IEA Bioenergy

Stump harvesting

Impact on Climate and Environment

Summary Series

IEA Bioenergy Task 43: TR2017-02

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Summary

The demand for fuel chips from stumps has fluctuated over time and is currently low. Most observers agree that the need for forest biomass will increase as we move into a future bio-based economy. The interest in stump harvest will most likely increase again, given that stumps have a high fuel value. Stump harvesting means a further intensification of forest management in comparison with stem-only harvesting and removal of tops and branches.

Around 2007, a number of knowledge gaps about the environmental consequences of stump harvesting were identified by researchers and foresters in Sweden, for example effects on climate, soil organic matter, water quality, stand growth and biodiversity. To fill these gaps, the programme "*Theme stump harvesting*" was launched by the Swedish University of Agricultural Sciences, the Swedish Energy Agency and nine FSC-certified forest companies and was run for eight years, 2008 – 2015.

Many results and conclusions are based on long-term field experiments. Other results are based on modelling efforts, life-cycle assessments and use of forestry inventory data. Stumps of Norway spruce have so far been the most targeted source in Sweden and Finland, and therefore most studies have focused on this particular tree species. The main results and conclusions are that:

- Utilizing stumps from production forests for energy provides a climate benefit when substituting fossil fuels such as coal or natural gas, also within a shorter time horizon of approximately two to three decades. The climate benefit of stump energy increases substantially over time, taking into account that the stumps otherwise would have been left in the forest to decompose.

- Stump harvesting increases the proportion of vegetation-free soil surfaces and also increases soil mixing. However, in contrast to earlier hypotheses, the results suggest that the soil disturbance will initially reduce the emissions of carbon dioxide from the soil into the atmosphere.

- Stump removal sometimes leads to increased nitrogen leaching. It can also increase the amount of pits in which toxic methyl mercury (MeHg) is formed. Despite this, the MeHg concentrations in surrounding stream water have not been shown to increase.

- Stump harvesting does not appear to affect timber production in the next forest generation; it increases the natural regeneration of pioneer species like birch and pine, and appears to reduce the infection rate of root rot.

- Stump extraction decreases the amount of berry-forming dwarf shrubs in young clear-cuts, and increases the occurrence of certain ferns and herbs. In a longer perspective (decades), the ground vegetation seems to recover.

- Biodiversity, especially species dependent on dead wood, is adversely affected by stump harvest. Rare and endangered species have mostly been found in stumps of broad-leaf trees. But also Norway spruce stumps are rich in species. Sixteen separate studies in Sweden estimated a total of 2,200 different species, of which more than 60% were fungi, on or in spruce stumps. Several beetle species but relatively few lichen and fungal species seemed to have a potential to be threatened by a high stump-harvest intensity at the landscape level.

- Model studies using beetles as model species suggest that the risk of species extinction is small if the stump harvesting is limited to 10% of the total clear-cut area in the forest landscape. Today this percentage means about 20 000 ha across Sweden. If however 30% of all new clear-cuts will be stump harvested during a long period (50-100 years), the risk of extinction rises for "*rare species with specific habitat requirements*".

The report provides a better basis than before to assess the pros and cons of stump harvest. One of the advantages of stump harvest, perhaps the greatest, is that the climate will benefit in comparison with burning fossil fuels. A disadvantage is that the species dependent on dead wood are adversely affected, but the degree of the influence is heavily dependent on the extraction level.

Conclusions

Stump harvesting reduces the amount of soil organic carbon in the short term, but long-term studies could not detect differences between stump-harvested and non-harvested treatments. In contrast to earlier hypotheses, stump harvesting seems to reduce emissions of carbon dioxide from the soil. LCA studies show that stump-based bioenergy reduces the climate warming effect in relation to fossil fuels viewed over a forest rotation. Stump removal does not affect timber production, and it often reduces root rot. Species dependent on stump wood can be adversely affected by intense stump harvest, but model studies suggest minimal risk of species extinction when only 10% of available clear-cuts are stump harvested.

For additional information, please refer to report TR2017-02 of IEA Bioenergy Task 43 and related presentations: http://task43.ieabioenergy.com/publications/stump-harvesting-climate-environment-impact-iea-bioenergy-tr2017-02/