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Daily water intake by individual dairy cows on a pasture diet during mid lactation

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ABSTRACT

Three small studies were undertaken in the Waikato involving daily measurements of water intake of individual mixed-age Holstein-Friesian and crossbred cows, mid lactation. In Trial 1 at Ruakura, cows were monitored whilst grazing and, in Trials 2 and 3 at DairyNZ, pasture was cut and fed to cows indoors. Mean daily water intakes by Trial were 41.3, 78.2 and 60.1 L/cow, respectively; standard deviations were 4.5, 8.3 and 7.2 L/cow, and between-cow repeatabilities averaged 0.56 ± 0.08 . There were two days of rain in Trial 1; the greater of these rainfalls (26.4 mm) led to a 62% reduction in water intake. There was no rainfall above 2 mm in Trials 2 or 3. Daily feed intakes (and feed dry-matter percentages) of cows were also available (Trials 2 and 3), and combined daily water intake (calculated from actual-water intakes plus water content of the feed consumed) averaged 104.5 and 110.6 L/cow, respectively. At an average water intake from the trough of 60 L/cow, the 25% of cows drinking least are expected to drink ~8.4 L (14%) less than average. This knowledge is useful when planning management practices such as supplementing water with zinc sulphate for facial eczema protection.

Keywords: lactating cow; individual; water intake; daily; pasture-fed.

INTRODUCTION

Water intakes of individual cows during lactation have seldom been measured, especially when cows are on a pasture diet. Despite this, the administration of supplements via water troughs is relatively widespread, with 55% of dairy farms using this method, according to a recent representative telephone survey of 530 New Zealand dairy farms (J.G. Jago, Personal communication). To achieve adequate supplementation for disease protection with minerals such as zinc (Zn) for control of facial eczema, or magnesium for control of hypomagnesaemia, when treatments are administered via water troughs, it is important to know average water intakes in some trough treatment systems, and to know the extent of cow-to-cow variation in all systems. Zinc, for example, is not stored long-term in the body, and is required continuously in summer/autumn during the period of facial eczema toxic challenge, if it is to provide protection. Few previous publications appear to have covered the subject of individual-cow daily water intake and its variation. Those by Campbell and Munford (1957) in New Zealand, and Winchester and Morris (1956) in the USA are available, but the farming conditions may not be relevant to modern New Zealand dairy cows at pasture. This paper summarises three small studies undertaken in the Waikato involving daily measurements of water intakes of individual lactating cows in summer.

MATERIALS AND METHODS

Ethics

This work was carried out with the approval of the Ruakura Animal Ethics Committee, Hamilton, New Zealand.

Trial designs

The first study (Trial 1) was set up at AgResearch Ruakura, Hamilton to monitor individual cows' daily intakes of ZnSO₄-treated water over a week at pasture, to provide information specific to Zn supplementation for facial eczema protection. The second and third studies (Trials 2 and 3), at DairyNZ's Lye Farm, Hamilton, were part of larger trial designs, which included measurements of individual cows' daily water intakes.

Trial 1

At the Ruakura Dairy No 1 Farm in December 2008, a trial was set up to monitor individual daily water intakes of 8 mixed-aged lactating Friesian x Jersey cows, recorded over seven days, and with stage of lactation averaging 115 days. Animals were selected as four heavy (528 ± 28 kg (mean \pm standard deviation)) and four light (424 ± 12 kg) cows, so that any effect of body size on water intake could be monitored. They were offered ryegrass-white clover pasture *ad libitum*. Milk yields were recorded twice daily. A small paddock was split into a lattice of plots with electric wire, so that each cow grazed a separate plot and received a new plot of fresh pasture every morning. Cows were in plots

TABLE 1: Mean, standard deviation, coefficients of variation (standard deviation/mean) and repeatability of daily water intake and milk yield in Trials 1, 2 and 3.

Measurement	Parameter	Trial 1	Trial 2	Trial 3	Combined
Number of animals		8	8	10	26
Duration of trial (d)		7	10	18	
Intake of drinking water (L/cow/d)	Mean	41.3	78.2	60.1	
	Standard deviation	4.5	8.3	7.2	
	Coefficient of variation	0.11	0.11	0.12	0.11
	Repeatability	0.61 ± 0.15	0.46 ± 0.16	0.59 ± 0.12	0.56 ± 0.08
Combined water intake including water content of feed (L/cow/d)	Mean		104.5	110.6	
	Standard deviation		9.4	8.1	
	Coefficient of variation		0.09	0.07	0.08
	Repeatability		0.50 ± 0.16	0.64 ± 0.11	0.60 ± 0.09
Milk yield (L/cow/d)	Mean	19.0	15.9	16.7	
	Standard deviation	1.5	0.7	1.3	
	Coefficient of variation	0.08	0.04	0.08	0.07
	Repeatability	0.83 ± 0.08	0.89 ± 0.06	0.74 ± 0.10	0.84 ± 0.04

next to each other and, to prevent oestrous behaviour during the trial, a CIDR-B device (SVS Veterinary Supplies, Hamilton) was inserted into the vagina of each cow, three days before the water intake measurements began. Each cow had access to her own water trough fed by a 2,000 litre mobile tank. Daily water levels in each trough were measured, and converted into volumes consumed, after adjustment for any change in level in a fenced-off trough, which was used as a control to monitor evaporation or rainfall. Average daily maximum temperature during the seven day recording period was 21°C (range 19 to 24°C). There was rain on two consecutive days across an 18 hour period with 26.4 mm on Day 2 and 5.2 mm on Day 3 (Figure 1a), but none on the other days.

ZnSO₄-heptahydrate was added to the mobile tank, at a concentration of 131 mg elemental Zn/L. Based on an average water intake of 60 L/cow/d, the average dose rate was expected to be 7.9 g elemental Zn/cow/d, or 35 g ZnSO₄·7H₂O equivalent/cow/d. To minimise or eliminate any taste of Zn salts in the water, 0.2 g/L of a commercial masking agent ('Grapple'; Agri-Feeds Ltd) was added to water in the tank.

Trials 2 and 3

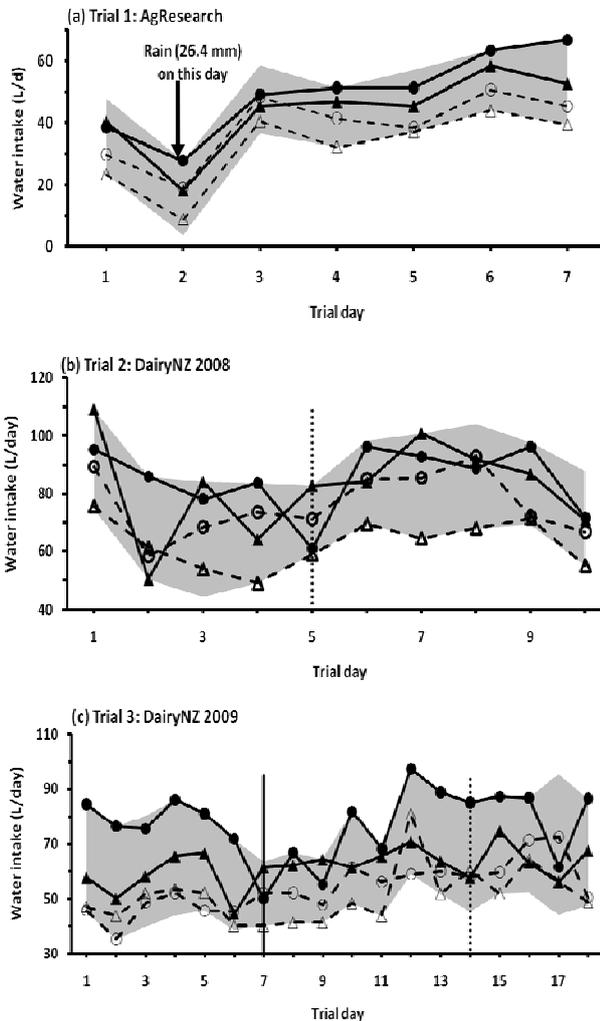
At DairyNZ's Lye Farm, two trials were set up which included monitoring individual daily water intakes of mixed-aged Holstein-Friesian cows. Data reported here are from January 2008, with eight cows recorded over ten days, and with stage of lactation averaging 202 days (Trial 2), and from January/February 2009, with ten cows recorded over 18 days, and with stage of lactation also averaging 202 days (Trial 3). Cow live weights (unfasted) averaged 550 ± 15 kg in Trial 2 and 542 ± 13 kg in

Trial 3. In both trials, ryegrass-dominant pasture was cut and fed to the cows indoors, twice daily *ad libitum* in a Calan gate system. The white clover contents of the summer 2008 and 2009 pastures were 12 and 2% of dry matter, respectively. Dry matter content of the diet was estimated at the time when the feed was offered to the cows. Individual cow net individual daily feed intake was estimated, after daily feed offered was recorded and refusals weighed and recorded. Most cows were pregnant at the time of these trials, and no oestrous synchrony was required. Daily water intakes of individual cows were recorded, with troughs being monitored two to three times a day. At about 7:00 h each day, water was added up to a marked level (60 L) in each trough, after weighing residual water. Where necessary during the day, water was added in 20 L aliquots and the total recorded. Zinc in the water supply was not part of the design of Trials 2 or 3. Individual milk yields were recorded twice daily. Two days in Trial 2 had light rainfall of 0.4 and 1.4 mm. There was no rainfall in Trial 3: Daily dry matter feed intakes and combined water intakes (defined here as including equivalent water from the water content of the feed), were calculated for each animal, following determinations of feed dry matter percentages. Average daily maximum temperatures were 27°C and 26°C for Trials 2 and 3, respectively with ranges of 23 to 29°C for both trials. Relative humidities in Trials 2 and 3 were 65.4 and 83.5%, respectively.

Statistical analyses

Data from each trial consisted of daily water intake/cow, twice-daily milk yields and (in Trials 2 and 3) net daily feed intake/cow and combined water intake/cow. Each variable was analysed fitting

FIGURE 1: Daily water intakes by selected individual cows ranked on mean weekly water intake, in Trials 1 and 2 (1st, 4th, 6th and 8th, out of 8), and Trial 3 (1st, 4th, 7th and 10th, out of 10). The range of daily water intakes are shaded in grey. (Vertical lines show a change by all animals to a new diet).



a mixed model in the SAS JMP (1995) package, to estimate the mean, standard deviation and between-cow repeatability in each trial (on a within-diet treatment basis in Trials 2 and 3: all animals changing to a new diet at the same time). Simple correlations among pairs of variables were also estimated in each trial. Estimates were combined across trials by weighting each estimate by the reciprocal of its sampling variance.

RESULTS

Daily water intake

Table 1 shows the mean, standard deviation, coefficient of variation (standard deviation/mean) and between-cow repeatability of daily water intake from the trough for each trial. Trial means varied considerably (41 to 78 L/cow/d) according to experimental and environmental conditions,

particularly ambient temperature and dry matter content of the feed. No formal comparisons were made across trials. Combined water intake in Trials 2 and 3 had a repeatability of 0.60 ± 0.09 overall (Table 1). On average, the proportion of the combined water intake derived from feed was 25% in Trial 2 and 46% in Trial 3. An example of individual cow variation in water intake is shown in Figure 1a. The eight cows were ranked over the whole week's water intake and the 1st, 4th, 6th and 8th plotted. Similar degrees of variation were found in Trials 2 and 3, as is shown in Figures 1b and 1c. Over the three trials, water intake had a repeatability of 0.56 ± 0.08 , indicating that cow rankings on any one day were often similar to those on any other day. In Trial 1, when 26.4 mm rain fell on Day 2, there was a 62% reduction in mean water intake of 41 L to 16 L. Water intake by all cows was reduced by about the same proportion.

Milk yield and other factors

From yield measurements taken on successive days, daily milk yield had a high repeatability (0.84 ± 0.04 , overall) across all trials (Table 1). Correlations between water intake and milk yield in Trials 1, 2 and 3 were 0.93, 0.71 and -0.14 respectively. Feed had a greater influence on combined water intake in Trial 3 than Trial 2, as almost half of the combined water intake came from water content in the feed. In Trials 2 and 3, correlations between combined water intake and milk yield were 0.78 and -0.01, respectively. The regression slopes of milk yield on water intake from the trough in Trials 1 and 2 were 0.52 ± 0.09 and 0.20 ± 0.03 L milk/L water, respectively (both $P < 0.01$). Live weight was not associated significantly with mean water intake in any of the trials.

DISCUSSION

The main objective in this study was to analyse animal-to-animal variation; trial and treatment means for water intake were secondary to this. Significant cow-to-cow differences were found in daily water intake with 56% of the daily variation in water intake being associated with cow-to-cow differences. From the coefficient of variation of 11.2% in Table 1, the theoretical range in water intake for at least 95% of the animals was $\pm 22.4\%$ of the mean. For example, at a mean water intake of 60 L/d, cows with the lowest water intakes are expected to drink 22.4% (13.4 L/d) less than average. From the standard deviations in Table 1, it can be calculated that the lowest 25% of the herd are likely to drink 14% less than average. With mineral supplementation in trough water, and assuming no animal variation in absorption and requirements of minerals per unit of mineral intake, then 14% of the herd would be receiving insufficient mineral

supplementation. It is important to note that these data were collected in a non-competitive situation where cows were not required to walk far for milking or to drink.

In Trials 1 and 2, greater milk yields were associated with a greater requirement for water. In Trials 2 and 3, some of these differences were also related to feed intake. From the data analysed, no clear explanation was formed in Trial 3 for the lack of association between water intake and milk yield. However, finding an explanation for the cow-to-cow water intake variation in terms of differences in feed intake, milk yield or any other factor does not lessen the farmer's need to allow for water intake variation from cow to cow. As calculated above, 25% of the herd are likely to be, on average, 14% underprotected with any intended mineral supplementation administered via the drinking water, if they are provided according to average water intakes. Some treatment systems such as the 'Peta' Zinc Dispenser (Anon, 1997) have an inbuilt mechanism to adjust for fluctuating day-to-day average volumes of water intake, but the farmer still needs to be aware of cow-to-cow variation. For comparison with the results obtained from our cows eating pasture, Holstein cows in Germany on a roughage plus concentrate diet (Meyer *et al.*, 2004) had a mean water intake of 81.5 ± 19.1 L/d at a mean milk yield of 31.1 L/d. This indicated that, under the conditions evaluated, New Zealand cows eating pasture showed less variation in their daily water intake (11.2% of the mean, when yielding 17.2 L/d) than in Germany (23.4% of the mean, when yielding 31.1 L/d).

Jago *et al.* (2005) have documented the drinking behaviour of grazing cows over 48 h in late lactation in New Zealand, where they have recorded the numbers of drinks per cow, but not the volume drunk by each cow. The present study shows the cow-to-cow variation in volume, indicating the potential impact that this might make to disease protection using mineral supplementation administered via drinking water.

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REFERENCES

- Anon 1997: Water treatment of farm stock (with sodium, magnesium, zinc, trace-elements and anti-bloating agents). Technical Bulletin Number 7. Dominion Salt Ltd., Blenheim, New Zealand. www.peta.co.nz/domsalt.html
- Campbell, I.L.; Munford, R.E. 1957: The daily water consumption of a herd of dairy cattle. *Proceedings of the New Zealand Society of Animal Production* **17**: 25-26.
- Jago, J.G.; Roche, J.R.; Kolver, E.S.; Woolford, M.W. 2005: The drinking behaviour of dairy cows in late lactation. *Proceedings of the New Zealand Society of Animal Production* **65**: 209-214.
- Meyer, U.; Everinghoff, M.; Gädeken, D.; Flachowsky, G. 2004: Investigations on the water intake of lactating dairy cows. *Livestock Production Science* **90**: 117-121.
- SAS. 1995: JMP version 3. SAS Institute Inc., Cary, North Carolina, USA.
- Winchester, C.F.; Morris, M.J. 1956: Water intake rates of cattle. *Journal of Animal Science* **15**: 722-740.