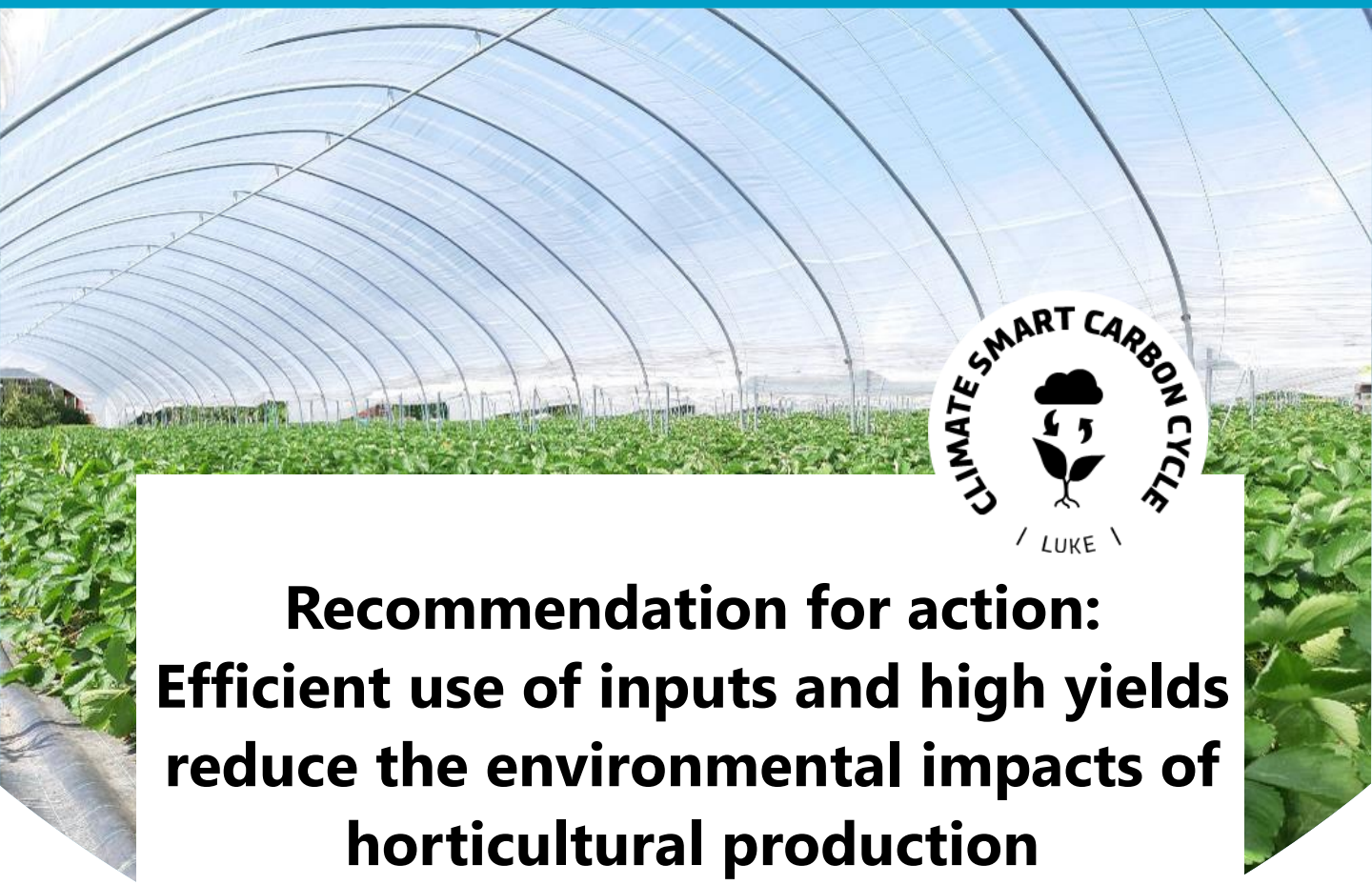
Luke
NATURAL RESOURCES INSTITUTE FINLAND

Factsheet



Recommendation for action: Efficient use of inputs and high yields reduce the environmental impacts of horticultural production

Profitable horticulture requires continuous development of cultivation techniques. However, environmental impacts should be assessed in parallel with technological progress. Growing conditions can be better controlled in tunnels and vertical farms than in the open field. Intensive production has high yield potential but requires large amounts of production inputs.

Optimising the use of inputs and energy in production and favouring renewable energy reduce the environmental impact of tunnel and vertical farming. In addition, high yields also have a positive effect on the environmental footprint of other production methods.

http://urn.fi/URN:NBN:fi-fe2024031811794

High yields and the effective use of production inputs are environmental acts that also improve profitability.

Data from Finnish farms

The life cycle assessment (LCA) method was used to assess the environmental impact

I. In open field and tunnel production of strawberries and raspberries
II. In vertical and greenhouse production of hydroponic lettuce and herbs

Eight impact categories were considered:

1. Climate change impact
2. Eutrophication impact
3. Ecotoxicity impact
4. Cumulative energy demand
5. Resource-use of non-renewable raw materials
6. Land use
7. Nutrient footprint
8. Water scarcity

In addition, the amount of food waste generated in primary production was assessed and four energy scenarios for lettuce production were evaluated.

The environmental impacts were allocated per **kilogram (kg) of product**.

Environmental impact results

Tunnel production of berries made efficient use of the available land, while input intensity reduced the difference with open field production in most of the impact categories studied. In berry production, the shift from open field to tunnel production reduced the use of chemical plant protection products, land use and food waste. In addition, the eutrophication impact of raspberry production decreased. In tunnel production, greenhouse gas emissions came mainly from production inputs.

Vertical farming of lettuce and herbs has the potential to reduce many environmental impacts compared to greenhouse production. However, this requires careful use of energy, waste heat recovery and the use of renewable energy sources. In greenhouse production, the environmental impact can be reduced by switching to renewable energy and reducing electricity consumption, for example by using LEDs.

Future challenges

Intensive production requires various **inputs**. How to reduce dependence on short-term inputs in production and ensure security of supply? How can farmers choose the best production inputs, taking into account the environment?

Nutrients and growing media must be used more efficiently. How can peat and coir be replaced? How can we increase the use of recycled fertilisers?

Energy consumption and waste heat recovery are key when considering the environmental impact of vertical farming. How can energy use be optimised and made cost-effective?

Open field berry production generates more **food waste** than tunnel production. Is there a cost-effective way to reduce the amount of food waste generated in open field production?

Life cycle assessment (LCA)

- **Carbon footprint** is the total greenhouse gas emissions in carbon dioxide equivalents (CO_2e) caused by an individual, event, organization, service, location or product.
- **Carbon footprint calculation** addresses greenhouse gas emissions generated during each phase of the lifecycle – from cradle to grave.
- **Eutrophication impact** represents the accumulation of nitrogen and phosphorus in waterbodies as a result of human activities.
- **Ecotoxicity** represents the impacts of hazardous substances on the local environment.
- **Nutrient footprint** measures the effectiveness of the use of nutrients in various production and consumption chains.
- **Water scarcity** determines the regional abundance of fresh water due to water consumption by people or the lack of it relative to available water resources.

Recommendations

- Risk factors associated with yield variation need to be addressed. High yields reduce the environmental impact of all production methods.
- The use of inputs in production, including planting density, fertilisation, energy use and irrigation, must be optimised to reduce environmental impact.
- Energy must be used efficiently in vertical farming and greenhouse production. LEDs, waste heat recovery and the use of renewable energy sources reduce the environmental impact.

Further reading

Joensuu et al. 2023. Puutarhatuotannon uusien menetelmien elinkaariset ympäristövaikutukset: Avomaalta tunneliin, kasvihuoneesta vertikaaliin. (In Finnish). Luonnonvara- ja biotalouden tutkimus. Natural Resources Institute Finland. Helsinki. http://urn.fi/URN:ISBN:978-952-380-865-2

The PuutarhaLCA project. Environmental impacts of new horticultural production methods –Life Cycle Assessment (PuutarhaLCA). Project period 2020–2023. Funded by the Ministry of Agriculture and Forestry: Development Fund for Agriculture and Forestry (Makera). Project coordinator Natural Resources Institute Finland (Luke).

More information
Marja Rantanen, marja.rantanen@luke.fi
Kati Räsänen, kati.rasanen@luke.fi
Frans Silvenius, frans.silvenius@luke.fi
luke.fi