Understanding and Applying Real World Experiences Associated with Separated Hog Solids Management to Manitoba

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Executive Summary

Background

Phosphorus regulations for livestock manure were first introduced in Manitoba in 2006. The regulation in effect requires that on a long-term basis, phosphorus application must be in balance with phosphorus removal to avoid very high soil phosphorus accumulations. Since many hog operations were established using nitrogen for land base calculations, for some additional land will be required. For most hog farms with phosphorus values above 60 ppm, simply increasing the application distance away from the farm by a further one to two miles allows the farm to access land with lower phosphorus in the soil as most custom dragline applicators have 5-8 kms of supply hose. However, in the more intensive livestock areas of the province such as Hanover and La Broquerie, finding lower phosphorus land within this distance may be problematic due to the high concentration of livestock facilities. A short-term solution may involve transporting (via semi-tractor trailer) raw manure or portions of the raw manure out of these intensive zones but doing this on a large scale may not be cost effective and may create a burden on the road infrastructure of the area.

Removing the phosphorus from liquid hog manure through solid - liquid separation can be an effective way to reduce transportation costs of relocating the phosphorus in the solids to deficient soil phosphorus areas. This technique often allows the producer to utilize the nitrogen rich liquid near the barn. The goal of this study is to understand whether or not the phosphorus rich solids pile is a asset or a liability on the barn's balance sheet.

To accomplish this goal, two other jurisdictions, which are currently using solid-liquid separation, were visited to understand their current practices with the separated solids. Based on this information, interviews were conducted with Manitoba companies who have the ability to transport and apply the separated solid manure to create a financial understanding of Manitoba costs. Our target recipient for the separated solids generated in the intensive RM's of Hanover or La Broquerie (phosphorus surplus area) was a grain producer 32-64 kms west (phosphorus deficient area) of these RM's in the phosphorus deficient Red River Valley. This was followed up with 10 producer interviews to understand market receptivity to paying for these solids. Lastly, a cost calculator and a financial analysis of the impact on price of a marketed hog was done to assist hog producers to understand how dealing with their solids pile would impact their bottom line.

Separated Hog Solids Management in other Jurisdictions

Value for separated hog solids is largely dictated by supply and demand. In Quebec, one producer had raw separated solids picked up from his yard for as much as $25/tonne although the current price is closer to $5/tonne picked up in the yard. Another site mixed their hog solids with chicken manure to reduce the dust from the chicken manure but was also influenced by the perception that chicken solid manure was more acceptable than hog solid manure alone.

The story in the Netherlands and Flanders, Belgium was very different as these countries/regions have an over-supply of nitrogen and phosphorus. Hog producers and brokers pay to dispose of this waste product. One separation plant in Holland paid receivers \$10 - \$18/tonne to come and pick up the solids from their plant. Another separation plant in Holland was hauling their separated solids over 2 hours to an incineration plant and then paying the incineration plant about \$22/tonne to take the product. Most of the hog separated solids generated in Flanders, Belgium were further composted and then hauled to northern France to be applied to fields. One separator site visited in Belgium paid \$26/t to a further processor to compost the solids. In order for solids to cross country borders in the European Union the manure product must be "pasteurized" by heating the product to a minimum of 70° C for 1 hour. Solids processors in Belgium will compost the manure or "quick compost" the product and then export to northern France. The grain farmer in France will pay about \$19/tonne to \$26/tonne for this composted product. A product such as this may be transported 300 - 500 kms in Europe. Advice received from several in the separated solids industry in Europe was that in the Manitoba situation composting these separated solids was unnecessary based on economics and hauling distances.

Manitoba Transport and Application

Bulk density has a large impact on the application costs. The bulk density of solids from a centrifuge after storage are about 0.56 ton/yd^3 (0.75 tonne/m^3). The bulk density of solids from a belt separator are closer to 1.1 tonne/m3 ton. This equals roughly a 30% difference in hauling costs to move this phosphorus rich product from a surplus area to a deficient area. Hauling a product with a bulk density of 0.56 ton/yd^3 (0.75 tonne/m^3) a distance of 20 miles will cost around \$10/tonne while hauling that product 64 miles will cost about \$15.32/tonne.

Application of this product requires equipment similar to that used to spread solid chicken manure. The target application rates may vary from 5-10 tonne/ac. The optimal piece of equipment to accurately spread at these rates and create an even spread pattern is an enclosed vertical beater with a spreader plate at the bottom. One advantage of separated solids over other forms of solid manure is that the dry matter of un-composted separated solids is consistently between 28% to 34% and has a very uniform particle size. The cost to apply the separated solids after they have been stockpiled on the side of the field will cost \$2.50 to \$5.00/tonne.

Manitoba Producer Comments

Target prospective receivers who had previous experience with liquid hog manure on their annual crops were interviewed to judge their receptivity to pay for this product. As there has been no formal Manitoba research of agronomic response from separated hog solids, the producers were asked about their receptivity to paying for 50% of the commercial phosphorus value and 50% of the total nitrogen value which would be released in year 1 (assuming 25% of the nitrogen will be released in year 1). Using this value assumption, the value the producers were asked to pay was about \$15/tonne.

Producer reception to this new fertility product was positive. This value proposition was accepted by 8 of the 10 producers interviewed while the remaining two wanted to see the products effectiveness on their land before committing to pay. There was also interest expressed in the possibility of being involved in either transportation, application, or storage of the product by 3 of the 10 producers (possibly suggesting a higher market value of the product).

Based on these interviews, there is a high potential that the cost to transport and apply this product could be a cost neutral line item on the hog barn's balance sheet with the possibility of providing a positive cash flow as the product is better understood in Manitoba conditions.

Economic Discussion

The cost of transport and application of manure solids on its own should not be cost prohibitive to producers, however, when taken in context of the financial challenges currently facing hog producers, it becomes an additional burden for many producers to deal with. The expansion of the hog industry as well as significant advances in liquid manure application in the last 15 years have created an increased interest and appreciation for manure as a crop nutrient. The opportunity that hog producers have to offset the ongoing disposal of manure solids should increase producers comfort when analyzing the economics of manure separation and provide them with additional options when considering their options to meet liquid manure spreading restrictions.

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1. Introduction

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2. Quebec Trip Discussion

(Supplementary field notes from the Quebec visit can be found in Appendix A)

Quebec has had phosphorus regulations since 1997 with a revision of the regulation in 2002. Every farm in Quebec is required to have an annual "P" balance which is tied to farm subsidies from the government. Their phosphorus regulation is a combination of both the soil test P and the P saturation in soil. Once a soil reaches a certain threshold the farm must apply based on 1 x crop removal. There are currently about 15 treatments systems in operation in Quebec which assist in bringing the hog farms into compliance with regulation. Due to the above factors, Quebec was chosen as one of the areas to visit to understand management of separated hog solid manure. Two treatment sites with centrifuges were visited.

2.1) Agromex Site

Background

The Agromex site is an 8000 head finishing site which produces 3.3 million gallons of manure per year. In 2007 an "Andritz" centrifuge was installed to separate the phosphorus in their liquid manure. The centrifuge runs 4 days/wk for 12 hours per day. (mainly when management is onsite) The centrifuge removes about 50% of the phosphorus. The site generates 785 tonnes of solids annually. The site has a 12000 gal pre-mixing tank to create a homogenous product. The site annually spends $124000 to treat and spread the manure. This works out to $0.0266/gallon.

Solids Management

The solids are stored onsite for about 3 weeks and then hauled 3 kms to a large storage shed where they are mixed with chicken manure. The 2 main reasons why they mix the separated hog solids with chicken manure is to reduce the dust from the chicken manure and there is a higher perceived value because poultry litter is deemed more acceptable. The transfer to the larger storage is done by a dump truck.

Figure 1: Solids Storage Structure where hog and chicken manure are mixed

-The analysis of the separated solids before it is mixed with chicken manure is: Total N = 19.1 lbs/tonne, P_2O_5 = 33 lbs/tonne with a dry matter of 34% (see Appendix B for detailed analysis)

-The analysis of the solids product after it is mixed with chicken manure is: Total N = 44.6 lbs/tonne, P_2O_5 = 35.2 lbs/tonne with a dry matter of 50% (see Appendix C for detailed analysis)

-From this central solids mixing site the product (consisting of hog manure solids and chicken manure) is sold to brokers for $10/tonne (picked up) for quantities of 500 tonne or less and $5/tonne for quantities over 500 t. The product is then hauled up to 100 kms to application fields. There is downward pressure on the price.

-The solids product is applied to corn or cereals at 4-5 tonne/ac using conventional solid manure spreading equipment. The receiver uses an agronomist to determine the application rate. This transfer of nutrients is based on detailed analysis of the solids and must be accompanied by a signed agreement.

2.2) Fournier Site

Background

The Fournier site is a 9000 head finisher site which owns 1300 acres of annual cropland (primarily corn). Two years ago an Alfa Laval G2 centrifuge was installed to treat about 4-5 million gallons of liquid hog manure. The average dry matter of incoming manure is 4-5%. The centrifuge runs 24 hours a day from mid-February till the end of the year. The corn land still requires some phosphorus and therefore some of the manure generated on the farm is not run through the centrifuge. The centrifuge has a 30 micron screen in it which removes about 70% of the phosphorus with no polymers or flocculants added. The site has a 42000 gal pre-mixing tank to create a homogenous product.

Solids Management

Fresh solid manure coming out of the centrifuge contains: Total N = 28.4 lbs/tonne, P_2O_5 = 58.3 lbs/tonne with a dry matter of 29% (see Appendix D)

-Older manure which has been stored for a while contains: Total N = 35.4 lbs/tonne, P_2O_5 = 64.9 lbs/tonne with a dry matter of 30% (see Appendix E)

-The pile of solids can heat up to 90° C which is a concern to the insurance provider and owner

-Other than the pile heating up there is no composting of this manure

- The solids are transported up to 50 km away from their farm in a tarped truck. The product must be applied to the land immediately or it will revert back to sludge/slurry if it receives rain on it in the field.

-Fournier is currently receiving about $5 tonne from the receiver (s) who picks up the manure as well as applies it to his land. Returns were as high as $25/t a year ago but that receiver no longer is picking up solids. Fournier and his agronomist make the deals with the receivers. Some of their agreements are up to 5 years in length. The solids are either applied to corn land or organic crop land. There is a negative perception of hog manure which depreciates its value but overall the price is dictated by supply and demand. The solids are applied with a disc spreader with vertical beaters at about 2 tonne/ac.

3. Europe Trip Discussion: Netherlands and Belgium

(A schedule of daily activities and supplementary field notes from the Europe visits can be found in Appendix F)

Note: It was our intent to also visit northern France as there are many centrifuges running on French farms but a week before our arrival in Europe our guide from Belgium who was going to take us to France broke his leg. (We ended up visiting a centrifuge manufacturer to discuss their technology and its application and then also visited a hog manure broker/transporter/applicator in the Netherlands who had a central treatment site.) Although we were unable to meet with solids receivers in France, going back to the Netherlands helped further understanding the Dutch situation.

3.1) The Netherlands Background

Holland is known for its highly productive agricultural capacity. The Dutch are ranked second in the world in agricultural exports behind the United States and France with exports of $55 billion annually. (www.hollandtrade.com, 2013) The Dutch also have a significant intensive livestock industry which has led to a surplus of animal manure in the forms of nitrogen and phosphorus. There are currently 394 million lbs. of P_2O_5 produced in animal manure in the Netherlands of which agriculture uses (in crop production) about 314.8 million lbs. (Mulleneers, 2012) This equals an excretion of 88.1 lbs/ac and a crop use of 70.3 lbs/ac over the Netherlands 4.4 million acres of agricultural land. (Mulleneers, 2012) The excess phosphorus is either hauled to neighboring countries, treated, or applied to land in excess of crop requirements. There is currently a regulatory requirement that in 2013, 10% of the phosphorus surplus must be exported out of the country and by 2015 this number will increase to 50% of the surplus. This is a key driver for separation and advanced treatment of manure.

Nitrogen and phosphorus regulations have been developed to limit the amount of manure applied to the land. These regulations have impacted producers in different ways. Most dairy producers own (or have access to) enough land to dispose of their manure because they require land to produce silage corn for their cows. Other than bedding recovery systems most dairies do not require manure treatment for nutrient management planning purposes. There are currently about 400 screw presses being used to remove dry matter for bedding. Most hog producers have an insufficient land base to apply their nutrients. This has led to the over application of nutrients and the development of specific regulations to limit manure application to crop requirements. Regulations limit the amount of nitrogen which can be applied to 151 lbs/ac and limits the application of P_2O_5 to 76 lbs/ac (with some flexibility based on soil test) for most farms.

The climate of the Netherlands also plays a role in how nutrients are regulated. The average mean temperature for January is 2° C and the average amount of precipitation is 765 mm annually. (www.nationsencyclopedia.com, 2013) Soils do not freeze in winter and therefore rain can leach nitrogen through the soil profile during the season when crops are not growing. This coupled with the fact that most arable land is tiled, means that fall applied nitrogen has a high risk of leaching or reaching a watercourse and therefore could be lost before the spring crop can access it. Therefore current regulations prohibit manure application from Aug 1 to Feb 1.

In the 1970's liquid swine manure was typically applied within a small radius near the hog barn. Regulations came into effect which limited the amount of nutrients/unit area. This forced the hog farmer to move excess manure nutrients above crop requirements further and further away to find application fields. This has led to the development of manure transporters who take manure from livestock intensive zones to areas which are nutrient deficient. There are currently 500 manure transport trucks in the Netherlands which move raw and processed manure to all agricultural lands in the Netherlands. Transportation of manure longer distances meant that manure was now more uniformly applied across the country.

Figure 2: Typical Liquid Manure Transport Truck

The manure transporters/brokers typically started as manure applicators who then offered a turn-key solution to farmers with excess manure by essentially offering a one fee service to have your manure picked up at the farm and dealt with. This also forced the manure applicators to form relationships with manure recipients and broker deals for manure application fields. This brokering relationship also means that the hog farmer no longer has contact with recipients of their manure.

Manure is typically transported by a semi-tractor trailer. The movement of these transport trucks is tracked by GPS systems hooked into a government tracking system. When manure is transported there

Figure 3: Tamper-Proof Manure Auto-Sampler

are auto-samplers on these trucks which take a tamper-proof manure sample for regulatory purposes. There is also a rigorous regulatory paper trail to record movements of manure. As the supply in Holland exceeded the demand it placed the recipient farmer in an advantageous position to ask for compensation for the right to use the land for manure application. It is now common practice to pay a landowner to accept liquid hog manure based on this over-supply. The price to dispose of manure onto an agricultural field can cost $0.018 /gallon to $0.03 /gallon, even though the manure has value. The full cost to have a manure broker remove your liquid hog manure from your farm and dispose of it is $0.12/gallon.

Another option to get rid of manure was to haul it to a neighboring country such as Germany. This was easily accomplished as many borders within the European Union are open and crossed easily. In 2009, the EU regulation 1069/2009 on animal by-products stipulated that manure or manure products must have an obligatory hygienisation before they can be transported across EU borders. (heat the product to 70° C for 1 hour to reduce the number of viable pathogens) As transport distances increased (in some cases beyond 100 km) and across borders to other countries, more economical solutions were required. This has led to the industry looking to various forms of treatment in order to allow manure nutrients to be moved out of Holland to other countries.

In countries like Holland, treatment and by-product management is interrelated amongst different sectors. One such related industry is bio-gas / digesters. Co-mingling of products to feed the digesters is common practice as separated hog solids are a good feedstock. There are over 5000 digesters in Germany while there are only 140-150 in Holland. This is largely due to the subsidy in Holland being half the subsidy of Germany. Holland subsidizes these gas plants at $0.12/kw. More than 50% of the plants are no longer profitable based on current prices.

Another regulation in Holland, which affects every hog farm, is that all raw manure storages must be covered to minimize ammonia emissions. The most common storage structure is a round concrete tank. The cover on this tank is elevated in the center to shed all rainwater. These covers reduce the amount of moisture added to the manure while also increasing the concentration of nitrogen in the manure (and thus increasing the nitrogen to phosphorus ratio).

One other significant fact learned in Holland is that finishing pig operations manage 220 gal/feeder space of manure per year, while a feeder operation in Manitoba with an earthen manure storage manages 550 gal/feeder space of manure. (In the 1970's a feeder pig operation in Holland produced similar amounts of manure as Manitoba.) Factors such as barn design, barn water management, and type of storage (considering the comments above about the storage cover not allowing precipitation to enter the manure storage) all influence these values. Economics of handling/transporting of manure has driven the need to reduce manure volumes in Holland.

3.1.1) Nistelrode Swine Farm (Day 1 Site 1)

The Nistelrode farm is an 1800 sow to weanling farm which produces 2.4 million gallons with an on-farm treatment system. Manure from the site is initially stored in a large covered concrete manure storage. This tank has an agitation system which homogenizes the manure. The raw manure is then sent to two elevated screw presses for solid-liquid separation. The solids are then immediately hauled to a biogas plant 1.5 miles away so that no on-farm solids storage is required.

Figure 4: Two Screw Presses with Aerobic Tank

The separated liquid is then placed into a smaller tank (aerobic tank for nitrification) which is aerated where most of the nitrogen is removed. (nitrogen is blown off into the air) In this tank solids will settle to the bottom and then this sludge is sent back to the screw presses. Liquid from this tank is then sent to an earthen manure storage. Initially the site had a constructed reed wetland to further remove nutrients but this approach was unsuccessful.

The nearby bio gas plant paid for the treatment system on this farm. The hog farmer signed a 7 year agreement with nearby bio-gas plant (they are currently in year 4 of the deal) for $0.078/gal of manure which includes transport of the solids to the bio-gas plant. The farmer feels a new deal with the bio-gas plant will cost at least $0.12 to $0.145/gallon.

This farmer is striving to continue with an on-farm treatment approach as he does not want to be dependent on a broker who can dictate the price for manure disposal.

3.1.2) Dairy Farm with Mobile Separator (Day 1 Site 2)

Background

The second site visited was a 75 cow dairy farm which was separating liquid manure with a mobile screw press. The dairy had enough land for all its manure but was short on manure storage and by separating was able to extract enough solids to ensure adequate storage through the winter.

Separation Unit

The mobile screw press unit was first developed 4 years ago with 6 screw presses mounted on the flat deck of a semi truck. An additional 4 more screw presses were added to increase capacity (screw presses built by Doda). The cost was $462k for the unit without the truck. Manure is pumped to the mobile unit, fed through the screw presses and the solids are then moved off the back of the machine by a conveyor into a manure spreader rented by the farmer. The mobile separator has a capacity of 22000 - 33000 gal/hr. Verkooyen (the owner) charges $211/hr to separate. It costs the producer between $0.0064 and $0.009 /gallon to separate manure with this mobile separator.

The mobile separator does not work as well with pig manure due to the lower solids content and less fiber in the manure which is required for the screw press to operate properly. Performance was also reduced if corn was not used in the diet (i.e. if by-products such as potato parts were fed to the pigs) as this manure contains less fiber.

(This mobile separator is owned by Gebr. Verkooyen, whose facility was our next visit)

Figure 5: Mobile Screw Press Separator

Solids Management

The farmer's goal was to separate about 500 tonnes of manure and extract about 120 tonnes of solids. Phosphorus removal was not this particular producer's goal. The regulation allows these solids to be applied at any time of the year onto clay soils (we were visiting this farm in the middle of November). The farmer indicated he would apply the solids onto his own land as they came out of the separator and would plow them in immediately (as per the regulation). This producer had clay soils around his farm and preferred to apply the solids in winter as this would have less compaction compared to applying in spring. If the farmer had too many solids for his own uses, he could give them to a local fruit grower who would accept them if the producer provided free transportation.

These solids provide nutrients for the following silage crop which were fed feed to his dairy cows. Additional commercial fertilizer nitrogen would be applied to the corn crop in spring. The liquid from the separator is pumped back into a separate storage where it would be used the following summer to be applied to hay/pasture. This liquid product contains a very low amount of organic nitrogen and therefore could be applied and utilized by the grass in that current growing season. Using the separated liquid in this manner would ensure no nitrogen would be released in later fall which would be susceptible to leaching losses and possible exit out the field tiles. Non-treated liquid manure would be applied to the grass in spring which would minimize the later season losses of slow release (organic nitrogen) nitrogen.

3.1.3) Verkooyen Broker and Processor (Day 1 Site 3)

Verkooyen provides a wide range of services to its clients: seeding, harvesting, as well as manure brokering services which includes transport, application, and processing equipment.

Verkooyen charges the pig producer $0.12/gal to remove and dispose of its manure. To do this Verkooyen has a large number of liquid-semi tankers which will come to the pig site and pick up the manure. From here the manure may be directly transported to a field for application or the manure may be taken to the Verkooyen main site or one of its remote storages where it will be stored until application season. Some of the manure which is stored at the main site will be run through a complete treatment system.

The treatment system was developed and installed by Kumac. The system primarily treats liquid hog manure but can also handle dairy manure. The system separates the manure into 20% solids, 30% mineral concentrate and 50% clean water. The system annually treats 5.5 million gallons but has been built to handle 22 million gallons. Verkooyen is awaiting a regulatory change before increasing the throughput to 22 million gallons.

Raw liquid manure is mixed in a collection tank prior to feeding the system to provide a homogenous product. This tank is never allowed to go below 50% full. This is done to prevent significant nutrient variability as different manures are dumped into the storage tank. A polymer is added to the manure to precipitate the phosphorus. The manure is then sent to a filter belt press where the solids are caught on the belt and sent by a conveyor to a pile in the next room. The liquid is then sent to a flotation tank where additional sludge is bubbled to the top of the tank. This sludge is skimmed off and sent back to the filter belt press for further solids removal.

Figure 6: Filter Belt Press

Figure 7: Flotation Tank

Solids

The solids have a dry matter content of 30% and a nutrient composition of: nitrogen 24 lbs/t, P_2O_5 40 lbs/t, and K_2O 13 lbs/t with a density of .79 ton/yd3 (1050 to 1100 kg/m3) (Rooyackers, 2013). There is minimal heat generated when the solids are stored as there is not enough carbon (such as straw) in the pile to properly compost. The solids are applied to the land at rates ranging from 1.8 t/ac to 9.1 t/ac. An application rate of 2 t/ac which equals 62 lbs/ac of P_2O_5. Holland does allow a multi-year application of phosphate from manure. In the future Verkooyen plans to add a process which will heat the solids pile to 75° C so that he can export the solids out of Holland (minimum of 70° C for 1 hr to pasteurize the product).

Figure 8: Verkooyen Solids Transport Truck

Verkooyen says the key to finding fields for the dry product are the relationships which they have built up over 30 years in the business. They have already proven, both agronomically and technically, that manure/solids provide valuable nutrients to crops. The solids product can be spread on a variety crops in Holland. One cautionary note from Verkooyen is to avoid barley in wet years. They don't apply this before silage corn as most of these acres are applied on by dairies. Every load of solids is weighed to ensure accuracy of application.

Figure 9: Verkooyen Land Application Spreader

They currently haul the solids throughout Holland (as it has not been pasteurized and therefore cannot leave the country) up to 200 km for free. If the transport distance is under 40 km, application is free and the receiver will also receive compensation to receive the product . At a transport distance of 200 km the receiver will have to pay for application and won't receive compensation for available acres.

Another Kumac installation pays \$10.50 - \$18.50/t to any receiver who will come pick up the separated solids. In spring the solids will be spread on clay ground for potatoes. (for phosphate value) In the fall the solids will be spread after the crop is harvested. Application rates for this product are 1.6 - 3.2 t/ac (Rooyackers, 2013).

Mineral Concentrate

After the liquid comes out of the flotation tank it is sent through paper filtration and a reverse osmosis system. The product which does not make it through the reverse osmosis filters is called concentrate which contains the rest of the nutrients which are not in the solids pile (primarily inorganic nitrogen and potassium).

This concentrate contains 80 lbs/1000 gal inorganic N (ammonia), 0 lbs/1000 gal P_2O_5, and 90 lbs/1000 gal of K_2O. Verkooyen will apply the mineral concentrate for free but will charge for the nitrogen value (currently \$0.48/lb). The product is applied to potatoes at a rate of 2000 gal/ac which corresponds to 160 lbs N/ac. A winter wheat crop will receive 1000 gal/a which corresponds to 80 lbs N/ac.

The regulation in Holland currently considers the mineral concentrate as a manure product which makes it subject to manure's regulatory application rates and application timing (which de-values the product and impedes the flexibility of using the product). The University of Wageningen has been involved with several similar technologies which produce mineral concentrate to understand whether a regulatory re-classification of this product as a fertilizer is justified. If this concentrate is no longer considered manure it will expand the application season and it won't be subject to application rate restrictions currently assigned to manure. Once this regulatory change is complete within Holland, Verkooyen plans to operate the processing plant at 22 million gallons /year.

Clean Water

The other product which comes out of the reverse osmosis component is permeate (or water). The water is then sent through an ion exchange to remove the last bit of ammonia in the water. At this point this water is considered pure and can be discharged back into nature. This water is not stored but directly discharged into a roadside ditch behind the treatment building.

Figure 10: Clean discharged water coming from RO

Other comments from Verkooyen

The treatment system cost $2 million including the two 440,000 gallon tanks but not including the building. It costs about $200k to operate annually. (polymer, filters, maintenance, not labor). The system is very stable.

Verkooyen's recommendation to Manitoba producers (based on our current phosphorus challenges and distance) was to do a good job on distribution and transportation but do not use treatment.

3.1.4) Mobile Pig Separator - Hans Hendrix (Day 2 Site 1)

(On Day 2 we met and travelled with Hans Hendrix. Hans sold compost for 7 years, largely from garden waste which was composted in a tunnel composter. He was also the inventor of the AgraSEP system which is a mobile or fixed separation unit).

The site we visited was a 330 sow to weanling site. The farmer was interested in removing the solids and then selling the solids product which will contain 20-25% of the phosphorus. The hog producer was separating at this site as it was easier to sell solids vs. selling raw manure. This producer had enough of his own land to apply the liquids. The farmer desired a solids product which would contain 55-66 lbs/t of P_2O_5. It cost the farmer $0.009/gallon for this custom separation process.

Process

Manure in under-barn pits was being agitated to create a homogeneous product. The manure's age varied from fresh to 8 months old.

The AgraSEP unit uses two vibrating screens followed by a screw press to remove solids/phosphorus. The manure is pumped up to a hopper and then gravity fed to the first vibrating screen that had a 500 micron screen size. The liquid falling through this screen would then go across a 70 micron vibrating screen. The solids which did not pass through either one of these screens would fall into the hopper of the screw press. By using the above two vibrating screens the product entering the screw press had a consistent dry matter content of 14% - 17% (which is more optimal than raw manure). The screw press (which has a 250 micron screen) then removes the final liquid of the solids and increases their dry matter content to 26% to 27%. Liquid coming out of the screw press is fed back into the front of the system to go back across the vibrating screens. Hans felt the AgraSEP could remove 30% to 35% of the phosphorus.

Figure 11: AgraSEP - Two Vibrating Screens plus a Screw Press

The AgraSEP unit had a processing capacity of 5500 gal/hr. They were also developing a much larger unit with 4 vibrating screens and 2 screw presses. The capacity of this larger system would be 22000 gal/hr. This smaller unit cost just under $100k while the larger unit will sell for about $300k.

Additional Comments from Hans

There is currently a debate on the use of polymers to separate liquid manure in Europe. Germany does not accept solids generated with the use of polymers based on a study done by a German university which indicated that polymers were detrimental to the environment. There are no regulations in Holland restricting the use of polymers. According to Hans, if you use a polymer, 70% of the phosphorus will be available in year 1 and the remaining 30% will released over 4 years (not sure where this number came from or what climatic conditions it is based on).

Recent regulations in the EU require that solid manure must be composted prior to export to Germany (heated to 70° C).

Every truckload of compost must be analyzed for nitrogen, P_2O_5, and K_2O although Hans indicated that the compost is sold based on its phosphate content. Composted manure sells for about $40/t and has dry matter of 70%. The phosphate in the composted manure is 90% available. If you do not add carbon to separated solids they will only heat to 35° C while separated hog solids with added carbon will heat to 70° C.

In Holland it is only economical to compost manure when the final destination is greater than 150 kms. (once compost is moved out of the intensive area there is a demand for the product) Hans's advise for Manitoba's situation is to not compost separated hog solids (based on current distance and the economic cost of composting).

3.1.5) Van Kaathoven Composting Center (Day 2 site 2)

The Van Kaathoven Composting facility takes in garden produce and industrial sewage sludge (not human) and uses tunnel chambers to compost the product. The facility has 15 tunnels, all measuring 30 m long, 5.75 m wide, and 4 m high. Raw product coming into the facility is first sent to a shredder. The shredded material is mixed with 50% composted material. The material is then placed into an enclosed tunnel and sealed inside. Heated air at 60°C is forced into the tunnel for 24 hours and then held at 40°C for the remainder of the 2 weeks. Inflow and outflow air temperatures are monitored to ensure temperature tolerance levels are achieved. All air leaving the facility is sent through a bio-filter to reduce odor from the site (outside the composting building, odors were similar to that of earthy topsoil). The product is removed from the tunnel and sieved out at 10-15 mm2. The larger material is sent back to the composter. The finer material is sent to potato farmers as a soil conditioner product.

The facility takes in 60000 t/yr and creates 25000 t to 30000 t of final product. The end user of the final products pays nothing for the product as costs of processing are covered in the tipping fees. The current cost to build a facility of this nature is $924k/ tunnel (this facility had 15 tunnels).

The company has 4 plants worldwide including one in Hamilton Ontario. (built by Gicom.nl)

3.1.6) Houbraken Day 5

(Since our trip to northern France did not materialize we decided to go back to the Netherlands and visit another swine broker: manure applicator, transporter, broker, and treatment company as it had been highlighted earlier in the week.)

The Houbraken treatment site is located in the southern Netherlands. The treatment system was first operational in 2000. This system is currently marketed under VP Systems of the Netherlands which has 3 additional systems in the Netherlands.

Process

Raw manure is first placed into a 330000 gallon pre-treatment tank. It is then agitated and fed into the system. Polymer is added and then the manure goes into a specialized flotation tank. The polymer reacts with the phosphorus and rises to the top of the flotation tank. Houbraken has tested many polymers and has found one they prefer. They perform a jar test every day to ensure the concentration of polymer is optimized (any time they can reduce the polymer addition it saves them money). In the flotation tank the air lifts the thick flake particles (created by the interaction of polymer and phosphorus) to the top where they are scraped off (this product has a DM of 15%) and fed to a belt press. The belt press further squeezes out liquids from these solids. The solid product coming off the belt press has a DM of 32% to 34% and contains over 95% of the phosphorus. The liquid from the flotation tank is then placed into a tank where it is allowed to settle for 30 hours to ensure the polymer is deactivated. This settling time reduces the potential for plugging of the reverse osmosis filters. The liquid is then sent through bag filters before it enters a specially modified reverse osmosis (RO) system.

The RO creates 2 separate products: water and mineral concentrate.

Figure 12: Reverse Osmosis System

The system currently runs 24/7 with about 2 weeks of down time per year for maintenance. The system can be controlled and checked remotely on an iphone or the internet. The display panel as well as remote cameras placed around the system can be viewed from this connection. The Houbraken system is currently treating 17.6 million gallons per year but they have plans to expand it to 37.4 million gallons/year if regulatory changes re-classify the mineral concentrate off the RO as a fertilizer and not manure. The system inflow is 2640 gallons/hr.

Economics of the system

The energy used to run the system cost about $0.006/gallon. (energy at this location costs $0.099/kw) It costs about $0.053/gallon for capital, labor, and operating costs. The system requires about 1 hour /day of labor. A pig farmer has to pay Houbraken about $0.118/gallon to pick up their manure and dispose of it. The Houbraken system costs $1.12 million, not including tanks and the building. With the current regulations in Holland the costs to treat manure in this type of system vs. hauling the raw manure a far distance are very similar.

Mineral Concentrate

The mineral concentrate from the RO has 82 lbs/1000 gal of nitrogen, 4 lbs/1000 gal of P_2O_5, and 100 lbs/1000 gal of K_2O. This product is sold to farms up to 80 kms away. Farmers apply this product at about 1100 - 1750 gal/ac. Houbraken commented that farmers have to learn how to use the concentrate product (timing/rates/crops) before they see its value. Currently, Houbraken will haul the concentrate to the receivers tank for free but charge for the nitrogen.

Clean Water

The cleaned liquid from the RO at this site is run through another municipal sewage plant where acid and an ion exchange is used to reduce the nitrate from 100mg/l to 10mg/l (this further purification costs $0.006/gal). In Manitoba this product could be irrigated but in Holland it is too wet to add back to the land.

Solids

The nutrient analysis for the solids is: Total N = 26 lbs/t, P_2O_5 = 40 lbs/t, and K_2O = 11 lbs/t. The density of the solids product is 0.825 ton/yd^3. (1.1 kg/m3) (Willems, Henk, 2013). This product stacks at least 5 - 6 m high. If the dry matter of the solids is 34-35% then no liquid will come out of the pile. If the dry matter is only 30% then liquid may come out of the pile. The solid storage is emptied at least every 30 days.

Houbraken is currently working with an incinerator company which will burn the solids for $23.10/tonne. The ash is high in phosphorus which is easily exportable. It is about a 2 hr drive to deliver these solids to the location 100 kms away. Solids were previously field applied or added to a digester. The solids could go to Belgium at a cost of $33/tonne (if pasteurized). Applying these solids in the Netherlands is not desirable due to the surplus phosphorus in the country and it is too expensive to compost as additional carbon is required.

Other Comments

The Houbraken system could be designed without the final reverse osmosis system if phosphorus removal is the only requirement.

It was also suggested that if our goal was to only move the solids 30-50 kms then we should just haul raw solids and not compost this product.

Houbraken has tried using a centrifuge at the front end of the system but found it couldn't remove enough phosphorus before entering the RO.

3.2) Belgium - Flanders

3.2.1) VCM - Flemish Coordination Center for Manure Processing (Day 3 Presentation at Office) and later phone interview (Nov 29, 2012) with Technology Expert from Belgium who has ties to VCM (Day 3 Site 1)

VCM is an independent organization and an intermediate between the government and the manure processing sector. The organization has members consisting of the Flemish government, banking sector, Farmers Union, manure processing sector, and the animal feeding sector.

The Flemish area of Belgium is called Flanders which is located in the northeastern part of Belgium. This area of Belgium which has 1.65 million acres of arable land is intensive in its pig and poultry production. Livestock agriculture produces 134 million lbs of P_2O_5 while the agriculture production uses only 107 million lbs of P_2O_5 (equals a surplus of 27.1 million lbs). In terms of nitrogen, net manure production is 280 million lbs while agriculture only uses 232 million lbs which equals a surplus of 48.5 million lbs. The Flemish region is considered one of the worst polluters in Europe as they have a surplus of both N and P. There is a current EU directive to reduce nitrate in surface and groundwater below 50 mg/l of nitrate which is also one of the goals of Flemish manure policy.

The Flemish Manure Decree came in 1991 and has been followed up by 4 successive manure decrees. In 2000 the decree added an obligation for manure processing which defined processing as " nutrient not returned to Flemish arable land." In 2011, 2.68 million tonnes of manure was processed in Flanders at 112 manure processing installations (includes 3 mushroom substrate installations). This represents about 20% of the total net manure production (N).

Mechanical Separation

Raw liquid or digestate coming from an anaerobic digester is mechanically separated into a solid and a liquid fraction. This is done by several different techniques: sieves, screw press, filter belt press, or centrifuge. In Belgium the preferred method of separation is the centrifuge. The centrifuge separates the manure into the thin fraction (85% of volume) and thick fraction (15% of volume) which contains

74% of the phosphorus.   The centrifuge requires a well agitated manure of uniform composition to function properly.

Solids Treatment

The solids are then further processed using one of several techniques: biothermal (drying/composting), drying, liming, or incineration. Biothermal (drying/composting) is the most common treatment process which creates solids of 40% - 60% dry matter content with 25% - 35% organic matter content. 90% of the solids created in Belgium are composted and sent to northern France. The remaining 10% of the solids are sent to digesters. Most composting is done on-farm while some is done at central facilities. As stated earlier manure cannot cross an EU border unless is has an "obligatory hygienisation = 1 hour at 70°C to reduce viable pathogens." Composting meets this criteria.

This compost is sold in France based on lab analysis of macro-nutrients and the degree of stabilization. A Flemish processor will get $16-$20/t while the French farmer will pay $40-$53/t. The difference is in transport, brokers, and the profit French cooperatives make selling to their members. This compost is mainly applied to cereal crops.

Stable drying is also used mainly on poultry manure to increase the dry matter content of the solids manure for long distance transportation. The most common heat source for this process is from the animal housing ventilation air.

Thermal drying uses heat from a biogas plant, wood furnace, steam or gas burning. Various techniques such as belt dryers, fluidized bed, or rotary drum/ disc dryers are used in the process. The end product is a product with a dry matter of >85% which has been hygienisized and can be pelletized for long distance transport to other counties. This process is highly technical, (with risks of ignition) uses a lot of energy, and therefore was not recommended by one technology consultant.

Another process used to treat the solids product is liming. In this process CaO (quick lime) is added to the solids. This results in a pH increase to 12 and the temperature quickly rises to 70°C. Mineral N is released as NH3, pathogens are reduced or inactivated and 10% - 15% of the water is removed. Again this is a hygienisation process which allows for export of the solids. The end product is a Ca-rich soil conditioner/ organic fertilizer which is also a (NH4)2 SO4 fertilizer. As this process drives off NH3 into the air, Belgium requires an acid (sulfuric acid) or biological air washer to capture the nitrogen.

In Belgium, an additional air treatment step may be required to reduce odor. This can be accomplished by the use of a biofilter or an activated carbon filter.

Liquid Treatment

The liquid fraction is sent through one of the following processes: biological treatment (76 of 112 installations which VCM tracks), liming, electrolysis, ammonia stripping, membrane filtration. A secondary step for final liquid nutrient removal may also consist of evaporation/condensation process, or constructed wetlands. The majority of all liquid treatment systems in Belgium use the biological treatment process. The goal of this process is the removal of N and organic compounds (BOD, COD) from the liquid fraction.

In this process the liquid fraction has air pumped into it and a nitrification (aerobic) process occurs turning the NH_4 into NO_3. The liquid is moved to a different reactor (tank) where it is allowed to sit and a denitrification (anaerobic) process occurs which converts the nitrogen to N_2 gas that is gassed off into the air. The liquid is then allowed to sit where further sedimentation occurs. The liquid in the different tanks may sit in the reactor tank for up to 30 days although liquid is commonly being moved between the different tanks in a "sequential batch reactor" process. The majority of sow manure is not mechanically separated (as it is difficult to separate water from water) but sent straight to the biology treatment process.

The liquid effluent from this process is then sent onto one of two post-treatment processes before it is sent back into nature or re-used. In the evaporation/condensation process, a concentrate of non-volatile compounds, phosphorus, and salts are concentrated and a condensate of water and volatile compounds is created. The other process used is a constructed wetland. In this pond, plants are grown to remove further nitrogen, phosphorus, and organics. These plants are then harvested and can be used in a digester. The climate in Belgium is such that the wetlands are only frozen for about 3 weeks of the year.

Other comments from Belgium:

Belgium used to have mobile units to mechanically separate the thin and thick fractions. When the biology process was adopted these mobile units mostly disappeared as now separation needed to occur on an ongoing basis. VCM commented that based on moving separated solids 20-40 km from the source, the extra cost of composting was not justified for the Manitoba situation.

3.2.2) Samagro Composting Facility (Day 3 Site 2)

Samagro Organic Fertilizers is a composting facility in Belgium which uses 3 technologies to treat manure: 1. Biogas (not currently working), 2. Quick Compost, 3. Organic Granulate fertilizer. Samagro started to process manure in 1990's to send composted manure to France.

Common Economic scenario: The pig farmer will pay the Belgium biology treatment (nitrification/denitrification) $0.096 to $0.108/gallon to pick up and process their manure. Samagro will take the separated solids (30% DM) from the treatment center, or an on-farm centrifuge for $21 - $26/t. Samagro will create quick compost using this product as one of the components. Samagro will then sell this compost to a French marketing coop for $20/t. This will net Samagro about $2.64/t.

The solid hog manure for the Samagro Composting facility comes primarily from centrifuges in Belgium.

Quick Compost

The site creates 80000 t of compost /yr made from 70% chicken manure, 15% solid pig manure (from centrifuge with a 30% dry matter), 10% mushroom compost, and 5% eggshells. These ingredients are mixed and composted for 48 hours with at least one hour at a temperature of 70°C. This product has the following characteristics: dry matter 55%, organic matter 35%, 2% nitrogen (80% organic and 20% ammoniacal), 2% P_2O_5, 2% K_2O and has an C/N ratio of 9:1. The product is very stable. This product will be transported 100-200 km to northern France. If they plan to move this product 200 - 500 km away they will increase the drying time to reduce the amount of water content.

Figure 13: Inside Samagro Quick Compost Building

The compost is sold mainly to French farming cooperatives but is also sold to individual farmers in France for $20/t. The agronomists working for these cooperatives sell this product for $22 - $26/t. It took some time for the French farmer to understand the significance of organic fertilizer as a fertility source. The product is purchased based on its content of N-P-K. Typical application rates for this product are 2 - 2.8 t/ac which will be supplemented with inorganic fertilizers.

Some other uses for this product are in the horticulture, tree nursery, and flower industries.

Pellets

The facility also makes pressed pellets from chicken manure which are marketed as SamaGROW 4-3-3 as well as pressed pellets of digestate from digesters called SamaGROW 2-4-3. These products contain humus, improve microbiological activity, structure, and aeration of the soil. The pressed pellet also diminish diseases and increase yield. Samagro can also add inorganic fertilizers to either of these products to create custom enriched pellets to suit the end user. These pellets are transported as far away as Asia.

Other Comments

Samagro commented that in the Manitoba situation it did not make sense to compost separated hog solids.

The facility used both a biofilter and sulfuric acid wash to clean the air coming out of the processing building.

3.2.3) Biology Site (Day 3 Site 3)

(The processes at this site are explained in the VCM write up earlier - description of process only summarized here.) This biology process was chosen for this site based on the economical cost being the lowest of all complete treatment systems.

This site treats 6.6 million gallons/year of raw pig manure. (95% from feeder barns and 5% from sow sites) Raw manure is first separated using a G2 Alfa Laval centrifuge. The centrifuge removes 70% - 85% of the phosphorus using no flocculants/polymers. The solids were stacked in a covered storage and then transported to a composting site. (such as the Samagro site) The liquids go through a series of

Figure 14: Alfa Laval G2 Centrifuge

Figure 15: Solids Pile

tanks for a nitrification/ denitrification process. The liquid leaving these tanks is finally pumped into constructed wetlands before discharged back into nature (the reeds growing in these wetlands are harvested and sent to a biogas plant).

It costs $0.107/gallon for this site to come pick up the hog manure and process it. This site pays $26.40/t to get rid of the centrifuged solids to a compost plant.

Other Comments

Age of manure was not considered a factor in efficiency of phosphorus removal. The centrifuge processed about 22000 gal/day (or 1800 gal/hr) and cost about $264k. They have operated the centrifuge for 5 years now with very low maintenance costs. It has been re-built once for $20k If the dry matter of the manure was low it created a wetter solid and they would feed the unit slower. They also ensure the raw manure pre-tank is never allowed to go below 1/2 full to buffer the incoming manure and create a homogeneous product for the centrifuge.

The raw manure sample we viewed had a dry matter of 12.4%, TKN of 1.2%, and P_2O_5 content of 0.6%. The liquid coming out of the centrifuge had an analysis of TKN 0.5%, P_2O_5 0.06%, and a dry matter of 2.7%. The solids coming out of the centrifuge had the following analysis: dry matter 30.7%, and a P_2O_5 content of 3%.

The site owner's advice for Manitoba was to keep it simple. A centrifuge should work for our situation. Raw manure should not be hauled more than 100 kms.

3.2.4) GEA Westfalia Centrifuge Day 4

(Day 4 did not turn out as planned. Initially we had planned to visit northern France to see centrifuges that were running on pig farms and hopefully speak with solids receivers. Our guide/contact broke his knee cap shortly before we arrived in Europe and therefore we lost our French connection. We then made a contact with GEA Belgium (the maker of the Westfalia Centrifuge) and asked for a presentation and possible tour of a farm installation. We were able to receive a presentation but the farm tour didn't materialize. I've attached the notes from that meeting in Appendix F.)

4. Manitoba Applicator and Transporter Interviews

(Field Notes from these interviews are in Appendix G)

4.1) Transporter Interviews:

The most efficient way to move separated solids is by hauling the largest volume/weight possible. Bulk density of these solids has a large influence on how much weight can be hauled per truck load. The bulk density of the solids coming out of a centrifuge in a one year storage is about 0.56 ton/yd^3 (0.75

tonne/m^3) (Trudelle, 2013). In discussions with Fournier, (Quebec centrifuge site) he indicated that they try to compact the load on the truck as it is not very heavy. The bulk density of top soil is around 0.9 ton/yd^3. (1.2 tonne/m^3). Therefore hauling these solids will not create a heavy load on the transport vehicle. Conversely, the solids coming off the Houbraken belt press have a bulk density of 0.825 ton/yd^3 (1.1 tonnes/m^3) as did the solids coming off the belt press seen at the Verkooyen site (Rooyackers, 2013).

Two transport companies were contacted and given a product with a density of 0.49 ton/yd^3 (0.65 tonne/m^3) to be hauled a distance of 47 kms (one-way). One quote came back at \$7.22/yd^3 (\$9.50/m^3) for this distance and the other quote came back at \$11.82/yd^3 (\$15.55 m^3). Both quotes included the loading of the product and used semi-tractor trailer combinations. Another transporter quoted \$100/hr for a 25 tonne tri-axle which could haul 33 yd^3 (25 m^3) of solids. If you would use the Houbraken solids coming off a belt press or similar technology with a density of 0.825 ton/yd^3 (1.1 kg/m^3), hauling costs can be reduced by approximately 30%.

One way to increase bulk-density when loading is to compact the load down with the loading machine. Trucks/trailers can also be modified if they are specifically designed to carry this type of product (or bulky products such as silage) by increasing the height of the box and therefore increasing the volume which can be carried per load. It is difficult to predict the cost savings from either of these two options. It is also known that as the age of the pile becomes older that the pile will begin to decease in size. There are several factors which can decrease the pile size: 1. loss of moisture from the pile, 2. preliminary composting of the pile, 3. Possible compacting of the bottom of the pile due to the weight of the material above it.

4.2) Applicator Interviews:

Five different solid manure applicators were interviewed to better understand the process and cost of applying these solids. The discussions revolved around several different factors:

1. What type of equipment is optimal for this product

- We talked with solid manure applicators that had either vertical or horizontal beaters. To achieve better precision in application an enclosed vertical auger/beater with a horizontal broadcast spreader is best.

2. Where was the most efficient spot to place the solids in the field

-Providing two or three dump sites on the edge of the field provide for the most efficient way to apply in the shortest time period.

Figure 16: Bunning Spreader with Enclosed Vertical Beaters

Figure 17: Vertical Beaters with Bottom Spreader Plate

3. What is the composition of the product. (Dry matter, consistency)

-The dry matter of the product will be between 30%-40%. Most separation technologies have been developed with this dry matter content in mind. This is an ideal dry matter content if the manure is to be further composted. At a dry matter content of 30%-40%, the solids can be easily stacked without significant dewatering of the pile. To create a drier product back at the hog barn simply costs more money and is not economical.

-This product will also be one of the most consistent products put through solid spreaders. This is due to the nature of the equipment which is producing the material. All of solid liquid separation technologies we observed used a mechanical process to remove the hair and undigested feed / fiber. The applicators we spoke with had experience with either solid poultry, beef, or dairy manure. Since there is no bedding material in the separated solids, the product will be very fine and will not have bulky/large/long materials in it. This coupled with the fact that the product will be kept in a covered storage and have a constant dry matter content will make the product very consistent which will aid in its flow out the back of the spreader.

4. What time of year will the product be applied and the corresponding field conditions

-The most ideal application season will be in the fall after harvest onto annual crop land, although there could be applications done on grass/alfalfa in-season. It is doubtful any spring applications of this product will occur on annual crop land due to compaction concerns on the Red River Valley's heavy clays. This would depreciate the value of the solids to the annual crop farmer. The optimal time to apply the product would be just after harvest, (and after excess straw is removed by baling or burning) but before tillage so application equipment can achieve their desired higher application speeds. Regulations will also require that the producer incorporate this product by tillage as per the Manitoba Livestock Manure Management Regulation 42/98 after the application.

5. What application rates will be used and what are the corresponding speeds for these application rates.

-It is expected that the application rates will be in the range of 5 to 10 tonnes/acre. The range in application speeds went from 6 mph to 13 mph.

6. In order that the product doesn't receive rain on it, the coordination of transport to the field and subsequent application will be timed very closely.

Pricing Discussion:

The final discussion with the applicators revolved around pricing. Most applicator's pricing revolved around the number of loads per hour multiplied by an hourly fee.

Applicator prices:	\$450/hr at 120 t/hr = \$3.75/tonne
	\$250/hr at 100 t/hr = \$2.50/tonne
	\$270/hr at 100 t/hr = \$2.70/tonne

$400/hr at 160 t/hr = $2.50/tonne

$3-$5 /tonne (depending on moisture content and distance)

(bulk density of the product was not discussed during the pricing discussion)

5. Manitoba Producer Interviews:

(Detailed field notes from the interviews are attached in Appendix H)

In order to understand whether the separated solids product can be marketed we met with 10 producers who could be potential purchasers.

Selection Criteria:

We used the following criteria in selecting producer candidates.

1. Producers had to be current recipients of liquid hog manure, understand its agronomic benefits, and have land which currently does not receive liquid hog manure because it is too far from the barn.

2. Producers had to have annual crop land outside of Hanover and La Broquerie. Because these 2 municipalities already have a surplus phosphorus budget, hauling to other deficient municipalities would provide the greatest regional benefit. Although there is non-manured land in Hanover and La Broquerie existing sites will compete to haul or tanker manure to these lands which will decrease the market value of the separated solids. In the short term, hauling to the closest acres in these 2 municipalities may make sense, but in the long term longer hauling distances will be required and therefore the longer haul scenario represents a long term sustainable solution. Our target location of producers was west of hwy 59 but east of hwy 75.

3. Four of the ten producers are not currently clients of Agra-Gold Consulting Ltd.   Hylife provided and attended 3 of the producer meetings. We also met with an independent grain producer with application equipment.

Producer Interview Process:

A "Separated Hog Solids Value Proposition" sell sheet was developed after the first interview was done to assist in explaining the value determination. The sheet was modified during the interview process. The final version used is attached as Appendix I. Value for the solids was based on total nitrogen and phosphorus as these are the macronutrients which producers are accustomed to purchasing. We included the analysis of the potassium and sulfur but did not assign a value to these nutrients. During the trip to Quebec , three separated solids samples were collected at the centrifuge sites from the solids pile. (see attached Appendix's B, C, and D) At the one centrifuge site a sample was taken from an older pile and a newer pile. The results from the 3 samples were averaged on the sell sheet.

For illustration purposes a transportation and application cost of $15/tonne was chosen for application rates of 5 and 10 tonnes/ac. ($75/a for 5 tonne/acre and $150/a for 10 tonne/acre). Using $15/tonne for transportation and application cost will allow for about an 38 km haul one-way from the hog farm. The producers which we interviewed had land which was generally 32-64 kms away from the affected sites in Hanover and La Broquerie.

P_2O_5 additions based on these rates were 259 lbs/ac and 518 lbs/ac. The analysis for nitrogen was only done for total nitrogen. It is assumed that the majority of this nitrogen will be in the form of organic nitrogen and therefore we assessed the crop available nitrogen in year 1 to be 25% of the total nitrogen. Additional nitrogen value would be released over the next 3-4 years. For phosphorus, a factor of 50% of commercial fertilizer was used. ($0.52 x 50% = $0.26 /lb) For nitrogen 50% of the usable nitrogen in year 1 was used. (50% of the 25%. ($0.521 x .25% x .5 = $0.065/lb) The 5 tonne/ac rate came to a value of $76/ac and the 10 tonne/a came to a value of $153/ac.

Using an 38 km distance and a cost recovery of 50% value on phosphorus and 50% value of the total nitrogen which will be released in year 1 (assuming 25% of the nitrogen will be released in year 1) netted out a value/cost of $0 for the hog producer for solids transportation and application costs. This was the presupposition (although the model developed throughout process) which was used as the initial value determination in the discussions with the producers. This pricing model factors in the limited agronomic research/experience in Manitoba on separated hog solids and should be viewed as a starting point. It is expected that pricing will increase as Manitoba producers work with separated solids and as agronomic research is completed.

The value proposition was approached from the perspective of having a custom hauler and custom application take care of logistics. It is anticipated that some receivers may want to participate in hauling and/or application of this product.

Interviews were shaped around a discussion of topics such as:

1. the producer's current experience with liquid hog manure

2. current fertility practices

3. crop rotations and crops that benefit most from manured fields

4. soil test values on their landbase

5. current landbase locations

6. benefits on land that have received multiple applications of manure

7. logistics of transport and application of the separated solids

8. some alternative arrangements where a producer may get involved in transport and application

9. how do we determine value / benefit from this product

10. future agronomic research for greater understanding of nutrient availability

Summary of Producer Interview Comments:

The producers were all keen to learn about separated hog solids as a new fertility source. Since all producers had previous experience with liquid hog manure they have all seen benefits on their land. The majority of the producers saw value in this product and felt the valuation of 50% of the commercial phosphorus value and 50% of the total nitrogen which will be released in year 1 (assuming 25% of the nitrogen will be released in year 1) as a fair starting point.

A Summary of Producer Responses is attached as Appendix J. All 10 producers saw value of the separated hog solids. 2 of the producers first wanted to evaluate the product on their land before committing to paying. 4 of the producers agreed that the suggested price was fair and that they would be willing to pay around that amount. The remaining 4 producers seemed anxious to get the product and wanted to ensure that there would be enough product for their land. These producers may possibly pay more than the suggested value first assigned to the product. Of these final 4 producers, 3 of them expressed interest in being involved in either storage, transportation, or application in different combinations.

Based on some of the comments from this last group, there are further options that could be explored to further strengthen the business relationship between the hog farmer with the grain producer. Two of the producers were interested in understanding whether it would be possible to build a solids storage on their land to have a guaranteed supply of this product. This option would also lead to the possibility of having a smaller storage at the hog site (such as 30 days) and then have the grain farmer haul the solids to their own storage throughout the year. Another grain producer expressed an interest in hauling and applying the product himself.

The crops which most often came up in the discussion as benefiting from the solids were corn, soybeans, and alfalfa. All these crops are high phosphorus users and would see the greatest value from an increased phosphorus soil test.

Although we talked about the agronomy of having a higher phosphorus soil test and an increase in organic matter, there are a lot of agronomic questions which will not be able to be answered until field trials are performed under Manitoba conditions. These questions will also be dependent on the technology and process which is used to create the solids. (i.e. was a metal salt used to precipitate the phosphorus which may impact release rates?) Answering these questions over the next number of years will be critical in confirming and enhancing the value of this product.

6. Economic Discussion

The hog industry in Manitoba has faced significant financial challenges since 2007. The number of hog producers in Manitoba has dropped from 1,200 producers in 2005 to 500 producers in 2012. The numbers of sows in Manitoba have also dropped 15% to 314,000 from the peak of 370,000 in 2007 (Manitoba Pork Council presentation 2013 Manitoba Swine Seminar). The financial state of the industry is further evidenced by the bankruptcy and sale of two of the largest producers in western Canada: Big Sky and Puratone.

From 2002 – 2006 hog producers averaged a cost of production (excluding interest, taxes and depreciation) of $120 per finished pig. During the same time period the average selling price was $144 per pig, leaving producers with $24/pig to service debt and profit. Since then it has changed dramatically. The average cost of production since 2007 has averaged $150 per head while the average selling price decreased to $140 per head over the six year time period leaving producers an average loss of $10 per pig sold for the entire six year time period. In 2012 the average hog price for the year rose to over $160 per head however cost of production also skyrocketed to over $170 per head due to drought condition in the US Midwest. Some individual producers, depending on their supply contracts and efficiencies may have fared better than the industry as a whole, however, most continue to struggle with profitability. (MNP internal hog data)

The single largest factor across the board is the cost of feed grains. From 2002–2006 the average price for corn was $142/tonne. The average price for corn between 2007-2012 was $223/tonne and now sits close to $300/tonne. During the same time period soybean meal rose from an average of $297/tonne, to an average of $405/tonne and now sits over $500/tonne (Industry data collected by MNP).

Producers who have stayed in the industry have coped using a number of tools, including increased efficiency and overall cost reduction but have also been forced to reinvest business and personal equity back into their operations as the last 5 years has created a negative return for most hog producers.

For hog producers without adequate landbase to currently comply with phosphorus regulations several questions should be asked/considered before installing a mechanical separation system. 1. How many more acres are required to be long-term sustainable? 2. Are there other close acres which can be accessed with a low phosphorus content via convention manure equipment? (through purchase or spreading agreement) 3. Has the diet been optimized to lower phosphorus in the feed? 4. What is the operation and capital costs of the mechanical separation system compared to hauling the raw manure a long distance? (this question should be considered in conjunction with the site's life expectancy) 5. What amount of phosphorus removal does the hog farm require? 6. Which mechanical separation system can deliver this result within the financial constraints of the operation?

If mechanical separation is determined to be the best solution the capital and ongoing operating costs of a mechanical separation system must be calculated when considering the overall cost of separation; however these costs are not within the scope of this project.

The cost of transport and spreading is the last piece of the phosphorus management strategy for hog farms that are restricted from land application of liquid manure containing phosphorus close to the site.

Using Calculator to Create Specific Farm's Economic Scenario (see Appendix K)

(an .xls copy of the calculator can be downloaded from the MLMMI website for individual producers to input their particular scenario)

For this report we have generated two sample farm operations that mimic existing farms scenarios. The first is for a farm based in the RM of Hanover that must transport its solids 20 miles 32 (kms) and the second is for a farm in the RM of La Broquerie that must transport its solids 40 miles. (64 kms)

A 8,000 head (producing 23,400 market pigs) all-in-all-out finisher site with a 17 week rotation will produce about 4,560,492 million gallons (4,560,492 / 220 = 20729 m^3 or 27275 yd^3 of raw manure) of manure with a dry matter of 3.7%. (industry average in Manitoba for an earthen manure storages) The solids coming from a centrifuge will equal 15%-20% of the total volume with a density of 650 kg/m^3 (0.5 ton/yd^3)(Trudelle, 2013). If the solids storage is designed for a year the average density will increase to about 750 kg/m^3. (.57 ton/yd^3) Therefore, this feeder site will produce about 3317 m^3 (4364 yd^3) of solids with a mass of 2156 tonnes, (2377 ton) but over time the solids pile will decrease in size to 2156 tonnes / .75 $tonnes/m^3$ = 2875 m^3 (3760 yd3) (Trudelle, 20130.)

These values were inputted into the "Separated Hog Solids: Transport and Application Economic Calculator," (Appendix K) along with manure nutrient values obtained from separated hog manure lab analysis.

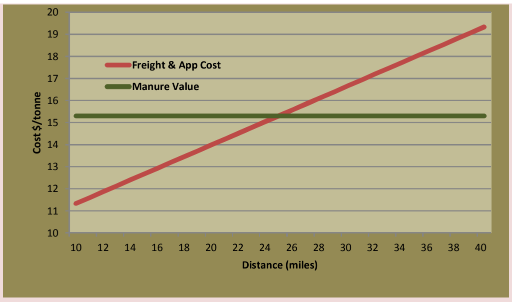
The transportation cost is based on a fixed cost of $\$7.50/m^3$ ($10/tonne) up to 20 miles (32 kms), and then $\$0.20/m^3$ ($0.266/tonne) for every additional mile beyond that. The application cost is assumed to be $4 per tonne.

For the nutrient value calculation we have assumed 12.5% of the total nitrogen content in the solid manure and 50% of the phosphorus value. This is consistent with the feedback received from the producer interviews carried out for this project. Nitrogen and P_2O_5 prices used in the calculator are based on 2012/13 winter commercial fertilizer prices.

For a producer in Hanover the total cost of transport and application is $30,184 or $14.00/tonne. This equates to $1.29 per pig marketed. A twenty mile radius for most farms in the RM of Hanover should allow significant opportunities for land available for spreading. When the nutrient value of the manure is considered against the cost, the total cost is reduced by $32991 to provide a revenue stream of $2807, which is about $0.12 per pig. The breakeven distance based on the selected transport and application costs is 24.9 miles. (40 kms)

Hanover Example: 32 kms (20 miles)

Site Name	Type	# Pigs sold/Yr
Hanover Farm	Finisher	23,400
Choose units for data entry	m3	
Manure Details	**m3**	**-**
Solids Volume m3	2,875	
Solids Density (kg/m3)	750	
Solids Weight (tonnes)		-
Application & Transport	**$/m3**	**-**
Application Cost	3.00	4.00
Base Cost	7.50	10.00
Incremental cost/mile	0.20	0.27
Base Distance	20	miles



Summary Analysis	Total	Per Tonne	Per Pig
Transport and Application	$ 30,184	$ 14.00	$ 1.29
Nutrient Value Recovery	$ 32,991	$ 15.30	$ 1.41
Net Application Cost	-$ 2,807	-$ 1.30	-$ 0.12
Breakeven Distance		24.9	miles
Total Tonnes Applied	2,156		
Total Tonnes Available	2,156		
Overage / (Shortfall)	0		

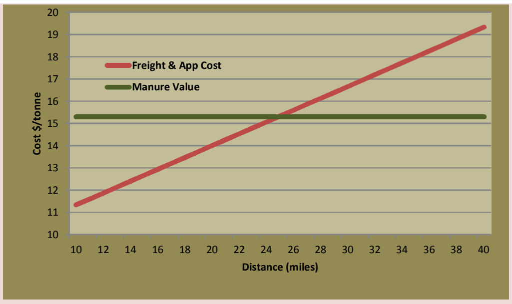
Nutrient Value	N	P2O5	K2O	S			Total
Market Price $/lb	0.53	0.52	0.45	0.56			
Nutrient Value Recovery %	12.5%	50%	0%	0%			
Manure analysis (lbs/ton)	25.10	47.00	9.40	4.80			
Manure analysis - lbs/tonne	27.66	51.79	10.36	5.29	-	-	
Recovery Value /Tonne	1.83	13.47	-	-	-	-	**15.30**
Total Value / Tonne	14.66	26.93	4.66	2.96	-	-	**49.21**

Application Costs			Application	Quantity Applied lbs/acre						Per Acre		Total	
		Distance	Rate							Market	Recovery	Recovery	
Field	Acres	(miles)	(T/acre)	N	P2O5	K2O	S	-	-	Value	Value	Value	Total Cost
Field 1	162	20	6.0	166	311	62	32	0	0	295.52	91.86	14,881	13,608
Field 2	91	20	4.0	111	207	41	21	0	0	196.68	61.17	5,567	5,096
Field 3	164	20	5.0	138	259	52	26	0	0	245.78	76.48	12,543	11,480
Field 4				0	0	0	0	0	0	-	-	-	-
Field 5				0	0	0	0	0	0	-	-	-	-
Field 6				0	0	0	0	0	0	-	-	-	-
												32,991	**30,184**

Figure 18: Separated Hog Solids Transport and Application Economic Calculator for Hanover example (32 kms: 20 miles)

La Broquerie Example (40 Miles: 64 kms)

Site Name	Type	# Pigs sold/Yr
L Broquerie Farm	Finisher	23,400
Choose units for data entry	m3	
Manure Details	**m3**	**-**
Solids Volume m3	2,875	
Solids Density (kg/m3)	750	
Solids Weight (tonnes)		-
Application & Transport	**$/m3**	**-**
Application Cost	3.00	4.00
Base Cost	7.50	10.00
Incremental cost/mile	0.20	0.27
Base Distance	20	miles



Summary Analysis	Total	Per Tonne	Per Pig
Transport and Application	$ 41,683	$ 19.33	$ 1.78
Nutrient Value Recovery	$ 32,991	$ 15.30	$ 1.41
Net Application Cost	$ 8,692	$ 4.03	$ 0.37
Breakeven Distance		24.9	miles
Total Tonnes Applied	2,156		
Total Tonnes Available	2,156		
Overage / (Shortfall)	0		

Nutrient Value	N	P2O5	K2O	S			Total
Market Price $/lb	0.53	0.52	0.45	0.56			
Nutrient Value Recovery %	12.5%	50%	0%	0%			
Manure analysis (lbs/ton)	25.10	47.00	9.40	4.80			
Manure analysis - lbs/tonne	27.66	51.79	10.36	5.29	-	-	
Recovery Value /Tonne	1.83	13.47	-	-	-	-	**15.30**
Total Value / Tonne	14.66	26.93	4.66	2.96	-	-	**49.21**

Application Costs			Application	Quantity Applied lbs/acre						Per Acre		Total	
		Distance	Rate							Market	Recovery	Recovery	
Field	Acres	(miles)	(T/acre)	N	P2O5	K2O	S	-	-	Value	Value	Value	Total Cost
Field 1	162	40	6.0	166	311	62	32	0	0	295.52	91.86	14,881	18,792
Field 2	91	40	4.0	111	207	41	21	0	0	196.68	61.17	5,567	7,037
Field 3	164	40	5.0	138	259	52	26	0	0	245.78	76.48	12,543	15,853
Field 4				0	0	0	0	0	0	-	-	-	-
Field 5				0	0	0	0	0	0	-	-	-	-
Field 6				0	0	0	0	0	0	-	-	-	-
												32,991	**41,683**

To use the calculator:

Figure 19: Separated Hog Solids Transport and Application Economic Calculator for La Broquerie (40 miles: 64 kms) example

For a producer in La Broquerie the total cost of transport and application is $41,654 or $19.32/tonne. This equates to $1.78 per pig marketed. A forty mile radius for most farms in the RM of Labroquerie should allow significant opportunitie**s** for land available for spreading. When the nutrient value of the manure is considered against the cost, the total cost is reduced by $32991 to $8692, which is $0.37 per pig.

Summary of Findings

In both scenarios the cost of transport and application is relatively small when compared to the overall cost of production for a finished pig. If the nutrient recovery is taken into account this cost is lowered further. The impact for hog producers is fairly significant for a number of reasons. At minimum this analysis assists in further understanding the implications of changing their manure handling practices and adapting to dealing with solid manure.

When comparing the two sites to each other, the incremental cost of hauling manure an additional 20 miles (32 kms) is only $19.33 - $14.00 = $5.32 per tonne. When this is considered against the value that some producers are willing to pay to receive the solids product, it encourages hog producers to seek out people who are willing to pay for the product. In theory, the further the manure is transported from the intensive livestock areas, the greater the opportunity for phosphorus deficient soils .

As established through grain farmer interviews, there is proof that value exists in the nutrients available and farmers are willing to pay to have solids applied on their fields. The key will be for individual hog producers to line themselves up with these types of grain farms and understand the transport economics from their own site. This may include the assistance from industry personnel such as brokers, as seen in other jurisdictions. The access to land suitable for solids application will be crucial to the long term sustainability of individual hog operations. Producers should consider signing contracts with solid manure recipients. These could be similar to existing contracts that some producers have for liquid manure.

Other Considerations

The bulk density of the separated solids coming out of the storage, using a centrifuge, was assumed to be 750 kg/m^3 (.57 ton/yd^3). This is quite bulky when compared to other products such as top soil. (1,200 kg/m^3) When the product is transported in trucks the volume will most likely be the limiting factor vs. weight. If producers use a technology such as the belt press or other technology which creates a higher bulk density solid, the cost savings could be significant. If the tonnes of product from our example farm were maintained, but the density was increased to 0.75 ton/yd^3 (1,000 kg/m^3), the cost of transport and application could be reduced by $30184 - $22638 = $7546 as seen in Figure 20. For the Hanover producer, this would create a further net benefit to the farm for the solid manure as the value recovered for the nutrients is greater than the cost of transport and application. For the La Broquerie producer the savings would make the solids hauling and application slightly better than a breakeven operation. These economics may encourage these producers to adapt different technologies and techniques depending on their individual economics.

Site Name	Type	# Pigs sold/Yr	
Hanover	Finisher	23,400	
Choose units for data entry	m3		
Manure Details	**m3**	**-**	
Solids Volume m3	2,156		
Solids Density (kg/m3)	1,000		
Solids Weight (tonnes)		-	
Application & Transport	**$/m3**	**-**	
Application Cost	3.00	4.00	
Base Cost	7.50	10.00	
Incremental cost/mile	0.20	0.27	
Base Distance	20		miles
Summary Analysis	**Total**	**Per Tonne**	**Per Pig**
Transport and Application	$ 22,638	$ 10.50	$ 0.97
Nutrient Value Recovery	$ 32,991	$ 15.30	$ 1.41
Net Application Cost	-$ 10,353	-$ 4.80	-$ 0.44
Breakeven Distance		44.0	miles
Total Tonnes Applied	2,156		
Total Tonnes Available	2,156		
Overage / (Shortfall)	0		

Figure 20: Hanover example in Figure 18 modified to 0.75 ton/yd3 (1000 kg/m3 bulk density)

Other Product Types

The analysis has focused on hog finisher sites. There are obviously other production types that have similar manure challenges. We have adjusted our calculations assuming the following industry averages for manure production and solid content in liquid manure to provide the following comparisons for Nursery and Sow facilities. The cost for both of these types of operations is significantly lower on a per pig basis as the manure production is significantly less (see Figure 21).

	Manure		Transport Distance	
			20 miles	40 miles
	L/pig/day	Solids %	Cost / pig	
Sow	23.0	1.96%	0.27	0.37
Nursery	3.0	2.40%	0.16	0.23
Finisher	7.1	3.72%	1.29	1.78

Figure 21: Assumptions for manure produced (L/pig/day) and solids % and the corresponding cost/pig

Conclusion

The average cost in Manitoba to apply liquid manure within a 2 mile (3.2 kms) radius is $0.01/gal to $0.011/gal. As you increase to 3-4 miles (4.8 - 6.4 kms) this cost can go up as much as 50%. (using a dragline) Long distance hauling with a tractor and wagon can cost $0.27/gallon at 6 miles. (9.6 kms) Manitoba does not have much experience with hauling raw hog manure long distances (20 kms to 40 kms) as countries such as the Netherlands does.

In the Netherlands full manure disposal/treatment costs $0.12 to $0.15/gallon whether you are paying for transportation and application of the raw liquid manure or paying a broker who will treat the manure. The case in the Netherlands is very different than we see in Canada based on the over-supply of nutrients in the country. Another fundamental difference in the Netherlands is that a feeder pig has 60% less manure to dispose of due to water conservation, barn design, and storage covers. This fact significantly changes the economics of manure treatment.

For those producers in Manitoba who require treatment to achieve phosphorus balance on their land, the total costs must be carefully calculated (including cost of capital and operation of the treatment system).

The cost of transport and application of manure solids on its own should not be cost prohibitive to producers, however when taken in context of the financial challenges currently facing hog producers, it becomes an additional burden for many producers to deal with. The expansion of the hog industry as well as significant advances in liquid manure application in the last 15 years have created an increased interest and appreciation for manure as a crop nutrient. The opportunity that hog producers have to offset the ongoing disposal of manure solids should increase producers comfort when analyzing the economics of manure separation.

7. Acknowledgements

Funding was provided by the Manitoba Livestock Manure Management Initiative, Agra-Gold Consulting Ltd. and PDK Projects, Inc.

Section 6 of the report was written by Peter Manness P.Ag. of MNP. Peter also created the Solids Cost Calculator.

Erik Eising of PDK Projects provided the networking, logistical planning, and translation services for the European visits. (without him it would have been very difficult to gain access to the people and sites we visited)

Marc Trudelle of Quebec Pork lined up and attended the Quebec producer interviews.

A special thank-you to the Manitoba transporters, applicators, and producers who gave us valuable information in our interviews with them. Thank-you to Matt Reimer of Hylife who lined up and attended 3 producer interviews. As well as our many contacts in Quebec and the Netherlands who provided us with information for this project.

Analytical services for the solid manure samples were provided by Agvise Laboratories in Northwood North Dakota.

Doug Redekop of Penner Farm Services for perspective on the Europe vs. Manitoba situation

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9. Appendix A: Supplementary field notes from Quebec (July 30-Aug 1, 2012)

General discussion with Marc Trudelle of Quebec Pork

- Province of Quebec has 360,000 sows, finishes 7.5 mil pigs/yr, 9 slaughter houses

- Average farm is 265 farrow to finish

- Agro-Quebec receives about one meter of moisture annually.

Visit at Agromex (Menard's)

- Site has partially slatted barns

- water usage is approx 5-5.5 l/pig/day

- Use 4 stage feeding for P management for finisher pigs (1.1 P excretion)

- Have 3 – 1 mil gal concrete storages, 2 are used for treated manure (liquids), and 1 is used for emergency for untreated manure

- When spreading untreated manure, spread as low rate as possible, approx. 2000 gal/acre

- Once treated, spread 3000 – 4000 gal acre

- Recipients pay $6 per 1000 gals of manure

- Have a pre-treatment mixing tank – approx 12,000 gals, could use a 50,000 gal tank

- Hydro / energy usage on centrifuge is $ 9,000 / yr

- Have a maintenance contract on control panels, cost is $ 10,000 yr

- Key for successful treatment is UNIFORM and FRESH manure, need 96-97% moisture

- Each receiving farm has to use an agronomist, signed agreements, detailed analysis, soil sample every 5 years, manure sample every year

Visit at Fournier

- No P added to stage 4 finishing ration

- Installed and Alpha-De-Laval centrifuge - $ 700,000 (doesn't run Jan 1 to mid Feb)

- uses a 30 micron screen

- 2 years of operation so far, tech support comes from Alpha Laval

- Energy / hydro bill is $ 5000 - $ 6000 annually

- Pre-mixing tank is 24' x 16' deep concrete,(42000 gal) Treated tank is 80' x 16' concrete (470000gal)

-Solids management

-Exporting approx 12,000 kg of P205 annually

Visit with Custom applicators in Quebec (Guy Vegiard 450-405-7200)

Applicator - Jean Noel Pare'

-Has 2 semi's – 9000 gal each, 3 tandems – 3500 gal each

-Have hauled as far as 100 kms, furthest was 3.5 hr round trip

-Sometimes immediately spread, sometimes dump into receiver's pits

-Have Fendt tractors with DM tankers

-Spread as low as 1000 gal/acre, usually 2500 – 4000 gal/acre (rates of 10,000 were unheard of)

-Quebec has very strict regulations for road travel, tractor speed, tanker weight etc.

Applicator - Reynauld St. Pierre

-5 Houle tankers, 4 T7070 tractors

-Apply 35 mil gals / year

-Also have solids spreaders, can spread as low as 8 cu/meter/hectare

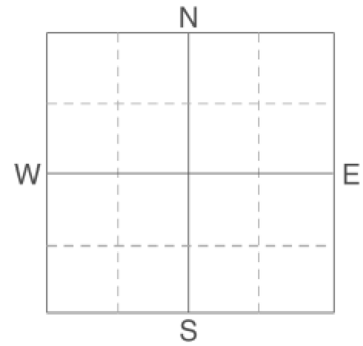
Appendix B: Menards - Fresh Pile of Separated Hog Solids

AGVISE LABORATORIES

P.O. BOX 510, NORTHWOOD, ND 58267
Northwood: (701) 587-6010
Benson: (320) 843-4109

MANURE REPORT

SAMPLE **#1 NEWEST - CENT**
TYPE **Solid Manure**
SOURCE **Swine**
STORAGE
LAB NUMBER **NW1258**



SUBMITTED FOR:
MENARDS
,

SUBMITTED BY: **EL1911**
AGRA-GOLD CONSULTING LTD
CLIFF LOEWEN
BOX 156
BLUMENORT, MB R0A 0C0

MOISTURE **66**
DRY MATTER **34**

Date Sampled **12/28/12** Date Received **12/04/12** Date Reported **3/14/2013**

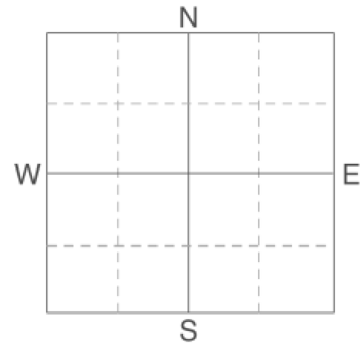
	Dry Basis	As Received	lbs/ton
Total Nitrogen (N):		.87 %	17.4
Ammonium Nitrogen:			
Nitrate Nitrogen:			
Inorganic Nitrogen:			
Organic Nitrogen:			
Phosphate (P2O5):	4.5 %	1.5 %	30
Potash (K2O):	.93 %	.32 %	6.3
Sodium:	.28 %	.094 %	1.9
Calcium:	5.4 %	1.8 %	37
Magnesium:	1.6 %	.55 %	11
Zinc:	850 ppm	290 ppm	.58
Iron:	1300 ppm	460 ppm	.94
Manganese:	490 ppm	160 ppm	.33
Copper:	240 ppm	82 ppm	.16
Sulfur:	.45 %	.15 %	3
Chloride:			
pH:		8.6	
Salts:		3.4 mmhos/cm	
Total Carbon:		13.82 %	276.4
Volatile Solids:			

AGVISE LABORATORIES

P.O. BOX 510, NORTHWOOD, ND 58267
Northwood: (701) 587-6010
Benson: (320) 843-4109

MANURE REPORT

SAMPLE **#2 MIXED SOLIDS**
TYPE **Solid Manure**
SOURCE **Swine**
STORAGE
LAB NUMBER **NW1259**



SUBMITTED FOR:
MENARDS
,

SUBMITTED BY: **EL1911**
AGRA-GOLD CONSULTING LTD
CLIFF LOEWEN
BOX 156
BLUMENORT, MB R0A 0C0

MOISTURE **50**
DRY MATTER **50**

Date Sampled **12/28/12** Date Received **12/04/12** Date Reported **3/14/2013**

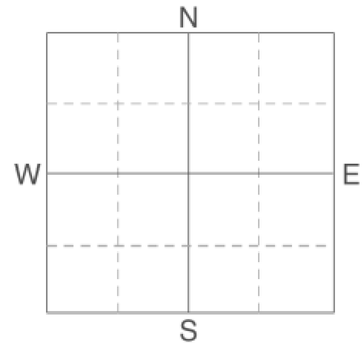
	Dry Basis	As Received	lbs/ton
Total Nitrogen (N):		2.03 %	40.6
Ammonium Nitrogen:			
Nitrate Nitrogen:			
Inorganic Nitrogen:			
Organic Nitrogen:			
Phosphate (P2O5):	3.2 %	1.6 %	32
Potash (K2O):	2.7 %	1.3 %	27
Sodium:	.5 %	.25 %	4.9
Calcium:	2.8 %	1.4 %	28
Magnesium:	.74 %	.37 %	7.4
Zinc:	580 ppm	290 ppm	.59
Iron:	1600 ppm	840 ppm	1.7
Manganese:	490 ppm	240 ppm	.49
Copper:	480 ppm	240 ppm	.48
Sulfur:	.5 %	.25 %	5
Chloride:			
pH:		8.4	
Salts:		9.1 mmhos/cm	
Total Carbon:		22.97 %	459.4
Volatile Solids:			

AGVISE LABORATORIES

P.O. BOX 510, NORTHWOOD, ND 58267
Northwood: (701) 587-6010
Benson: (320) 843-4109

MANURE REPORT

SAMPLE **#1 NEWEST CENT**
TYPE **Solid Manure**
SOURCE **Swine**
STORAGE
LAB NUMBER **NW1260**



SUBMITTED FOR:
FOURNIER
,

SUBMITTED BY: **EL1911**
AGRA-GOLD CONSULTING LTD
CLIFF LOEWEN
BOX 156
BLUMENORT, MB R0A 0C0

MOISTURE **71**
DRY MATTER **29**

Date Sampled **12/28/12** Date Received **12/04/12** Date Reported **3/14/2013**

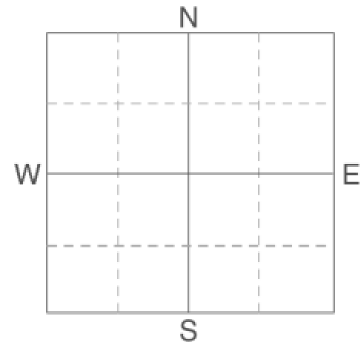
	Dry Basis	As Received	lbs/ton
Total Nitrogen (N):		1.29 %	25.8
Ammonium Nitrogen:			
Nitrate Nitrogen:			
Inorganic Nitrogen:			
Organic Nitrogen:			
Phosphate (P2O5):	9.2 %	2.7 %	53
Potash (K2O):	2.1 %	.61 %	12
Sodium:	.45 %	.13 %	2.6
Calcium:	1.8 %	.51 %	10
Magnesium:	3.3 %	.95 %	19
Zinc:	1700 ppm	510 ppm	1
Iron:	1800 ppm	520 ppm	1.1
Manganese:	890 ppm	250 ppm	.52
Copper:	300 ppm	88 ppm	.18
Sulfur:	.94 %	.27 %	5.4
Chloride:			
pH:		7.3	
Salts:		9.7 mmhos/cm	
Total Carbon:		11.59 %	231.8
Volatile Solids:			

AGVISE LABORATORIES

P.O. BOX 510, NORTHWOOD, ND 58267
Northwood: (701) 587-6010
Benson: (320) 843-4109

MANURE REPORT

SAMPLE **#2 OLDEST CENT**
TYPE **Solid Manure**
SOURCE **Swine**
STORAGE
LAB NUMBER **NW1261**



SUBMITTED FOR:
FOURNIER
,

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MOISTURE **70**
DRY MATTER **30**

Date Sampled **12/28/12** Date Received **12/04/12** Date Reported **3/14/2013**

	Dry Basis	As Received	lbs/ton
Total Nitrogen (N):		1.61 %	32.2
Ammonium Nitrogen:			
Nitrate Nitrogen:			
Inorganic Nitrogen:			
Organic Nitrogen:			
Phosphate (P2O5):	10 %	3 %	59
Potash (K2O):	1.7 %	.51 %	10
Sodium:	.38 %	.11 %	2.3
Calcium:	2.3 %	.69 %	14
Magnesium:	3.5 %	1.1 %	21
Zinc:	1900 ppm	580 ppm	1.2
Iron:	2000 ppm	610 ppm	1.2
Manganese:	890 ppm	260 ppm	.54
Copper:	300 ppm	92 ppm	.18
Sulfur:	1 %	.31 %	6.2
Chloride:			
pH:		7.7	
Salts:		7.7 mmhos/cm	
Total Carbon:		10.96 %	219.2
Volatile Solids:			

Appendix F: Field Notes from the Netherlands and Belgium

Europe Agenda and Locations

Day 1: Nov 19: (Holland)

1. **Agronomy Consultant:** (our guide for day 1) Meeting with Herman Krebbers of DLV Plant: Agricultural Consultant (s-Hertogenbosch)

2. **Pig Farm:** with solids separation - (Nistelrode)

3. **Dairy farm** with mobile separator - (Bunnik)

4. **Applicator, Transporter, Broker, Full Treatment Site:** Verkooyen Broker - (Langeweg)

Day 2: Nov 20 (Holland)

1. **Pig Mobile Separator - Pig Farmer:** AgraSEP Mobile Processor at Sow Farm - (Hoge Mierde)

2**. Compost Marketer** - Interview with Hans Hendrix

3. **Organic/Municipal Regional Composter:** Van Kaathoven Composting - (Bladel)

Day 3: Nov 21 (Belgium)

1. **Flemish Coordination Center for Manure:** VCM Office Presentation - (Brugge)

2. **Separated Solids Composter:** Samagro Composting Facility for Organic Fertilizers - (Beverenstraat)

3. **Centrifuge / Full Treatment Site:** Biological Site with Alfa Laval Centrifuge (Vleteren)

Day 4: Nov 22 (Belgium)

1. **Belgium Centrifuge Office:** Visit GEA Belgium office, makers of the Westfalia Centrifuge - (Antwerpen)

Day 5: Nov 23 (Holland)

1. **Applicator, Transporter, Broker, Full Treatment Site:** Houbraken Broker - (Bergeijk)

(Note European conversion rate for $1 EU = $1.30 cdn, 1 m3 of manure = 220 Imp gallons)

Interview With Herman Krebbers

- Regulation set by EU: 170kg/ha of N and 85kg/ha of phosphate (some flexibility based on soil test)

    -if fertilized then not regulated

    -Dairy can apply 250kg/ha of N because of extra efforts in nutrient management - not seeing 50mg of nitrate in ground water and they get higher yields - dairies have enough acres for their manure as they need silage corn/roughage to feed

    -pig farms do not have adequate acres to spread manure

    -The Dutch and German's make agreement to regulate manure moving across the border. (costs 3.6 EU cents to 4.5 EU cents to move manure to Germany)

    -all liquid manure must now be injected (no liquid visible) and solids must be incorporated within 1 day

- Promest - first big manure processing facility developed in 1992. cost 6.8 EU cents to 9 EU cents / gallon to send to processing plant.

- this pellet factory ran out of manure as broker could take manure for 4.5 EU cents/gallon and get rid of it by hauling to other area/country

- 80% of all cereals in Holland fertilized with manure

- DLV (Herman's company) is working with potato farmers to use manure as well.

- There is skepticism of government: In 1990 the government legislated all manure had to be injected. So applicators bought specialized equipment to inject. The farmers union pressured the government and the rules were relaxed. Applicators were stuck holding this more expensive equipment until injection legislation was passed.

- costs 4.5 EU cents to 6.4 EU cents to process, 3.6 EU cents to 4.5 EU cents to put on the land, leaving 2.7 EU cents to 3.6 EU cents profit for the broker

- There is currently no government subsidy to process manure.

- Lots of extra storage has be built around the country by brokers and farmers.

- There is a general EU subsidy. In Holland a cereal hectare can get $400 to $500 euro/ha. This subsidy will decrease to $100 euro/ha in 2015. Extra $$$ will be available for innovation in terms of climate and environment.

- About 10 brokers have invested in processing equipment.

- Solids are applied on potatoes in fall (phosphate) and liquid in spring for N and K.

- Most arable land is tiled at 5 m to 10 m.

- Reverse Osmosis breakdown: If manure can be disposed of for less than 6.8 EU cents/gallon then RO not usually considered but over this amount and RO is attractive.

- Average Yields: Corn Silage 15 tonnes/ha DM = 6.1 tonnes/a

Winter Wheat 9 tonnes/ha = 3.64 tonnes/a

Potatoes 50 tonnes/ha = 20 tonnes/a

Research shows manure plus extra N = higher yields eg. 16 tons/ha DM of pasture grass (up to 5 cuts of hay)

- Soil test Phosphorus readings: Pw = mg P2O5/l, P.pae=available, P.all= all in soil -bound reserve, Pnalavering = from reserve easily available

Nistelrode Swine Farm

- uses pelleted feed

- The farm had set up a system in that the liquid phase would then go through a reed wetland but this didn't work.

- The pre-tank has a tractor propelled agitation system, (big fan) with a sloped floor to collect manure.

- Why don't they use a centrifuge? Costs $100k EU

The land price in this area is $60k to $80k EU/ha.

The current net price to send a 25kg pig to Germany is $53 eu.

Average salary for a swine worker is $3500 eu/month which nets about $2100 eu/month.

Dairy Farm near Bunnick with Mobile Separator

- Separated solids can be applied all year-round. If he was on sandy soils then winter application would not be allowed.

- Dairy Manure - start with 1.8 kg/m3 phosphate to 1.3 kg/m3 phosphate in 1m3 of raw manure.

- Pig at 8% DM, 4kg to 3.2kg phosphate = 20% reduction. If fed with by-product (potato by products) then separation is worse.

- If you used a centrifuge on old manure then 4kg/m3 would be reduced to 2.8kg/m3 of phosphate.

- If they were to design the portable unit again would increase capacity.

Verkooyen Broker and Processor

- This broker handles about 13.2 million gallons/year. With his various storages he is no more than 20kms of all his fields.

- There is currently 20 million kg of excess phosphate in Holland.

- In the 80's arable farmers paid 1 cent for gallon for pig manure and 2 cents per gallon for poultry manure.

- If hog production decreases the arable farms will not charge to take manure. (as manure will be taken from the system and there will be an increase in demand)

Solids Marketing

- There are basically no centrifuges in Holland.

- Keep the pre-tank for treating always 1/2 full as a buffer. (manure is finicky)

- Every load of liquid and solid is weighed and analyzed.

Pig Mobile Separator by AgraSEP

- The 25m3/hour unit requires a 32 amp service to operate. Hans was going to experiment with different sizes of screens

- Sieves can be changed in 15 minutes.

- Dairy Quota will be done in 2015 according to EU rules.

- The Dutch have a pig quota system which will continue.

- The AgraSEP custom price for separating is $0.0068 EU per gallon.

Other Comments on Separating:

- The custom price centrifuge is $0.018 EU per gallon due to capital and higher maintenance costs.

- This includes: Maintenance = \$0.0068, Polymer = \$0.0034, Energy = \$0.0027, Capital = \$0.0045 plus labor.

- ITE sells a centrifuge which is good as a permanent installation but not a good mobile solution. The mobile unit can treat 5500 gal/hr and costs \$300k EU. One of the issues with the centrifuge is the solids contain polymer which makes them more difficult to sell.

Interview Comments from Hans Hendrix - Compost Expert

- Polymers: Germany no polymers, France may not allow once they know of availability, Holland has no regulation on polymers. (German university did research on polymers which placed fear about using polymers)

- Every time you handle or do something with manure it costs \$0.0045 / gallon.

- Typical analysis of well separated manure: DM = 27% to 28%, TN = 18-20kg/tonne, P_2O_5 = 30kg/tonne, K_2O = 6-8 kg/tonne (this composition will be the same for non-composted and composted manure) The DM% of composted manure if 70%. 90% of the P_2O_5 is available in year 1.

- If you treat 100m3 of 1-2% solids = 10m3 of DM, 3-4% solids = 20m3 of DM, 5-6% solids = 25m3 of DM

- We looked at an area where there was 200,000 pigs within 1km2. These pigs produced 200,000 tonnes of manure. This area was 500 m from the Belgium border.

Tour of Van Kaathoven Composting Center

- It costs about 700k EU / tunnel: this site had 15 tunnels. (30m long, 5.75m wide, 4 m high)

- Process: roughage to shredder to chop, mixed with 1/2 composted material in tunnel, left for 2 weeks blowing air through it, sieve out 10-15mm2. The larger particles get sent back to tunnel and smaller particles take to potato farmers. The air used in the tunnel is 24 hrs at 60 C and then 40 C for the rest of the 2 weeks. Temperature is measured as in and out flow of air.

- The end user pays nothing for the product. The cost is covered in tipping fees.

- The top of the tunnel has biofilter so there is no smell outside.

- The facility takes in 60000 tonnes of roughage material and creates 25000 to 30000 of final product.

- This company has 4 plants worldwide with one in Hamilton. (Gicom.nl built it)

VCM Presentation

Phone Interview with Dieter (technology expert in Belgium)

-Mobile separators have been in Britain, France, and Belgium

-Raw manure going to the centrifuge is stored in silo so they can mix consistently. The pre-tank should be sized at 14 days retention time.

- With a 4% DM manure the centrifuge has to be adapted to the manure.

- For weak manure use a differential speed of 3 to 4 rpm. (run at 4000 rpm) Thick manure is 10 rpm differential. Both Westfalia and Alfa Laval should be able to do the same.

- With thin manure you can put more volume through.

- They used to use a mobile centrifuge in Belgium but when they moved to the biology process then they needed a stationary unit. If you use a mobile unit the sample must be very well agitated. This wouldn't work in Canada b/c we use earthen cells.

- The solid manure fraction is either composted like at Samagro (12 facilities in Flanders), dried thermally with external heat (12 facilities in Flanders) or limed with CaO (2 facilities in Flanders). For composting there exist very different types, from high-tech to very low-tech, large scale to small scale.

Samagro Composting Facility

Biological Site

- The G2 was capable of separating 22000 gallons of manure per day. This machine costs about $200k EU. They felt the cost of capital per gallon was 1.1 cents EU. They run about 1800 gallons/hr through the G2. The cost of energy was 9 cents EU/kw.

- The operator stated that if he had thicker manure he created a bigger differential RPM in the centrifuge vs thinner manure. (this was the main adjustment which had to be made based on the manure coming in to the unit) Another tip was that the pre-tank was never allowed to go below 1/2 full to buffer the manure going into the centrifuge

- If a producer takes the liquid back after the denitrification/nitrification treatment they get a reduction of 1.4 cents EU per gallon. At this point the liquid is still a good source of potash.

- The centrifuge should work for us with or without polymer. He felt that a Manitoba solution of just a centrifuge would cost around 3.5 cents/gallon EU. This would include hauling out the thick fraction (a cost of 1.3 cents EU/gallon) and include capital, depreciation, maintenance, and electrical based on 6.6 million gallons/yr. He also stated that it wasn't economical to haul raw manure more than 100 km.

GEA Westfalia Centrifuge

- Based on presentation and questions answered by Jake Deighton. (General Manager of GEA Belgium maker of the Westfalia Centrifuge) There are currently 40-50 decanters running on farms/farm centers. There have been 4-5 mobile units since 2000 but as legislation has become more strict the mobile units have left Belgium. There is a GEA mobile unit in Denmark which can separate up to 35200 gal/hr. Often they will run the decanters at night when energy is cheaper.

-Belgium average DM of pig manure content is 9%. (Sow 4% and feeder 10-12%) This dry matter amount contains 5-7% of fibers, (which can be removed by the centrifuge), 2% sediment solids, (which requires polymer to be able to remove by the centrifuge) and .5% very fine particles which can't be removed by the centrifuge. There is simple lab test that can determine the manure composition which is very helpful in knowing how effective the centrifuge will perform. This can be performed by placing raw manure into a test tube running at 4000 rpm in a lab centrifuge. These 3 types of solids will stratify and will be able to tell you how the manure will perform in an on-farm centrifuge.

-In Belgium, without polymer centrifuges remove 65% to 85% of phosphorus, with polymer they will remove up to 90%.

-Centrifuges can work with manures of less than 3% but must be designed carefully to perform well with this manure.

-Jake was a bit concerned with older manure going through the centrifuge as it has had time to digest and decompose some of the fibrous solids into smaller particles.

-The screw press is only capable of taking out half of the fibrous material. (it's phosphorus removal is only about 15%)

-Ensure the pre-tank is agitating properly to create stable product. (larger is better and round is better)

-Proper maintenance is important as you will have wear on the unit. Maintenance can be an expensive component of the overall cost of the unit. (sand has the most potential to wear the machine)

-Polymer is hardly used in Belgium due to the high cost of polymer. Polymer doesn't need resonance time and can be added directly at the centrifuge.

- The amperage draw with go up and down based on the size of the plug. (inside the machine) The differential speed should be regulated automatically on torque. (about 45% torque is optimal)

- Hog farms have an easy product to go through the machine and therefore the usual 4500 rpm may be able to be reduced to 3500 rpm. (with the use of a frequency inverter)

<u>Houbraken</u>

-Biogas needs 19 cents/kw EU to breakeven. They are currently getting 18 cents/kw EU.

- Houbraken has proof that 48 hours after application the polymer within the solids disappears.

- In Holland a feeder pig produces 1m3 of manure per year. In Canada a feeder pig produces 2.5 m3 of manure per year. (this is based on barn design, barn management, and type of storage)

Appendix G: Field Notes from Applicator and Transporter Interviews

Applicator Comments:

1. Jan 16, 2013 Phone Interview with Applicator 1

- Have applied at a treatment site in Pine Falls (about 1500t at 10t/a), loaded with backhoe

10t/ac - 15 t/ load = 1.5 acres/t

- 1 mile /load at 10 miles/hr = 2 miles in 12 min.

- 14-18 minutes to load and spread

- this equals 4 loads/hr (dumping product on the end is best)

- they charge $50/load (15 t)

- they have 2 trucks plus a wheel loader costs $450/hr (at $160/hr x 2 plus $130/hr for loader)

- They can spread about 120t/hr

- If bidding he would bid 8 loads/hr although they may be able to do 10 loads/hr

- So $450/hr / 120t/hr = $3.75/t

- They use single horizontal beater with a floor chain and a spread pattern of 10 ft. This provides a consistent spread. They have done a lot of poultry manure at 6 t/a. (currently do 98% cattle manure)

- (with a vertical beater you can control to 0.5 t/a and gives a wider spread)

2. Jan 17, 2013 - Interview with Applicator 2

- Responsible for loading and hauling from composted chicken manure (used to be dried but no longer)

- Dry matter changes from soupy mix to very dry

- Uses a Bunning spreader with horizontal beaters with spinners on the bottom. Full width chain on bottom to move load to the back. About 35 tonnes capacity (cost $110k)

- Average spread rate is 5 tonne/a to 10 tonne/a (at 10 t/a = 200 lbs N of avail N.) which is incorporated shortly after.

- They drive on 40 ft centers which overlaps application. (using Auto-steer)

- They will test manure at the beginning and end of field.

- Have hauled up to 12 miles one way. Also have hauled with a truck and reloaded in the field.

- Will apply only in fall due to compaction and seed-bed issues related to spring. (and ruts)

- Drive about 6-8 mph. Use quad-track with 485 hp. (375 hp not enough)

- If 3 miles to field then 1 hr round trip (including loading time)

- Last year they did about 200-220 loads and it took 200 tractor hrs. They moved about 7000 tonnes.

- If they did this custom they would charge $200-$250/hr.

- If hauling on same field. 33 t/load x 3 loads /hr = 100 t/hr

- So $3-$4/ tonne custom for application seems reasonable

3. Jan 14, 2013 Interview Applicator and Transporter 3

- Equipment: has access to 25 tonne tri-axle trailers (about 25 m3) - will cost about $100/hr

-currently has 12 t and 15 t tandems (haul about 15 yds topsoil)

-bill these out at $75/hr (includes fuel and driver)

-Winnipeg rates for gravel delivery is $85-$90/hr

-tandems are ideal for hauling > 5 kms (otherwise use spreaders to transport to field)

-He can slide a spreader into the back of the tandem. - has floor chain to unload

-estimated about $20k for 1500 t, which equals $12-$15/t to apply only

-breakdown. average 4 loads per hour if product on the field with 2 trucks = 100-120 T/hr

- this will cost $270/hr, so 1500 t at 100 t/hr = 15 hrs x $270 = $4050 or $2.70/tonne

-could this be considered a class 2 material under TDG regulation?

- for a 30 mile one way haul = 5-6 loads/day on a tri-axle

4. Jan 14, 2013 Interview with Applicator 4

- Has a 2 - Bunning spreaders which hold 23 ton each

- Has tried a Kuhn and Myers and feels they are not strong enough for the work he does (largely cattle industry)
- To apply 6 t/acre would have to travel 13 mpg
- Costs to apply 6 tonne/acre (1000 ton) = 10 tn/ac on 100 acres
- $125-$150/hr per spreader x two plus excavator at $125/hr equals $375 to $400/hr
- He uses an excavator as he feels it is faster than a wheel loader
- If solids in the spread field then one unit should be able to do 4 loads/hour or 80 tonnes/hr
- So two units should be able to spread 160 tonnes/hr at $400/hr = $2.50 / tonne

5. Feb 11, 2013 Interview with Applicator + Transporter 5

- generally it would cost $3-5 / tonne dependant on moisture and distances at 8-10 tonne / acre

- with layer manure have seen seepage out of trucks on road

- normal application up to 5 miles but would go up to 15 miles - every extra 10 miles is $1.50/tonne more

- machine has floor chains, horizontal beater enclosed, built in weigh scale, GPS and autosteer

- can go as low as 3 tonne /a

- 15 mile transport is about $7.50/ tonne - would transport with tandem trucks or larger (tandems will haul 15 tonne)

6. January 21, 2013 - Quotation on Transportation (from Steinbach area transporter with end-dump tri-axle trucks)

- $9.50 per m3 of hauled product at 29 miles (based on a density of .65 m3 / tonne) (loading included)

- $0.20 /m3 /tonne/mile if we travel more or less miles

-ie. 39 miles would be $11.50/m3 and 19 miles would be $7.50/m3

7. January 21, 2013 - Quotation on Transportation (from Steinbach area transporter with end-dump tri-axle trucks)

- 1500 tonnes with density of .65 tonnes/m3

-Loading included

-$23.93 / tonne or $15.55 m3 for 29 miles

Appendix H: Field Notes from Producer Interviews

1. Jan 17, 2013 - Interview with Producer 1

- Typically fertilize canola as cereals get too much disease with high N rates, can go flat, and can't handle the variability in fertility rates. (from poultry manure)

- Will still add 40-50 lbs of starter N in spring.

- They try to alternate solid manure every 2 years but have done back to back applications.

- If we applied 1500 t/a at 40 lbs/t (P205) = 60000 lbs phosphate on 200 a = 300 lbs/a or 15 ppm increase in soil P at 20 lbs/1 ppm. (includes about 100 lbs of organic N)

- This would be a good fit for alfalfa. Currently should apply about $40/a of fertilizer (mainly phosphate)

- Soybeans - they currently apply 20 lbs of phosphate to this crop. (soybeans would also greatly benefit)

- The key is pricing at 50% of commercial fertilizer. (would make sense on their farm to buy this product)

- There is also extra value from micronutrients as higher canola yields need extra micros.

2. Feb 7, 2013 Interview with Producer 2

- was interested to know whether there would be additional value delivered by removing fungicides due to better plant health

- would put it on a 160a of a 320a piece

- they generally spread 15-35 lb of phosphate in normal fertility program

- wondered how much clay would absorb the extra P

- has land north of Domain (4 miles east and 5 miles north/1 west)

- would pay $80-$100 for 320 lbs of phosphate and then evaluate crop

- desired rotation would be canola, soybeans, and then corn (maybe)

3. Feb 15, 2013 Interview with Producer 3

- Certainly sees value in elevated O.M. levels and elevated P soil test

- Made comments though that seeding date / soil temp were maybe just as significant in crop response to soil test P

- Would like to see this solid product demonstrated on field, maybe try half field, 40-80 acres, and see value

- They would be willing to do some trials in comparison to conventional methods

- Would not commit to a price

- They would not take advantage of a desperate livestock producer, but would be more than happy to pay for value.

- Have available land close to and around Otterburne … some on east side of RR tracks

4. Feb 11 + 20, 2013 Interview with Producer 4

– would be very interested in trying some

- saw value for soybeans but would apply the year before so higher availability the year after

- did some research and sees good potential for value

- thinks the price might be a bit on the high side, is certainly willing to pay something.

- No price confirmed, but something less than 50%

5. Feb 11 + 20, 2013 Interview with Producer 5

- would be very interested in trying some

- would love to participate in a trial, if product proves to be of significant benefit, is very willing to pay for value.

- Says that value and benefit needs to be established first, then willing to pay.

- No price confirmed before trying product

- quite costly at $125/a for 10 tonne/a

6. Feb 11, 2013 Interview with Producer 6

- liked the fact that there would be about 65 lbs avail. N, would side band 100 lbs more of N

- has 480 a 2 miles north of 23 and PR 200, but a total of 2000 acres he would accept the product on

- has seen benefits from higher soil test ppm of phos. and increased organic matter

- looks like a good analysis for soybeans

- no issue with paying for this product at $12.50/tonne

- wondered whether he could build a storage on side of storage for this product

- would consider doing his own trucking of the product

7. Feb 15, 2013 Interview with Producer 7

- sounds very good, would want field covered end to end

- value proposition in the ballpark of what he would be willing to give

-grows corn, sunflowers, canola, soybeans, malt barley

- has land 6 miles south and 2 miles east of Dufrost (whole section), and 240 a at intersection of 217+218 which would be ideal for solids

- too bad he can't start getting solids yet

-concerned he wouldn't get the solids as there isn't enough supply

8. Feb 15, 2013 Interview with Producer 8

- would be willing to build his own storage near Piney

- has about 2500a in Piney area

- grows continuous corn on hog manure, has beans , beans, wheat, rye-grass rotation on other land

- would be interested in transporting product on back-hauls of grain

- has very low P and K soil tests and would benefit from increasing their values

-why pay fertilizer company when we could pay the local livestock producer

- current liquid hog manure - pay 100% of cost of spreading...50% in year 1 and 50% in year 2 as part of rental agreement

- current transport grain costs - $10 to Steinbach, $15 to Letellier, and $20/ton tonne to Brandon with Super B

9. Feb 21, 2013 Interview with Producer 9

- Grain, beef, forage producer (sells hay to US) close to Dufrost.

- Is very keen on seeing higher P levels in his soil tests, would like to have 20 ppm before a new seeded stand of alfalfa

- Targets for 5-7 tonne per acre removal of hay crop – alfalfa

- Agrees with an approx 50% cost for manure nutrients, whether it is liquid or solid

- Would even consider doing the work themselves (trucking and application), have lots of equipment

- Said it needs to be put on the right time of year, sees a lag in crop response to added P

- Is very interested in pursuing this concept of treated solids

- Have lots of land east of Dufrost toward the Rat River, just half – 1 mile off of 23 hwy

10. Feb 21, 2013 Interview with Producer 10

- Farms about 4600 a in the St. Malo area (east of #59)

-has a block of land (about 2000 acres) about 2 miles south of St. Malo off of 218. (rest of land within 7 miles)

- crops grown are canola, wheat, and beans. (will be planting corn in the future)

-they have some very low phosphorus soil test fields

-would consider paying 50% of phosphate and available N

-would need to see a benefit though

- their experience with liquid hog manure was poor in the first years after application (largely due to application issues) but now see benefits. - soil is more mallow, easier to pull tillage equipment.

- showed concern there would not be an adequate supply of separated solids for their farm

Appendix I: Separated Hog Solids Value Proposition

Nutrients per tonne		Total at 5 tonnes/ac	Total at 10 tonnes/ac
Phosphate	47	259	518
Total Nitrogen	25.1	138	277
Potash	9.4	52	104
Sulphur	4.8	14.5	53

Separated hog solids also contains micronutrients such as zinc, copper, and magnesium.

Separated solids contain a lot of organic matter (humus) which improves soil structure and contributes to moisture and nutrient retention.
This nutrient product diminishes diseases and increases yield.

Value Proposition at 5 tonnes/ac

Phosphate 259 lbs should increase soil test by 13 ppm at $0.52 = $134/ac
Total Nitrogen 138 lbs at 25% availability ($.52/lb) = $18/ac
If you were to pay for 50% of these nutrients = $76/ac
Cost of transportation and application = $15.00/t x 5 tonnes/ac = $75.00

Value Proposition at 10 tonnes/ac

Phosphate 518 lbs should increase soil test by 26 ppm at $0.52 = $269/ac
Total Nitrogen 277 lbs at 25% availability ($0.52/lb)= $37/ac
If you were to pay for 50% of these nutrients = $153/ac
Cost of transportation and application = $15.00/t x 10 tonnes/ac = $150

Appendix J: Summary of Producer Responses

Producer #	1	2	3	4	5	6	7	8	9	10
Saw Value in Proposition	x	x	x	x	x	x	x	x	x	x
Wanted to try before paying			x		x					
Would immediately pay	x	x		x						x
May pay more						x	x	x	x	
Location	Dufrost	Domain	Otterburne	Dufrost	Dufrost	Arnaud	Dufrost	Piney	Dufrost	St. Malo
May participate in logistics						x		x	x	

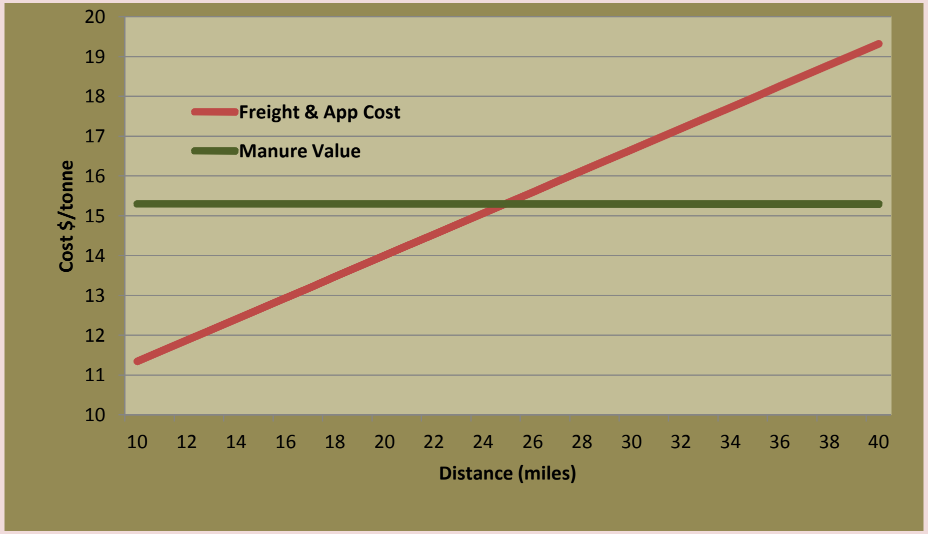
Appendix K : Separated Hog Solids: Transport and Application Economic Calculator

Site Name	Type	# Pigs sold/Yr
Hanover	Finisher	23,400

Choose units for data entry Tonnes

Manure Details	-	Tonnes
Solids Volume m3	2,875	
Solids Density (kg/m3)	750	
Solids Weight (tonnes)		2,156

Application & Transport	-	$/Tonne	
Application Cost	3.00	4.00	
Base Cost	7.50	10.00	
Incremental cost/mile	0.20	0.27	
Base Distance	20		miles



Summary Analysis	Total	Per Tonne	Per Pig
Transport and Application	$ 30,184	$ 14.00	$ 1.29
Nutrient Value Recovery	$ 32,991	$ 15.30	$ 1.41
Net Application Cost	-$ 2,807	-$ 1.30	-$ 0.12
Breakeven Distance		24.9 miles	
Total Tonnes Applied	2,156		
Total Tonnes Available	2,156		
Overage / (Shortfall)	0		

Nutrient Value	N	P2O5	K2O	S			Total
Market Price $/lb	0.53	0.52	0.45	0.56			
Nutrient Value Recovery %	12.5%	50%	0%	0%			
Manure analysis (lbs/ton)	25.10	47.00	9.40	4.80			
Manure analysis - lbs/tonne	27.66	51.79	10.36	5.29	-	-	
Recovery Value /Tonne	1.83	13.47	-	-	-	-	**15.30**
Total Value / Tonne	14.66	26.93	4.66	2.96	-	-	**49.21**

Application Costs			Application	Quantity Applied lbs/acre						Per Acre		Total	
		Distance	Rate							Market	Recovery	Recovery	
Field	Acres	(miles)	(T/acre)	N	P2O5	K2O	S	-	-	Value	Value	Value	Total Cost
Field 1	162	20	6.0	166	311	62	32	0	0	295.52	91.86	14,881	13,608
Field 2	91	20	4.0	111	207	41	21	0	0	196.68	61.17	5,567	5,096
Field 3	164	20	5.0	138	259	52	26	0	0	245.78	76.48	12,543	11,480
Field 4				0	0	0	0	0	0	-	-	-	-
Field 5				0	0	0	0	0	0	-	-	-	-
Field 6				0	0	0	0	0	0	-	-	-	-
												32,991	**30,184**

To use the calculator:
1. Select working units in cell B 5 (ie weight or volume)
2. Only White cells can be adjusted