Interreg
EUROPEAN UNION
2 Seas Mers Zeeën
FRESH4Cs
European Regional Development Fund

Water exchange between industry and agriculture at Lamb Weston Meijer, Kruiningen, The Netherlands

Authors: Mariska van Dalen (Lamb Weston Meijer); Bastiaan Notebaert (VITO)

Date: 31/03/2023

FRESH4Cs has received funding from the Interreg 2 Seas program 2014-2020 co-funded by the European Regional Development Fund under subsidy contract No 2S06-028.

Table of contents

Executive Summary

Lamb Weston / Meijer (LWM) operates a factory in Kruiningen (Province Zeeland, NL) to process potatoes. In this demo a feasibility study was made that examines the potential of using LWM effluent as a water resource by local farmers during drought periods. A first focus is on water quality:

- what is the current effluent water quality
- which quality is needed by the farmers
- which quality is needed for regulations for storage and transport (through ditches) of the water
- which improvements in the production processes and the water treatment can be made to improve the quality

Water quality is mainly a concern for water storage (underground storage in *CRI*[1]) or transport through ditches. Main substances of concern are phosphorous and salinity. For phosphorous a number of measures are proposed that decrease the total P content of the effluent. For salinity no economically feasible technology could be selected to decrease it enough, which means the effluent does not meet the regulatory requirements for infiltration in a CRI system. Water storage should thus happen in another way.

A second part of the feasibility study focuses on the practical non-technological aspects of water exchange: cooperation forms, business cases, regulations. Based on the water quality underground storage in a CRI is not possible, meaning that a pipeline or transport through (existing) ditches are necessary to exchange the water. This also has an influence on the business case. It is important that all relevant stakeholders are involved in this process to reach an integral value and take into accounts everybody's needs. The regulatory framework is also a main barrier, and should be adapted with such an integral value as main objective to allow water exchange in an economical feasible way.

[1] So called *creek ridge infiltration*, in which water is infiltrated in a sandy phreatic aquifer in the polders

Introduction

Lamb Weston / Meijer (LWM) operates a factory in Kruiningen (Province Zeeland, NL) to process potatoes. We yearly use about 1,5 million m^3 of Biesbosch Water delivered by water company Evides in our processes to turn a potato into a Lamb Weston fry or dried potato product.

Water reduction is one of our key objectives in our Sustainability Program. One of our ambitions is to reuse cleaned process water both internally and externally. Evides has invested in an ultrafiltration system (Innowater) which has been operational since 2020. However, despite this, we still need to discharge cleaned process water to the sea via the Westerschelde estuary.

During this demonstration, we conducted a feasibility study on the investments and permits required to reuse all the process water from our future new production line (starting from November 2023) for fries, either locally by farmers or internally at a rate of 100 m^3 per hour.

Technical aspects of the demo

Demo setup

By monitoring the quality of the effluent water from our processes for critical parameters that affect discharge in local ditches and use for irrigating crops for farmers, we gain insight into the water's usability. Since we process potatoes throughout the year, it is important to evaluate the entire cycle to have a comprehensive understanding of the water quality.

Obtaining a permit from the waterboard is necessary to send the water to farmers through waterways such as ditches. During the application process, we will establish the key criteria and requirements to select the appropriate technologies to comply with regulations.

The final step is to identify the most optimal method for transporting the water to external and internal users, ensuring that the water is reused within a circular system. We are also exploring the possibility of using creek ridge infiltration[2] for storing our effluent water.

Technical performance

During the monitoring of the current effluent quality, we have observed that the phosphate requirement of 2 mg/l total P is never met. However, the total nitrogen (N) content is within the requirements for discharging to the ditch for 45% of the time. The average electrical conductivity (EC) level, which are a measure for salt levels, is 780 mg/liter, while the EC in the local ditch exceeds 800 mg/l.

Prevention of P in the water

1. To lower the phosphates at the source, we have worked on three optimizations: Optimizing the efficiency of the white starch installation from 60% to 95%. The efficiency directly influences the phosphate load, as phosphate is organically bound to starch.
2. Optimizing grey starch removal directly at the blancher, pending successful results from our pilot in our Innovation Centre (which is not part of this study). This generates a closed water

[2] More info on this nature based technology can be found in the dissemination file of the Braakman Zuid case

loop and higher recovery of grey starch and nutrients (including phosphates). Currently, grey starch is settled and dewatered at the WWTP, which directly influences the phosphate load.

3. Optimizing the usage of SAPP (Sodium Acid Pyrophosphate) in the production area. By optimizing the SAPP usage based on cut size, line rate, battered product, etc., the surplus of SAPP from the SAPP installation will decrease to a minimum. The long-term solution is the re-use of the remaining SAPP surplus (feasibility study of process engineering, not part of this study). In the meantime, adding the SAPP surplus to cattle feed is a temporary solution

Recover P and N

- To lower the phosphates during the process water treatment installation, we will replace our existing batch struvite installation (one of the first installations in the Netherlands) with the newest technology in a continuous process.
- To lower the nitrate, in the existing situation we use aerobic and anoxic bacteria. For the new production line, we have selected a Membrane Bio Reactor (MBR) which has aerated and non-aerated zones.

Infrastructure and storage

Due to the low salt level (< 200 mg/liter EC) in the *creek ridge* aquifer, it is not feasible to infiltrate our effluent water into the creek ridge as a storage step for use of the water as irrigation water by farmers. When designing circular water models, it is important to maintain high water quality and avoid downcycling of water. As a result, we have explored options to deliver the water through waterways (existing ditches) or pipelines directly to farmers who are interested in using our effluent water.
We have defined three scenarios based on the proximity of farmers who are interested in using our effluent water. These scenarios involve investments in establishing pipelines and adjusting water levels in ditches around the farmland during dry periods. The estimated investment required for these scenarios is approximately 900,000 euros. Careful consideration of infrastructure requirements, water availability, and regulatory compliance is essential in determining the feasibility and cost-effectiveness of these scenarios for utilizing effluent water for agricultural irrigation.

Lessons learned

- Water quality measurements are crucial to gain insights into local water quality and historical traces. During our project the PFAS problem emerged in our region. We conducted measurements of our own effluent water and found that PFAS levels were below detectable limits. We identified traces of pesticides in our effluent, including remnants of past pesticide that originate from washing the potatoes.
- The need for water is depending on a lack of rainwater you need to design a hybrid system. Make sure you can reuse the water the whole year. We can wash the potatoes with the internal/external; mix it for the right purpose (cascade)
- The water demand is influenced by rainfall patterns, necessitating the design of a hybrid system that allows for year-round water reuse. This can be achieved through internal/external mixing and cascading of water for various purposes, such as potato washing.
- Creek ridge infiltration was not a viable option for us, because of the salt content in our effluent. There is no best available technology for recovering salts from our effluent, and this would be very expensive. Instead, we opted to reuse the salt bath for selecting floaters. But water storage can still not depend on CRI as a storage step.
- Considering ongoing infrastructure projects along the pipeline route towards nearby farmers, it is important in determining the optimal scenario, as changes in ditches due to these projects can impact water management. It is crucial to incorporate future changes and their potential impact on ditches at the outset of a project.
- Planting willows in ditches, as seen in the Koksijde (Belgium) case of the FRESH4Cs project, can be an effective nature based system for treating effluent and removing nutrients and heavy metals from water.

Non-technical aspects of the demo

Regulatory framework

To discharge water into local ditches, a permit from the Waterschap is required. We have completed the application process and the permit parameters have been determined based on the water quality in the local ditches. The permit has been published in concept form, and we anticipate the final permit to be published on April 15th.
Regarding the investment in the MBR (Membrane BioReactor) technology, which was not part of the FRECH4Cs project but was selected during the feasibility phase, the permit was granted in the summer of 2022, and the construction of the MBR is currently underway.

Business setup

During the external stakeholder sessions, we learned that there is a growing interest in fresh water during the course of this project. It has become evident to all parties involved that the current system needs to be changed in order to redesign our water systems. Water has been a major challenge for LambWeston since the inception of our sustainability strategy in 2009.

Business case

LambWeston does not have a direct business case for providing effluent water to farmers. However, we believe there are direct benefits, particularly if this concept can work in other locations as well. To make our delicious fries we need potatoes and lots of potatoes. However, during dry periods, the quantity and size of potatoes are at risk. This is why we invested in a Membrane Bioreactor (MBR) to allow for the discharge of 100 m3/h of water to the ditch. We also conducted a feasibility study to investigate the business case for providing water to local farmers.
For fruit and vegetables, freshwater is critical during long dry periods. The amount of water needed during dry periods is 30 mm/ha, which is equivalent to 300 m3/ha. To have a significant effect, this amount of water needs to be applied three times, totaling 900 m3/ha. We have 2,400 m3 of water available each day, which can be used to water 2.77 ha/day during dry periods.

During dry periods, farmers can lose up to 50% of their potato crops. On average, one hectare of land produces 40-70 tons of potatoes. The value of 1 ton of potatoes is approximately 229 euros (as of 2022). Losing 50% of 55 tons of potatoes would result in a loss of around 6,300 euros per hectare. In addition to watering the land, it is important to maintain the moisture level of the soil to optimize mineral intake. During dry periods, the nitrogen content in the soil tends to be high due to reduced potato production and thus potato N uptake. With a production decrease of 20 tons, about 60 kg of nitrogen would remain in the ground, which can then end up in the surface waters. Moreover, mineralization of the soil can stop during dry periods, making water essential for maintaining a healthy soil.

If we consider the entire system and take into account all the costs, including the nitrogen challenge in our area (Yerseke Moer), we can create a business case for investing in infrastructure in collaboration with the waterboard, farmers, and the Province (owner of the Zanddijk reconstruction) to discharge our effluent into local ditches and make it available for farmers to use during dry periods.

This includes utilizing the ditches to maintain adequate water levels for healthy soil throughout the year.

Lessons learned

- Doing the right thing is sometimes more expensive. In our case the fees for discharging on the ditch (to allow reuse of the water by farmers) are higher than discharging in the sea. This makes the incentive for to contribute to circular local water systems low.
- Legislation is not future-proof. For example:
    - legionella risk analyses for growers are not addressed in the current legislation.
    - Pipelines for process water to the ditch of the farmers are not considered 'essential infrastructure', which means that building them depends on the goodwill of landowners. In some cases we might have to find a more expensive alternative routing when a landowner is not willing to provide us access. This is different for a drinking water company like Evides.
    - In the law, our effluent is considered wastewater, but it becomes a useful resource for farmers. The government should reconsider the definitions of this water as waste product.
    - Our permit from the waterboard requires a lower P content for discharge in the Ditches, which is expensive. On the other had our growers love the P as a fertigation method. In a circular economy, all nutrients are resources (wastewater sludge, P, struvite, organic matter?).
- It is important to involve local stakeholders from the start to identify needs and solutions to build a robust reliable system together. As such shared value can be reached, and the design of the system can be based on everybody's needs.
- When looking at the water price and the business case we can learn from other cases. The F2AGRI project at Ardo (Belgium) is a good example where the growers have invested in the infrastructure through a cooperation. A water precising system is set up to pay for the infrastructure and operational costs, based on water usage and a 'reservation cost' of water.
- During meetings with the water company Evides and other local parties, we discussed using the current pipeline for agriculture and investing in local storage and adding the process water of agroindustry as a future scenario option for the long term.

Conclusions and replication potential

To bring cleaned effluent water from agri-industries to farmers is essential during dry periods because the benefits of healthy soil will provide the food needed to feed the world with nutritious potato products, vegetables and fruit.

With our demo, we have proven that it is possible to treat process water effluent to the quality needed for farmers. Points of attention are the phosphorus and the salt levels in the effluent water. More research is necessary on the benefits of organic matter, phosphorus (P), and nitrogen (N) which are available in the process water for use by farmers (fertigation), and the regulatory aspects of this use. Currently, it is removed in the wastewater treatment process, but it might be more beneficial to reuse this water with the organic matter for the farmers to create healthy soil and prevent high costs for chemical fertilizers.

From an organizational point of view, this demo has shown that it is important to involve all stakeholders in an early phase of the process, to come to a shared understanding and create an integral value. The effluent of Lamb Weston Meijer can be a valuable resource for nearby farmers, but regulations can be a barrier. There is a need for an integrated approach on water quality and quantity.