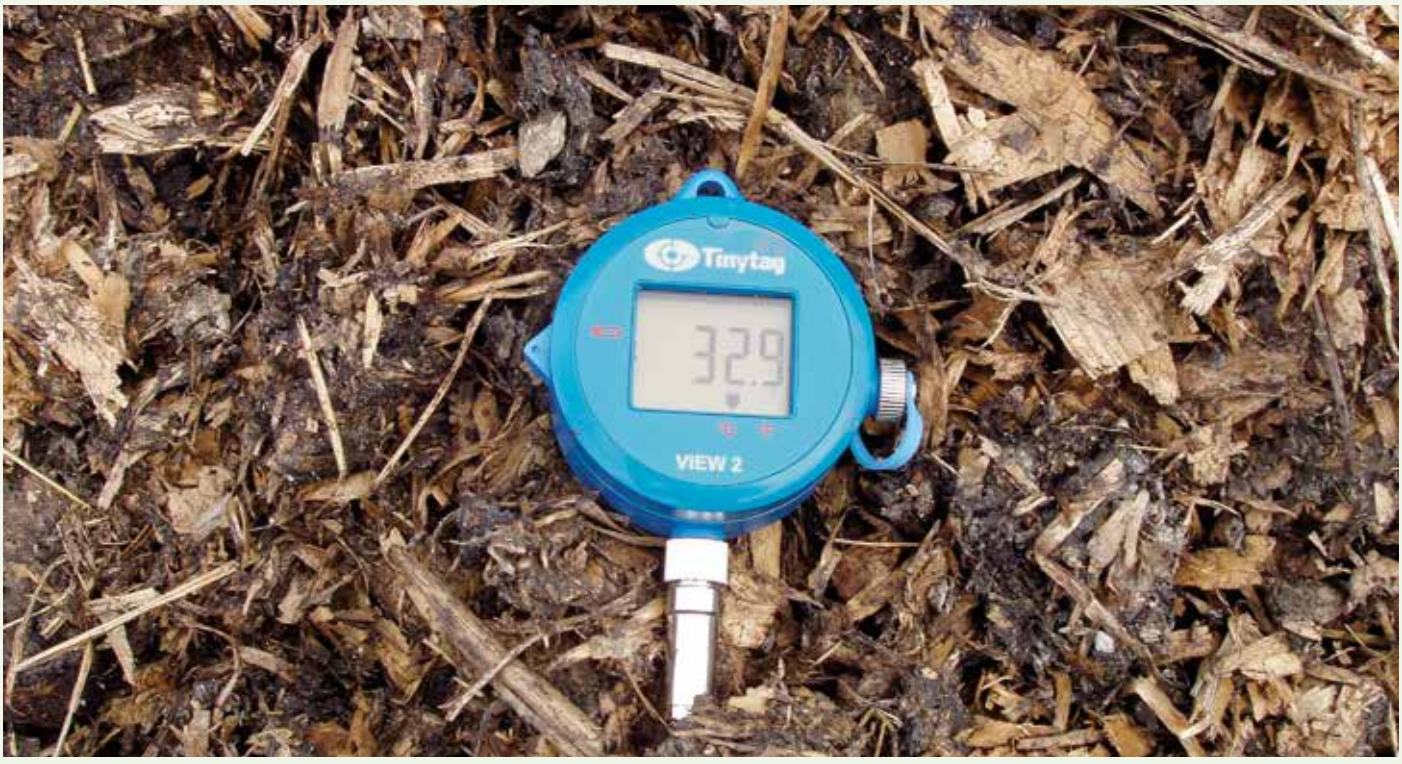
	Trial stack kg/tonne fresh weight	Control stack kg/tonne fresh weight
Potash	5.99	2.73
Phosphorus	3.71	2.8
Magnesium	1.9	1.5

The value of soil sampling and undertaking a nutrient management plan

- Optimum soil pH is vital to maximise the uptake of nutrients. 88% of the fields tested at Caerhys required lime applications to correct soil pH.
- Phosphate levels were measured and all samples were at the desired index. Only maintenance levels of P would be required, to cover crop off take and maintain P levels at the optimum index. Applying any additional P to these fields would increase diffuse pollution risks, as well as unnecessary costs.
- 41% of samples were below the desired potassium soil index. A derogation from the farm's organic certification body would be required prior to buying in approved forms of potash.
- Magnesium levels were more variable. None of the samples were below the desired soil index but 35% of the samples were at a high index 4 or 5, so no more Mg should be added to these fields, in order to ensure good crop growth and save on costs.

Key messages

- Manures are a valuable resource on both organic and conventional farms.
- Simple composting principles will improve the benefits of the manures.
- Simply covering your manure pile with sheeting is beneficial.
- Weed seed and some pathogens will be killed if the stack gets hot enough.
- Turning the stack speeds up the composting process and results in a more consistent product.
- Use analysis of both soil and manures to get a reliable overview of nutrient requirements and supply.
- Well composted manure improves soil structure, and the worm activity in the stack results in friable humus.
- Leaching of the stack by rainwater may result in the loss of valuable nutrients, and covering the stack also prevents gaseous loss of nitrogen as ammonia.



An investigation into the value of rye production in Wales

When considering which crops to include in an arable rotation, farmers are always on the lookout for cost effective alternatives. At Upper Pendre focus site near Llangorse wheat, barley and triticale are successfully grown in an arable rotation to feed to the dairy herd and beef cattle. The limitations of triticale led to an investigation into using rye as an alternative arable crop.

Triticale fits well in the rotation but is susceptible to yellow rust which has a big impact on yields and is time consuming and expensive to control. Breeders are also struggling to multiply up new varieties of triticale, and varieties are not tested for disease resistance. Rye has the advantage of being less susceptible to take-all (a fungal disease that causes significant losses) than wheat, barley and triticale. This project investigated the value of growing rye as the third crop in the rotation. Rye benefits from early drilling and gives greater scope for grass weed control than barley. However, there is very little information available on growing and feeding rye grain to cattle, as it is mainly grown for anaerobic digestion (biogas) plants with limited quantities harvested as wholecrop for livestock.

Project activity

The rye variety SU Cossani Hybrid was drilled at the end of September 2016 on a 6ha field at 200 seeds/ m^2 and sprayed with a pre-emergence herbicide.

Late frosts in May took a portion of the rye ears as they emerged, and harvest was delayed due to wet weather.

Project results

The rye yielded **6.9 tonnes/ha**, with a negative net margin/ha of **£132.83**

The triticale yielded more **(7.75tonnes/ha)** and costs were lower, with a positive net margin of **£270.79/ha**

The rye was disadvantaged by several factors

- Rye is susceptible to mildew and brown rust.
- It needs a very robust plant growth regulator programme to keep it standing.
- With early ear emergence, the crop is susceptible to late frosts.

The quality of the four crops grown in 2017 were compared

	ME (MJ/kg DM)	Crude Protein %	Moisture %	Starch %
Triticale	13.8	11.5	15.1	60.6
Barley	13.2	9.7	13.8	51.5
Wheat	13.7	12.1	14.1	57.3
Rye	13.6	10.9	13.2	49.2

Key messages

Rye is worth considering as an alternative arable crop, but has its limitations, as shown by this project.

The rye could be used as a straight substitute for any of the other cereal crops in the Upper Pendre feed rations, for both the dairy herd and finishing the suckler herd cattle. Rye also has the benefit of containing around 5% sugar which can provide a readily available source of energy for rumen microbes, complementing the slower fermentation of starch in the rumen.

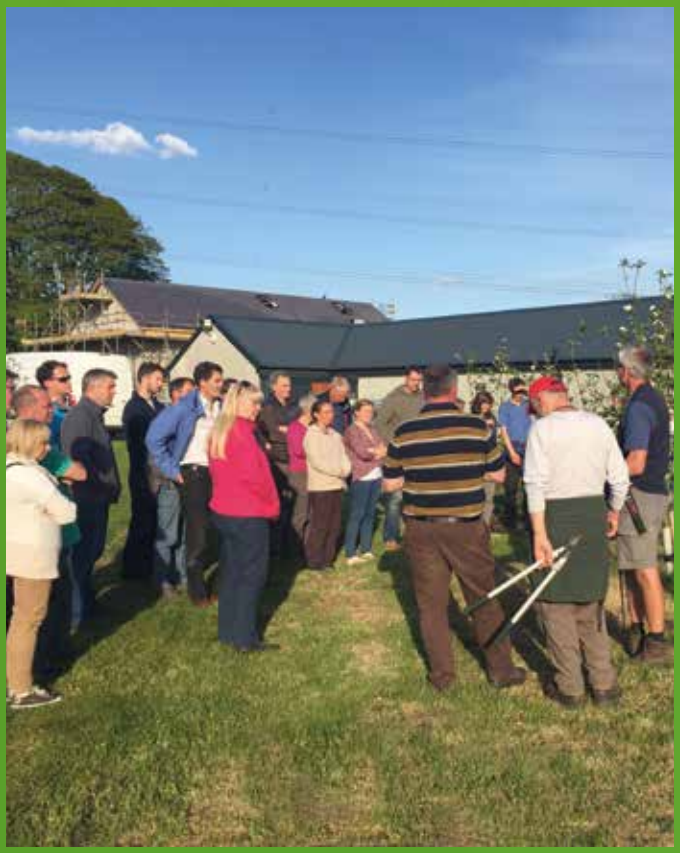
Seed depth is important as rye is small seeded and does not have the reserves to emerge from depth, so a 2cm drilling depth is advised. Slug control is essential in the early stages and seed treatment is advisable.

Rye is also susceptible to barley yellow dwarf virus (BYDV) so best practice advice should be followed for pyrethroid application.

Apple orchard management

Pant Du focus site is a small but successful vineyard and orchard in the Nantlle valley, near Caernarfon. To improve quality and yield on the site a project was undertaken to assess the nutrient requirements of the apple trees to ensure a high quality, flavoursome product.

Soil testing was undertaken along with corrective management to address nutrient deficiencies. In addition, consideration was given to tree management techniques including pruning to reduce susceptibility to disease.



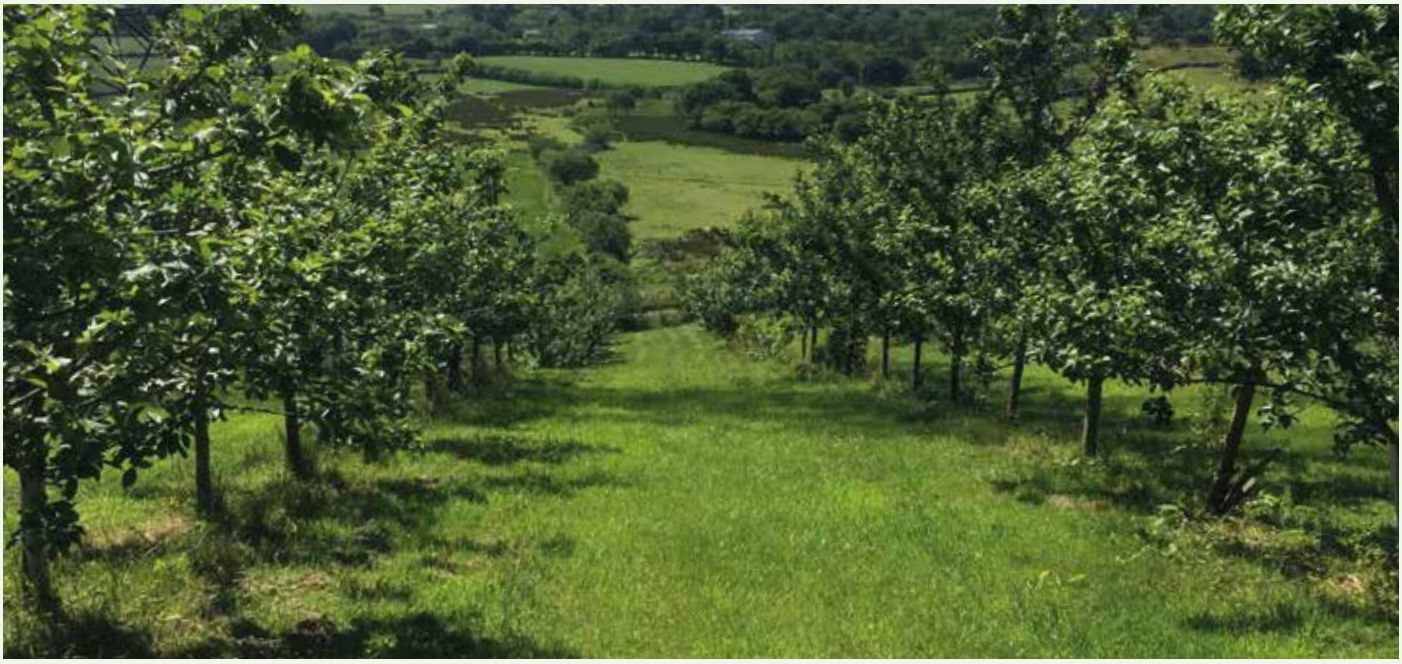
Project results

Sampling showed the majority of soils had below optimum pH levels. Lime was applied across these areas, to improve crop growth

Deficiencies in phosphorus, potassium and magnesium were identified

Several of the planted varieties at Pant Du were more suited to intensive commercial orchards. Advice was to use locally adapted varieties

Tree stability, planting techniques, winter tree management and in-orchard grass control were identified as areas to address



Outcomes from the project

Deficiencies in phosphorus, potassium and magnesium were corrected over a three year period. Nutrient levels are now regularly checked at key times in the growing season.

The optimum pH for apple production is 6.0-6.5. Check foliage regularly for discolouration around the leaf edges which indicates potassium deficiency. The target potassium index is 2.

Trees need to be stable in their planting holes. New stakes have been installed to support the trees, filling any holes with silver sand for increased support.

Maintain good planting techniques. Do not twist roots when planting. Improving the soil conditions around the established trees with twisted roots has encouraged new growth from the rootstock. An additional long term strategy is to prune the roots very close to the trunk in the early spring on one side of the tree. This would gradually increase root recovery, albeit over several years.

Flail between alleys and trees and keep grass short during the growing season. Pant Du invested in a swing wing mower for inter-row mowing. This improved orchard conditions and reduced time spent mowing by 75%.

The importance of winter pruning was highlighted. This will help ensure the orchard remains productive for over 50 years.

Choose carefully when selecting varieties. Pant Du is now focusing on a narrower range of apple varieties, more suited to the local conditions, including Sweet Alford, Michelin and Enlli (the Bardsey Apple).

Encourage pollination to increase apple volumes - as a result of the project, Pant Du is now providing apiary space for a local beekeeper, benefitting from pollination services.

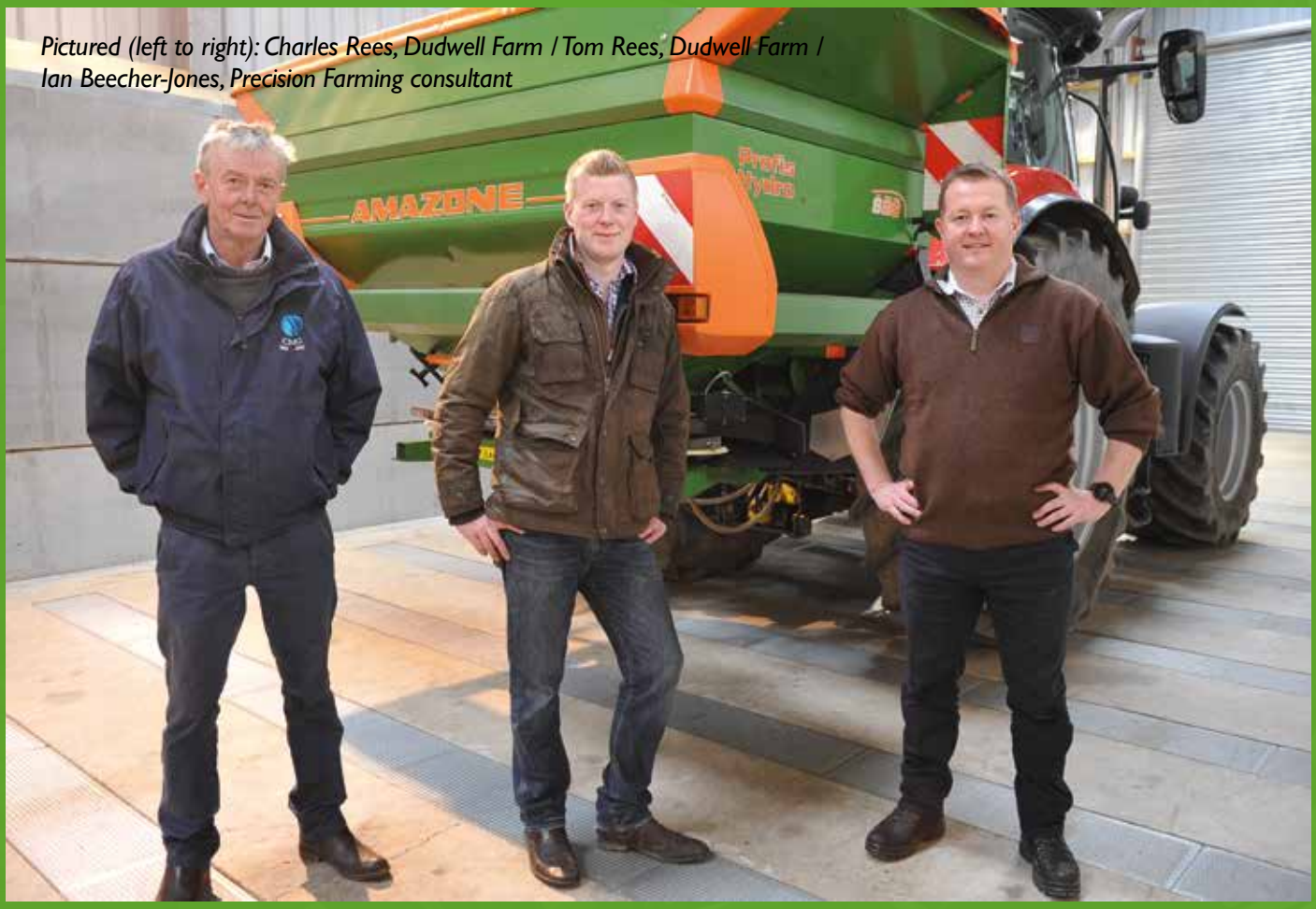
Choose apple varieties based on

- Longevity of production
- Annual productivity
- Suitability to the site
- Customer requirements

Consider

- Climate
- Slopes
- Soil conditions
- Labour requirement/availability
- Market potential

Soil nutrient mapping and precision farming techniques for arable crops



Pictured (left to right): Charles Rees, Dudwell Farm / Tom Rees, Dudwell Farm / Ian Beecher-Jones, Precision Farming consultant

Precision farming technology has the potential to help improve the performance, profit and efficiency of grass and arable farming systems.

Dudwell focus site, near Haverfordwest, grows a range of cereals, including wheat, barley, oats and oilseed rape, as well as running a sheep flock, suckler herd and store cattle enterprise. Farming Connect supported the farm to assess the value of precision farming, gaining a better understanding of farmland characteristics and providing more accurate information to guide fertiliser inputs.

Soil electrical conductivity (EC) scanning was used to map the soil types in each field, splitting the field area into one hectare grids before taking samples from the centre of each grid. Soil testing for various nutrients then showed the soil nutritional status across the sampling grids. This enabled inputs to be tailored specifically, optimising production and improving land condition.

What is electrical conductivity (EC)?

Electrical conductivity (EC) is a method of precision farming which measures how easily an electrical current flows through a material such as soil. The electrical conductivity of a soil sample will indicate the amount of salt, sand, clay, organic matter and water it contains. With GPS input such indications can be used to create soil maps. Measurements can be taken at two depths, referred to as a shallow array and a deep array measurement, with the relationship between the two providing valuable and useful information to farmers.

The cost of this type of precision sampling ranges from £15-£25/hectare, and needs to be repeated every three to five years.

Project results

Variations within fields was confirmed using soil EC

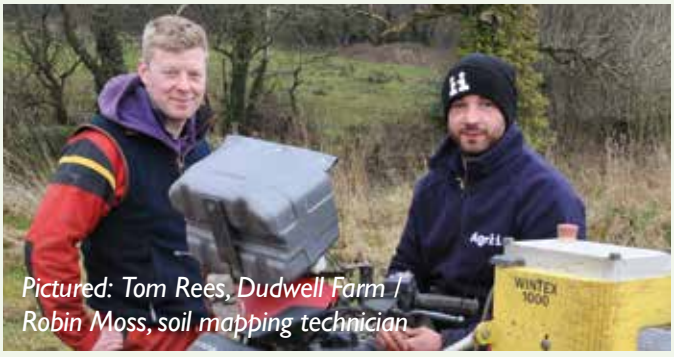
In one field sampling showed a huge range in the phosphorus level, from a low of -1 in some parts to a high of +3 in others while potash ranged from 0 to 3+.

Only 25% of a field sampled matched the overall field average of 2- reinforcing the benefits of taking a more specific within field approach to nutrient application.

The farm now uses a variable rate fertiliser controlled spinner linked to the GPS box on the tractor to apply phosphate as required across the field zones.

Different soil nutrient mapping companies produce similar results

The project compared two different soil EC testing services. Both tested the selected grid zones and results were very similar, providing reassurance on accuracy, and providing the basis for management decisions.



Pictured: Tom Rees, Dudwell Farm / Robin Moss, soil mapping technician

Actions from the project

- The digital maps produced, used in combination with the variable rate fertiliser technology and yield monitoring equipment on the combine harvester, allows fields to be managed more efficiently.
- Rather than working with a six or seven hectare field, fields will now be managed in areas of one or one-and-a-half hectare blocks.
- Digital soil sampling use will be rolled out across the whole farm.
- The technology has particular relevance for use in fields next to watercourses, allowing Dudwell farm to reduce any potential runoff from the use of excess nutrients.

Soil nutrient mapping doesn't necessarily reduce financial costs associated with inputs but does reduce inefficiencies associated with standard applications

Take action for improved efficiency and productivity

1. Use a nutrient recommendation system, such as the Nutrient Management Guide (RB209).
2. Contact your local Farming Connect Development Officer to see what's available regarding nutrient management planning.
3. Sample soils for pH, phosphate, potash and magnesium every three to five years.
4. Improve accuracy by looking at samples for 'in field variations' and tailor applications accordingly.
5. Check throughout the season for any visible crop deficiencies.
6. Take soil or herbage/crop samples from good and poor areas of the field to help diagnose cropping issues.

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