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Life Cycle Assessment (LCA) for Wheat (*Triticum aestivum* L.) Production Systems of Iran: 1- Comparison of Inputs Level

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Introduction

Agricultural intensification has serious environmental consequences such as depletion of non-renewable resources, emission of greenhouse gases, threatening of biodiversity and pollution of both surface and underground water resources. The life cycle assessment (LCA) provides a standard method for assessing environmental impacts from various economic activities, including agriculture, and covers a wide range of impact categories across the entire production chain. Over the past few decades, food production in Iran has been increased drastically due to heavier use of chemical inputs. Since the use of LCA method is overlooked for assesseing the effects of agricultural intensification in Iran and few researches are conducted at local level (such as province, cities), the purpose of this research is evaluation of wheat production systems throughout the country based on the level of intensification using LCA method.

Materials and Methods

Fourteen provinces covering 80 percent of total cultivated area of wheat production in the country were subjected to a cradle to gate LCA study using the standard method. The selected provinces were classified as low, medium and high input based on the level of intensification and all inputs and emissions were estimated within the system boundaries during inventory stage. Required data for yield, and level of applied inputs for 14 provinces were collected from the official databases of the Ministry of Jihad Agriculture. The various environmental impacts including, abiotic resource depletion, land use, global warming potential, acidification and eutrophication potential, human, aquatic and terrestrial ecotoxicity potential of wheat production systems over the country was studied based on emission coefficients and characterization factors provided by standard literatures. The integrated effects of emission of each impact category were calculated per functional units (hectare cultivated area as well as ton grain) and three production systems were compared for the intensity of environmental impacts of each category.

Results and Discussion

The results indicated that on per hectare basis all impact categories increased significantly with increasing inputs level. However, with grain yield ton as a unit of functional variable, results were obtained due to yield differences in wheat production systems. Depletion of non-renewable resources (fossil fuels and P+K resource) in high input systems was 27.1 GJ ha^{-1} which is almost 1.8 times higher than low input systems. However, energy consumption per unit of yield was exceeded in intensified system only by 10% because 1 ton of grain yield in high input systems was obtained from 2374 m^2 area compared to 3850 m^2 required for the same amount of yield in low input systems. Higher yield of intensified systems when calculated per ton grain was led to lower acidification potential, aquatic toxicity and terrestrial toxicity. However, global warming potential, eutrophication potential and human toxicity was not compensated by yield advantage and these impacts were higher in high input systems with both functional units. Global warming potential (GWP) in high input systems reached to 2911 kg CO_2eq ha^{-1} but it was 45% lower (1600 kg CO_2eq ha^{-1}) in low input systems. When calculated with ton grain as functional unit, GWP of high input systems (1600 kg CO_2eq t^{-1}) was only 11%

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greater than that of low input systems.

Conclusion

Global warming potential, depletion of non-renewable resources, eutrophication potential, and human toxicity were identified as the most sensitive impact groups to intensification in wheat production systems of Iran, compared to other impact categories. In general environmental impacts of high input systems were greater than low input systems and the difference was very clear when the area was used as functional unit. It seems that increasing the use efficiency of inputs together with management practices based on the replacement of external inputs, is an appropriate approach to reduce environmental impacts while sustaining high yields. Further analysis at provience level is needed to compare the spatial variation of environmental impacts of wheat production systems in the country.

Keywords: Energy use, Environmental impacts, High input system, Sustainability, Wheat