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ASSESSMENT OF ENVIRONMENTAL IMPACTS IN INTENSIVE AGRICULTURAL PRODUCTION SYSTEM WITH THE USE OF LCA (LIFE CYCLE ASSESSMENT) METHODOLOGY

Summary

Key words: intensive agricultural production, impact on the environment, life cycle assessment, nitrogen balance, phosphorus balance, potassium balance, energy efficiency of agricultural production, toxicity index of pesticides

The aim of this work was to assess the impact of intensive agricultural production system on the environment. The study was conducted in the years 2010–2013, in the large-scale farm, located in the Wielkopolska region. Evaluation was performed using the following methods of assessment: balances of nutrients on the farm, energy efficiency of production processes and the impact of use of plant protection products on the environment. For achieving a comprehensive, synthetic assessment of the environmental impact of agricultural production life cycle analysis (LCA) was used. This method enables to identify the source of the environmental threats throughout the production cycle, and thereby allows one to determine the ways to limit the environmental impacts. LCA was carried out from from "cradle-to-farm gate", i.e. from manufacturing the agricultural means of production, through the process of field cultivation, harvesting and crop transport to the customer.

The balance of macronutrients calculated by the "farm gate accounting method" showed balance surpluses: 67.5 kg $N \cdot ha^{-1}$, 3.4 kg $P \cdot ha^{-1}$, 9.1 kg $K \cdot ha^{-1}$, and balance surpluses "at the field level": 50.2 kg $N \cdot ha^{-1}$, 5.5 kg $P \cdot ha^{-1}$ and 25.4 kg $K \cdot ha^{-1}$. The size of the surpluses can be shaped by the technology and the structure of agricultural production. Raw materials and materials, such as fertilizers, pesticides, agricultural machinery, seed had a significant share in total cumulative energy expenditure in plant production. Among the analyzed plant species the highest value of cumulative energy indicator had maize for grain (7.9), and the lowest value had winter rape (4.0). Multicriteria index of the pesticides impact on the environment amounted to on average 63.9 points. Factors that influenced its value were changes in the chemical crop protection as a result of the occurrence of weather extremes. The greatest risk of negative impact of pesticides on the environment arising from the physico-chemical properties and the toxicity of active substances was found for root crops. The results of

analysis of plant production impact on the environment showed that in the development of more environmentally friendly technologies, emission risks related to the use of mineral fertilizers have to be taken into account. Normalization showed that the priority direction in mitigation the environmental impacts associated with intensive plant production should be lowering adverse effect on soil acidification, followed by global warming and eutrophication. Life cycle analysis of intensive agricultural production system related to the overall country condition provides relevant inventory data that can be used in agriculture, food-processing sector and industry. They are source basis for the environmental assessment of products for which agriculture supplies raw material. The total water footprint for winter wheat production amounted to on average 632.5 $m^3 \cdot t^{-1}$, of which 66.2% was green water footprint, and 33.8% grey water footprint. The value of the grey water footprint points to the needs for controlling and reducing water pollution by nitrates coming from the use of nitrogen fertilizers.