Comparing the maize yield levels and climate change potential in Zambia by LCA

Organic maize monoculture, conventional maize monoculture, and agroforestry

Approach:

The approach in this thesis was to compare climate change potential of different maize production systems by using the LCA method. The main research questions are which of the product systems is having the lowest climate change potential and which of the studied systems is having the highest yield.

Objective:

In this thesis the objective was to compare maize monoculture without external inputs, conventional monoculture with chemical fertilizers, and maize-Faidherbia albida agroforestry system. The climate change potential from cradle to farm gate was studied.

All the systems are relatively simple, since all the farming practices are done by hand, i.e., machinery is not used. Therefore, most of the emissions are occurring from soil emissions and LUC from primary forest to cropland.

Methods:

The two different cases were created to study different maize systems. Case 1 did have a functional unit of 1000 kg d.m. maize grain. Land use change from primary forest to cropland was considered. Carbon sequestration to F. albida was allocated for maize, and it was assumed that above-ground biomass of F. albida is a carbon stock, i.e., used as a building material. In the Case 2, the functional unit was 3 ha maize field, i.e., LUC was not considered and the whole system was studied.

Emissions from LUC, soil emissions and carbon sequestration to F. albida was calculated by IPCC 2006 Guidelines for National Greenhouse Gas Inventories and 2019 refinement (Tier 1) methods. Other values, e.g., production of chemical fertilizers, was conducted from the Ecoinvent 3.7.1 Cut-off regionalized database. The OpenLCA software and and ReCiPe Midpoint (H) impact assessment method was used for calculating the climate change potentials of each system.

Results / Conclusions:

Agroforestry is having the lowest climate change potential in both cases. Only in the sensitivity analysis where above-ground biomass of F. albida was used as a cooking energy in Agroforestry system, and hydropower was used in other systems, the organic monoculture did have the lowest climate change potential. This is because there are very low soil emissions in organic monoculture compared to conventional or agroforestry systems since there are not added nitrogen.

LCA did work well for estimating the climate change potential of the systems, but when the agroforestry system would be more complex, the allocation issues might be more difficult to solve. Also, agroforestry is having some advantages that should be included to the LCA, but they are difficult to estimate. For example, agroforestry can increase the biodiversity, enhance natural pest

control, and increase crop pollination. These benefits could possibly be added to the LCA by using system expansion, i.e., producing these services by some other ways in other systems. But giving the numerical value for these benefits and finding out how big is agroforestry's role for providing these advantages might be difficult. Therefore, including these benefits to LCA needs more research.

Master's thesis by
Oskari Lahtinen