Impacts of Conservation and Precision agriculture management practices on energy use and carbon footprint of winter cereals

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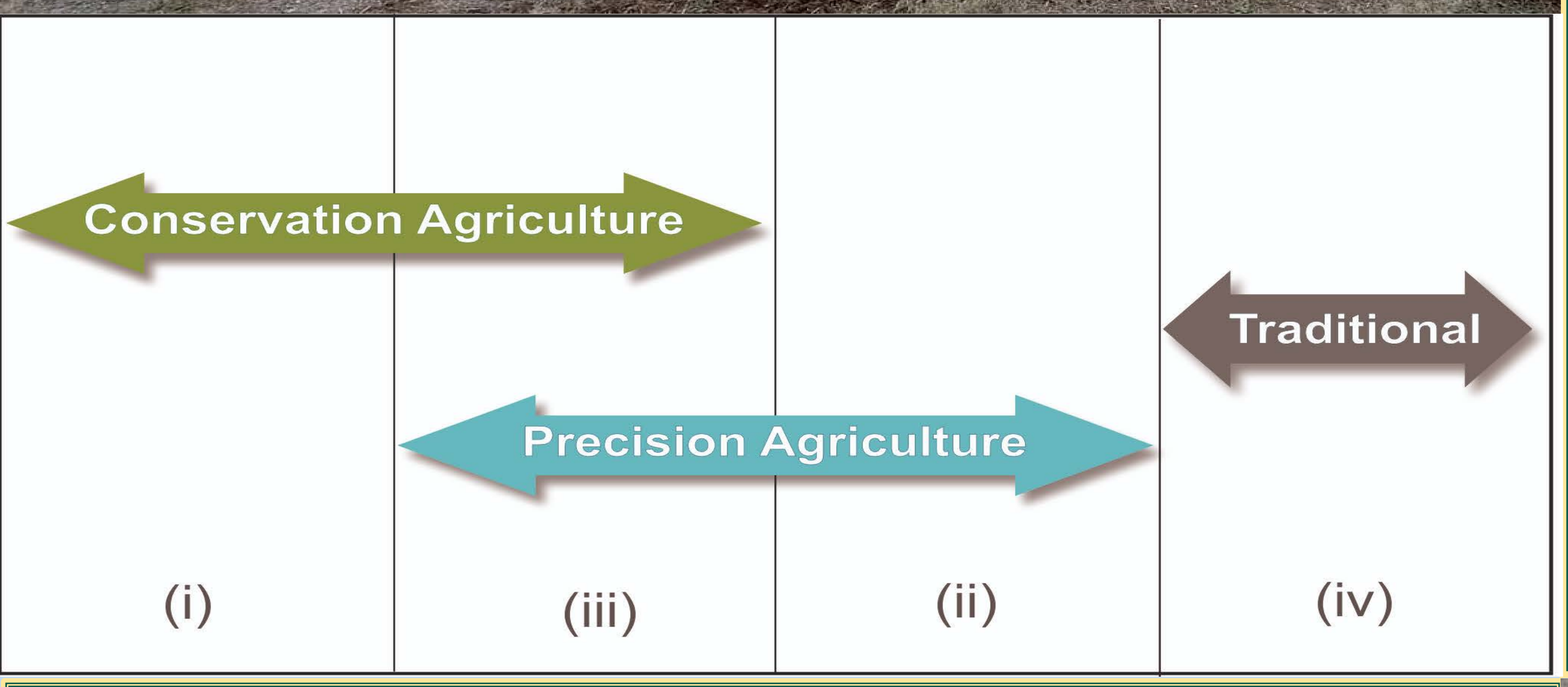
Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

INTRODUCTION - SCOPE

Conservation agriculture and **precision agriculture** are two major components for the broader concept of Regenerative Agriculture that aims on rehabilitation of soil and ecosystem's function, eliminating the dependence and the risks for pollution aroused from the use of chemical inputs, and assisting on the mitigation and adaptation to the climate change. The current study presents preliminary findings from the first year of the project "**PreConAgri**", which is an operational group funded by the Greek Ministry of Rural Development and Food under Measure 16. The project aims at demonstrating the co-benefits of Conservation and Precision Agriculture techniques applied in **winter wheat production on soil quality**, crop productivity and climate change mitigation. To that end, an **energy use and greenhouse gasses** (GHGs) emissions analysis was performed over data collected from four pilot fields in two Greek regions with severe erosion problems, Kozani and Larissa. Two pilot fields were established in each region, and each pilot consisted of four plots with alternative management regimes: Conservation agriculture (CA), Precision agriculture (PA), Conservation and Precision agriculture (CPA) and Control (C).



MATERIALS AND METHODS

Sowing on no-till in the CA and CPA treatments were performed with the help of two direct drilling machines, a Kuhn SDLiner 3000 that was used at the two fields of Larisa and a Gaspardo Diretta that was used for the Kozani pilots. The C and PA treatments were sown with the traditional farmer's sowing machines.

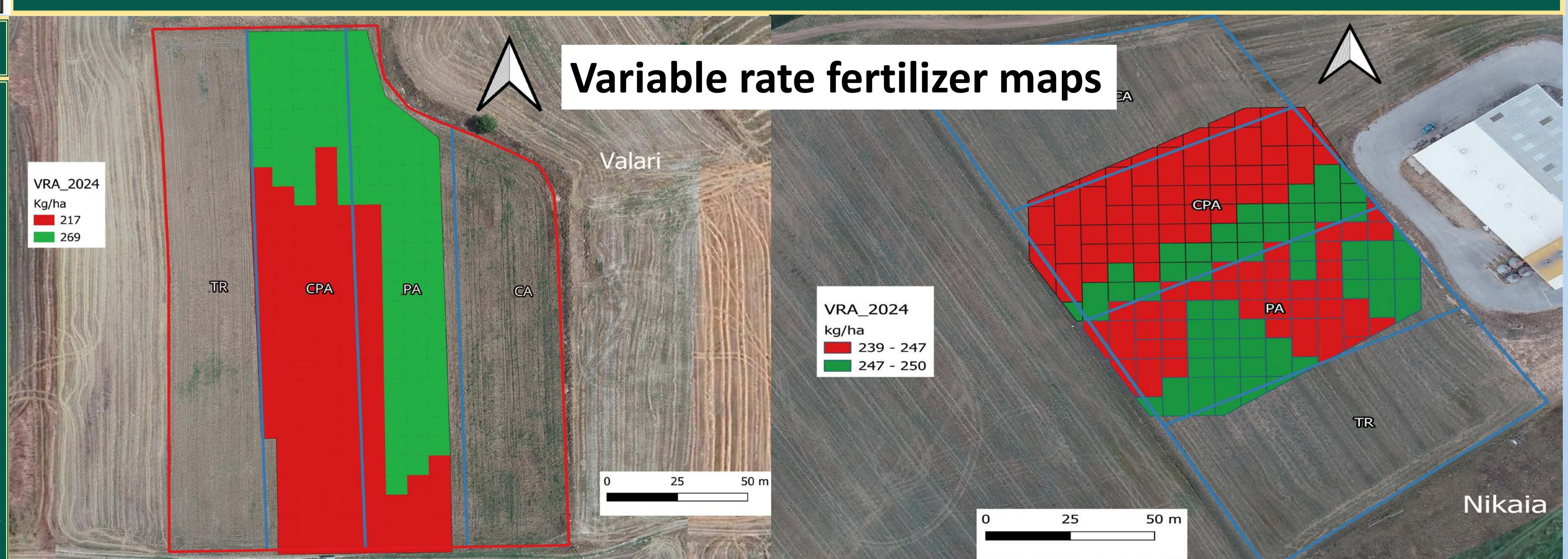
Precision agriculture includes the techniques of variable rate fertilization (VRF) and controlled traffic farming (CFT). VRF concerned the superficial spring nitrogen applications but not the basal fertilization performed during sowing. In Kozani, the VRF was performed with the help of a commercial variable rate device (Augmenta Field Analyzer, Raven Industries Inc.). The device uses a video multispectral sensor and AI technology to record a company defined vegetation index called "Augmenta index".

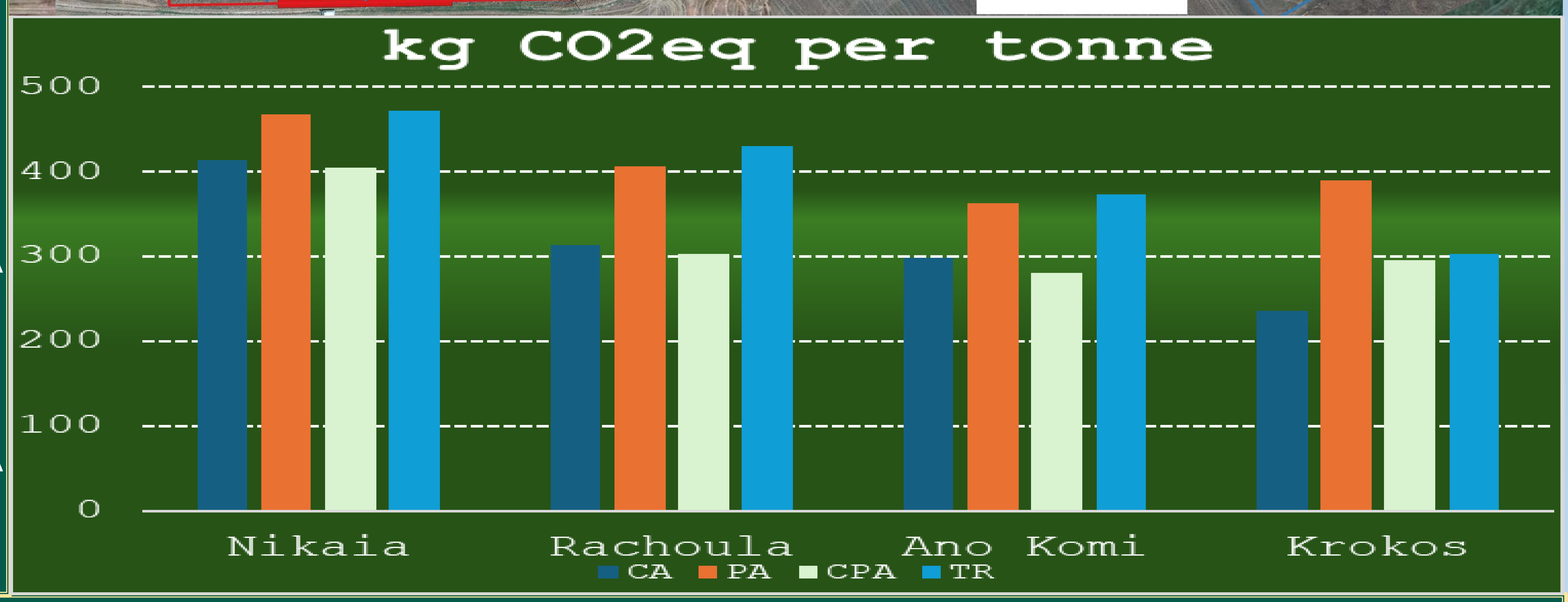
Energy use and carbon flows were estimated with the Cool Farm Tool (v2.11.0) [https://coolfarm.org/]. The tool provides scientifically robust assessments for greenhouse gasses cycles, water footprint, biodiversity, food loss and waste for open farming and livestock. In the present study, the greenhouse pathway was followed. The outputs of the analysis provide information about CO2, N2O and CH4 emissions, all expressed as CO2 equivalents (CO2eq) per ha and per tonne of product as well as information about the diesel and electricity consumption and the energy usage.

RESULTS AND DISCUSSION

The first-year results showed that conservation agriculture provided a considerable **energy saving** from diesel usage. Compared to the traditional farmer practices, CA reduced the energy usage from the range of 2.23 - 3.15 MJ/ha to 1.43 - 1.72 MJ/ha, a reduction of 35.9 to 49.7%. Precision agriculture with VRF on the other hand was capable of reducing the nitrogen usage during the spring applications from 4.8 to 8.8%. The savings on energy and nitrogen resulted in a respective reduction of GHGs emissions. In addition, CA provided soil carbon stock changes of 57 to 133 kg CO2eq per ha resulting on a total GHGs mitigation of 97.3 to 109.1% higher compared to the control while precise fertilizer application prevented soil NO2 losses by 3.2 to 5.9%.

Crop yield in CA was -4.5% lower to 1.3% higher compared to the control. PA affected the yield from -1.6% to 3.1%. The CPA treatment that combined conservation and precision agriculture practices resulted on yield changes from -4.9 to 0.9%. Expressing the GHGs changes per tonne of product it was estimated that CA provided CO2eq savings of 12.6-27%, the PA savings of 1-5.5% and the CPA combination savings of 14.3-29.5%.





CONCLUSIONS

The results highlight the importance of conservation agriculture as a core element practice for mitigating GHGs emissions into a regenerative farming approach. Variable rate fertilization proved also a valuable practice for reducing GHGs but also, eliminating the risks for groundwater pollution, a thread that wasn't evaluated on this study. Another impact that this study wasn't able to evaluate during the first year was the energy savings from controlled traffic farming because it will start on the second one. Overall, **the combination of conservation and precision agriculture practices provided the best results with synergistic co-benefits on soil GHGs emissions**.

ACKNOWLEDGEMENTS

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