Modifications to Manure Spreading Equipment for Improved Application and for Minimizing Nutrient Losses

INTRODUCTION

The purpose of this fact sheet is to describe modifications which can be made to conventional manure spreading equipment to improve application and minimize nutrient losses.

The most common piece of liquid manure application equipment is the vacuum tanker with a splash plate. The two most common solid manure spreaders are the rear discharge and side thrower units.

Control of application rates, nutrient loss and odours can be poor with these types of manure applicators. Modified manure spreading systems can help producers distribute liquid and solid manure more evenly and accurately, improve nutrient-use efficiency on the farm, and mitigate odour and nutrient concerns.

SOLID MANURE SPREADERS

Control of application with conventional solid manure spreaders

Conventional solid manure spreader

Applying manure evenly can be difficult when using a conventional solid manure spreader. Controlling the application rate of solid manure (>20% solids) is improved when using a rear discharge spreader instead of a side thrower. Rear discharge units can achieve an application rate as low as 10 t/ha. However, the evenness of spread is generally poor with both types, and many spreaders do not chop manure adequately to prevent the spread of large lumps. These lumps can interfere with the operation of other field equipment. To achieve better and more even application control, flail- and spinner-type spreaders can be used with drier manures, such as poultry litter, to reduce the spread of clumps.

Solid manure spreader application rates are essentially controlled by the wagon chain, auger, push ram, and moving bed or expeller speed which can be adjusted by changing the drive sprockets. Key performance criteria include tractor speed, discharge rate, application width and uniformity of application. Both the side thrower and rear discharge spreader can be modified to achieve lower and more even applications rates.

New types of solid manure spreaders

The two most conventional solid manure spreaders have received only minor modifications since coming onto the market. In the 1970s and 1980s, these models saw the following improvements: box spreader drive system improved; spreader size increased; and hydraulic endgates to enable the handling of manures with higher liquid contents. Some box spreaders had a pan under the spreading mechanism and extra paddles installed to ensure a more even spread of manures with more liquid.

More recently, the design of the paddles/ejectors on some horizontally-mounted rear throwers has been improved (more paddles, more paddle area or additional banks of paddles), providing a more consistent spread. With some side throwers or flails, the powered centrifugal lateral thrower can be adjusted to provide a consistent spreading pattern, even when using heavily-bedded manures.

Improved horizontal augers

On certain spreader models, the auger and expeller speed can be adjusted by changing drive sprockets to match the consistency of the manure being spread. These spreaders also work with lighter materials such as chicken litter.

There are newer spreaders with vertically-mounted rear manure throwers. Their twin vertical augers are more effective at chopping manure.

Vertical augers

These units also spread manure more evenly and accurately than conventional spreaders. They can throw manure up to 12 m, distributing a full load in approximately two minutes. This type of spreader provides a more even distribution of solid or semi-solid manures than conventional models. There are also centrifugal rear throwers that allow a more even distribution of solid or semi-solid manures.

LIQUID MANURE SPREADERS

Control of application using conventional liquid manure spreaders

Application rates and nutrient losses using a vacuum tanker with a splash plate are essentially controlled by the tractor speed and the angle and height of the splash plate above the ground. Operators should calibrate the spreader to determine the effects of these adjustments.

Take time to ensure the spreaders are assembled properly and that the set speed will provide the desired application rate. Conventional vacuum tank spreaders, equipped with a splash plate, rarely provide an even distribution, although careful use of settings can improve performance.

The lowest practical liquid manure application rate, using a splash plate vacuum tanker spreader, ranges from 15 to 20 t/ha. Lower application rates and nutrient losses can be achieved by improving the application control systems.

Conventional liquid manure spreader

New types of liquid manure spreaders

Several types of spreaders are now available that either inject manure into the soil, spread manure from a low height above the ground, or apply manure directly on the ground surface. With these types of spreaders, the manure does not travel as far through the air. This reduces odour emissions, manure spray drift, potential for loses via runoff, volatilization of ammonia and nutrient losses to the environment. Liquid manure should not travel more than two meters horizontally or one meter vertically.

These new spreaders produce a uniform manure application rate across the field, better nutrient-use efficiency and improved crop yields. The accuracy of this type of equipment also allows the operator to respect minimum separation distances.

Examples of new liquid manure application equipment are:

Photo A: Tank spreader with a simple splash plate, but with the splash plate set at a much lower height than a conventional splash plate spreader.
Photo B: Spreaders with an application boom set at a height of less than 1 meter.
Photo C: Spreaders with a boom that drags tubes directly on the soil surface, ensuring the manure does not become airborne.
Photo D: Spreaders with a boom and applicators that apply manure directly to the soil surface, extending below the standing forage crop (sleigh foot).
Photo E: Spreaders that inject manure directly into the soil.

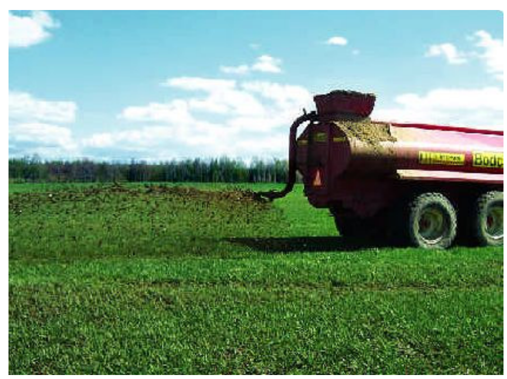

Photo A - low splash plate

Photo B - low height application boom

Photo C - surface application tubes

Photo D - sleigh foot

Photo E - manure injector

Manure injection systems have a tool bar with cultivator teeth, discs, shoe openers or shanks that open the soil, allowing the liquid manure to be injected below the surface. There are several different designs available, each with the tool bar height, openers and injectors arranged for use in different crops.

Modified liquid manure injection systems have also been developed for injecting liquid manure into minimum tillage cropping systems. These systems inject liquid manure while producing low soil disturbance. Irrigation piping is often laid out along a field, which can be used to transport manure to the spreaders. This type of liquid manure injection and low-height application system uses a drag hose rather than a tank.

MODIFYING EXISTING SPREADERS

A conventional liquid manure spreader can be modified to perform low-height application, surface application or injection application. To do so, flow regulators, agitators, choppers, low-height application booms, injectors or openers may be required to modify the manure spreader. These can be purchased commercially from equipment dealers. Several models, differing in functionality and size, are available. Equipment dealers can help to determine what is required to modify manure application equipment.

PRECISION APPLICATION EQUIPMENT

In recent years, Global Positioning System (GPS) has become more common on manure spreaders, particularly on liquid manure models. They are available at equipment dealers either as an option or standard equipment on some new manure spreaders. GPS and the required flow control equipment are also available commercially and can be installed onto existing manure spreaders.

A GPS system can accurately indicate your location in a field. When coupled with flow controllers, GPS on a manure spreader can provide precise manure application rates and record where the manure has been applied. This will enable the operator to apply different rates of manure to match the crop requirements in all sections of the field. The GPS unit records the amount of manure applied, the location, date applied and other information. Such data are useful for nutrient management planning, allowing the producer to optimize nutrient usage and respect environmental concerns for nutrient loss.

IMPLEMENTING MANURE SPREADING MODIFICATIONS ON THE FARM

One consideration before buying spreading equipment: the cost of applying manure increases the further one travels from the storage facility.

- Vacuum tank spreaders which use any one of the following: a splash plate at a low height; a low-height application boom; surface application tubes; or an injector system, should be equally efficient in terms of the volume of manure spread per hour.

- Manure drag hose systems, fed with irrigation piping, are more efficient in the volume of manure spread per hour, compared to vacuum tank spreaders with either a low-height splash plate or low-height application bar. Drag hose systems, fed by irrigation piping, are expensive, but can be more economically efficient if the manure application sites are within 2 km of the manure storage.

Manure drag hose systems, fed by irrigation piping, also require large and flat fields in order to be practical or efficient

Liquid manure injection systems require more engine power to pull, making them more expensive to purchase and operate. These systems are also difficult to operate in stony soils. The addition of double concave disks, in place of cultivator teeth, allows the liquid manure injectors to function adequately in stony soils, as well as in soils with a high level of crop residue.

The modified liquid manure application equipment best suited to your farm operation may vary with the type of production system.

- An injector boom with cultivators may be most effective for corn production. This can be used post-emergence, up to a plant height of 45 cm.
- A low-height boom spreader may be most effective for pre-plant or post-planting liquid manure application to fields in cereals and for pasture prior to plowing.
- For pastures, a spreader which applies liquid manure directly to the surface is highly effective, such as a boom with trailing dribble tubes or surface applicators.
- For dense liquid manures or liquid manures that contain straw, manufactures have developed spreaders with large diameter manure conduits from the distributor and straw choppers.

Operating modified liquid manure application equipment on fields that have undulating or rolling topography can be challenging. The application booms can catch the ground or the injectors may be lifted completely out. The rate of manure application will also vary on gravity-fed spreaders, with the highest rate of application occurring on the low side of the boom.

- To an extent, these problems can be managed by installing wheels on booms that are free to move vertically, keeping them or the injectors at an even height.
- While navigating hills at various speeds, a variable-speed pump on the flow controller, tied to a forward speed sensor, will hold the application rate constant.

Spreaders require flow regulators or restrictors in order to apply liquid manure at low rates.

- Recent model manure tankers have flow restrictors installed.
- Adding a flow meter to the drag hose system, fed with irrigation piping, will improve the accuracy of the application rates.

Testing and verifying the manufacturer's calibration charts for manure application equipment is recommended. A difference of less than 10% between the actual rate applied and the rate expected is an indication of a well-regulated spreader.

For heavier tank spreader systems, using over-sized low-pressure tires will help to distribute weight and reduce the risk of soil compaction.

- Larger liquid manure spreading equipment will reduce the number of passes required to cover an entire field.
- Manure drag hose systems may reduce soil compaction. In comparison to heavy-tank spreader systems, drag hose systems place less weight on the soil because there is no tank.

REGULATORY ENVIRONMENT

The farm owner and/or the operator must ensure that manure application practices meet all federal, provincial, municipal and rural legislation, regulations, orders, bylaws and guidelines. These include:

Federal

Canadian Environmental Protection Act.
http://laws.justice.gc.ca/en/C-15.31/

Fisheries Act
http://laws.justice.gc.ca/en/ F-14/

Provincial

Nova Scotia Department of Agriculture and Marketing. (1991). **Guidelines for the Management and use of Animal Manure in Nova Scotia.** Publication no. R-91-2000, Prepared by the Manure Management Task Group, Project assisted under the Canada/Nova Scotia Agri-Food Development Agreement, Nova Scotia Department of Agriculture and Marketing. p.18

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Newfoundland and Labrador Agriculture. (2002). **Environmental Guidelines for Livestock Producers.** Newfoundland and Labrador Agriculture. A fact sheet Series on Environmental Guidelines for Livestock Producers, Publication SLM045. p.109
http://www.nr.gov.nl.ca/agric/soil_land/envseries/livestock.stm

ADDITIONAL INFORMATION

1. Prince Edward Island Agriculture and Forestry, Prince Edward Island Fisheries, Aquaculture and Environment, and Environment Canada. **Best Management Practices. Agricultural Waste Management.**

2. Agriculture and Agri-Food Canada website: **ManureNet** http://res2.ag r.ca/initiatives/manurenet/

3. Agri-Environmental Advisory Clubs. 2004. **Equipment for Spreading and Handling Liquid Manure. Testing at 75 sites.** *(document in French: Clubs conseils en agroenvironnement. 2004. Équipements d'épandage et gestion des lisiers. Caractérisation de 75 chantiers - saison 2004. Clubs conseils en agroenvironnement. p.8)*

4. Québec Federation of Hog Producers. 2005. **Spreading Booms. Why a Boom?** *(document in French: Fédération des producteurs de porcs du Québec. 2005. Rampes d'épandage. Pourquoi une rampe. Fiche technique No. 5, Fédération des producteurs de porcs du Québec. p.6)*

Acknowledgements

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