

## **Abstract**

At the dawn of the present century, principal global issues include the accelerated greenhouse effect, emission of CO<sub>2</sub> and other GHGs from agricultural practices and food security in relation to soil and environmental degradation. Agriculture is the largest contributor to anthropogenic emissions of greenhouse gases, so the quantification of different agricultural practices is essential for identification of more sustainable practices. Nowadays, carbon footprinting must be harnessed as a strong tool to promote GHG emission reductions from the production of grain crops and is considered a new indicator for farm management. Wheat is a strategic crop for Iran with respect to food security and environmental impact. In the Northeastern Golestan Province irrigated and rainfed wheat production systems co-exist. In the light of climate change the comparative assessment of the two systems regarding productivity and sustainability is of urgent importance. Based on the collected data from 540 wheat production farms in two irrigated and rainfed systems of Golestan province, all different activities and consumption of inputs, which each farm manager normally have done or consumed during the past three years have been registered. Documentation results show that the average area of irrigated farms was more than rainfed farms. Most of irrigated farms were cultivated by two summer crops including soybean and rice before sowing wheat. Most of rainfed farms had no summer crop but they were cultivated by wheat and barley in the previous year of sowing wheat. Most of producers of irrigated and rainfed wheat have used the moldboard and disks as a primary tillage. In addition, the most type of equipment which used in cultivation of wheat in both systems was grain drill. Morvarid cultivar was the dominant cultivar which used in both irrigated and rainfed wheat systems. Applying more extended sowing window in rainfed system comparing with irrigated system was another result of this survey. Half of farmers have used at least 95 and 70 kg Nitrogen fertilizer (equivalent to 200 and 150 kg of urea fertilizer) in the irrigated and rainfed investigated farms, respectively. In both systems, Geranstar and Topic were the most used herbicides, Tilt was the most used fungicide and Diazinon was the most used pesticide. Farmers preferred to use of conventional irrigation for their farms. The harvesting time of wheat was ranged from the early May to middle of June. The average yield of irrigated wheat was more than rainfed wheat. The present study investigates productivity and environmental impact of wheat production in Golestan

using greenhouse gas (GHG) emissions and product carbon footprint (PCF) as environmental sustainability indicators. The huge heterogeneity identified among wheat producers with regard to yield, GHG emissions and PCF, highlights the potential for improving crop management of a large share of farmers. In comparison irrigated production realizes significantly higher yields than rainfed production. However, the more than twice as high GHG emissions per land unit in irrigated compared to rainfed production result in a significantly worse PCF of irrigated ( $0.9 \text{ kg CO}_2\text{-eq kg}^{-1}$ ) compared to rainfed wheat ( $0.6 \text{ kg CO}_2\text{-eq kg}^{-1}$ ). The major contributors to total GHG emissions of wheat production are energy for irrigation (only in irrigated production),  $\text{N}_2\text{O}$  emissions related to fertilization and residue handling, diesel for machinery, and emissions related to fertilizer production and transport. The observed trade-off between productivity and sustainability is also confirmed on the sub-regional level. Among others the study concludes that input intensity should be higher in irrigated compared to rainfed production to better balance productivity and climate change impact.

**Key words:** Sustainability Index; Carbon Footprint; Greenhouse Gases Emission; Rainfed and Irrigated systems; Documentation



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