Water Quality Requirements For Saskatchewan's Agri-Food Industry

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PFRA commissioned a report with the above title. I wrote the report in collaboration with PFRA. Strategic funding was provided by the Canada-Saskatchewan Agri-Food Innovation Fund (Canada-Saskatchewan) and WateResearch Corp. The report has been reviewed by provincial and federal government agencies, universities as well as industry across Western Canada. Typical ground and surface water quality occurring in rural Saskatchewan was compared with the water quality requirements for Saskatchewan's agricultural sector. Similar agricultural sectors were grouped together. The following is a list of the different groups for which water quality requirements were addressed:

- Livestock
- Irrigation
- Micro-irrigation for horticultural applications
- Chemical mixing
- Industrial processing of agricultural products
- Domestic uses

Livestock

The unique aspects of each of these groups were addressed. Livestock industry water quality problems can be both of a health concern and of a delivery concern, where restricted flow nozzles may clog because of microbial growth, chemical precipitation or particle trapping. There is no consensus as to what level of microbial contamination is acceptable in livestock water supplies; nor is there conclusive information on effects of poor quality water on livestock performance. The present options when dealing with water quality problems in the livestock sector are quite limited. For example, producers facing microbial problems can disinfect and/or filter the water and excess sodium in the water can be offset by adjusting the sodium level in the feed. There is a need to provide better information in a comprehensive fashion so that livestock producers can optimize their operations.

Irrigation

Irrigation was divided into two sections: standard irrigation (center pivot, large nozzle type systems) and micro-irrigation (trickle and drip irrigation mainly using low volume, small nozzle type systems). For micro-irrigation, water quality concerns include effects on plants as well as nozzle (emitter) clogging problems. Standard irrigation is largely concerned with effects of water quality on plants and soil. Water quality effects on plants include total soluble salt content (salinity hazard), relative proportion of sodium, alkalinity effects (carbonate, bicarbonate, calcium and magnesium concentrations), concentration of toxic elements (sodium, chloride and boron in particular), excessive nutrients (yield and quality problems), unsightly deposits (reduced marketability), and excessive corrosion of equipment.

When dealing with effluent irrigation, some additional criteria must be addressed. Effluent suitability depends on the concentration of compounds that may become toxic, such as sodium, boron, nickel, cadmium. In addition, there is potential for nutrients to accumulate in the soil. This area has been extensively researched, although it appears that nutrient/toxic effects of different compounds (for example boron) may require assessment on a species-specific basis. Most Saskatchewan surface water sources are suitable for centre-pivot irrigation if soil conditions permit, but many Saskatchewan groundwater supplies are too saline for this purpose.

Micro-irrigation for horticultural purposes

The water required for micro-irrigation applications (most horticultural applications fall under this category) must be of a considerably higher quality than what is required for standard irrigation applications (centre-pivot systems). In micro-irrigation applications, the small size of the nozzles (emitters) facilitates precipitation of chemicals, trapping of particles, or growth of organisms in the orifices. Therefore, clogging of nozzles is a major concern to micro-irrigation applications. Many characteristics of both surface and ground water sources in Saskatchewan increase the probability of plugging; both inorganic and organic compounds can cause clogging, and thus must be removed.

Treatment of water is generally recommended only as a last resort for horticulture; when such expensive treatment as reverse osmosis is used, there is a great need for pre-treatment of the water. Research and development into treatment of micro-irrigation water is called for as this could be a growth industry for Saskatchewan producers.

Chemical mixing (mainly pesticides)

The quality of the water used as a carrier for pesticides (i.e., chemical mixing) can affect the efficacy (effectiveness) of the pesticides. Specific ions (calcium, magnesium) will decrease performance of a number of pesticides including glyphosate and 2,4-D amine. Sodium bicarbonate may also decrease the effectiveness of several pesticides including tralkoxydim, sethoxydim, and clethodim (Achieve, Poast, Select) and 2,4-D. Liquid ammonium sulphate fertilizer (and some other nitrogen fertilizers, such as urea) can alleviate some of the negative effects of calcium, magnesium, and sodium bicarbonate on pesticide efficacy. High pH levels can inactivate some pesticides (organophosphate compounds).

There is an urgent need to systematically research how pesticide efficacy is altered when they are used with natural water sources high in inorganic material. Saskatchewan surface and ground waters commonly also contain high levels of dissolved organic matter, which may also modify the efficacy of pesticides. Traditional methods used by agriculture researchers (visual field effects) to study pesticide efficacy may not be suitable to evaluate the quality of water; it will be necessary to develop improved evaluation methods. If efficacy is increased by using water of suitable quality then crop protection will be improved possibly to the extent that less pesticide could be applied. Increased chemical optimization would also result in environmental benefits and a more competitive farming product.

Industrial processing of agricultural products

Food and non-food processing industries have a wide scope of acceptable water quality requirements, which range from poor water to ultra-pure water. Industries that produce water for consumption (breweries, soft drinks, and bottled water) require high quality water with specific characteristics. For example, in the manufacture of beer, precipitation of bicarbonates can occur when phosphate-rich malt is used. Taste, odour and colour must also be controlled.

In order to locate food and non-food processing industries in rural Saskatchewan, existing municipally treated water will likely require polishing treatment, including removal of fouling compounds (particulate and dissolved organics), scaling compounds (calcium, magnesium, silicates and carbonates), and some other compounds (such as iron and manganese). Interestingly, some of the highest water quality needs are required for industrial use, such as boilers and other equipment, which need very pure water in order to function properly.

The issue of microorganism removal from the water has not yet become critical, although it is anticipated that this will occur during the next several years. Water requirements of the food and non-food processing industries are intimately linked with effluent disposal. In some jurisdictions, processors must pay close attention to the amount of effluents produced (quantity of both water and organic load); attention to these details can reduce costs and it can dramatically lower the environmental impact of effluents released. Assisting companies in evaluating effective water reduction techniques and developing water optimization strategies are essential steps in decreasing water consumption as well as reducing effluent releases.

Domestic uses

Guidelines (not covered by law) and standards (enshrined in law) are used to guide water users and consumers on the suitability of distributed water for human consumption. Both the U.S. and Europe have drinking water quality standards, while Canada and Saskatchewan have only guidelines. In addition, the European and U.S. standards are often more stringent than the Canadian guidelines, which are based on negotiations between federal and provincial agencies. In most developed countries, federal agencies are ultimately responsible for the provision of safe drinking water (for example the U.S.). In Europe, all countries must abide by European Community Standards, which makes drinking water quality uniform across many countries. In contrast, Canada has taken the opposite approach. In Canada, the provision of safe drinking water rests with provincial agencies. Federal agencies can only give advice. Even provinces with small population bases, such as Saskatchewan, are therefore expected to maintain expertise capable of dealing with complicated drinking water issues.

A large number of Saskatchewan untreated ground water and surface water sources exceed standards/guidelines for many compounds. It is essential to support research and development that will provide effective and sustainable treatment solutions for poor quality surface and ground water sources so that it can become palatable and safe. In order to address these issues in a systematic fashion, it is necessary to evaluate different treatment techniques for their suitability to solve specific water quality issues that are of concern in Saskatchewan.

The emerging issues for the agricultural sector include removal of particles, inorganic ions, fouling components, microbes and microbial by-products. The processes required to remove problem compounds and microorganisms must be established. Saskatchewan surface and ground waters contain problem compounds for most water uses, but linkages between water quality and impairment of process or product have often not been established. It is no longer sufficient to define suitability of a water source through an analysis of total coliforms and nitrates. A water needs to be defined in terms of its content of dissolved inorganic and organic matter (which among other things can colour the water and foul membranes), its content of particulate matter (which includes microbes) and it is only following these assessments that optimum treatment solutions for a particular water use can be designed. ■