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Evaluation and Comparison of Environmental Indicators of Hybrid Corn (*Zea mays* L.) Production by Three Different Harvesting Methods in Alborz Province using Life Cycle Assessment

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Introduction

Agriculture itself serves a dual role as an energy user and also energy supplier in the form of bio-energy. Recently, the energy use in agriculture has been intensified in response to the rising population, the increasing of standards of living and the limitation sources of energy. Efficient use of energy is a possible pathway for reducing the environmental impacts of energy inputs in agriculture, and providing sustainable agricultural production, since it brings financial savings, fossil resources preservation and air pollution reduction. Life cycle assessment (LCA) is defined as the compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle. Hybrid seed in agriculture is produced by cross-pollinated plants. Hybrid seed production is one of the main contributors to the dramatic rise in agricultural output during the last half of the 20th century. The alternatives to hybridization are open pollination and cloonal propagation. All of the hybrid seeds planted by the farmer will produce similar plants while the seeds of the next generation from those hybrids will not consistently have the desired characteristics. Controlled hybrids provide very uniform characteristics because they are produced by crossing two inbred strains.

Materials and Methods

The purpose of this study was to compare the energy consumption pattern and environmental consequences caused by the use of agricultural inputs in the production of seed corn harvested by hand, combine and picker husker. Information required was prepared by the questionnaire method in Alborz Province using census the total producers of hybrid corn in the Province. The investigated inputs were labor, agricultural machinery, diesel fuel, chemical pesticides, fertilizers, gas, electricity, water and seed. The energy of each input was calculated by multiplying the amount of that input with its energy equivalent. The ten environmental indicators including eutrophication potential (EP), global warming potential (GWP), acidification potential (AP), ozone layer depletion (OD), abiotic depletion (AD), photochemical oxidation (PO), human toxicity (HT), terrestrial ecotoxicity (TE), marine aquatic ecotoxicity (MAE) and fresh water aquatic ecotoxicity (FAE) were investigated. LCA was conducted using Sima Pro software from cradle to grave, i.e., from the production of raw materials to the production of hybrid corn considering the both farming and processing stages. One ton of produced hybrid corn was chosen as the functional unit in this study.

Results and Discussion

Total energy input to produce hybrid corn harvested by hand, combine and picker husker methods were calculated as 118711, 111335 and 120403 MJ ha^{-1}, respectively. Electricity and nitrate fertilizer were the most important energy inputs for their investigated harvesting methods. The results of life cycle assessment revealed

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that electricity and diesel fuel used for irrigation had the most environmental impact in production of hybrid corn in the farm, while the consumption of fungicides had the largest environmental impacts in the processing stage. On the other hand, in harvesting method by picker husker, environmental indicators such as GWP, EU, HT, AP, AD and PO were higher than other harvesting methods. The different harvesting methods had no significant effect on OD and TE. MAE and FAE were higher than those of other harvesting methods because of the high consumption of diesel fuel and electricity in hand harvesting method,. Combine harvesting method had less environmental damage than other methods.

Conclusion

The combine harvesting method was recognized as the best harvesting method from environmental viewpoint. Electricity and diesel fuel consumption for supplying irrigation alter had the most environmental burdens in the agricultural stage. The right application of inputs such as herbicides and chemical fertilizers, substitution of non-renewable energy resources with renewable ones and green manure application can reduce the environmental burdens in hybrid corn production.

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Keywords: Environmental indicators, Harvesting method, Hybrid seed corn, Life cycle assessment