A Co-operative Program Between

ALBERTA FARM MACHINERY RESEARCH CENTRE

PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

Research Update

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A Slurry Injection System for an "Off-the Shelf" Cultivator

Broadcast methods of applying swine manure to fields create odourproblems and result in significant losses of valuable crop nutrients to the air. Research has shown that up to 30% of the usable nitrogen may be lost.

The Challenge

Injecting slurry into the soil prevents or reduces ammonia loss and odour problems. A few commercial and farm manufactured injectors are available, but they have shortcomings.

Because these machines have large hoses and can deliver a great deal of slurry, there may be problems attaining adequate soil cover over the slurry behind each opener.

Existing injectors have fewer openers with a typical row spacing of about 20 inches (500 mm). This spacing may result in poor nutrient distribution causing crop striping, uneven maturity, and lower yields.

Slurry distribution systems were designed to operate with liquid, not with solids. With the growing popularity of using straw cover to control lagoon odours, plugging in commercial distribution manifolds has become more prevalent.

PAMI Responds

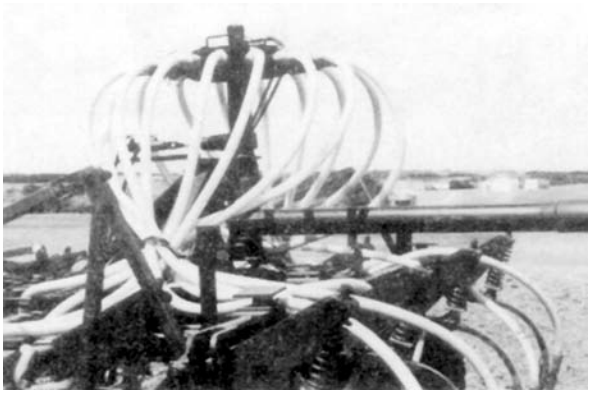
PAMI has developed a cultivator-based high-volume injection system which:

- Maximizes the fertilizer value of liquid swine manure.
- Reduces odour during the application process.
- Reduces the potential of nitrate pollution due to over-application.
- Provides well distributed nutrients for efficient crop use
- Can handle slurry trash such as straw, hair, and other foreign materials.
- Can operate in fields with very heavy surface residues and long stubble.

The key to the system is a specially designed slurry distribution manifold with a hydraulically powered, rotary cutting/distribution system incorporated within it.

The manifold was mounted on a donated Flexi-coil 820 chisel plow with 16 openers placed at 12 inch (300 mm) row spacings.

PAMI's cultivator-based high-volume injection system, maximizes fertilizer value of liquid swine manure, reduces odour during the application, reduces the risk of nitrate pollution due to over-application, and provides well distributed nutrients for efficient crop use. The system can also handle slurry trash such as straw, hair, and other foreign materials, and can operate infields with very heavy surface residues and long stubble.



A sixteen port manifold distribution system was mounted on a Flexi-coi1820 chisel plow with 16 openers placed at 12 inch (300 mm) row spacings.

The slurry distribution manifold has a hydraulically powered, rotary cutting/distribution system.

A series of lab tests and field trials were conducted using combinations of two types of drop tubes and openers.

A detailed description of the manifold, the various configurations of openers and drop tubes, testing procedures and results are available by referring to the PAMI Research Report "Improved Methods of Injecting Swine Manure to Agricultural Land".

System tests positive

In lab tests and in preliminary field trials, the manifold distributed fluid very uniformly from shank to shank across the width of the machine.

A combination of a "pig's foot" drop tube and 12 inch (300 mm) sweeps on 12 inch (300 mm) row spacings provided the best lateral spread of slurry in the furrow–8 inches (200 mm)–and completely covered the manure, which reduced odour.

The problem of crop striping--which is an indicator of uneven slurry distribution--associated with wider row space machines was not apparent with the PAMI prototype.

After field testing, an additional 210 acres (85 hectares) of field operation of the prototype was conducted. The 12 inch (300 mm) sweep with the "pig's foot" drop tube was used for the entire test.

No mechanical failures in any of the injection system components were encountered in the 55 hours of field operation. The delivery hoses from the manifold to the drop tubes normally did not plug with straw or other debris.

The injector operated very well in the heavy, 8 to 10 inch (200 to 250 mm) high barley stubble.

The system

The system consisted of a swivel coupler which allowed adaptation to a 500 gal/min (2,202 L/min) umbilical or tanker delivery system, a distribution manifold with a built-in debris cutting system, and a delivery boot/soil opener combination mounted on a Flexi-coil 820 chisel plow.

Except for the specially designed manifold, all components of the system are available commercially. A 12 inch (300 mm) row space cultivator was chosen because it is a common type of tillage equipment.

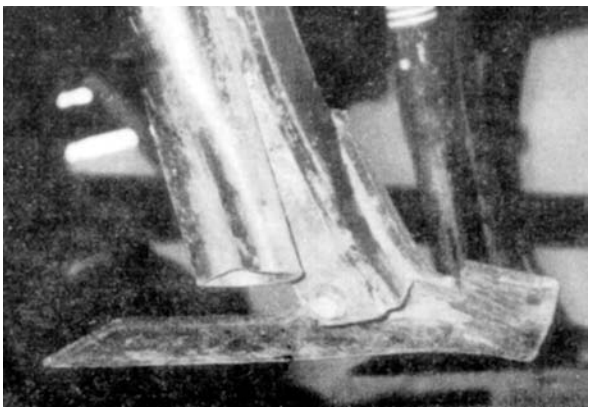
In the field, the injector was operated at approximately 2 mph (3.2 kph), in 10 inch (250 mm) high barley stubble. The injector was supplied by a 500 gal/min (2,202 L/min) irrigation pump located at the solid storage cell. The application rate of the slurry was approximately 8,000 gal/ac (14,700 L/ha).

Distribution manifold

A rotary cutter in the distribution manifold was considered necessary to cut solids andassist in distributing slurry evenly to all ports.

The rotor consists of a pair of knives mounted between a pair of backswept wipers. The knives cut the solid

Crop striping–note the lighter coloured stripe in the centre of this photo–is usually an indication of a plugged drop tube or openers that are spaced too widely apart.



The "pig's foot" opener–a straight pipe with a V-shaped crease in the bottom to create a small amount of back pressure in the manifold to assist with even distribution.

materials and the wipers pushed the material through the ports, keeping them clear. Four cutting anvils were welded to the manifold housing inner wall to provide a sharp cutting surface for the cutter.

The rotor was hydraulically powered. At no time did the motor driving the rotor bind or stall. The 1.5 inch (38 mm) delivery tubes conveying slurry from the manifold to the openers are smaller than those found on most commercial injectors. However, plugging was not a problem, likely because the flow through these hoses was aided by the rotary cutter in the manifold. In addition, the back pressure created by the smaller hoses helped to produce uniform distribution between ports in the distribution manifold.

Openers and drop tubes

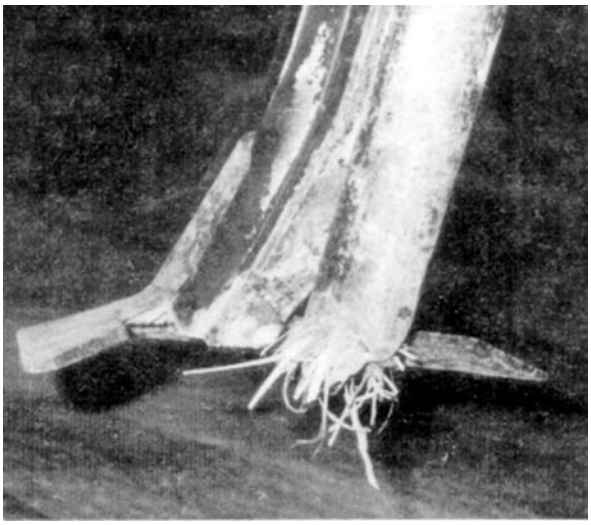
The two types of openers–standard 12 inch (300 mm) sweeps and 4 inch (100 mm) chisels (spikes)–and two types of delivery boots were tested.

A "pig's foot" is a straight pipe with a v-shaped crease in the bottom to create a small amount of back pressure in the manifold to assist with even distribution. The smaller open area also accelerates the slurry and increases spread width in the furrow

A "tee" is a straight drop tube modified with a small piece of angle iron welded across the open end splitter at the bottom. The intention is to deliver the slurry further out to the edges of the sweep.

The "pig's foot" drop tube did not plug in any of the tests. When used with spike openers, the slurry bandwidth in the soil was about 4 inches (100 mm) wide, leaving 8 inch (200 mm) untreated strips between the rows. Some slurry was left on the soil surface and some crop striping was evident with this combination.

However, the combination of the "pig's foot" and 12 inch (300 mm) sweeps produced an 8 inch (200 mm) banc width of slurry behind the sweeps. Little or no slurry was left on the field surface. There was no crop striping.



The "tee" (splitter boot) plugged immediately when used with the 12 inch (300 mm) sweeps.

The "tee" (splitter boot) plugged immediately when used with the 12 inch (300 mm) sweeps, and as a result was not suitable for slurry injection.

A few notes

Shut-off valve

A hydraulically operated shut-off valve was incorporated into the injector system to allow the flow to the injector to be shut offquickly as a means ofreducing slurry flow when turning the machine. If slurry flow is not reduced when turning at headlands, over-application may occur. (A flow by-pass must be installed at the pump to allow for pressure relief when the valve is shut off).

Crop striping

The distribution effectiveness in the field was determined by seeding a test strip of wheat across the injector test plots, and by monitoring the nitrogen response as the crop matured. Crop striping indicates gaps in the slurry application.

A couple of coupler problems

Cam-lock quick couplers were used to attach the delivery tubes to the manifold. Plugging did occasionally occur at these couplers because of their smaller inside diameter. These couplers were installed for testing purposes only. A commercially produced manifold probably would not use cam-lock couplers, thus eliminating the problem.

Trash clearance

Trash clearance capability is more related to the design of cultivator used than the injection function, so injectors should be mounted on cultivators with very good trash clearance features if they are to be used in long stubble conditions.

Other Research Updates available on manure handling issues are:

Hog Lagoon Odour Control, #698

A Guide to Pipeline Manure Injection Systems, #729

A Guide to Swine Manure Management Methods, #730

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