FACTFILE:

GCE NUTRITION & FOOD SCIENCE

IMPACT OF FARMING ON CLIMATE CHANGE AND NATURAL RESOURCES

Rewarding Learning

IMPACT OF FARMING ON CLIMATE CHANGE AND NATURAL RESOURCES

Learning outcome

- Discuss the impact of the following ethical and environmental factors on climate change and natural resources (water, soil):
  - Animal farming;
  - Locally and seasonally produced food; and
  - Organic farming.

Animal Farming

Animal farming is raising livestock for meat, milk, eggs or other products. The demand for animal products is growing at an unprecedented rate across the world resulting in an increase in livestock numbers, especially cows, pigs and chickens. This trend is undesirable for the environment because intensive farming of animals contributes to global greenhouse gas emissions and damages natural resources such as water and soil.

Impact of animal farming on climate change

The production of food from animal farming is a significant source of emissions especially the production of the greenhouse gases carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). Methane is released by ruminant animals during digestion of grasses and feed in a process called enteric fermentation. It is produced to a lesser degree when manure decomposes during storage.

Nitrous oxide arises from manure storage and the use of organic and inorganic fertilisers used on crops for animal feed.

Animal farming produces carbon dioxide in a number of ways:

- Intensive farming typically uses high-energy crops such as corn and soya which are dependent on large amounts of artificial fertiliser. The production of these fertilisers generates large quantities of carbon dioxide globally.
- Intensive farming operations require fossil fuel-based energy to cool, heat and ventilate the facilities and energy is also used to operate farm machinery to cultivate and harvest feed crops.
- Slaughtering animals and packaging and

transporting animal products emit millions of tonnes of carbon dioxide globally every year.
- Forests are important carbon sinks, sequestering carbon and preventing it from reaching the atmosphere. Deforestation for animal farming – both for clearing land for feed crops and for grazing, greatly increases the global, annual production of carbon dioxide.
- Grazing of pastures can cause once fertile soil to dry and releases millions of tonnes of carbon dioxide into the atmosphere annually.

Different models of farming have different levels of emissions and the animal farming sector in the UK is working to become more sustainable. According to the Government's Committee on Climate Change greenhouse gas emissions from UK beef are about half the global average.

However, global emissions from animal farming are roughly equivalent to the entire global transport sector and continue to be a major environmental problem.

Impact of animal farming on water

Water use has been growing globally at more than twice the rate of population growth and an increasing number of regions are reaching the limit at which water services can be sustainably delivered. The expected increase in the world population will result in available freshwater resources being reduced by half by the mid twenty-first century. All industries are being asked to consider their water footprint and to treat water as a scarce resource. Animal products have a large water footprint relative to crop products. This is one of the reasons why consumers are encouraged to consider a reduction in meat consumption.

Animal farming and water usage

According to Compassion in World Farming, approximately one quarter of global blue water (freshwater in rivers, lakes and aquifers) use relates to producing meat and dairy, which is likely to increase as production continues to rise to meet demand.

Animal farming has a large water footprint because water is used at each stage of the production process from producing animal feed, farm water use and water used to slaughter and process the animal. Of all of these, animal feed is the dominant factor in the amount of water used to produce meat. Grain-based animal feeds use significantly more blue water (freshwater in rivers, lakes and aquifers) and grey water (polluted or waste water) per kg of feed than is needed for grass-based animal feeds.
As a result, grass-based farming may be preferable to intensive farming from a water usage point of view.

Animal farming and water pollution

Poor practices in the management of manure, fertiliser and soil can result in water pollution.

Manure produced by the animals is stored in a pit for disposal or use as fertiliser. If not stored properly it can leak into waterways. If too much is used as a fertiliser or it is applied in rainy weather, excess can run off into rivers and lakes. Nitrogen from the waste causes eutrophication (the nitrogen encourages excessive growth of algae which depletes the oxygen in water, damaging

Animal waste can also pollute water with pathogens (such as Salmonella and E Coli). In intensive farming, antibiotics are used for disease suppression and growth enhancement. Scientific studies suggest that 75-90% of antibiotics are excreted from animals un-metabolised and enter water sources.

Crops grown for animal feed may be treated with artificial fertilisers. Rain washes nutrients such as nitrogen and phosphorus from these fertilisers into local rivers and streams causing eutrophication of ecosystems.

Soil loss as a result of farming activities such as planting, installing drainage, irrigation, creating farm tracks allows pollutants to get into watercourses. Over-grazing of livestock compacts the soil and encourages run-off of fertilisers and sediment from soil.

Impact of animal farming on soil

Intensive farming of animals can increase soil erosion and damage soil fertility.

Overgrazing
Soil erosion occurs when grasslands are subject to extensive grazing of animals without sufficient recovery periods. In addition, if too many animals are grazed in the same land area, their hooves damage and compact the soil. When land becomes compacted it is more likely to become waterlogged which leads to run-off and flooding. This reduces nutrient levels in the soil necessitating the use of manufactured fertilisers which eventually depletes soil.

Livestock activity removes vegetation from the land leaving the soil exposed to water and wind and is easily swept away as a result.

Overfarming
With the continued growth of intensive animal farming, livestock feed consists primarily of corn, soya and oats. These high-protein/high-energy foods allow animals to reach market weight quickly and are cheaper for farmers. Unsustainable farming methods can be used to meet demand for these crops such as monoculture. Monoculture is detrimental to soil health because as the same plant is grown annually on the same land, the available nutrition found in the soil is gradually reduced. To supplement this depletion, farmers use manufactured fertilisers which have numerous environmental impacts including the pollution of waterways and decline of pollinator populations.

Deforestation
As available arable land and nutrient-rich soil decrease due to erosion and over-farming, an increase in the demand for meat has driven land-use change. Converting forest to pasture for beef cattle is responsible for destroying millions of hectares of tropical forest each year. As trees are deforested, the soil loses protection from the tree canopy cover and root systems, exacerbating soil erosion.

However, good farming practices can protect the soil. Grass-based grazing systems and low-intensity grazing reduce pressure on the land. Livestock can play an important role in maintaining and enhancing the soil used to grow crops. The introduction of grass and livestock into arable crop rotations is beneficial to soil health and fertility with manure from grazing livestock helping to boost soil organic matter.

Locally and seasonally produced food

Local food is a term used to describe a method of food production and distribution that is geographically localised rather than national or international. Food is grown, reared and caught close to consumers' homes, then distributed over much shorter distances than is usual in global industrial food systems. This method can have a positive impact on climate change, use of natural resources and local economies.

Impact of locally and seasonally produced food on climate change

Locally produced food includes food sold at farm shops, box schemes, farmers' markets, independent high street shops such as greengrocer, butcher and fishmonger. Their impact on climate change is not straightforward and depends on a range of factors.

Production: Farming methods used to produce food locally may use fewer nitrogen fertilisers. The manufacture of nitrogen fertilisers is an important source of emissions. The process by which fertiliser is produced is both energy intensive creating carbon dioxide and leads to the production of the powerful greenhouse gas, nitrous oxide.

For fruit and vegetables, the main environmental issue is out-of-season production. In the winter, for example, emissions associated with glasshouse production may mean that it is less greenhouse-gas-intensive to import fruit and vegetables from Spain than to produce them in the UK.

Retail: Locally produced food is usually sold locally too which reduces the distance the food has travelled. Long distance transportation depends on refrigeration. On the positive side, refrigeration can reduce food waste and therefore greenhouse gas emissions, but, overall, it is an energy-intensive method of storage and preservation.
For some foods, transport can be a major problem. One study found that air-freighted green beans from Kenya were at least 20 times more greenhouse-gas-intensive than beans grown in

season in the UK. On the other hand, the emissions from producing meat and dairy are generally so large that transport tends to account for a relatively small part of their carbon footprint. Similarly, for bulk products such as sugar, transported by ship, the effect of distance is negligible compared with other factors.

While much of the concern over emissions from food transport has focused on distribution in the supply chain, the environmental impacts of shopping by car are estimated to be greater except possibly when food is air-freighted. This is because cars are a fuel-inefficient means of transporting goods compared with ships, trains, trucks or vans. For example, a farm shop selling vegetables grown on-site has minimal emissions from distribution. However, most farm shops are in rural areas which consumers drive to. The greenhouse gas emissions from consumer cars travelling to the farm shop may well cancel out the environmental benefits achieved when growing and selling the vegetables on-site.

Storage: Locally produced food is typically fresh rather than processed. This can reduce the dependence on energy-intensive refrigeration. Refrigeration is a main source of emissions in food manufacturing. Refrigeration contributes to climate change both because of the energy used to operate the equipment and because of the impact of refrigerant gases. Some refrigerant gases are thousands of times more potent than carbon dioxide at warming the atmosphere.

Storage of fresh food so that it can be eaten out of season is also very energy intensive.

Packaging: Locally produced and sold food is unlikely to be heavily packaged. This can be both positive and negative in relation to climate change. Making packaging generates greenhouse gas emissions because it uses up energy. Food packaging has been estimated to be responsible for 1.27% of greenhouse gas emissions. However, packaging reduces food waste by preserving the food and preventing food spoilage. Packaging disposed of in landfill releases fewer greenhouse gas emissions than equivalent amounts of food waste. Farm shops and other sources of locally produced food need to ensure that reducing packaging does not come at the expense of increased food waste.

Impact of locally and seasonally produced food on natural resources (water and soil)

Locally produced food is more likely to come from small farms that support good farming practices which are more sustainable than global food systems.

Soil Management and Fertility: Soil is the basis of all agricultural production and the conservation and improvement of this resource is more likely in local farms. Healthy soil can increase resilience to climate change, by storing carbon, locking in greenhouse gases that would otherwise be released into the atmosphere, and helping to prevent flooding. Farmers will take action to reduce compaction of soil from machinery and livestock, spreading manure onto fields increases the amount of organic matter returned to the soil and reduces the need to use artificial fertilisers. The farmers may use crop rotation to grow different types of crops in succession on the same piece of land so that the soil is not exhausted of any particular set of nutrients.

Crop Health and Protection: Locally produced food is less likely to use chemicals to control weeds, pests and disease. Safe and effective control will also help reduce the risk of water pollution and help preserve the abundance and diversity of native species.

Pollution Control and By-product Management: Nearly every process and practice in farming results in the generation of 'by-products' or 'wastes' and therefore poses a potential risk of pollution and a threat to the environment. Well organised pollution control and by-product management will help avoid pollution, and play an important part in protecting water, energy, biodiversity and soil management. These practices are more likely in local farms.

Water Management: Local farms are more likely to manage water wisely to help protect water sources and improve water quality. In particular, good water management will contribute towards reducing run-off and pollution.

Organic farming

Strict regulations, known as 'organic standards', define what organic farmers can and cannot do – and place a strong emphasis on the protection of wildlife and the environment. All organic farms and food companies are inspected at least once a year

and the standards for organic food are laid down in law.

Overall, organic farms tend to have better soil quality and reduce the risk of soil erosion compared to their conventional counterparts. Organic agriculture generally creates lower greenhouse gas emissions and less soil and water pollution and is more energy efficient. For example:

- Artificial chemical fertilisers are prohibited – instead organic farmers develop a healthy, fertile soil by growing and rotating a mixture of crops, adding organic matter such as compost or manure and using clover to fix nitrogen from the atmosphere.
- Pesticides are severely restricted – instead organic farmers develop nutrient-rich soil to grow strong, healthy crops and encourage wildlife to help control pests and disease.
- A diversity of crops and animals are raised on the farm and rotated around the farm over several seasons, including fallow periods. This mixed farming approach helps break cycles of pests and disease and builds fertility in the soil.
- The routine use of drugs, antibiotics and wormers is banned – instead the farmer will use preventative methods, like moving animals to fresh pasture and keeping smaller herd and flock sizes.

The impact of organic farming on climate change

Organic farming lowers greenhouse gas emissions by using less artificial chemical fertilisers. The manufacture of nitrogen fertilisers is an important source of emissions. The process by which fertiliser is produced is both energy intensive (generating carbon dioxide) and leads to the production of nitrous oxide – a powerful greenhouse gas.

Organic farming conserves soil carbon. Conserving soil carbon reduces emissions from the soil and retains soil nutrients, reducing the need for fertilisers. The Soil Association estimates that organic farming produces 28% higher levels of soil carbon on average in Northern Europe and that widespread adoption of organic farming in the UK could offset at least 23% of UK agriculture's greenhouse gas emissions.

The impact of organic farming on water

Organic farming reduces the deterioration of water quality by reducing nutrient leaching and run-off. It is of concern to water quality when nutrients are transported into groundwater. Phosphorus is the nutrient of most concern for run-off and erosion losses because even a modest addition of phosphorus to lakes, rivers, or streams can cause nutrient imbalances that stimulate the growth of algae, which in turn limits the access fish have to nutrients and oxygen. Organic farmers can protect against the contamination of water by using practices that conserve and recycle nutrients within the farming system. Maintaining nutrient balances within fields while keeping water within fields, and capturing any water that flows away from fields will conserve nutrients on the farm while protecting the environment.

Organic farming makes use of a diverse range of plants such as rotation crops and cover crops which enhances soil quality, facilitates nutrient capture, and helps recycle nutrients that would otherwise be leached through the soil.

Organic farming reduces soil erosion. Soil erosion can damage surrounding fields and contaminate adjacent water bodies. Sediments transported by erosion carry attached nutrients, pathogens, and other contaminants. These sediments affect fish habitats by making water cloudy and altering water temperature. Nutrients transported by sediments also cause algae blooms, degradation of fish habitats, and eutrophication. Pathogens attached to sediments can degrade the quality of water for animal and human consumption and increase purification costs if lakes fed by contaminated streams are used as a source of drinking water. To protect land against the forces of erosion, organic farming use practices that maintain a cover of growing plants or residues over the soil surface at all times.

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The impact of organic farming on soil

Organic farming principles improve the quality of soil. Healthy soil:

- is necessary for good agricultural productivity and profitability;
- is essential for flood risk management. Healthy soil is essential for water storage and preventing floods and droughts. Healthy soil stores water so that crops have a longer life when a drought kicks in and improves water quality by filtering out pollutants;
- is necessary for climate change mitigation.

Healthy well managed soils capture carbon dioxide and store it as soil organic carbon. In the UK, soils hold an estimated 9.8 billion tonnes of carbon, making them an essential resource in reducing greenhouse gas emissions and tackling climate change. By contrast, degraded soil emits carbon into the atmosphere, potentially speeding up climate change; and

- has better soil structure and can reduce soil erosion through water damage.

Suggested Activities:

1. Consider the advice you would give to consumers in Northern Ireland to achieve sustainable consumption of meat and other animal products.

2. Research the arguments against organic farming as a global solution to climate change and depletion of water and soil.

3. Investigate the availability of local and in-season food in your area.