Water consumption, Ecotoxicity and Global Warming Potential Assessment of Sugar Beet Production Using Different Irrigation Sources

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Sugar beet is one of the most important products as it is a major source for sugar and biofuel. Agricultural production processes of sugar beet rely heavily on inputs including water, energy, fertilizer, and pesticides, making the environmental impacts potentially high (Renouf *et al* 2008). The extensive water requirement of sugar beet production is particularly believed to have substantial environmental consequences, but in Turkey, which ranks 5th in the world in the sugar beet and sugar production, no comprehensive study has been conducted to quantify them.

As global warming has been progressing every day, measuring the environmental impacts of current production methods, and investigating the methods for reducing the environmental impacts and for cleaner production have become urgent priorities.

This study used the current data from farmer's practices in the Kayseri region in central Turkey to evaluate environmental impacts of the use of surface water and groundwater for the irrigation of sugar beet. Nine farmers, five of which are using surface water, four of which are using ground water for irrigation, contributed to the data on the agricultural processes. A life cycle assessment (LCA) study was conducted using SimaPro software and in line with TS EN ISO 14040 and TS EN ISO 14044 standards to examine the potential environmental impacts of irrigation on the sugar beet production in the agriculture stage (ISO, 2006a; ISO 2006b). Environmental impact calculations were performed using the ReCiPe 2016 midpoint (H) approach using the Ecoinvent database, which is one of the most widely used methods in the literature. Figure 1 shows the system boundaries of the agricultural processes in the sugar beet production.

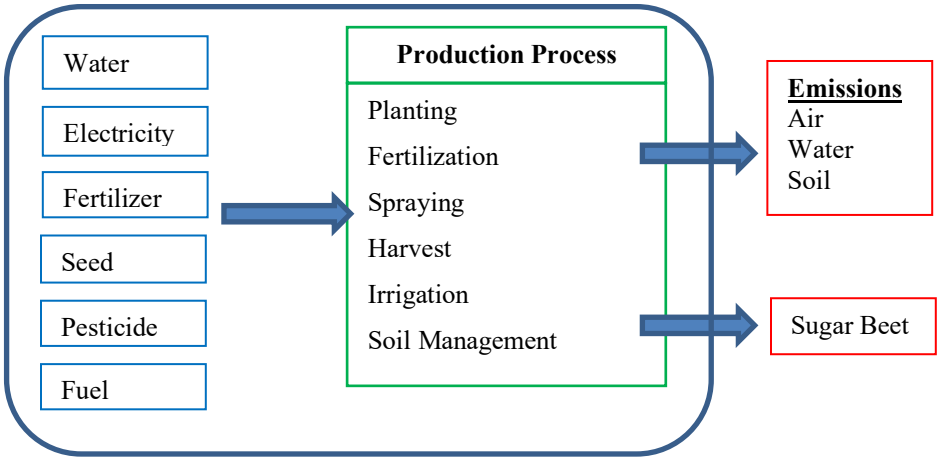

Figure 1. Agricultural production processes, inputs and outputs of sugar beet.

LCA is a valuable method for comparing the effects of various water sources and irrigation/fertilization management practices used by farmers (Azeb *et al*, 2020). Using life cycle assessment methods, this study examines the influence of water sources for irrigation in sugar beet production.

Figures 2 and 3 depict the water consumption, ecotoxicity and global warming potential results obtained from the LCA analyses. The most relevant environmental indicators are water consumption and freshwater ecotoxicity, which stand out in all types of irrigation sources. The environmental impacts of sugar beet production utilizing surface water resources in the field are generally higher than the values obtained from the farmers using groundwater resources and the smaller environmental impacts are observed in the farms using groundwater.

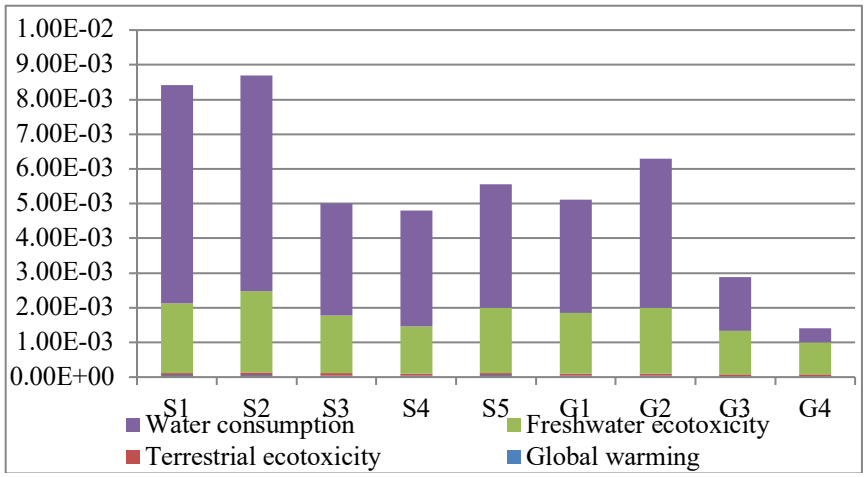

Figure 2. Normalization results of the environmental impacts of sugar beet farms (S:Surface water, G: Groundwater)

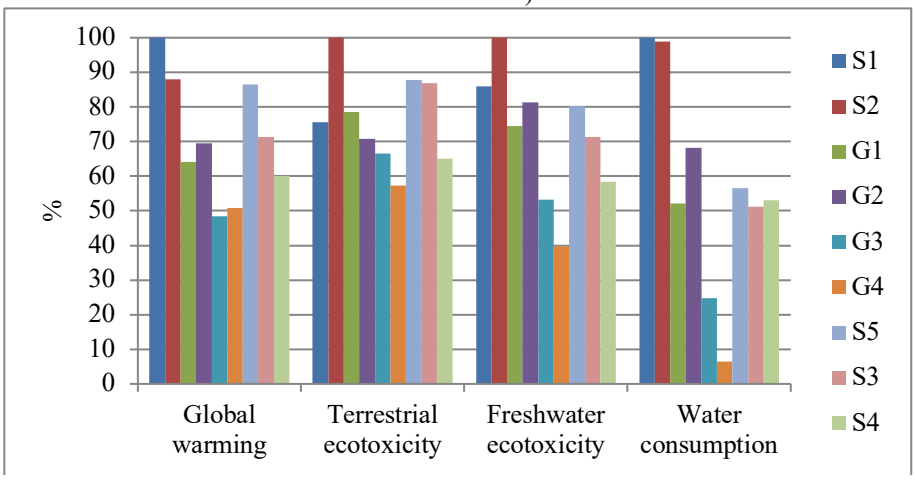

Figure 3. Characterization results of the environmental impacts (S:Surface water, G: Groundwater)

This study shows that as well as the water source, effective quantitative and qualitative water management is critical. It also provides a basis for the future improvements for agricultural production of sugar beet in Turkey. Further, LCA results showed that it is a valuable method for comparing the effects of various water sources and irrigation/fertilization management practices.

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