SUMMARY

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ASSESSMENT OF ENVIRONMENTAL EFFECTS OF INTENSIVE AGRICULTURAL PRODUCTION SYSTEM AGAINST THE BACKGROUND OF THE CO_2 SEQUESTRATION FUNCTION IN AN AGRICULTURAL SPACE OF FARMS

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The intensification of agricultural production has led to a number of threats to the agricultural environment in recent years, mainly related to greenhouse gas (GHG) emissions, nitrogen compounds emissions, loss of organic matter and the decline of biodiversity. Implementing the requirements of sustainable development of agriculture, it is therefore important that it can not only achieve its primary goal, i.e. food production, but also develop targeted actions aimed at mitigating the effects of climate change and environmental degradation. In international climate policies, farms are often referred to as sources of constant GHG emissions, not paying attention to the fact that agricultural production, as one of the few sectors of the economy, is closely connected with the environmental space. Therefore, in order to objectively assess the environmental effects of an intensive agricultural production system, CO_2 sequestration potential across the entire farm has been taken into account. In the work, a number of indicators were used to assess the sustainability of agricultural production: the N system balance, production energy efficiency, GHG emissions, the carbon footprint of agricultural products, and the organic matter balance. The obtained GHG emission results were compared with the potential for CO_2 sequestration by mid-field afforestation.

A large-scale commercial farm (with an area of over 516 ha of agricultural acreage) located in the Wielkopolska Voivodship was assessed. Based on surveys and farm registers, data on all inputs and fixed assets used and production effects from three consecutive years 2011-2014 were collected. The main direction of agricultural activity on the farm was the cultivation of basic commodity cereals and heifers rearing until calving. Based on the results obtained, an average stocking density of 0.82 LU ha^{-1} was found. The high level of mineral fertilization (272 kg NPK ha^{-1}) allowed for high yields, however, at the expense of N balance surpluses and thus a nitrate pollution risk. Three scenarios for reducing emissions and N surpluses were analysed. The best effects were obtained in the scenario, which assumed the use of mineral fertilizers with

lower N emission factors, while reducing N gas emissions to the atmosphere as a result of changes in the way cattle were maintained and reducing the level of mineral N fertilization by 15 kg ha^{-1}.

The average annual GHG emissions in field cultivation amounted to 1074 t CO_2 eq, while in animal production 1276 t CO_2 eq. When calculated per functional unit, the total GHG emissions were 4.48 t CO_2 eq ha^{-1} and 5.56 t CO_2 eq LU^{-1}, respectively. Fertilization was the main source of GHG emissions in plant production.

In the surveyed farm, 58% of energy was absorbed by raw materials and materials used in production, of which the majority, almost 44%, were mineral fertilizers. In animal production, on the other hand, about 60% of energy was used to produce animal feed. The highest energy efficiency in terms of dry matter yield was obtained in the maize production for silage.

The results of GHG emissions in relation to the area of arable fields were transformed into the value of the carbon footprint of plant products. This indicator was over 0.09 kg CO_2 eq kg^{-1} roots in the production of sugar beet, 0.42 kg CO_2 eq kg^{-1} for winter wheat grain and 0.8 kg CO_2 eq kg^{-1} for winter rape seeds. Analysis of the obtained carbon footprint results in relation to 1 kg of obtained yield gives the opportunity to identify crops in the cultivation of which inputs and energy are most effectively used. In this set of crops, the lowest environmental burden were associated with silages and sugar beets.

Despite the intensive production system, the organic matter balance was positive and amounted to 0.25 t C-humus ha^{-1}. However, analysing individual arable fields with respect to degradation and reproduction of organic matter, a large impact of crop rotation and fertilization with natural fertilizers on the final organic matter balance was noticeable, which due to the generally low content of organic matter in the farm soils (0.8% C org) should be increased.

Field studies of the permanent elements of the agricultural landscape allowed determining the length, density, type and species composition of the existing mid-field shelterbelts, and the average annual sequestration at the level of 371 kg CO_2 ha^{-1} $year^{-1}$. It has been estimated that existing and newly designed shelterbelts would allow for a storage of about 735 kg CO_2 ha^{-1} $year^{-1}$.

The analysis confirms that farms with an intensive agricultural production system, after introducing low-emission solutions into plant and animal production systems, and including mid-field shelterbelts in the balancing of GHG emissions, can conduct their activities in a sustainable manner and contribute to mitigating the adverse effects of climate change.