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ENVIRONMENTAL EFFECTS OF CONVENTIONAL FARMING TECHNIQUES

Z.K. HASHIM[1,2] - V.M. VONA[3] - A.G.S.D. DE SILVA[1,2] - I.M. KULMÁNY[1,2]
[1,] Széchenyi István University, Agricultural and Food Research Centre, Győr, Hungary
[2,·]Széchenyi István University, Albert Kázmér Faculty of Agricultural and Food Sciences, Department of Plant Sciences, Mosonmagyaróvár, Hungary
[3,·]Széchenyi István University, Albert Kázmér Faculty of Agricultural and Food Sciences, Department of Water Management and Natural Ecosystems, Mosonmagyaróvár, Hungary

ABSTRACT

The green revolution has increased crop yields and population but poses environmental challenges. Conventional practices, including heavy use of agrochemicals, contribute to environmental harm. The agriculture sector now accounts for 23% of all anthropogenic greenhouse gas (GHG) emissions. Synthetic fertilizers double food production but cause nutrient pollution. Conventional practices, such as frequent ploughing and heavy machinery, cause soil degradation, erosion, and soil health disruption. Compared to conventional tillage, conservation tillage enhances soil organic carbon and soil nitrogen. Herbicides used in weed management negatively affect non-target plants, water, and the development of herbicide-resistant weeds. Improper agricultural practices, such as crop cultivation, pesticide, irrigation, soil processing, burning, and animal waste, increase GHG emissions. Sustainable agriculture practices and technological advancements are crucial for environmental challenges.
Keywords: greenhouse gases, agriculture, environmental challenge, conservation tillage

INTRODUCTION

The deployment of large machinery and high-input farming methods in modern agriculture is one of the major causes of anthropogenic greenhouse gas (GHG) emissions. According to the US EPA (2023), 23% of the world's GHG emissions come from the agriculture sector, primarily from the release of nitrous oxide (N2O), methane (CH4), and carbon dioxide (CO2) in 2022. Numerous factors contribute to these emissions, such as the usage of chemical fertilisers, animal production, and mechanised farming.

Over 70% of the freshwater resources in the world are used in agriculture, with a large amount going towards irrigation. Nevertheless, there are drawbacks to this crucial practice. In addition to contributing to salt build-up, anaerobic breakdown, and changing

temperature and pressure patterns, it depletes aquifers, rivers, and groundwater. In addition to causing habitat loss and coastal erosion, irrigation also modifies rainfall patterns (*Ruhl*, 2000).

Although the use of fertilisers including phosphate and synthetic nitrogen (N) has greatly increased food production, it has also resulted in a sixfold rise in reactive nitrogen (Nr) in the environment. These fertilisers produce N_2O, a powerful GHG, into the atmosphere and contaminate groundwater through N runoff (US EPA 2022).

Despite being essential for weed control and soil preparation, traditional tillage techniques have drawbacks. They worsen soil erosion and release carbon from the soil, which raises CO_2 and CH_4 emissions (*Alam et al.*, 2016). Conventional tillage reduces organic matter and upsets microbial populations in the soil. The widespread use of pesticides, particularly herbicides, in industrial agriculture reduces biodiversity, harms biodiversity, contaminates water sources, and endangers aquatic habitats (*Ruhl*, 2000; *John and Babu*, 2021).

Finding a balance between the need for more agricultural output and environmental sustainability becomes increasingly important as the world's population grows. Given the interrelated problems of addressing environmental degradation, mitigating climate change, and providing food security for an expanding population, conventional farming methods can no longer be sustained. Innovative technologies and sustainable agricultural practices are essential to addressing these urgent environmental issues. This paper examines the various ways that traditional farming practices affect the environment and highlights how urgent it is to transform into more ecologically friendly practices.

METHODOLOGY

A review of existing literature and research studies related to the environmental effects of conventional farming techniques was conducted. Data from various sources, including international reports, scientific publications, and environmental organizations, regarding the impact of conventional farming practices on the environment were collected from different sources. This includes data on greenhouse gas emissions, synthetic fertilizer usage, soil degradation, and pesticide effects. A conceptual diagram was prepared based on the existing knowledge in the literature. The collected data was reviewed to identify trends, correlations, and the extent of environmental impacts caused by conventional farming techniques.

IMPACTS OF CONVENTIONAL FARMING TECHNIQUES

The fundamental elements of conventional and sustainable farming are the same and include waste management, crop and disease management, water management, and soil management. The techniques employed are frequently very varied. The following areas should be compared between conventional and sustainable agriculture, yield, biodiversity, soil erosion and composition, water and energy consumption, and

greenhouse gas emissions. The overall efficacy of any method as a countermeasure to increasing tendencies will depend on how it affects the environment and how much it produces. These comparisons are essential to determine the most effective farming technique that can meet the demands of the present population sustainably (*John and Babu*, 2021).

Farming to achieve the highest level of productivity is attainable with the use of modern technology but without considering environmental pollution and food safety.

The effects of long-term conventional agricultural practices since the industrial revolution are desertification, groundwater pollution by pesticides, water scarcity in many places, loss of wetlands and wildlife habitats, global climate change, destruction of forests, and endangering the health of humans (*Ruhl*, 2000).

Figure 1 shows the conceptual portrait of how conventional practices lead to multifaceted environmental impacts while considering only the high-yield target.

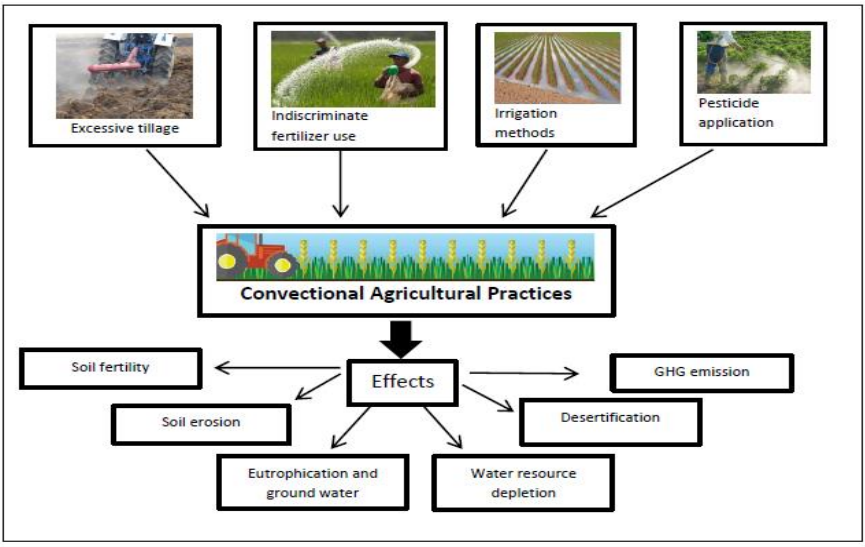

Figure 1: Conceptual diagram showing the practices followed for conventional agriculture and their components that lead to soil health and environmental concerns around the world

The yields of key crops like wheat, rice, and maize have increased dramatically due to the widespread use of synthetic fertilisers and agrochemicals, essentially tripling the world's food production. Nonetheless, there has been a significant environmental cost associated with this astounding rise in agricultural output. Despite being essential for food security, synthetic fertilisers have unintentionally led to nutrient contamination, which has a detrimental impact on aquatic ecosystems and water bodies (*John and Babu*, 2021).

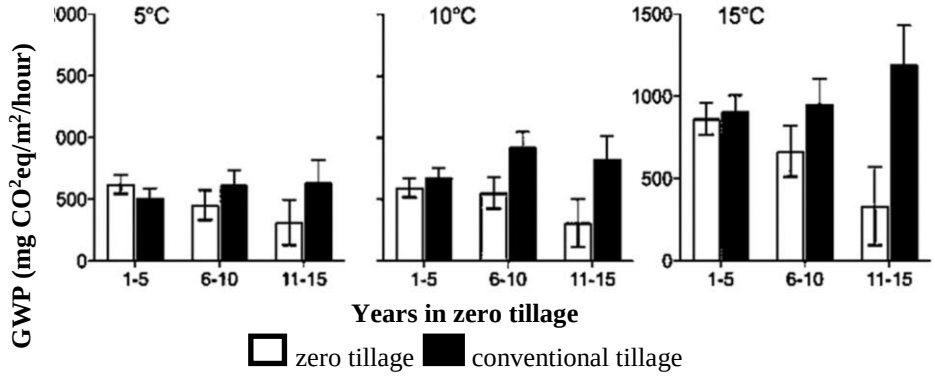

Figure 2: Global warming potential grouped by a length under zero-tillage with adjacent conventionally tilled pairs incubated at 5 °C, 10 °C and 15 °C. Adapted from Cooper et al. (2021).

Crucially, Cooper et al. (2021) demonstrate that the Global Warming Potential (GWP) from zero-tilled soils was much smaller than at the paired traditionally tilled soils when fluxes of all three GHGs are taken into account (*Figure 2*). When incubated at 10°C and 15°C, respectively, the mean GWP of emissions from the conventionally tilled soils was 33% and 36% higher than that from the zero tillage managed soils. Higher rates of CH_4 oxidation and lower CO_2 emissions were the main causes of the decreased GWP (*Figure 2; Cooper et al.*, 2021).

Conventional farming ignores the naturally occurring soil spatial heterogeneity and crop conditions among and within fields in favour of managing resource inputs (i.e., fertiliser, irrigation water, amendments, and pesticides) evenly. Over and underuse of resources arise from the homogeneous use of inputs (*Corwin and Scudiero*, 2019).

Soil erosion resulting from dryness, salt, runoff, and nutrient loss is a significant issue in agriculture. Because "intensive farming exacerbates these phenomena, which are threatening the future sustainability of crop production on a global scale, especially under extreme climatic events such as droughts," soil erosion poses a challenge to the expansion of agriculture (*Gomiero et al*., 2011). Moreover, erosion alters soil carbon dynamics, leading to non-point source water contamination and the release of trace gases, while deposition effectively sequesters carbon (*Lal*, 2001).

For conventional agriculture to produce, prepare, and deliver food, a staggering amount of energy is needed. Energy efficiency is crucial to agriculture because it can lower production costs and reduce GHG emissions (*Gomiero et al*., 2011). The agricultural sector plays a substantial role in the generation of GHG emissions, however, it also possesses the potential to alleviate this environmental impact through the adoption of sustainable practices.

Enhanced agricultural land management is crucial to mitigate the impacts of crop production. *Alam et al*. (2020a) indicated that the implementation of conservation agriculture practices has altered the cycle of N by decreasing the amount of mineral N

that is accessible to plants during the initial stages of the growing season when the demand for nutrients by crops is low, but by increasing the total of N in the soil and plant N uptake which enhanced the synchrony between the demand for crops and the availability of nitrogen supplies.

Many alternatives to tillage practices (zero/no-tillage, strip tillage, non-puddling of rice, direct seeding of rice (*Alam et al*., 2020b), pesticide use (Integrated Pest Management, Biocontrol agent use, etc.), fertilizer management (4R nutrient stewardship, localized application, organic farming, CA, etc.) and varietal development (herbicide-resistant variety, fourth generation pesticide development) have been developed to fit in the conventional farming so that agricultural farming turns into sustainable form.

CONCLUSION

Conventional agricultural practices have increased crop yields, but it has also brought up environmental problems. Increasing amounts of GHG emissions and issues like soil degradation, water pollution, biodiversity loss and water resource depletion are caused by conventional farming in keeping with increasing crop production. Technology development, modification of practices to fit traditional practices in a sustainable way and sustainable practices are essential for resolving these problems.

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