Summary: Sustainable Conservation Manure Slurry Application Report
September 2010

Introduction

This report summarizes the testing of a manure slurry injection technology to fertilize dairy crops, comparing the greenhouse gas and ammonia (NH3) emissions from that method to surface spreading. The injection tool in draghose application creates sub-surface cavities and manure slurry is injected into the closed-slot cavity through the draghose thus minimizing slurry exposure to air and reducing NH3 volatilization. This technology is relatively new in California. It appears to be an effective way to reduce greenhouse gas and ammonia (NH3) emissions. The research was conducted in a dairy forage field in central California in September 2010 on behalf of Sustainable Conservation.

Background

Manure sources are commonly used to supply the nutrient needs of dairy silage corn and forage crops. However, if not applied properly, land application of manure sources can result in large emissions of ammonia [NH3] and major greenhouse gases, which include carbon dioxide [CO2], nitrous oxide [N2O] and methane [CH4]. Greenhouse gases from dairy land application may contribute to climate change. Further, NH3 emissions from land application can lead to high levels of NH3 in the local areas which can cause strong odors, nuisance and atmospheric pollution. It is desirable to cut these emissions and improve environmental quality.

Factors influencing greenhouse gases and NH3 emissions from dairy land application include dietary, housing and manure handling systems; climatic conditions such as temperature, humidity, and wind; soil properties such as texture and pH; and manure application rate and method.

There are several options available for applying solid and liquid manure (e.g., broadcasting with or without incorporation, surface spreading, liquid surface application, shallow or deep injection). Liquid manure can be applied through irrigation systems or spread as a slurry. Application of liquid manure through irrigation systems is very common in California dairy farms.

In general, surface application increases the air contact of the slurry and thus could increase greenhouse gas and NH3 emissions. On the other hand, injection application reduces the air contact but can promote anaerobic conditions which could increase emissions. The objective of this research was to monitor and compare emissions from these two methods.

Technology

The draghose is a liquid manure application system where the application unit is attached to the source (lagoon) by a long flexible hose, see Figure 1. A pump moves the liquid down the hose to a manure applicator mounted on the tractor, and the application unit injects the manure 10 to 15 centimeters (4 to 6 inches) deep into the soil with a closed slot technique. (The slurry was fully covered after injection by closing the slots.) This minimizes slurry exposure to air and reduces NH3 volatilization.

Figure 1. Injection of manure into fields using flexible hose system fed by dairy lagoon.

Results

Injecting the slurry into the soil appeared to be an effective way to reduce greenhouse gas and NH_3 emissions. The method resulted in lower greenhouse gas emissions and thus lower global warming potential. It also showed lower NH_3 emissions because significant volatilization of NH_3 can occur right after manure slurry application.

Carbon dioxide emissions: No significant differences were observed in CO_2 emissions between surface spreading and draghose injection method. In general, land application is not considered a significant CO_2 source compared to other CO_2 sources in the soil-crop environments.

Methane emissions: The CH_4 emission fluxes were generally low with both methods and the land application methods appeared to have no effect on CH_4 emissions in this experiment.

Nitrous oxide emissions: Surface spreading emitted more N_2O in all 3 days of measurements, about 2 times more N_2O on average. Unlike other gases which increased sharply after application and declined in the following days, N_2O emissions increased in the second day of land application and remained relatively high in the third day.

Ammonia emissions: The draghose injection method produced much less NH_3 gas flux in the first day of measurement following land application, approximately 9 times less NH_3 emissions. NH_3 emissions in both treatments were negligible in the second and third days of land application.

Further Research

A large portion of NH_3 volatilization and the loss of greenhouse gases from dairy can occur in land application. Yet, limited field experiments are available on how manure application practices (i.e., surface vs. subsurface) affect NH_3 and greenhouse gas emissions in California. More data is needed in this field. While the data from this experiment compared short term emissions of NH_3 and greenhouse gases for surface and injection methods, long term manure management practices, including manure storage and farming operations are very important in determining seasonal emissions for the dairy and cropping systems.