RHET
The Royal Highland Education Trust

STEM curiosities on the farm Level 3

Suggested Participants – S1-2

Farmers use a wide variety of science, technology, engineering and maths on a daily basis. The use of STEM on the farm enables efficient use of money and resources and assists with maximising yields and identifying illnesses. The range of STEM utilised varies depending on the type of farming enterprise with dairy units in particular maximising the potential STEM has to offer.

Our STEM curiosities on the farm resource provides an interactive platform for students to find out more about STEM on the farm as well as comprehensive notes for you to guide learning.

What this pack contains:

- All the links and content required to deliver our 'STEM curiosities on the farm' activity.
- Learning Intentions, Success Criteria and Suggested Experiences & Outcomes.
- Learning for Sustainability links.
- Lesson plan.
- Suggested additional activities.

Learning Outomes

- We are learning about the science, technology, engineering and maths used on the farm.

Success Criteria

- I can discuss some of the actions farmers are taking to be climate friendly.
- I can use real farm data to solve problems.
- I can discuss how scientists in Scotland are undertaking innovative research.
- I can discuss the role of STEM on the farm in minimising environmental impacts.

Experiences and Outcomes

- MNU 3-03a I can use a variety of methods to solve number problems in familiar contexts, clearly communicating my processes and solutions.
- MNU 3-07a I can solve problems by carrying out calculations with a wide range of fractions, decimal fractions and percentages, using my answers to make comparisons and informed choices for real-life situations.
- SCN 3-20a I have collaborated with others to find and present information on how scientists from Scotland and beyond have contributed to innovative research and development.
- SOC 3-08a I can identify the possible consequences of an environmental issue and make informed suggestions about ways to manage the impact.
- TCH 3-05a I understand how scientific and technological developments have contributed to changes in everyday products.

Learning for Sustainability

- Goal 2 Zero hunger, ensure sustainable food production systems and implement resilient agricultural practices.
- Goal 4 Quality education: achieve literacy and numeracy.
- Goal 9 Industry, innovation and infrastructure encouraging innovation and substantially increasing the number of research and development workers.

DYW

- Developing the Young Workforce – Entitlement Opportunities to engage in profiling that supports learning and the development of skills for work and future career choices.

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STEM curiosities on the farm Level 3 Lesson Plan

Introduction	• Share/discuss the learning intentions and success criteria. • Hear from Emily a farmer discussing some of the STEM she uses in sheep production. Talk to your class about STEM on the farm and let them explore the STEM curiosities resource.
Suggested discussion points	• How do you think STEM is used on the farm? • How can STEM be used to minimise environmental impacts on the farm?
Learning	• **Science outcomes:** The ability to discuss the innovation and research taking place on farms in Scotland. The ability to explain how STEM is used to reduce environmental impacts on the farm. • **Numeracy outcomes:** The ability to solve problems using real life data sets. • **Technology outcomes:** The ability to discuss how technology and science have shaped the production of everyday items like milk and bread.
Additional tasks	• You can find out more about food and sustainability with our 'Exploring food and sustainability' pupil platform.
More information	• There is more information on a range of STEM food and farming careers in our 'There's a role of everyone' resource.
Social media	Please tag **@TheRHET (Twitter)** or **@TheRoyalHighlandEducationTrust (Facebook)** in your lesson photos/comments.

Teachers' notes

STEM curiosities on the farm

What to do

This is an activity to encourage critical thinking around STEM on the farm.
You can either

a) get the items listed below and run the whole activity or
b) focus the whole activity on the interactive digital platform.

Each item comes with prompt questions, a video and a quiz. This resource is designed as a starting point to prompt further discussion, questioning and research.

Background information

Precision Agriculture involves collecting and processing data to make farm management decisions around efficiency, productivity, quality, profitability and sustainability of agricultural production.

Agriculture collects a vast amount of data and to process this, and to see any trends, requires both technology and maths.

There are a wide range of different robots used in agriculture however they all have the same overall aim – to automate slow and/or repetitive jobs like feeding livestock.
In our A-Z of food and farming, letter R provides more details and activities related to farming robots.

STEM curiosities

The STEM curiosities to prompt discussion:

1. A handful of soil
2. A box of cereal (or a sheaf)
3. A toy dairy cow
4. A tomato
5. A toy pig
6. A toy beef cow
7. A globe
8. A woolly sheep

Questions to pose for each item

- What is the object?
- How is it linked to food and farming?
- Can you think of any examples of science related to this object?
- Can you think of any examples of technology related to this object?
- Can you think of any examples of engineering related to this object?
- Can you think of any examples of maths related to this object?
- Is this object linked to global food production?
- What do you think the future STEM links for this object might be?

1 Handful of soil

Themes: Climate, Water, Biodiversity, Land use, Genetics

Introduction:

Soil supports human life on Earth. Over 95% of the food we consume comes directly or indirectly from the soil. As well as providing the growing medium for various foodstuffs, soils also cycle nutrients, regulate climate and sequester carbon. Soils are damaged through erosion, compaction and pollution. However, we can sustainably manage soils by reducing disturbance, keeping the soil surface covered with vegetation throughout the year and implementing crop rotation.

Soil related questions

These questions and the further information links below provide a starting point to expand on learning.

- What is soil?
- How is it formed and how long does this take?
- Are there different types of soil?
- Why is soil so important to our survival?
- What type of creatures live in the soil?
- What are the threats to soil?
- What is being done to help soils?

Science	Technology	Engineering	Maths
Soil mapping is very important in sustainable land use management. For example testing soil pH across a field generates a map that can determine where to apply lime. The tractor is programmed so the lime is only applied in the field where it is needed.	Sensors mounted on tractors sense how green the chlorophyll in plants is to determine how much fertiliser requirements. Genetic techniques let scientists study soil food webs that are essential to soil fertility.	Soil mechanics investigate the compaction of soil by heavy machinery like tractors.	Mathematical modelling of soils helps determines what might happen to soils in different scenarios. This is particularly helpful when looking at what might happen to soils with climate change.

Further information

Soils alive story
In our A-Z of food and farming, letter S is for soil
Soil functions poster

2 Cereal

Themes: Genetics, Climate, Science, Water

Introduction:

All modern tractors have Global Positioning Systems GPS technology. A driverless tractor is any autonomous farm vehicle that can manage its own speed, steering, braking, and navigation. This involves GPS, lasers and cameras. The hands free hectare project has shown that an entire cropping cycle can be completed without a person entering the field – this is entirely via autonomous farm machinery.
Crop breeding is the science of improving crops for the benefit of people. One of the most important traits that plant breeders aim to improve is 'yield'. Crop yield is the weight of grain harvested from a particular area. At its most basic level, crop breeding involves crossing two plants to produce offspring that share the best characteristics of both parent plants. Plant breeding can also produce varieties with better disease or drought resistance, reducing the use of chemical fungicides and helping us adapt to global warming.

Cereal related questions

These questions and the further information links below provide a starting point to expand on learning.

- What cereals do we grow in Scotland?
- Where in Scotland do these crops grow?
- How do autonomous farm machines work?
- What type of tasks could be completed by autonomous farm machinery?

Science	Technology	Engineering	Maths
The greenness of chlorophyll in plants is related to environmental stresses and sensors monitoring greenness can determine which plants need extra food in the form of fertiliser.	Farmers across Scotland use drones for a whole range of different jobs like crop spraying and seeding, monitoring crop health and growth, chlorophyll and phosphorus analysis and drought assessment. Drones can improve efficiency and maximise productivity. Variable-rate technology (VRT) enables fertilisers, chemicals, water and other farm inputs to be applied at different rates across a field. This reduces the time spent on applications, reduces waste and potential run off from the field by applying only what is required.	There are many different jobs to do on an arable farm. In our A-Z of food and farming, letter M is for machinery. Different piece of machinery have been engineered to carry out a wide range of different tasks from turning over the soil to planting a seed. Machinery is engineered to be a certain size, so that minimal passes need to be made over the fields. Tramlines are routes that all machines using the fields follow.	Data is collected throughout the crop growing lifecycle. Here are a few examples: As crops are harvested, combine harvesters map the yields coming from different areas of the field. This data is processed for trends with the aim of improving future yields. This information can also indicate areas of the field that need further investigation with regards to pH or nutrient status. Crop moisture content is measured from harvesting right through storage to ensure the grain remains in peak condition.

Further information

The Journey of food: Seeds and grains
Grow Your Own Loaf

3 Dairy

Themes: Climate, Genetics, Robotics

Introduction:

Dairy farmers utilise a lot of STEM as looking after dairy cows is a time consuming job and milking happens twice or three times every day of the year. In parlours where robotic milking happens cows can chose when and how many times they come in for milking.

Dairy related questions

These questions and the further information links below provide a starting point to expand on learning.

- How much milk do dairy cows produce?
- Can you think of any jobs on a Dairy farm which could be automated?
- What products does milk get make into?

Science	Technology	Engineering	Maths
A dairy cow needs a nutrition plan! Dairy cows are finely tuned milk producers and require different diets depending on their stage of lactation (milk production). The genetics of dairy cows are important to ensure high milk yields and family lines are recorded. To improve herd genetics artificial insemination involves using semen from the highest quality bulls which can be sex-selected to ensure almost all calves born are female and can enter into the herd.	A lactation cycle starts at calving, with milking continuing until yields start to decline. The cow then has a dry period of approximately 2 months when she is not milked. After this period, she calves and another cycle begins. Computers linked to collars monitor the lactation cycle and work out when the cow needs to have another calf to maximise milk production. The milk yield is calculated utilising computers which read microchips on the cow (often in a collar). High yield will be one of the factors that decide which females are used for breeding programmes. Some advanced dairy farms have slurry bots these robots sweep cow poo into gaps on the floor before it goes into the slurry tank. Dairy cows often where pedometers, which highlight any foot issues the cow may have as well as indicating when cows are in season and ready for breeding.	The engineering on a dairy farm is set up to collect and store the cow's milk safely and hygienically. Cows can be milked robotically using lasers to identify where the teat is before attaching a suction cup to remove the milk. The milk is then transported through pipes into a holding tank, where it is cooled and held until collection each day.	Each cows produces a different volume of milk – its milk yield. Daily milk yield data is analysed to identity unwell cows as well as highlighting which cows to breed from. The quality of milk from a cow is determined by its butterfat to protein ratio. Adjusting the diet can alter this ratio. Collecting this data can highlight the impact of different diets on the cow and this determines how much the farmer is paid for the milk.

Further information

The story of dairy

4 Tomato

Themes: Water, Climate, Resource use

Introduction:

We grow a wide range of fruits and vegetables in Scotland. Some crops like leeks, onions, carrots and cauliflowers grow outside in the fields. Soft fruits like strawberries are grown undercover in polytunnels and tomatoes are grown in very large greenhouses.

Fruit and vegetables related questions

These questions and the further information links below provide a starting point to expand on learning.

- What type of fruit and vegetables do we grow in Scotland?
- What are these fruits and vegetable used for?
- Where in Scotland do they grow?

Science	Technology	Engineering	Maths
Tomato farmers buy in pollinators in the form of Bumblebees to pollinate the tomatoes. These bees live in boxes into the glasshouse and use coloured flags to navigate round the glasshouse. Use of ethelyne gas helps to ripen green tomatoes.	Tomato plants like warm conditions. To keep a constant heat over the growing season heat is often required. Tomato greenhouses are sometimes close to dairy units. The poo from the cows is fermented with a little bit of plant material, in anaerobic conditions this produces methane and C02 (biogas) which heats the glasshouse. The waste material produced from the fermentation process is fed to the growing tomato plants inside the glasshouse providing a natural fertiliser.	Tomato greenhouses need the engineering infrastructure in place to heat the building and harvest the tomatoes at height. Once tomato plants come to the end of the season in November, they are fed back into the biogas system to produce more green power and so the cycle continues. The automatic ventilation required to control the microclimate within the greenhouse, utilises computers.	Tomatoes are encouraged to grow up to the roof to gain maximum fruit trusses (10m +) and data is collated on the volume of fruits produced. The farmer needs to calculate the number of pollinating Bumblebees required for the greenhouse.

Further information

In our A-Z of food and farming, letter V is for vegetables.

5 Pig

Themes: Land use, Genetics, Robotics

Introduction:

In June 2019, there were an estimated 319,000 pigs in Scotland, with 36000 sows and gilts (a female pig who has not yet had her first litter of piglets) in the breeding herd.
Despite the breeding herd increasing in recent years most of the pigs born in Scotland are slaughtered and processed elsewhere.

The pig industry has invested heavily in genetics, technology, feeding systems, monitoring and housing, allowing for improvements in performance and efficiency to be made.
(Source Farm Advisory Service)

Pig production related questions

These questions and the further information links below provide a starting point to expand on learning

- Where is Scotland are pigs produced?
- What type of systems might pigs be reared in?
- What products do pigs provide us with?

Science	Technology	Engineering	Maths
Fat scanning software can be used to analyse intramuscular fat levels of live pigs. By understanding levels of fat in the body, farmers can work on breeding pigs that are tastier and more appealing to consumers. Fat scans allow breeders to actively select animals for higher intermuscular fat without excess back fat and enable the diet to be changed rather than waiting until slaughter to score animals.	Artificial intelligence enables facial recognition of pigs. This can monitor interactions in pig herds and help the farmer solve any behaviour issues. Robots can improve animal welfare, safety and production. Pigs wear sensors like FitBits, allowing farmers to track individual pigs and monitor health. Sensors can also alert farmers to illness concerns, heat cycles, food and water intake. In outdoor pig systems, drones can be used to check herds and relay the status of their location or health. intake. In outdoor pig systems, drones check herds and relaying status of their location or health.	Fixed sensors in pig units can record house ammonia levels, dust, humidity and temperature. This allows these things in the environment to be maintained at a comfortable level for the pigs.	Data is collected and analysed looking at piglets per sow so that each sow breeding is as productive as possible. Data on ammonia levels is analysed to determine ways of reducing in house levels.

6 Beef

Themes: Technology, Innovation, Resource use

Introduction:

There are 413,400 beef cattle in Scotland. The majority of these graze outside in the summer and come indoors for the winter.

Cattle production related questions

These questions and the further information links below provide a starting point to expand on learning.

- What products do cattle provide us with?
- What do cattle eat?
- What type of technology might you find on a beef farm?

Science	Technology	Engineering	Maths
The efficiency of beef production involves applying knowledge of nutrition and breeding. Grass is used to produce silage, which is eaten by the cows over the winter. The nutrition of this silage is very important.	Beef cattle can be fitted with Electronic Identification devices (eID) - small ear tags that have a unique number identifier, which is printed on the tag and able to be read by radio frequency devices remotely. The information in the transponder can be read with a handheld or static reader. 3D imaging technology can be used on beef cattle to provide carcase characteristics of live animals. If they don't meet specifications the diet of the animal can be amended so that that they gain weight in a way that means they will produce the most suitable type of carcass.	Systems which integrate the data sets gathered on-farm from applications like Electronic weigh crates and eID increase profitability.	Beef cattle eat grass and calculating the amount of vegetation available is vital in beef production. Maths is used to calculate weight gain. Beef cattle are regularly weighed using electronic weigh scales which graph changes in weight over time. This helps determine how much to feed them and when to sell the cattle to maximise profit.

Further information

Story of beef Wakelet.

7 Globe

Themes: Climate, Biodiversity, Technology

Introduction:

Climate-positive farming is a transformational approach to farming that achieves net-zero or even negative carbon emissions, whilst also protecting and enhancing the natural assets of a farm and ensuring long-term financial sustainability of the farm business. This involves:

- producing and using renewable energy for transport, heating and other machinery
- energy efficiency
- 'carbon farming' (removing CO2 from the air) through crop choice, expanding woodland, restoring habitats and soil
- innovative and transformative management to minimise GHG emissions
- protecting biodiversity
- smart water management and conservation
- selling direct from farm to table where possible
- minimising supply chain related emissions

Source glensaugh.hutton.ac.uk/climate-positive-farming/overview

Climate and farming questions

These questions and the further information links below provide a starting point to expand on learning.

- What is the difference between climate and weather?
- What is climate change?
- How might a changing climate impact farmers?
- How might a changing climate impact what you eat?

Science	Technology	Engineering	Maths
Carbon dioxide is a greenhouse gas. The soil can store carbon and help regulate the climate. Soil carbon storage can increase or decrease depending on how the soil is managed. Farmers are working on increasing biodiversity on their farms and this involves being able to identify plants and animals.	Sensors are used on farms to monitor a wide range of different things from methane emitted from cows to monitoring the weather. Renewable energy for transport, heating and other machinery energy efficiency.	Some farmers are looking at planting crops without turning over the soil by ploughing. This is called no till. There is a new trial piece of engineering that will use jets of steam to kill the grass in a small area before planting seeds.	Increasing on farm biodiversity goes hand in hand with climate adaptations. Farmers are working to increase the number and range of different species on the farm. Research is happening on some Scottish research farms where data is collected on plant and pollinator numbers and graphed to show increases and/or decreases over time. Maths helps calculate stocking densities for livestock, determine pest numbers and monitor emissions.

Further information

Glensaugh climate friendly farming initiative

8 Sheep

Themes: Land use, Technology

Introduction:

Scottish sheep production involves hill, upland and lowland systems, utilising all areas of Scotland. The Scottish sheep system is often described as stratified, meaning it is designed to use the strengths of specific environments, matched to attributes within breeds.

There are approximately 6.67 million (2019) sheep in Scotland, compared to a population of 5.45 people. Popular cuts of lamb meat for the Scottish consumer are leg and loin.
(Source Farm Advisory Service)

Sheep related questions

These questions and the further information links below provide a starting point to expand on learning.

- Where is Scotland do you find sheep farmers?
- What products do sheep provide us with?
- What do sheep eat?
- Do sheep have teeth like us?

Science	Technology	Engineering	Maths
Fat scanning software can be used to analyse intramuscular fat levels of live sheep. By understanding levels of fat in the body, farmers can work on breeding sheep that are tastier and more appealing to consumers. Fat scans allow breeders to actively select animals for higher intermuscular fat without excess back fat and enable the animals diet to be changed so they finish correctly rather than waiting until slaughter to score animals.	Ultrasound scanning in sheep allows the farmer to find out how many lambs a sheep is carrying. This means the sheep can be separated into groups which are then feed a suitable diet. Drones are used to keep an eye on hill sheep and identify any issues that need attention quickly. Sheep wear Electronic Identification (eID) devices - small ear tags that have a unique number identifier, which is printed on the tag and able to be read by radio frequency devices remotely. The information in the transponder can be read with a handheld or static reader.	Sheep need to be sheared each year. This requires a system of gates to funnel then into the correct pens. Sheep need regular foot trimming. A turnover crate turns the sheep onto its back and holds it there giving the farmer the opportunity to trim the hooves.	Each sheep provides a fleece each year. The price paid for the fleece depends on the breed of sheep and the condition of the fleece. Maths is used to calculate medicine doses, record and monitor sheep weights and determine profit margins.

Further information

The story of sheep