



Inspiring STEM learning through agriculture



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Introduction

Agriculture is an industry that embraces new technology to enable us to produce more food while impacting less on the environment. Science, technology, engineering and maths are all subjects deeply embedded in the sector. From soil science to plant breeding techniques and cutting-edge precision engineering, agriculture is in a great position to provide real-life examples of STEM in action and help children learn these subjects in an inspiring and engaging environment.

Using agriculture to help teach STEM subjects will benefit high-tech industries that will need STEM professionals to help them innovate and thrive, including agriculture. But it can have significant wider ranging, and longer term, benefits too. It is one of the most accessible ways to teach STEM inside and outside the classroom. It is relevant and applicable to all age groups – from learning about life cycles and the different seasons and how they affect agriculture in primary school, to understanding nutrition and tackling the challenges of feeding a growing population using fewer natural resources and while impacting less on the environment as part of the secondary curriculum.

Learning about British food and farming from a young age will also ultimately help our future generations make informed choices. Educating children about where food comes from will help them to make healthy choices about buying, preparing and enjoying food as they grow older.

Discovering more about our natural environment and how we live and work in it also has major benefits through ensuring a better understanding of how food production and maintenance and enhancement of the environment go hand in hand. Having lessons in an outdoor environment and working together to help solve problems fosters team skills that will be invaluable in later life. It also helps connect children to the natural environment and helps improve physical and mental



wellbeing. We also face the issue of climate change and our ambition of achieving net zero greenhouse gas emissions from agriculture by 2040. The next generation of STEM professionals will play a crucial role in helping us achieve this, as will the farmers who are keen to play their part too.

Government has the opportunity to recognise and promote the role that farming can play in teaching vital STEM subjects in an exciting and innovative way that benefits the next generation. We ask the government to make sure agriculture is pushed as a way of doing this. It would make a huge difference for the pupils, the school and wider society.

By engaging children with agriculture at an early age, and showing them that science, technology, engineering and maths play crucial roles in the sector, we can inspire future generations of STEM professionals. This will have benefits for other industries and the wider economy, as well as inspiring interest in working in Britain's all-important food industry. The work the NFU Education team has done demonstrates the real learning outcomes for children as well as the benefits for schools in teaching STEM through an agricultural lens, as this report shows.

Minette Batters
NFU President

Preface



I am a strong believer that learning is never exclusive to the classroom. It does not have to be taught from textbooks or even in a situation that is considered a learning environment. The most effective way of learning is by applying it to real situations. Incorporating vital STEM subjects into an exciting scenario such as farming provides a more creative delivery mechanism for teachers and engages their pupils, enabling them to develop key problem-solving and STEM skills.

There is currently a lack of STEM graduates and people with the skills needed to create a productive and sustainable Britain for the future. This is not just in agriculture, but the wider economy as well. This is where agriculture can help. Agriculture is a subject every student in the country can relate to – we all eat food produced on farms every day – and relatable activities increase student participation and interest. It also has another advantage – the current STEM curriculum links exceptionally well to food and farming, in areas like life cycles, habitats, food chains, food technology and others.

The AT Kearney Tough Choices report¹, published in 2016, pointed to a reduction in interest in STEM subjects from Upper Key Stage 2 (years 5 and 6, ages nine to 11) onwards. To stop this, we need to engage children early before they form any misconceptions about STEM subjects. Doing this through the prism of agriculture can also ensure young people do not develop negative preconceptions about food and farming as a possible career.

The NFU's Farming STEMterprise and Farmvention projects were designed to provide a relevant and motivating experience to ensure children experienced the transition from primary to secondary school with a strong enthusiasm towards STEM study. They have proved hugely popular with pupils and teachers alike. This has demonstrated that food and farming can help to bring the core STEM subjects to life for many children. As we continue to grow our offering and work with older students, connecting students with diverse role models continues to be equally important. It is vital that neither STEM subjects nor agriculture are seen as abstract or foreign concepts.

Children living in our cities have access to amazing STEM employers and higher education institutions but may lack understanding of food and farming; children who grow up in rural areas may have a greater understanding of farming and where food comes from but have less access to high quality STEM learning experiences. The link between agriculture and STEM can have huge benefits for children wherever they live, as well as long-term benefits for employers who need STEM skills.

STEM is not just about science, or technology, or engineering or maths. It's about all of them together and implementing them in situations that will teach children about life outside the classroom. It's about providing a new way for them to learn important skills, in a way that doesn't seem like learning. It's about challenging children to think about the future and their part in it. Using agriculture is a great way of doing this – and the benefits will be felt from field to fork, and beyond.

Josh Payne
NFU Chief Education Manager

Inspiring STEM learning through agriculture

Agriculture has a unique ability to engage and inspire children in STEM learning both inside and outside the classroom. Using agriculture in this way has multiple benefits – it reconnects children with where their food comes from, it teaches them about the environment around them, and it develops an early interest in science, technology, engineering and maths and the exciting and innovative opportunities these subject areas can lead to. This can have long-term benefits beyond food and farming, by having a positive impact on other industries that need STEM skills.

Agriculture is an innovative and forward-looking industry. To meet the challenges of increasing productivity so we produce more of our food, while simultaneously maintaining and enhancing our natural environment, it is going to need to continue to innovate and embrace science and technology.

Work is taking place on the development of robots to plant and monitor crops, and tackle weeds, in an efficient and targeted way; drones are being used survey fields; and GPS-guided machinery is already being used in fields. As the sector develops, the need for more people with STEM skills to work in it will only grow.

“Agriculture is the perfect context for STEM teaching because you have so many different areas to draw on. Even at the most basic level you are investigating how much water to put on crops, analysing data, costings, profit, life cycles, packaging, designing, engineering, nutrition and so much more.”

Claire Hofer
Science coordinator, Brompton
Westbrook Primary School, Gillingham



Science



Agriculture is a great fit for science teaching because science permeates through everything farmers do – from medicines for animals, to plant breeding technology to make plants more resistant to disease, pests and natural events like droughts, to monitoring and maintaining the health of our soils.

The NFU's Farming STEMterprise project helps teach children nutrition, growing and caring for crops, what humans and animals need to be healthy, plant and animal life cycles, plant reproduction, seasons and weather and much more.



Engineering



Agricultural engineers attempt to solve problems concerning power supplies, the efficiency of machinery, the use of structures and facilities, pollution and environmental issues, and the storage and processing of agricultural products. As well as designing machinery and equipment for a range of uses, engineers assess the impact of agricultural production methods, supervise construction projects, and analyse GPS and weather data to advise farmers and businesses on best land use. The Royal Academy of Engineering has recognised the value of delivering STEM learning through the lens of food and farming and its role in inspiring the next generation of engineers by funding a new NFU education project to bring to life engineering roles in agriculture.

Working through both the Farming STEMterprise and Farmvention projects involves taking children through the engineering design process: Ask, research, imagine, plan, create, test, improve.



Technology



Technological innovation is one of the driving forces behind agriculture. Work is constantly being done to develop new technologies to enable farmers to improve their productivity while also minimising their impact on the environment. Whether it is GPS technology which allows machinery like combine harvesters to operate accurately and effectively at night during harvest, the use of drones to map fields and monitor livestock, or the development of robots to plant, monitor and treat crops autonomously, agriculture is at the cutting edge of developments.

The NFU's Farmvention project involved children designing a tractor of the future, a farming machine for 2040 and investigating what the best material would be for a polytunnel.

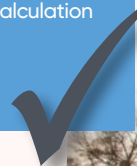


Maths



Maths is a key element for every farm business which goes beyond general business calculations of profit and cost. Agriculture also lends itself to working out heights, weights and distances, as well as calculations like how much seed would be needed to plant a field and how much feed is needed for animals.

Farming STEMterprise covers statistics, pie charts, bar charts, tally charts, line graphs, calculating profit, calculating with money, fractions, decimals, measurement, conversion, working within a budget and all four calculation methods.



Teaching through agriculture can also bring all the benefits of outdoor learning. Studies have shown that outdoor learning can have a number of benefits for school children, including:

- **Boosting academic performance;**
- **Improving personal child development;**
- **Improving children's physical, mental and emotional wellbeing;**
- **Connecting young people to nature;**
- **Giving children a love and appreciation of our natural surroundings;**
- **Giving practical experience.**

Yet despite the importance of nature to children's wellbeing and development being well-documented, a 2016 study found that three-quarters of UK children spend less time outside than prison inmates. It is therefore unsurprising that a 2019 survey by the National Education Union found that 'largely, mental health issues are on the rise with almost 68% of respondents saying they believe their school is having to deal with more pupil mental health issues than five years ago'.



There has already been an acknowledgement from government that agriculture can be used to teach STEM. At the 2019 Oxford Farming Conference, the then-Defra Secretary of State Michael Gove acknowledged that agriculture should be seen as a STEM subject, adding that:

“We need to make sure that the next generation coming to work in farming and food production recognise that it is one of the most scientifically exciting and academically rigorous areas of future industrial growth in this country”.

Welcoming that statement, Professor Jo Price, vice chancellor at the Royal Agricultural University², said: “There is a desperate shortage of skilled workers who understand technology, can interpret complex data, and operate the sophisticated equipment that productive farms increasingly depend upon.

“Although agriculture is a science-based discipline increasingly dependent on the use of technology and data, it is not perceived to be a ‘modern’ subject of choice for young people. The problem is compounded by there being a limited understanding among those working in schools of the diverse and exciting range of careers available in the agri-food and land management sectors.”

“What is school science for? This question is often something we ponder on and query. Perhaps over the years the emphasis has been on the retention of knowledge and scientific facts – of course worthwhile and relevant to all.

“Yet it is crucial that young people use and apply this learning in meaningful contexts that are relevant to their lives. Focusing on agriculture education could seem, to some, highly specialised on first view – but all it takes is to realise that this area of science and engineering actually provides the basis for helping young people understand how the world around them works. From the food on their plate, to the air that we breathe, children need exposure to nature, especially those who lack access to open spaces and the countryside.

“This area of work needs support, expert guidance and challenge. Schools and teachers cannot be expected to have key information and knowledge about the sector. By working in partnership and close connection with senior leaders and teachers, there are real opportunities to encourage questioning leading to working scientifically. As innovation has improved the efficiency of farming, this too is a great way to enable young people to see how science and engineering



come together to find solutions to problems such as watering crops, harvesting without damaging fruits, and precision planting. The sector is working in smart ways. Now we need to get smarter about how we use high quality STEM learning in schools to champion this vital, yet often underexposed, area of science and engineering.

“It is only by working in partnership and being connected across the sector that teachers will ultimately get the best experience. As much as we need schools and teachers to respond to this agenda, we need the wider educational landscape to embrace it as well. Doing this can only help the national agenda for excellence in STEM education.”



Dr Lynne Bianchi

Director, Science and Engineering Education Research and Innovation Hub, The University of Manchester and Great Science Share for Schools Director



The wider benefits of teaching STEM through an agricultural lens

The benefits of inspiring STEM learning through agriculture extend beyond creating the next generation of scientists, engineers and mathematicians. Using agriculture in this way reconnects children with where their food comes from and also about the environment around them.

Learning about British food and farming from a young age will ultimately help future generations make informed choices. Educating children about where food comes from will help them to make healthy choices about buying, preparing and enjoying food as they grow older. Healthy eating has positive benefits for society by playing a role in tackling issues around obesity and related health concerns.

Bridging the gap between the food on our plates and the knowledge of how and where it is produced is also an important step towards a sustainable food and farming industry.

Understanding how agriculture works with nature to maintain and enhance our natural environment will only become more important as we strive to feed a growing population in an ever-more sustainable way.

The other benefits of outdoor learning that teaching STEM through an agricultural lens can bring are also important, especially in terms of improving personal development, the ability to work in teams and boosting physical, mental and emotional wellbeing.



There are also the wider long-term economic benefits of engaging young people in STEM subjects at an early age and showing them the wide range of career opportunities available, not just in the food and farming sector but beyond.

The UK Commission for Employment and Skills report on high level STEM skills³ highlighted the agri-tech sector as one that increasingly needs STEM professionals because of the wide range of skills needed across the sector.

It said: "Agriculture is being transformed by a technological revolution based on breakthroughs in nutrition, genetics, informatics, satellite imaging, remote sensing, meteorology, precision farming and low impact agriculture.

"A strong scientific capability is needed to support the agri-food supply chain, which plays a crucial part in the UK economy. The skills needed to support the sector are changing rapidly, moving towards technology and higher level scientific and managerial skills to match advances in informatics, precision farming and engineering."



Addressing the STEM learning challenges using agriculture in practice



“The STEMterprise project has given our whole school a driver and an end goal to achieve. Every child has been motivated and inspired, all hoping to reach the highest profit. It has given our children a real-life purpose and enabled them to apply their skills in Maths, Computing and Design & Technology while understanding the real-life application of their Science learning.”

Craig Smith
Science coordinator, Bedford Drive Primary School, Birkenhead

One of the key factors that has been identified as impacting on children’s interest in STEM subjects is their lack of perceived usefulness or relevance to real life. Presenting STEM problems in real-life contexts can help to increase children’s motivation.

But the concept of real-world learning is frequently misunderstood. Dan Meyer (the creator of Three Act Maths) explains that simply framing dull questions in a real-world context is not sufficient. We also need to be looking at what the children are being asked to do. Tasks that provide real work in a real-world context will be the most effective in engaging reluctant STEM learners and giving them a purpose and direction for their learning. This

consequently improves their motivation and perseverance when tackling challenging topics.

The ‘Inspiring Growth: CBI/Pearson education and skills survey report’, published in 2015, highlighted early engagement with young people as a problem area, saying: “There are a number of challenges around primary science education – such as the level of prioritisation assigned to the subject,

finding time within the wider curriculum and issues around teacher confidence.”

Another key factor that is often cited as a reason for children losing interest in STEM subjects is their perception that careers in those subjects are for people who fit the stereotypical image of “a scientist”.

Before learning about the NFU’s Farming STEMterprise materials, a survey showed:

64% of teachers did not teach about farming because it is not on the national curriculum.

43% of teachers did not teach about farming because they lacked subject knowledge.

'Science capital' is a term used to refer to an individual's science-related knowledge, attitudes, experiences and resources that are acquired throughout their life. In short, the more science capital an individual has, the greater the likelihood is of them perceiving science and related careers to be "for them" or something they can aspire to.

One of the ways that schools can increase their pupils' science capital is by introducing them to people in science-related roles, either through external visitors to schools or trips away from the classroom. Another way is to provide learning experiences that demonstrate to children that science is everywhere around us and highly relevant to everyday life and agriculture is the perfect context for this as food is a topic all that all children have some knowledge, experience of or interest in.

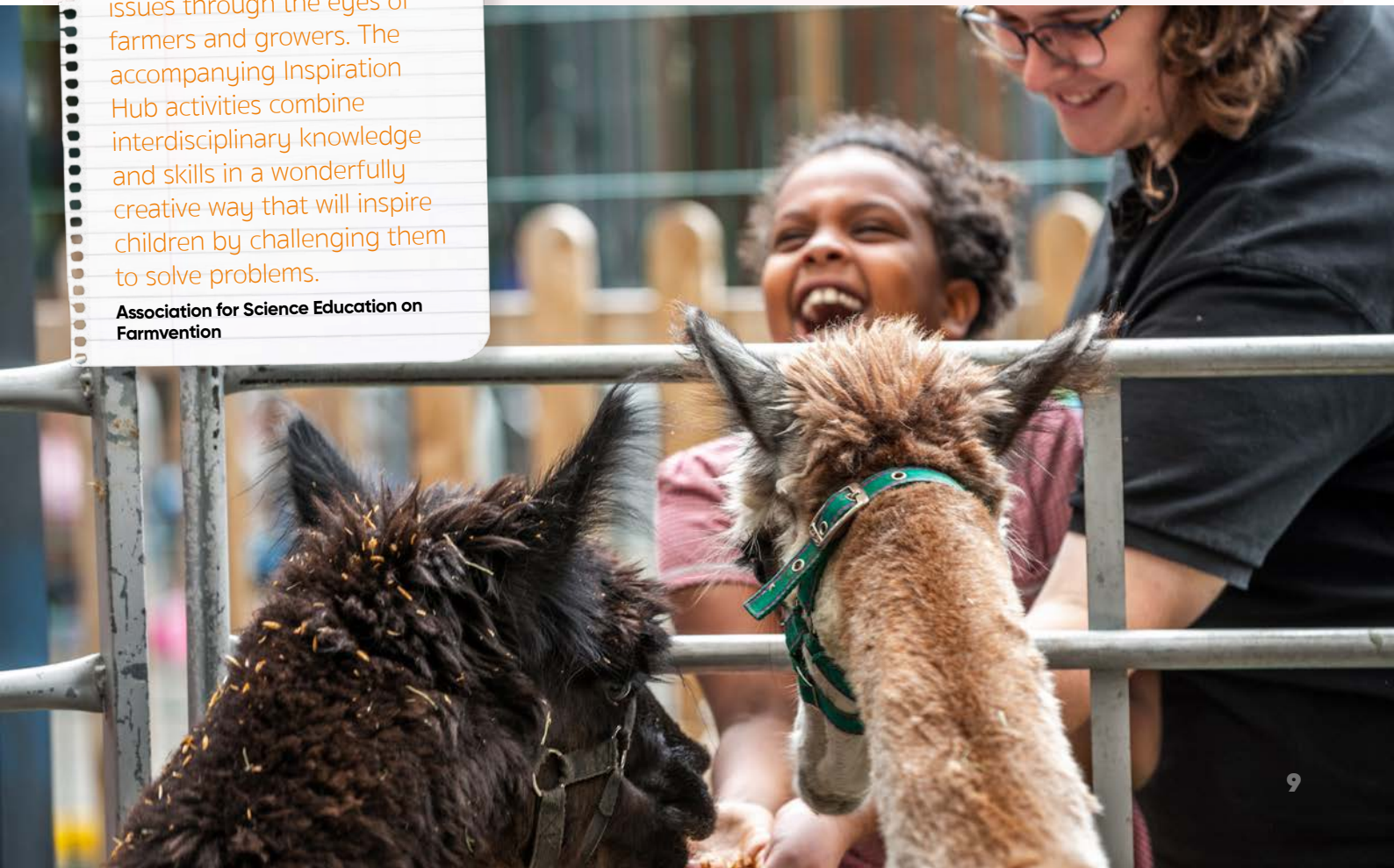
Two education projects developed by the NFU – Farming STEMterprise and Farmvention – have been designed to deliver STEM learning through engaging real-life contexts and highlight the wide range of career opportunities available in the sector. They also provide fully prepared lesson plans that help address issues around teachers' time, workload and confidence. They are also linked closely to the curriculum and designed so teachers can use them to cover specific topic areas and curriculum objectives. This is an example linked to just one objective from the Year 3 programme of study.



Topic	Curriculum objective	NFU Education activities
Working scientifically	Recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts and tables	<ul style="list-style-type: none"> • Farming STEMterprise Year 3 Stage 3: Conduct market research • Farming STEMterprise Year 3 Stage 5: Investigate the requirements of plants for life and growth • Farming STEMterprise Year 3 Stage 7: Investigate how water is transported in plants • Farmvention: Design a product made from wool • Farmvention Climate Superheroes: Investigate the best shape for a drone • Farmvention Climate Superheroes: Investigate how nutrients affect plant growth • Farmvention Climate Superheroes: Investigate wind energy

"The Farmvention competition provides an extremely stimulating opportunity for children in KS1, KS2 and KS3 to learn about environmental issues through the eyes of farmers and growers. The accompanying Inspiration Hub activities combine interdisciplinary knowledge and skills in a wonderfully creative way that will inspire children by challenging them to solve problems.

Association for Science Education on Farmvention



This helps to address the skills shortage in both STEM subjects and agriculture through the creation of early intervention projects and teaching resources that inspire interest in education and engage children with where their food comes from at an early age.

Of the teachers who used the Farming STEMterprise project

90% agreed or strongly agreed that the project provided an engaging context for STEM learning

The Farming STEMterprise projects involve Key Stage 1 and 2 children (ages four to 11) completing a range of cross-curricular tasks in order to set up their own farm shop business and design, develop, make and market a new food product.

The projects take children through each stage of setting up a farm shop business: considering seasonality when deciding which crop to grow, growing their own ingredients, considering nutrition when designing their recipes, using market research to test their ideas out with potential consumers, working within a budget when buying ingredients, calculating profit, designing responsible packaging and more.



“The Farming STEMterprise projects provided a breadth of skills development which engaged our children across the curriculum (Maths, Science, Design & Technology) through contextual stimulus and competition. In addition to their Science learning, the children gained an understanding of product design/development, marketing and budgeting through setting up their own farm shop businesses and producing food products for their parents and wider family to purchase.”

Steve Morris
Head teacher, Hillside Primary School,
Birkenhead

Farmvention (when farming meets invention) – a national STEM competition aimed at children aged five to 14 (school years one to nine) in England and Wales – included problem-based challenges, focused on engaging children with key STEM topics as well as getting them thinking about the everyday challenges farmers in Britain face.

Presenting STEM learning through this engaging cross-curricular approach and challenging children to work as a team to solve a range of real-life projects increases their levels of engagement and enjoyment. This was demonstrated in a survey of teachers who took part in NFU Education's programme of activities during British Science Week 2021. Of the teachers who used the Farming STEMterprise project resources, 97% reported their children's engagement to be either 'High' or 'Very high'.



“The NFU Education Science Week programme has been great for developing the children's science capital and helping them to understand that science is not just something that happens in a science lesson but it's everywhere in the world around them. This project has helped them to understand and appreciate the science involved in growing their food and caring for their own plants, as well as considering costing and manufacturing. It has been a fantastic real-life project for the whole school to get their teeth into.”

Claire Hofer
Science coordinator, Brompton Westbrook Primary School, Gillingham

Additionally, in a survey of teachers who entered the Farmvention competition in its first year, 96% of teachers agreed or strongly agreed that their children enjoyed the Farmvention competition and were engaged throughout and 90% of teachers agreed or strongly agreed that the project provided an engaging context for STEM learning.

A survey of teachers who had used the Farming STEMterprise materials, carried out in 2020, showed how impactful and relevant to the current curriculum the materials were. Before learning about Farming STEMterprise, 23% of teachers thought farming was relevant to the primary curriculum. After learning about the projects, 89% thought farming was relevant to the curriculum.

Farming STEMterprise's value as a STEM resource was also recognised when it won the STEM category of the 2020 Teach Primary Awards, with the judges describing it as "a cross-curricular gem".

The feedback both projects have received from teachers also demonstrates how agriculture-based projects can effectively contribute to the high-quality teaching required to nurture a passion for STEM learning.

Farming STEMterprise teachers survey results:

After learning about Farming STEMterprise, **97%** of teachers said they associated farming with teaching science.

After learning about Farming STEMterprise, **91%** of teachers said they associated farming with teaching maths – a **79% increase**.

After learning about Farming STEMterprise, **95%** of teachers said they associated farming with teaching design and technology.

93% of teachers surveyed **planned to use Farming STEMterprise** with their class.

98% of teachers surveyed would **recommend Farming STEMterprise** to their colleagues.



Before learning about Farming STEMterprise

23% of teachers thought farming was relevant to the primary curriculum.

After learning about the projects

89% of teachers thought farming was relevant to the primary curriculum.

"This resource will make a valuable contribution to the primary school and provide teachers with ideas and materials to support pupil learning across a number of curricular areas. The farming and business context breathe life into the content and ensure that every lesson is closely connected to the everyday world of farmers and consumers. The resource could be adopted for a scheme of work over a number of weeks or, alternatively, given the wide range of content and activities, teachers could incorporate specific lessons and activities into their existing teaching programmes. Either way, pupils and their teachers will be the winners."

Association for Science Education on Farming STEMterprise.

REFERENCES:

1. Tough choices: the real reasons A-level students are steering clear of science and maths, AT Kearney/Your Life, 2016
2. Three cheers for Michael Gove: if he can make agriculture a STEM subject, Professor Jo Price, Royal Agricultural University Vice-Chancellor, Higher Education Policy Institute website, January 2019
3. Reviewing the requirement for high level STEM skills, UK Commission for Employment and Skills, July 2015
4. Inspiring Growth: CBI/Pearson education and skills survey, CBI/Pearson, 2015

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