Nat. Volatiles & Essent. Oils, 2018; 5(2): 140-148
https://doi.org/10.52783/nveo.5488

Influence Of Agricultural Conservation Practices On Soil N_2o Emissions

MAHESH BHATT

Department of School of Architecture and Planning, Graphic Era Hill University, Dehradun, Uttarakhand, India 248002

ABSTRACT

The agricultural sector is both susceptible to and a net generator of human greenhouse gases (GHG), making it a key player in the climate change crisis. But with better management, agriculture could cut down on emissions and potentially become a net sink for greenhouse gases. Enhanced methods that cause less soil disturbance have been shown to have the potential to store carbon (C) from the atmosphere as organic matter in the soil. It is not as clear, however, how these methods affect emissions of soil N2O, a powerful GHG. Both the impact on greenhouse gas emissions and the likelihood of widespread adoption of these strategies by farmers must be evaluated. In this study, I looked at why farmers in India's Great Plains are switching from tilling to no-till (NT), and how it could affect the amount of farmland that is eventually turned into permanent grassland.

KEYWORDS N_2O emissions, Agriculture, GHG, soil

INTRODUCTION

More frequent occurrences of severe weather are linked to global warming, which is the primary cause of the Earth's climatic shifts. Due in large part to agricultural and industrial activity, the amount of greenhouse gases (GHGs) in the atmosphere has been steadily rising since the Industrial Revolution. The absorption of long-wave energy by GHGs and their subsequent release to the surface, which raises global temperature, contributes to the warming of the Earth's surface through the receipt of energy in both short and long waves. Global temperatures have increased by more than 1 °C beyond their pre-industrial levels during the last century, which has had an impact on the planet's weather. In addition to boosting food production, the acceleration of economic expansion has prompted the increased extraction of minerals and fossil fuels. One of the most pressing concerns of the last several decades is climate change. It is becoming more accepted that human activities are contributing to environmental changes, despite the fact that climate has fluctuated naturally throughout history.

Agricultural practices have had a profound effect on the nitrogen (N) cycle and the ecosystem as a whole due to the release of nitrogenous gases. National statistics on anthropogenic emissions of carbon dioxide, methane, and nitrous oxide are being monitored and published as a consequence of the 170 countries that have signed the Kyoto Protocol of the United Nations Framework Convention on Climate Change. Since Bouwman's research used a default emission factor of 1.25 percent of all nitrogen delivered to the soi, the IPCC advised a Phase II technique for creating national inventories of N2O from agricultural land. Climate, management practices, irrigation, soil, and crop types are only some of the other variables that have been shown to affect N2O emissions but aren't accounted for here.

LITERATURE REVIEW

Hossein Ali. Alikhani et.al (2018) When comparing CA to traditional farming, changes in soil characteristics and microbiological activities are most noticeable. Greenhouse gas (GHG) fluxes between the soil and atmosphere may be influenced by these shifts. In this review, we compiled the findings from the international literature and identified the gaps in our knowledge of how to measure and explain GHG fluxes in both CA systems and traditional agriculture. The findings of tests comparing conservation agriculture, no-till systems, and conventional farming with regard to soil carbon sequestration and soil respiration were inconsistent. research have shown that no-till increases N2O emissions compared to conventional tillage, whereas other research have found no difference between the two. The mechanisms and processes that impact soil GHG fluxes are poorly understood in the vast majority of CA investigations due to a lack of needed information. Environment, plant residues, soil, crop rotation, cover crops, and study length are disregarded as potential determinants. Most research has employed the static chamber approach to measure soil-atmosphere GHG fluxes. Since GHG flux rates are extremely variable in space and time, the static chamber technique risks over- or underestimating the flux balance by missing a portion of highly episodic occurrences. Accurate GHG balance may be calculated with the use of established procedures for monitoring continuous fluxes.

Guihua Chen et.al (2017) Nitrous oxide (N2O) is a major contributor to stratospheric ozone loss. Seventy-five percent of the world's anthropogenic N_2O emissions come from agricultural soils. Conservation tillage's impact on carbon sequestration in farming systems has received a lot of research attention as of late. However, there is little data on how these methods affect N_2O emissions, particularly in organic vegetable farming. Because of this, researchers in the US Mid-Atlantic coastal plain compared the N2O emission rates of a conventionally tilled field and a conservation-tilled field transitioning to organic vegetable cultivation over the course of three years. Winter cover crops of a different variety were produced each year then flail-mown in April. Forage included radishes, red clover, and rye. During the vegetable growing season, more than 80% of the yearly N2O-nitrogen emissions occur. All of CT-BG, CT-BP, CT-ST, and NT had the same annual N2O-N emissions. N2O-N emissions were found to be at their lowest in NT and ST and their greatest in CT-BP and CT-BG. N mineralization was boosted by conventional tillage, and mulching with plastic, which increased soil warmth, increased N2O-N fluxes. Despite having a greater water filled porosity and a significant correlation with N2O-N fluxes, NT had the lowest annual N2O-N emissions, suggesting a deficiency of substrates for nitrification and denitrification processes. While CT-BP had the greatest yield-scaled N2O-N emissions throughout three years, NT had the lowest yield in Year 1 and Year 3, respectively. Based on our findings, organic vegetable production systems may be able to minimize N2O emissions by using conservation tillage methods on coastal plain soils with winter cover crops.

Ognjen Žurovec et.al (2017) Conservation tillage is believed to enhance soil physical features and soil Carbon (C) storage while reducing the use of fossil fuels, labor, and equipment. However, the benefits of enhanced C sequestration may be nullified if lower tillage leads to higher emissions of nitrous oxide (N_2O) from the soil. Conservation tillage has seen little in the way of research or implementation in Bosnia and Herzegovina (BH) so far. Conditions typical of humid, continental BH were replicated in the field near Sarajevo, where the soil was composed of clayey loam. Over the course of two growing seasons, N_2O emissions were tracked in a Maize-Barley cycle. At the conclusion of the second season, soil structure was analyzed. Emissions of N2O followed the pattern CT > RT > NT in the significantly rainier 2014, but RT > CT > NT in the drier 2015. Soil saturation in the spring, soil crusting, and random droughts all reduced production, particularly in the next growing season. Because of crop failure, the yield-scaled N2O emissions for maize in 2015 were much greater than in 2014, when they ranged from 83.2% to 161.7% of the harvested grain N Mg-1. N2O emissions were found to be lowest at RT in both years. As a result of weak yields in both years and increased costs associated with weed control, NT yielded economically unacceptable returns. Since fewer RT processes were involved, manufacturing costs were down and net profits went up. Consequently, RT has the potential to improve agronomic and ecological outcomes in BH crop cultivation.

J. Lelieveld et.al (2015) The toxicity of particles from different sources makes it difficult to accurately calculate early death due to air pollution, especially in areas where air quality is not monitored. Here, using a global atmospheric chemistry model, we look at seven kinds of emission sources in both urban and rural areas and how they relate to premature mortality. Based on the worldwide incidence of disease in 2010, we calculate that outdoor air pollution, caused mostly by PM2.5, is responsible for about 3.3 million premature deaths annually, the vast majority of which occur in Asia. Although we mostly assume that all particles are equally hazardous, we do offer a sensitivity analysis that takes into account differences in toxicity. Assuming carbonaceous particles are the most harmful, We demonstrate that emissions from heating and cooking at home, especially prevalent in India and China, are the single most important risk factor for early mortality throughout the globe.

E. C. Suddick et.al (2012) Studies on the key environmental and management factors that lead to the production of nitrous oxide (N2O) from agricultural soils, a potent greenhouse gas (GHG), have been conducted for decades. An annual N_2O emission budget that is detailed, accurate, and reliable is crucial for evaluating the impacts of current and potential future agricultural systems on climate change. This is especially true in light of rising global food demand and the accompanying rise in the use of N fertilizers to meet this demand. Annual budgets for some of California's most significant, high acreage income crops, including grapes and nuts, are either absent or incomplete due to the state's complex cropping systems. In this study, In this article, we discuss new studies that evaluate conventional vs innovative methods of N2O emission control in California's perennial and annual cropping systems. In a Northern California almond orchard, we found that conventional and conservation irrigation methods resulted in significantly different levels of N2O emissions.

METHODS

Analyses of Statistics The linear mixed-effects modeling technique was used to analyze the differences in N2O emissions resulting from the switch from FT to NT or the transformation of annual farmland into grassland. Comparable to linear regression modeling, Both fixed and random factors may be accounted for using the linear mixed-effects method. Observational dependencies are taken into account by the random effects. The following equation describes the overall layout of the model:

$$Y = \beta_o + \beta_1 X_1 + \ldots + \beta_p X_p + \gamma_{site} + \gamma_{year*site} + \varepsilon$$

Management parameters such as the number of years since the last tillage modification, N application rates and types, crop type, irrigation methods, and residue management practices were investigated as fixed effects in the tillage study, along with environmental variables such as soil texture and climate. The percentage of clay in the soil was the independent variable. Since sand and silt contents are substantially correlated with clay contents, these variables were not evaluated directly. For weather, average annual temperature and precipitation to evaporation ratio were the two key factors considered. It is usual practice to use this ratio as an indicator of the relative dryness or dampness of the climate, Climates with a humidity-to-precipitation ratio below 1 are considered dry, whereas those with a ratio over 1 are considered humid. Since the transition period was not stated in many of the research, particularly those that compared cropland to natural grassland, it was not taken into account in the grassland study.

Samples from the same location and replicate samples from the same treatment plots must be treated differently to account for geographical interdependence, we incorporated random factors in the models for both analyses and assessed both first- and second-order interactions among fixed variables. Significant variables at the 0.1 alpha level were included in the statistical models. The model generated by Equation 1 was used to forecast future changes in N2O emissions, and The error covariance structure of the fixed effects was used to compute the variance in these forecasts, which was then presented as a standard deviation. Predictions were made for soils with a 15% clay percentage and a 30% clay content using the model. Due to a lack of data, no predictions were given for soils with a greater clay content.

DATA ANALYSIS

Tillage

Although some research has shown significant reductions or increases in N_2O emissions by switching to no-till, the vast majority of studies looking at this topic have found changes between NT and FT of between -1 and +1 kg N_2O-N ha^{-1} yr^{-1}. (Figure 1a).

The meta-analysis findings (Table 1) reveal that climate and soil texture impacted the shift in N_2O emissions due to NT adoption. In more humid areas, N_2O emissions rose after the introduction of NT, but in drier regions, they fell or stayed the same.

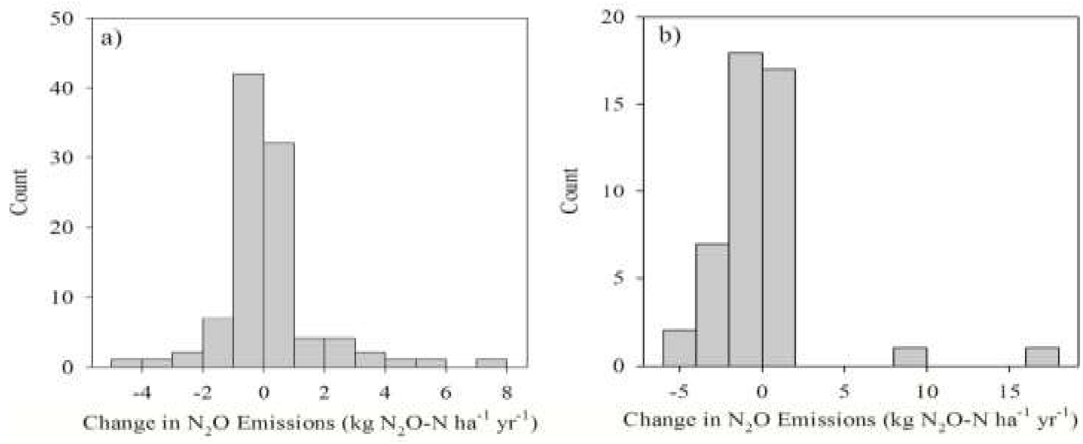

Figure 1. Comparison of full-inversion tillage (FT) and no-till (NT) emission histograms.

The climate's reaction varied depending on the soil's texture, as evidenced by the two factors interacting. Adopting NT reduced N_2O emissions from low clay soils in arid regions, but intermediate clay soils showed little to no decrease in N_2O emissions. N_2O was shown to rise with NT conversion in both low and high clay soils in humid regions.

Grassland Conversion

N2O emissions varied greatly from the tillage study (Figure 1b) to the conversion of croplands to grasslands. Most variations were on the lower end of a range of -5 to +5 kg N_2O-N ha^{-1} yr^{-1}. The collection included experiments with MAP:PET ratios ranging from 0.84 to 3.9 and clay concentrations from 9 to 77%. Fertilizer dose adjustments ranged from -180 kg N ha^{-1} yr^{-1} to +339 kg N ha^{-1} yr^{-1}.

Table 1. After switching to no-till (NT) or turning farmland into grassland, linear mixed-effect models for N2O emissions shift.

Parameter	Parameter value	s.d.	p-value
	Adoption of NT		
Intercept	-4.64	2.11	0.03
Clay %	0.12	0.06	0.06
MAP:PET†	2.86	1.27	0.03
Clay % x MAP:PET	-0.07	0.04	0.07
Random effect: site		0.0001	
Random effect: site by time		0.0002	
	Conversion to Grassland		
Intercept	-1.68	2.8	0.55
N fertilizer change	0.02	0.005	0.0001
Clay %	0.14	0.04	0.0008
MAP:PET	0.51	1.65	0.76
Clay % x MAP:PET	-0.04	0.01	0.0003
Random effect: site		4.2	
Random effect: site by time		0.0005	

† MAP:PET = Ratio of mean annual precipitation to potential evapotranspiration

According to the data, Table 1 shows that the N fertilizer rate was the most important factor in determining the change in N_2O emissions that occurred throughout the transition from cropland to grassland. Increased N_2O emissions are a well-known consequence of mineral fertilizer. Emissions rose across all soil and climate types when N fertilizer application was increased, and decreased when N application was decreased (Figure 3). The amount by which emissions shift also depends on the soil texture, with moderately clay soils exhibiting a bigger shift in emissions than low clay soils. Emissions respond differently in humid climates than dry ones, and the apparent variations in emissions as a function of soil texture are larger in the former.

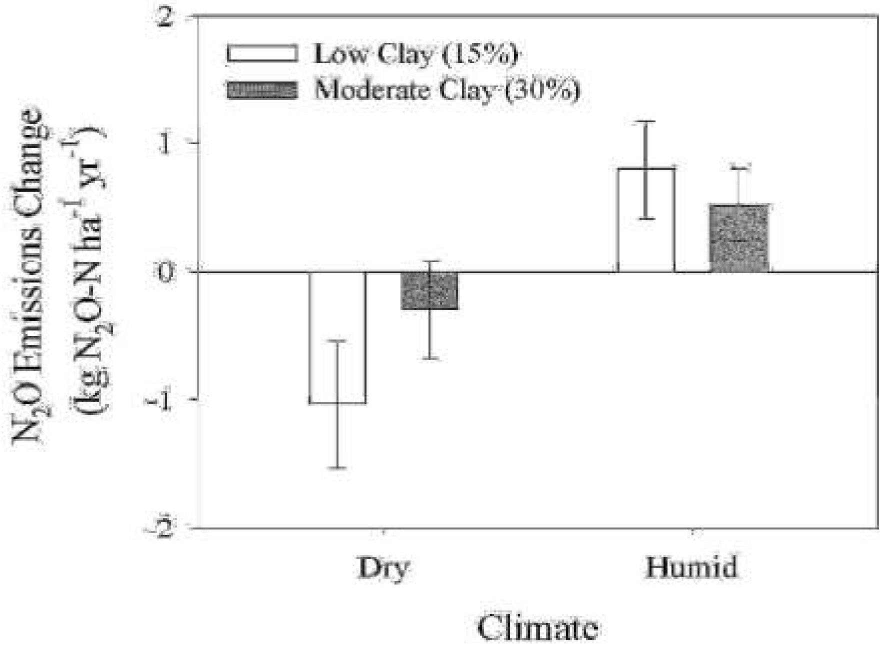

Figure 2. Comparison of full-inversion tillage (FT) and no-till (NT) on predicted N2O emission variations in dry and humid areas with low clay content.

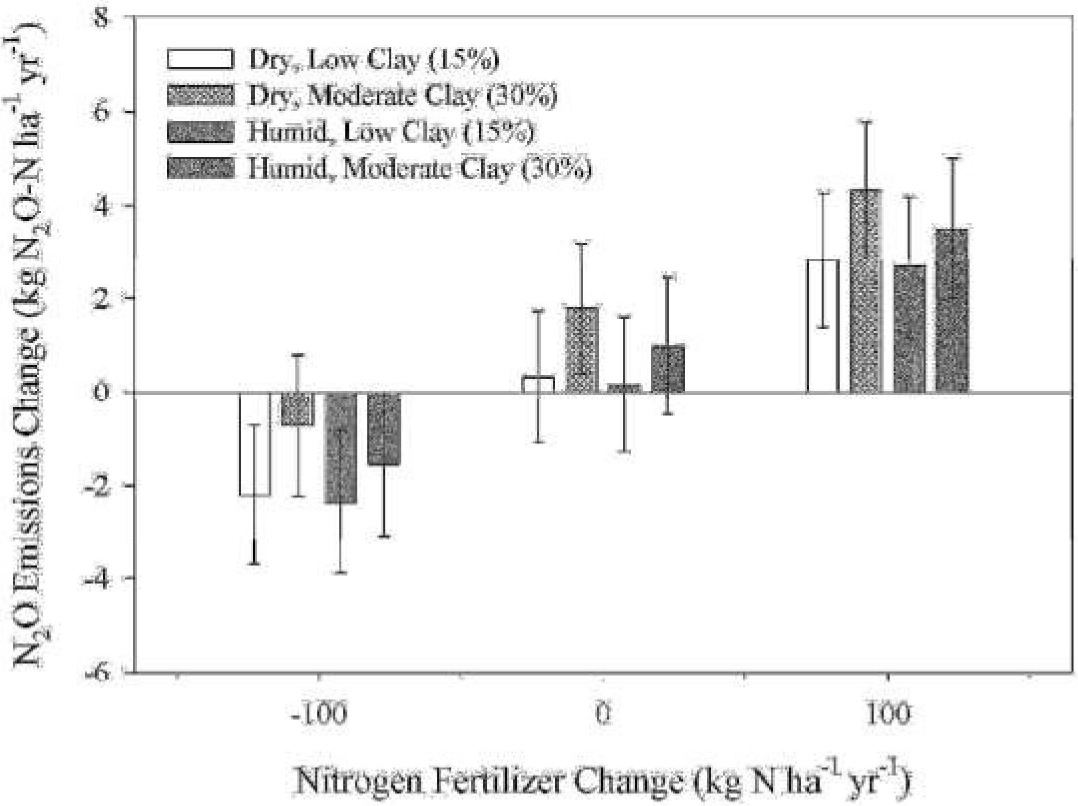

Figure 3. Modeled shifts in N2O emissions during farmland conversion to grassland result from varying rates of nitrogen fertilizer use in dry and humid areas with low clay content.

CONCLUSION

This meta-analysis of field studies revealed broad patterns about how changes in management interact with climate and soil to modify the mechanical mechanisms that control N_2O emission rates. Key results from this research reveal that changes in N_2O emissions rely substantially on site-specific variables, Despite the fact that there are doubts around N2O emission forecasts due to changes in land use and administration. It was predictable that changes in fertilization rates would affect soil N_2O emissions when agriculture was converted to grassland. But the effect was different depending on soil texture and, to a lesser extent, climate. Converting farmland to grassland without altering fertilization rates is controversial, as shown by our findings in the literature. To further understand the impact of these conservation techniques on soil N_2O emissions, more study is required across a variety of climatic, soil, and management situations.

REFERENCE

1. Alikhani, Hossein & Karbin, Saeed & Zadeh, Babak. (2018). Conservation Agriculture Effects on Soil Greenhouse Gas Fluxes: An Overview. 10.20944/preprints201804.0125.v1.

2. E. C. Suddick et.al “Discerning Agricultural Management Effects on Nitrous Oxide Emissions from Conventional and Alternative Cropping Systems: A California Case Study” doi: 10.1021/bk-2011-1072.ch012

3. Guihua Chen et.al “Can conservation tillage reduce N2O emissions on cropland transitioning to organic vegetable production?”2017

4. Žurovec O, Sitaula BK, Čustović H, Žurovec J, Dörsch P. Effects of tillage practice on soil structure, N2O emissions and economics in cereal production under current socio-economic conditions in central Bosnia and Herzegovina. PLoS One. 2017 Nov 8;12(11):e0187681. doi: 10.1371/journal.pone.0187681. PMID: 29117229; PMCID: PMC5678699.

5. Lelieveld, J., Evans, J., Fnais, M. et al. The contribution of outdoor air pollution sources to premature mortality on a global scale. Nature 525, 367–371 (2015). https://doi.org/10.1038/nature15371

6. Zheng C, Jiang Y, Chen C, Sun Y, Feng J, Deng A, Song Z, Zhang W. 2014. The impacts of conservation agriculture on crop yield in China depend on specific practices, crops and cropping regions. The Crop Journal 2(5):289–296 DOI 10.1016/j.cj.2014.06.006.

7. Woźniak A, Gos M. 2014. Yield and quality of spring wheat and soil properties as affected by tillage system. Plant, Soil and Environment 60(4):141–145 DOI 10.17221/7330-PSE.

8. Yeboah S, Zhang R, Cai L, Song M, Li L, Xie J, Luo Z, Wu J, Zhang J. 2016b. Greenhouse gas emissions in a spring wheat–field pea sequence under different tillage practices in semi-arid Northwest China. Nutrient Cycling in Agroecosystems 106(1):77–91 DOI 10.1007/s10705-016-9790-1.

9. Taa A, Tanner D, Bennie ATP. 2004. Effects of stubble management, tillage and cropping sequence on wheat production in the south-eastern highlands of Ethiopia. Soil Tillage Research 76:69–82 DOI 10.1016/j.still.2003.08.002.

10. Six JAET, Elliott ET, Paustian K. 2000. Soil macroaggregate turnover and microaggregate formation: a mechanism for C sequestration under no-tillage agriculture. Soil Biology & Biochemistry 32(14):2099–2103 DOI 10.1016/S0038-0717(00)00179-6.

11. Reicosky DC. 1997. Tillage-induced CO2 emission from soil. Nutrient Cycling in Agroecosystems 49(1-3):273–285 DOI 10.1023/A:1009766510274.

12. Nelson DW, Sommers LW. 1982. Total carbon, organic carbon and organic matter. In: (eds). AL Page, ed. Methods of soil analysis Part 2. Chemical and microbiological properties, Second edition. Wisconsin/Madison: American Society of Agronomy and Soil Science Society of American Journal, 301–312.

13. Li L, Zhang R, Luo Z, Liang W, Xie J, Cai L, Bellotti B. 2014. Evolution of soil and water conservation in rain-fed areas of China. International Soil & Water Conservation Research 2(1):78–90 DOI 10.1016/S2095-6339(15)30015-0.

14. Lamb JA, Peterson GA, Fenster CR. 1985. Wheat fallow tillage systems' effect on a newly cultivated grassland soils' nitrogen budget. Soil Science Society of America Journal 49(2):352–356 DOI 10.2136/sssaj1985.03615995004900020016x.

15. IPCC. 2013. In: Stocker TF, Qin D, Plattner GK, Tignor M, Allen SK, Boschung J, Nauels A, Xia Y, Bex V, Midgley PM, eds. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom: Cambridge University Press.