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Comparative Rates of Nitrogen Values and Crop Yields Using Digestate Dairy Manure and Unaltered Dairy Manure

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What is Digestate Dairy Manure Versus Unaltered Dairy Manure

The key difference between digestate dairy manure and unaltered dairy manure lies in their nutrient composition and potential benefits as fertilizers. Digestate is a byproduct of anaerobic digestion, a biological process in which organic matter, such as manure, food waste, or agricultural residues, is broken down by microorganisms in the absence of oxygen. Anaerobic digestion is commonly used to treat organic waste and produce biogas, a renewable energy source. During this process, the organic matter is converted into biogas, leaving behind a nutrient-rich residue known as digestate.

Unaltered dairy manure refers to the raw manure directly collected from dairy cows without undergoing any additional treatment processes. It contains a mixture of animal waste, bedding materials, and other organic matter. Unaltered dairy manure has long been used as a traditional organic fertilizer in agriculture due to its nutrient content, which includes nitrogen, phosphorus, potassium, and other essential elements required for plant growth.

What is Cycles Modeling

Cycles modeling is a scientific approach used to simulate and understand the complex interactions between biogeochemical processes in ecosystems. It involves the construction of mathematical models that represent the cycling of nutrients, such as carbon, nitrogen, phosphorus, and other elements, through various environmental compartments, including soil, water, atmosphere, and living organisms.

The primary goal of cycles modeling is to gain insights into the dynamics of nutrient fluxes, transformations, and storage within ecosystems over time. These models can help researchers and scientists better comprehend how different factors, such as climate change, land use, and human activities, impact nutrient cycling and overall ecosystem functioning.

Comparing Till Types

No-Till Drill

No Till- Seed drills or planters that create narrow openings in the soil to place seeds without inverting or tilling the soil.

This option creates less soil disturbance, which creates less erosion and pollution.

Conventional- Moldboard Plow

Conventional tillage - thorough soil disruption, where the entire soil surface is tilled and turned over using various implements, such as plows and harrows. This practice is characterized by deep soil inversion and typically leaves the soil bare between planting seasons.

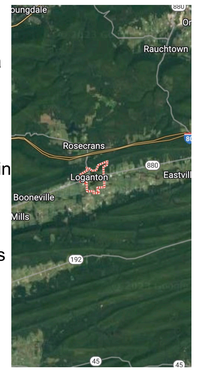
Gathering Data Using Cycles Modeling

Using Cycles is a free data base that utilizes the command prompt on your computer to collect, analyze and and create data to view in excel. This research was conducted using soil and weather data for Loganton, Pennsylvania. The Cycles simulation ran real life data using real weather data from 1980 to 2016.

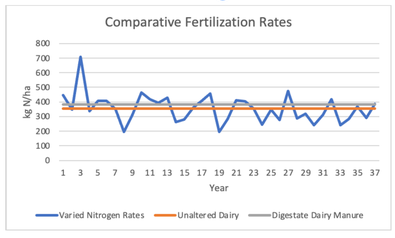
The crop rotation that was used for this simulation was corn silage, which harvests the entire plant for its use as a feed for livestock that was planted in Spring, and harvested in late summer. Winter rye silage, 'rilage', was planted in early fall as a harvestable cover crop and collected in early spring.

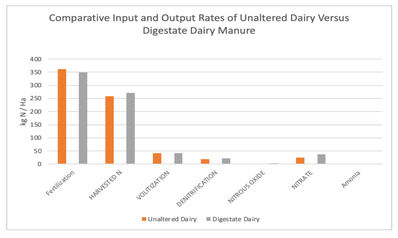
Both crops were planted via a no till drill and the winter rilage received a small amount (12kg) of inorganic fertilizer as a supplemental nutrient on all variations of manure application.

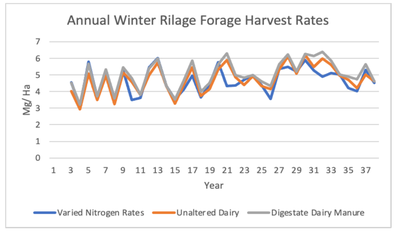
The difference came when running the two different main manures on each rotation. 9,210 kg of unaltered dairy was on one rotation, and 5,756 kg digestate manure on the other. I also ran a rotation with varying amounts of Nitrogen each year, keeping the same mass as unaltered manure for another comparison rate.

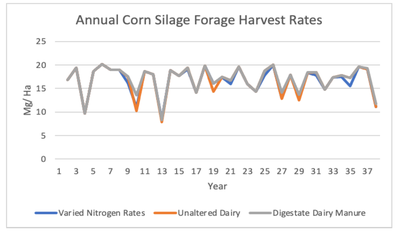


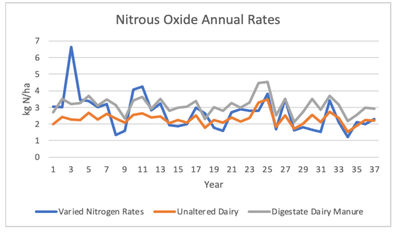
Data Tables: Comparing Fertilization, Nitrogen, and Crop Yield Rates

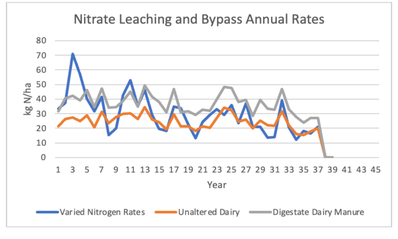


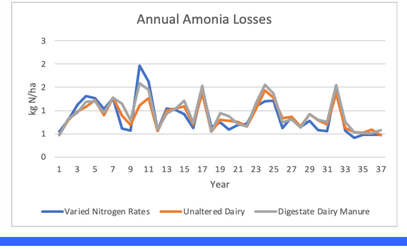


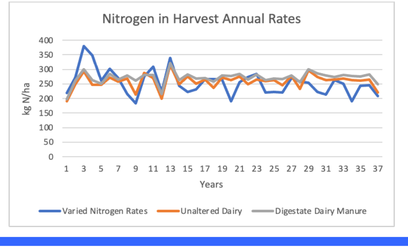








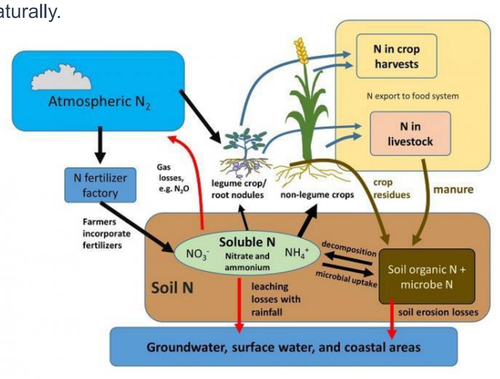




Why is Nitrogen important in Agriculture

Nitrogen is one of the most essential elements for agriculture and plays a critical role in various aspects of crop growth and overall agricultural productivity. Its importance stems from its involvement in several vital biological processes within plants. Nitrogen is a fundamental building block for the formation of amino acids, proteins, enzymes, and chlorophyll, all of which are essential for plant growth and development. Chlorophyll, in particular, is responsible for photosynthesis, the process by which plants convert sunlight into energy and produce carbohydrates, enabling their growth and survival. Adequate nitrogen levels are crucial for promoting vigorous leaf growth. Leaves are the primary sites for photosynthesis, so healthy leaf development translates to improved photosynthetic efficiency and greater carbohydrate production.

Nitrogen is directly linked to crop yield and productivity. Plants with sufficient nitrogen supply exhibit healthier growth, produce more flowers, fruits, and seeds, and generally have higher overall yields compared to those lacking nitrogen. Nitrogen availability affects the nutritional quality of crops. Nitrogen deficiency can lead to lower protein content in grains, reducing their nutritional value. In sustainable agricultural practices, nitrogen plays a crucial role in crop rotation strategies. Certain crops, known as nitrogen-fixing crops (e.g., legumes), have the ability to capture atmospheric nitrogen and convert it into forms usable by other plants. These crops are often integrated into rotation systems to enrich the soil with nitrogen naturally.



Conclusions of the Comparisons

In cycles, the Nitrogen needs of each crop were calculated for best yield. When fertilizing with unaltered dairy manure, it took 37.5% more unaltered dairy manure to match the Nitrogen rates in the digestate dairy manure

The use of digestate manure versus unaltered dairy manure, shows overall higher Nitrogen values in all forms of Nitrogen. When applying manure in Cycles, digestate manure has a higher amount of ammonia than unaltered dairy. Ammonia is in the more readily usable form of nutrient for crops. Since the Nitrogen is able to be fixated and used quicker, there is less of a chance for that fertilizer to be washed away and wasted. This gives the crops more nutrients with less mass.

Proper nitrogen management in agriculture is essential for minimizing environmental impacts. Excessive application of nitrogen fertilizers can lead to nutrient runoff, causing water pollution and contributing to algal blooms in aquatic ecosystems. The use of digestate manure is an effective way to get the most out of your manure using the least amount of liquid to haul onto the fields. However the cost of a set up to incorporate digestate manure is a lot more than the average farmer can afford.

Further research and field studies are necessary to fully understand the implications of using digestate manure and dairy manure on crop yields, soil health, and environmental sustainability. Process such as extracting just the Nitrogen and Phosphorus in the digestate is a concept some are working on currently.

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