Introduction

Dairy farmers are faced with difficult decisions with respect to water purification solutions for their farms. There are hundreds of products available, all with different price tags and varying degrees of effectiveness. One thing is for certain: no two situations are the same, meaning that source water at one farm is in no-way the same as at another farm. Many important factors must be taken into consideration when water solutions are being discussed. Determining if the well (source) can be upgraded should be the first step. In many cases, however, this is not possible due to location, cost, or the simple fact that the farm in question uses surface water instead. In most cases, the solution is to install a water purification system that is tailored to the specific circumstances surrounding the farm.

Studies have shown that using clean, purified water in farm applications contributes significantly to the bottom-line of the business. Dairy farms, for example, experience significant gains in productivity when clean water is consumed by cows, and used to wash milking equipment. With purified water, cows drink up to 40% more per day, allowing them to yield more milk. On average, a typical dairy farm with 100 cows can expect an increase of 25% milk production when giving cows purified water to drink. Water is the most important nutrient to cattle. It has many health and production effects. There are definite economic gains to providing an unlimited supply of high quality water. Managing water quality should become as important as the feed source and ration planning in a beef cattle management program.¹

There are many products available, and this report aims to educate the dairy farmer on these options so that they may make the best decision for their particular situation.

Water Technologies

Chlorination

This is a relatively inexpensive way of treating water, and it is easy to install. Chlorination will disinfect highly-contaminated water by adding chemicals (namely chlorine) to the water source. Operating the system accurately, however, does pose some major difficulty. Chlorine is a highly corrosive chemical, which must be precisely measured and administered in relation to how much water throughput is passing the filtration system. Water availability is reduced by 10% from the source, meaning that 10% of water is lost during

¹ Agriculture and Agri-Food Canada, Water Quality and Cattle, Importance of Water Quality to Cattle, August 2007.
treatment. Chlorination is only suitable for water sources with very little or no organic content present, and must be used in conjunction with sediment filtration if particles are present in the source.

**Membrane Filtration**

This type of water filtration is easy to operate, with no harsh chemicals to add, and is semi-efficient at removing pathogens from water, while improving taste and smell. Water with a high turbidity level (cloudiness or haziness of water caused by individual particles or suspended solids, invisible to the naked eye), requires other pre-treatment options before the water makes contact with the membrane. Otherwise, solids foul the membrane. Water wastage is above 20%, and membrane filtration is best suited to water with low turbidity level. This method is not very effective when used by itself, and becomes rather costly when combining it with other pre-treatment filtration. Also, membrane filtration is not very efficient, with over 20% of source water being eliminated during treatment.

**UV - Ultraviolet Radiation**

UV water treatment systems have continually proven to be the fastest-acting, most-efficient, lowest-cost technology that successfully removes the highest amount of pathogens and parasites from the water source. This technology is chemical free, meaning that it is the most environmentally friendly of the group. UV systems work by exposing the water source to Ultra Violet light, which serves to quickly and efficiently eliminate harmful characteristics of the water. UV lamps generally last for 1 year, and lamp replacement is a simple, quick procedure, which does NOT require disconnection of the water source. UV systems also take up minimal space, and require very little maintenance. Water should be clear, meaning that solids should already be removed. Combination of a UV system with simple, inexpensive sediment filters is a perfect solution to provide purified water to a farm. Systems are available with flow rates of up to 500 GPM (most applications will require around 100 GPM, depending on how many animals and the size of the farm). Many UV Systems are available with self-monitoring alarm systems, which alert the user when something goes wrong with the system. This is unlikely, as the reliability of UV Systems has been proven from many years of usage, but the peace-of-mind in knowing that you will always be protected is beneficial.

**Coagulation-Flocculation**

This technology is useful for removing solids from turbid water before it's treated by chlorination, membrane filtration, or UV radiation. These types of systems are generally low-maintenance in nature, while removing high levels of pathogens and turbidity from the water source. These systems, however, take up considerable amounts of space, and proves quite difficult to keep calibrated. The coagulant (agent that is added in this process), is quite expensive. About 20% of the water is lost from each batch treated, making this system not very efficient.

**Ozonation**

Ozonation is an interesting approach to water purification solutions. Results from preliminary testing show that ozonation effectively disinfects contaminated water and removes pathogens and organic compounds, in an environmentally friendly way. No water wastage is experienced with this type of purification.
There are many safety concerns, however, with handling ozone, and the system has a much higher capital cost than the more effective and efficient UV radiation systems. Also, if the source water happens to contain traces of bromide, this treatment can unfortunately lead to producing toxic bromate. More work must be done in developing this technology for it to be in any way comparable to alternatives presented in this report.

**Purified Water & Dairy Farmers**

Livestock farmers have long-known that healthy animals are a result of good farm practice and healthy feed. Largely overlooked is the fact that healthy water is a part of the food portion of this equation, and has a huge impact on the health of farm animals. Obviously, if you feed people clean, good tasting, healthy water, they will prefer it over non-treated, stale,groundwater. The same goes for animals. Studies have shown that farm animals (in this case, cows), tend to drink up to 40% more water per day when the source is treated, and free from bacterial pathogens that cause illness and bad taste and smell. These animals then, in turn, produce substantially more milk because of this increased water intake. Also, all bacteria and disease that was present in the water before treatment is now non-existent, meaning the animals live much healthier. Costly veterinary bills are reduced because of healthier livestock, and the number of animals can also be reduced, to meet the same production, because of the increased milk being made from each animal.

The most common problems with farm surface water in Canada are: bacteria, viruses, parasites, sulphates, and dissolved solids. Problems associated with groundwater are: sulphates, dissolved solids, nitrates, iron, and manganese. Both types of water suffer from undesirable taste and odour, wrong temperature (usually too hot), and unfavourable pH/alkalinity levels. Water is just as important as feed to the production of dairy cows. Providing clean water to cattle is the single most effective way in ensuring good quality milk, free from disease. The intake of water is the single largest ingestion of cows. Water intake is also directly related to levels of milk production.

> “Water as an essential nutrient is second only to oxygen in importance to sustain life and optimize growth, lactation and reproduction of dairy cattle. The water requirement per unit of body mass of a high-producing dairy cow is greater than that of any other land-based mammal.”

> Water is the single most important essential nutrient supplied to dairy cattle.

> Water quality and provision of water is often not optimal to maximize animal performance and health.

> Water quality, presence of bacteria and parasites, as well as taste and odour all affect water intake.

> Water testing is essential to evaluate water quality, and should be done at least once a year. Ask a laboratory for a “Livestock Suitability” analysis.

2 Agriculture and Agri-Food Canada, Water Quality and Cattle, Importance of Water Quality to Cattle, August 2007.

3 Quote: Dr. David Beede, PhD, Michigan State University, Evaluation of Water Quality and Nutrition for Dairy Cattle, November 2008.
<table>
<thead>
<tr>
<th>Air Temperature</th>
<th>Water Required (water / kg dry feed intake)</th>
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<tbody>
<tr>
<td>&gt; 35 °C</td>
<td>8 - 15 L / kg</td>
</tr>
<tr>
<td>25 - 35 °C</td>
<td>4 - 10 L / kg</td>
</tr>
<tr>
<td>15 - 25 °C</td>
<td>3 - 5 L / kg</td>
</tr>
<tr>
<td>-5 - 15 °C</td>
<td>2 - 4 L / kg</td>
</tr>
<tr>
<td>&lt;-5 °C</td>
<td>2 - 3 L / kg</td>
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It is important to note that bacteria and parasites are not the only things present in source water that can reduce farm performance and make animals ill. Naturally occurring metals and chemicals, as well as man-made pesticides will have detrimental effects on production and health. The following is a partial list of chemicals and pesticides that are commonly found in farm water sources throughout North America:

**Naturally Occurring**
- aluminum
- arsenic
- boron
- cadmium
- chromium
- cobalt
- copper
- fluorine
- lead
- manganese
- mercury
- nickel
- radionuclides
- selenium
- vanadium
- zinc
- salinity
- toxic algae

**Pesticides**
- aldrin
- chlordane
- carbamate
- DDT
- dieldrin
- endrin
- heptachlor
- epoxide
- lindane
- methoxychlor

**Dairy Farm Water in Reality**

Jennifer Swim, of J.E. Swim Dairy Consulting Inc of Cambridge City, Indiana, has been working as a dairy nutrition consultant for more than 30 years. She has been helping dairy farmers around the world in troubleshooting their specific farm problems, and developing solutions. She explains how she recently encountered a heard that was really struggling, and no one could explain why. The owners had built a new barn and installed new waterers in good locations. She goes on to explain, that to her surprise, dry-matter intake was excellent, and the feedstuffs were good quality, and the overall ration was well-balanced and efficiently delivered. Milk production, however was lagging. The cows were in poor body condition, hair coats were rough, and the heard had a whole host of metabolic disease problems. Mrs. Swim goes on to explain that she has always thought of water as just “being there.” She admits that she had never given it much consideration, unless baby calves or children on the farm would suddenly fall ill (because they are the first to succumb to bacterial or parasitic water contamination).

Finally, the farms water was tested. To everyone’s surprise, extremely high levels of iron were found. While iron itself poses little concern to the animals, the presence of iron was feeding iron-consuming bacteria that were contaminating the water and suppressing drinking behaviour. A water purification system was installed, and the turn-around was almost instantaneous. Cows started gaining weight, and milk production increased practically overnight. Mrs. Swim strongly believes that this farm is still in business today solely because their water quality issue was addressed.

“I advise all of my clients to develop and implement a regular water cleaning protocol. When diagnosing problem herds, I recommend screening water sources for iron, sulfur, hardness, pH, total dissolved solids and sodium. My most successful herds are the ones managed by individuals who pay excellent attention to their water quality. I would personally drink from the water troughs on those well-managed farms.”

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4 Quote: Jennifer Swim, J.E. Swim Dairy Consulting Inc., Cambridge City, Indiana, USA.
A group of farmers in Nova Scotia, Canada, have water supplied to their barn that's good enough to drink. The Canada-Nova Scotia Water Supply Expansion Program is partly responsible for this. The goal here was to identify options for managing and treating surface water used for both livestock watering and equipment sanitizing on dairy farms. This is especially important now because as of August 2006, any water used to clean milk-contact surfaces and equipment on dairy farms must meet the same potability standards as drinking water. The reason is to reduce e-coli and bacteria levels to zero. The results on this farm are increased milk production and healthier cows. The owners stated that they are very pleased, and even though they had to spend money to install the system initially, the increased production on their farm is well worth the investment in clean water.

Conclusion

There are many forms of water treatment systems available to the dairy farmer today. This report discussed some of the most common solutions offered. All systems aim at purifying water such that all parasites, bacteria, and pathogens are removed. They all have advantages, and some work better than others. We know that no two dairy farms are exactly alike. Apart from regular differences, the water source quality most certainly is not the same. Water quality tests should be conducted on a regular basis, and is recommended at minimum once per year. The only way to know for certain which system is right for each circumstance is through analysis of water quality test results.

Of all the systems included in this report, a simple two-step system including regular sediment filtration and UV disinfection, shows to be the best solution for the widest range of water source types. UV disinfection is the most effective at removing harmful pathogens and bacterial parasites from water, and does so in a cost effective manner. A simple, cheap, sediment filtration unit should be installed before the UV unit to remove any suspended solids that may be present in the source water.

UV disinfection units are available in endless configurations, with capability of extremely high flow rates. One benefit is that UV technology can be combined with any other type of pre-filtration, so depending on what else is present in the water source, a UV system can be installed in series on the water line. For example, if the water source is heavily contaminated with arsenic and iron, for example, a specified arsenic and iron system is installed first in the line, and then a UV system right behind it. Because of this flexibility, UV disinfection is the most widely used water purification solution for today's successful dairy farms.

Check out JTS Global Associates on the world wide web for more information on agricultural water purification systems, and dairy farmer specific documentation.
References:


Visit www.jtsglobal.com for more relevant resources.