EFFECT OF ORGANIC FARMING ON CLIMATE CHANGE

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Abstract. *Organic farming has multiple objectives and potential gains, for example, biological diversity, provision of soil quality and animal welfare, avoidance of pesticides and justice in the entire production chain. However, with regard to reducing greenhouse gas (GHG) emissions, this production pathway not always makes a positive contribution; for this reason, a solution is required regarding how to calculate the amount of emissions in organic farming and what opportunities may be regarded as improvements. Maintaining soil fertility though crop rotation, using green manure and livestock manure and reduced soil tillage are the direct techniques for reducing the consumption of energy resources and a more efficient use thereof. However, organic farming provides additional gains; for example, it contributes to the preservation of biological diversity and to animal welfare, supplies local products of natural origin, protects the environment from pollution with chemicals and, in general, ensures sustainable agricultural management.*

Key words: *organic farming, climate change, soil fertility, reduced soil tillage.*

INTRODUCTION

The organic farming movement in the European Union increasingly introduces innovative techniques in agricultural production, which is a good foundation for successful agricultural management and which also reduces greenhouse gas emissions. IFOAM EU Work Programme 2015 notes that organic farming is more stable and sustainable and it can significantly contribute to reducing greenhouse gas emissions in the agricultural industry and promote adaptation to climate change; besides, it is ready to increase its capability to support more ambitious actions aimed at reducing agricultural greenhouse gas emissions at EU and national level. Organic agriculture provides management practices that can help farmers adapt to climate change through strengthening agro-ecosystems, diversifying crop and livestock production and building farmers' knowledge base to best prevent and confront changes in climate. Organic farming practices are positioned in SBSTA's (Subsidiary Body for Scientific and Technological Advice) work as key solutions for mitigation and adaptation of agriculture, improving food and nutrition security and livelihoods of farming communities worldwide. IFOAM EU supports a more effective reduction of GHG emissions within the EU Climate Package 2030 in the whole agricultural sector, including organic farming [2].

CARBON SEQUESTRATION IN SOIL AND ITS ROLE IN REDUCING CLIMATE CHANGE

An annual research study by Rodale Institute in the USA, comparing the organic and conventional agricultural systems, proved that equal yields can be achieved in a long-term if necessary conditions are ensured in both systems. In the organic agricultural system, higher yields are achieved in dry years, as this system contributes to the formation rather than the depletion of organic matter in soil, thus making the system more sustainable. Rodale Institute scientists have calculated that organic farming consumes 45% less energy and the energy is used more efficiently, while the conventional agricultural system produces 40% more greenhouse gases; this system turned to be economically more efficient than the conventional one [7].

However, a 21-year research study (DOK-Trial) by the Research Institute of Organic Agriculture (FiBL) in Switzerland showed that crop yields in organic farming were approximately 20% lower than those in conventional farming that used fertilisers; at the same time, the amount of nitrogen brought into the organic and the biodynamic system was 65%, phosphorous 40% and potassium 45% less. In a long-term, the account of nutritional elements brought in/out showed that all the researched systems received less nitrogen than it was necessary for crops (the additional nitrogen withdrawn was derived from soil mineralisation, nitrogen fixation by leguminous plants, and aerial deposition). The deficit of phosphorus and potassium in the organic system was even greater; therefore it is important to regularly determine the amounts of nutritional elements in soil and the biogenic reserves available for crops.

Like in the research study by Rodale Institute, Swiss scientists have also calculated that the production of organic crops requires 30-50% less energy per area unit than in conventional production (for the production of energy, fertilisers and pesticides). Although the yield per area unit in the conventional system is higher, energy consumption per unit in the organic system is 19% lower [11].

The lack of mineral elements is one of the key distinctions between the organic and the conventional management system; accordingly, a much greater role is played by green manure from crop rotation, especially stressing the availability of nitrogen for crops. A more appropriate organic management model involves mixed crop-livestock farms where the source of nitrogen is manure. However, in this respect, it is important to assess the effects on the environment, as the density of animals and the amount of manure produced are interrelated variables [3]. The greatest emission reduction potential in agriculture relates to carbon sequestration in soil where the greatest role is played by organic farming, which, in this respect, may be placed on the same level with growing leguminous crops and using manure. Yet, it is important to optimise the soil fertility maintenance system, assessing the link between the rotation of crops, the type of soil, fertilisation and carbon sequestration in soil. Optimisation in the livestock industry requires a global vision, accounting for life-cycle emissions of feed production. By feeding coarse fodder, emissions decrease; yet, the most effective way is to radically reduce the number of livestock, which is possible in the organic system, as the density of animals in such farms is lower. This aspect has to be taken into consideration beyond the agricultural industry, changing the food consumption habits in the society, for example, the consumption of meat has to be reduced or attitude to food waste has to be changed. Organic farming is well positioned as a way of mitigating climate change in a systemic context; therefore, if seeking for ways how to mitigate climate change, change in attitude is also needed in conventional agriculture. One has to understand the significant role of carbon sequestration in soil, and one has to focus on a global approach to sustainable systemic and multifunctional agriculture [5]. Financial assistance for transition from the conventional to the organic system or for introduction of climate-friendly practices on crop and livestock farms could be an important step towards agricultural sustainability; besides, organic farming makes a significant contribution to the production of products of plant and animal origin:

- in the process of production of crop products, composts are used, biological waste and manure are stored and used for soil fertilisation, biogas is produced and the burning of biomass is avoided in agroforestry to maintain the balance of carbon in soil. Given the fact that the agricultural area is large, carbon sequestration in soil has a large potential to mitigate global climate change;
- the key focus in the production of livestock products is placed on the reduction of greenhouse gas emissions per unit of product produced. The reduction of use of feed concentrates has a large potential, as the use of land, to a great extent, affects the production of feed concentrates. It is difficult to determine a direct gain from carbon sequestration, but additional gains are important, for example, energy efficiency, biodiversity, a greater amount of organic matter in soil, higher soil fertility and the whole system's stability and endurance in a long-term [6].

APPLICATION OF REDUCED SOIL TILLAGE

One of the most effective ways of reducing GHG emissions is to minimise soil tillage, thus decreasing the consumption of energy resources. Using such a technique in the organic management system can lead to lower crop yields; yet, research studies show that a decrease in yields not always correlates with the intensity of soil tillage, but usually yields decrease if the intensity of soil tillage is reduced. Reduced soil tillage affects the yields of leguminous crops to a smaller extent and the rotation of crops also does not influence the differentiation of yields. An increase in weediness is a greater risk, which can make a greater contribution to lower yields.

Organic farming has to provide ecosystem services of conservation agriculture, while at the same time maintaining crop yields consistent with all optimal agricultural and technological activities (crop rotations, crop choice and tillage intensity). Deep soil tillage has to be performed in the beginning of crop rotations when weeds have to be intensively controlled, green manure has to be incorporated into soil or permanent grasses have to be restored. Yet, it has to be taken into account that deep ploughing can cause immediate loss of accumulated soil organic carbon and that large pores built by earthworms and roots may be disrupted. It is useful to employ a double-layer plough for primary tillage or some other specific tool, for example, chisels with large goose feet sweeps or a stubble cleaner to undercut the soil and thereby control weeds, and special ploughs to superficially till the soils may still be useful. However, traditional tools can be also used in minimal soil tillage [1]. No-till or minimal soil tillage techniques have to be employed as conserving soil tillage techniques with high potential to restore or improve the functions of soil and significantly mitigate climate change. Yet, in the temperate climate zone, the use of green manure and minimal tillage, which positively affects soil qualitative characteristics, for example, the amount of carbon in soil, the biomass of microorganisms in soil and fermentation in the upper layer of soil, are the most appropriate. However, according to research studies, the positive effects of crop rotations on microorganism communities, bacteria, fungi and earthworms are stronger than soil tillage effects. The introduction of crop rotations and minimal tillage reduces carbon emissions and labour consumption. It is suggested that reduced soil tillage in organic farming can contribute to a more flexible crop system in the future [4].

EMISSION REDUCTION OPPORTUNITIES

According to a number of researchers, nitrous oxide emissions from organically managed soils are 492 ± 160 kg CO_2 eq. $ha^{-1}a^{-1}$ smaller than from non-organically ones. The difference in emissions from arable land reaches 497 ± 162 kg CO_2 eq. $ha^{-1}a^{-1}$. However, if measured per unit of crop yield, nitrous oxide emissions are greater by 41 ± 34 kg CO_2 eq. $ha^{-1}a^{-1}$ DM. To equalise the difference in nitrogen oxide emissions between both types of farming, the difference in yields has to be less than 17%. In the conventional system, nitrous oxide emissions mostly arise from the use of nitrogen fertilisers, whereas in the organic system, in this respect, soil properties are more important. It may be explained by faster availability of non-organic fertilisers, whereas in the organic system N mineralisation takes place at a much slower pace [9]. In the conventional system, nitrification inhibitors, which reduce the activity of soil bacteria and thus hinder the process of denitrification, are an effective means for mitigating environmental problems and improving the use of nitrogen. An inhibitor is added to the fertilisation product that contains ammonia and carbamide in order to increase the effectiveness of use of N fertilisers, reducing nitrogen leaching and emissions [10]. In the organic system too, using liquid manure, it is possible to add an inhibitor for the purpose of increasing the absorption of N from slurry, reduce its leaching loss and N_2O and NO emissions, especially if fertilising grassland [8].

CONCLUSIONS

By optimising the soil fertility maintenance system, assessing the link between the rotation of crops, the type of soil, fertilisation and soil carbon sequestration in the organic farming system, it is possible to reduce GHG emissions.

The introduction of green manure in combination with a minimal soil tillage system reduces GHG emissions from organic farming.

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