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Evaluation of watering systems with bite valves for pigs

Kjell Larsson

A project made on an assignment of AquaGlobe AB

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Foreword

Water supply to growing/finishing pigs is of a crucial importance for the animals growth and health and therefor also for the whole production economy. Water can be provided in the troughs together with the feed or in bite valves located above the dunging passage. In this project two different types of valves were studied, one newly developed valve with a ball as a trigger for the water and a traditional valve with a spindle trigger. The purpose was to compare the water consumption and the water spillage from the two bite valves and their affect on the animal's growth and feed consumption.

The project was made on an assignment of AquaGlobe AB, Uppsala, in a growing/finishing operation at Jan Olof Andersson's farm, Skuttunge.

Research leader Kjell Larsson who has written the following report has supervised the project. Mechanical technician Torbjörn Morén has mainly conducted the experimental work.

To those who actively have contributed to this study the Swedish Institute of Agricultural engineering gives a warm tank you.

Ultuna, Uppsala

Björn Sundell
President of the Swedish Institute of Agricultural Engineering

Summary

The supply of drinking water to growing/finishing pigs is of decisive importance for the weight gain and health of the animals, and thus for the entire production economy. Water can be supplied in feed troughs together with the feed or in bite valves located above the dunging passage. The present project studied two types of bite valves, a newly developed valve with a ball for release of water, and a traditional valve with spindle release. The purpose was to compare water consumption and spillage in the two bite valves and their respective effects on weight gain and feed conversion. One valve of each type was fitted above the dunging passage in four boxes, each containing nine pigs. A spillage collector was placed below each valve. The experiment was conducted in a commercial herd for pig production and was continued throughout almost an entire growing period.

The main results are summarized below.

Water consumption of animals using the conventional valve was 37 % higher than those using the new valve design throughout the entire period (63 days). The difference was largest at the start of the period. In the later part of the growing period the difference was 33 %. When expressed in terms of daily consumption, this implies, for the entire period, volumes of 8.5 l/animal and day and 6.2 l/animal and day, respectively.

Water consumption was largest in connection with feeding, 0.4-0.6 l/animal and half-hour. During the period between feedings in the mornings and afternoons the consumption was about 0.2 l/animal and half-hour. During the night, between 22.00 and 06.00, the consumption was very low. Water consumption increased with increasing weight of the animals and with increasing temperature in the building.

Spillage from the valves was, on average, 1.6 l/animal and day with the new bite ball valves and 2.7 l/animal and day with the conventional valve, a difference of 1.1 l/animal and day (69 %). The younger animals spilled more water than the older ones. In relation to the total water consumption, the spillage was about 24 % with the new bite ball valves and about 32 % with the conventional valves. The difference in water spillage probably depended on differences in the technical design of the valves and their different capacities (flow). The water flow was 1.3 l/min in the new bite ball valve and 2.0 l/min in the conventional valve.

Daily weight gain was about 830 g and feed conversion about 2.9 kg feed per kg weight gain. No differences could be found in production results between the two types of valves.

The technical function of the valves was entirely satisfactory, but no studies were made of their durability, wear, etc. Neither were behavioral studies made of the way the animals were drinking from the two types of valves.

Background

Water supply to growing/finishing pigs is of a crucial importance to the animals growth and health and therefor also for the whole production economy. Water can be provided in troughs together with the feed in dry feeding as well as in wet feeding. The water can also be provided with bite valves in the dunging passage. According to the Swedish animal protection law the animals have to be able to always have access to fresh water. Normally this fresh water is provided through bite valves in the dunging passage.

One problem with providing water is the water spillage from the valves. A water spillage is always created when the animals drink. The animals can also start with the habit of playing with the water valve. According to different studies the water spillage can be up to 30-50 %. Spillage in feed troughs can create bacteria in the feed with water standing still in the troughs. Spillage in the dunging passage creates direct water losses. The water consumption is increasing and it creates higher costs and environmental pressure in the box as well as out on the fields when the waist is spread. The cost is not in first hand concerning the fresh water itself, it is concerning the cost of taking care of the water spillage in containers and for the spreading on the fields. According to JTI's calculations these costs are 40-100 SEK/ton (m^3) depending on the circumstances. A number of factors like behavior, water flow, placement and technical specifications of the valves can affect the water spillage.

Purpose

The purpose of this project is to compare the water consumption and the water spillage with two different bite valves and their affect on the growth and feed conversion of growing/finishing pigs.

Experimental method

The trial was conducted in an integrated growing/finishing pig operation stable with room for 270 animals. The piglets came from a nearby piglet stable. The feed was dry provided in long troughs while the water was only provided with water valves in the dunging passage. Every box had nine animals. A number of boxes were equipped with two sorts of valves in each box. The valves were connected to a water meter. The water spillage was measured in special spillage troughs that were placed under the bite valves. The feed conversion and the growth of the animals were measured by repeated weighings. The experiment was conducted trough almost a whole growing period.

Extent

Valve types

Two types of valves were studied.

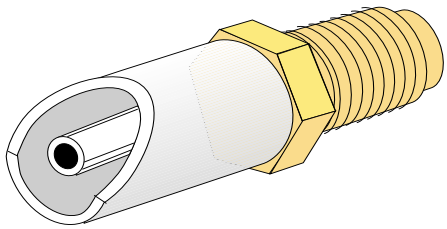
1. Newly developed bite valve with a ball as a trigger of the water.
   Manufacture: AquaGlobe 2010-100. R 1/2”
   Flow: 1,3 l/min at 300 kPa (3 Bar)

2. Conventional bite valve with spindle operation and adjustable flow.
   Manufacture: Piggy Bite Vario, R 1/2”
   Flow: 2,0 l/min at 300 kPa (3 Bar)

The two valve types are illustrated in picture no. 1. Both valves were placed 50 cm from the floor and with a 15° downward angle against the horizontal plane.

a)

b)



Picture no. 1. Studied valves. a) Newly developed bite ball valve, b) Conventional valve with spindle.

Number of boxes and animals

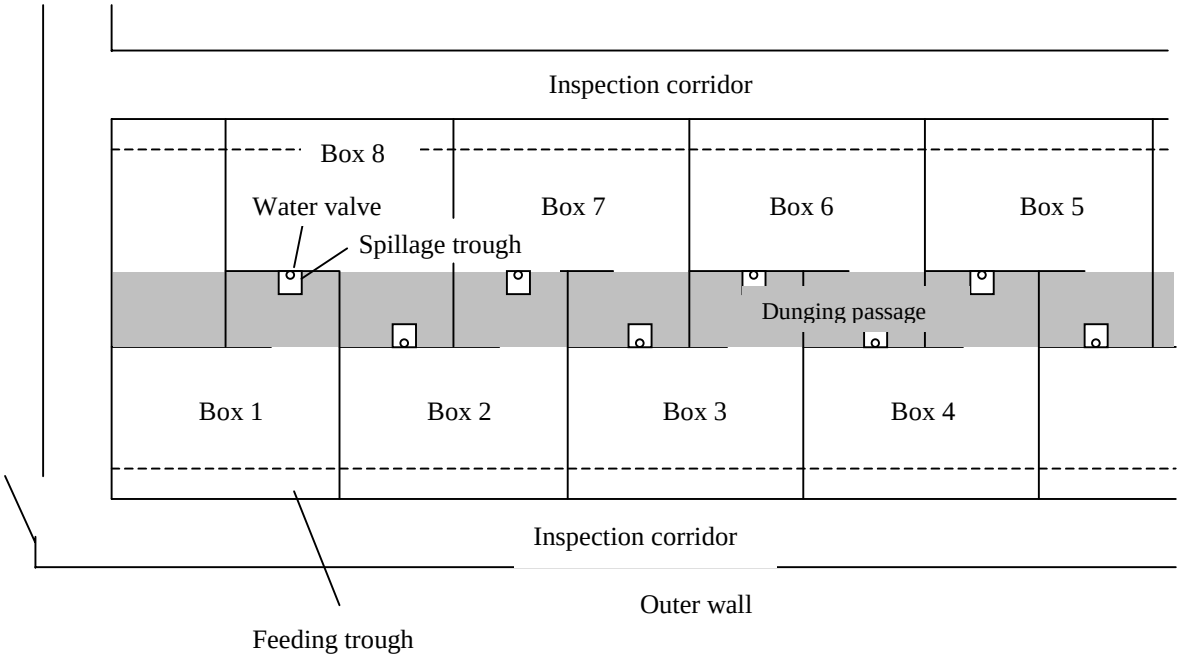
Four boxes with each nine animals were equipped with valve type 1 respectively 2. There were totally 72 animals in eight boxes in the experiments. In each box there was a spillage trough placed underneath the valve.

The placement of the different boxes and placement of valves and spillage troughs can be seen in picture no. 2. Pen no. 1, 3, 5 and 7 had valve type no. 1 and pen no. 2, 4, 6 and 8 had valve type no. 2.

Number of experiments

Round 1. The experiment started February the 20th, 1997 but had to be restarted again in the beginning of April because of problems created by using the wrong kind of feed. All measuring data had to be disregarded except for a spillage test that was made from the10th -14th of mars, before the growth disturbance occurred.

Round 2. The experiment was started the 12th of may1997 and went on to the 14th of July 1997. During these 63 days the water- and the feed consumption was measured. Two water spillage tests were also made together with four weighing tests on the 72 animals in the test.



Picture 2. Plan over experiment stable.
Box 1, 3, 5, 7 = AguaGlobe-valve, box 2, 4, 6, 8 = Reference valve.

Conducted measurements and measuring methods used

Water consumption

Traditional water meters are less exact and not enough accurate at very small and highly variation flows. In a stable with just a few animals the flow can vary from close to zero when one animal is toughing the valve to higher flows when all valves are used. For this purpose JTI has developed a water meter with high accuracy independent of the variation in water flow. It contains a piston working both ways with adjustable volume. The water is measured by counting the strokes and multiplying it with the volume of the water in each stroke. In the trial the piston volume was set to 1,0 l/stroke, because ± 1 liters precision was efficient enough for these long-term trials. One stroke is a piston movement forth and back to the starting point. The number of strokes was registered both by a mechanical stroke counter and an electronic non-touching counter. Time data from every impuls from the non-touching counter were collected in a computer. The water consumption during the whole day and night could therefore be registered. The water pressure was regulated with a pressure regulator at 300 kPa or 3 Bar.

The accuracy of the water meter and the results from measurements during the growth period are shown in table no.1. At the start and control of the measuring device, very high precision and repeating accuracy could be noted. The precision was maintained all through the trial period. The volume 1,0 l/stroke has been used for calculation of the water consumption.

Table 1. Calibrating and control of water meter. 1 stroke = a piston movement forth and back to the starting point.

Calibrating before start: Flow 1-12 l/min.; x = flow l/min; y = quantity; kg (l)
Ekv. Meter 1: $y = 0{,}0014\ x + 1{,}0056$
$R^2 = 0{,}8567$
Meter 2: $y = 0{,}0021\ x + 1{,}0013$
$R^2 = 0{,}9416$

Water meter/ Valve type no.	Flow l/min	Control during operation, l/stroke		
		20/2	5/6	23/6
1	1,3	1,007	1,018	1,003
2	2,0	1,006	1,015	1,002

Water spillage

The water spillage from the valves was collected in a spillage trough underneath each valve. The troughs had the dimensions 500x250x250 mm (length x wide x height) and contained approximately 30 l. The troughs were emptied twice every 24 hours depending on the amount of spillage. Three spillage measurements were conducted with each four 24 hour periods and one spillage measurement during experiment no 1 and two measurements during experiment no 2.

Similar spillage troughs have been used in other kind of trials with acceptable results. All water spillage is however not collected in the troughs, but from what can be seen there are very small losses of water and it is equally spread over the trial periods. The experiences of the method from this trial are positive but the method requires a lot of work and despite the fact that some of the animals do their natural needs in the spillage troughs.

Feed conversion

The animals were fed with meal feed from a local feed mixer. It was portioned with a stationary weighing system in long troughs. The portioning of the feed was conducted with two mechanical balance scales per box and the feed portioned out with drop tubes to four parts of the troughs. The animals were fed three times every 24 hours, 07.00, 12.00 and 17.00. The amount of feed was portioned out accordingly to the recommendations of the Swedish Agricultural University and was adjusted once a week (Wednesdays). The precision in the feeding was good – better than 2%. With the right maintenance the mechanical balance scales have good performance.

Growth

The pigs in experiment no.2 were weighed when they were first put into the boxes the 12th of May. They were weighed three more times the 5th and 23d of June and the 14th of July when the trial was ended. The weighing was conducted with a newly developed electronic scale with four sensors placed under the scale. The animal's weight was checked with an accuracy of one hectogram.

The pigs were individually marked and the animal's sex was checked. There was not any consideration made about how many of each sex that were put into each box. It was also hard to stear the weights from the beginning of the tests because the pigs were taken from an integrated production on the same farm.

Temperature

The temperature in the stable was registered with a termo element (copper-constantan) connected to a collecting computer. The average temperature was registered every third minute.

Results

Water consumption, stable temperature

The water consumption of each water valve in the four boxes is shown in tables and diagrams. The water consumption according to the mechanical counters is shown for the whole trial period, May 12th – July 14th, while data from the electronic counter is showing the period June 2nd - July 14th.

Mechanical stroke counters

During the trial period (63 days) the water consumption with the valve type 1 was 14 039 l and with the valve type 2 was 19 224 l (table 2 and 3). Shown as daily consumption per animal this means an average of 6,2 and 8,5 l/animal and day. The water consumption was therefor 37% higher in boxes with the conventional valve compared to the bite ball valve.

The difference in water consumption was, according to the mechanical stroke counters, highest in the beginning of the trial period when the animals were young. One explanation to this can be that when the animals are young it is harder for them to use the valve correctly in their mouth. The younger animals also like to play more with the valves especially if the valves are easy to release. Until June 2nd when the electronic counter started to be used one fourth of the total water consumption for the trial period had been consumed. The difference in water consumption between the two valves was lowered after that to a level of 33% on the remaining three fourth of the total water consumption.

Table 2. Water consumption measured with a mechanical stroke counter. Trial 2: 12/5-14/7 1997, 63 days, 36 animals/valve.

	Valve type 1	Valve type 2
Water consumption, l total	14 039	19 224
Number of animals x days	2 257 *	2 268
Water consumption, l/animal, day	6,2	8,5
Relative number	100	137

* 1 animal to slaughter 3/7

In table no.4 the daily water consumption is presented per animal for different occasions when the measurements were conducted. The time between the different measuring occasions can vary from one day to a week. As shown in the table the water consumption was increasing with the growth of the animals from 4-5 l/animal and day to 7-8 l/animal and day with valve type 1. With valve type 2 the water consumption increased from 6-7 l/animal and day to 10-11 l/animal and day. As can be seen later with the electronic counters the stable temperature is also important for the water consumption. That shows that not only the weight of the animals is important for the water consumption but also the stable climate.

The mechanical stroke counters were very reliable and they didn't fail at any time during the test period.

Table 3. Accumulated water consumption during trial no.2 measured with mechanical stroke counter.

Date	Water consumption, liter		
	Valve type 1	Valve type 2	Notes
12/5 Measurement start	0	0	
16/5	617	874	
23/5	1 773	2 658	
26/5	2 247	3 430	Spillage 2
27/5	2 421	3 695	”-
28/5	2 578	3 924	”-
29/5	2 768	4 198	”-
30/5	2 946	4 455	”-
2/6	3 517	5 280	
5/6	4 152	6 100	
10/6	5 390	7 725	
17/6	7 000	9 784	
23/6	8 392	11 573	Spillage 3
24/6	8 687	11 901	”-
25/6	8 919	12 179	”-
26/6	9 193	12 503	”-
27/6	9 486	12 858	”-
4/7	11 508	15 586	
14/7 Measurement stop	14 039	19 224	

Table 4. Water consumption measured with mechanical stroke counter.

Date	Number of days	Water consumption, l/animal, day			
		Valve type 1		Valve type 2	
		In total	l/animal, day	In total	l/animal, day
12-16/5	5	617	3,4	874	4,9
17/5-23/5	7	1 156	4,6	1 784	7,1
24/5-26/5	3	474	4,4	772	7,1
27/5	1	174	4,8	265	7,4
28/5	1	157	4,4	229	6,4
29/5	1	190	5,3	274	7,6
30/5	1	178	4,9	257	7,1
31/5-2/6	3	571	5,3	825	7,6
3/6-5/6	3	635	5,9	820	7,6
6/6-10/6	5	1 238	6,9	1 625	9,0
11/6-17/6	7	1 610	6,4	2 059	8,2
18/6-23/6	6	1 392	6,4	1 789	8,3
24/6	1	295	8,2	328	9,1
25/6	1	232	6,4	278	7,7
26/6	1	274	7,6	324	9,0
27/6	1	293	8,1	355	9,9
28/6-4/7	7	2 022	8,0	2 728	10,8
5/7-13/7	9	2 531	7,8	3 638	11,2
Sum	63	14 039	6,2	19 224	8,5

Electronic counters

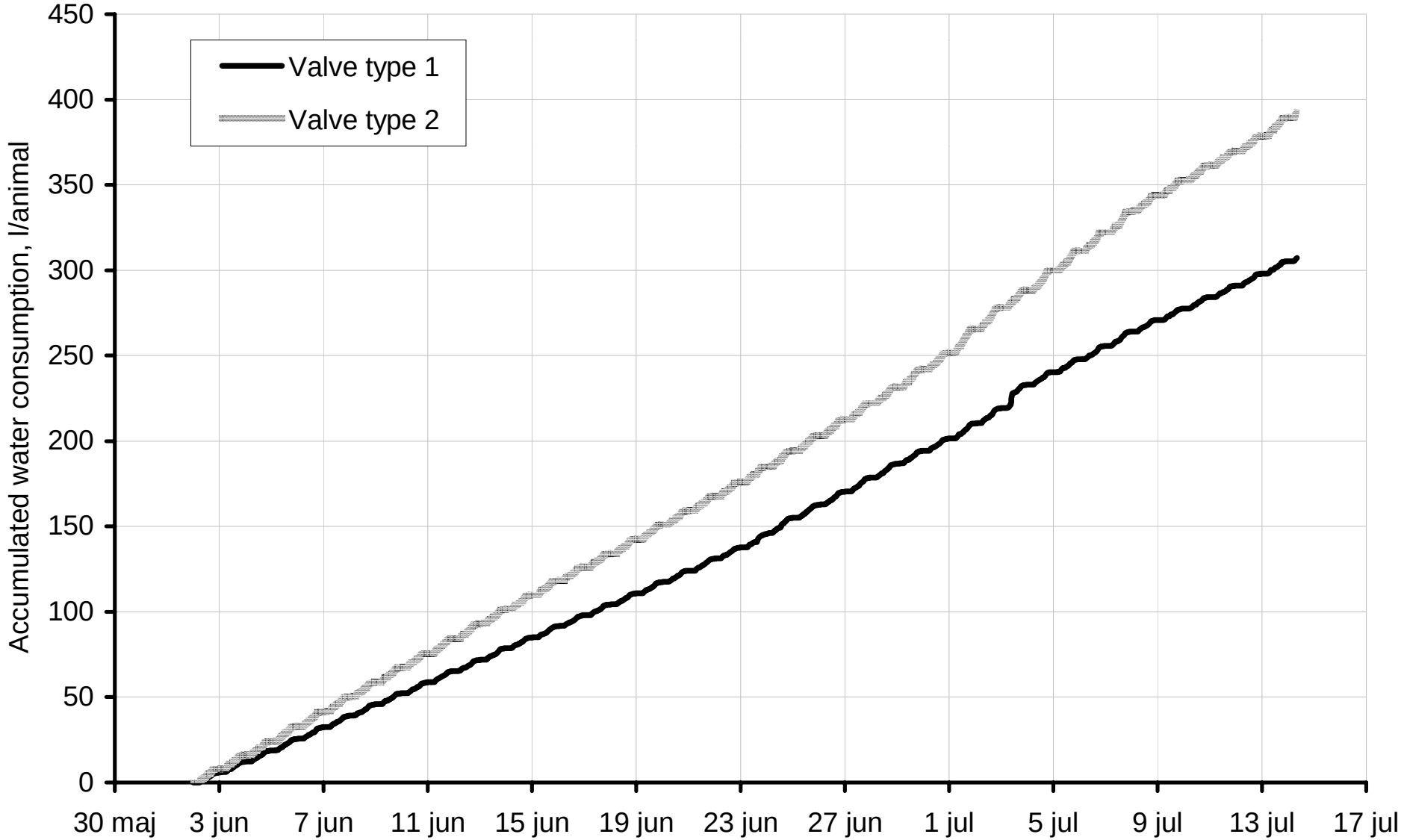
The collecting of data to the computer gave a detailed picture of the water consumption and the stable temperature during the different parts of the day. The result is presented in three types of diagrams, one with the accumulated water consumption during the whole period. One with the average water consumption per animal and day including the average 24 hour temperature and finally a diagram for every week during the trial period when looking at water consumption and stable temperature on an average 24 hours. In the later diagram the data are presented every 30 minutes. The diagrams give a clear view of what is happening during a typical 24 hours and its change during the growth period.

As can be seen in picture no. 3 the accumulated water consumption was higher with the conventional type of valve than with the new valve type. The turns are diverting and the lines are not straight, they are turning upward because of the increased daily consumption of the animals. During the 41 days as the electronic counter was operating every animal consumed a little less than 400 l of water with the conventional valve and 300 l with the bite ball valve. The difference confirmed what had been measured by the mechanical counters.

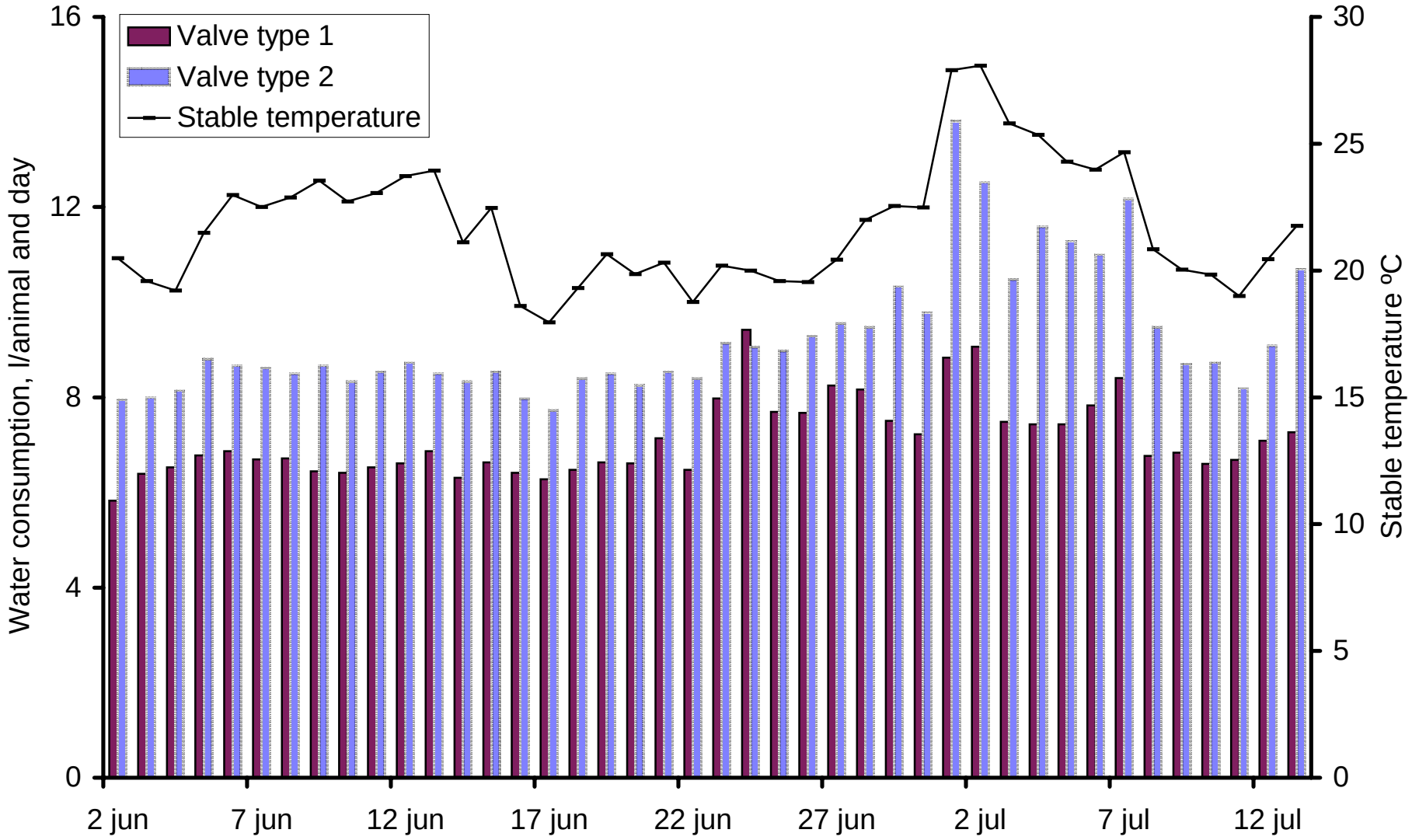
The diagram in picture no. 4 shows that the water consumption, with one exception, was higher per day with the conventional valve compared to the new valve. The daily variations in water intake can also be seen by the diagram, with the gradual increase during the growth. A connection between the water intake and the temperature can also be seen. During the warm days the water consumption increased. The temperature in the stable was high during one week in the beginning of June aproximately 24°C, that lead to relatively high and even water consumption, approximately 7 l/animal and day with valve type 1 and 9 l/animal and day with valve type 2. The highest peek of the temperature was reached when June turned to July with an average temperature of 25-28°C. During these days the highest daily intake of water was registered, especially in the boxes with the conventional bite valve (11-13 l/animal and day). The temperature in the stable therefor has a clear effect on the animals water intake.

The diagrams in picture no. 5-11 show the water consumption and the stable temperature per every 30 minutes both every week and also spread out through the whole trial period. The water consumption was highest in connection with the feeding occasions at 07.00, 12.00 and 17.00 hours. The highest water intake could bee seen when the animals were fed in the afternoons. The peeks were very distinct and were normally 0,4-0,6 liters every 30 minutes and animal. After the peeks the consumption was at a lower level, approximately 0,2 liters per 30 minutes and animal while the consumption between 22.00 and 06.00 hours, was very low. After midnight there was only occasional drinking. The pattern of the drinking was broken during one of the periods, 23-29th of June, depending on the spillage measurements when the animals were locked out from the water valves for a couple of hours.

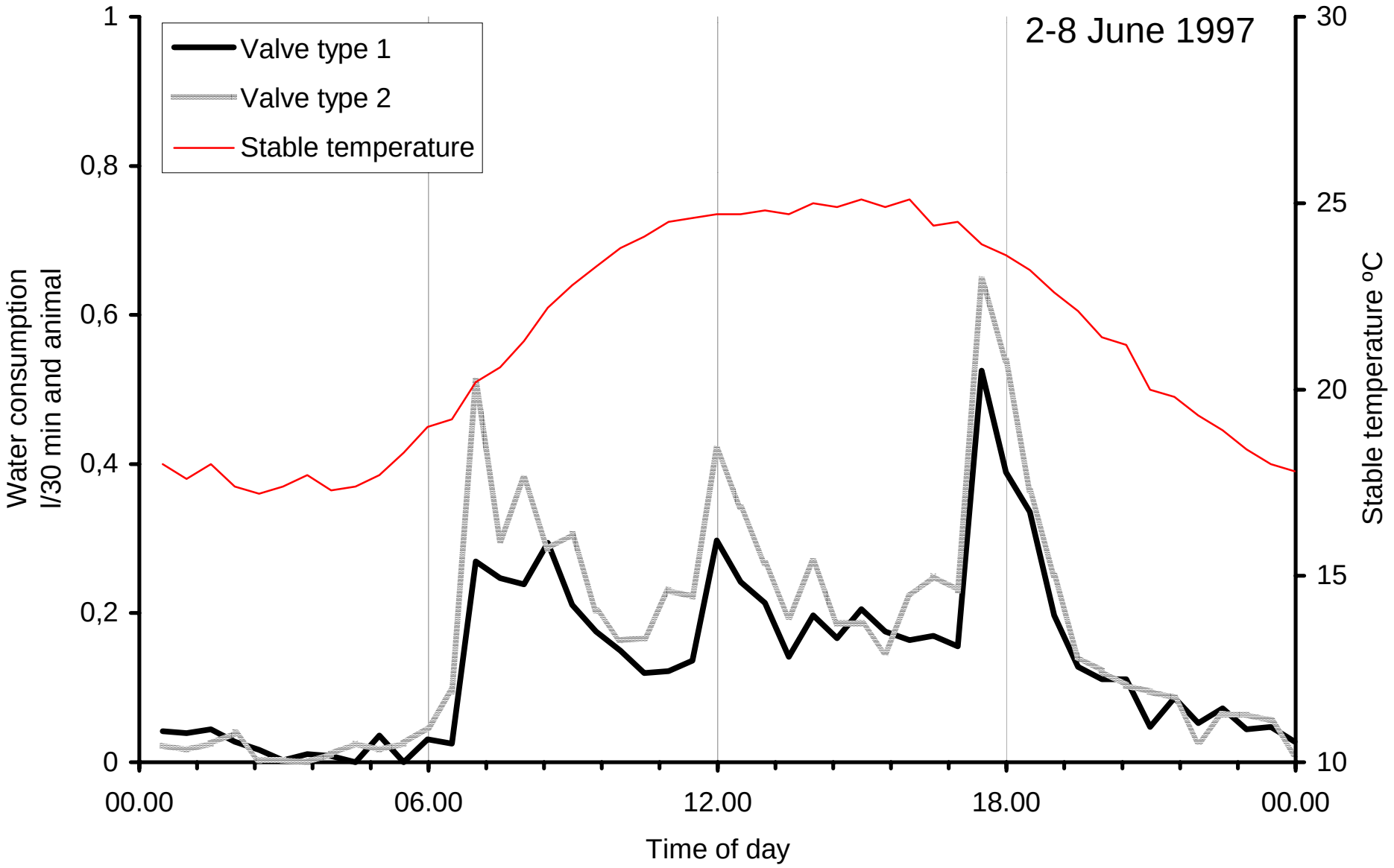
The temperature in the diagrams shows the average temperature at different occasions during the 24 hours. The warmest periods 9-15th of June and 30th of June – 6th of July can clearly be seen in the diagrams. As can be seen the water consumption was higher during these periods compared to the cooler periods.



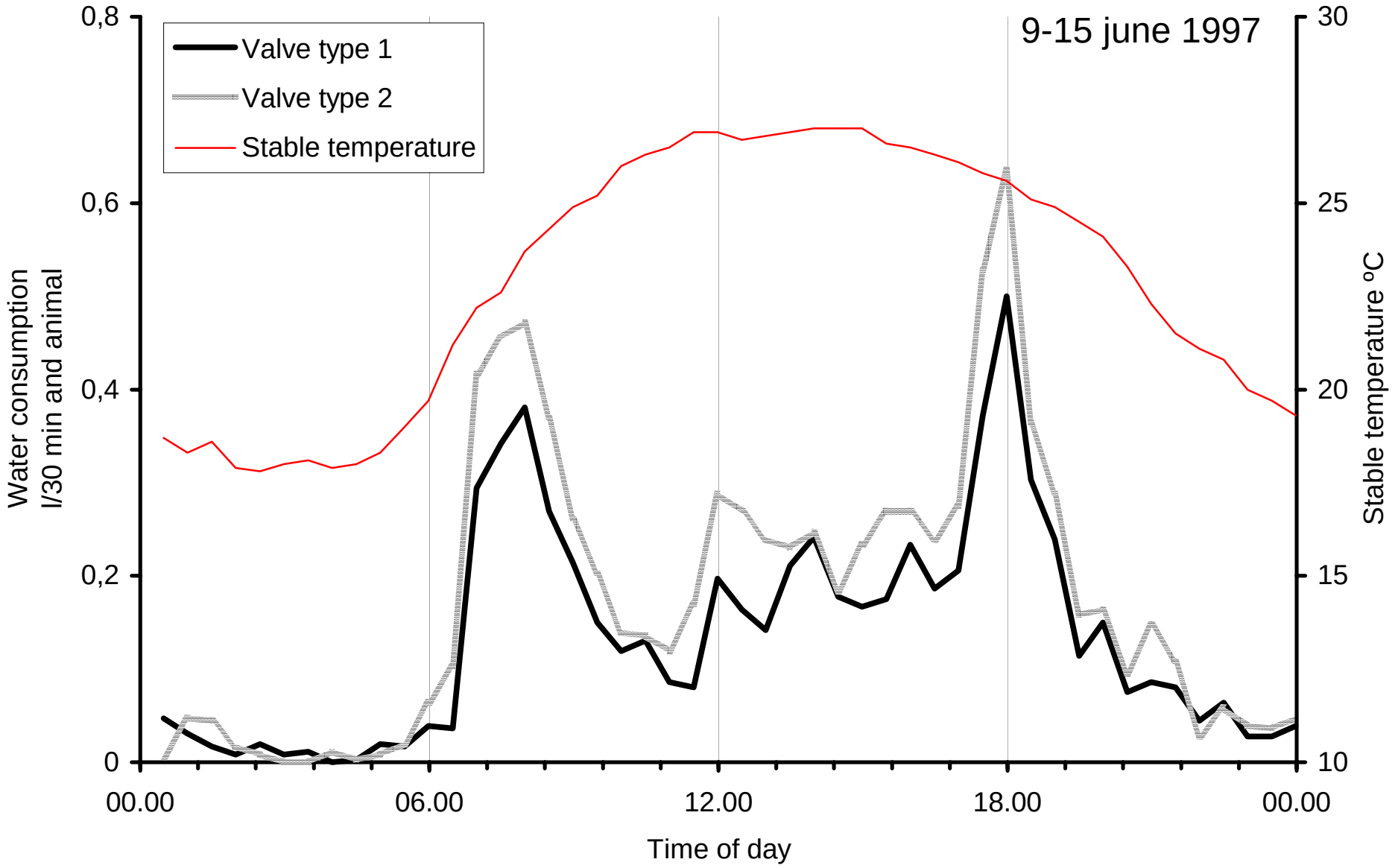
Picture 3. Accumulated water consumption during trial no. 2, 2 June – 13 July.



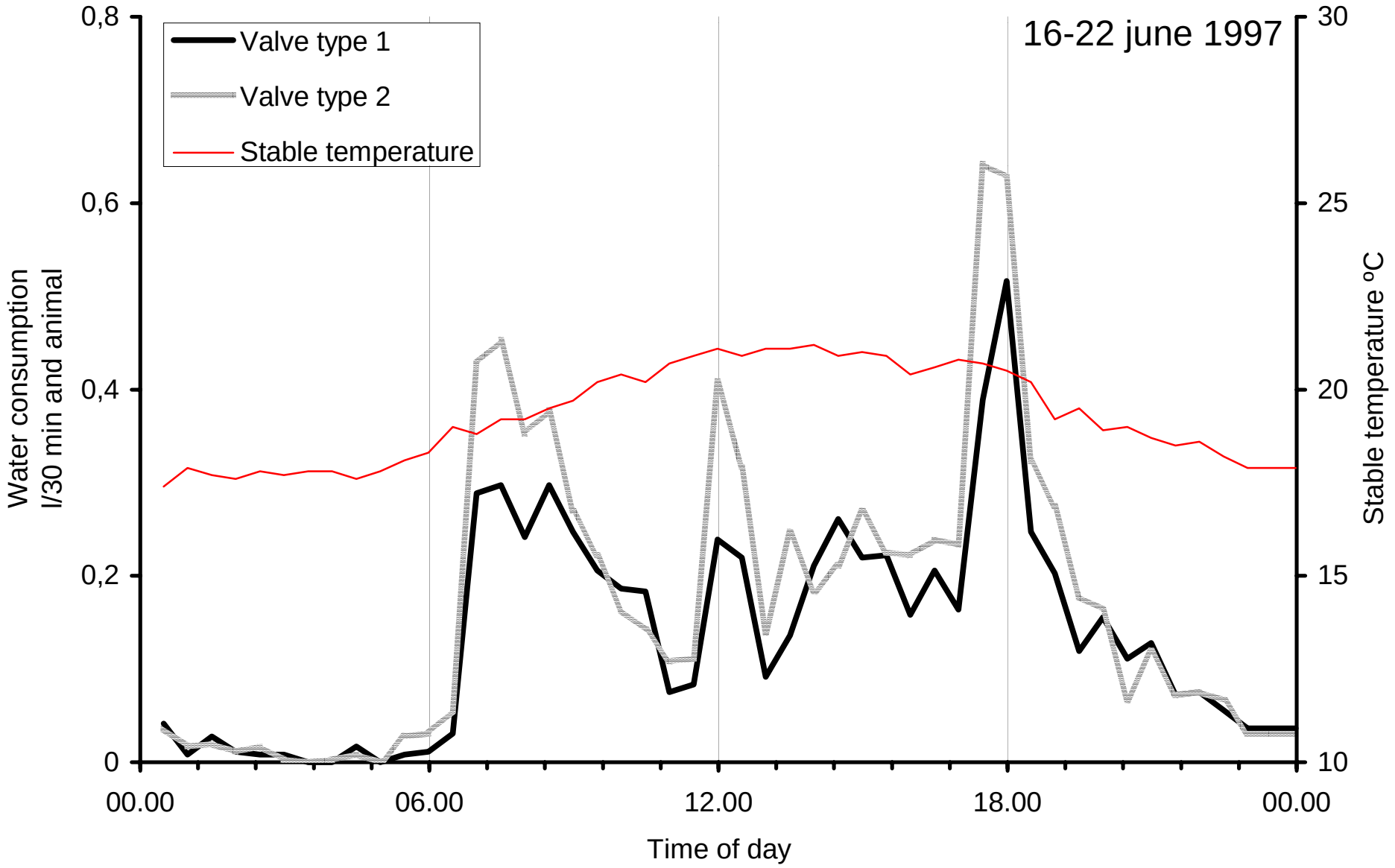
Picture 4. Daily water consumption with valve type 1 and 2, average temperature in the stable during trial no. 2, 2 June – 13 July.



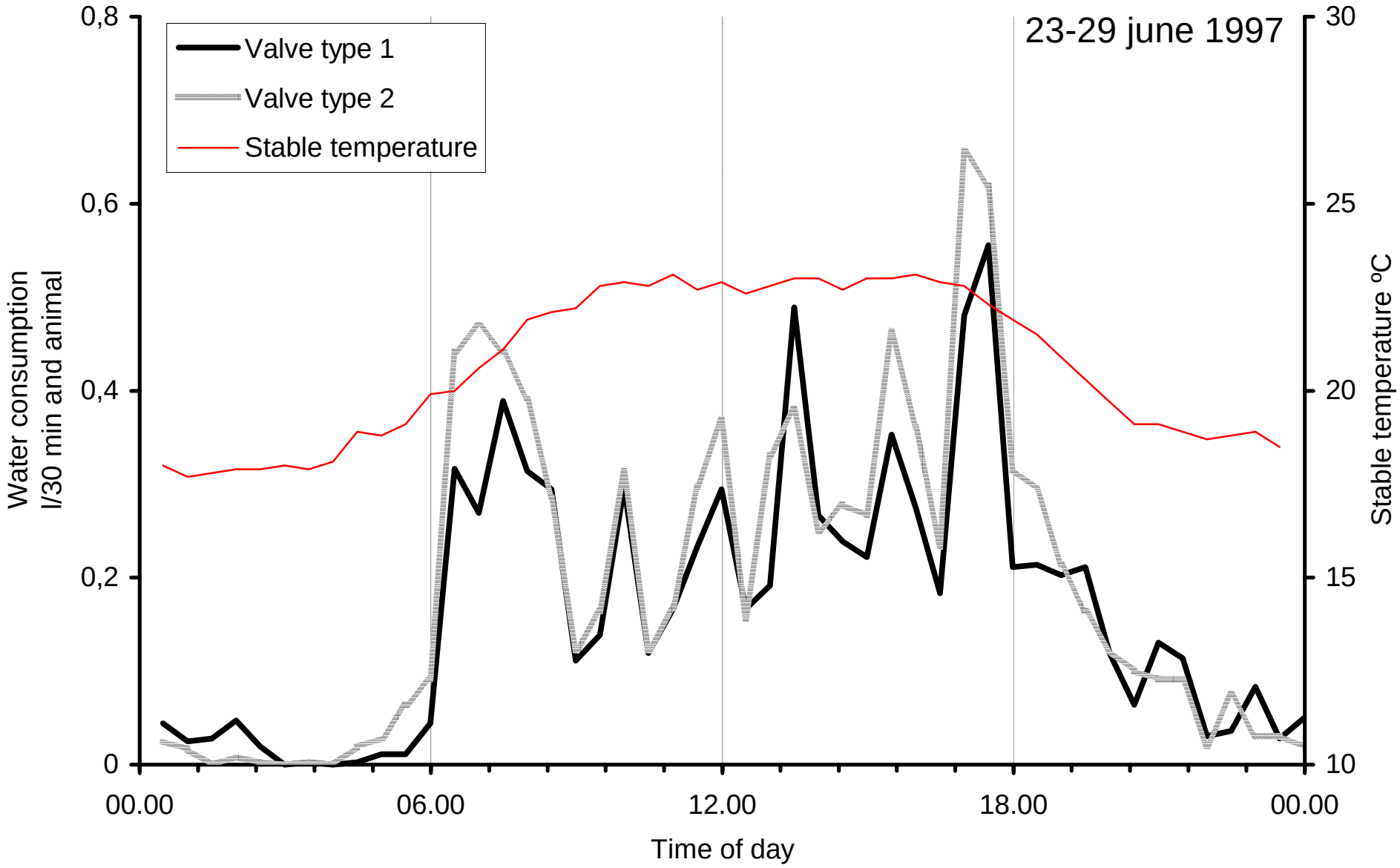
Picture 5. Water consumption and stable temperature during an "average 24-hours" during the period 2-8 June.



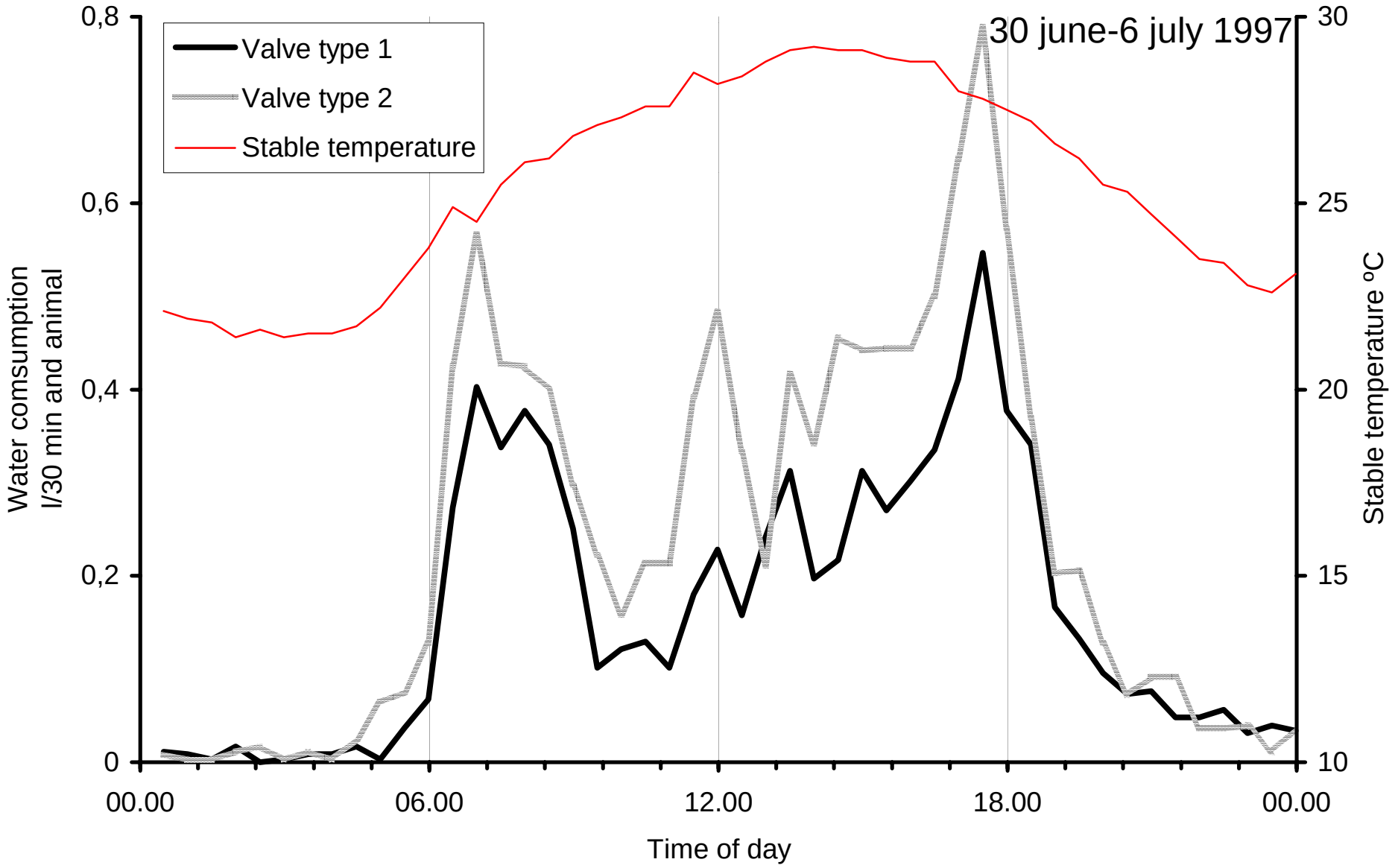
Picture 6. Water consumption and stable temperature during an "average 24-hours" during the period 9-15 June.



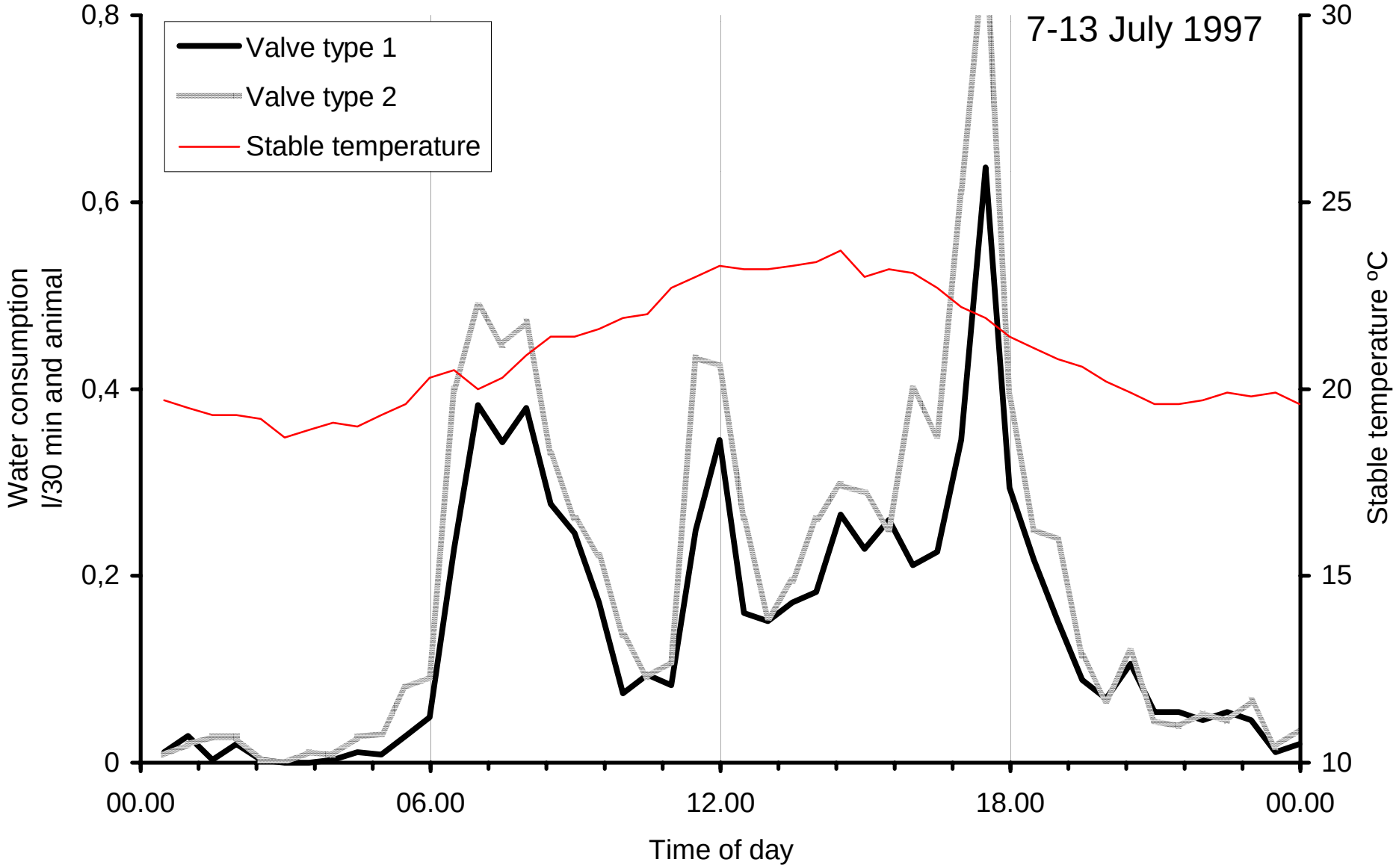
Picture 7. Water consumption and stable temperature during an "average 24-hours" during the period 16-22 June.



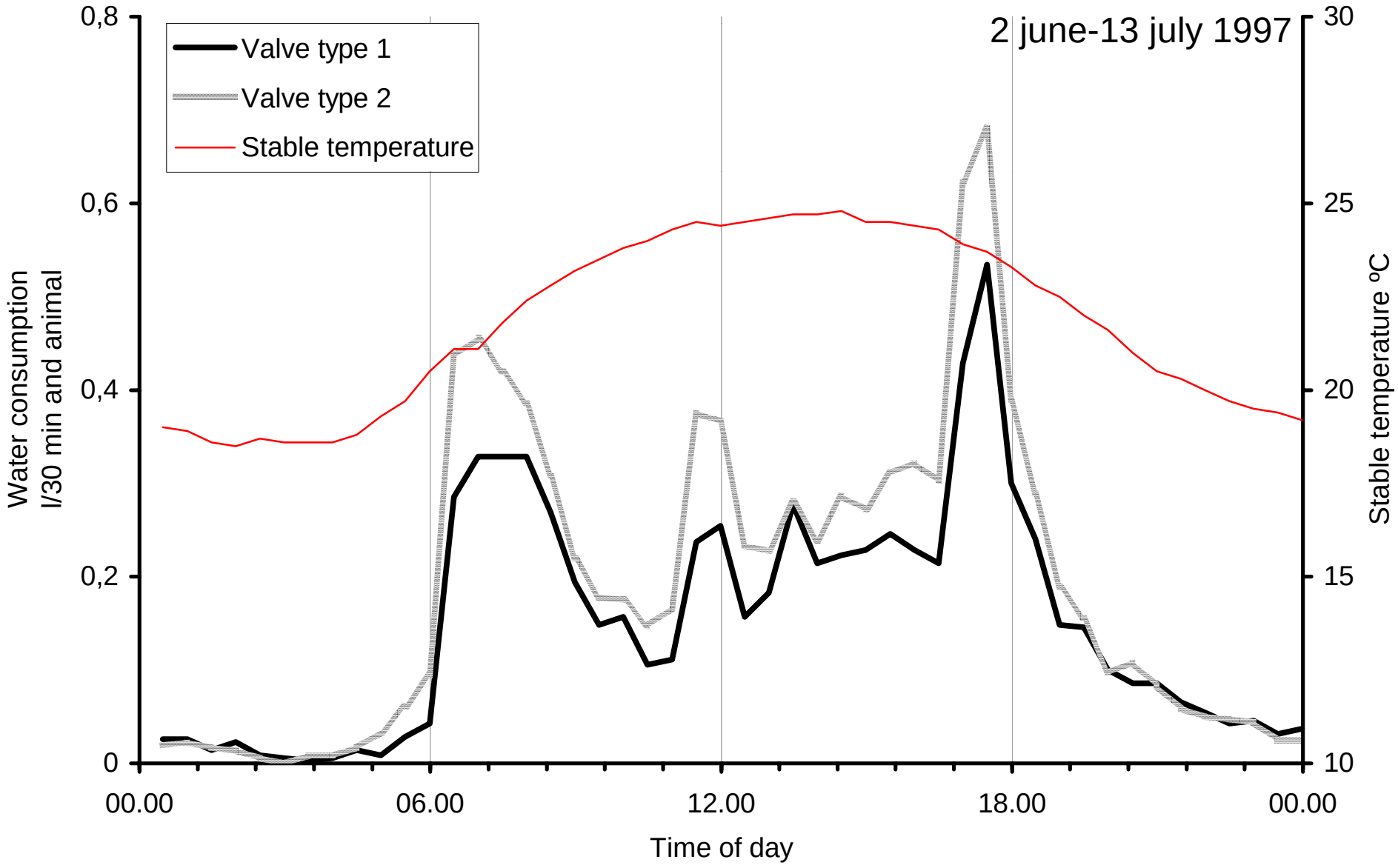
Picture 8. Water consumption and stable temperature during an "average 24-hours" during the period 23-29 June.



Picture 9. Water consumption and stable temperature during an "average 24-hours" during the period 30 June – 6 July.



Picture 10. Water consumption and stable temperature during an "average 24-hours" during the period 7-13 July.



Picture 11. Water consumption and stable temperature during an "average 24-hours" during the period 2 June – 13 July.

Water spillage

Spillage measurements were made three times on four days each. The result from these measurements is shown in table no. 5-8. The spillage varies a lot both between the boxes and between the measuring occasions. Certain boxes, for instance box no. 2 in measurement no.1, had two to three times as much spillage (45-50 l/day) as the other boxes in the same length (12-25 l/day). The behavior of just a few of the animals is probably the answer to the big difference.

The new bite ball valve gave generally lower water spillage than the conventional valve and the spillage was also more even if you compare from day to day. In all the three measurements the average spillage was 1,6 l/animal and day compared to 2,7 l/animal and day with the conventional valve which makes a difference of 69%. The difference was lower in measurement no.1 and 3 when the animals where bigger while the younger animals spilled more than the double with the conventional valve. The differences in spillage can depend on different facts but the main reason is probably the design of new bite ball valve and that it has a lower flow, 1,3 l/min. To be able to release the valve the animals have to take the whole valve into their mouths. It is also harder to release from the side. The chance that the water is going far into the mouths of the animals is therefor big. With a conventional valve with a spindle operated water flow the animals can release the water by just touching the spindle with the nose so that some of the water will go on the side of the mouth. The animals are more interested in playing with the valve because it is so easy to spray the water on the side of the mouth. The flow with the conventional valve was 2,01 l/min according to the recommendations from the manufacturer.

The recommended water flows, 1,3 and 2,01 l/min at 300 kPa was retained in a satisfactory way but low points in water pressure and dirt in the pipes made the flows a little bit lower in practice, maximum 10%.

The water consumption during the spillage measuring periods was in average 6,5 l/animal and day with the new valve and 8,3 l/animal and day with the conventional valve, a difference of 1,8 l/animal and day. The difference in spillage was 1,1 l/animal and day, which means that the real water consumption would be 0,7 l/animal and day higher of animals with the conventional valve with a higher flow. This is if all the spillage is collected by the spillage troughs. In practice some of the water is not collected by the spillage troughs, some of the water is going on the side of the trough. According to what could be seen it was relatively little water and it was about the same for the two types of valves. An animal that is drinking from a valve that is easy to release with a higher flow has higher water consumption, that is reasonable. On the other hand the “spillage” outside the troughs can be relative to the flow of the valves, which decreases the difference between the two types.

Table 5. Water spillage. Average 3 spillage measurements.

	Measurement no.							
	1 10-14/3		2 26-30/5		3 23-27/6		Average 1-3	
Valve type	1	2	1	2	1	2	1	2
Water consum. l/animal, day	7,1	9,0	4,9	7,1	7,6	8,9	6,5	8,3
relative no. (valvetype 1=100)	**100**	**127**	**100**	**145**	**100**	**117**	**100**	**128**
Water spillage l/animal, day	2,0	3,2	0,9	2,3	1,9	2,7	1,6	2,7
relative no. (valvetype 1=100)	**100**	**160**	**100**	**255**	**100**	**142**	**100**	**169**
% of water consumption	28	35	19	32	25	30	24	32
Animal weight, kg average	68	72	58	54	78	75	68	67

Table 6. Water spillage. Spillage measurement no. 1, 10-14/3 1997.

Valve type 1		Date				Sum	
		11/3	12/3	13/3	14/3	4 days	per day
Water spillage, l	box 1	17,0	19,0	24,0	19,5	79,5	19,9
	box 3	15,0	20,0	22,0	21,5	78,5	19,6
	box 5	10,0	12,0	12,0	19,0	53,0	13,3
	box 7	16,0	19,0	20,0	19,0	74,0	18,5
Sum		58,0	70,0	78,0	79,0	285,0	71,3
Water consum.,	l	241	259	266	260	1 026	257
”	l/animal	6,7	7,2	7,4	7,2	-	7,1
Water spillage,	l/animal	1,6	1,9	2,2	2,2	-	2,0
”	%	24	27	29	30	-	28
Animal weight, kg average: 68 kg							

Valve type 2		Date				Sum	
		11/3	12/3	13/3	14/3	4 days	per day
Water spillage, l	box 2	46,0	50,0	51,0	50,5	197,5	49,4
	box 4	17,0	19,0	22,0	17,5	75,5	18,9
	box 6	17,0	21,0	25,0	24,0	87,0	21,8
	box 8	19,0	26,0	28,0	24,0	97,0	24,3
Sum		99,0	116,0	126,0	116,0	457,0	114,0
Water consum.,	l	304	330	346	312	1 292	323
”	l/animal	8,4	9,2	9,6	8,7	-	9,0
Water spillage,	l/animal	2,8	3,2	3,5	3,2	-	3,2
”	%	33	35	36	37	-	35
Animal weight, kg average: 72 kg							

Table 7. Water spillage. Spillage measurement no. 2, 26-30/5 1997.

Valve type 1		Date				Sum	
		22/5	28/5	29/5	30/5	4 days	per day
Water spillage, l	box 1	9,0	7,0	10,0	11,0	37,0	9,3
	box 3	9,0	7,0	9,0	8,5	33,5	8,4
	box 5	6,0	5,0	5,0	4,5	20,5	5,1
	box 7	10,0	10,0	11,0	13,0	44,0	11,0
Sum		34,0	29,0	35,0	37,0	135,0	33,8
Water consum.,,	l	174	157	190	178	699	175
”	l/animal	4,8	4,4	5,3	4,9	-	4,9
Water spillage,	l/animal	0,9	0,8	1,0	1,0	-	0,9
”	%	20	18	18	21	-	19
Animal weight, kg average: 58 kg							

Valve type 2		Date				Sum	
		27/5	28/5	29/5	30/5	4 days	per day
Water spillage, l	box 2	25,7	23,8	26,5	25,0	101,0	25,3
	box 4	17,0	14,0	19,5	19,0	69,5	17,4
	box 6	29,0	23,0	27,5	25,0	104,5	26,1
	box 8	15,0	11,5	13,5	12,0	52,0	13,0
Sum		86,7	72,3	87,0	81,0	327,0	81,8
Water consum.,	l	265	229	274	257	1 025	256
”	l/animal	7,4	6,4	7,6	7,1	-	7,1
Water spillage,	l/animal	2,4	2,0	2,4	2,3	-	2,3
”	%	33	32	32	32	-	32
Animal weight, kg average: 54 kg							

Table 8. Water spillage. Spillage measurement no. 3, 23-27/6 1997.

Valve type 1		Date				Sum	
		24/6	25/6	26/6	27/6	4 days	per day
Water spillage, l	box 1	12,0	17,5	17,0	20,9	67,4	16,9
	box 3	12,5	12,0	13,0	16,4	53,9	13,5
	box 5	17,5	16,0	20,5	26,9	80,9	20,2
	box 7	15,0	16,0	20,0	24,4	75,4	18,9
Sum		57,0	61,5	70,5	88,6	277,6	69,5
Water consum.,,	l	295	232	274	293	1 094	274
”	l/animal	8,2	6,4	7,6	8,1	-	7,6
Water spillage,	l/animal	1,6	1,7	2,0	2,5	-	1,9
”	%	19	27	26	30	-	25
Animal weight, kg average: 78 kg							

Valve type 2		Date				Sum	
		24/6	25/6	26/6	27/6	4 days	per day
Water spillage, l	box 2	18,5	29,5	29,5	36,4	113,9	28,5
	box 4	17,5	17,5	21,0	28,9	84,9	21,2
	box 6	24,5	23,0	29,5	37,9	114,9	28,7
	box 8	14,5	16,5	19,5	22,4	72,9	18,2
Sum		75,0	86,5	99,5	125,6	386,6	96,7
Water consum.,	l	328	278	324	355	1 285	321
”	l/animal	9,1	7,7	9,0	9,9	-	8,9
Water spillage,	l/animal	2,1	2,4	2,8	3,5	-	2,7
”	%	23	31	31	35	-	30
Animal weight, kg average: 75 kg							

Feed conversion, growth

The animals were fed three times a day. Different amounts of feed in different stages of growth are shown in table no. 9. When the animals had an average weight of aproximately 60 kg the daily amount of feed was not increased. It was maintained at 8 kg per time, that means 24 kg per box and day the rest of the growth period. That is 2,67 kg/animal and day, just under the recommendation of the Swedish Agricultural University, which is 2,75 kg/animal, and day. Table no. 10 shows the total feed consumption every week, the amount was adjusted on Wednesdays. During the 63 days when the trial was conducted, the animals were fed between 1 300 and 1 400 kg feed per box.

The animals were weighed on four occasions, 12/5, 5/6, 23/6 and 14/7. The growth and the feed consumption in different stages and totally for the whole period are shown in table no.11. The animals were in the beginning relatively heavy, in average 41,6 kg (valve type 1) and 38,7 kg (valve type 2). One animal in box no. 1 was slaughtered as early as 3/7. This animal is not included in the calculations at all.

The wieght gain for the period was in average 830 g/animal and day which is a technically good result. The increase in weight was a little bit faster in the first and the second stage compared to the third stage of the production period. No statistically proven differences could be seen between the two valves. P-number is a measurement of how likely it is that there is a difference between the valves. The higher the P-number is the less difference it is between the two valves. P = 1,0 means exactly the same result. First when $P \leq 0,1$ it is possible to say that a tendency is shown. With a one star significance $P \leq 0,05$, with a two star significance $P \leq 0,01$ and with a three star significance $P \leq 0,001$. P-numbers were in this case between 0,52 and 0,92 which means that it is very likely that both valves showed the same growth.

In the same table it is possible to see the feed conversion, expressed as kg feed per kg weight gain. With valve type 1 the feed conversion for the whole period was 2,96 kg per kg weight gain and 2,91 kg per kg weight gain with valve type 2. Even this is a good production result. As can be seen by the P-numbers, 0,5-0,96, the feed consumption was the same with both valve types.

In the table the water consumption is expressed in liter per kg feed and per kg weight gain. With valve type 1 it was 2,5 l/kg feed and 7,5 l/kg weight gain. The corresponding amounts with valve type 2 were 3,5 l/kg weight gain and 10,3 l/kg weight gain. The water efficiency is important in animal production today; it will be even more important in the future, especially in countries with limited resource of water.

As a summary it can be said that the total production result was the same for the two valves. There was therefor not too little water coming out from valve type 1. The evaluation of the slaughter weight is not included in this trial.

Remainder

Behavior studies of the way the animals were drinking from the different valves have not been involved in this study. The valves technical durability and risks for stoppage have not been studied in this project. There have not been any problems in that way during the trial period. With an exception for the four trial boxes with conventional valves, the whole stable had the new bite ball valve installed. A consequence of that was that the consistency of the manure was more dry and it was harder to transport the manure out of the stable and into the manure container. Adding water to the manure easily solved the problem. Problems of this kind are happening with a certain kind of manure system and do not have to be seen as a general problem.

From an economical point of view the water spillage is of great importance. The difference in the total water consumption would for a stable with 300 pigs be about 200 m^3 less water spillage per year with the new bite ball valve. The saving in cost for storing and spreading of this water is 8 000-20 000 SEK per year (40-100 SEK/m3). On top of this there is a lower cost for less fresh water with 1 000-1 400 SEK per year (8-12 SEK/m3) according to the local water cost. Lower water consumption also gives a better climate in the stable.

Table 9. Amount of feed per feeding occasion. 3 feed occasions per day.

Date	No. of days		Valve type 1, box				Valve type 2, box			
			1	3	5	7	2	4	6	8
12-13/5	2	kg/feeding	4,9	5,2	4,7	5,8	4,5	5,4	4,5	5,7
14-20/5	7	”	5,4	5,6	5,5	5,8	5,0	5,7	5,7	5,7
21-27/5	7	”	6,6	6,7	6,8	6,9	5,5	6,8	6,7	6,4
28/5-3/6	7	”	7,1	6,7	7,4	6,9	6,4	7,2	7,1	6,8
4/6	1	”	7,7	7,4	7,7	7,6	6,8	7,8	7,6	7,4
5-10/6	6	”	7,7	7,4	7,7	7,6	6,8	7,8	7,6	7,4
11/6-17/6	7	”	7,9	8,0	8,0	8,0	7,1	8,0	8,0	8,0
18/6-22/6	5	”	8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
23/6-24/6	2	”	8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
25/6-24/6	7	”	8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
2/7-8/7	7	”	8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
9/7-13/7	5	”	8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
Sum	63	”								

Table 10. Total feed. Feeding 3 times/day, feed portion is adjusted once a week (Wednesdays).

Date	No of. days		Valve type 1, box				Valve type 2, box			
			1	3	5	7	2	4	6	8
12-13/5	2	kg tot.	29,4	31,2	28,2	34,8	27,0	32,4	31,2	34,2
14-20/5	7	”	113,4	117,6	115,5	121,8	105,0	119,7	119,7	119,7
21-27/5	7	”	138,6	140,7	142,8	144,9	115,5	142,8	140,7	134,4
28/5-3/6	7	”	149,1	140,7	155,4	144,9	134,4	151,2	149,1	142,8
4/6	1	”	23,1	22,2	23,1	22,8	20,4	23,4	22,8	22,2
5-10/6	6	”	138,6	133,2	138,6	136,8	122,4	140,4	136,8	133,2
11/6-17/6	7	”	165,9	168,0	168,0	168,0	149,1	168,0	168,0	168,0
18/6-22/6	5	”	120,0	120,0	120,0	120,0	120,0	120,0	120,0	120,0
23/6-24/6	2	”	48,0	48,0	48,0	48,0	48,0	48,0	48,0	48,0
25/6-1/7	7	”	168,0	168,0	168,0	168,0	168,0	168,0	168,0	168,0
2/7-8/7	7	”	168,0	168,0	168,0	168,0	168,0	168,0	168,0	168,0
9/7-13/7	5	”	120,0	120,0	120,0	120,0	120,0	120,0	120,0	120,0
Sum	63	”	1 382,1	1 377,6	1 395,6	1 398,0	1 297,8	1 401,9	1 392,3	1 378,5
Number of animal days			556	567	567	567	567	567	567	567
Feed, kg/animal, day			2,49	2,43	2,46	2,47	2,29	2,47	2,46	2,43

Table 11. Growth, feed and water consumption.

	Valve type		P-number
	1	2	
Number of animals	36	36	
Removed animals	1	-	
Start weight, kg	41,6	38,7	
End weight, kg	93,9	90,9	
Daily weight gain, g			
interval 1, 12/5-4/6	856	868	0,74
interval 2, 5/6-22/6	828	848	0,52
interval 3, 23/6-13/7	791	778	0,67
whole period	831	828	0,92
Feed conversion kg feed/kg weight gain			
interval 1, 12/5-4/6	2,46	2,41	0,49
interval 2, 5/6-22/6	2,84	2,85	0,96
interval 3, 23/6-13/7	3,47	3,44	0,76
whole period	2,96	2,91	0,50
Water consumption whole period			
l water/animal and day	6,2	8,5	
l water/kg feed	2,5	3,5	
l water/kg weight gain	7,5	10,3	