Bowler, L., Longhurst, B. 2020. Using Green Water for yard washing: Case study of a Manawatu Dairy Farm. In: *Nutrient Management in Farmed Landscapes*. (Ed. C.L. Christensen). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 33. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand. 7 pages.

USING GREEN WATER FOR YARD WASHING: CASE STUDY OF A MANAWATU DAIRY FARM

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Abstract

The water used for cleaning holding yards on dairy farms does not have to be of the highest quality. Effluent management systems that reduce the volume of water used will also reduce the amount of effluent generated at the farm dairy. Recycling pond effluent (green water) for washing down holding yards is an option for farmers to consider.

A study was undertaken on green water usage on a 210-cow System 3 dairy farm in the Manawatu over two lactations (2016/17 & 2017/18). Effluent samples were collected from the point of entry onto the holding yard and analysed for solids content, major nutrients and *Escherichia coli.*

Water usage was found to average 30L/cow/day, far below the industry average of 70L/cow/day. Median nutrient concentrations in green water (n=100) of potassium (0.345 kg K/m^3) and phosphorus (0.041 kg P/m^3) were higher than the concentrations typically found for pond effluent (0.290 kg K/m^3 and 0.030 kg P/m^3, respectively) while nitrogen concentrations (0.205 kg N/m^3) were similar (0.190 kg N/m^3). Median *Escherichia coli* populations (n=49) were 4.0E+5 MPN/100 mL, a level within the normal pond effluent range.

Introduction

Water is a valuable natural resource that can no longer be taken for granted. Dairy farms use large volumes of water to achieve high milk production. Clean water is required for stock drinking, cooling milk and cleaning the milking plant. Industry water volumes quoted are 70 litres/cow/day for both stock water and dairy shed usage (DairyNZ, 2012). In general, normal water usage in a herringbone shed consists of 10% for plant washing, 25% for hosing out the bail area and 65% is used to hose the yard (Bowler, 2014). Therefore, by installing a green water yard washing system, daily water use in and around the farm dairy can be slashed by up to 65 per cent

Most Regional Councils now require farmers obtain a resource consent for water abstraction above a certain volume. For example, Horizons One Plan require a resource consent for volumes greater than 30m^3/day (Stewart & Rout, 2007). Therefore, processes that efficiently reduce milk cooling, vat wash and yard hosing can provide significant savings in water usage.

One option for consideration in reducing water usage is to use of green water for cleaning the holding yard. Green water is described as recycled effluent (usually from the storage pond). This practice is used on some farms however little information is known of its characteristics (chemical and microbial) and how these might change throughout a lactation.

Aim

To determine the water usage and effluent characteristics of green water throughout a dairy farm lactation.

Approach

The case study was undertaken on a 210-cow dairy farm near Feilding in the Manawatu over the 2016/17 and 2017/18 seasons. During the lactations effluent samples were collected from the point of entry onto the holding yard weekly. The same effluent pump was used to wash the yard and to irrigate farm dairy effluent (FDE) to land. This pump drew the effluent from near the pond surface and no stirring occurred beforehand.

A total of 100 samples were collected over the two lactation. Each effluent sample was sent to Hill Laboratories, Hamilton for analysis of solids content, major nutrients: (nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca), magnesium (Mg), sodium (Na), and mineral-N.
Microbial populations in the green water were also measured using *Escherichia coli* as the indicator organism and results are reported as Most Probable Number (MPN) per 100 mL.

Results and Discussion

Rainfall

Rainfall was not recorded on site during the study but instead obtained from the Horizon's Regional Council climate station at Makino near Cheltenham, about 5 km from the dairy farm. Annual rainfall was similar between both years with 1067 mm and 1029 mm recorded in 2016/17 and 2017/18, respectively (Dr Amy Lennard, Horizons, pers. comm.).

Chemical characteristics

A summary of the chemical characteristics (n=100) of green water analysed during the 2016/17 and 2017/18 lactations is presented in Table 1.

Table 1: Chemical composition of green water (n=100) during study period.

		2016/17 (n=78)		2017/18 (n=22)		Pond
Parameter	Unit	Median	95% C.I.[1]	Median	95% C.I.[1]	Effluent [2]
pH	pH units	7.50	0.02	7.55	0.06	7.2
Total Solids	g/m^3	2300	117	2135	398	2800
Nitrogen	kg/m^3	0.210	0.009	0.196	0.031	0.190
Phosphorus	kg/m^3	0.042	0.002	0.038	0.006	0.030
Potassium	kg/m^3	0.350	0.022	0.285	0.066	0.290
Calcium	kg/m^3	0.097	0.005	0.091	0.014	0.070
Magnesium	kg/m^3	0.042	0.002	0.039	0.007	0.040
Sodium	kg/m^3	0.051	0.002	0.043	0.006	0.040
Sulphur	kg/m^3	0.017[3]	[3]	[3]	[3]	0.030
Ammoniacal N	g/m^3	139	5	117	19	1300

[1] C.I. = confidence interval

[2] Total Sulphur results reported as < 0.3 kg/m^3 except for one June 2017 sample.
[3] Typical pond concentrations, Longhurst et al, 2017.

Results from Table 1 show that the median values are in close agreement between the two lactations with the possible exception of K. The green water is a K-rich effluent with median values of 0.350 and 0.285 kg K/m^3 for the 2016/17 and 2017/18 lactations, respectively. These K concentrations for green water are similar to the 0.290 kg K/m^3 median value reported for pond effluent (Longhurst et al, 2017). Median P concentrations for green water of 0.042 and 0.038 kg P/m^3 were higher than the median pond effluent concentrations of 030 kg P/m^3 (Longhurst et al, 2017). Median Ca concentrations for green water were also higher than those for pond effluent while median N, Mg and Na concentrations were similar.

Potassium concentrations in green water showed a consistent trend over the two seasons of increasing levels through the lactation until around the end of summer then levels declined rapidly (Figure 1). Nitrogen and P concentrations in green water also increased throughout the lactation in a similar manner but not to the same degree. The likely reason for this being that because less water is being used in yard washing the proportion of urine to water would be greater and most of the K (~90%) is in the urine.

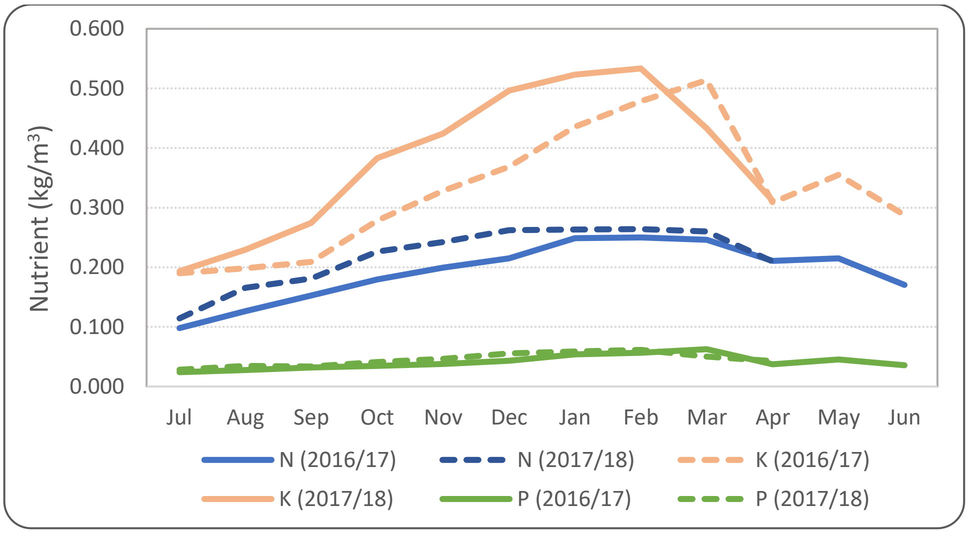

Figure 1: N, P and K concentrations in green water during 2016/17 and 2017/18.

<u>Microbial characteristics</u>

Escherichia coli (E. coli) populations of green water were measured throughout both lactations (n = 31, 2016/17; n = 18, 2017/18) and are presented in Table 2.

Table 2: *Escherichia coli* populations (MPN/100mL) of green water over two lactations (n=49) compared to published effluent pond populations (Donnison et al., 2011).

	Median	Mean	Std. Dev.
Green water			
2016/17 (n=31)	3.70E+5	5.11E+5	4.47E+5
2017/18 (n=18)	4.55E+5	5.87E+5	5.05E+5

Effluent Pond			
Pond storage 1	2.20E+4	7.70E+4	1.10E+5
Pond storage 2	1.40E+5	1.90E+5	1.90E+5

The *E. coli* populations found in green water were of a similar magnitude as those reported for pond effluent by Donnison et al (2011). These authors also noted the high variability within pond effluent *E. coli* populations as shown by the large standard deviations. Plotting the *E. coli* populations of the green water at the study farm over the two lactations illustrates this point (Figure 2).

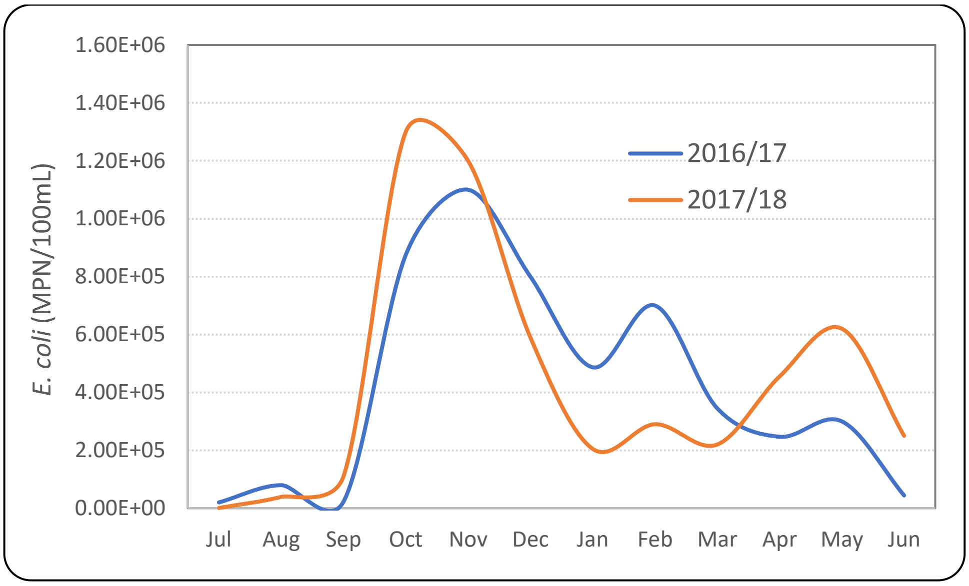

Figure 2: *Escherichia coli* populations in green water over two lactations.

Figure 2 clearly shows a rapid increase in *E. coli* populations to 1.10E+6 and 1.30E+6 during the spring of 2016/17 and 2017/18 respectively, before declining to approximately half these population levels over the summer/autumn period.

MPI (2017) provides design and operational rules for the use of green water yard washing. One such rule requires the use of low pressure and low application heights above ground which reduces the risk of aerosols from the green water. These rules help minimise the health risks to farm staff.

Advantages of using green water system

Water usage

Water usage at this studies' dairy shed using green water averaged 30L/cow/day over the two lactations, this volume is considerably less than the 70L/cow/day industry average. Water usage at the dairy shed, in general, does vary throughout the lactation with late spring likely to be the peak period and winter the lowest, as found by Higham et al (2017), however these authors found no significant difference in water volumes used between milking parlour type (herringbone versus rotary).

Reduced pond storage requirements

The volume of water used in the dairy shed and holding yard has a large impact on pond storage volume requirements. Incorporating a green water system into dairy shed management reduces the water volumes required and has significant flow-on effects with farm management. For example, using this existing 210-cow case study farm, water usage would decrease from 14,700 litres per day to 6,300 litres per day and reduce the effluent pond sizing requirements from 842 m^3 of useable storage (25m x 25m x 3m) to 312 m^3 (20m x 15m x 3m) of useable storage. This equates to a reduction in annual effluent generation (water used, rainfall on the yard and rainfall on the pond surface) from 5.66 million litres to 2.8 million litres.

Reduced farm working expenses

Using a green water system can not only reduce effluent storage requirements but also reduces electricity and labour costs related to land application.

A 15kW effluent pump might pump approximately 4 litres per second (14.4m^3 per hour) to an irrigator. At $0.25/unit of electricity the pump would cost approximately $3 per hour to run. To pump the additional 2,860m^3 of effluent would cost approximately $600. Additional to this could be the reduction in pumping costs of abstracting the water from its source (surface or groundwater take) that may save an additional $400 in electricity.

The big savings come in labour reduction. If hosing the yard took 20 minutes (40 minutes per day) then annually time saved would be 193 hours. At an hourly rate of $25 per hour, $4,825 could be saved a year- or time made available for more productive jobs. Added to this is a reduction in effluent irrigation. If an irrigation run spread 60m^3 of effluent (200m run by 30m width by 10mm application depth) per run, there is a reduction of 48 runs per year, and if a run took on average one hour to set up then an additional labour saving of $1,200 is achieved.

Using the above calculations there could be a labour saving of approximately $6,000 and an electricity saving of approximately $1,000. For some farms that are currently using clean water through under gate washers or flood washers, it might be that their investment in green water use is paid off in two or three years.

Green water options for dairy farms

Reducing the time spent washing holding yards requires an efficient cleaning routine and careful design of wash down systems. The more water used in yard cleaning, the greater the volume of effluent that is produced. This is an important consideration when sourcing water.

A green water system that utilises the backing gate for cleaning is very effective. Cleaning times can be reduced using scrapers and water jets mounted on backing gates. Some options include:

- Using four or five nozzles mounted with a drag chain between each water outlet – as the gate moves the chain breaks up the dung pats and the water flushes the manure away.

- A system with a number of small high pressure jets behind a scraper-like barrier (e.g., dung-buster). This washes the yard as the backing gate moves. It may still be necessary to scrape or hose a narrow wedge of the yard but this amount of time is minimal, i.e., less than a minute.

- Flood wash - high volume, low pressure systems work best.

Dairy Industry rules for green water washing

The main rules that apply to using green water (MPI 2017) are:

- Must be free from sediments and solids
- Can only be applied at low pressure to eliminate any aerosol dispersal
- Can only be applied no higher than 300mm from the yard surface
- Must not be used within 5m of any milk harvesting equipment
- Cannot be used when cows are on the yard
- Farmer must have the ability to wash the yard with clean water (e.g., use of hand-held hose).

Further information on the rules for using green water can be obtained from accredited effluent designers, the dairy milk company or the DairyNZ's website.

Acknowledgements

We wish to thank PGP for funding this project, DairyNZ for their support and Jonathon & Linda Sievwright for making their farm available for the case study.

References

Bowler, L. 2014. Choosing the right effluent system. South Island Dairy Event, pp 10. https://side.org.nz/wp-content/uploads/2014/05/3.6-Choosing-the-right-effluent-system.pdf

DairyNZ 2012. Farm Water Quantity and Quality. FarmFact 5-15. DairyNZ, Hamilton.

Donnison, A., Ross, C., McGowan, A. 2011. *Escherichia coli* and *Campylobacter* in two conventional Waikato dairy farm effluent ponds. New Zealand Journal of Agricultural Research 54: 2, 97-104.

Higham, CD., Horne, D., Singh, R, Kuhn-Sherlock, B., Scarsbrook, MR. 2017. Water use on nonirrigated pasture-based dairy farms: Combining detailed monitoring and modelling to set benchmarks. Journal of Dairy Science 100: 828-840.

Longhurst, B., Rajendram, G., Miller, B., Dexter, M. 2017. Nutrient content of liquid and solid effluents on NZ dairy cow farms. In: *Science and policy: nutrient management challenges for the next generation*. (Eds L. D. Currie and M. J.Hedley). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 30. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand, pp 9.

MPI. 2017. Operational Code: NZCP1 Design and Operation of Farm Dairies. Ministry of Primary Industries, Wellington, pp 76.

Stewart, G., Rout, R. 2007. Reasonable Stock Water Requirements: Guidelines for Resource Consent Applications. Technical report prepared for Horizons Regional Council. Horizons Regional Council, AQUAS Consultants Ltd & Aqualinc Research Ltd, pp 29.