Northern NY Agricultural Development Program
2014 Project Report

Water Quality and Its Impact on Production Parameters on Northern New York Dairy Farms

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Contributing Producers:
91 NNY producers submitted water samples and completed the water quality survey.

- Clinton County (n=12)
- Franklin County (n = 18)
- Essex County (n=1)
- Jefferson County (n = 20)
- Lewis County (n = 22)
- St. Lawrence County (n=18)

Background:
Water is the most important nutrient for dairy cattle (NRC, 2001) and often the most overlooked. It is required for all of life's functions: transport of nutrients to and from cells; digestion and metabolism of nutrients, elimination of waste materials and excess heat from the body, maintenance of proper fluid and ion balance, and provision of a fluid environment for the developing fetus.

Cattle require large volumes of clean water every day and meet their requirement through three sources: drinking water, and water contained in feed and water produced by metabolism of nutrients. It is estimated that 83% of the total water requirement is met by drinking water (Nocek and Braun, 1985). Rules of thumb to estimate a lactating cow's water intake include: 4 to 5 pounds of water intake/pound of dry matter intake (DMI) or 3 pounds of water/pound of milk produced.

In a recent study conducted in Pennsylvania, 26% of water supplies on dairy farms contained at least one component that could reduce milk production. Milk production on these farms averaged 56 pounds/cow, while milk production averaged over 75 pounds/cow on farms that had no water quality issues (Swistock, 2013). Primary anti-quality factors that are known to cause a reduction in water intake or impair metabolic functions include total dissolved solids (TDS), sulfur, sulfate, chloride, nitrate, iron, manganese and fluoride (Beede, 2006).

Drinking water with < 1,000 mg/L TDS is ideal for dairy cattle, with levels of 1,000 to 3,000 satisfactory, >3,000 mg/L can lead to dehydration, reduced water intake and reduced milk production. Sulfate concentrations above 350 mg/L can lead to diarrhea and mineral imbalances in calves. In adult cattle it has been reported that high sulfate drinking water reduced feed intake and milk production in early lactation as well as increased the incidence of retained placenta and abomasal displacement (Beede, 2006).

Iron is the most frequent and most important anti-quality consideration for dairy cattle drinking water. Iron not only decreases the palatability of water, but iron toxicity and oxidative stress caused by the ferrous from of iron that is found in water lead to compromised immune function, thus leading to an increase in fresh cow mastitis, metritis, greater incidences of retained fetal membranes, diarrhea, reduced feed intake, decreased growth rates and impaired milk yield (Beede, 2006).

Increased levels of nitrates in drinking water has been linked to poor reproductive performance; increased number of services per conception, lower first service conception rates and longer calving intervals were observed in a 35 month study testing the influence of nitrates on reproductive efficiencies (Kahler, 1974).

Objectives:

The objectives of this study were to:

1) evaluate water quality on Northern New York (NNY) dairy farms,
2) evaluate how water quality impacts production parameters on NNY dairy farms, and
3) increase awareness on the importance of water quality and quantity availability to dairy cattle in NNY.

Methods:

Survey Development:

A questionnaire was developed to obtain information about farm demographics, DHI herd information and water testing history. The final survey consisted of 14 questions; six farm demographic questions, five DHI questions, and three water testing questions. Surveys were administered at the time of sample collection.

Farm Selection:
Farms had to be located in one of the six counties of NNY (Clinton, Essex, Franklin, Jefferson, Lewis, and St. Lawrence) and on DHI test. Additionally, farms had to be willing to complete the survey and allow farm data to be shared with regional extension staff. All participants are identified in the dataset by a randomly generated farm number to maintain the confidentially of farms, samples and DHI herd data.

Water Sampling:
Water samples were collected between April and August, 2014. Samples were collected in the water sample bottles provided by Dairy One Forage Lab (Ithaca, NY). Samples were collected from the cold water faucet that was closest to the drinking water source to the lactating cattle on farm. The faucet was sterilized by flaming, and cold water was run for a minimum of 3 minutes prior to sample collection. The bottle was rinsed once with the water to be sampled, then filled, the lid was tightened and the sample was placed in a cooler during transportation to the drop off site. Samples were refrigerated prior to pick-up and analysis at the Dairy One Forage Laboratory (Ithaca, NY). Samples were analyzed for total coliform, total dissolved solids, pH, hardness, Ca, P, Mg, K, Na, Fe, Zn, Cu, Mn, Mo, Chlorides, Sulfates and Nitrates.

Statistics:
The GLM, MEANS and Corr procedures of SAS 9.2 (SAS Institute, 2012) were used to analyze differences in survey data. Data was analyzed as a complete set; class variables included herdsize, county, source and treatment.

Herdsize was categorized as < 100 cows (n =34), medium (100 to 499 cows; n = 44), or large (> 500 cows; n = 13). During the analysis "large" was then broken into two groups, 500 – 999 cows (n=7) and >1000 cows (n=6).

County: There was only one sample from Essex County; it was determined to classify the sample as Clinton County for statistical analysis based on watershed location.

Source was where the water originated from: municipal, pond, spring or well.

Treatment was a yes/no variable; did the farm have a water treatment system? This could be a ultra-violet filtration system, nitrate filtration system, hydrogen peroxide system or other. Only 10 farms had some type of treatment system. Significance was declared at $P < 0.05$).

Results:
A total of 91 water samples were collected between April and September, 2014, on NNY dairy farms located in Clinton (n = 13), Franklin (n = 18), Jefferson (n = 20), Lewis (n = 22) and St. Lawrence (n = 18) counties.

Water sources on dairies included municipal (n = 4), pond (n = 3), spring (n = 7), stream (n = 1) and wells (n = 76).

The average herdsize was 297.14 with a range of 35 to 3,000 head. Average daily milk production was 32.00 kg/day (± 5.56) with a range of 15.88 to 46.72 kg/d (Table 1.)

Water quality means and ranges are presented in Table 2. All samples fell within the expected measurements for chlorides, Zn, and Mo (Table 2). Total coliform/100 mL was above the expected value on 30 farms (32.97%; Fig. 1). Magnesium and TDS fell above the expected values on 26 farms (28.57%). Calcium, Mn, and hardness were challenges on 18, 15 and 12 farms. Less than 10 farms had challenges with Fe, N, Na, K, and P, while only one farm was above the expected value for S.

Water Quality Challenges:

- A total of 25 (27.48%) of farms had no water quality challenges
- 29.67% of farms had one water quality challenge
- 15.38% of farms had two water quality challenges
- 9.89% of farms had three water quality challenges
- 9.89% farms had four water quality challenges
- 2.20% of farms had five water quality challenges
- 4.40% of farms had six water quality challenges, and
- 1.10% farms had seven water quality challenges (Fig. 2).

Average daily milk production of the herds within each group was not significantly impacted by the number of water quality variables above expected value. However, there was a 6.45 kg/d/cow numerical difference between the farms with no water quality challenges and the farm with 7 challenges. There was a 2.54 kg/d/cow difference between the farms with no water quality challenges and farms with six quality challenges.

While there were county differences in mean water quality factors (pH, nitrates, hardness, TDS, Ca, Mg and Fe), none of the county means were above the problem threshold (Table 3). The mean Fe concentration for St. Lawrence County was 0.297 ppm, which is extremely close to the problem threshold of 0.3 ppm. St. Lawrence County Fe concentration ranged from 0 – 2.21 ppm, with seven farms above the problem threshold.

The majority (83.55%) of water samples collected originated from a well (Table 4). Water source differences were observed for pH, total coliform count, Fe and Zn. The mean Fe concentration for ponds was 0.34 ppm, which is above the problem threshold. All pond samples in the data set originated in Lewis County and Fe concentration ranged from 0.15 to 0.35 ppm. All other water quality means for water source were below the threshold value.

Ten farms had a water treatment system in place. Nitrates, nitrogen and Zn concentration was greater on farms with a treatment system as compared to farms without a treatment system (Table 5).

Farms with more than 1,000 cows had the greatest concentration of P in the water; however this value was well below the problem threshold (Table 6). Only two farms had P values above the problem threshold (0.25 and 1.29 ppm), these farms had herdsizes above 500 cows.

Farms with 100 cows or more had a greater concentration of Mg as compared to farms with less than 100 cows. All Mg values were below the problem threshold of 125 ppm; however 25 farms across all herdsizes fell above the expected value of 29 ppm (Fig. 1).

Average farm milk production was impacted by specific water quality variables. Farms producing more than 40.82 kg of milk/cow/day had the lowest P concentration (Table 7). While these farms also had the greatest mean Fe concentration it is due to one farm with a Fe concentration of 1.12 ppm, all other farms averaging greater than 40.82 kg of milk/cow/d had Fe concentrations < 0.17 ppm.

Conclusions/Outcomes/Impacts:

The anti-quality water factors that farmers in NNY have the greatest challenges with are total coliform counts, TDS, Mg, Ca, and Mn. These water quality parameters are above the problem threshold on greater than 15% of farms.

Milk production was not impacted (statistically) by total number of anti-quality factors above the problem threshold. However, there was a 6.45 kg/d/cow numerical difference between the farms with no water quality challenges and the farm with 7 challenges. There was a 2.54 kg/d/cow difference between the farms with no water quality challenges and farms with six quality challenges. This information is worrisome as it suggests lost milk production and lost revenue to producers. However, additional farm management practices need to be reviewed prior to determining if the water quality was the primary reason for reduced milk production. Anti-quality factors P and Fe concentration were correlated with milk production.

Farmers that receive a water sample analysis with elevated values should run a second sample to determine there was not a laboratory error. They should then work with the nutritionist to determine is ration changes can/should be made to reduce the risk of lowered performance. If a problem is consistent, water treatment systems should be researched.

Outreach:

To date this research project has reach 161 dairy producers in Northern New York through individual contact; this includes involvement in the management survey, DHI record analysis or participated in the Northern NY Dairy Institute (NNYDI) Reproductive Efficiency course that was utilized as a location to share research results & have discussion on future projects.

- 91 farmer participants
- 20 farmers and 3 industry representatives attended a twilight meeting, Peru, NY that focused on water quality and cover crops.
- 50 NNY dairy farmers and industry representatives attended the NNYDI Reproductive Efficiency workshops that utilized as an outreach opportunity.

Next Steps:

Follow up will continue with producers who submitted water samples and/or attended the NNYDI program to determine the impact of management changes in regards to water quality.

- A follow up research proposal “Do high mineral concentrations in water affect feed digestibility, cow health and performance on Northern New York dairy farms?” has

been funded by NNYADP for research to start April, 2015. The primary goal of this study will be to measure total intake of cation-anion difference (TICAD) on farms with water quality issues and determine the impact their water quality has on TICAD for the close-up dry and lactating cow groups on these farms. In addition, the effect of water quality on the digestion of forages in the rumen will be assessed.

- A second area of research that should be pursued is the impact of water quality on calves & heifers. Water quality (pH and hardness) can impact mix-ability of milk replacers and colostrum replacers. Additionally, anti-quality factors in water may impact calf health and hydration status.

Acknowledgments:
This project would not have been successful without the 91 farmers across Northern NY that allowed us to visit their farms, complete surveys, and share their DHI information.

Reports and/or articles in which results of this project have been published.
A presentation on the results of the study was presented during the 11th Northern New York Dairy Institute Improving Reproductive Efficiency course. All producers in attendance received a copy of the preliminary results.

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APPENDIX

Table 1. Demographics of participating farms.

Variable	N	Mean	Std Dev	Minimum	Maximum
Acres farmed	81	865.346	1108	97	6000
Lactating herd size	91	297.144	507.629	35	3000
Average daily milk production (lbs)	89	70.536	12.2635	35	103
Rolling herd average (lbs)	64	22883	4294	14000	33113