Reducing Water Use in the Meat Supply Chain for Cattle and Sheep: Water monitoring on case study farms

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Introduction

Water is becoming an increasingly scarce commodity in some parts of the world and climate change already appears to have had an impact in some parts of the UK. This is against a background of increasing abstraction for domestic use, where mains provision may reach its limit in some areas. Water use and water saving will become increasingly important areas of management in order to build in a degree of resilience against the risk of increasingly common dry periods and the rising cost of mains water.

Objective

This report covers the water usage monitoring on case study farms of the Eblex project: Reducing Water Use in the Meat Supply Chain for Cattle and Sheep. The main objective of the project was to assess water use on typical beef and sheep farms.

Methodology

Farm selection. The project set out to find four case study farms across England to represent typical beef and sheep enterprises. Water consumption by livestock needed to be monitored and this required the installation of water meters at strategic points on the farm. The farmers were required to check the readings on a regular basis. The water usage would then be monitored throughout the housing period and compared with consumption figures taken from published literature.

The case study farms needed to be working farms and it was expected that stock numbers and classes would vary through the housing period and that diets would vary throughout the period.

ADAS contacted a number of farmers from our own client list to ask if they would be willing to participate. Several farmers were keen to participate, but did not feel in a position to devote the time or resources to provide a consistent monitoring service, particularly in view of the extreme season of 2012. However, four farmers were agreeable as follows:

Eastern Region:
Phil Sabin, French Hall Farm, Moulton, Suffolk
Sheep only, Cheviot Mules crossed with Suffolk or Texel crosses.

South West:
Dave Knight, Wydon Farm, Minehead, Somerset
Cattle: Hereford and Angus crosses
Sheep: Exmoor Mules, Lleyn crossed with Suffolk and Poll Dorset

North West:
Stephen Lord, Gayton Hall Farm, Great Asby, Cumbria.
Cattle: mainly Charolais and Limousin crosses
Sheep: mainly Swaledale crosses

West Midlands:
James Evans, Partridge Farm, Bishops Castle, Shropshire
Cattle: Stabiliser
Sheep: Lleyn cross Highlander

An initial visit was conducted on each farm to check that the facilities would be suitable and whether it would be possible to install additional water meters at the point of inlet into the relevant buildings.

A recording form was designed to record stock numbers, dates and water use throughout the housing period – see Appendix. The farmers were asked to record water meter readings at least when stock numbers and types changed.

The farmers were left to purchase and install the required water meters themselves to ensure that they were happy with the supplier and fitter (unless self-fitted) and they understood how to use them. Basic water meters were specified and those fitted were either 15mm or 20mm in size to match the pipework on site.

Results

The project was carried out against the background of the wettest season in living memory and the second wettest on record. This meant that across all farm types in the UK, farmers were hard pressed to run their farms normally, and throughout the year from April 2012 to May 2013, prolonged heavy rain, winds and very cold temperatures prevailed. Indeed, at the ADAS Boxworth farm in Cambridgeshire, in terms of thermal time, the day degrees accumulated from 1st September 2012 to 1st April 2013 would normally have been reached on 3rd February 2013. Clearly, at the outset, the extreme weather could not have been predicted.

Actual water usage was recorded on a monthly or daily basis depending in the farm and unit in question.

In practice, both stock type and number varied in some buildings, so that in some cases, both sheep and cattle of different ages were using the same troughs and it was not possible to separate them for the purposes of monitoring water consumption.

Installation of meters was complete by the time the stock were housed in late autumn. Wydon Farm and Gayton Hall used three meters.

During the winter, difficulties were experienced due to the extreme weather causing frozen pipes and troughs. This caused some disruption and will have affected some of the readings.

In order to assess the results they were compared with consumption figures taken from the literature using Defra project WU0132, which looked at sustainable water use for livestock farms in the UK. The literature review carried out for that project included water use among all classes of livestock from a range of sources. The figures are broad ranges and include consumption by different sizes and age ranges of different breeds of receiving diets with different moisture content.

Table 1 Overview of typical water use requirements by livestock

Livestock type	Litres/day
Beef cow	25-45
Calf	5-25
Sheep	3.3-7.3

Source Defra project WU1032

The readings from the case study farms recorded the usage from single groups of similar stock and mixed groups of stock, so to interpret the results, predicted consumption was calculated by taking a figure from WU0132 for each class of stock and multiplying it by the number of stock in that class and the number of days between readings. The figures used to calculate the predicted consumption were adjusted for the size of animal within the class shown in WU0132 to match as closely as possible the animals in each group.

In the tables below, actual use is recorded on a daily or monthly basis for a given meter. The predicted intake was then calculated and the resulting total was then compared with actual use.

The results for each farm are shown in the tables below together with a value for the actual consumption as a percentage of predicted consumption. In some cases, the correlation between actual and predicted use is very high, but in others, it is poor. Some of the differences can be explanation, but for others, no obvious reason was found.

Water consumption monitoring continued throughout housing until turnout, which was later than normal in some cases due to the continued cold, wet weather.

The type of diet fed during housing was noted, since this is likely to have affected water intake, for example, cereal based concentrates will contain far less water than silage.

Partridge Farm

The severe winter weather caused extensive problems with frozen pipes and keeping stock fed over a significant period of the winter housing period. Added to these difficulties, James Evans had a severe illness and had to decline to continue to participate from late winter.

French Hall Farm (sheep only)

The east of England probably suffered least from the poor weather and progress was steady at French Hall Farm. At grass, mains water was supplied to the sheep as required using a bowser, which meant that the intake could be measured. Intake at grazing was very low, due to requirements being met largely from grass.

Table 2 Water use compared with predicted use

Date	Days	Actual use litres	Stock	Stock no.	Predicted use l/hd/day	Total (l)	Actual as % predicted
15-Sep							
22-Jan	129	22,345	Ewes	500	0.34		
			Lambs	3	0.34	22,062	101%
15-Feb	24	53,300	Ewes	500	4.40	52,800	100%
02-Mar	15	42,080	Ewes	500	5.60	42,000	100%
01-Jul	121	407,150	Ewes	485	4.40		
			Lambs	870	1.40	405,592	100%

The sheep were housed on 22nd January when cereal based concentrates were introduced into the diet. From the date of housing, water intake rose broadly to anticipated levels. However, it is interesting to note that as concentrate feed intake increased towards lambing, water consumption did not increase with it.

Water consumption showed a very close correlation to the predicted values throughout the housing period. It should be noted that the feeding regime was of relatively dry cereal based concentrates and straw and not silage.

Predicted consumption by the ewes reduced after March when they had access to fresh grass and the consequent reduction appears to agree with the meter reading for June, which covered the period from 2nd March to 1st June.

Gayton Hall

Three buildings were included in the project at Gayton Hall, the cattle yard, the cubicle shed and the sheep shed. The three buildings held a range of stock throughout the winter, which is detailed in the tables below.

The Cubicle Shed. Water supply infrastructures on farms are generally the result of additions and adaptations over a period of many years resulting in various problems such as leaking old pipework and the loss of records as to where the pipes are routed.

In the case of the cubicle shed, it is thought that in spite of efforts to trace pipework, it was supplied by two water pipes serving different ends of the building, only one of which was found and metered in the project. This would explain why the water consumption was generally around half of that predicted throughout the monitoring period. The result for the reading taken on 1st June (91%) is due to the cows drinking from the metered end of the buildings.

Other comparisons are close and result from a range of individual factors as suggested below.

Table 3 Cubicle shed monthly water use compared with predicted use (housed 01/11/12 calving from 01/05/13)

Date	Days	Actual use m^3	Stock	Stock no.	Predicted use l/hd/day	Total (m^3)	Actual as % predicted
1-Nov							
1-Dec	30	65	bull	1	1	114	57%
			cows	76	68		
			calves	74	44		
1-Jan	31	47	cows	76	71	107	44%
			calves	58	36		
1-Feb	31	33	cows	77	72	108	31%
			calves	59	37		
1-Mar	28	26	cows	83	70	77	34%
			stirk	1	1		
			calves	11	6		
1-Apr	31	41	cows	82	76	89	46%
			calving heifers	6	6		
			calves	11	7		
1-May	30	42	cows	81	73	81	52%
			calves	13	8		

1-Jun	31	44	cows	52	48	48	91%

The Cattle Yard. The meter was connected before a spur supplying the farmyard taps and the farmhouse. The usage for the latter two was estimated at 15m^3 per month. However, it is also thought that this section of pipework was leaking over the period of the study, since during a site visit, the meter was running at a rate of around 5 litres per minute in spite of the fact that the livestock were not using the troughs when the meter was checked. Over a period of a year, this would amount to over 2,500m^3. At an average cost of £1.50/m^3, this would amount to £3,750, a significant burden to a livestock farm. However, in this case, the water was from a spring at no cost.

This is the case on many farms, where water use may not appear to be excessive, but there may be one or a number of leaks over long periods that go unnoticed by the farmer.

The cattle yard housed a large number of groups of livestock of different classes and sizes throughout the housing period. Actual consumption as a percentage of predicted varied widely and no particular reason could be found apart from the leak, which was expected to increase the ratio of actual to predicted consumption. This was clearly not always the case.

Care was taken to ensure that the predicted daily rates of consumption for each class of livestock was as true a reflection of the type and size of each group and that the figures were applied consistently to each group of stock across the farms to ensure that like could be compared with like. However, consumption of some groups appeared to be less than the predicted value whereas for similar groups, it appeared to be higher and we continue to consider why this was the case.

Further work is being carried out on the farm to try to clarify matters. One point that may have influenced consumption was rainfall blowing in onto feed. The ration was mainly silage fed along the side of the building and this would have become wet when it rained. Records were not kept of rainfall events, but this was noted to have occurred on a number of occasions.

Table 4 Yard monthly water use compared with predicted use (includes a deduction of 15m^3/month for house and yard taps)

Date	Days	Actual use m^3	Stock	Stock no.	Predicted use l/hd/day	Total (m^3)	Actual as % predicted
1-Nov							
1-Dec	30	155	bulls	3	30	33	426%
			cows	12	30		
			calves	24	20		
			calving heifers	6	25		
			tups	4	4		
1-Jan	31	67	bulls	3	30	45	116%
			cows	13	30		
			calves	40	20		
			calving heifers	6	25		
			tups	4	4		
1-Feb	31	50	bulls	4	30	48	73%
			cows	12	30		
			calves	38	20		
			calving heifers	6	25		
			steers	6	25		
1-Mar	28	46	heifers	8	25	55	56%
			stirks	6	20		
			bulls	3	30		
			calves	84	20		
1-Apr	31	106	cow	1	30	71	128%
			heifers to calve	5	25		
			cow and calf	1	35		
			bulls	3	30		
			stirks	9	20		
			calves	85	20		
			tups	3	4		
			lambed ewes	11	7		
			pet lambs	18	2		
1-May	30	116	heifers to calve	5	25	67	150%
			dry cow	1	25		
			calved cows	3	35		
			bulls	3	30		
			stirks	9	20		
			calves	87	20		
1-Jun	31	95	1tups	10	4	110	73%
			lambed ewes	15	7		
			pet lambs	60	2		
			cows	5	35		
			heifers to calve	4	25		
			dry cow	1	25		
			cow and calf	1	35		
			bulls	2	30		
			stirks	6	20		
			calves	30	20		

The Sheep Shed. Comparison of actual against predicted consumption in the sheep shed appeared to be more consistent than in the other buildings, but there was still some variation.

Table 5 Sheep Shed: monthly water use compared with predicted use

Date	Days	Actual use m^3	Stock	Stock no.	Predicted use l/hd/day	Total (m^3)	Actual as % predicted
1-Nov							
1-Dec	30	18	fat lambs	238	2	14.28	126%
						14.85	121%
1-Jan	31	17	fat lambs	108	2		
	25		tups	15	4		
	30		stirks	10	25		
1-Feb	31	40	ewes	276	4	40.15	100%
	31		tups	29	4		
	31		fat lambs	5	2		
	31		stirks	4	25		
1-Mar	28	71	ewes	822	3.5	82.92	86%
	28		tups	23	4		
1-Apr	31	107	ewes to lamb	581	5	92.63	116%
	31		tups	23	4		
1-May	30	58	ewes to lamb	321	5	52.20	111%
	30		tups	26	4		
	30		pet lambs	21	2		
1-Jun	31	14	ewes	45	5	18.26	77%
	31		tups	26	4		
	31		pet lambs	118	2		
	31		cow and calf	2	35		

Wydon Farm

At Wydon Farm, the sheep shed and cattle shed were monitored. There was a second farm yard some twelve miles away where two cattle sheds of different ages were also monitored (Brompton 1 and 2), both of similar portal frame construction, but with one heavily boarded whilst the other was very open. The apparent low water use in the former has no obvious explanation.

At Wydon, the results for the cattle shed are shown in table 6. The predicted consumption rates were consistent with the other farms, with differences due to the size of the livestock. In this case, actual consumption was consistently somewhat above the predicted values (generally around 10%), and the diet was haylage only plus mineral blocks.

Table 6 Wydon Shed: monthly water use compared with predicted use

Date	Days	Actual use m^3	Stock	Stock no.	Predicted use l/hd/day	Total (m^3)	Actual as % predicted
11-Nov							
12-Dec	31	33,232	Cows ~ 600kg	25	30	30,070	110%
			bull, ~ 600kg	1	30		
			calves 5-7 mths, 150-200kg	19	10		
12-Jan	31	35,116	Cows ~ 600kg	25	30	30,070	116%
			bull, ~ 600kg	1	30		
			calves 5-7 mths, 150-200kg	19	10		
10-Feb	29	30,788	Cows ~ 600kg	25	30	28,130	109%
			bull, ~ 600kg	1	30		
			calves 5-7 mths, 150-200kg	19	10		
15-Mar	33	35,311	Cows ~ 600kg	25	30	32,010	110%
			bull, ~ 600kg	1	30		
			calves 5-7 mths, 150-200kg	19	10		
25-Apr	41	42,294	Cows ~ 600kg	25	30	39,770	106%
			bull, ~ 600kg	1	30		
			calves 5-7 mths, 150-200kg	19	10		
Total		176,741				160,050	110%

The Brompton Sheds. The Brompton sheds are in an elevated position some twelve miles south of Wydon, north of Dulverton. They are more exposed than the Wydon unit and thought to be on a site with higher rainfall.

These two sheds showed quite different results. The diet was again haylage only in both cases, but at this site, the haylage was fed chopped and intakes were thought to have been higher than at Wydon. Mineral blocks were provided for each shed.

The heavy boarding of Brompton 1 is likely to have increased the internal temperature of the building and caused greater consumption of water by the stock, but the figures are fairly consistent with the predicted intakes.

Table 7 Brompton Shed 1: monthly water use compared with predicted use

Date	Days	Actual use m^3	Stock	Stock no.	Predicted use l/hd/day	Total (m^3)	Actual as % predicted
11-Nov							
12-Dec	31	31,715	Cows ~ 500kg	2	25	30,690	103%
			calves ~ 18 mths ~ 275-330kg	94	10		
12-Jan	31	30,995	Cows ~ 600kg	2	25	30,690	100%
			calves ~ 18 mths ~ 275-330kg	94	10		
10-Feb	29	29,667	Cows ~ 600kg	2	25	28,710	103%
			calves ~ 18 mths ~ 275-330kg	94	10		
15-Mar	33	33,214	Cows ~ 600kg	2	25	32,670	101%
			calves ~ 18 mths ~ 275-330kg	94	10		
25-Apr	13	14,569	Cows ~ 600kg	2	25	12,870	113%
			calves ~ 18 mths ~ 275-330kg	94	10		
Total		140,160				135,630	103%

Brompton 2 was the more open shed and therefore the livestock lived in ambient conditions. However, the feed barrier was on the windward side of the building and it may be that rain fell on to the feed before the stock could eat it, therefore skewing the readings taken for water consumption. Here, the percentage of actual to predicted consumption ran at or above 80%, indicating that actual consumption was in fact lower than predicted, suggesting water from other sources such as rain, was consumed.

Table 8 Brompton Shed 2: monthly water use compared with predicted use

Date	Days	Actual use m^3	Stock	Stock no.	Predicted use l/hd/day	Total (m^3)	Actual as % predicted
11-Nov							
12-Dec	31	23,250	cows & in calf heifers ~ 500kg	28	25	28,830	80%
			bull ~ 500kg	1	20		
			calves, 6mths at housing, ~ 175-250kg	21	10		
12-Jan	31	24,300	cows & in calf heifers ~ 500kg	28	25	28,830	84%
			bull ~ 500kg	1	20		
			calves, 6mths at housing, ~ 175-250kg	21	10		
10-Feb	29	21,600	cows & in calf heifers ~ 500kg	28	25	26,970	80%
			bull ~ 500kg	1	20		
			calves, 6mths at housing, ~ 175-250kg	21	10		
15-Mar	33	25,210	cows & in calf heifers ~ 500kg	28	25	30,690	82%
			bull ~ 500kg	1	20		
			calves, 6mths at housing, ~ 175-250kg	21	10		
25-Apr	13	8,258	cows & in calf heifers ~ 500kg	28	25	12,090	68%
			bull ~ 500kg	1	20		
			calves, 6mths at housing, ~ 175-250kg	21	10		
Total		102,618				127,410	

Sheep shed. During the housing period, sheep were allowed access to grazing due to shortage of conserved fodder. This is shown in the asterisked figures in table 9 below. However, over the period, the figures for actual and predicted consumption show a close correlation. The diet during housing was 0.25kg concentrates and haylage with access to molasses buckets and mineral blocks. Also included in the consumption figures is the water used in the hospital shed with a kettle, sink and for supplementary feeding.

Table 9 Sheep shed: daily water use in April compared with predicted use

date	hospital shed			main shed		
	no. sheep	actual use	predicted use (l)	no. sheep	actual use (l)	predicted use
03-Apr-13	8					
04-Apr-13	8	68	58.4	216	1,885*	1576.8
05-Apr-13	6	37	43.8	204	1,214	1489.2
06-Apr-13	8	73	58.4	247	1,939	1803.1
07-Apr-13	8	62	58.4	236	1,691	1722.8
08-Apr-13	8	106	58.4	216	2,049	1576.8
09-Apr-13	8	54	58.4	197	1,403	1438.1
10-Apr-13	8	33	58.4	178	635	1299.4
11-Apr-13	8	67	58.4	154	1,506	1124.2
12-Apr-13	8	76	58.4	137	1,112*	1000.1
13-Apr-13	8	62	58.4	142	1,103*	1036.6
14-Apr-13	8	56	58.4	118	1,041*	861.4
15-Apr-13	6	52	43.8	104	788*	759.2
16-Apr-13	6	54	43.8	96	737*	700.8
17-Apr-13	6	40	43.8	72	610*	525.6
18-Apr-13	0			62	401	452.6
		840	**817.6**		**18,399**	**19,082**
Actual as % of predicted			**103%**			**96%**

* days when the sheep had access to outdoor water source

Discussion

The water consumption figures for beef and sheep in the case studies were in some cases very close to those that could be predicted from figures in the literature. However, in conditions reflecting the day to day situation on farms including variation in the weather, building design and uncertainties over water infrastructure, it can be difficult to match actual and predicted consumption.

In some cases, actual consumption was less than predicted and this seems to have been largely due to differences in the moisture content of the feed. However, in other cases, consumption was more than predicted due, for example, to leaks and this implies that in planning water provision for livestock, a degree of variation should be included to avoid shortages.

This applies to the planning of the size and number of troughs and also to having an effective infrastructure with correctly sized pipes in good serviceable order together with an accurate water supplies plan.

On farms with water provided from mains sources, quantity is rarely an issue, since it is the responsibility of a water company to ensure demand is met. For private supplies, these may vary when wells or springs run dry for example.

Conclusion

With the continued increase in demand for domestic supplies and climate change creating more frequent dry periods, the reliability of all sources of water may come under question. It is important to be aware of both the water requirements of stock and the reliability of supply and to have plans in place to reduce demand where possible and to cope with shortages

In this way, the demand for water by the industry can reflect that which is actually required, thereby reducing its water footprint and the demand for all three forms of water, particularly green and blue water.

Appendix

Tables of water use by livestock sector and type from WU0132 project report, summarised by requirement and on a per day basis are shown below.

Cattle

Source*	Animal	Drinking water requirement (L day^{-1})
1	Dairy cattle	0
	Calves	15-25
	Beef cows	25-45
2.	Dairy cattle	-
3	Dairy cattle	-
4	Dairy cow – lactating	104.5
	Dairy cow – dry period	20
	Dairy cow – overall	91.8
	Beef cows	20
	Dairy & beef bull	20
	Calves	5
5	Dairy cattle	91.8
	Growers & replacements	20
	Beef cows & heifers	20
	Dairy & beef bulls	20
	Beef store cattle	20
	Dairy & beef calves	5
6	Dairy cattle	53.9 – 64.8
7	Dairy cow	75
	Dry cattle & beef	50

*Source

1. Environment Agency (2003)
2. King et al (2006)
3. Water code (Anon, 1998)
4. Cottrill (2006)
5. Environment Agency (2007)
6. Dairy Co (2009)
7. Whiteley (2001)

Sheep

Animal	System	Drinking water requirement (L day^{-1})
Sheep	Drinking	2.5 - 5.0
Sheep	Dipping (per dip)	2.5

Source: Environment Agency (2003)

Animal	Drinking water requirement (L day^{-1})
Non-pregnant lowland ewes	3.3
Ewes in early pregnancy	4.2
Ewes in mid pregnancy	5.2
Ewes in late pregnancy	7
Ewes in early lactation	7.3

Source: King et al (2006) & Consultancy experience - Kate Phillips

Animal	Drinking water requirement (L day^{-1})
Ewe	4.5
Lambs (general)	2
Lambs finished early (October)	1.4
Lambs finished late (February)	3.3

Source: King et al (2006)

Animal	Drinking water requirement (L day^{-1})
Ewes	4.5
Rams & other adult sheep	3.3
Lambs under 1 yr	1.68

Source: Environment Agency (2007)

Animal	Drinking water requirement (L day^{-1})
Non-pregnant lowland ewes	3.3
Ewes in early pregnancy	4.2
Ewes in mid pregnancy	5.2
Ewes in late pregnancy	7
Ewes in early lactation	7.3
Lambs finished early (October)	2
Lambs finished late (February)	3.3
Rams & other adult sheep	3.3