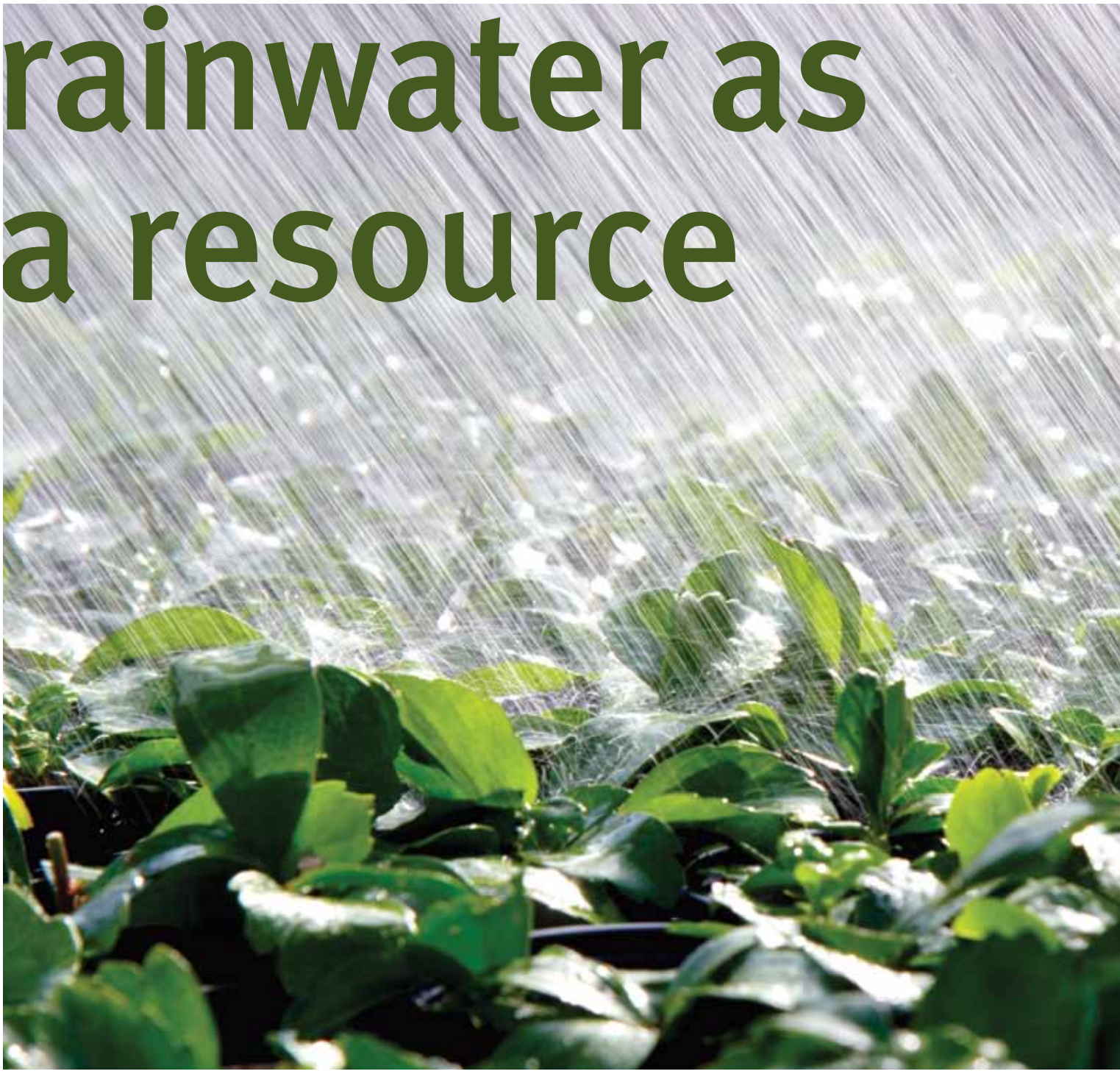
Environment Agency

Rainwater Harvesting: an on-farm guide

rainwater as a resource



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Your environment is the air you breathe, the water you drink and the ground you walk on. Working with business, Government and society as a whole, we are making your environment cleaner and healthier.

The Environment Agency. Out there, making your environment a better place.

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Foreword

Water is essential for farming but often is taken for granted. Yet in many parts of England and Wales water resources are already scarce and are likely to become even scarcer as a result of climate change.

It's the Environment Agency's job to manage water resources and to plan to ensure that there is enough for people and the environment. We know how important water is for agriculture and want to work with farmers to help them make best use of the water they have. We believe that, although many farmers think carefully about using water more efficiently, there is still scope for further improvement. Our Water Efficiency Awards showcase best practice and provide cost-effective ideas to reduce water use.

In addition to using water more wisely, rainwater harvesting is a way of reducing your reliance on mains water, or on your borehole or spring. Making use of the rain that falls on your farm buildings can save you money. It can also mean potentially less storage for slurry, and reduce the likelihood of contaminated runoff from yards entering rivers and streams.

Rainwater harvesting might not be suitable for everyone. But even if it cannot supply all your water needs it's still worth thinking about. It can reduce your costs and help reduce your environmental impact.

I hope that this booklet will give you some ideas about what might work on your farm. Do give it a go!

Ian Barker
Head of Water

Contents

Throughout the seasons, we all routinely harvest often hard-won rewards in the farming industry – but what of, arguably, the most valuable "crop" of all? Rainwater! It is there for the taking... an asset that can save you money and reap dividends for farming and the environment alike.

The Environment Agency recognises the need for 'good practice' advice to help both farmers and land managers establish the most efficient methods of water usage before any need to look for new resources.

This booklet provides a guide on appropriate rainwater harvesting systems available to the agricultural industry. It describes the material which may well help decide the construction of the system you want to install – tailor-made to your requirements. Inside, are calculations for the collection of volumes of water – as well as helping to gauge the size of storage tanks and pumps and fittings that might be used. Some case studies illustrate water harvesting systems based on practical experiences of farmers and growers from the various sectors of agriculture, who have constructed their own schemes.

What is rainwater harvesting?

Rainwater harvesting (RWH) is the collection and use of rainwater falling onto buildings which would otherwise have gone down the drains, been lost through evaporation, or soaked into the ground.

Buildings under construction present the ideal opportunity to install a RWH system – or it can be added to existing structures. A system may involve diverting drainage to a tank or reservoir to collect water and if necessary, could include treatment to improve water quality for specific uses. Distribution pumps and pipes may also be required to supply the water to where it is needed on-farm.

There is a RWH system to suit all needs and budgets. It could simply be created by diverting roof gutters into a storage tank or water butt, or it could be more complex involving pumped storage, filters and UV treatment for use on ready-to-eat crops.

Benefits of rainwater harvesting – what's in it for you?

Potentially, there are both economic and environmental benefits of rainwater harvesting.

- Typical charges for mains water are currently between £1 and £2 per cubic metre and are expected to rise in the future. Using RWH for some or all water use on-farm could reduce this expenditure, however savings will have to be offset against capital and operational outlay of the RWH equipment.
- Where water is discharged to a sewer, your water company will charge you a proportion of supply costs in your water bill for this discharge. Reducing your mains water use will ensure these additional savings can be made.
- Harvesting and using rainwater can reduce the quantity of water entering your slurry store, running across fouled yards, or entering your dirty water tank. This can mean a reduction in slurry store size and reduced amounts of dirty water to dispose of, resulting in cost savings.
- Rainwater does not contain treatment additives, such as chlorine, and is therefore considered by some to be better for irrigation. However, filtration and/or UV treatment may still be required for some crops.
- Rainwater is also considered better than mains water for spraying some crop protection products.

You can reduce the size of the slurry store that you need if you divert clean roofwater away from the store

By harvesting water not only are you making best use of the water but you can prevent soil erosion and compaction

- RWH can reduce dependence on a supply from rivers and groundwater sources – now under increasing demand from an increasing population.
- RWH can also reduce the risk of localised flooding where water from large roof areas is not managed correctly.
- Other benefits may be particular to your farm, Haygrove Farm in Herefordshire (Case Study 1) has found benefits of better soil drainage, improved humidity levels and plant health.

Some farm assurance schemes actively encourage the use of RWH.

What are the wider implications of rainwater harvesting?

Although there are many positive benefits from RWH systems, there are also wider implications.

- RWH can have an impact on energy use and carbon emissions where water, weighing 1 tonne per cubic metre, is pumped to where it is needed around the farm. The change (positive or negative) in energy use and carbon emissions, resulting from using a RWH system, does depend on your current system and use of pumps.
- The manufacture and installation of RWH systems also has an environmental impact.
- In addition, where water quality needs to be high for specific uses and water needs to be treated, for example using ultraviolet (UV) treatment, this can result in significantly increased energy consumption on-farm.
- A common concern is that harvesting rainwater on a large scale may affect the natural recharge of groundwater and river flows. Whilst this could be an issue for large systems in very small catchments, in most cases, even the largest roof areas are still small compared to the area of a catchment. Furthermore, harvested rainwater is usually used very close to the point of collection with surplus run-off allowed to soak away or drained and returned to the catchment.
- RWH systems are unlikely to provide relief to the mains water supply in times of water shortage, since the low rainfall during droughts is unlikely to be sufficient for rainwater storage. Climate change may exacerbate this problem in the future and a RWH system, on its own, is unlikely to provide enough water for your farm and so there is likely to be a need for alternative sources.

You need to think about how much energy a new system may use

Case Study 1

Haygrove Ltd

Haygrove Ltd is a Herefordshire fruit farm, growing raspberries, strawberries, cherries, blackberries and blueberries. The company also market polytunnels, designed with valley guttering made of tensioned, clear, polythene sheet between the ridges and with standard guttering along the sides.

The site has 120 ha of tunnels, with 12 ha fitted with roof drains connected to a natural reservoir. This water is pumped from the reservoir to the irrigation pump house where it passes through sand filters, has fertiliser added and then fed back through the tunnels to irrigate crops grown in containers. An automated irrigation scheme waters the plants, using individual drippers running up the rows of plants.

The farm has harvested 5,852 m^3 water per year, and in three years will recoup the additional investment for replacing old tunnels. Will Delamore, from Haygrove, also highlighted other, noticeable benefits, such as better soil drainage between the tunnels, improved humidity levels inside them and a marked improvement in plant health through the use of harvested water.

Things to consider before installing a rainwater harvesting system

The key issues you need to work out before you decide whether a RWH system is right for your farm are:

- How much water is used?
- What is it used for?
- How efficiently is it being used?
- Is there enough rainfall?
- Is there a suitable collection area?
- What quality of water is needed?
- What are the energy or carbon costs of implementing a RWH system?
- Is it worth harvesting water?

This section will tell you how to answer these questions before you go any further.

How much water do I need and what is it used for?

Before RWH is considered, all uses of water should be identified and quantified. The *Waterwise on the Farm* booklet (EA, 2007[1]) sets out how to carry out a water audit on farm and develop an action plan. This methodology is also detailed in the *Effective Use of Water On Dairy Farms guide* (MDC, 2007[2]). To summarise the methodology:

- Identify all sources of water use.
- Calculate cost of water use – check water bills, or look at pumped volumes from abstracted sources. You may also want to check changes in water use through different seasons.
- Examine how and where the water is used.
- Calculate how much water you should be using. *Waterwise on the Farm* is a useful guide.
- Identify and compare water efficiency practices in order to reduce water use.

1 http://publications.environment-agency.gov.uk/pdf/GEHO0307BLVH-E-P.pdf
2 http://www.dairyco.net/media/10351/effectiveuseofwaterondairyfarms.pdf
3 This is potential as how much you actually collect will depend on the tank size and the number of times that the tank is flushed through overflow.

How efficiently are you using water?

Before installing a RWH system you should identify opportunities where water could be used more efficiently on your farm. There is no value in investing in a RWH system if water is simply wasted. There are a number of ways to improve the efficiency of water use on-farm at low or minimal cost.

Five things to consider are:

1 Preventing and repairing leaks.

2 Reducing pressure.

3 Fixing dripping taps and hosepipes.

4 Alternative washing and cleaning processes.

5 Correct scheduling of irrigation to meet crop needs and reduce evaporation.

Further information and guidance on using water efficiently on-farm can be found on **www.environment-agency.gov.uk, www.envirowise.gov.uk and www.ukia.org**

How much rainfall do you have?

The amount of rainfall available for collection is a key factor in the success of any RWH system. The amount of rainwater available for collection depends upon:

- Rainfall;
- Roof area;
- Run-off coefficient;
- Filter efficiency.

The collectable rainfall can be calculated by:

Potential[3] collectable rainfall (litres) = roof area (m^2) x run-off coefficient x filter efficiency factor x annual rainfall (mm) (see worked example).

Roof Area: The roof area is the surface that will collect and channel rainwater to the storage tank. A 1000 tonne grain store on a farm would have an area of around 500 m^2. The area is calculated by multiplying the width by the length of the roof, so a roof that is 20 m wide and 30 m long would have an area of 600 m^2.

Before considering new sources of water supply identify where you may have leaks first

The amount of rainfall that can be collected depends on your roof area

Runoff Coefficient: This coefficient determines how much water will flow from the roof surface, and how much is lost. A coefficient value of 0 would mean that no run-off occurs whilst a value of 1 would collect all of the rain falling on the roof.

Table 1. Common roof coefficients

Roof Type	Coefficient
Pitched roof	0.85
Flat roof, smooth surface	0.55
Flat roof with gravel layer or thin turf (<150mm)	0.45

Filter Efficiency: Filters designed for collecting rainwater will often reject the first flush from the roof to prevent debris getting into your tank. Filter efficiencies are best obtained from the suppliers of RWH components. In the absence of more specific data an efficiency factor of 0.80 (80% efficiency) should be used.

Annual Rainfall: There are three categories of rainfall data that can be used in calculations. They are:

1 Daily rainfall (mm)

2 Monthly rainfall (mm)

3 Yearly total rainfall (mm)

In the absence of the shorter term data a yearly average figure can be used, but bear in mind that there will always be seasonal and annual variations in rainfall patterns. It is also worth considering the changing rainfall patterns because of climate change, particularly if you are planning to make a large investment in RWH. More detailed rainfall information can be obtained from the Meteorological Office or you can use a rain gauge. If using a rain gauge, it should be installed so as not to be exposed to strong winds, or sheltered by trees and other obstacles. As a general rule, place a rain gauge at a distance of at least twice the height of any obstacle away from the obstacle. For example, if a tree is 10 m high, the rain gauge should be sited 20 m from the tree.

Potential collectable rainfall (litres) = roof area (m^2) x run-off coefficient x filter efficiency factor x annual rainfall (mm)

Worked example

85000 litres = 250 x 0.85 x 0.80 x 500

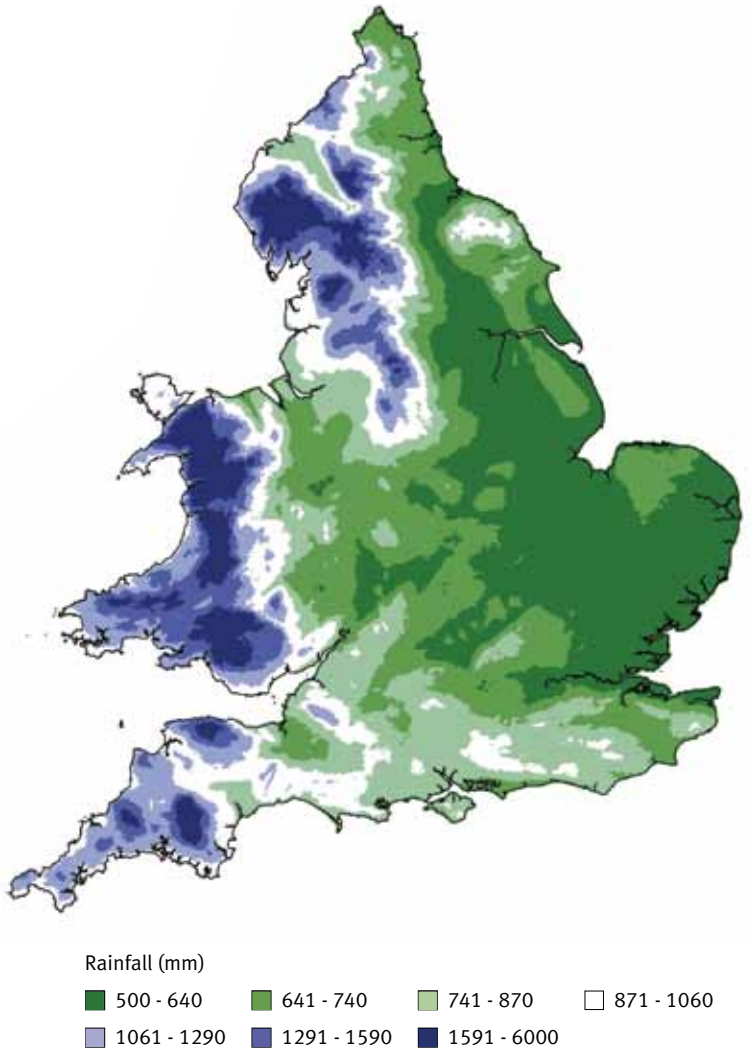
Roof area = 250 m^2
Run-off coefficient = 0.85 (pitched roof)
Filter efficiency factor = 0.80 (estimated 80%)
Annual rainfall = 500 mm

Note: To convert from litres to m^3 divide by 1000.
So for the example above 85000 litres is equal to 85 m^3

Once you have calculated how much water you may collect from your roof area, you need to consider what size storage tank you can afford and whether this volume is enough water to meet all your needs, or for any specific tasks on the farm.

Good guttering is vital to capture rainwater

Figure 1 ➜ Annual average rainfall in the UK (Environment Agency)



What quality of water do you need?

Collected rainwater will contain traces of environmental pollutants, animal and bird faecal matter and vegetation, such as leaves and moss. There may also be a risk of contamination from the roof and drain structures to consider, such as asbestos or lead. All this must be evaluated before you install any RWH system.

Quality for crop irrigation. If harvested water is used for crop irrigation, there are recommended standards set out by the World Health Organisation (WHO). Many food assurance schemes and food retailers will have additional requirements for irrigation which will have to be achieved to meet their contract. These are usually more rigorous than the WHO recommendations.

Quality for animal drinking. Before using rainwater, you should check that this does not breach any hygiene or farm assurance scheme requirements. The Dairy Hygiene Regulations require that any water used for hand, udder or dairy plant washing must be from a potable source. This normally means that in dairies, this water will come from mains water supply. The National Dairy Farm Assurance Scheme (NDFAS) requires water for animal drinking to be 'fresh and clean', and so collected rainwater will need to be filtered to meet those standards and if necessary, treated. Filtration and treatment should be considered for all livestock drinking water.

Table 2. Harvested rainwater quality and possible treatments (adapted from Envirowise, 2008[4])

Water Use	Quality Required	Treatment Options
Plant nurseries Field irrigation Buildings and farmyard cleaning Toilet flushing Machinery cleaning Filter backwashing	Water is not used for consumption and there is a very low risk of contact. Water should look clean and be odour free.	First flush diverted Coarse filter Sand filter
Cleaning of equipment or process cleaning Sprayer wash out	Water is not used for consumption and there is low risk of contact. Water must be clean and odour free but not necessarily sterile.	All of the above, plus Fine filter (possibly membrane filter)

4 Envirowise 2008, Reducing mains water use through rainwater harvesting: EN896. www.envirowise.gov.uk

Case Study 2

Oaklands Farm Eggs Ltd

Oaklands Farm Eggs Ltd is a company in Shropshire. One of the farm sites has 6.5 ha of total yard area, including colony egg production buildings.

Farm manager Alex Pike, has designed and built the bespoke system on the farm to collect all the rainwater in two lagoons, which is then treated in a water-cleaning plant to use as drinking water for the 1.4 million hens on the site.

About £750,000 has been invested on the one farm, to harvest and treat all the water generated from rain on the site. The annual water charge used to be £120,000 per year, but Alex estimates the harvesting system can meet nearly the full water demand on the site, with mains supply used only for staff facilities and for supplementing the harvested water in extreme dry conditions. This was a large investment, but if the system covers the previous potable demand and maintenance costs are low, it could pay for itself in around 6 years.

Disease control is a concern in the intensive pig and poultry industries, particularly with the risks posed from wild birds. Because of this, the level of treatment to run-off required to provide adequate biosecurity could rule out the use of RWH as drinking water for intensive pig and poultry units, but it could be used for cleaning purposes. At Oaklands Farm Eggs they do use harvested rainwater for drinking water but only following thorough treatment which has needed considerable capital investment.

Is it worth harvesting water?

The strongest influence on the viability of a RWH scheme will be the economic return. This can be calculated by working through the questions on water use in Section 2 (above) to determine the present cost of your water supply, set against the revised costs of using a rainwater harvesting system as a part supplement. This can be determined by identifying what type of system you need (Section 3) and using the costings in Tables 4 and 5.

It is important to consider **all** the costs, including both capital and maintenance costs, to determine the difference a RWH system can make. You will need to assess your current energy use for pumping water and compare it to the planned system.

For example:
A dairy farm with a 200 cow herd, has an annual water use of 11,300 m^3, approximating 7,300 m^3 for drinking, 2,190 m^3 for milk cooling, and 1,825 m^3 for parlour washing.

The farm has a 3,000 m^2 roof area, and is in an area of 700 mm annual rain and could therefore potentially harvest 1,680 m^3 of rainwater.

Some water will overflow the tank and some may be diverted as first flush from the roof. Assuming the farmer can store half of the 1,680 m^3 of rainwater, including payment for maintenance and pumping, the potential saving on a water utility bill at £1 per cubic metre could be approximately £400 using the harvested water for the parlour washing, or for animal drinking water. A farmer seeking a 10 year pay back could invest up to £4,000 in water harvesting.

What are the costs of running a RWH system?

All systems will incur operating and running costs, which you will need to consider before installing your system. The costs will relate to the type of system you plan to install (see Section 3).

A further running cost is the maintenance of the system (Table 5). Maintenance should be carried out in accordance with the manufacturers' instructions and annual testing is suggested for all RWH systems.

Do I need any permission to install a RWH system?

Although you do not necessarily require permission to install a RWH system you will need to speak to the following organisations.

- If you are using harvested water for hand, udder or dairy plant washing or for irrigation of ready-to-eat crops. This requires you to contact your Local Authority, since an Environmental Health Officer will need to assess the water annually to ensure its purity. You also need to make sure that it meets the requirements of any contracts or farm assurance schemes.
- If you are discharging the overflow water from your RWH system into a watercourse. You need to inform the Environment Agency as you may require discharge consent, depending on the quality and quantity of the water. However, we would much prefer any clean overflow to go directly to soak-away to prevent flooding.
- If you are discharging clean overflow water into surface water drains. This is permitted but only providing it is uncontaminated. If water is contaminated (runs across dirty yards, collected from roof vented poultry houses) it should be collected in the dirty water system for treatment or disposal. Again, we would much prefer any clean uncontaminated overflow to go directly to soak-away to prevent flooding.

- If you are discharging any contaminated water into foul sewer. You will need to contact your local sewerage company. In these situations, we would prefer you to remove the source of contamination of the overflow water rather than treat or dispose of the water.
- If you are making considerable alterations to existing buildings or putting up new structures. You will need to contact your local planning authority to check whether you planned changes would require planning permission.

Table 3. Typical running costs of a RWH system

Item	Electricity usage[6]	Cost[5]	Assumptions
Pump	1 – 3 kW hr per m^3	10p – 30p m^3	10p per kWhr of electricity
UV unit	120- 140 kWhr per year	£12 – £14 per year	10p per kWhr of electricity and the unit operates 24 hours a day

Table 4. Regular maintenance activities and cost

Component of system	Maintenance frequency	Cost[5]
Manually cleaned filters	Clean monthly	None if carried out by system owner
Self cleaning and/or coarse filters	Check and clean every 2-3 months	None if carried out by system owner
Roofs and gutters	Clean once or twice a year depending on site conditions	£50 - £100
Cartridge filters	Replace every 3-6 months depending on the suspended solid loading of the source water	£25 - £60 for 4 filters
UV bulb	Replace every 6 months to 1 year	£10 - £70 per bulb
Annual maintenance contract	Annual site visit by an engineer who will: • check and clean filters; • check pump and repair/replace as required; • replace other components.	£250 per year

5 Prices are correct in July 2009

6 Leggett, D.J., Brown, R., Brewer, D., Stanfield, G. and Holliday, E. (2001) Rainwater and Greywater use in Buildings: Best practice guidance. CIRIA Report C539, London

Rainwater

harvesting systems

There are many different RWH systems but they all have the following features:

- the water is first collected, filtered and then stored;
- water is then piped or pumped directly to the points of use, or to an internal break tank;
- if the system runs low on rainwater, a mains water (or other) back up will guarantee continuous supply;
- when it rains again, the system changes automatically back to prioritise the use of rainwater.

The following section gives details of three different systems:

- indirectly pumped;
- directly pumped;
- gravity fed.

The other elements of a RWH system detailed in this section are:

- filters;
- treatment system;
- storage;
- overflow drainage.

Use of low cost rainwater harvesting systems are also introduced.

Indirectly Pumped Systems (Figure 2)

Rainwater is initially held in a storage tank and then pumped to a header tank. Water is delivered to appliances via gravity.

Advantages	Disadvantages
If the pump fails then water is still supplied via the mains top-up function.	Water is delivered at low pressure (may be solved by using a hybrid system).
Low cost pumps.	Requires a header tank which can add to the overall cost.
Simple controls.	Need for sufficient roof space, or high tank mounting.
Energy efficient as the pump runs at full flow.	Issues with high, structural loads.

Directly Pumped Systems (Figure 3)

A directly pumped system is a pressurised system. Rainwater, collected and held in a storage tank or reservoir, is then pumped directly to the point of use when required. This is typical of most horticultural irrigation applications as shown in the Hedon Salads case study. There is usually a mains or abstraction supply option that maintains a minimum level that is able to meet short term demand.

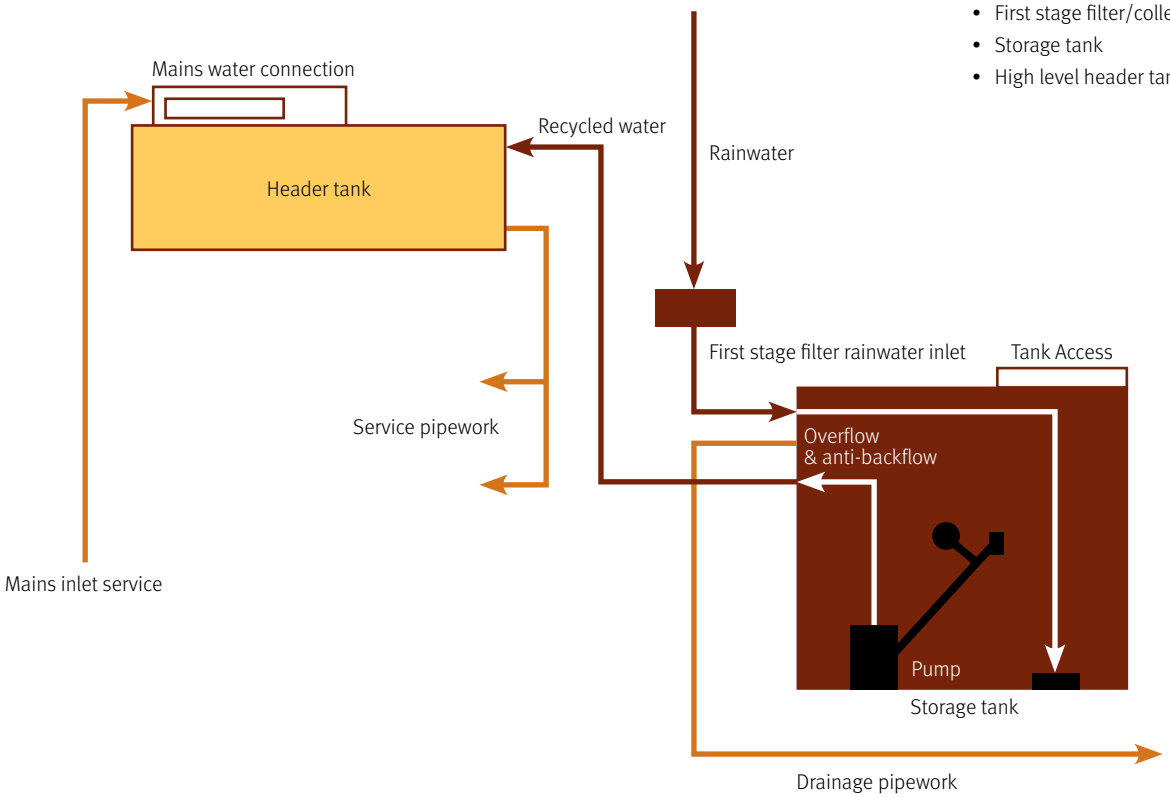
Advantages	Disadvantages
Water is provided at pressure.	If the pump fails then no water can be supplied.
No header tank is required.	The use of mains top-up controls are more complicated.

Gravity Fed Systems

Rainwater is collected from the roof, filtered and piped by gravity to a storage (header) tank. Water is delivered to appliances via gravity. Mains top-up water can also be fitted if needed.

Advantages	Disadvantages
Does not require a pump.	Low water pressure – pumps may be required to boost the pressure.
No electrical supply required.	Issues with high, structural loads.
No risk of pump-associated failure.	Water quality issues, due to fluctuating temperatures in the stored water.
	The relative height of the components (roof, filter, tank) are critical.

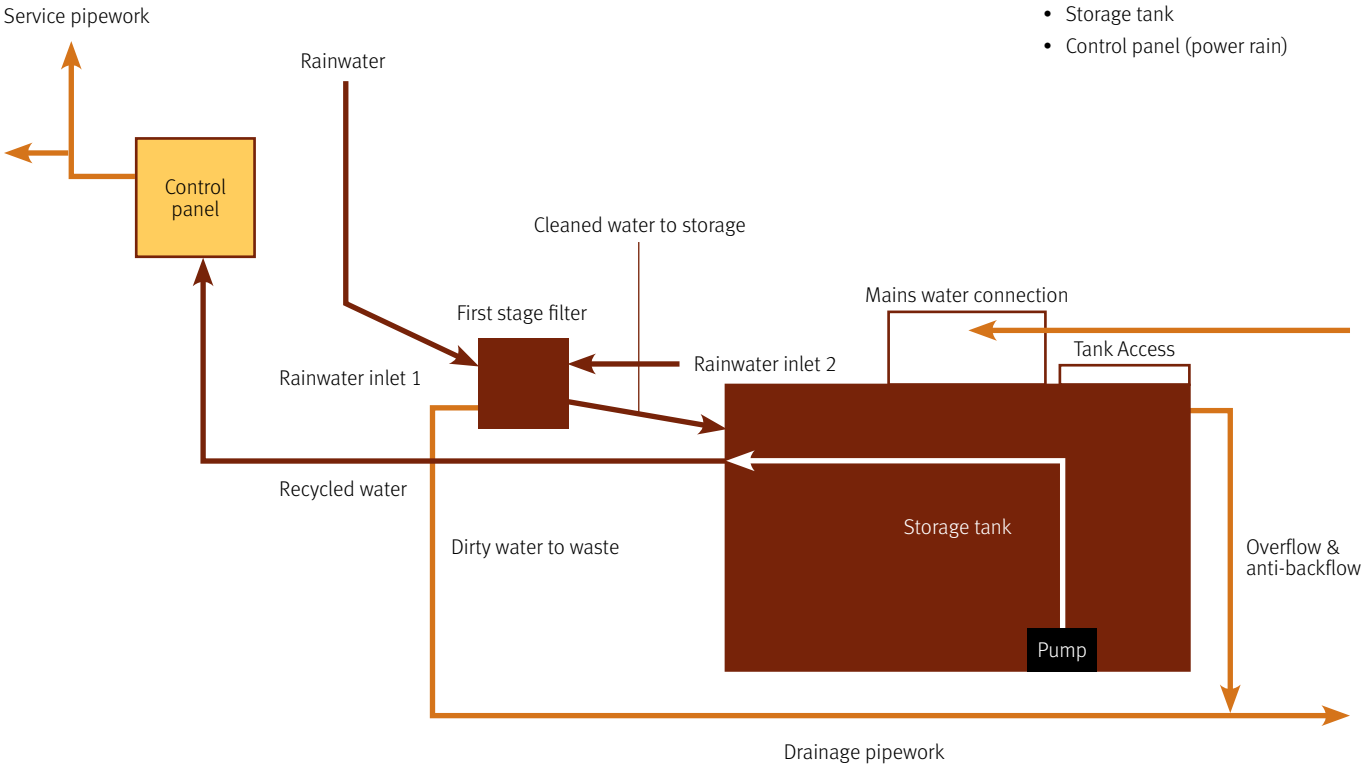
Figure 2 ➜ Principles of an indirect system



Priniciples of an indirect system

- First stage filter/collector
- Storage tank
- High level header tank

Figure 3 ➜ Principles of a direct system



Priniciples of a direct system

- First stage filter/collector
- Storage tank
- Control panel (power rain)

What system to use?

For irrigation applications, the direct pumped system is the most common because they fit typical irrigation system configurations. However, for low flow intermittent applications, indirect pumped systems are generally most appropriate because:

- peak demands can be high, with long periods of no flow;
- if the pump fails, the header tank acts as a failsafe because water can still be supplied via gravity;
- the header tank eases the demand on the pump, increasing pump reliability and life expectancy.

What makes up a RWH system?

A RWH system comprises a number of components. Some of the parts are specific to RWH and some are part of the building such as guttering and donwpipes.

Filters

It is recommended that rainwater is filtered before entry into the storage tank. The filter should be easy to clean (or self-cleansing) and should not block easily. If you require high quality water, then additional filtration is also required after the storage tank.

Table 5. Types of filters

Name	Description	Suitability	Cost[7]
Crossflow	A mesh screen that splits the water into two parts. The 1st part passes through the mesh to the storage tank. The remaining water is used to clean the mesh of any debris and goes straight to the sewer system/soak away	Before storage tank Self cleaning	£500 - £2,500
Vortex	Form of cross flow filter	Roof areas up to 3,000 m^2 Before storage tank Self cleaning	£500 - £2,000
Cartridge	Requires water to be passed through them under pressure	After storage tank Not self cleaning Pre-filtration is required Require replacement every 3 months	£160 - £700
Fine Mesh	Placed in-line or at the inlet to submersible pumps	Typically 300 micron screens 100 micron screens for trickle irrigation Cannot be retro fitted After storage tank	£40
Sand	Uses the ability of filter sand to self grade so that the filter medium becomes progressively finer, through the bed	Horticultural irrigation systems Can be constructed on large sizes for large flow rates Self cleaning After storage tank	£400

7 All costs are current as of July 2009

Case Study 3

Hedon Salads

Hedon Salads are the largest growers of cucumbers and aubergines in the UK but they also grow other crops, including peppers. General Manager Phil Clarkson runs 40,000 m^2 of glasshouses at Burstwick Nursery.

Rainwater is collected from a proportion of these houses and channelled to a reservoir next to the greenhouse complex. The water is used in the hydroponic plant-feeding system, from the first week in January until the end of October.

The system is gravity-collected from the roofs and then pumped from the reservoir, through a filter, with automatic back flush, then through a self-cleaning, main filter and into two 40,000 litre stores, which supply the greenhouse Rockwool-based growing system. The site benefits from 8,500 m^3 of harvested water which saves £8,500 on the annual water bill. The £16,000 invested in the reservoir, pumps and filtration system was repaid in two years.

Case Study 4

Fresca Group

A fresh produce company, Fresca Group, in Spalding in Lincolnshire has used harvested water from cold store roofs for air humidification in the root cold stores.

The water harvesting system was incorporated into the original building design, constructed in the mid 1990's, connecting the gutters into 150 mm pipes in the eaves to drain to the 25 m^3 above ground water storage tank. The rainwater supplements the mains water supply to the tank.

The system has harvested 400 m^3 per year from a roof area of 750 m^2 which is then pumped into the cold stores' humidification system. The company currently pays £1.08 per cubic metre for water, including a standing charge for supply and so can save over £430 each year on water charges, if all the harvested water is used. It is now planned to divert harvested water for use in the hydroponic irrigation system of the chicory growing rooms on the site.

Ultra Violet (UV) Sterilisation Units

If you require water that is free from pathogens, such as for ready-to-eat crops, then a sterilisation unit must be installed. UV radiation is effective at killing a wide range of waterborne bacteria, pathogens and viruses. This has a number of advantages:

- ease of use;
- requires no chemicals;
- it is quick;
- no effect on the chemical characteristics, taste or odour of the water;
- maintenance is not onerous;
- no risk from excessive use, as might be the case with chemical treatment;
- however, UV systems are energy intensive to use and therefore may not be the best solution for high quality water on your farm.

A complete UV sterilisation unit will have extra filters and these will need replacing approximately every six months. The UV bulb consumes electricity and will generally need replacing after six months of use. The cost of UV units depend on the flow rate required, but as a guide can be from £360 (8 litres per min) up to £710 (54 litres per min). The energy cost associated in running the UV units also needs to be taken into consideration. On average, the UV unit electricity consumption will be 120 – 140 KWhr per year. Assuming the UV unit operates 24 hours a day and the average cost of electricity is 10p then the annual cost of running one UV bulb is £12 – £14.

Storage

It is important that you have sufficient storage to meet your needs and can accommodate the amount of water to be harvested. It is also recommended that the tank should be sized, so that it overflows at least twice a year to remove floating debris.

Above Ground Storage

There is usually adequate space on-farm for the use of above ground storage tanks and, the height of modern agricultural buildings is sufficient to enable rainwater harvesting by gravity. Where tanks are above ground, fitting insulation and frost protection to pipes and pumps close to the tank, is recommended. Covers for the tank are also needed to prevent debris, leaves and access of animals and birds. Covers can be made of the same material as the tank, or in Robin Buck's case he uses a large circular above ground storage tank for his rainwater with a canvas cover.

Be aware of health and safety when using above ground stores


A new large above ground store

Figure 4 ➜ Examples of above ground storage tanks

The advantages and disadvantages of above ground tanks include:

Advantages

Ease of inspection.

Ease of repair and maintenance of the tank and equipment.

Lighter and less expensive construction.

Easier to add or increase capacity.

Lower cost of installation.

Avoids groundwater problems (high water table).

Disadvantages

Risk of frost damage to the pipe and equipment.

Occupies ground space.

Susceptibility to damage/vandalism.

Appearance.

Requires a cover.

More susceptible to algal growth and poor water quality.

Requires a tank specifically designed for use above ground.

Reservoirs

Where water is collected over a large area, such as on polythene tunnels or glasshouses, a clay or synthetic lined reservoir is often used. More information on what you need to consider before constructing a reservoir can be found in 'Thinking of an Irrigation Reservoir' booklet.

Reservoirs collecting harvested rainwater can be ideal for irrigation

Underground storage tanks

Many RWH systems use underground storage tanks. Installing a tank underground will result in additional installation costs in excavating the ground and, where water tables are high, securing the tank – however, there are also a number of advantages. An underground storage tank is used at Humberstone Golf Course in Leicestershire, which aimed to keep the stored water out of view.

Advantages

It helps to prevent algal growth by shielding the tank from daylight.

Protects the tank from extreme weather conditions such as frost damage.

Protected against mechanical damage.

Helps to regulate the water temperature in the tank, keeping it cool and limiting bacterial growth.

Saves space on site.

Hidden from view at ground level.

Disadvantages

Additional cost of excavation.

Additional cost of installation, particularly in high water tables.

Less accessible for inspection and maintenance.

Figure 5 ➜ Examples of underground storage tanks

Images: © of WPL Ltd

In underground storage tanks ensure you can access the pump for maintenance

Roofwater enters the drinking trough and a level overflow takes it to the surface water drains

Overflow Drainage

Storage tanks must have a controlled overflow arrangement to:

- prevent localised flooding if the capacity of the tank is exceeded;
- help avoid stagnation of stored water;
- remove floating debris.

The overflow can be connected to a soak-away, infiltration device, storm drain, or combined sewer system. An overflow must include an anti-backflow device (to prevent contaminated water entering the tanks) and a rodent barrier. *Please see Section 2 for permissions needed for managing overflow.*

Pumps

Stored water can be pumped either to where the water is needed, or to a header tank. Pumps can also be used in gravity fed systems in order to increase the water pressure. The choice of pump depends on the application.

Pumps require repair and replacement at some point, typically after 5-10 years. It is also recommended that they are checked on a regular schedule to ensure they are functioning correctly.

Pumps are needed to ensure the right pressure for the use of water

Mains Top-up Arrangement

Most RWH schemes will have a top up arrangement for times of little or no rainfall. This is taken from a water mains or abstracted supply. If you use a mains top-up arrangement, then an air gap must be incorporated that is compliant with the *Water Supply (Water Fittings) Regulations 1991*, which makes sure non mains supply cannot contaminate mains water supply. Pipes carrying non-potable water should also be clearly identified. Use of a Water Regulations Advisory Scheme (WRAS) Water Industry Approved Plumber Scheme (WIAPS) will ensure that you are compliant.

Low Cost and DIY Systems

In a farm environment, there are many inexpensive RWH options that could be considered. Recycled containers can be used for storage, though care must be taken to ensure any tank is thoroughly clean and does not contain residues from previous uses and will not cause any contamination of the water. Some of the low cost systems can have short payback times as demonstrated at Brynkinalt farm (Case Study 7).

Figure 6 → Low cost systems

Recycled container with lid 6 m³ = £145

Brand New storage tank 2.5 m³ = £465

IBC container (recycled) 1 m³ = £70

Disclaimer: Prices are correct at time of print.
Images: © Smiths of the Forest of Dean Ltd

Case Study 5

Jack Buck Farms Ltd

Robin Buck farms 400 ha in the highly productive area of the fens in Lincolnshire growing a range of arable crops and some specialist crops of Fennel, Artichoke, Celeriac and Chicory.

The farm has long recognised the value of efficient resource management – installing a rainwater collection system on an existing machinery store and later, another system on a new cold store.

The farm harvests 285 m^3 per year from part of an 840 m^2 machinery building, collected in a circular above ground store which is used for the farm crop sprayer. When a new 900 tonnes capacity cold store was constructed on the farm last year, Robin was determined to include water harvesting and now the roof water is used to supply 5.4 m^3 per week - feeding the misters in the store to maintain humidity for the chicory. The farm pays £1.10 per cubic metre for water, including standing charges, so the costs of RWH installation were paid back within a year.

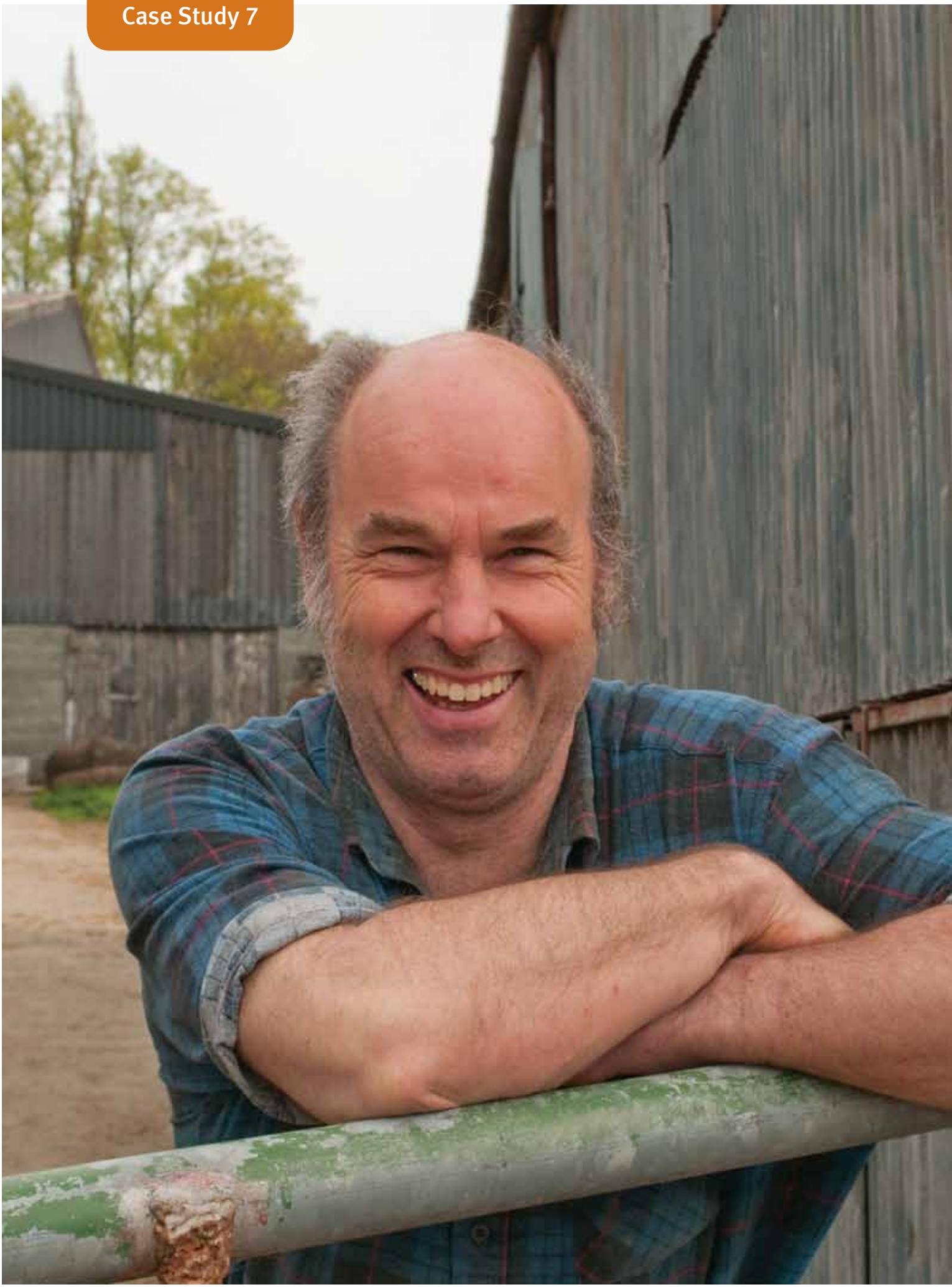
Case Study 6

Humberstone Golf Course

This is a former farm located within the urban area of Leicester which has diversified into leisure by turning land and facilities into a golf complex. The farm house has been converted into a club house and the roof water from the buildings is collected and stored for use in the golf greens' irrigation scheme.

The buildings have a guttering system which drains into a brick-built, underground pump chamber installed in the courtyard of the original farm house. The tank now has a submersible pump, with a float switch, to transfer automatically the water to the 22 m^3 capacity above groung irrigation storage tank. The system supplements the mains water supply to the tank with 160 m^3 per year of harvested water. It was estimated that these costs were within a £1,000 budget, and the saving of £160 per year on water, estimated at costing £1 per cubic metre, gives just over a six year pay back.

Case Study 7



Brynkinalt Home Farm

Brynkinalt is located in Wrexham. A DIY rainwater storage system has been installed by the farmer, David Manford.

The farm consists of 96 ha of land in total and has 70 milking cows, 70 followers and 100 ewes. Crops grown are maize and barley to use as cattle feed.

Rainwater is collected from the roof of two buildings (1431 m^2). The RWH systems on the two buildings are gravity fed, with rainwater being diverted via pipes to two storage tanks. One of the tanks is constructed from a former cheese vat (3.37 m^3), the other is a concrete (1.18 m^3) structure. Each tank has an overflow pipe that diverts any excess water to the surface water drainage system. The harvested water is used as drinking water for the cattle. Total costs for installing the system has been kept low by utilising existing infrastructure on site. The cost of new pipe work was approximately £100 and the concrete tank cost £200. The volume of harvested water is approximately 479 m^3 per year. 1 cubic metre of water is worth approximately £1.20p therefore each time the tanks are filled a saving of £5.46 is made. This saves David £574 per year – and consequently the system paid for itself within the first year!

An added benefit to this DIY system is that roof water does not run across fouled yards and add to the stored dirty water.

Rainwater

harvesting by agricultural sector

Rainwater harvesting can be used by all agricultural sectors, this includes:

- livestock;
- pigs and poultry;
- arable;
- protected cropping;
- food processing and storage;
- farm diversified enterprises.

So whatever you farm, there can be a rainwater harvesting system to suit your needs.

Livestock Sector

During a recent study[8], it was found that dairy farms pay between £31 and £100 per cow, each year for water and could meet 20% of their water use with rainwater harvesting. Livestock farms mainly use water for:

- livestock drinking;
- livestock feed preparation;
- pen cleaning;
- slurry management;
- vehicle washing.

8 ADAS 2008, Resource and Energy Audits Pilot Scheme. Report for Farming Connect Cumbria

Harvesting and using rainwater, can reduce the quantity of water entering your slurry store, running across fouled yards, or entering your dirty water tank. This can mean a reduction in the size of your slurry store and in the quantity of dirty water to dispose of and therefore is cost effective. It may also help you in complying with Nitrate Vulnerable Zone Regulations, where volumes of storage are calculated with the volume of rainwater entering your slurry tank or lagoon. RWH may also improve your site drainage!

Pigs and Poultry Sector

Pig and poultry housing can be used for rainwater harvesting and water can be used on-farm for wash water and dust suppression, but unless the water is treated it is unlikely to be suitable for livestock drinking.

Arable Farming Sector

On arable farms, there are often very large areas of roofing which can offer opportunities of rainwater harvesting, including:

- machinery stores and workshops;
- general purpose stores for fertiliser seeds and sundries;
- grain, potato and vegetable stores.

Use of harvested water on arable farms can include:

- irrigation for root crops and field vegetables;
- vegetable washings;
- machinery washing;
- crop spraying and sprayer wash down;
- yard washing;
- dust suppression.

Harvesting rainwater prevents clean water running across fouled yards

Harvested rainwater can be used for irrigating field vegetables and potatoes

The level of filtration that is needed depends on the application. Crop sprayers require low levels of physical contaminants. Provided that a suitable level of filtration is incorporated into the system, there will be a reliable and cheap source of water for spray mixes and wash out.

Protected Cropping Sector

Use of harvested water on horticultural sites can include:

- irrigation for plants;
- water addition to hydroponic systems;
- machinery washing;
- crop spraying;
- staff toilets.

In deciding to use harvested water for protected cropping, it is important to consider crop product quality and hygiene. Harvested rainwater is suitable for root zone watering, such as hydroponics, trickle irrigation systems and ornamentals. It is not suited to overhead irrigation systems on edible salads or fruit products.

Glasshouses are an obvious source of rainwater harvesting, since the glass cover over the crop intercepts the rainfall that would otherwise reach the plants inside. Systems are generally gravity-fed to above-ground, circular, butyl-lined, galvanised steel storage tanks or to lined reservoirs. The multi-span greenhouses have water gutters and valley drainage, connected to a collector pipe located at the gable ends. These can be fitted to a water tank. Filtration is generally needed to avoid pumps and irrigation equipment becoming blocked.

Polythene tunnels: In addition to water saving, rainwater harvesting reduces drainage problems around the tunnels as well as humidity inside them, while outside, soil erosion is reduced and vehicle movements become easier.

Specialist Food Production and Processing

Food production and processing is generally a housed operation, where roofs can be used for RWH. There are strict hygiene regulations for the quality of water to be used in direct contact with food, requiring the water to be treated to drinking standards. Other uses for water on site can include:

- humidification;
- yard cleaning;
- vehicle cleaning;
- staff toilets.

Harvested rainwater can be used in your sprayer once filtered to ensure the nozzle will not block

Harvested rainwater can be used for direct irrigation in protected cropping sector

Farm Diversified Enterprises

Farms are diversifying into a whole range of other activities, with buildings often converted and then rented to small enterprises. Harvested water can be used for servicing these diversified buildings to include:

- yard cleaning;
- vehicle cleaning;
- staff or customer;
- other uses, specific to diversification.

Even diversified farm enterprises find that rainwater harvesting can help their business

Rainwater can be used for many purposes around the farm

Glasshouses give an ideal opportunity for rainwater harvesting

Harvested rainwater is collected from polytunnels in the guttering shown and then collected in the lined reservoir to be used for irrigation

Legislation

If you are thinking of installing a RWH system, you need to be aware of some legislation that may apply to you. This includes:

- Planning and building regulations;
- Water fittings regulations;
- Environmental permitting for pigs and poultry;
- Farmed animals and food production;
- Water impoundment and abstraction;
- Nitrate Vulnerable Zones;
- Health and Safety.

Planning/Building Regulations

Sections of The Building Regulations 2000 will affect positioning of any tank and pipes (*Part H: Drainage and Waste Disposal; and Part G: Hygiene*). Both of these documents can influence the design of the RWH system.

Planning permission may be needed for structures such as tanks, lagoons, or pump sheds, depending on size and location – so it is advisable to speak to your local planning authority before installing a rainwater harvesting system.

Water Fitting Regulations

Where mains water supply is used on any premises in the UK, the *Water Supply (Water Fittings) Regulations (1999) (or Byelaws 2000 in Scotland)* must be adhered to. These regulations prevent the misuse, waste, undue consumption or erroneous measurement of water and most importantly, prevent contamination of drinking water through cross-connections, backflow or back siphonage into the mains from non-mains sources, including harvested rainwater. In addition, water supplied that is not for drinking must be clearly marked. Using a plumber approved by WIAPS[9], should ensure this. More information can be obtained from the *Water Regulation Advisory Scheme (WRAS)* [10].

Environmental Permitting

If you run a pig or poultry unit with more than 750 sows, 2,000 production pigs over 30kg or 40,000 poultry (includes chickens, layers, pullets, turkeys, ducks and guinea fowl), the *Environmental Permitting (England and Wales) Regulations 2007* state you will need to have an environmental permit. Permits require that operators optimise water use, and reduce waste water production and require the permit holder to review site drainage. This should be detailed in a review of water use on-farm which could include RWH as an alternative source of water supply. More information is available on environmental permitting from the Environment Agency.

9 http://www.wras.co.uk/WIAPS/
10 http://www.wras.co.uk/PDF_Files/IGN%209-02-04%20Reclaimed.pdf http://www.wras.co.uk/PDF_Files/AGRIPREM.PDF

Farmed Animals and Food Production

The Food Hygiene (England) Regulations 2006 and *The Food Hygiene (Wales) Regulations 2006* require that food business operators do not use any substance, other than potable water or clean water, to remove surface contamination from products of animal origin, unless use of the substance has been approved. If it is to be used for such a purpose, harvested water needs to be assessed annually by the local authority's Environmental Health Officers.

The Welfare of Farmed Animals (England) Regulation 2000 state that all animals shall either have access to a suitable water supply and be provided with an adequate supply of fresh drinking water each day or be able to satisfy their fluid intake needs by other means. *The National Dairy Farm Assurance Scheme (NDFAS)* requires water for animal drinking to be 'fresh and clean'.

Water Impoundment and Abstraction

The Water Resources Act 1991 and The Water Act 2003 apply to the impoundment (storage) and abstraction of water. These require anyone who intends to impound or abstract water (more than 20 cubic metres per day) from any inland waters to obtain either an impounding licence or an abstraction licence from the Environment Agency.

If you intend to store harvested rainwater in an artificial pool which is self contained and fed only by the rainwater or natural runoff, then no licence is needed. If harvested rainwater is diverted to a natural pool or pond which is fed from, or feeds to, other water sources then a licence will be required. If in any doubt about the requirement of a licence, contact the Environment Agency for clarification.

Nitrate Vulnerable Zones (NVZ)

NVZs are designated areas where nitrate pollution is considered to be a problem. The regulations affect how to determine minimum manure and slurry storage requirements and capacity for the closed spreading periods.

Other liquids from average rainfall and washings that are collected and mixed with the slurry must be included in the capacity requirement. If existing storage is not sufficient to cover the closed period, then the farmer will need to consider either extra storage, or methods to remove excess dilution. RWH of clean roof water and clean runoff is one way in which excess volume of slurry can be avoided. More information is available on NVZs from the Environment Agency.

Health and Safety

Storage of water on farm may pose a health risk where conditions result in contamination of the water. Harvested rainwater should not be used for drinking. Taps and pipes containing harvested water should be clearly marked. There may be a number of risks around storing and using non potable water including legionnaires disease[11] and weil's disease[12]. In addition, there are hazards of enclosed spaces, falls and structural failures associated with rainwater harvesting. You should consult the Health and Safety Executive for further information about health and safety considerations when storing water.

11 http://www.hse.gov.uk/pubns/iacl27.pdf
12 http://www.hse.gov.uk/pubns/indg84.pdf

Funding support

Enhanced Capital Allowance

The Enhanced Capital Allowance (ECA) Scheme 1 enables businesses to claim 100% first year capital allowances for investment in rainwater harvesting equipment, named in the Water Technology List. The following equipment is supported:

- monitoring and control equipment;
- rainwater filtration equipment;
- rainwater storage vessels;
- rainwater treatment equipment;
- water efficiency equipment.

Contact:
Envirowise Advice Line 0800 58 57 94
or email: wtl@envirowise.gov.uk

http://www.eca-water.gov.uk/

Rural Development Plan for England (RDPE) 2007- 2013

Funding is available through the Regional Development Agencies for measures that increase the resource efficiency of rural businesses. Some RDAs may provide grants for rainwater harvesting, often when used in conjunction with a larger scheme on-farm.

Contact:
Defra: http://www.defra.gov.uk/rural/rdpe/index.htm

RDAs: http://www.englandsrdas.com/visit_rdas/

Catchment Sensitive Farming

For farms in catchment sensitive farming priority areas, as identified within the England Catchment Sensitive Farming Delivery Initiative (ECSFDI), there may be grants available for rainwater storage tanks, first-flush rainwater diverters and downpipe filters.

These grants do not cover pumps etc. and advanced treatment for re-use, but would cover tanks and supply drainage. Check the Defra website to find out if you are in one of the 50 catchments across the country and check what grants may be available.

Contact:
Natural England (0845 600 3078)

www.defra.gov.uk/farm.environment/water/csf/delivery-initiative.htm

www.magic.gov.uk/staticmaps/national.asp
(maps showing priority catchments)

Contacts

Environment Agency
Phone: 08708 506506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

UK Rainwater Harvesting Association
www.ukrha.org

Agricultural and Horticultural Development Board
Tel: 0247 669 2051
Email: info@ahdb.org.uk
www.ahdb.org.uk

UK Irrigation Association
Phone: 01427 717627
www.ukia.org/

Envirowise
Phone: 0800 585794
www.envirowise.gov.uk

Met Office
Phone: 0870 900 0100
Email: enquiries@metoffice.gov.uk
www.metoffice.gov.uk

Water Regulation Advisory Scheme:
Phone: 01495 248454
Email: info@wras.co.uk
www.wras.co.uk

Other useful information

'Waterwise on the Farm' **– a simple guide to implementing a water management plan'.**
Available from the Environment Agency, LEAF and NFU.

'Best Farming Practices' **– What's in it for you.....? Profit from a good environment'.**
Available from the Environment Agency

Thinking about an Irrigation Reservoir?
Available from the Environment Agency and the UK Irrigation Association

'Effective use of Water on dairy farms'**.**
Available from Dairy Co (contact via AHDB)

'Effective use of Water on dairy farms' **Dairy Farm DIY Full Audit Pack.**
Available from Dairy Co (contact via AHDB)

'EN896 reducing Mains Water Use through Rainwater Harvesting'
Available from Envirowise

BS 8515:2009 Rainwater harvesting systems. Code of practice

Defra and ADAS have produced four best practice guides for irrigators:

Irrigation best practice: Water management for potatoes – a guide for growers.

A guide for container-grown ornamentals.

Water management of soil and substrate-grown crops, a guide for top and soft fruit growers.

Water management for field vegetable crops, a guide for vegetable growers.
Copies are available from Adas, Boxworth, Telephone +44 (0)1954 268214

Disclaimer: This booklet is for information only. If you are considering installing a rainwater harvesting system, then you should seek professional advice at all stages of planning and construction.

Would you like to find out more about us, or about your environment?

Then call us on

08708 506 506* (Mon-Fri 8-6)

email

enquiries@environment-agency.gov.uk

or visit our website

www.environment-agency.gov.uk

incident hotline 0800 80 70 60 (24hrs)
floodline 0845 988 1188

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