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Science brief from the ZEF-UNESCO project on Sustainable Management of Land and Water Resources in Khorezm, Uzbekistan

Fertilizing the air or the land? How Uzbek farmers and the environment can gain by changing cropping practices

Summary

This brief presents results of studies carried out in the irrigated areas of Khorezm to assess to what extent the dominant agricultural land-use systems of this region contribute to the emissions of nitrous oxide (N₂O) and methane (CH₄), two major gases belonging to the so-called greenhouse gases. It also shows ways to alter it.

Greenhouse gases and global warming

In Uzbekistan, carbon dioxide (CO₂), the most important anthropogenic greenhouse gas worldwide, also accounts for the largest proportion (70%) of greenhouse gas emissions, originating mainly from energy production. However, there are two other major greenhouse gases: methane (CH₄) and nitrous oxide (N₂O), which account for 24% and 6% respectively of Uzbekistan's total greenhouse gases. Agricultural production is a major source of emissions of methane (CH₄) and nitrous oxide (N₂O); 90% of the nitrous oxide (N₂O) in the country is emitted from agricultural soils following the application of N fertilizers, whereas 10% of its CH₄ emissions stem from rice production and ruminant livestock.



Background

Nearly eight million hectares of land in the five central Asian countries are being used for irrigated agricultural production. However, irrigation water not only stimulates plant growth but also affects the cycling of nutrients between soil, plant and atmosphere that occurs in all ecosystems at the field and landscape level.

The predominant irrigation method in the Aral Sea region is flood irrigation. Flooding the fields not only affects the hydrological cycles, but also accelerates the microbial turnover of carbon (C) and nitrogen (N) in the soil. Under the wet soil conditions immediately after irrigation, soil bacteria manage to convert the nitrate in the fertilizer into molecular nitrogen



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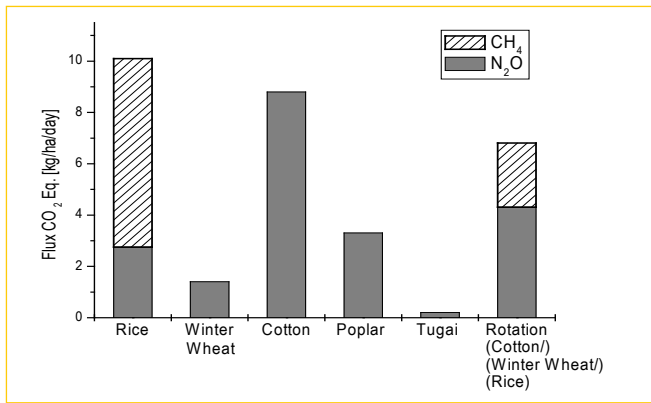


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(N₂), nitrous oxide (N₂O) and nitric oxide (NO). In addition, under the anaerobic soil conditions found in flooded rice field soil, bacteria can convert soil organic material into methane (CH₄) and lowland rice cultivation has been acknowledged as a major source of atmospheric methane. These gaseous compounds leak into the air and contribute to air pollution and global warming. Farmers in Khorezm often put very large quantities of mineral nitrogen fertilizers (i.e. ammonium nitrate, urea) on their fields and also apply irrigation water excessively: around 18,000 cubic meters per hectare, compared with the roughly 6,000–8,000 cubic meters needed under optimized management conditions. This means that high fluxes of molecular nitrogen (N₂), nitrous oxide (N₂O), nitric oxide (NO) and atmospheric methane (CH₄) gases can be expected as a result of irrigation. In fact, emission takes place all the time on the cotton, wheat and rice fields, which together cover about 70% of the country's agricultural land.

GHG emissions from irrigated agriculture in Khorezm

The studies carried out at ZEF show that crops commonly grown under irrigation produced high emissions of nitrous oxide (N₂O) in the case of cotton and wheat fields, and even higher emissions of CH₄ in the case of flooded rice fields. The flux of nitrous oxide from the soil varied during the cropping season and depended on which N fertilizer was used and which irrigation management methods were implemented. But 80–95% of the total nitrous oxide flux in cotton and wheat occurred in short bursts immediately after fields received fertilizer plus irrigation water.

Thus, greenhouse gases emissions and the corresponding global warming potential – which is an estimate of how much a given mass of greenhouse gas contributes to global warming in relation to carbon dioxide (CO₂) – depended on how the cropping land was being used. The highest global warming potential was found in areas with rice and cotton cultivation. For example, a two-year rotation of cotton-wheat-rice produced on average the considerable amount of 2.5 tons of CO₂ equivalents per hectare per year. This means that if all the irrigated farmland in Uzbekistan (4.3 million hectares) had the same emission rates, it would produce nitrous oxide and methane fluxes totaling 10.5 million tons of CO₂ equivalents per year. This figure equals about 7% of the country's total man-made emissions, whereas the energy sector accounts for 83% of overall emissions.

One might argue that 7% of Uzbekistan's total emissions of greenhouse gases is only a small portion. However, any reduction in greenhouse gases is beneficial, since lower irrigation-related emissions are in line with policies for sustainable development, improving environmental quality, and making better use of scarce water resources. But there is more.

Improving fertilizer use efficiency and reducing greenhouse gases emissions

What should make farmers and policy-makers think is that these same figures also indicate that up to 70% of the nitrogen fertilizers do not end up where they should be – in the plant – but in the atmosphere instead. This implies a low rate of efficiency of fertilizer use by the individual farmer and means that a substantial amount of money which farmers spend on fertilizers does not make any contribution at all to their yields. The financial loss for overall irrigated farmland in Uzbekistan is assessed on US\$ 36 million spent on fertilizers per year. Thus, improving fertilizer use efficiency would not only reduce emissions of greenhouse gases from irrigated farmland, but would also contribute to saving farmers' money.



How can this be achieved?

Modified management practices, such as sub-surface N fertilizer application and drip irrigation can increase fertilizer use efficiency and therefore reduce emissions of greenhouse gases. Switching land from annual crops to perennial forest plantations or cultivating these forests on marginal lands would reduce land degradation as well as N₂O and methane fluxes. Above all, it would reduce farmers' consumption of N fertilizers and fuel, which together account for over 40% of total production costs.

A mix of improved land use practices and modified cropping systems would thus offer the potential to increase both N fertilizer use efficiency and farmers' incomes, whilst at the same time reducing emissions of greenhouse gases from these irrigated agricultural systems.

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