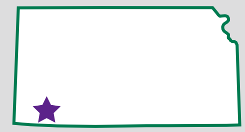
KANSAS DAIRY INGREDIENTS

1010 East 10th Street, Hugoton, KS 67951
NAICS: 31151 Dairy Product (Except Frozen) Manufacturing
EPA Region 7

Company background

Established in 2012, Kansas Diary Ingredients, or KDI, is a world leader in manufacturing and marketing ultra-filtered concentrated dairy ingredients found in many products at grocery stores. KDI has around 160 employees and is headquartered in Overland Park, Kansas. Its products are manufactured in Hugoton, Kansas, at its 30,000 square-foot manufacturing plant and new 90,000 square-foot cheese plant.



Incentives to change

KDI is committed to protecting the environment and has won awards from the U.S. Environmental Protection Agency and the Kansas Department of Health and Environment in recent years for its actions. The company has constructed an irrigation pond to reduce well water usage, changed truck routes for significant emission reductions and altered chemical purchasing practices to reduce toxic chemical waste [1-4]. This commitment continues with its goals for 2025, which aim to reduce domestic water usage by 50%, greenhouse gas, or GHG, emissions by 15%, and solid waste sent to landfill by 50%.

PROJECTS

Water is a valuable resource, made especially scarce in western Kansas during droughts in recent years. In recognition of that, KDI has implemented several projects to reuse water within its processes. Before the new cheese plant expansion, all milk was processed by KDI's milk manufacturing process to reduce the water weight of dairy products before shipment. This was accomplished by implementing ultrafiltration, which uses membranes to separate milk into ultra-filtered milk, or UF milk, and a mixture of lactose, water and minerals known as milk water. Lactose is then extracted from milk water to produce ultra-filtered permeate, or UFP, for animal feed through a reverse osmosis polish, and the remaining mixture is treated with ultraviolet light to produce a quality of water that is safe to drink. This byproduct water will be referred to as potable water. See Figure 1 for a visual comparison of UF milk, UF permeate and potable water pictured from left to right.

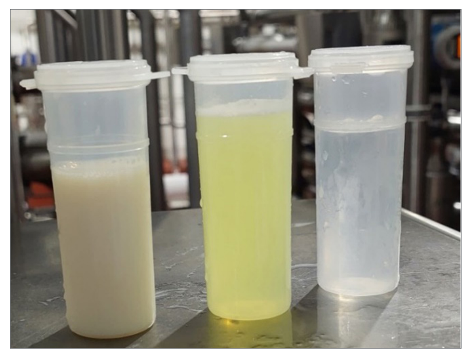


Figure 1 - Vial Comparison

After the cheese plant expansion, milk still undergoes the milk manufacturing process but most milk is now reserved for the cheese manufacturing process. During this process, milk is pasteurized and curdled, but cheese curds must be separated from a mixture of whey protein and milk water that will be referred to as whey. Separation is accomplished by wash tables that drain whey from cheese curds and rinse them with water to ensure whey proteins are separated from cheese and obtain a

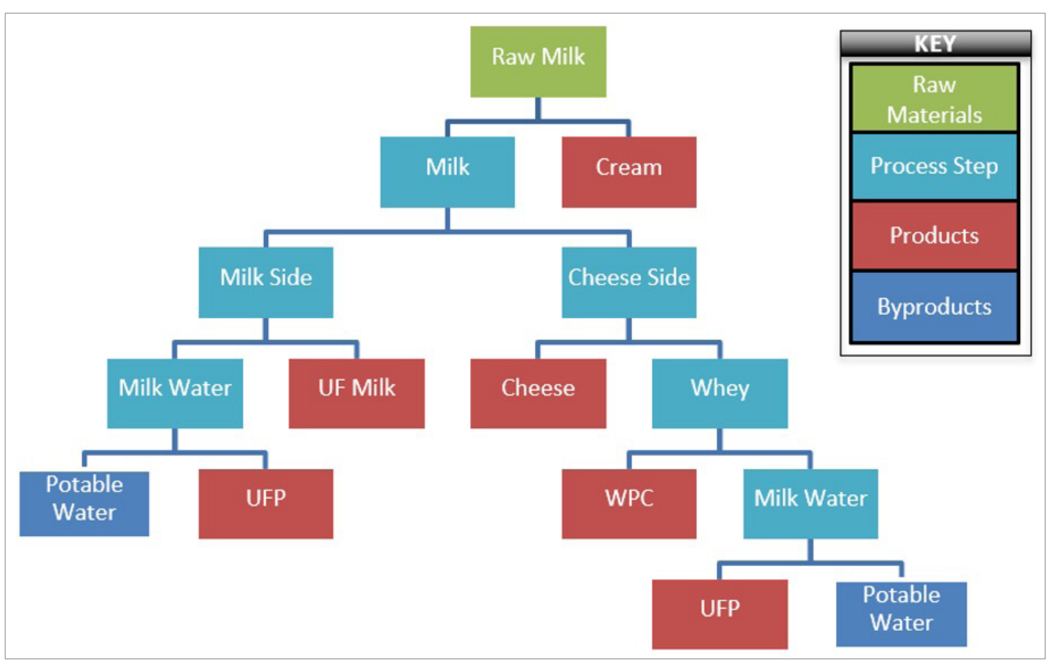


Figure 2 - KDI's Daily Process Tree

better-tasting product. Once whey is fully separated from cheese curds, it undergoes a process similar to that of milk water. The results are a product called whey protein content, or WPC, UFP and potable water. See Figure 2 for a visual representation of KDI's daily process.

It is important to note that potable water obtained from the cheese side is a combination of recovered potable water and additional potable water extracted from the new cheese side. Potable water from both milk and cheese sides is stored and, eventually, used to clean in place (CIP) on the milk side. After being used for cleaning, the water is recollected in drains and diverted for treatment before being sent to KDI's irrigation pond. Water treated to be sent to the irrigation pond will be referred to as crop water. See Figure 3 for a depiction of crop water stored in KDI's irrigation pond.

Figure 3 - KDI's Irrigation Pond

Project 1: Cheese plant water recovery

Stored potable water is used in the cheese plant process and recovered, which eliminates city water usage. To determine environmental benefit, one must obtain the amount of potable water used to accomplish the cheese plant process in a year. KDI's current environmental benefit is 351,000 gallons of city water conserved per year, with a potential of 675,000 gallons.

The economic savings of this project come from water bill savings. To determine economic savings, one must obtain the price rate for city water usage and the reduced gallons of city water used per year. KDI is charged an average of $1.46/1,000 gallons based on their previous water bill and 351,000 gallons of city water are conserved per year based on current operations, so economic savings are $512/year, with a potential for $985/year. Equipment was purchased and installed to connect the preexisting potable water storage tank to the cheese side and transport obtained potable water, including recovered potable water, from the cheese side back to the potable water storage tank. These costs accumulated to $1,325,000.

Project 2: Cleaning project expansion

Stored potable water is also used for CIP on the milk side, so the additional potable water from the cheese side reduces city water usage to complete this task. To determine environmental benefit, one must obtain the amount of additional potable water based on the current intake of milk for the cheese manufacturing process. Figure 2 serves as a guide to accomplishing this calculation. Based on current daily intake of milk by the cheese plant, 105,987 gallons of city water are conserved per day, so 38,155,190 gallons of city water are conserved per year based on 360 days of operation.

The economic savings of expanding upon this project come from water bill savings. Based on 38,155,190.64 gallons of conserved city water and $1.46/1,000 gallons, annual savings are $55,707 for this project expansion. The purchase of a fines saver along with another ultrafiltration system, reverse osmosis polisher, and ultraviolet light was required to process whey into additional potable water. These costs accumulated to $3,350,000.

Project 3: Irrigating project expansion

After being used for cleaning, potable water becomes crop water to irrigate crops. KDI approaches a circular economy by integrating crop water into the irrigation supply of crops purchased by local dairies. Currently, most economies are structured linearly or for reuse, but both produce waste in the end. Circular economies are structured to use raw materials to manufacture products and, eventually, recycle used products back into the raw materials used for the same manufacturing process. Ideally, this cycle would repeat endlessly without producing waste. The circular cycle that KDI contributes to is depicted by Figure 3. This cycle is not 100% efficient because most materials escape the cycle in the form of a product or through loss, but approaching a circular economy is beneficial to our environment because these economies reduce the limited resources ending in waste.

Additional crop water derived from the additional potable water from the cheese side reduces well water usage to complete the task of irrigation. To determine environmental benefit, one must obtain the amount of well water conserved, which is equal to the additional crop water. The loss from converting potable water used for cleaning into crop water is assumed to be negligible, so 38,155,190 gallons of well water are also conserved.
There are no economic savings associated with reduced water usage for expanding upon this project, since KDI is not

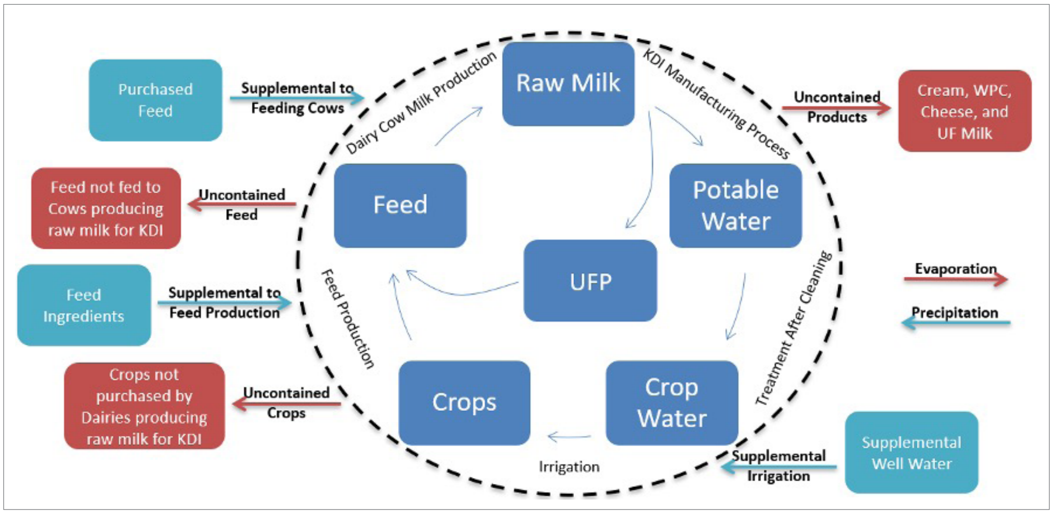


Figure 4 - Circular Cycle

financially responsible for the farmers' well water usage. Due to this working relationship, KDI is able to approach a circular economy by ensuring some crops grown by their extracted waters are kept within the cycle to feed cows and so on. KDI invested in converting an anaerobic digestor tank into a sequence and batch reactor so crop water can maintain the quality and composition beneficial to crops. This cost accumulated to $1,056,000.

RESULTS

The Ogallala Aquifer contributed to the development of an agricultural-based economy in regions above it, but irrigation practices have drained the Ogallala Aquifer faster than it can be replenished according to the U.S. Department of Agriculture [5]. City and well water both draw from the Ogallala Aquifer, so conserving these waters is vital to the continuance of the economy in these regions and to the community's ability to access clean drinking water. In addition, GHG emissions are reduced by water conservation because getting water from the Ogallala Aquifer to drinking water for cities requires energy generation. Furthermore, conservation can be accomplished by embracing circular economies which avoid wasting limited resources by recycling them for continuous use in the same process. All of these water reuse actions have resulted in significant water conservation, protecting the environment and promoting public health through water conservation. With a total cost of $5,731,000 and total economic savings of $56,219/year associated with these projects as shown by Table 1, the simple payback period is 102 years. The additional savings once the cheese plant is operating at full capacity will reduce this long simple payback period, and additional revenue from cheese, WPC and additional UFP products will contribute to reaching a more timely return on investment.

TABLE 1 - SUMMARY TABLE

Project	*Annual estimated environmental impact (gal)	**GHG reductions ($MTCO_2e$)	Estimated cost savings ($/year)	Estimated project costs($)
Project 1	351,000	2.27	512	1,325,000
Project 2	38,155,190.13	246.55	55,707	3,350,000
Project 3	38,155,190.13	***37.07	None	1,056,000
Total	**76,661,380.26 gal**	**248.82 $MTCO_2e$**	**$56,219/year**	**$5,731,000**

*Conserved water is the only environmental impact in consideration for these projects

**GHG Reductions estimated by P2 GHG Calculator [6] based on eliminated energy consumption of pumping, treatment, and transport of water in KS [7]. Does NOT account for added GHG Emissions from newly installed pumps within facilities due to projects.

***GHG Calculator assumptions are not valid for irrigation application of well water, instead, 923 kWh/mil gal [8] was used and GHG Calculator converted conserved energy to GHG Reductions.

SOURCES

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[3] "Kansas Dairy Ingredients Facility - 2019 P2 Awardee," Updated 2022, EPA in Kansas, EPA. https://www.epa.gov/ks/kansas-dairy-ingredients-facility-2019-p2-awardee.

[4] "Kansas Dairy Ingredients in Hugoton, Kansas, Receives EPA Region 7 Pollution Prevention Award," 2021, Region 7, EPA. https://www.epa.gov/newsreleases/kansas-dairy-ingredients-hugoton-kansas-receives-epa-region-7-pollution-prevention.

[5] Dobrowolski, James, 2021, "NIFA Impacts: Saving the Ogallala Aquifer, Supporting Farmers," US Department of Agriculture. https://www.usda.gov.

[6] P2 Greenhouse Gas Calculator. https://www.epa.gov/p2/pollution-prevention-tools-and-calculators.

[7] "Pollution Prevention Greenhouse Gas (GHG) Calculator Guidance," 2014, Pollution Prevention (P2), EPA. https://www.epa.gov/p2/guidance-pollution-prevention-ghg-calculator.

[8] EPRI & Water Research Foundation, "Electricity Use and Management in the Municipal Water Supply and Wastewater Industries," November 2013. https://www.sciencetheearth.com/uploads/2/4/6/5/ 24658156/electricity_use_and_management_in_the_municipal_water_supply_and_wastewater_industries.pdf.