Cairngorms NATIONAL PARK

Climate Change and Scottish Agriculture

Farmers' Guide:
Reducing greenhouse gas emissions from farms

introduction

Global warming and climate change is one of the greatest environmental, social and economic threats facing the planet. The burning of fossil fuels (oil, coal and gas) to satisfy our unquenchable thirst for energy and power is one of the main source of emissions. Seldom a day passes without climate change being mentioned in the media.

Farming and land-based activities are on the frontline of climate change. We need to find solutions to adapt to the changing climate and also help to reduce greenhouse gas emission.

What are 'greenhouse gases' (GHG)?

GHGs are the gases present in the atmosphere which reduce the loss of heat into space and therefore contribute to global temperatures through the greenhouse effect. Greenhouse gases are essential to maintaining the temperature of the Earth. Without them the planet would be so cold it would be uninhabitable. However, an excess of greenhouse gases can raise the temperature of the planet to levels where natural systems break down.

The three main greenhouse gases...

CO_2 **CARBON DIOXIDE (CO_2) is produced by all animals, plants, fungi and microorganisms during respiration and is used by plants during photosynthesis.**

CH_4 **METHANE (CH_4) the principal component of natural gas. The gas is formed naturally by anaerobic decay of organic matter and by livestock through the digestion of feed.**

N_2O **NITROUS OXIDE (N_2O) is commonly known as 'laughing gas'. Agriculture is the main source of human-produced nitrous oxide: cultivating soil, the use of nitrogen fertilisers, and animal waste handling can all stimulate naturally occurring bacteria to produce more nitrous oxide.**

'Climate change brings opportunities as well as threats to the agriculture sector which has a significant role to play in reducing carbon emissions'

MIKE RUSSELL ENVIRONMENT MINISTER 2008

farm sources of GHGs

Global warming potential of each Greenhouse Gas

If Carbon Dioxide = 1
Methane is 21 times more potent
Nitrous Oxides are 310 times more potent

Greenhouse gas emissions

CO_2 accounts for nearly 80% of all Scotland's emissions. Farming is the largest source of methane (74%) and nitrous oxides (83%) emissions in Scotland.

Source: Scottish Government Climate Change Bill

why agriculture needs to reduce its GHG emissions

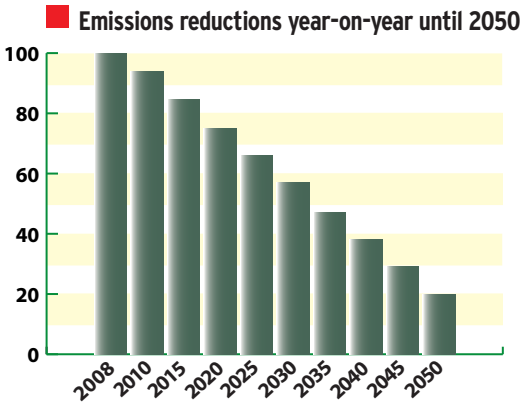
- **Tackling climate change is everyone's responsibility**
- **The industry may have to take action due to Government policy**
- **It is an opportunity to improve business efficiency and performance**
- **Consumers may wish to source and pay extra for low carbon produce**
- **There may opportunities to get paid to enter land for carbon offsetting schemes**

legislation

The Scottish Climate Change Bill

The Scottish Government is considering ambitious plans within a new Scottish Climate Change Bill, which aims to reduce emissions by 80% by 2050. The target is the equivalent to a 3% reduction in emissions per year.

It is proposed that 5-year targets would be established to monitor progress. The Bill, if enacted, will have a major impact on agriculture and other business sectors. It provides further incentives for farmers to reduce GHG emissions and adapt to climate change.



Consumers are already looking for low carbon produce

The challenge of climate change offers both opportunities and threats to agriculture. Consumers are increasingly more aware of climate change and the need to reduce carbon emissions. They are now actively searching for more sustainable and environmentally friendly products. Retailers, including the major multiplies, see this new trend and are keen to promote their 'green' credentials which is often used as a point of differentiation and competition. For example, most supermarkets are currently considering a carbon labelling scheme for their store products. Many are changing their business model 'so that the reduction of the carbon footprint becomes a central business driver.'

where to start

How are carbon footprints calculated?

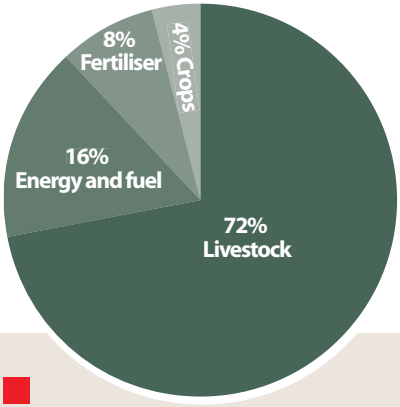
The carbon footprint is a measure of the total amount of carbon emissions that is directly and indirectly caused by an activity or accumulated over the life of a product. It is expressed as tonnes of CO_2 emitted usually on an annual basis. Emissions caused through N_2O and CH_4 are also included in the calculation through a conversion to carbon.

Know your own carbon footprint

Estimating your carbon footprint is complex, however, there are now a number of web-based calculators for farmers and landowners. The methodologies used to calculate carbon footprints vary, and are only estimates based on assumptions. Irrespective of their accuracy, they greatly help us understand where emissions occur.

There are two free web-based calculators aimed at farmers:

- **www.cplan.org.uk (Scottish)**
- **www.cla.org.uk (CALM)**



GHG emissions from an upland farm

Note: up to three-quarters of the GHG emissions from an upland farm occurs from livestock

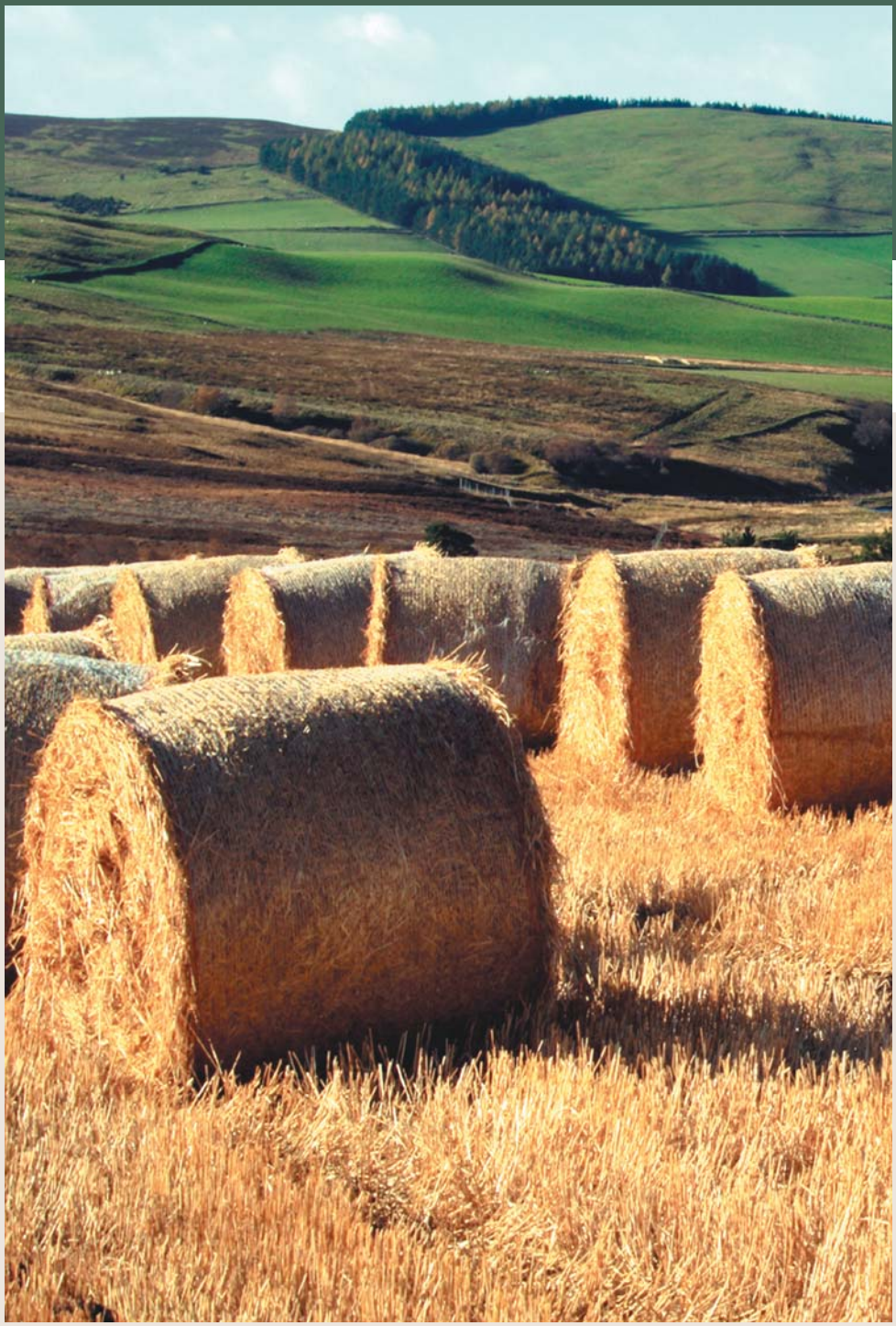
You will need to provide information on your annual livestock numbers, crop production, utilisation of FYM/slurry, fertiliser use, fuel, electricity and other energy use, purchased feed and land use changes.

What next?

You need to first look at the changes that will provide the easiest and greatest savings. Consider possible actions to reduce your GHG emissions carefully – what impact will it have on your business? The most important thing for a farm business is **to create a profitable, sustainable business**.

The good news is, reducing your carbon footprint is consistent with a farm's business objective – **sustainable efficient production**. This involves reducing input use per unit output, and lowering production costs. **So by improving your efficiency and saving costs, you will also lower the farm's carbon footprint.**

'By improving your efficiency and saving costs, you will also lower your farm's carbon footprint'



practical steps to reduce GHG emissions on farms

1 Management

2 Livestock

3 Fertiliser

4 Energy

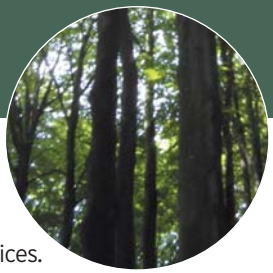
5 Crops

6 Co-operation

'Agriculture's main contribution to climate change will be to reduce methane and nitrous oxide emissions. However, energy use and carbon dioxide emissions will still be crucial'

SAOS

1 management



LAND USE

Farmers can directly influence GHG emissions through land use practices. Land use is one of the few areas which can actively remove CO_2 from the atmosphere. The creation of woodland, the conservation of soils (peat and moorland) and conversion of arable land to grassland all create carbon sinks with CO_2 being locked up in biomas and soils. Practices which release CO_2 include the deforestation of land, drainage of wet lands and taking permanent vegetation into regular arable use.

What you can do to reduce GHG emissions from land management

- **Maintain and manage any woodland, hill and natural vegetation on your farm**
- **Consider planting new woodland. Trees lock up carbon and are a good source of renewable energy**
- **Maintain and protect any peat bog, moorland or wetland**
- **Encourage the regeneration of any new native woodland and links to existing woodlands**
- **Reversion of crop land to native vegetation/wetlands and reduce soil cultivations**
- **Build up organic matter in soils through incorporation of crop residue, FYM/slurry, and cover crops**
- **Consider conversion to organic production**
- **Min-till cultivation systems produce lower emissions compared to conventional ploughing systems**

Remember there are grants available under SRDP to support sustainable land management.

Depending on land use and farming practice, carbon sequestration can balance the GHC emitted from a farm – **making it carbon neutral.** We also need to move away from thinking solely on a single farm-basis. Are there opportunities to work with neighbours to do things on a landscape scale to acheive even greater benefits?

Potential of carbon sequestration of various land use practices

MEASURE	TONNES CARBON SEQUESTED/ha/year
Zero tillage	0.4
Reduced tillage	< 0.4
Perennial grasses	0.6
Animal manures	0.4
Crop residues	0.7
Sewage sludge	0.3
Convert arable to grassland	1.2 – 1.7
Convert arable to woodland	0.3 – 0.6

Source: Part of the Solution – Climate Change, Agriculture and Land Management

RENEWABLE ENERGY

Most renewable fuels are 'carbon neutral' and have the potential to make a significant impact on a farm's carbon footprint.

Renewable energy offers exciting opportunities for the future in energy supply and usage on farms.

However farmers need to ensure that the economics and logistics of renewables are right for their individual circumstances and the land they manage.
To make sure that you make the right choices you need to consider all of the options available.
The key challenge is extracting usable energy as effectively as possible from natural sources.
What suits a particular site will be dictated by the availability of the prime renewable energy source, and how it fits in with the local environment.

The alternatives:

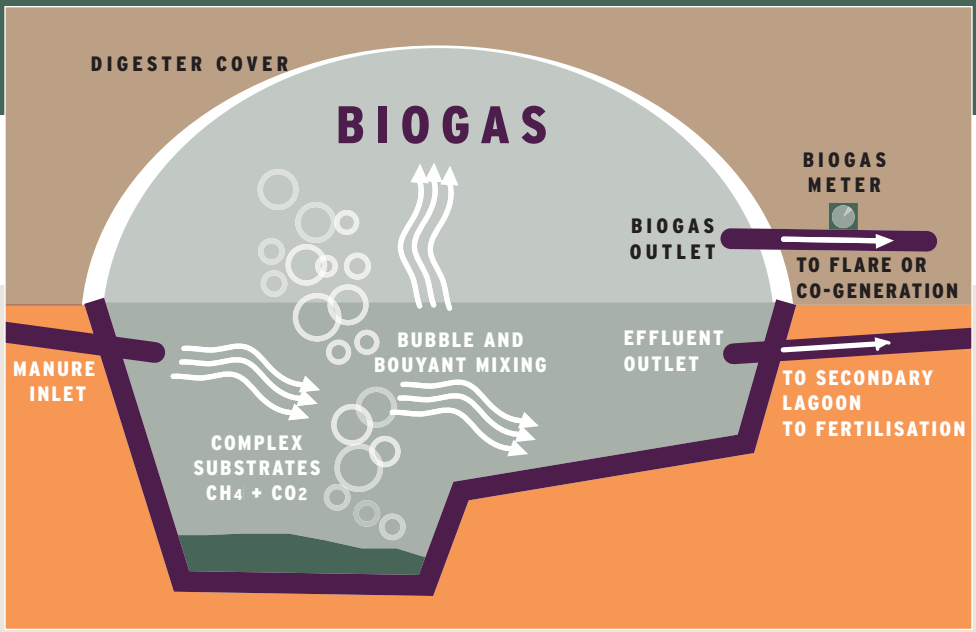
- **Anaerobic digestion**
- **Hydropower**
- **Biomass**
- **Wind**
- **Solar**

Will it pay?

The marginal cost of generating renewable energy is generally less than buying from a non-renewable source and in many cases is virtually free. However, other costs have to be included to get a true economic picture of the viability of a technology. For example, capital and installation costs have to be paid for. These need be amortised over the life of the system and the number of kWh to be generated to give a true energy unit cost. Again grants are available under the new SRDP. Suitable renewable energy projects will also generate Renewable Obligation Certificates (ROC) which provide an additional income source.

Items that need to be considered are:

- **INSTALLATION**
  Ground works, buildings, interfacing the energy output with the current energy using system.
- **PURCHASE OF THE EQUIPMENT**
  Either a one off purchase, lease or other finance deal.
- **PLANNING** Can be expensive where objections are raised that require a response.
- **ONGOING MAINTENANCE** A realistic year-on-year assessment must be made.
- **GRID CONNECTION**
  If the system is to generate into the grid, the costs of connection can be extremely high because of safety, security and metering equipment required by the electricity company.



ANAEROBIC DIGESTION (BIOGAS) PLANTS

Anaerobic digestion (AD) is the process where micro-organisms breakdown slurry and biodegradable materials in the absence of oxygen in an enclosed tank. The process produces **biogas** (methane 60%, carbon dioxide 39% and ammonia 1%), which can then be utilised to fuel a generator to **produce electricity and heat**. The treated liquid (digestate) can be applied to farmland as a fertiliser. AD plants have the double advantage they reduce methane emissions and are a source of renewable energy, offsetting carbon emissions. **AD is the best method for reducing GHG emissions from manures and slurries**.

In the majority of cases, farm-scale AD plant are not viable unless there is a source of biodegradable waste which would attract gate fees. **An opportunity for a joint-venture co-operative plant involving local farmers and processors is a more feasible model**. A business plan would be required to ensure viability. Grant support could be available for biogas plants under the new SRDP.

STAFF TRAINING

Don't forget the impact of training to **ensure good livestock husbandry.** Also make sure that machinery is operated effectively.

Training and involving staff provides enormous benefits. Once they understand what you're trying to do and why it's important, they can really contribute to your business.

2 livestock

Methane emission from agriculture are estimated to contribute up to a third of the total UK methane emissions. 90% of the methane emissions from agriculture comes from digestive fermentation in livestock.

The two principal strategies to mitigate methane emissions from livestock:

1 Ensure optimum livestock performance

One of the most effective ways to reduce the carbon footprint from livestock farms is to ensure livestock productivity is optimised. Enhancing individual animal performance can be achieved through improvements in the following:

- **Genetics**
- **Animal health**
- **Diet and nutrition**
- **Food conversion ratio**
- **Live weight gain**

This is consistent with the majority of livestock farmers' current objective. They recognise the benefits of maximising performance and the link to the economic viability of their livestock.

2 Reduce enteric fermentation from livestock

Research is now on-going throughout the world looking into improving diet utilisation in the rumen to reduce methane production. This includes for example:

- **Feeding oils to mop up hydrogen**
- **Addition of bacteria additives**
- **Promotion of acetogens in the rumen**
- **Improving the digestibility of forage**
- **New grass varieties**

The economic benefit of feed additives is still unproven in many cases, however, this may quickly change with new research and products.

'Research suggests that enteric fermentation can be reduced by 10 – 40% through diet changes, use of feed additives and introduction of microflora'

SOURCE: PART OF THE SOLUTION – CLIMATE CHANGE, AGRICULTURE AND LAND MANAGEMENT

3 fertiliser

Most of the strategies concerning fertiliser use concentrate on their efficient use. With the current high prices of inorganic fertiliser it is more important than ever that we use them effectively.
Optimising fertiliser efficiency saves GHG emissions and money.

- **Mineralisation of soil organic matter**
- **Decomposition of crop residues**
- **Fixation of atmosphere nitrogen**
- **Application of fertilisers and manures**

...are all sustainable land management practices and contribute to the ammonium and nitrate supplies in soil.

Nutrient balances

The manufacture and use of nitrogen fertiliser is another major source of GHG emissions. The nutrient balance of crops will have a major impact on the environment and GHG emissions. Any deficiency in nutrients will also impact on crop yields and quality.

The amount of fertiliser applied should be based on the crops requirements less the contribution from the soil and any FYM/slurry applied.
To estimate the fertiliser required you need:

- **Regular soil analysis**
- **Crop nutrient balances**
- **Waste management plan**

You need to undertake regular field analysis and remember to apply maintenance dressings of lime.
Tips to improve fertiliser effectiveness:

- **Check accuracy of tramlines and application**
- **Use GPS technology; precision farming if possible**
- **Apply fertiliser when crop actively growing**
- **Apply on damp days to increase absorption and reduce evaporation**
- **Avoid run-off, leaching, diffuse pollution**
- **Incorporate fertiliser as soon as possible**

'Matching fertiliser and manure/slurry applications to plant growth conditions will reduce nutrient wastage and N_2O emissions'

GUIDELINES FOR FARMERS IN NVZs

Some farmers only calibrate their fertiliser spreaders by quantity used over a field, however, you need to check spread pattern too.

- **Calibrate fertliser spreaders on an annual basis.**
- **Ensure proper repairs and maintenance**
- **Train all operators**

Waste management plans

Making better use of livestock waste reduces the need for bagged fertiliser. In the past, FYM /slurry was considered as a cost, now must be seen as a valuable resource.

Injecting slurry on land is more effective than conventional spreading with lower nitrate oxide losses. It reduces nitrogen losses by 80% – a value of £10/acre. And livestock can graze the land quicker following injection. Covering slurry stores has the advantage of preventing methane losses and it stops rainfall diluting the slurry.

Utilising clover, grassland management

Use more clover. Experiences from organic farmers demonstrate the viability of establishing clover swards to fix nitrogen. Grass growth may be slow to take off in the spring so an initial top dressing/slurry application may be required to stimulate early growth.

Grassland management and fertiliser policy has major impact on grass growth and utilisation. Grass is one of the cheapest livestock feeds but many farmers struggle to ensure its effective utilisation. Buffer grazing and conservation should be used to maintain grazing at the optimum stage.

'The availability of nitrogen from slurry varies from 5% - 40% depending on the time of year, temperature, soil conditions and application method'

AGRICULTURE AND CLIMATE CHANGE STAKEHOLDERS REPORT

4 energy

You need to carefully monitor your use of inputs particularly; **fertiliser, diesel, other fuels, and electricity**.

You can save 10% of the energy you use through better energy management. In practice this means you need to collect better energy consumption data and use the information to set realistic energy saving targets for your business.

Only by relating how much energy you use to production and/or output can information about your energy efficiency be obtained and the areas for improvement identified. There is value in carrying out an energy efficiency and carbon audit on your farm which could be eligible for grant under SRDP. The key steps are:

- **Take your own meter readings**
- **Consider installing sub-meters**
- **Analyse your data**
- **Relate energy use to production**

It is worthwhile thinking about annual use, and then calculating use per head or ha. You need to identify areas of weakness and how to reduce energy use to save costs. Really it is about efficiency and best practice.

Machinery utilisation & operation

A recent Defra study showed that over **35% of the energy used in UK agriculture is attributable to tractors and vehicles**.

This shows that savings made in this area can have a big impact on carbon emissions and cost.

The trend is for tractors to get bigger. 150hp tractors (or larger) are now the norm. However, few farmers think about fuel use or match their equipment to these larger tractors.

Savings of 20% and over have been made by farms that have tackled the efficiency of fuel use in tractors. Areas where savings have been made include:

- **REGULAR CHECKS** Tyre pressures, lubricant levels etc should all be checked according to handbook recommendations.
- **MAINTENANCE** Regular servicing will save money and reduce emissions. Set up a schedule for servicing all tractors and vehicles.
- **MACHINE ALLOCATION AND IMPLEMENT MATCHING** Allocating machines to the most appropriate task is the best way of ensuring that fuel is not wasted. Draw up a schedule listing the most appropriate tractor and implement/task combinations.
- **TRACTOR SET-UP** Correct ballasting and the right tyre pressures ensure that operations are carried out efficiently and effectively. This is particularly important when carrying out draught operations where the optimum level of wheel slip is 15%. Find out the correct ballast and tyre pressure combinations for all of your major tasks and once you know them keep a record of what they should be. Also remember to remove unwanted ballast when you are not carrying out draught operations.
- **DRIVER TRAINING** Train drivers so that they know how to operate machines efficiently. The driver, and the way a machine is operated, is a key influence on how much fuel is used. Bad driving technique can waste up to 20% of the fuel used.
- **MINIMUM TILLAGE** Eliminating heavy draught operations like ploughing and minimising the number of cultivation passes can make significant fuel savings. Consider switching to min- till systems.

Carrying out these simple improvements and upgrades cost savings will ensure that fuel costs associated with tractors and vehicles will be reduced. **In addition your 'carbon footprint' will go down.**

> 'Most farmers know the cost of energy but not how much they use'
>
> **CENTRE FOR FARM ENERGY**

5 crops

Grain dryers

Grain drying and conditioning can require huge amounts of energy so are a major potential for inefficiency.

Experience shows that many growers are not servicing their burners or maintaining equipment. This needs to be done on an annual basis. Calculate fuel use and drying costs and consider changes to your system to improve efficiency e..g. consider joining a central co-operative grain group. For own use, can you treat with propcorn, urea or crimp the grain?

Keeping an eye on grain drying efficiency can save you up to £3/tonne/year.

Key points to look for are:

- **FANS** Check for corrosion and damage
- **AIR INLET AND EXHAUST VENTS** Inadequate air inlets / outlets will restrict airflows
- **HEATERS AND DEHUMIDIFIERS** Inadequate or damaged equipment will prolong drying times. Have equipment professionally maintained and tested to ensure that it is working properly.
- **CONTROLS** Automatic control on fans and heaters will ensure that efficient operation is achieved and crops are dried quickly.
- **OPERATING STRATEGY** Remember that the efficiency of a drier is highest during warm weather. Concentrate on working the dryer hard during the harvest period and aim to finish as soon after the completion of combining as possible.

The best way to ensure that you keep drying costs under control is to prepare your dryer and stores in good time for harvest. Just because it worked last year doesn't mean that this year will be the same.

'Experience shows that many growers are not servicing their burners or maintaining equipment'

SAOS GROWERS SURVEY

6 co-operation

Co-operation offers many opportunities to improve efficiency and save costs and it is available in various forms. It will have a major role to play in helping farmers reduce their carbon emissions.

At farm level, neighbouring and joint venture farming offers opportunities to:

- **Share resources, eg labour, machinery and skills**
- **Invest in new equipment and technology to increase productivity**
- **Develop new ventures**

Away from the farm, co-operation can help to assist a farm business improve efficiency and productivity in a number of ways by:

- **Providing technical advise and information, eg measuring costs and returns for individual farmers**
- **Co-ordinating the collection of farm produce to achieve the lowest haulage costs**
- **Opportunities exist for the development of a wood-fuel supply chain for farmers**
- **Undertaking processes, eg drying malting barley, which can be achieved more efficiently if it is completed in greater volumes**
- **Developing and providing training and sharing best practice**
- **Matching the needs of one farm with the spare capacity of another through machinery rings**

A key consideration is to look beyond a single farm business and to consider how collaborative activity in all its various forms can maximise efficient, sustainable production. For information on co-ops that can help you visit **www.saos.co.uk.**

'Co-operation will play a key role in helping farmers reduce their carbon emissions'

SAOS

jargon buster

CARBON DIOXIDE (CO_2)
One of the major greenhouse gases contributing to global warming. By-product of the combustion of fossil fuels. Also produced by animals and plants during respiration and used by plants during photosynthesis

SEQUESTRATION
Storage of CO_2, normally from the atmosphere, through a biological process

ANAEROBIC DIGESTION (AD)
AD or biogas plants is the process where micro-organisms breakdown biodegradable materials in the absence of oxygen in an enclosed tank. Methane is captured from slurry and manures, which leads to reductions in emissions to the atmosphere. AD is also a renewable energy source suitable to replace carbon fossil fuels

CARBON NEUTRAL
Where a farm (or business) balances its greenhouse gas emissions with CO_2 sequestrated or offset

SCOTTISH RURAL DEVELOPMENT PROGRAMME (SRDP)
£1.6bn programme (2007-13) of public funding for rural development. Includes a range of grant and support schemes

BIOMAS
Living or recently dead, biological material that can be used for an industrial process or fuel, eg willow, miscanthus, vegetation, all trees

CARBON SINK
Where CO_2 is stored in a natural state. Includes where plants remove CO_2 from the atmosphere by photosynthesis and store it (sequestration). Examples include trees, natural vegetation, and peat bogs. The oceans are the largest natural CO_2 sinks in the world

GREENHOUSE GASES (GHG)
The gases found in the atmosphere which lower heat loss and so contribute to rising world temperatures – global warming. Includes a number of gases including carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and chlorofluorocarbons (CFCs).

CARBON FOOTPRINT
The total carbon emissions attributed to a product, business or activity expressed in tonnes CO_2 emitted. All other GHGs are converted to CO_2 so expressed as 'carbon dioxide equivalent'.
Allows individuals or businesses to estimate their impact on the environment and contribution to global warming

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CAIRNGORMS NATIONAL PARK AUTHORITY

SAOS co-operating enterprises