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Invasive species application in bioeconomy. Case study *Heracleum sosnowskyi* Manden in Latvia

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Abstract

Since there is a constant battle with invasive species – *Heracleum sosnowskyi* Manden in Latvia, the case study aim is to evaluate possible solutions for the use of the hogweed and find if there is socio-economic benefit, greater added value and possibility to use it effectively in bioeconomy. The most explored aspect is hogweed use in biobutanol production. Evaluation has been determined with cost-benefit analysis and environmental impact assessment. The obtained testing results shows that producing products with higher added value is biobutanol production.

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Keywords: *heracleum sosnowskyi*; hogweed; feedstock; biobutanol; invasive species; bioeconomy

1. Introduction

Since *Heracleum sosnowskyi* Manden was introduced in Latvia as a promising fodder crop, it has spread uncontrollably in many Latvian regions reaching a total area in 2016 of 10801.41 ha [1]. After implementing the state support program (VIDMProg_060406_latvanis), in 6 years' time it did not succeed as planned, the attention now is drawn to control, combat and limit the spread of hogweed dramatically [2]. This species is not only invasive and

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decreases biodiversity, but the plant has also proven to be a serious threat to human health and can provide second degree burns in case the plant sap is in contact with human skin and sunlight [3, 4].

The biggest concern is to eliminate the invasive species in Latvia and, especially on agricultural land, to prevent further spread of the hogweed. So the biggest effort has been put to find and apply the most effective method to control the species. For now, the most effective method is a combination of chemical and mechanical treatment [5, 6]. Combined control method is effective only if implemented for at least 6–7 years. If the mechanic treatment is done every week from May to October, then there is possibility to eliminate hogweed in 2–3 years' time [6]. This method consists of one-time chemical use, 3 times mowing, 1-time soil milling and soil cultivation after soil milling 3 times in the growing season [5].

Hogweed can be used as fodder crop for cattle or for sheep. In Latvia cattle breeding is more developed than sheep breeding, cattle can produce more meat and cattle needs more feedstock, which means that with a lower number of animals it is possible to control the spreading of hogweed and achieve more economic benefits. However, caution must be provided for cattle health, as the hogweed sap can be dangerous, so they should be monitored of any changes in places that are not covered with hair coat – like lips, udder and nostrils. It is important that there is biodiversity in pastures and cattle get a more diverse feedstock to prevent from any internal health problems [5].

As the latest studies show, hogweed can be an effective bioresource for bioethanol or biobutanol production. Biobutanol has proven to be next generation biofuel superior to ethanol and therefore the third scenario was chosen as hogweed use in biobutanol production [5].

Biobutanol is a second generation biofuel, and it does not compete with the food market nor the fodder stock, because at the end of the production of the biobutanol, the biomass residue can make a high quality protein fodder [7].

The engineering solution for biobutanol production is fermentative technology using enzymes. The process is simplified and involves four steps: milling that destroys cells structure and neutralizes lignin, cellulose and hemicellulose hydrolysis to the conventional sugars using enzymes, fermentation using bacteria *Clostridium acetobutylicum* and butanol extraction [8]. The research about biobutanol production from agricultural waste shows that from several residues – starch, grass, green algae, hogweed, particularly hogweed has demonstrated the highest percentage of sugars: 40 % in green mass and 30 % dry mass [9].

Biobutanol is a biofuel superior to ethanol because of its similarity to conventional gasoline, it has greater density, if 1 l of gasoline can replace with 0.66 l bioethanol, than 1 l of gasoline can replace with 0.9 l biobutanol. Butanol is not corrosive and it can be transferred through existing pipelines, which is a great benefit, because there is no need to transform or invest in new infrastructure. It is now being proven an effective blend of 16 % with gasoline or diesel, but it can be used as well as 100 % fuel without any engine transformations [10, 11].

2. Methodology

The purpose of the case study was to find if there is an effective possibility to use hogweed for bioeconomy purposes by choosing three alternative scenarios with greater added value based on quantity that can be used and the main use of hogweed. As the increasingly important issue in Bioeconomy is sustainable use of the biomass [12].

Methodology is based on screening analysis that ensures detailed and strong analyses of adaptation measures.

To evaluate the scenarios first data was collected on potential bio-products and hogweed quantities. Based on these data, the best engineering solution for each alternative was found.

The most appropriate geographical location was determined based on availability of agricultural land invaded with hogweed and socio-economic aspects.

For each scenario there economic evaluation with cost-benefit analyses and environmental impact evaluation were conducted, so the possible impact on environment and climate is taken into account. Cost- benefit analyses show net present value, discounted payback time and internal rate of return as well as sensitivity analyses.

If the alternative scenario after evaluation is justified it is considered as one of the best alternatives, if there is more than one alternative to be justified, the best alternative is that with the highest economic benefit and lowest negative impact on climate or highest positive impact on environment.

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