Teacher Guide Notes -
A Case for the Countryside

Science 1

Power Games

THE CONTEXT

This project focuses on matching supply to demand in terms of renewable energy. It aims to show by example that land can be used not only to provide food and fibre, but can be farmed to produce renewable energy.

It does not take account of seasonal demands, or factory development or technology. These could be considered as extension activities.

THE ACTIVITY

This focuses on producing a project report on a farm-based renewable energy source.

FOCUSED PRACTICAL ACTIVITY

Divide the class into 6 groups and use the student activity sheets provided. Each group is expected to produce a project report on a farm based renewable energy resource, to meet the needs of the local community i.e. school/town/school bus service.

Each group has a project leader who must present a summary of their report to the rest of the class. The summary can be printed and distributed (no more than 2 sides of A4). A vote can be taken on the most suitable project at the end of the second lesson.

Pupils will need to consider:

1. **energy consumption (market)**
2. **potential energy products - area of land required**
3. **potential siting of project on the farm**
4. **planning and environmental issues i.e. visual impact, impact on physical environment (including global warming, air quality, soil/water), impact on ecology, impact on wildlife**
5. **suitability of project in local area**
6. **factory development**
7. **cost of energy production.**

The groups will cover:

- **biodiesel production**
- **short rotation coppice**
- **wind power**

The information about renewable energy sources given on the students' technical data sheets is only a summary. It is envisaged that the topic of renewable energy will have been introduced in previous lessons.

At some stage the teacher may wish to introduce the economic viability of various alternative energy sources in the UK .... most of the sources are marginal in economic terms and are not currently viable. Much depends on the price of competing energy resources. Alternative sources may only become viable when the price of fossil fuels rises substantially due to depletion of reserves or by altered legislation.

RESOURCES

Additional facts and figures and specimen answers (following sheets)

Student Activity Sheet

Maps from Maths Unit on Eastrop Farm

RELEVANT WEB SITE LINKS

Planet Energy - http://www.dti.gov.uk/renewable/ed_pack/index.html;
National Energy Foundation Renewables - http://www.greenenergy.org.uk;
British Association for Bio Fuels and Oils - http://www.biodiesel.co.uk;
British Wind Energy Association - http://www.britishwindenergy.co.uk;
ETSU - http://www.etsu.com;
AEA Technology Environment - http://www.aeat-env.com;
Future Energy Solutions - http://www.future-energy-solutions.com

ADDITIONAL FACTS/FIGURES

OIL SEED RAPE (OSR) BIODIESEL TECHNICAL DATE

1. PROPERTIES OF MINERAL DIESEL AND BIODIESEL DERIVES FROM OSR

	BIODIESEL	DIESEL
Density g/m3	0.88	0.83-0.85
Cerane numbers	45-54	48-58
Viscosity mm2/s @ 20 oC	3-8	6-8
Net calorific MJ/1	35.6	32.5

2. OSR AND BIODIESEL YIELDS

1 hectare (ha) of OSR produces an average 3.2t (tonnes) rape seed

3.2t rape seed produces 1.25t rape oil and 1.86t rape seed meal

1.25t rape oil produces 1.18t biodiesel and 1.14t glycerine

- **At harvest moisture content tends to be around 50%**
- **1 tonne of woodchip can occupy 2-6 cubic metres (average depending on chip size, moisture content, settling, etc.)**
- **1 tonne woodchip (20% moisture = 5 GJ total energy = GJ useful energy)**

ANSWERS AND COMMENTS

1.a If 1t of biodiesel is produced from 1 ha of land, then the area needed to produce 45,000 litres of biodiesel is:

45,000 x 1 = 45 ha

1,000

This assumes 1 kg biodiesel - 1l biodiesel

The OSR would be grown on arable land, however grass acreage should remain constant to supply the cattle with feed and remain close to dairy buildings.

45 ha would be a substantial proportion of the arable enterprise (approx. one third). It would result in lower income as less wheat and barley could be grown. There would also be problems in terms of crop rotation.

2.a 1 tonne woodchip = 1 MWh = 1,000 kWh

Eastrop Farm electricity use = 50,000 kWh / yr

50 tonnes of woodchip needed each year, if over a three year rotation 40 total dry tonnes are produces per ha, then area of land at Eastrop Farm required = (50/40) x 3 = 3 ha

2b. Warneford School Electricity use = 14,000 kWh / yr.

Therefore 145 tonnes of woodchip needed each year.

Area of land required = (145/40) x 3 = 10.9 ha

2c. Highworth Recreation Centre electricity use = 155,000 kWh / yr.

Therefore 155 tonnes of woodchip needed each year.

Area of land required = (155/40) x 3 = 11.6 ha

The area of land that needs to be taken up by arable coppice is negligible in all cases and would have little effect on current farming practices. Care and consideration would need to be taken when siting the willow as there needs to be access during the winter with heavy machines and so the heavy clay areas may not be suitable. There may be a perceived problem with the visual impact of a very large plantation.

3. Assume that with an above ground level wind speed of 6.1 m/s that the typical annual output is 1,000,000 kWh/yr.

3a. Highworth Recreation Centre total energy used = 155,000 + 700,000 = 855,000 kWh

A wind turbine rated at 500 kWh would therefore support entirely the energy needs of the recreation centre.

3b. If the average electrical consumption in the average house is 4,200 kWh / yr then a 500 kWh turbine would support 1,000,000 / 4,200 = 238 homes.

KEY REFERENCES

ATB Landbase. The Future Green. An introduction to Biomass Energy Crops. 1995

ETSU Renewable Energy in Agriculture

Centre for Alternative Technology Education. A Pupils' Guide to Windpower

Teachers' Guide to Renewable Energy Project

ETSU Wind Energy Fact Sheets 1 - 10

ETSU Agriculture and Forestry Fact Sheet

ETSU Short Rotation Coppice 1 - 15

ETSU Conversion 1 - 8

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Science 2

The Heat is On

THE CONTEXT

This focuses on monitoring energy use within the school. It introduces pupils to the Energy Topic in the context of a common environment.

THE ACTIVITY

The focus is on assessing energy usage in the school.

STARTING POINT/STIMULUS

An energy walk around school with the school caretaker.

Ask class to suggest how in the school:

1. **energy is used**
2. **energy is fuelled**
3. **energy use is monitored and controlled**
4. **energy is wasted**
5. **energy could be saved**

FOCUSED PRACTICAL TASK

Monitoring/Measuring

On the walk pupils should observe:

1. **position of radiators (obstructions)**
2. **temperature - (room/corridor/door)**
3. **light levels**
4. **windows, doors - open/closed**
5. **light bulbs - clean? energy efficient?**
6. **taps - temperature (hot should be >60 degrees Celsius) and drips**
7. **thermostat timings**
8. **meter reading } Caretaker**
9. **electrical appliances - fridges/computers**
10. **external temperatures - light levels**

FOLLOW UP ACTIVITY

Pupils can then:

1. **compare classroom temperatures and light levels to recommended levels, observe areas of the school where there is unsuitable heating/lighting, make recommendations to reduce wastage**
2. **collate light temperatures for areas of school over time, i.e. break/lunch and identify key periods where heat is lost and again produce recommendations to reduce this loss**
3. **monitor electricity use and calculate cost over a period of time, compare energy use to previous years**
4. **use a school plan to map where most energy is used/lost**
5. **design a poster campaign to raise awareness of energy efficiency in schools**
6. **compare energy use (meters) at home.**

KEY EXPERIENCES

Pupils completing this activity will develop skills and knowledge about:

- **sources of energy, fuel for heating, electricity and solar**
- **making measurements over time**
- **thermostatic control and feedback.**

RESOURCES

Thermometers

Record sheets

Graph paper

Light meter

Student Activity Sheet

(Liaise with local authority Energy Officer on this project; he/she may be able to supply light meters.)

RELEVANT WEB SITE LINKS

School Energy - http://www.schoolenergy.org.uk/

FURTHER INFORMATION:

Introduction to Energy Efficiency in School

Energy Efficiency Office

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Science 3

Willow Watch

THE CONTEXT

This focuses on a renewable resource, fast growing willow coppice, biomass.

THE ACTIVITY

This activity should take place in February/March and focuses on the growth of willows.

STARTING POINT/STIMULUS

Photograph of willow coppice on Student Activity Sheet

FOCUSED PRACTICAL TASKS

1. **Measure rate of growth of willow sticks in the lab. A 10cm unrooted stick can be placed simply in a jam jar and watered at the end of the previous lesson. Roots will grow 10cm in one week - shoots will grow 2.5cm/week in March.**
2. **Investigate factors affecting rates of growth, i.e. temperature, water (water bath), light.**
3. **Make accurate observations using hand lens and microscopes - do drawings of root and bud development.**
4. **Plant willow sticks in school grounds allowing one stick per square meter**

   - cutback after one season's growth. Leave shoot to regrow

   - harvest every 2-4 years between leaf fall and leaf set (winter/early spring)

   - stagger three plants at three stages.

The shoot will continue to grow after cutting at least ten harvests and grow to a height of 5 metres!

Willow is vandal proof.

KEY EXPERIENCES

Pupils completing this activity will develop skills and knowledge about:

vegetative reproduction / sexual reproduction.

RESOURCES

Willowsticks (20p each from Long Ashton Research Station)

Rod Parfitt
C/O IACR
Long Ashton Research Station
Long Ashton
Bristol
BS41 9AF

Tel: 01275 392 181
Fax: 01275 394007

Jam jars

Rulers

Long Ashton nutrient solution (if the sticks are to be kept for some time)

Student Activity Sheet

RELEVANT WEB SITE LINKS

Growing Willow -
http://www.sac.ac.uk/envsci/External/WillowPower/GrowCrop.htm

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Science 4

Fry Drive

THE CONTEXT

Making biodiesel in the laboratory and testing it against conventional diesel.

THE ACTIVITY

This involves making biodiesel in the laboratory and making comparisons with similar processes in the agricultural context.

STARTING POINT/STIMULI

Make connections between the raw materials and the product in an agricultural context, i.e.

- **Wheat - milling/feed**
- **Barley - malting/feed**
- **Linseed - flax/oil etc.**

Introduce the new concept of growing crops for fuel, i.e.

- **Oilseeds (rape seed) > Biodiesel**
- **Starch crops (cereals, rootcrops, sugar cane, maize)**

FOCUSED PRACTICAL TASK

Biodiesel can be made simply in the lab by mixing cooking oil, i.e. rape seed oil, olive oil etc. with Methanol (at 10%) using Sodium or Potassium Hydroxide as a catalyst. No heating is required. The Biodiesel can be purified by distillation and used in a simple diesel engine:

Oil + Methanol > Glycerine + Methylester

Such biodiesel can then be compared with physical appearance and in a simple burning trial.

RESOURCES

100g vegetable oil
Wick
Tin
Methanol
Catalyst - Sodium or Potassium Hydroxide
Student Activity Sheet

RELEVANT WEB SITE LINKS

Planet Energy - http://www.dti.gov.uk/renewable/ed_pack/index.html;
National Energy Foundation Renewables - http://www.greenenergy.org.uk;
British Association for Bio Fuels and Oils - http://www.biodiesel.co.uk;

THE CONTEXT

This focuses on pupils gaining a greater understanding of fuels, their disparate nature and their various applications.

THE ACTIVITY

Pupils compare the heating properties of various fuels by designing an experiment to compare the heating ability of a number of different fuels. It provides an additional activity follow up to 'Fry Drive' Student Activity Sheet and useful background for 'Power Games' Student Activity Sheet.

STARTING POINT/STIMULUS

WHAT IS A FUEL?

The benefits of fuel as a commodity:

- **heat**
- **power**
- **light.**

Make connections between raw materials and domestic applications:

- **oil, gas, coal and wood used for domestic heating**
- **burning matches**
- **petrol in a car**

ALTERNATIVE FUELS

In developing countries where conventional fuels may be unavailable as a result of economics or logistics, any readily available combustible material may be used, such as nut kernels, dried manure or straw.

Appropriateness of fuels to their application.

Minimum temperature requirements of certain industries - steel processing.

Fumes.

Smoke not acceptable in certain areas.

FOCUSED PRACTICAL TASK

Pupils are given the task of designing an experiment which compares the ability of different fuels to heat water.

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Science 5

A Burning Question

KEY EXPERIENCES

Pupils completing this activity develop skills and knowledge about:

- **the need for identical conditions when comparing variables**
- **taking measurements over time**
- **the disparate nature of fuels**
- **burning of fuels being a reaction**
- **planning experimental procedures**
- **obtaining evidence**
- **analysing results**
- **energy resources and energy transfer**
- **irreversible process.**

RESOURCES

A number of different fuels

- **wood**
- **coal**
- **charcoal**
- **diesel**
- **straw**
- **dried manure**
- **nuts**

The biodiesel, willow and charcoal produced in other sections of this resource would make good comparative fuels.

Suitable lab apparatus for designing such an experiment. If the session is to be a demonstration exercise then a Kelly Kettle is most appropriate.

Student Activity Sheet

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Science 6-12

Mix and Match Activities

Activities 6-12 focus on questions relating to breeding, looking at sheep and cattle including so called rare breeds, as well as the controversial issues surrounding intensive and extensive farming. The theme of genetics is introduced and explored in an interesting and practical way. The following is some background information to act as an aid.

AN INTRODUCTION TO: GENETICS/BIODIVERSITY/SUSTAINABILITY

This information is provided as background information for teachers for the units which follow. It may be adapted for wider pupil use or used as it stands with more able pupils.

The process of reproduction is one of the unique properties of living things. Not only do organisms reproduce their own kind, but they also reproduce variations of their own kind. These variations provide the essential ingredients for evolution and natural selection. They also provide man with the opportunity to choose domesticated animals which are good to eat, produce a lot of milk or grow quickly to breed the next generation. In this way, by selective breeding over many years, man has developed distinctive kinds of animals.

A. PRE-DOMESTICATION

1. **Wild animals exist in a natural environment, each adapted to a specific habitat. There is a balance of nature in established ecological systems.**
2. **The balance of nature can be disturbed by a change of environment which may be caused by:**
   - **a) a change in climate**
     - **i) long-term (e.g. the sequence of ice-ages and interglacial periods can be seen from the presence or absence of vineyards, reindeer etc. in Britain at various times).**
     - **ii) short-term (e.g. hot-house gases cause holes in the ozone layer and raise global temperature).**
   - **b) growth of the human population causing erosion of natural habitat (e.g. extinction in Great Britain of wolves, aurochs (wild cattle) and wild boar - wild ancestors of domestic animals).**
   - **c) the introduction of alien species which expand at the expense of native species (e.g. grey squirrel, mink and crayfish).**

B. DOMESTICATION

1. **Reasons why species are selected for domestication.**
   a) **behaviour (species which have a group/social structure are more amenable to domestication).**
   b) **ritual/religion (Apis bulls were worshipped in Egypt and buried in guarded tombs, white cattle had a special role in the rituals of sun-worshipping Celts and were probably sacrificed by the druids).**
   c) **products (wool, milk, meat, power).**
2. **Many species have been domesticated. They include cattle, sheep, goats, horses, asses, pigs, deer, rabbits, dogs, cats and poultry which are found in Britain, plus buffalo, camelids, and elephants found elsewhere.**
3. **Development of local types of domestic livestock:**
   as each type (breed) of animal was developed by man it acquired different characteristics and qualities.
   This variation is an important part of biodiversity. The combination of characteristics in each breed is unique.
   a) **Differentiation of types between each locality was influenced by:**
      i) **environment, both natural and artificial.**
      ii) **selection; initially selection may have been an unplanned process; later it was based on genetics.**
      iii) **isolation because of lack of mobility/communication.**

      Breed names are frequently associated with the locality of origin; e.g. counties - Devon, Sussex, Hereford, Lincoln Red, Fife, Ayrshire, Kerry, Suffolk Dun, Shetland Cattle, or Pennine breeds of sheep - Teeswater, Swaledale, Wensleydale, Derbyshire Gritstone.

      Breeds are recognised by the similarity of characteristics of the animals in the breed. Some characteristics are very visible (e.g. horns, ears, colour, shape, size), while others are not (e.g. physiology, production, behaviour, blood-types) and must be measured in other ways.
   b) **Increased variation (biodiversity) is produced as a combined result of environment and selection. Adaptation is an important part of this development. Compare the hair of Belted Galloway cattle (cold, wet uplands) with that of Red Poll cattle (dry lowlands) or the wool of Swaledale sheep (cold, wet region) with that of Norfolk Horn sheep (cold, dry region). Note the peculiar characteristics of feral Exmoor ponies in their native habitat. Wensleydale sheep originated in the North of England, but they are not hardy and their wool does not resist wind or rain because they were kept indoors during bad weather. Similarly Merino sheep originated in southern Spain where warm wool is not necessary, but the deep, fine fleece of the breed was selected for the woollen industry.**

C. IMPROVEMENT OR CHANGE

Most breeders attempt to improve their livestock, but the opinion of each breeder will vary from that of other breeders. Improvement is subjective, and we should simply regard 'improvement' as 'change' which will be evaluated in different ways.

1. **New breeds have been developed by selection and the application of genetics. They inherit characteristics from different ancestors. For example, Suffolk sheep (black face and no horns) are derived from Norfolk Horn (black face) X Southdown (no horns); Red Poll cattle (red hair and no horns) are derived from Red Norfolk (red hair) X Suffolk Dun (no horns) cattle.**
2. **Existing breeds can be changed by selection. For example if a breeder wishes to increase the size of his stock, he will use the biggest animals for breeding.**
3. **The ability to change animal populations by selection enables some breeds to become more fashionable or popular than others.**
    a) **As a result, many local types are replaced by a small number of dominant breeds (e.g. Holstein dairy cattle, broad breasted white turkeys). There is an inevitable loss of genetic material, thus reducing biodiversity. Some breeds/types have become extinct - 26 breeds of large livestock in UK during twentieth century, e.g. Goonhilly, Cushendale and Galloway ponies; Ulster White and Dorset Gold Tip pigs; Suffolk Dun, Fife, Red Norfolk and Glamorgan cattle; Cannock Chase and Rhiw sheep.**
    b) **The criteria governing change are:**
        i) **natural selection (see above A.1). This has a purely ecological/biological base.**
        ii) **artificial selection (i.e. imposed by man) is associated with the search for higher production from livestock and with the intensification of livestock production systems.**

The intensification of animal production is largely led by demands made by the market. Changes in diet since the 1950s have led consumers to demand lean meat products throughout the year, thus creating a drive amongst farmers towards developing systems which deliver the desired products at a competitive price. This has led to the introduction of intensively reared animals which have a high growth rate and consistently produce a lean carcass with a high meat to bone ratio.

The areas of controversy associated with intensification fall into four main sections, namely, welfare, disease, environment and food quality. Welfare itself can be considered in four separate headings: physical (embryo transfer, tail docking, debeaking, etc.); space (hen batteries, pig crates, sweat boxes, feedlots etc.); behaviour (selective grazing,

changed habitat) and production (shape of turkeys, litter size, milk yield, culard etc.). The threat of disease is increased by the homogeneity of a strongly selected population which makes it more vulnerable to a disease challenge and less adapatable to change. The use of inappropriate feeds such as meat and bone meal in ruminant diets results in 'unnatural' systems of production. The environment is under a greater potential risk due to the concentration of effluent. The quality of food may be reduced by mass production of immature meat in intensive situations.

The process of artificial selection and intensification has been speeded up by the use of systems such as MOET (multiple ovulation embryo transfer), and by the advanced technology of artificial insemination, embryo transfer and cloning.

D. SUSTAINABILITY

1. **Requirements for sustainability:**
   a) **non-finite resources**
   b) **elimination of threats to systems of production.**
2. **How might sustainability be achieved?**
   a) **return production to less intensive methods which are adapted to 'natural' systems.**
   b) **reduce dependence on artificial aids (chemicals/fertilisers, hormones/growth promoters) and encourage the use of biological control of pests and diseases.**
   c) **avoid monocultures and homogeneous populations**
   d) **maintain a wide variety of genetic material, such as old vegetable varieties (this may require a change in legislation as the sale in seeds from many old plant varieties is banned in the EU), naturally-mating, outdoor turkey varieties, or native beef cattle adapted to grazing, in addition to the currently popular breeds which are suitable for intensive systems.**
3. **Sustainability is most likely to be threatened by efforts to maximise production to meet current demands through intensification. The loss of natural resources in this process (native breeds of livestock, old plant varieties, etc) may prejudice the ability to maintain production in the future.**

Can non-intensive systems of production produce enough food?

Will there be two qualities of food - natural, non-intensive, high quality food for a niche market and artificially-stimulated, mass-produced food for the majority of the population?

Should there be more planning and control of food production?

WHITE PARK CATTLE

Characteristics

1. **White coat with black points (ears, muzzle, eyebrows, feet, teats): dominant colour pattern (see genetics).**
2. **Medium size, mature cow ca 635 Kg (12.5 cwt), mature bull ca 1000 Kg (1 ton) compared with feral relatives (Chillingham cows) which weigh ca 300 Kg and Charolais (see below) which weigh ca 880 Kg (cows and ca 1250 Kg (bulls).**
3. **Small population; high levels of inbreeding.**
4. **Great genetic distance from other breeds; measured by blood typing, DNA analyses and historical evidence.**
5. **Docile (except immediately after calving, when the cows are very protective); result of selection after domestication (cf Chillingham).**

Values:

1. **Colour marking; the colour pattern (white with black points) is dominant over other colours and patterns.**
2. **Adapted to non-intensive systems of production; hardy; grazing habit favours a variety of natural herbage; compatibility with animal welfare and protection of the environment.**
3. **High meat quality; consumer preference tested by tasting panels; low cholesterol content.**
4. **Heterosis (hybrid vigour) is derived from the great genetic distance; it is expressed in crosses between the White Park and other breeds.**

Values v Imported breed (e.g. Charolais):

1. **Ancient native breed that has contributed to the history and heritage of the nation; first recorded in pre-Christian Ireland and then in the tenth century Welsh laws coded by Hywel Dda; the ancient Dynevor (Dinefwr) herd dates from this time; other herds were enclosed in large country parks during the thirteenth century; the quality of White Park meat was recognised James I who knighted a joint - the original 'Sir Loin'.**
2. **Thrifty, hardy breed, adapted to British climate and herbage.**
3. **Suitable for non-intensive systems of production, producing mature beef mainly from grass (cf Charolais - intensive production of immature beef off concentrated food).**
4. **High meat quality measured by texture, flavour, colour and low cholesterol; specialist niche market (cf Charolais meat sold through supermarket).**
5. **Efficient production in non-intensive, low-input systems (cf Charolais - high production in intensive high-input systems).**

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Science 6

A Cow(nt)

THE CONTEXT

Biodiversity is a contraction of 'biological diversity', a term for variety or diversity within the biological world. In its widest sense biodiversity is virtually synonymous with 'Life on Earth'. The word was coined in 1985 and during the 1990s has become very widely used in the popular media, in government and in scientific circles. The number of species in an area is one measurement of its diversity.

Species richness varies geographically: warmer areas tend to support more species than colder ones: wetter areas more species than drier ones: less seasonal more than strongly seasonal ones: areas with varied topography and climate support more species than uniform ones. The objective of this task is to compare the variety of species of plants in two contrasting local habitats and then compare with the variety of species of animal on a farm from field work or evidence supplied.

THE ACTIVITY

It is possible to count the number of species at any given sample site, for example using a land transect pupils start with comparing plant species on 2 local school sites.

Gathering data from a farm is an appropriate homework for schools in a rural setting or may be used during a school field trip. Alternatively, the data and maps of livestock and crops at Eastrop Farm provided with the mathematics unit can provide a useful comparison.

STARTING POINTS/STIMULI

Video footage of Eastrop Farm (Tape 3) and Wrangmandale Farm (pigs and arable) - Tape 1. (The videos can be ordered from The Countryside Foundation's web site http://www.countrysidefoundation.org.uk)

Illustrations of cattle breeds - see Designer Cow Student Information Sheet

Farm Visit - http://www/farmsforschools.org.uk

FOCUSED PRACTICAL TASKS

Collecting data for numbers and breeds of plants and livestock

Correct observation and identification

Devise systems for amassing data

Effective presentation of findings

EXTENSION ACTIVITY

Develop the concept of why biodiversity exists and how man influences this (Mix and Match Teachers' Guide is a useful aid).

KEY EXPERIENCES

Collecting data in the field

Working with others in collaboration to amass a large amount of data

Handling large amounts of data in the most appropriate way

RESOURCES

Maps and data from Eastrop Farm Mathematics Unit

Livestock identification chart - Designer Cow Student Information Sheet

Student Activity Sheet

RELEVANT WEB SITES

National Biodiversity Network - http://www.nbn.org.uk/;

UK Biodiversity - http://www.ukbap.org.uk/;

UK Agricultural Biodiversity Coalition - http://www.ukabc.org/

Rare Breeds Survival Trust web - http://www.rbst.org.uk

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Science 7

A Woolly Question

THE CONTEXT

The activity is designed to show the variation (biodiversity) in domestic livestock and to relate these variations to the areas and origins of the breed.

THE ACTIVITY

The activity has two strands; devising fair tests to test the qualities of wool samples; and investigating the origins of the breed and relating the characteristics of the wool sample to its environment.

STARTING POINTS/STIMULI

Illustrations of sheep in the Student Information Sheet
Wool samples

FOCUSED PRACTICAL TASKS

Devising appropriate tests for comparing qualities of wool - strength, length, *crimp*, diameter.

Taking accurate measurements.

Making value judgements based on the results.

EXTENSION ACTIVITY

Relate the breeds of sheep to their place of origin; climate and natural habitats.

Does environment appear to influence the qualities of wool?

KEY EXPERIENCES

Devising an investigation by developing their own techniques using standard and non-standard equipment.

Relating their findings to the original natural habitat of the breeds in question.

RESOURCES

Illustrations of sheep
Wool samples from 4 breeds of sheep, the four applicable breeds are Norfolk Horn, Swaledale, Wensleydale and Merino.
Stands and clamps
Fine soft wire
Cotton
Weights and weight hangers
Newton meters
Sticky tape
Rulers
Hand lenses
Microscopes
Section C of 'Mix n Match' Teachers' Guide
Student Activity Sheet
Student Information Sheet

RELEVANT WEB SITES

Breeds of Livestock (sheep) - http://www.ansi.okstate.edu/breeds/sheep/;
British Wool Marketing Board - http://www.britishwool.org.uk/;
British Sheep Breeders Societies and Associations - http://www.tumpline.com/stackyard/pedigree/html/uksheep.html;
Rare Breeds Survival Trust web - http://www.rbst.org.uk

Words in *italics* appear in the glossary.

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Science 8

Designer Cow

THE CONTEXT

This focuses on cattle which are bred to be able to withstand the environment in which they are farmed and to provide the final product that the market needs.

THE ACTIVITY

The student is presented with information about a number of different breeds and their main characteristics and is asked to select appropriate ones to produce a new breed.

STARTING POINTS/STIMULI

Profiles and photographs of cattle in the Student Information Sheet.

Relevant web sites - see below.

FOCUSED PRACTICAL TASKS

Designing a cow with specific characteristics. Interpreting the information to determine the desired characteristics.

EXTENSION ACTIVITIES

Some cattle show extremes of characteristic.

For Example:

Extensively reared beef e.g. Highland (shaggy coat, slow growth)

Intensively reared beef e.g. Belgian Blue (double muscling - known as culard) imported breed

Dairy e.g. Holstein (very tall, very bony) imported breed

Design a cow that can be a hardy animal which can be farmed in the wilds of Scotland but still give good milk and plenty of meat. Can it be done? Why is it not done in practice? Pick any two of the breeds in the 'Cattle Profile' and describe the calf resulting from cross breeding.

KEY EXPERIENCES

Comparing and contrasting information

Making deductions from evidence obtained.

RESOURCES

Student Activity Sheet

Profiles and photographs of cattle - Student Information Sheet

RELEVANT WEB SITES

Breeds of Livestock (cattle) - http://www.ansi.okstate.edu/breeds/cattle/ ;
Cattle Today - http://www.cattle-today.com ;
Rare Breeds Survival Trust web - http://www.rbst.org.uk

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Science 9

Question a Bull

THE CONTEXT

Sometimes breeders of farm animals need to be certain of the purity of breeding stock, e.g. when breeding pedigree stock.

The purpose of this activity is to study the nature of inherited characteristics and how dominant characteristics can make identifying the parents potentially difficult.

THE ACTIVITY

Students are presented with a calf which has two possible sires. The dam's colouration is dominant and therefore the sire cannot be identified from the calf's physical appearance. A DNA analysis has been undertaken which has to be analysed to determine the true sire.

STARTING POINTS/STIMULI

Illustration of the sires and calf in the Student Information Sheet

Letters exchanged between farmers in the Student Activity Sheet

FOCUSED PRACTICAL TASKS

Analyse and interpret data which is presented in an unusual format.

EXTENSION ACTIVITIES

Discussion:

Use background notes in 'Mix and Match' Teachers' Guide to introduce:

Chromosomes are divided into genes (gene mapping).

Each gene controls a characteristic e.g. hair colour.

Genes consist of DNA

DNA can be analysed to determine:
- parents of offspring
- differences between breeds

KEY EXPERIENCES

Evaluating non-standard information

How science is applied in a practical situation

RESOURCES

Farmers' Letters in Student Activity Sheet

Bulls and calf illustration Student Information Sheet

"Hand-Me-Down-Genes" section Student Information Sheet

DNA analysis

Student Activity Sheet

RELEVANT WEB SITES

S-Cool - http://www.s-cool.co.uk (in the search box type "Genetics" or "Genetic Engineering" etc, for the relevant page.)

Schoolzone - http://www.schoolzone.co.uk/documents/CZ/genetisist.htm - (then click on the links on the right hand side that say MORE ON GENETICAL ENGINEERING AND GENETICS)

Rare Breeds Survival Trust web - http://www.rbst.org.uk

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A Case for the Countryside

Science 10

Hand me down Genes

THE CONTEXT

This activity shows one of the most important factors which control similarities and differences between organisms is heredity. Genetics attempts to explain how heredity works, that characteristics are inherited by comparing adult cattle and their calves.

THE ACTIVITY

After an introduction and explanation of heredity and genetics, this activity focuses on comparing different images of adult cattle and their calves in order that students may observe consistencies in the colour and shape of the animal in question to affirm the concept of inheritance; and differences between breeds - developed in 'Designer Cow' unit.

STARTING POINTS/STIMULI

Picture of sires and calf in the Student Information Sheet of the "Question A Bull" section.

Photograph of chromosomes in the Student Information Sheet

FOCUSED PRACTICAL TASKS

Observing and recording characteristics of different breeds.

Pairing chromosomes from photograph or actual slide.

EXTENSION ACTIVITIES

Study the concept of recessive genes.

Read through the 'Mix and Match' notes about White Park Cattle and then try to explain why:

a) some black calves are born into White Park herd
b) some animals have recessive (hidden) black genes.

Consider what other characteristics of cattle may be inherited, which may not be apparent from pictures. These could include:

Milk yield and buttermilk content
Growth rates
Ease of calving
Udder conformation
Mothering ability
Meat quality

KEY EXPERIENCES

Using evidence to discover inherited characteristics

Using a microscope and prepared slide

RESOURCES

Diagrams of genetic maps in the Student Information Sheet

Illustrations of Hereford, Galloway, Belted Galloway and White Park cattle with calves in the Student Information Sheet

'Mix and Match' information sheet - White Park Cattle

Photograph of prepared slide to show chromosomes in the Student Information Sheet

The school may have actual slides for viewing, in which case students will need access to a suitable microscope to view them

Student Activity Sheet

RELEVANT WEB SITES

DNA Heredity and Beyond - http://library.thinkquest.org/20830/main.htm

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Science 11

Des Res

THE CONTEXT

This activity focuses on intensive production systems which produce large quantities of marketable plants and livestock throughout the year at a lower price to meet the demands of consumers. They can also generate problems because of inherited factors through mono-cultural breeding, disease resistance and spread.

Producers will breed the best possible species to satisfy the needs of their customers. When they have developed a suitable new breed/variety, they will continue to rear this plant or animal. Commercially successful breeds can interbreed with themselves with the possibility of some characteristics, normally hidden, showing themselves. These characteristics may be helpful, but can also cause real problems, sometimes on a catastrophic scale.

STARTING POINT/STIMULUS

Information on pig breeding and cattle rearing

EXTENSION ACTIVITY

What are the advantages and disadvantages of:

- indoor pig production
- outdoor pig production

THE ACTIVITY (1)

Intensive Breeding

- **This activity focuses on practical work.**
- **Demonstrating the problem of the appearance of an unviable characteristic in tobacco plants.**
- **Investigating the problems of an albino recessive gene in tobacco crops.**

THE ACTIVITY (2)

Intensive Production

1. **Find out about the Irish potato famine. How might breeding a number of different varieties prevent such an event happening again?**

2. **Many turkeys are bred intensively. They are usually the same breed (Broad Breasted White), which are produced by artificial insemination and reared in a controlled environment to ensure maximum growth.**

Consider the benefits and potential problems of rearing Broad Breasted White turkeys in an intensive system as opposed to a breed of turkey in a non- intensive system:

- **Which system will provide a more natural environment for the birds?**
- **Which system is easier to manage?**
- **Why are Broad Breasted White turkeys more common in supermarkets?**
- **Are traditional breeds of turkey available in supermarkets?**
- **Why do people choose to buy intensively reared turkeys?**
- **Are birds advertised as having been reared in different ways? Give examples.**

Design two posters:

a) to promote turkeys from intensive systems sold in supermarkets
b) to promote traditional non-intensive turkeys sold in a butcher's shop.

NOTES:

- **All the same breed (mono-culture) poses a potential threat from those diseases to which they do not have a natural immunity.**
- **Intensively reared birds depend on vulnerable resources, e.g. an artificially controlled environment.**
- **There is a potential danger to human health from growers who may use growth promoters, antibiotics or cause pollution.**
- **Intensive production may affect the quality of life for:**
  a) humans who eat what some would argue is a lower quality of meat
  b) the birds whose confined environment will affect their shape and behaviour.
- **Intensive flocks meet consumer demands by ensuring a consistent, regular supply of cheap meat.**

- **Broad Breasted White turkeys have a high meat to bone ratio making it a more productive bird. As a result of selection for broad breasts they are unable to mate naturally.**
- **Intensive flocks have very precise management systems which can quickly respond to problems with the birds, thereby disease and diet inadequacies can be soon rectified.**
- **Waste produced from intensive flocks can be controlled on one site and utilised effectively.**

KEY EXPERIENCES

Devising appropriate tests

Making accurate observations

Recording observations in a comprehensive manner

Making balanced judgements on the basis of real evidence.

RESOURCES

Tobacco seeds available from suppliers such as Philip Harris Education - http://www.philipharris.co.uk catalogue reference A03992. These are F2 generation and give a 3:1 green vs. albino germination ratio. One pack of 100mg contains approximately 1000 seeds.

Suitable growing medium, e.g. fine damp soil, damp filter paper or 1.5% agar. Scorable seedlings should be seen in about 10 days.

Student Activity Sheet

RELEVANT WEB SITES

Farm Animal Welfare Council - under publications - http://www.fawc.org.uk;
Pig Resources - http://www.cullen.org.uk/pig/index.htm;
Rare Breeds Survival Trust web - http://www.rbst.org.uk;
The NFU - http://www.nfu.co.uk;
The Little Red Tractor - http://www.littleredtractor.org.uk

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Science 12

Back to the Future

THE CONTEXT

This unit is concerned with intensive and extensive farm systems and the sustainability of non-intensive systems of production. Over this century agriculture has changed significantly. Extensive systems are based on low input/low output and intensive systems on high input/high output. This would mean, for example, that for any given crop more fertiliser, pesticides, control of the environment and breeding produces increased yield or productivity. Greater intensification has produced more food for the world but is often blamed for increased pollution and other unsuitable practices.

The unit can be introduced by reference to information provided on rare breeds (Mix and Match Teachers' Guide') and farm animals shown on the video tape. It is illustrated with a practical task growing plants from seeds which can be carried out in the classroom. Extension activity can relate findings to stock breeding and farming.

THE ACTIVITY

To simulate extensive and intensive conditions and the effect of climatic conditions and other factors of production, within the limits of the school environment.

STARTING POINT/STIMULUS

- **Map of Origin of Native Breeds - Student Information Sheet**
- **Mix and Match Teachers' Guide'**

FOCUSED PRACTICAL TASKS

Design investigations to show the effect of sowing density and artificial inputs on plant growth and development (use easy and quick to grow plants such as radish or cress). The investigation should be designed to be a fair test and be able to be replicated. In addition to increasing sowing density, the effects of other variations such as addition of fertiliser and artificial changes to the environment - light, warmth, moisture - can be investigated and comparisons made.

The results can be used to show the effect of increased intensification.

EXTENSION ACTIVITIES

- **Using Mix and Match Teachers' Guide notes as a background, discuss how native breeds are an important part of biodiversity and sustainability:**
  - variety of breeds
  - natural feed - grass - non-intensive systems
  - natural functions - grazing, mating
  - quality, safe products

KEY EXPERIENCES

- **A comparison of contrasting agricultural practices to enable pupils to use value judgements about a key environmental issue.**
- **Using scientific investigation to inform views on an agricultural issue.**

RESOURCES

- **Mix and Match Teachers' Guide**
- **Student Information Sheet**

Illustration of Irish Moiled and White Park cattle in the Student Information Sheet for the "Question A Bull" section, Wensleydale and Norfolk Horn Sheep in the Student Information Sheet for the " A Woolly Question" section.

RELEVANT WEB SITES

Rare Breeds Survival Trust web - http://www.rbst.org.uk
UK Agriculture - http://www.ukagriculture.com/index.html

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A Case for the Countryside

Science 13

Timescale Detectives

THE CONTEXT

The context is based on the complicated life history of the salmon. The information pages give students a clear guide to a salmon's life history. The activity of counting the rings on scales brings to life the various stages through which a salmon will go.

THE ACTIVITY

Examining salmon scales to determine the age and physical environment of individual fish.

STARTING POINTS/STIMULI

- **Student Information Sheet**
- **Salmon skins.**
- **Salmon leather.**
- **Scale photographs in the Student Activity Sheet**

FOCUSED PRACTICAL TASKS

- **Demonstrate competent use of magnifying equipment**
- **Accurately illustrate and annotate observed patterns.**

ANSWERS

To the Salmon Scale drawing section of the Student Activity Sheet - the fish were three years old - spending two in a river and one at sea.

To the Salmon Scale Photographs section of the Student Activity Sheet - this is a 2+ year old fish.

EXTENSION ACTIVITIES

The extension activities provide a scheme of work for those who wish to use the topic as a larger area of study:

- **Working areas of the curriculum with the design and technology department:**

  - **create a colour chart based on salmon's colours at different phases of life,**
  - **study salmon angling flies. You may know an angler who uses flies or you may be able to:**
    a) arrange for a fly dresser to visit your class

    b) try tying some flies of your own

  - **Why do some flies work at certain time of the year?**
  - **Salmon skins make very fine leather. What kind of things could be made from salmon skins?**

- **Salmon have been a protected species longer than any other creature, with salmon laws dating back to the 11th Century. Why?**
- **Study salmon fishery in your area:**
  a) visit a salmon farm
  b) visit a salmon lift or ladder - how does it work? When do most fish come up the river?
  c) how does the life cycle of farmed salmon differ from that of wild salmon?
  d) how are salmon being protected in your area?
  e) what effect might a salmon fishery have on the natural balance of the area?

KEY EXPERIENCES

- **Accurate observations.**
- **Making deductions from evidence obtained.**

RESOURCES

- **Copies of the Atlantic Salmon information sheets including example of fish scales.**
- **A selection of fish scales if it is possible to obtain these.**
- **Strong hand lenses or simple microscopes.**

RELEVANT WEB SITES

The Atlantic Salmon Trust - http://www.atlanticsalmontrust.org/;
The Atlantic Salmon Federation - http://www.asf.ca/Overall/atlsalm.html
Salmon and Trout Association - http://www.salmon-trout.org

Contacts you may wish to consult or invite into school:

- **Atlantic Salmon Trust**
- **Local Fisheries Officer**
- **Environment Agency - http://www.environment-agency.gov.uk/**
- **Local River Authority**
- **Salmon and Trout Association - they have fly dressers who will come into school to demonstrate their craft.**

Teacher Guide Notes -
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Science 14

Something to Grouse About

THE CONTEXT

The context focuses on conservation issues surrounding the red grouse and its habitat.

THE ACTIVITY

Activities centre on biological investigations into populations and their interaction with the environment. Pupils will need to consider issues concerning the role of human activity in the conservation of wildlife.

STARTING POINTS/STIMULI

- **Wildlife and Countryside Act, 1981.**
- **The game laws.**
- **Newspaper cuttings.**
- **Bird books.**
- **The 'Glorious 12th'.**

AONB/conservation areas/RSPB/biodiversity.

FOCUSED PRACTICAL TASKS

1. **Pupils are introduced to the concept of 'population', initially by doing a practical experiment to determine the population of a plant, e.g. dandelions.**

   This is followed by applying the same activity to grouse.
2. **The second activity focuses on the problem of loss of habitat. Pupils explore reasons for the reduction in heather - the main component of the grouse habitat.**

EXTENSION ACTIVITY

- **In groups of 5, one person must take on the role of each of the following:**

  - sheep farmer
  - conservationist
  - grouse shooter

- forester
- rambler

- **Using the background information found in the Student Information Sheet, discuss in your groups the advantages and disadvantages of managing a moorland habitat.**
- **Select a spokesperson and report back the news of the group to the class.**

KEY EXPERIENCES

Pupils will have developed knowledge and understanding about:

- **considering evidence**
- **living things in their environment - adaptation, habitat, food chains**
- **life processes - the principles of digestion.**

And developed skills and strategies in:

- **systematic enquiry**
- **devising investigations/experiments**
- **fair tests**

KEY VOCABULARY

- **environment**
- **habitat**
- **population**
- **conservation**
- **sustainable**
- **immigration**
- **emigration**

RESOURCES

Dandelion Activity

- **metre sticks**
- **tape measure**
- **ball of string**
- **the plant population section of the Student Activity Sheet**

Crop Investigation

- **grouse crop**
- **scientific balance**
- **petri dishes**
- **evaporating dishes**
- **graph paper**
- **the crop section of the Student Activity Sheet**

RELEVANT WEB SITES

The Moorland Association - http://www.moorlandassociation.org/
The Game Conservancy Trust - http://www.gct.org.uk
The RSPB - http://www.rspb.org.uk

Teacher Guide Notes -
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Science 15

Bonehead

THE CONTEXT

Deer management and conservation depends on a scientific understanding of their growth, development and life cycle.

THE ACTIVITY

Shows how an understanding of the growth and development of antlers can be used in the management of deer populations.

STARTING POINTS

- **Link life processes and the effect of environment on growth and development.**
- **Develop the relationship between an individual organism and its population.**

FOCUSED PRACTICAL TASKS

- **Interpretation of research data to consider populations.**
- **Observation and recording of animal behaviour.**
- **Relate field observations (video) to the management of deer.**
- **Studying Antlers to identify age.**

CURRICULUM LINKS

Science - life processes, living things in their environment, systematic enquiry and the application of science.

KEY EXPERIENCES

- **Interpretation of population data.**
- **Investigate antler development.**
- **Introduction to animal behaviour.**

RELEVANT WEB SITES

The British Deer Society - http://www.bds.org.uk
Deer UK - http://www.deer-uk.com
Deer Commission for Scotland - http://www.dcs.gov.uk/
"A Runnable Stag" -
http://www.library.utoronto.ca/utel/rp/poems/davidson1.html

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Science 16

Teething Troubles

THE CONTEXT

In the section on Antlers - "Bonehead" Student Information Sheet - one way of determining the age of Red Deer is described. This unit looks at how teeth can also be used to age animals.

"Teething Troubles" Student Information Sheet makes comparisons with human teeth.

THE ACTIVITY

This involves examining the jawbone of a deer and conducting investigation relating to ageing and the effect of environment.

STARTING POINTS/STIMULI

- **This is a follow up activity to the unit on antlers.**
- **Or alternatively it can be used as a free-standing unit on teeth:**
  - comparison with human teeth
  - looking at different human and animal jawbones.

EXTENSION ACTIVITY

This is a more accurate investigation of ageing by counting the layers of growth in the cement layer of a first or second molar.

FOCUSED PRACTICAL TASKS

- **Direct observation of teeth to construct a dental formula.**
- **Make observations and comparisons of deer teeth.**

KEY EXPERIENCES

Interpretation of population data.

Investigate antler development.

Introduction to animal behaviour.

RESOURCES

- **Half a jawbone of a deer.**
- **Loose teeth from a deer.**
- **Student Information Sheet**
- **Student Activity Sheet**

RELEVANT WEB SITES

The British Deer Society - http://www.bds.org.uk
Whitetail Deer - http://www.kerrlake.com/deer/teeth.htm;
Alabamha Wildlife and Freshwater Fisheries -
http://www.npwrc.usgs.gov/resource/tools/deerteth/basics.htm;
Northern Prairies Wildlife Research Centre -
http://www.dcnr.state.al.us/agfd/teeth.html

CONCLUDING ACTIVITY

Units 14-16 "Something to Grouse About"; "Bonehead" and "Teething Troubles" have looked at different aspects of resource (land and water) management in highland areas. Units 14-16 have particularly reviewed issues associated with the conservation of wildlife. A concluding activity has been provided at the end of the "Teething Troubles" Student Activity Sheet, to encourage pupils to consider these issues from different view points.

Pupils are asked to prepare for a class debate on the topic:

'Mankind has a duty to manage wildlife populations".

They are invited to take the roles of various interested parties in the participating debate. This should help them to gain an insight into the issues around wildlife management in the UK. These could include reference to Unit 13 "Timescale Detectives" - the salmon - its lifecycle in the wild as well as salmon farming.