SMALL-SCALE BIOCHAR PRODUCTION ON SWEDISH FARMS

Elias S. Azzi, Department of Sustainable Development, Environmental Engineering and Sciences (SEED), KTH Royal Institute of Technology, Sweden
eazzi@kth.se
Erik Karltun, Department of Soil and Environment, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden
Cecilia Sundberg, Department of Sustainable Development, Environmental Engineering and Sciences (SEED), KTH Royal Institute of Technology, Sweden and Department of Energy and Technology, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden

Key Words: biochar, on-farm production, optimization, life cycle assessment, climate change

Several small-scale pyrolysis plants have been installed on Swedish farms and the trend is also expanding in the Nordic countries. These projects are driven by ambitions of achieving carbon dioxide removal, reducing environmental impacts and improving farmers' economy and resilience. The pyrolysis plants are fuelled with either commercial pellets or agricultural residues. The pyrolysis plants co-produce heat for the farm's buildings, biochar for non-oxidative applications, mostly agricultural ones, and electricity in some cases. In the Nordic context, on-farm biochar production potential is thus linked to energy consumption. The main research question investigated is whether farms producing biochar can meet their own biochar needs in an energy-efficient way. The research also provides insights on how biochar production at various scales, centralized and decentralized, can be integrated in a given landscape.

In this study, we developed a general model to estimate the amount of biochar that can be produced as a by-product of an energy-optimized farm. We then investigated how the biochar production potential is affected by different scenarios and under different climatic conditions. The model is applied to one Swedish case study and compared with preliminary data from this case. The environmental impacts and energy efficiency of the farm's energy consumption are evaluated through life cycle assessment, including soil carbon stock changes. We also develop a framework to describe, qualitatively and quantitatively, how biochar is used on the example farm for different applications: feed, manure and compost additive; orchard and perennial root-zone amendments; vegetable production; greenhouse cultivation; and sale to other farms in the region. This framework provides an estimate of farm biochar demand and serves as a basis for future environmental evaluation of biochar practices in Sweden.

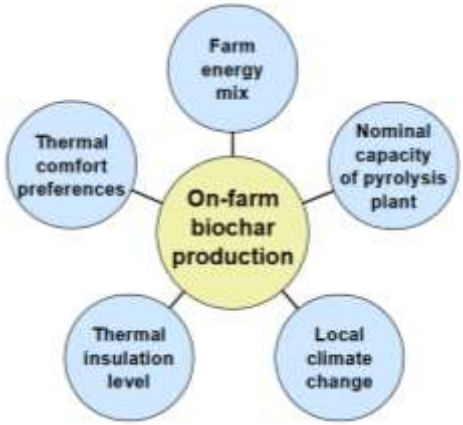

Figure 1 – Dimensions investigated in the scenario analysis

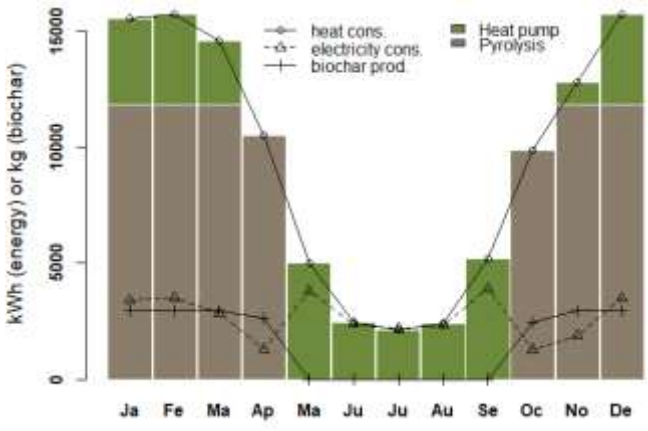

Figure 2 – Monthly heat supply, electricity consumption and biochar co-production in current standard operation

environmental evaluation of biochar practices in Sweden.
For an average year, with heat supplied to a 400 m^2 residential building, by a heat pump and a pyrolysis plant, the biochar production is estimated to be 10 Mg yr^{-1}. At full scale, the case studied is expected to produce 19 Mg yr^{-1}. Detailed life cycle, energy and scenario analyses are under preparation. These analyses will enable estimation of biochar production variability and comparison of different environmental performance indicators. Applying the model to other cases may support farmers and advisors in their evaluation of on-farm energy supply and biochar production alternatives