Water use, reduction and rainwater harvesting on beef and sheep farms

Plus+
Better Returns Programme

**Information provided by ADAS UK Ltd and Cranfield University.
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Key messages

- Some of an animal's water requirement may be satisfied by its feed.
- Global demand for meat is predicted to increase by 50% over the next 20 years.
- There is the greatest concern about blue water use.
- Most to gain from looking at blue and grey water use, by avoiding waste and leakage and considering alternative water sources.
- It is possible to collect up to around 90% of rainwater falling on roofs if they are clean and made of suitable materials.
- Consider daily amount of water the stock will drink and whether the water collected can be used all year round.
- Important: Check that there is insurance cover for any issues related to use of rainwater.
- Work out your specific farm example to see if it justifiable to install a rain harvesting system on your farm.

Keywords:

Blue water, Green water, Grey water, rainfall.

Contents

Introduction

Large quantities of water are used to produce each kilo of meat, when you consider the amount required to grow forage and concentrate feeds for washing and cleaning, in the processing plant and for animal drinking.

Water is a limited resource and currently water use in agriculture is a global concern. Climate change may see an increase in droughts and water shortages in the future. AHDB Beef & Lamb has responded to these concerns by commissioning a review of the amount and source of water used on beef and sheep farms and to outline options which may reduce use.

It is important that we consider water use and that it is not wasted, but used efficiently to produce beef and lamb.

Farms which use a mains water supply may save money if they can reduce water use without reducing profitability.

One potential way of reducing reliance on mains water is rainwater harvesting. This is becoming more popular where a cost-effective system to reduce use and/or provide some measure of resilience in times of drought is required.

A system to harvest rainwater needs to be correctly designed and maintained to ensure the water is safe for stock to drink.

Water use and the potential for reduction on beef and sheep farms

The average water requirement or 'footprint' is estimated at 18m³/kg for English beef and 58m³/kg for English lamb. But only a small proportion of this water is required for drinking, with average annual requirements of about 7.3m³ for adult cattle, 1.8m³ for calves, 1.2-1.6m³ for adult sheep and 10.6m³ for lambs under one year old. Some of an animal's water requirement is satisfied by its feed, with fresh grass typically containing 77 to 88% water.

Some of an animal's water requirement is satisfied by its feed.

A water footprint is the amount of water used required to produce a specific product.

1m³ of water = 1,000 litres

Table 1: Water footprint of English Beef and Sheep

Production system	Total water m³/kg of meat	% Blue* water
Lowland suckler beef	19	0.4
Upland suckler beef	16	0.5
Hill suckler beef	47	0.2
Dairy beef	10	0.4
Lowland sheep flock	25	0.1
Upland sheep flock	27	
Hill sheep flock	135	

Source: EBLEX 2010. *See Blue water definition on page 4.

Why is water use a cause for concern?

The global demand for meat is predicted to increase by 50% over the next 20 years, which will in turn increase the industry's requirement for water. In the UK the majority of home-grown feed comes from grassland and crops watered by rainfall, however, outside the UK and Ireland crops are commonly irrigated with high quality water suitable for other uses (see blue water definition). Although such crops are not grown in the UK, the fact that they are imported as animal feed means they contribute to the water footprints of cattle and sheep production.

Global demand for meat is predicted to increase by 50% over the next 20 years.

In the UK, there have been shortages of mains water in periods of drought and the cost of mains water has been increasing. Many livestock farms have their own natural water sources to provide some or all of the drinking water. However, animals having direct access to water courses to drink is being discouraged or prevented as it can lead to environmental problems from diffuse pollution.

Water sources and classifications

When determining 'water footprints', water falls into three different categories depending on source and potential use. These categories are blue, green and grey water, with the greatest concern being blue water use.

Blue water is the greatest concern.

Blue water is high quality surface or ground water, treated or with the potential to be treated for domestic, commercial and environmental use. Even in England's wet climate, increasing demand means agriculture is in competition for this resource. It is used for irrigation, feed processing, animal drinking and cleaning of buildings. It may be called potable water. This includes rivers and streams, wells, springs and boreholes.

Green water comes from rainfall and may be stored in the soil. It is the main supply for non-irrigated agricultural crops. Green water is generally unavailable for other uses.

Grey water in domestic use, relates to waste water from washing. In some cases it is included in water 'footprints' as the amount of water needed to dilute polluted water to a pre-determined water quality. In agriculture, grey water may come from slurry, silage effluent or agricultural crop sprays.

Scope and reasons for reduction in farm use

With the current UK climate there is most to gain from looking at blue and grey water use, by avoiding waste and leakage, considering alternative water sources and through recycling. It may also be possible to replace some of the blue water used with green water sources, such as collecting rainwater for animal drinking, which may be deemed more sustainable.

Most to gain from looking at blue and grey water use, by avoiding waste and leakage and considering alternative water sources.

There is currently little to gain from reducing green water requirements directly on most farms, but this may become more important in the future. Crops bred for improved water use efficiency could have a role to play in continuing to supply feed in times of drought, while using livestock breeds which have adapted to drier climates may also play a role.

Potential practical actions

There are a number of potential actions that can be taken to increase water use efficiency on most farms, reduce risks during a drought or interruption to the farm's water supply.

However, the economics of reducing water use must be considered for any individual farm situation. This may be influenced by the current source and costs of water, with river-water or spring water at little or no cost, mains water typically costing £1-2/m^3 and supplying borehole water somewhere in-between. However, some of the options for reducing water use may offer additional savings, through improving feed conversion efficiency, supplying more feed from the farm or reducing other costs of production.

- ## Short term:

Identify and attend to water leaks as these can be expensive when using mains water or cause other concerns, such as loss of pressure or wet areas, from on farm sources. Checking ball valves and meters regularly or installing water meters can be worthwhile. A leaking ball valve can waste 150m^3 of water a year, or £225 worth at £1.50/m^3.

On one livestock farm being monitored by ADAS, the meter readings led them to find an unidentified leak, with the water being lost amounting to more than 2,500m^3 a year, worth £3,750 at £1.50/m^3. Luckily, this farm was using its own spring but the lost water could have still incurred costs and disrupted supplies over time.

Reduce time to slaughter through more efficient finishing systems and/or higher quality feed will save drinking water as well as forage and concentrates that would go towards livestock maintenance requirements if they were kept longer.

For more information see AHDB Beef & Lamb BRP Manual 1 - **Marketing prime lamb for better returns** and Manual 2 - **Marketing prime beef cattle for better returns**

Use grazing efficiently by using grazing strategies which see a higher proportion of the forage grown eaten by stock. One example could be switching to rotational or paddock grazing and saving on requirements for bought in feed. This can also increase the quality of the forage grazed, which can lead to higher growth rates and reduce time to slaughter.

For more information see AHDB Beef & Lamb BRP Manual 8 – **Planning grazing strategies for better returns**

Creating and maintaining good soil conditions will lead to increased infiltration, leading to increased crop yields, by improving the uptake of nutrients such as N, P, K and lime, thereby increasing the efficiency of rainwater use.

For more information see AHDB Beef & Lamb BRP Manual 3 - **Improving soils for better returns** and Manual 7 - **Managing nutrients for better returns**

Forage crop management by reseeding, using nutrients efficiently and good crop agronomy will ensure the best yields are achieved, so more feed is produced on farm. Care when conserving these crops will ensure optimum forage quality, potentially saving on concentrate purchases. Introducing and managing clover well can save on inputs and increase forage protein, reducing reliance on bought in protein feeds.

For more information see AHDB Beef & Lamb BRP Manual 1 - **Improving pasture for better returns**, Manual 5 - **Making grass silage for better returns and Grass MOT**

Feeding livestock to match requirements can optimise growth potential whilst also potentially reducing feed inputs and the time to slaughter. Maximising the use of low water footprint feeds such as high quality forages and co-product feeds, such as distillers' grains or sugar beet tops can also lower the water footprint.

For more publications on feeding beef and sheep **beefandlamb.ahdb.org.uk**

Minimise wasted feed by evaluating the feeding system. Ensure good trough hygiene and design, storing feeds correctly and reducing wastage at the clamp face by keeping it tidy and minimising surface area.

Providing animals with access to shade in hot weather will reduce drinking water requirements.

Evaluating the use of cleaning water and whether water used for tasks such as washing calving/lambing pens can be reduced. For example, by switching to high pressure hoses and brushing out pens well prior to washing.

- ## Medium term:

Increase production efficiency different breeds of livestock and systems currently practiced in England show varying performance levels an these can be improved by using, for example, Estimated Breeding Values (EBVs) in ram and bull selection is seeing increases in growth rate potential leading to more efficient meat production.

Consider growing maize which processes carbon dioxide differently to most other livestock feed crops by yielding well with less water and has better water use efficiency than other crops, including cereals. Maize cannot currently be grown economically in all parts of England and is low in feed protein.

Replace soya with home-grown protein as soya imported for animal feed often comes from irrigated crops. It may be possible to replace this with alternative sources of protein, such as beans or clover, in animal diets. However, ensuring adequate protein quality is supplied in animal diets may require crop improvement or novel crop development.

Use non-mains water sources. Drinking water for livestock can be supplied by rainwater harvesting (see pages 7-11). The capital cost of such systems needs to be balanced against the costs saved. Where rainwater runs over dirty yards and into manure storage facilities, there may also be disposal cost savings. *Replacement of blue water with green water.*

- ## Longer term:

Utilise improved crop varieties, as plant breeders are working to identify varieties of many crops, including cereals, grasses and clovers that have improved water use efficiency, either by requiring less water to produce a given yield or through improved drought tolerance. In some cases varieties have increased root length, making them more drought tolerant or they may recover quicker after a drought, which will improve crop yields during a dry period. This will offer the potential to use more home-grown feed, and may reduce the impact of climate change on crop yields. The development and use of gene marker technology is increasing the rate of genetic improvement by reducing the time taken to identify plants with desired traits.

Changing crops grown should droughts become more common, as droughts will reduce the average yields of many forage crops. More drought-tolerant crops include fodder beet, stubble turnips, lucerne and chicory.

Using livestock breeds from dryer climates that have adapted to cope with scarce water supplies. For example, Zebu cattle have adapted to hot, dry climates, with their lose skin, large ears and humps helping them to keep cool and helping lower their relative water requirement. Composite breeds have been developed by crossbreeding these breeds with European breeds and are being used in water scarce areas of America and Australia.

AHDB Beef & Lamb research projects relating to water use on can be found at **beefandlamb.ahdb.org.uk/research/climate-change/climate-change-generic/**

Why harvest rainwater?

Drinking quality (potable or blue) water is a limited resource in the UK and the cost of mains water is likely to continue to rise, due to increasing energy costs in its treatment and transportation. This means that the use of rainwater harvesting technology is becoming increasingly viable.

In addition, water quality is more controllable where as some on farm water sources such as bore holes and wells, may have water quality issues. In some systems it may also reduce the amount of dirty water that runs into slurry stores or water courses.

Is rainwater harvesting suitable for the farm?

The first things to consider before investing in rainwater harvesting are:

+ Local rainfall - in terms of quantity and frequency of rain
+ The size of buildings from which water can be harvested
+ Roofing materials – while many are suitable, those that include materials such as lead, zinc and bitumen can contaminate water and must not be used
+ Requirements of stock and how much of the harvested water can be used
+ Current water supply and costs which may be saved, including dirty water disposal
+ Physical issues in terms of installing an efficient gathering, storage and distribution system and the costs associated with installation

Calculating the amount of rainwater which can be harvested on a farm?

The amount of rainwater that can be harvested is calculated by the equation:

Rainfall (mm) x area of roof (m²) x efficiency factor = litres harvested

It is possible to collect up to around 90% of rainwater falling on roofs if they are clean and made of suitable materials.

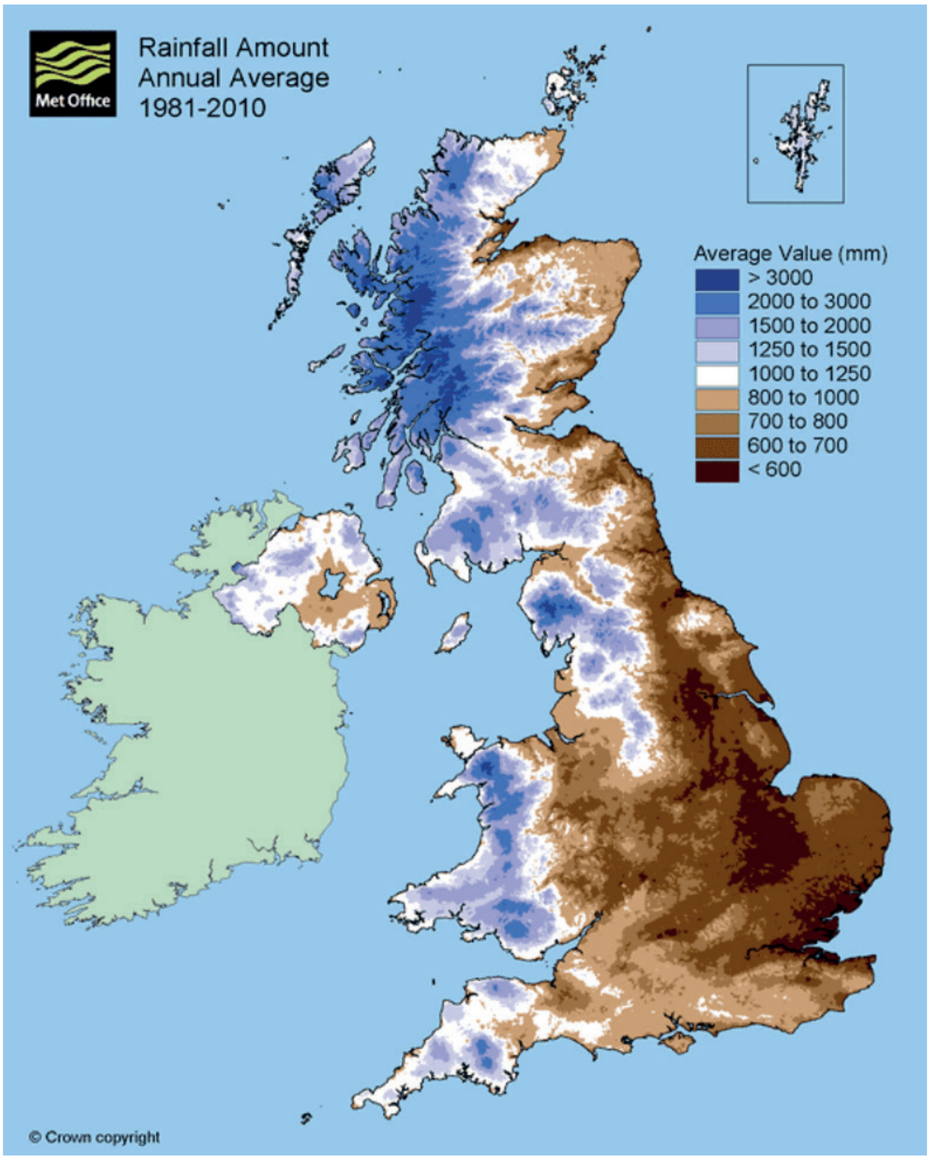
The efficiency factor depends on the angle and material of the roof, plus any material which may hold onto water, including gravel and moss, as that water will be lost via evaporation, reducing the water collected.

Roof type	% rain harvested
Pitched roof – tiled	75 to 90
Flat roof – smooth finish	50
Flat roof – with gravel layer	40 to 50

It is possible to collect up to around 90% of rainwater falling on roofs if they are clean and made of suitable materials. Further losses of about 10% can result from filtration to remove debris.

Checking local rainfall

Rainfall in many beef and sheep producing areas of England is 800mm or more as can be seen from the Met Office map below, but individual farms should consider more local data available from the Met Office (www.metoffice.co.uk) and any factors that may influence that, such as aspect or shelter from hills.



How much water can be used?

Consider daily amount of water the stock will drink and whether the water collected can be used all year round.

There are two factors to consider when calculating this. First, the daily amount of water the stock will drink and secondly, whether the water collected can be used all year round.

If, on the farm in question, stock are only able to use the collected water during the housing period, much of the collected water will not be used. This needs to be taken into account when calculating the economics of the installation. However, on farms with dairy or finishing units or other enterprises, it might be possible to use all the water harvested either for drinking or washing. There may also be other factors to take into account, such as savings in slurry storage requirements.

Approximate daily water requirements of beef and sheep:

Class of stock	Litres per day (drinking)
Beef cow, dry	15-40
Beef cow, lactating	40-70
Fattening cattle	25-75
Growing cattle	15-50
Sheep	3.3-7.5

Note: water requirements are highly dependent on the type of ration fed, ambient temperature and stage of the production cycle, particularly whether lactating.

Gravity above ground storage with filter unit at top left (courtesy of ADAS)

Costs of equipment

A simple system for a 100-cow beef herd might cost £5,000 to £7,000 depending on the size and type of storage tank.

The tank is the most expensive part of the system, but there may be second-hand tanks available. However, it is important to ensure a tank is suitable for the purpose and properly cleaned out. A filtration system is also required to provide water that is fit for stock to drink.

Choice of equipment will influence the total cost of the project and hence its viability when compared to mains water. There may also be additional costs for rainwater collection infrastructure, such as gutters and pipes, if they are needed to link a number of buildings or divert water to a tank.

Submersible pump
(courtesy of Rainharvesting Systems Ltd)

Important: Talk to your water company if considering connecting non-mains water supplies to a mains water system. The appropriate steps must be taken to comply with water regulations.

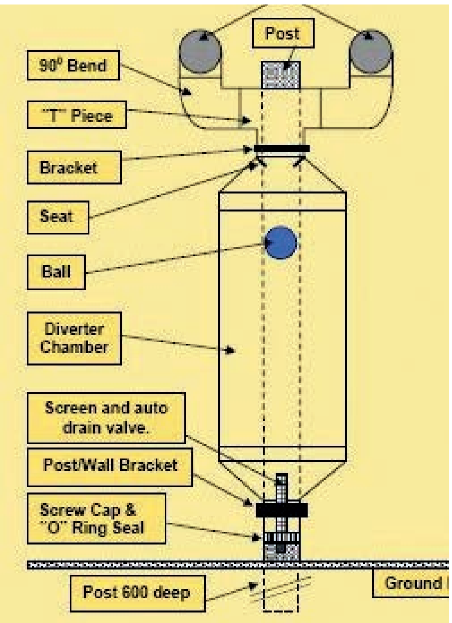
Storing harvested water

The size of tank required depends on the frequency of rainfall and livestock requirements. Typical systems store up to around a week's worth of water, relying on mains back up for periods without rainfall.

Underground storage is more expensive, but water remains cooler and at a constant temperature, so it is likely to keep fresh for longer. But water may need pumping out with an electric pump.

Above ground storage allows water troughs to be supplied by gravity. However, water can heat up in summer, risking water quality problems through the build of potentially harmful bacteria.

Tip: Place the water tank on the north wall of the building to reduce water heating up.



First flush diverter
(courtesy Rain Harvesting Pty)

Vortex filter
(courtesy Rainharvesting Systems Ltd)

Moving water around the farm

Water may need to be pumped into troughs and this will often require a submersible pump. The pump lies on the bottom of the tank and the inlet floats just below the surface to avoid taking in any floating matter or oil which may have entered the system.

Water quality - Filtering harvested water

Rain must be filtered to remove debris and bird droppings (which carry the risk of Salmonella) that collects on roofs. There are different types of filters available:

+ **First flush diverters** – collect the initial run of water so they do not enter the store, but these need to be emptied after each rainfall
+ **Horizontal louver-type diverters** – water runs over the louvers and the debris drops down along with some of the water to a soakaway
+ **Vortex filters** – swirl the water and throw it through the filter, leaving the debris to fall to a soakaway

Most of these filters will remove 10% or so of water coming off the roof.

For high quality water, other filters such as sand filters or cartridge filters, can be used, but these are not generally required for livestock watering.

Water quality – UV treatment

In general, for watering beef and sheep, harvested rainwater can be used without UV treatment. However, when water is stored for long periods or at higher temperatures (above 20°C), bacteria may be a concern and put stock health at risk. This may require additional filtering and treatment with a ultra-violet (UV) filter, which kills bacteria in well filtered water.

Installing a UV filter which can cope with a heavy downpour will be expensive. One option for reducing costs may be to route the rainwater to a tank then pump it through the UV filter at a suitable rate into a second tank.

Rainwater has no minerals in it, so livestock may require mineral supplementation as normal water supplies are likely to contain some minerals.

Assurance scheme requirements

The Red Tractor Farm Assurance Beef and Lamb Standards (2011) states that livestock must have adequate access to fresh, clean drinking water at pasture or outdoors. This should be by provision of water troughs unless there are sufficient natural water sources. "Natural sources" should not be polluted or turbid with algae/sediment.

However, each farmer should check supplier contracts and farm assurance requirements for any restrictions.

Important: Check that there is insurance cover for any issues related to use of rainwater.

Example calculation of the costs and benefits?

Work out your specific farm example to see if it justifiable to install a rain harvesting system on your farm.

Our example farm has buildings with a roof area of 500m^2, in an area of 1200mm annual rainfall. The annual amount of water falling on the roof would be 600m^3. Some of this will be lost through evaporation and on a clean smooth roof this could reduce the yield by 15% to 510m^3 per year. Filtration will also generally result in a further 10% loss. **Therefore, the water available would be 459m^3**.

If the installation of a system costs £6000 and this is spread over 10 years and maintenance is estimated at 2% of the installation costs/year, the annual cost would be £720 a year. If all the 459m^3 of water harvested can be used **the water would cost £1.56m^3.**

A beef unit finishing a total of 100 beef cattle over 300 days of the year, with a daily requirement of 30 litres a day, their annual requirement would be approx. 900m^3. The 459m^3 could provide approx. **153 days' worth of water to the beef unit**.

However, if on our farm there were 100 suckler cows, who are only able to use the water for the 150 days they are housed with a daily requirement of 25 litres a day, their requirement would be 375m^3. But with only 150 days to collect rainwater for their use, and if we assume half the annual rain falls in this time, only 230m^3 would be available for their use. **Therefore, the costs of water harvested would be £3.13m^3**.

With a mains water cost of £1-2/m^3, being able to justify the installation on mains water savings alone will depend on the amount of water which can be used and the lifespan of the equipment. But there may also be other reasons to consider for installing a rainwater harvesting system.

This document is not intended to be a specification for a rainwater harvesting system, but as a guide to what can be achieved and the things to consider. When specifying a rainwater harvesting system, discuss the technical requirements with a number of suppliers or independent adviser.

For more information:

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