BSAP Fund

The Tullstorp Stream Project

Pre study – Controlled drainage

Tullstorpsån ekonomisk förening

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Executive summary of the project

Eutrophication of the Baltic Sea and ongoing climate change is a major challenge we are facing!

The European Environment Agency (EEA) has issued a new report where they assess how food production and agriculture will be affected by climate change. The report reiterates that cultivation in parts of southern Europe can be made more difficult. In some cases, so much that land is abandoned and areas are depopulated. And the slightly warmer climate can instead provide benefits for cultivation in Northern Europe. For Sweden, animal husbandry and agricultural production can benefit from an extended growing season and increased harvests. As a joker in the game for all European countries, there is extreme weather with heat waves, but also floods and hail, which can cause major crop damage. Drought will increase the need for irrigation and it will cause conflicts as a result of the need for water in other areas. The changes in the precipitation pattern will also place new demands on agriculture's soil drainage facilities.

Well functional drainage promotes the growth of the crop by increasing the oxygen content in the soil and reducing the risk of the root zone becoming water-saturated (Eriksson, 1990). The plant roots can grow deeper into the soil and gain access to a larger volume of soil for nutrient and water uptake. Other benefits include; earlier sowing, better establishment, less weed occurrence, safer wintering for autumn-sown crops, lower traction requirements and less risk of soil compaction damage.

Through drainage, the distribution of runoff between surface water runoff and different types of soil water flow, which in turn affects the quality of the drainage water. However, knowledge of how this happens is poor, both nationally and internationally, but is extremely important in assessing the risk of phosphorus leakage (see, for example, Radcliffe et al., 2015). This applies not least to Swedish clay soils that often have a rapid infiltration into cracks and macropores, an infiltration that needs to be levelled spatially over as large area as possible to dampen the effects of strongly channelled water flows.

Significant phosphorus leakage can occur via drainage pipes (e.g. Heackrath et al., 1995, Ulén 1995). The magnitude of the phosphorus leakage varies depending on the design and maintenance of the drainage system (Skaggs et al., 1992). The status of the drainage system may be one reason why several international studies have reported poor or no relationship between high phosphorus leaching and amount of drained water via drainage pipes (Madramootoo et al., 1992, Macrae et al., 2007). In theoretical model calculations, the effect of an improved drainage is often simplified to a reduced drainage distance which leads to an increased infiltration which in turn is followed by an increased phosphorus leakage (Reid et al., 2012). This can lead to direct misjudgements in scenario calculations because there is now a lack of data on how the concentrations actually change when the infiltration becomes more efficient and at the same time spreads over a larger area.

Despite countermeasures, diffuse emissions of nutrients from agriculture to recipients are still major environmental problems. New measures are needed. Special attention is required for light textured soils with intensive plant production and high animal density, which are often found in the coastal areas of the Baltic Sea region. Within the concept of controlled drainage, a method has been developed that makes it possible to adapt the drainage intensity to the need for drainage. With controlled drainage, you can control the amount of runoff from the drainage system. The system involves the use of weirs that keep the groundwater surface in the soil elevated during periods when cultivation measures do not need to be carried out. During the growing season, the groundwater level can be lowered if necessary to provide sufficient soil bearing capacity during periods of tillage and harvest and when needed to protect crops. Controlled drainage as a measure to reduce the environmental impact of agriculture has been studied in many research projects in the USA and Canada (Skaggs et al., 2012; Williams et al. 2015; Ross et al., 2016; Sunohara et al. 2016 Shedekar et al., 2021). The research has focused on losses of N via drainage water.

Due to the environmental benefits of controlled drainage, the system has been accepted as "best management practices" by US regulators.

The effects of controlled drainage on N- and P-leaching under climatic conditions and soils in southern Sweden have been studied since 1996. Compared with conventional drainage, controlled drainage had less runoff and lower nutrient losses from the drainage system. The annual reduction of N and P losses through the drainage system was 60-90% (20-30 kg N ha-1 and 0.02-0.13 kg P ha-1) (Wesström & Messing, 2007; Wesström et al 2014). The potential of arable land in southern Sweden's coastal areas that are suitable for controlled drainage was investigated with digital data in a study (Joel et al., 2009). The results showed that 90,000 ha of the surveyed arable land was very suitable and another 90,000 ha of arable land had some suitability for controlled drainage.

We have several indications of the environmental benefits of good drainage, but no solid studies can directly show this. We believe that the environmental benefits are often underestimated and experience that drainage pipes that flow into watercourses sometimes are considered as 'sewer pipes' from agricultural land. We also see a great need to be able to make reliable measurements over a longer period of time and on full-scale controlled drainage systems at fields in operative agricultural production. Measurements over longer periods of time provide valuable information on how effective various measures are in counteracting nutrient losses from agricultural land under varied weather conditions and cultivation measures. More effective actions would benefit both Swedish agricultural production and improve the status classification of our watercourses.

The Tullstorp Stream project has received funding from NEFCO (BSAP fund) to perform a pre-study regarding controlled or customized drainage. WWF is supporting with co-financing to the project.

This project is a part of a larger project, i.e., “THE TULLSTORP STREAM 2.0 – MITIGATION ACTIONS REGARDING ONGOING CLIMATE CHANGE”. Customized drainage is a part of the context of the larger project but is broken out and run as a separate project. Customized drainage is identified as one possible component in a toolkit for mitigation actions to meet the ongoing climate change effects, increase recycling of nutrients from agriculture as well as increase local food production. As a first step – this pre study (phase 1) is initiated with the purpose to define scope, costs and set up for the full demonstration project (phase 2) and finally an evaluation of the full-scale systems effects is planned (phase 3).

The proposed methods in the overall large project are aimed to reduce the eutrophication of the Baltic Sea. By collecting runoff water in multifunctional water reservoirs and recirculate the stored water by irrigation during the vegetation period, it is possible to reduce nutrient loads from land to sea. Additionally, by using customized drainage systems the subsurface runoff and nutrient loads can be reduced.

Project owner is the Tullstorp Stream Economic Association (TSEA). Jordberga Gård AB (JOB) will run the project management and later on provide arable fields for the full-scale demonstration systems. Hushållningssällskapet (HIR) will support with technical design of the systems and the Swedish University of Agricultural Sciences (SLU) will set up description and preparation for monitoring system and evaluation. Finally, TSEA will report and prepare for the next phase – the full-scale demonstration project (phase 2. 1.3.

The purpose with this pre-study is to define scope, costs and set up for the full demonstration project that will follow as next step.

Since this is a pre study – no concrete reductions will be a result of the project. The project outcome will be in terms of descriptions of the next phase of the project;

- technical design of the systems

- description of monitoring system and evaluation

Eutrophication – Sweden's provisional nutrient reduction requirements for Nitrogen is 20.780 tonnes in the current HELCOM Baltic Sea action plan. This pre study and potential next step with a full-scale demonstration system will be one important part in reaching the goal. Field trials with controlled drainage in Halland and Skåne (Wesström & Messing, 2007; Wesström et al 2014) show the results that nitrogen leakage can be reduced by 20 to 30 kg N per hectare per year compared to traditional drainage.

Climate change mitigation – with a controlled drainage system the field will be more resilient against the predicted intense periods of rain and drought, hence being a flooding and drought preventing action.

Sustainable use of water – the controlled drainage system will efficiently use the available drainage water by up-take in growing crops and hence have the potential to increase local food production.

Social impacts – Swedish agriculture achieves a better resilience to extreme periods of wet and dry climate conditions. Increased local food production is a step towards the Swedish goal of being self-supporting with products from the agricultural sector.