KØBENHAVNS UNIVERSITET SEGES INNOVATION Promilleafgiftsfonden for landbrug

Goal and scope for life cycle analysis of sustainable, commercial nut production in Denmark

Project: Etablering af lokal nøddeproduktion som en del af et klimavenligt landbrug (Local Nuts)
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1. Aim

The aim of the assessment is to calculate the prospective environmental impacts of cultivation, processing and transport of walnuts, chestnuts and hazelnuts cultivated in Denmark, using a Life Cycle Assessment (LCA) methodology.

2. Modeling scenarios

The assessment will include six modelling scenarios consisting of conventional and organic production systems for walnuts, hazelnuts and chestnuts: i) Danish production of conventional walnuts; ii) Danish production of organic walnuts; iii) Danish production of conventional hazelnuts; iv) Danish production of organic hazelnuts; v) Danish production of conventional chestnuts; vi) Danish production of organic chestnuts.

3. Functional unit

The functional unit will be one kilogram (kg) of each of the three included nuts: 1 kg of Danish walnuts, at retail; 1 kg of Danish chestnut, at retail; and 1 kg of Danish hazelnut, at retail.

4. System boundary

Environmental impacts will be assessed from cradle up to, but excluding, the retail stage. Impacts from retail, consumer and waste handling operations are expected to be similar across the three different types of nuts and equal to the otherwise imported nuts. The impacts from retail, consumer and waste handling operations are therefore not accounted for in the system boundary.

The LCA will be conducted as a screening/hotspot assessment, with the results communicated to the public. At present, there is no commercial production of nuts in Denmark, so access to full scale proven data will not be possible.

The LCA approach will be attributional LCA, while following the main recommendations from the EU PEF (Product Environmental Footprint) guidelines to the extent possible. The allocation method will be economic allocation, assuming full responsibility for the treatment of waste products. For the Life Cycle Impact assessment (LCIA) method, the EF method will be used, including single score impacts. All growing stages of the trees will be represented in the prospected production, including unproductive years before the first harvest.

5. Modeling and data

Cultivation data for all the growing stages of the plantations will be based on existing studies and generic LCA databases, adjusted using best guesses and expert judgments. For crop yields a best

guess could be based on an estimate for the general relationship between yields in Denmark and yields in existing nut-producing countries for other tree crops, such as fruit trees. For organic production, a best guess for yield differences could be based on the existing relationship between conventional and organic crops in Denmark.

The individual growing stages will be modeled similarly to the walnut cultivation process in Agribalyse, with adapted activity data that take Danish conditions into account. All impacts will be ascribed to the main product (i.e. one kg nut). A sensitivity analysis will be conducted.

It will be assumed that the expected commercial Danish nut production will not be established on areas that in the last 20 years were natural forest or grassland. This assumption can be supported by the fact that no knowledge exists of where or how a Danish commercial nut production will develop. Furthermore, following current Danish targets, the forested area is expected to keep expanding within the next years, so the assumed commercial Danish nut production cannot be established on forest land.

Commercial nut production may be established anywhere in Denmark, so it will not be possible to forecast the extent to which that will be on drained organic soils. A simplified approach that assumes all national drained organic soil emissions (as reported in the National Inventory Report for Denmark) are distributed over the whole Danish cropland, including the potential future nut plantations, may be used during the modelling phase. These impacts could be presented as additional information.

Estimates for field emissions of NH_3, CO_2, N_2O and NO_3^- will be based on either IPCC 2006 (in line with the current PEFCR for feed) or IPCC 2019, and emissions of heavy metals and phosphorus will be based on the modelling approaches used in Agrifootprint or Ecoinvent.

Drying and shelling will be estimated based on available literature, adjusted to Danish conditions if necessary. Transport to retail will be estimated based on assumptions derived from transport of similar products, i.e. other packaged, dry goods that do not require cooling or other special handling.

6. Limitations

It will not be possible to follow the PEF guidelines in their entirety, but the overall methodological framework will be based on it. In reality, the PEFCR for feed explicitly state that no LCA should be performed on perennial crops until the stage of full productivity has been reached. A PEF study is based on proven steady state activity data, but no full-scale steady state data exists on Danish nut production.

Comparisons between locally produced and imported nuts, and between locally produced nuts and other food products are not the aim of this assessment. A comparative assessment can only be made with scenarios that offer a similar data quality or that at least share the same methodology, making sure that the different scenarios provide similar functions (e.g. in terms of nutritional aspects). Additionally, the LCA ISO standard requires comparative LCA studies to be externally reviewed by minimum three people. These measures are not possible within the scope of this project, and data on nut production in all countries Denmark currently imports from is not available.

In general, the data availability on nut production is low. For these reasons, this study will only be able to investigate the prospected Danish nut production. The results may be put into perspective based on the currently available literature, but no real comparison can be made. To date, we could only retrieve carbon footprints from scientific studies made on hazelnut cultivated in Italy, (Italian hazelnuts represent 14% of hazelnuts consumed in Denmark), walnut cultivated in the United States (American walnuts represent 26% of walnuts consumed in Denmark) and chestnut cultivated in Portugal (Portuguese chestnuts represent 9% of chestnuts consumed in Denmark). Very few processes describing nut production are available in LCA databases. In short, the availability of LCA studies and datasets describing the current Danish market for hazelnuts, chestnuts and walnuts is limited.

7. Sensitivity analysis

It is expected that a sensitivity analysis will be carried out as part of the study to test some of the methodological choices. The final choice of sensitivity scenarios will depend on the LCA results obtained for the baseline scenarios, as well as on the available time. Potential ideas for sensitivity analysis include variations in the expected yields (affecting the calculated impact per kg product), variations in the fertilizer use (affecting the soil N_2O emissions), variations in the type of management applied for crop residues, shells and hulls (e.g. burned in the field, left on top of the field (possibly increasing the soil carbon stocks), or potentially sold to a bioenergy facility or feeding company), variations in irrigation (which affects the use of water) and variations in the national area of drained organic soils used for agriculture.

8. Discussions and perspectives

The LCA of Danish production of walnuts, hazelnuts and chestnuts will highlight and discuss the environmental hotspots related to this production. The results will be presented and discussed in comparison with the available literature describing imported nuts. The mid and long term production scenarios described in the project application will also be discussed, with specific focus on the required land use.