CONSERVATION INNOVATION GRANTS

Final Report

Grantee Name: FERMENTATIONEXPERTS INC	
Project Title: Fermented liquid feeding to reduce phosphorus in swine manure	
Agreement Number: #69-3A75-10-139	
Project Director: Robert Fischer, PhD	
Contact Information: Monte Fuhrman, DVM	Phone Number: 605 310 3232 E-Mail: monte@fermentationexperts.com
Period Covered by Report: October 2010 through September 2013	
Project End Date: September 10, 2013	

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Executive Summary

・**What NRCS designated priorities were met with this grant?** We attempted to show that utilizing a new technology in the United States would help relieve the burden of phosphorus excretion in swine manure while maintaining or improving economics of swine production.

・**What were the goals and objectives for this project?** One goal was to show comparative manure nutrient values, particularly phosphorus, in manure from pigs fed controlled fermented liquid feed (CFLF). Decreased phosphorus application to farm lands should mean decreased phosphorus runoff into waterways. Decreased phosphorus runoff into waterways may help the Gulf of Mexico Mississippi River kill zone from excess phosphorus in the river. The second goal was to show decreased Salmonella exposure in CFLF fed pigs. We also hoped to show we could accomplish these things while not changing feed efficiencies and perhaps improving them. We want to show producers the possible benefits associated with CFLF. We showed food processing companies the potential benefits of providing the food byproducts and waste to CFLF utilization of the nutrients contained.

・**What were the accomplishments?** We were able to place two initial liquid feed systems. Troubles plagued the first one. We were then able to place another system late in the grant time frame. There are currently two operating CFLF farms in South Dakota. Sampling of manure and pig serum has recently come online to get numbers that we need to analyze the two major goals we have. Data available so far has been looked at. It is likely that with the two farms running well at this time additional data could be generated. Both of the existing operational farm managers are now optimistic that this technology will be a permanent part of their production systems. We made business relationships with food processing companies. Other swine production farms are now interested in how CFLF could be incorporated into their production techniques. Educational meetings were held and informal educational farm visits occurred. A new method of lactic acid forming bacteria fermentation to provide fermented dry feed but still with some of the benefits of providing the active bacteria to the pig gut is being explored.

・**Were the goals and objectives met? If not, what were the barriers to completion?** Barriers to completion of some of the project in the 3 year timeline existed. Liquid feed equipment installation took mildly longer than we anticipated. Liquid feed system number one operated poorly. Despite assurances to the contrary, freezing did occur both at the equipment level and in underground piping. The equipment company and the fermentation company had trouble providing necessary technical service onsite. One equipment technician moved to Denmark. Another, perhaps the most knowledgeable in the United States, died suddenly. This project needed at least one of them. We do have another one working with us now in the United States. In the meantime, farm owners became disgruntled and were unable to provide adequate daily liquid feed equipment maintenance due to new technology implementation. Liquid feed equipment initial expenditures surpassed budget in the grant proposal. This led to tension between equipment companies and the fermentation company. Eventual removal of the equipment from the first farm occurred, thereby stopping the data flow we had begun there. The equipment from the first farm was moved to the third farm that is currently online functioning well and being sampled. Farm two also is being sampled. Technicians working on the second and third farms are becoming well versed in CFLF and associated equipment.

・**Was the project completed on time? If not, what were the reasons for extending the timeframe?** The project was completed in the three year time frame, albeit not in the way we had projected. We had hoped to procure more data than we have so far. We currently have two production sites functioning well. Additional data could be obtained, though the entire budget for the project was utilized early. Hence, we could not apply for an extension of the project.

・**Who are the customers that benefit from this grant?** USDA/CIG and our environment should benefit from looking at technologies that can help decrease high-phosphorus runoff into waterways. The nation's food processing companies that produce byproduct solids that can be used in CFLF are big beneficiaries. The local sanitation systems have already seen great decreases in solids from such companies. They benefit by not having such a large solids load entering the sanitation systems. The farmers benefit by utilizing less costly feed stuffs in their swine production operations. The pigs benefit by having theoretically better gut health due to high lactic acid forming bacteria load (like that in active culture yoghurts). Swine meat processing companies benefit from possibly smaller Salmonella load at the abattoir. Consumers benefit for the same reason. Local economies benefit by creating jobs in transportation logistics, byproduct de-packaging and animal feeding operations.

・**Were project funds spent as anticipated? If not, describe major changes in the budget.** Project funds were spent somewhat as anticipated. The only big difference is the equipment expense, which was the biggest expense, needed to be 40-50% higher. This left no monies available for some of the technical testing and personnel needed to complete the grant project. These monies were provided by FERMENTATIONEXPERTS Inc., the fermentation technology company, and Sioux Nation Ag Center of Sioux Falls, SD.

・**What methods were employed to demonstrate alternative technology in this project?** Controlled Fermented Liquid Feeding (CFLF) had not been utilized in the USA to our knowledge. USA Patents are pending with the fermentation company at this time. While liquid feeding has been attempted and is still used in some places, the controlled fermentation of feedstuffs by lactic acid forming bacteria at the food processor level has not.

・**What were the quantifiable physical results from this project?** Data so far is lacking. Raw data is included in the report but not enough has yet been generated to provide CFLF vs conventional rearing analyses. We can speculate that feed costs to the farmer will be lower using CFLF from the data we have. No statistics have been applied. We can speculate that Salmonella exposure still occurs with CFLF. We cannot even speculate on effects of CFLF on phosphorus level in the manure nutrient from data so far.

・**What were the economic results?** Raw data has been provided in this report. There does appear to be benefit for pig producers based on cost of feed per pound of gain. However, insufficient data has been generated to provide statistical analysis. We know also that phosphorus addition to pig rations is reduced or eliminated. That is important.

・**Are there Federal, State and local programs that may be used to implement this project?** USDA/CIG/NRCG money was used in this first stage USA project along with matching funds from Fermentationexperts Inc. While not budgeted, some in-kind professional technical services were also provided. Individual enterprise and for-profit farming should implement most of this type of project in the future, now that we know the farm benefit appears usable.

・**What are the major recommendations resulting from this project?** The CFLF concept is still great. Environment/waterways/carbon unit usage all win. Farmer wins. Pigs win. Food processing company wins. Local sanitation load wins. Swine processor wins. Consumers win. Local economies win. We need to continue to move forward with this technology. It is amazing the amount of wasted food byproduct and food that can be utilized in this country that is still put into our sanitation systems and landfills. Project implementation works better if we do or know most of the following: Insure equipment technicians and fermentation technicians are capable. Insure the nutritionist is capable. Insure farm workers are the farm owners and are the pig owners in the case of any new swine feeding technology. Farm lessors (barn owners who did not own the pigs in the barn) seemed less interested in making sure the technology worked than did farm owners who also owned the pigs. Liquid feeding systems take a bit more care and 'nurturing' than conventional dry feeding systems. Transportation logistics of liquid byproducts are and will be even more important as transport costs rise. Potential project sites need to be near food processing plants from which byproducts can be utilized. "Nutrient" (manure content) management still needs to be planned in any new and existing project using regional historical norms until phosphorus excretion reduction can be proven further. Additionally, new project sites ideally would be in areas where soil phosphorus levels are already at the top end of accepted levels.

Introduction

・**A brief overview of the project: who, what, where, when and how (key personnel and a description of their qualifications)** The need for some investigation into topics discussed in this grant came to us during a meeting with Jens Legarth and Thomas Pedersen from Denmark and an Englishman, Steve Stokes. They wanted to see if the USA was ready for controlled fermented liquid feeding (CFLF) technology implementation. Our company was primarily interested in decreasing swine feed costs associated with, at that time, soon-to-soar corn and soybean prices. We (Sioux Nation Ag Center) primarily were looking at the well-being of our swine producing customers. We believed, through literature review and a direct visit to functional farms in Denmark and northern Germany that CFLF should work in the Midwestern USA. There were other questions we wanted answered, as did the representative/owner of FERMENTATIONEXPERTS Inc. Dr. Robert Fischer was chosen as lead investigator. He is a PhD swine nutritionist from Sioux Falls, South Dakota. His scientific training, already extensive use of byproducts in swine feeding and his proximity to both the Fermentationexperts Inc. office and the site locations that likely may be used in the study qualified him as the best candidate as lead investigator and lead nutritionist. A table of participants follow.

Dr. Robert Fischer, PhD Sioux Nation Ag Center 1812 N. Cliff Ave. Sioux Falls, South Dakota 57103 Tel: (712) 348-2850 Email robertfischer@siouxnationag.com	US Swine Nutritionist consultant to *FERMENTATIONEXPERTS INC*, the primary Fermented Liquid Feeding initiative in the US. In addition to having substantial US swine conventional dry feeding nutrition experience, Dr. Fischer has trained in Europe in CFLF technologies and ration optimization utilizing byproducts.
Dr. Monte Fuhrman, DVM, BSc Sioux Nation Ag Center 1812 N. Cliff Ave. Sioux Falls, South Dakota 57103 Tel: (605) 310 3232 Email: montefuhrman@siouxnationag.com	US Swine Veterinary Consultant to *FERMENTATIONEXPERTS INC*, the primary Fermented Liquid Feeding initiative in the US. Dr. Fuhrman has been practicing swine veterinary medicine specifically for 20 years. He has international training in CFLF technologies. He is also a microbiologist with an interest in CFLF technologies.
Jens Legarth Vorbassevej 12 6622 Bække, Denmark Tel: 011 45 (75) 38 90 34 Email jel@fermentationexperts.com	President of *FERMENTATIONEXPERTS* AS in Denmark and FERMENTATIONEXPERTS INC in US. Mr. Legarth has over 13 years of experience in development and implementation of controlled fermented liquid feeding technologies in Denmark, Germany, Poland, Sweden, Norway, Netherlands and Hungary.
Thomas Pedersen, VP Vorbassevej 12 6622 Bække, Denmark	Thomas Pedersen is Vice President and Business Development Leader of *FERMENTATIONEXPERTS*

Tel: 011 45 (75) 38 90 34 Email: top@fermentationexperts.com	*INC.* operations and has a thorough knowledge of US based fermented liquid feeding opportunities.

- **Project goals and objectives (including those designated in the NRCS grant request).** One goal of the project was to show comparative manure nutrient values, particularly phosphorus, in manure from pigs fed controlled fermented liquid feed (CFLF). Because of studies in Europe[1] we hypothesized we might find significantly decreased excreted phosphorous in the manure. Decreased phosphorus application to farm lands should mean decreased phosphorus runoff into waterways. Decreased phosphorus runoff into waterways may help the Gulf of Mexico Mississippi River kill zone from excess phosphorus in the river. I learned this at a fascinating meeting the USDA put on in Mankato, MN. The second goal was to show decreased Salmonella exposure in CFLF fed pigs. We hoped to show reduced Salmonella exposure in swine during feeding. This is another branch control point of Salmonella reduction in meats for the consumer. We hoped to show we could accomplish these things while not worsening feed efficiencies or profit capability and perhaps improving them for the farmer. We hoped to show producers the possible benefits associated with CFLF. We wanted to educate producers on CFLF technologies. We hoped to show food processing companies the potential benefits of providing otherwise low value food byproducts from their process to CFLF nutrient utilization.
- **The scope of project tasks.** We first had to find funding. Thanks for helping with that, USDA CIG/NRCS! We then had to 'cold turkey' convince the subset of producers that would allow us to use their swine growing facilities for this project. We talked to dozens of potential users in six states. You can imagine the long list of objections we came across amongst the swine production community. Our first choice production site, when just ready to 'come on board', had an offer to buy his whole farm site that he could not refuse. The subsequent owner did not wish to continue with this project despite aggressive education efforts on our part. Our second and third choices did allow equipment installation for the project. There was the obvious amount of paperwork and law necessary. During the same "sales and education" phase to the producers we also were doing "sales and education" to the food processing companies and ourselves. Ladders of command exist in large company hierarchy that had to be overcome. Appropriate safeguards to our national food safety have to be considered and followed, which I am glad to say the large food production companies are really aware of and complying with. The series of contacts that this effort entailed was enormous. I estimate 5 or 6 contacts were required prior to getting to the right person and then 4 or 5 more to get to a platform where we could begin discussing byproduct procurement from that company. We were fortunate in that some of the city sanitation departments were requiring immediate decrease in solids discharge from more than one of the companies. Without that impetus, I am not sure we would have some of the byproduct supply we now have. Once appropriate permitting and environmental permission was given, liquid feeding equipment bids, procurement and installation had to occur. Installation was virtually impossible in populated swine buildings so delayed scheduling had to occur. This put us behind in our task by a few months. Installation was finally completed in the first farm site. Multiple hurdles occurred in the first six months at both of the farm sites selected and at the food processing companies. Farm lessors, as we knew when we started,

were not going to be patient if things did not work immediately and every moment afterward. We found the best personnel we could for installation, maintenance knowledge and workings of the systems. One left the USA and one died at critical times. We were forced by lessors to remove liquid feeding equipment from one farm. We found a replacement farm, which is one we had been grooming for such an occurrence. The two sites are functional and sampling now. Sampling and testing procedures were determined and procured prior to submission of our proposal to USDA/CIG/NRCS. Our testing laboratory that we started with for the nutrient testing of the manure shut its doors part way into the study. A new lab was procured. Currently, tasks include procuring as much data as we can; mining the data in the feeding computers and farm offices we need to complete economic data analysis.

・**Business or academic relationships that facilitated the project, including leveraging (both direct and in-kind support).** Financial, professional services and full-fledged support of both Fermentationexpert Inc.'s international staff and Sioux Nation Ag Center's Midwest regional staff allowed the project to occur and go forward despite over-budget equipment expense for purchase, installation and maintenance. These being our largest expenses, both Fermentationexperts Inc. and Sioux Nation Ag Center provided about 40% over-budget support in addition to use of technical experts at little charge to the project. Dr. Robert Thaler, South Dakota State University, swine nutrition extension, provided exemplary in-kind support to this effort. Additional in-kind support was provided by Dr. Joel DeRouchey and Dr. Mike Tokach of Kansas State University.

・**How the project was funded.** The project budget was directly funded by 50% FERMENTATIONEXPERTS Inc., USA. It was directly funded 50% by USDA/CIG/NRCS grant number #69-3A75-10-139 agreement. Additional funding-over-budget was aggressively provided by financial and in-kind support from FERMENTATIONEXPERTS Inc. USA and Sioux Nation Ag Center.

Background

Describe the factors that lead to the development of this project. Include:

・**What is the problem the project was intended to address?** This project addressed three problems. The first is audacious phosphorus discharge into streams, creeks and waterways with resultant Mississippi River Gulf 'kill zone'. The second is Salmonella species presence in meat products at swine processing plants in the USA. The third is unnecessary discharge of byproduct solids materials into local sanitation systems and landfills that could be converted to value added nutrition for swine feeds. CFLF technology has become increasingly adopted in Europe. The European swine industry and European food processors are already benefitting from CFLF. European farm soils are already saturated with phosphorus. US soils are becoming saturated. Adopting known phosphorus reducing technologies now will help the US farmer/producers manage the soils for better sustainability and provide for less phosphorus run off. New research has confirmed the benefits of FLF to help reduce bound phosphorus contained in manure nutrient and reduce the amount of added phosphorus to swine diets.[1] Economic benefits by users in Europe have occurred.[2] Liquid byproduct opportunity is immense for the US producer and the US food processor. Many dry food byproducts are currently value added. The ability to utilize liquid byproducts has not been optimized in the USA. A gathering of Midwest swine production experts occurred at our offices in August of 2008. The experts included swine nutritionists, swine veterinarians, pork industry representatives, pork packing industry representative, select swine producers, university swine extension personnel and an expert in US byproduct opportunities. We invited European providers of the technology to speak. We examined and heard about CFLF technology. The consensus of that day was that we need to implement this technology in the USA.

・**A brief account of previous attempts to solve the problem.** Comprehensive Nutrient Management Plans (CNMP's) are designed to address natural resource concerns related to soil erosion, livestock manure and disposal of organic by-products. Phytase implementation has occurred to utilize more phosphorus than what was previously available from grains. Most nutritional programs attempt to minimize the amount of phosphorus in feeds to help develop the most effective CNMP's.

・**How the problem is usually dealt with today.** Nutrient management plans are used in all agricultural lands in the USA today through United States Department of Agriculture/Natural Resources and Conservation Services. Our South Dakota offices and federal help are accessed at http://denr.sd.gov/des/sw/ManureNutrientManagementTools.aspx. Phosphorus is often the limiting factor as to how much nutrient can be applied to farmlands.

・**What agriculture or environmental sector could benefit by this project?** USDA/CIG and our environment should benefit from looking at technologies that can help decrease high-phosphorus runoff into waterways. The nation's food processing companies that produce byproduct solids that can be used in CFLF are big beneficiaries. The local sanitation systems have already seen great decreases in solids from such companies we have worked with, so they benefit by not having such a large solids load. The farmers benefit by utilizing less costly feed stuffs in their swine production operations. The pigs benefit by having theoretically better gut health due to high lactic acid forming bacteria load (like that in active culture yoghurts). Swine meat processing companies benefit from possibly smaller Salmonella exposure load at the abattoir. Consumers benefit for the same reason. Local economies benefit by creating jobs in transportation logistics, byproduct de-packaging and animal feeding operations.

・**What natural resource issues are addressed?** Phosphorus run-off of farmlands is the major natural resource issue addressed in this project. Salmonella contamination of abattoirs and local sanitation system solids input from food processing companies are also addressed.

・**The negative effects of the problem on the environment, the community, or the producer's economic welfare.** Phosphorus loads onto farmlands are approaching maximum level in the USA. In addition, some states are reducing maximum levels on farmlands. Hence, more acres of farmland will be needed to be available for nutrient application with phosphorus being a major bottleneck nutrient. Nutrient management plans are constructed and variable by state and require farmlands to be under certain phosphorus load restrictions. Many areas of the USA are becoming phosphorus saturated on agricultural lands. Local city and county sanitation systems are loaded to capacity. Solid waste load from food production and processing companies add greatly to this diminishing capacity in existing systems. Swine producer's feed costs have increased and still make up the majority of expense in animal feeding businesses. Potential feed cost relief is available with this technology.

・**Explain what is innovative about the project, in terms of the equipment used, the management process employed, changes in timing, or anything about the project that makes it different from standard practice.** CFLF has been used in Europe for 10 years both successfully and unsuccessfully. The one big change in process is included in a patent pending application in the USA. It involves inoculating liquid byproduct food items with friendly lactic acid forming bacteria immediately after the initial food production process so that microflora population in the byproduct will be that of the desirable lactic acid forming bacteria as opposed to other bacteria and yeasts that wish to invade the newly, nearly sterile, food byproduct. By overtaking the microflora of the new product we can control not only fermentation of the byproduct, but use this new semi-truck load of lactic acid forming bacteria as an inoculant to control fermentation of on-farm additional feedstuffs. The goal is to provide only liquid feed to the pigs that are entirely fermented with lactic acid forming bacteria (like in active yoghurt). Benefits include 1) more usable phosphorus and breakdown of the inositol phosphate molecule 2) more usable nutrients other than phosphorus to the pig 3) reduction of undesirable enteric bacteria (particularly Salmonella) colonizing the gut due to overload of lactic acid forming bacteria 4) less Salmonella colonization of pig meat due to decreased enteric exposure

・**Compare the innovative portions of the project to existing practices to show differences in labor input, materials input, economic input and return, changes in production, or changes in the fate and transport of pollutants.** Changes of the fate and transport of pollutants in this project have changed. Phosphorus excretion has supposed to have lessened due to breakdown of inositol phosphate molecule. What would have been waste product solids entering sanitation systems have turned into viable and valuable feedstuffs for swine. Labor input may be a bit higher than conventional methods of feeding swine. Feeding equipment needs are similarly priced as dry feeding systems on a per-pig basis. Economic return has the potential to be better than conventional systems at the farm level due to decreased price of total feed stuffs per pig.

- **If part of the project revolves around marketing an alternative product (example: composted manure), describe how the potential market was analyzed, economic projections, and any actual marketing activity that took place.** A United States website was constructed to showcase the technology. Information concerning CFLF is available at www.fermentationexperts.com. Marketing was focused on individual farms and training meeting participants.

- **Describe what the producer had to do differently to accommodate the project, in terms of labor, maintenance, obtaining materials, feeding, milking, pasturage, cropping, or any other operation adjustments.** This project required a different mindset of farm owners as the change was made from dry conventional feeding to liquid feeding of the swine. Feeding equipment was obtained from ACO FUNKI. This equipment type was chosen after three liquid equipment feed system suppliers were looked at. Stainless steel liquid feeders, liquid feed distribution equipment, liquid feed mixing equipment and liquid component storage equipment were procured. We also had to build housing for the liquid feed mixing, storage and distribution equipment. Feed component delivery was changed to liquid for some items. While we felt that liquid feeding equipment would have pretty similar maintenance and labor requirements going into the project, it is apparent that labor is more intense in liquid systems. Dr. Fischer was under constant on-call ration formulation duty. As potential byproducts became available, decisions as to potential use and value had to be made. He used a table similar to this, knowing nutrient values, that he could plug in to find out if an ingredient was worthy of further use.

Ingredients	**Cost/lb**	**Cost/ton**
Corn	0.053571429	3.00
SBM	0.15	300
Salt	0.045	90
Limestone	0.02	40
MonoCal	0.27	540
VTM	1.2	2400
Lysine	1.1	2200
Threonine	1.4	2800
Methionine	2.25	4500

By-Products	**Cost/lb**	**Cost/ton**
Whey Permeate (Green)	0.0105	21
Gelita		
Gilsa La La		
Pepperoni		

Dry Matter = 25%

Base Corn-SBM Diet

Ingredients	Pounds/ton	Cost/Ton
Water	1440	0
Corn	428.31	22.94518
SBM	114.31	17.1465
Salt	2.66	0.1197

Dry Matter = 25%

Whey Permeate diet

Ingredients	Pounds/ton	Cost/Ton
Whey Permeate	1157.56	12.15438
Water	500	0
Corn	253.27	13.56804
SBM	77.04	11.556

Limestone	7.63	0.1526
MonoCal	2.37	0.6399
VTM	2	2.4
Lysine	2.04	2.244
Threonine	0.61	0.854
Methionine	0.07	0.1575
Cost/Ton	**2000**	**46.65938**

Limestone	4.69	0.0938
Lysine	3.44	3.784
VTM	2	2.4
Threonine	1.48	2.072
Methionine	0.52	1.17
Cost Per Ton	**2000**	**46.79822**

Formulation of the rations for the fermented liquid feeding system necessitated all by-product ingredients be initially analyzed for dry matter (DM), crude protein, macro- and micro-trace minerals, and amino acids. This information was used along with current nutrient concentrations of dry ingredients to formulate rations with a dry matter concentration of 24 to 27 percent dry matter. Diets were formulated to meet the dietary requirements of growing and finishing pigs by matching the nutrient needs of the pigs at various weight ranges or by using a feeding curve within the feeding system. The feeding curves were stepped up to change the nutrient density of the rations at various weight ranges to decrease the nutrient concentration in the diet as the pigs increased feed intake and weight. The diets were analyzed for DM as a check to make sure diets were getting mixed correctly and pH of the diet was also used as an indicator to make sure fermentation process was occurring in the rations. The main indicator that was used to determine if diets were over formulated for protein/amino acids was the color and consistency of the stools. In addition to feed curve schedule, diet formulation changes were made when pigs were observed to have loose, watery stools indicating a diet that was formulated with too much protein. The weight of the pigs moving out of the nursery and at slaughter were used as indicators of optimum diet formulation as these weights were compared to industry standards for growth in pigs on dry feed.

Include a schedule of events that shows when components were built or installed, the period of time that data was collected, and any adverse events such as storms or equipment failure that affected the project. I first am showing a planned schedule of events as listed in our proposal.

Project action plan and timeline:

October 2010 – January 2011	Procure demonstration farm sites and willing participants in central regional locations
October 2010	Planning of and material procurement for regional educational meetings
October 2010	Continue dialogue with food processing/byproduct supply companies
October 2010	Begin pre-study manure nutrient sampling conventional barn values prior to fall nutrient applications
January 2011 – January 2012 and	Provide 12 – 16 regional educational meetings

June 2013-Sept 2013	
March 2011	Begin installation of fermented liquid feeding equipment and video key installation techniques
May 2011	Final installation of fermented liquid feeding equipment completed on two farm sites
May 2011 through May 2013	Generate growing pig data sets in FLF barns and video liquid feeding process
May 2011 through May 2013	Generate manure nutrient measurement data sets in FLF barns and conventional barns
May 2011 through May 2013	Provide monthly veterinary reporting on disease status for growing swine groups in demonstration barns
May 2011 through May 2013	Provide Salmonella and Lawsonia surveillance testing and reporting in demonstration barns
March 2012	Report prepared and delivered on initial educational meeting content, meeting participation and meeting efficacy
May 2013 to June 2013	Categorize data for material publishing and provide materials for regional post-project educational meetings
June 2013 to September 2013	Provide regional educational meetings post-project

I am now going to show what really happened.

Project action plan and timeline:

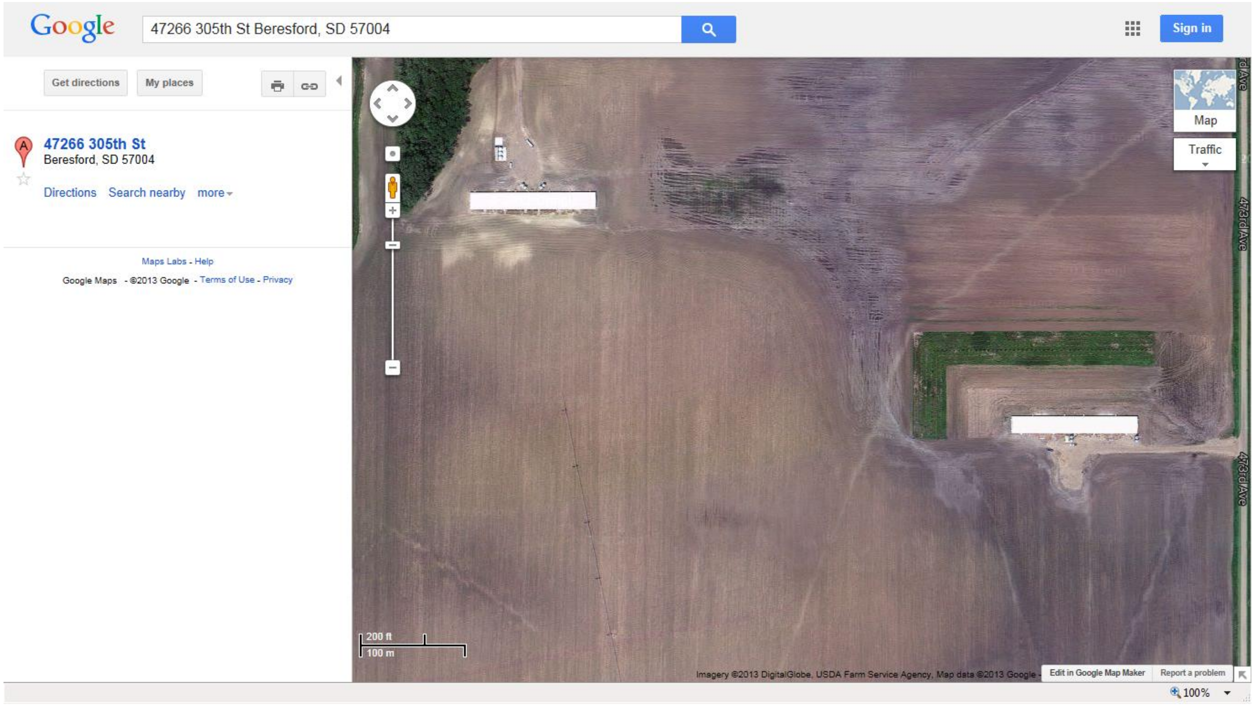
October 2010 – January 2011	Procure demonstration farm sites and willing participants in central regional locations
October 2010	Planning of and material procurement for regional educational meetings
October 2010	Continue dialogue with food processing/byproduct supply companies
October 2010	Begin pre-study manure nutrient sampling conventional barn values prior to fall nutrient applications
December 2010	Additional training in Denmark for USA participants
December 2010	Continued business partner procurement for byproduct supply
January 2011 – Sept 2013	Provide 12 – 16 regional educational meetings

March 2011	Begin installation of fermented liquid feeding equipment and video key installation techniques Video progress was not accomplished but still photos were made. Installation began in 4/2011 at the Jim and Steve Andrews site (site1).
May 2011	Final installation of fermented liquid feeding equipment completed on two farm sites. Final installation at the first site occurred in 8/2011.
May 2011 through May 2013	Generate growing pig data sets in FLF barns and video liquid feeding process. Liquid feeding equipment and computerization did not work as smooth as planned. Growing data sets did not begin to become available until site two came online. We constantly had to reboot the computers running the equipment. Backup of data was not available to us at this time. This was due primarily to the wireless internet connection we chose to install, as it seemed to be the only thing available. Eventually we fiber-optic wired the connections in underground piping between the "kitchen" and the barns. The barns and the kitchen needed to communicate. The Knology wireless connections kept disrupting. The feeding communications needed to be complete and non-interrupted.
May 2011 through current 2013	Generate manure nutrient measurement data sets in FLF barns and conventional barns. We began collecting manure "before and after" data as soon as we could. May 2011 was our first "before" data that we collected on site one. Site 1 shut down before we could generate meaningful data. The best data we have coming up is site 3 which was started using the equipment from site 1. This data procurement is ongoing.
May 2011 through May 2013	Provide veterinary reporting on disease status for growing swine groups in demonstration barns. Veterinary visits were provided approximately quarterly.
May 2011 through current 2013	Provide Salmonella surveillance testing and reporting in demonstration barns. Data

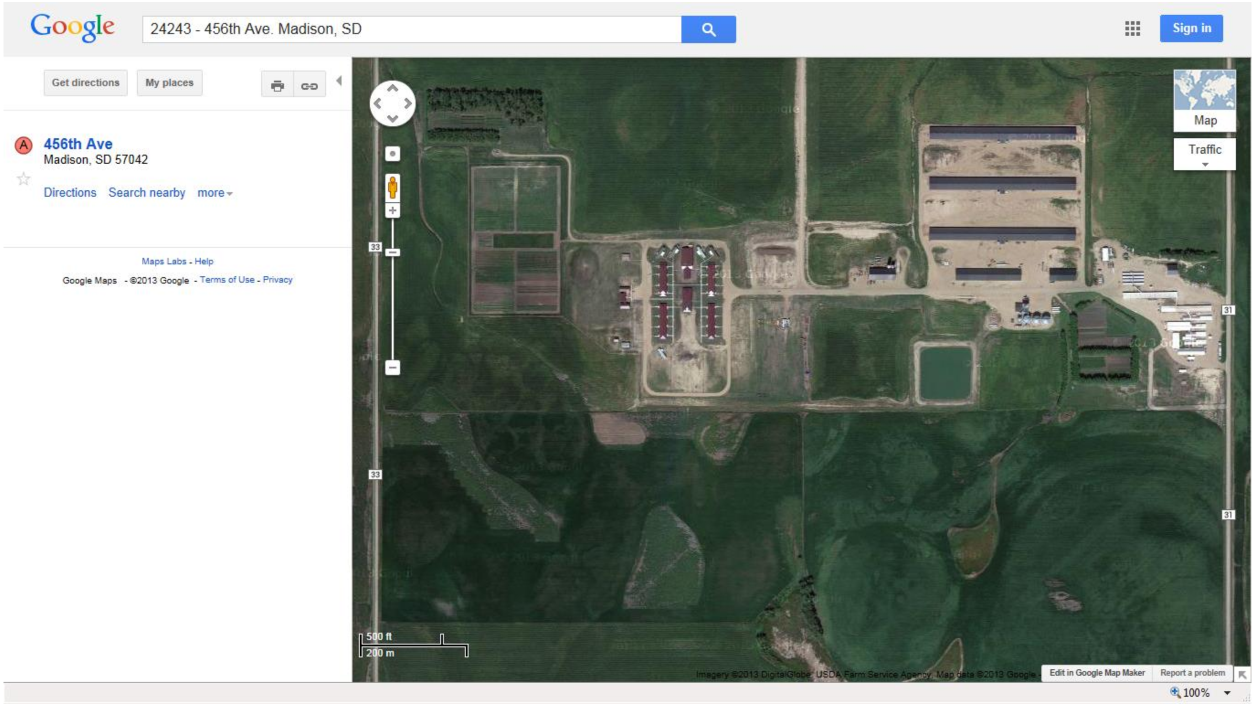
	collection continuing.
March 2012	Report prepared and delivered on initial educational meeting content, meeting participation and meeting efficacy.
May 2013 to current 2013	Categorize data for material publishing and provide materials for regional post-project educational meetings Since meaningful data is not available, this step is not completed. We hope to provide information from this project as more data becomes available.
June 2013 to September 2013	Provide regional educational meetings post-project. Area/regional meetings and visits to existing functional facilities are ongoing. Most educational materials are now online, along with flash discs with educational movies and information how to access the website.

・**Include maps, diagrams, and other material that shows the location of the project, location of equipment and facilities, environmentally sensitive areas, etc.**

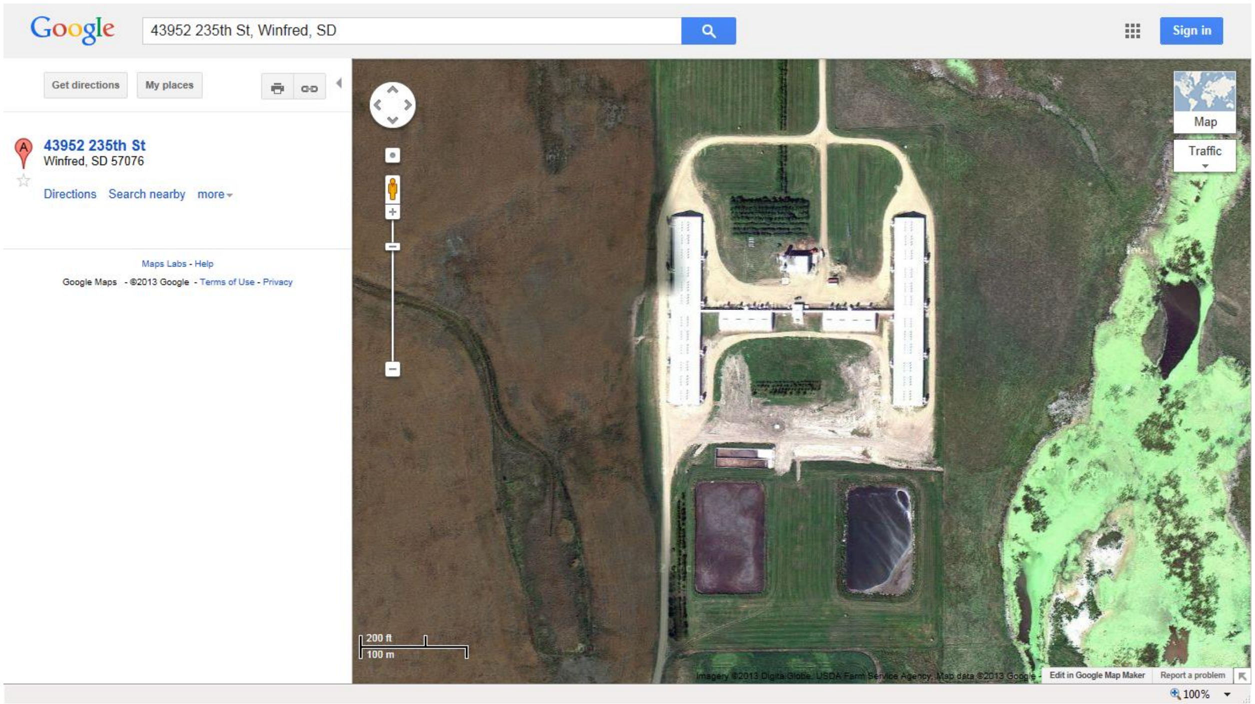
Farm site 1



Farm site 2



Farm site 3



• **Summarize what worked, what didn't work, and why. It is important to know if parts failed or processes did not behave as expected, or maintenance was different than expected, in order to assess future projects.** What worked: Pigs did well the second half of the feeding project. Farm/barn worker efforts have been great in site two and site three. We eventually figured out byproduct transportation logistics. Negotiations with food processing companies were gradually successful. We got better at installation and maintenance of equipment by the time we got to the second and third sites. Communications with participants were successful. Educational meetings were always interesting and sparked much discussion. Legal contracts/forms were well done by our attorney. Laboratory analysis of feed stuffs and manure nutrients were deemed successful in method, not in timeframe. The latest manure nutrient analyses were performed at the newly formed "South Dakota Agricultural Laboratory". This lab is a commercial outshoot of what once was the Olsen Biochemistry Laboratory that shut down due to SD state budget constraints. We were fortunate to have Thomas Pedersen from Fermentionexperts Inc. work on the project the whole time. He is an eternal optimist and diplomat. Without his diplomacy skills the project could have broken down completely. The un-installation and movement of equipment to site three from site one worked better than anticipated, though added cost to the project. Site three is converting even more of their finishing pig production to controlled fermented liquid feeding technology. Site two is planning expansion of their CFLF also.

What didn't work: The whole first farm site was difficult from day one. We had kitchen and equipment cost override, underground piping that continued to fail, internet connection difficulty, ration formulation trouble, feed spoilage, barn worker lack of effort, software and hardware issues, language barrier, technician absence and turnover, freezing problems, pig health issues, lack of significant amount of data at end of project timeline, laboratory shutdown, very little actual production data available due to computer failures. I would like there to have been a more definitive point where we could measure manure values before and after the switch to CFLF technology. The bacteria that we were able to use are not exactly the same ones that are used in Europe. I am going to tell you a long story here: The main fermenting bacteria that FERMENTATIONEXPERTS Inc. uses in Europe is Lactobacillus rhamnosus. Lactobacillus rhamnosus used to be named Lactoabacillus caseii variation rhamnosus while we were applying for the grant. The bacteriologists, during that time, decided that L. rhamnosus should be a separate species from L. caseii var. rhamnosus. Hence, when we were trying to use this bacteria (approved for use in human baby formulas for gastric upset and colic) we could not because the 'new' bacteria nomenclature did not allow us to use this bacteria in microbials fed to food animals. We spent much time in conversation with the FDA group responsible for direct fed microbials. Hence, our bacteria being used in the USA are not the OPTIMAL bacteria. The bacteria we use optimally ferment carbohydrates rapidly and take over resident microflora rapidly. We ended up using Lactobacillus plantarum isolates and Pediococcus species that are approved for use as direct fed microbials in the USA. What is funny is Lactobacillus rhamnosus would have been allowed if we would have started just a few months previous when it was named Lactinobacillus caseii, var. rhamnosus.

・**What would be done differently in this project if it were started today?** As my colleague Thomas Pedersen put it, "We will never, never, never, never put liquid feeding equipment into a contract finishing barn again". What he means is that the contract growers did not put forth the effort needed to insure success in this 'attention to detail' aggressive venture as the barn/pig owners did. We had a similar experience outside of the demonstration sites with another contract grower. We would have insulated everything to the cold more at site one. As South Dakotans we knew the cold weather would be an issue but as Danes, the equipment company folks didn't quite believe it. We would have required more contractual stability in the equipment quotes up front. This ended up being a 'fight' between Steve Stokes and the FERMENTATIONEXPERTS Inc. guys. Hence, we lost Steve Stokes who was our equipment advisor and had provided the initial quotes. We ended up paying around 50% more than we budgeted to a different company just on equipment and installation. Equipment and installation was the biggest expenditure budgeted in the grant. FERMENTATIONEXPERTS and Sioux Nation Ag Center picked up the tab on equipment items over budget. Hence, better familiarity to equipment company suppliers besides the one we were relying on would be necessary. It is too bad we could not have stayed with Steve Stokes. He had previously come to the USA to do a couple of pre-study educational meetings at his own expense. He was really into the project but failed to provide us with correct equipment quotes. I would have used English language in the computers so I could better retrieve data regularly. As start-ups were occurring, too many computer shutdowns, reboots, internet connection failures, fiber-optic malfunction, etc. etc. occurred for me to retrieve reliable growth/feed efficiency data.

Review of Methods

・**Explain what is innovative about the project, in terms of the equipment used, the management process employed, changes in timing, or anything about the project that makes it different from standard practice. Compare the innovative portions of the project to existing practices to show differences in labor input, materials input, economic input and return, changes in production, or changes in the fate and transport of pollutants. Describe what the producer had to do differently to accommodate the project, in terms of labor, maintenance, obtaining materials, feeding, milking, pasturage, cropping, or any other operation adjustments.** Conventional feeding of swine in the Midwestern USA is done with dry corn/soybean meal based diets. We have brought liquid feeding of not only corn/soy base feedstuffs, but food processing company byproducts/co-products to the pigs. This is entirely a new way of thinking about pig feeding for regional producers. In the 1990's and the early 2000's the corn producers in the USA were trying to figure out ways to better market their grains. Now that grain is being used in livestock feeding and ethanol production around the world, the corn producers have succeeded in achieving value added market value increase. This makes it economically more difficult for livestock producers, in that feed costs have increased (doubled or more). Use of previously considered 'waste products' as nutritional inputs for livestock lowers cost of feed and removes many tons of materials placed into our sanitation systems that include waste water and landfill applications. An effort to move to liquid feeding of swine occurred in the '80s but failed. Liquid feeds spoiled too rapidly. The CFLF method of controlling spoilage by fermentation with lactic acid forming bacteria is effective in controlling fermentation. Fermentation of the grain portions of the feed is supposed to allow less phosphorus to be lost in the manure of the pigs. This translates into less phosphorus being discharged into the USA waterways. Entirely different feed delivery equipment is necessary to complete this task. Entirely different frame of mind in producers is necessary. Economic benefits are potentially significant for hog producers (lower cost feed) and human food production companies (less cost of waste solids removal). Environmental benefits are potentially significant for hog barn owners, in that manure can be spread on more acres of land without phosphorus bottleneck restriction.

・**If part of the project revolves around marketing an alternative product (example: composted manure), describe how the potential market was analyzed, economic projections, and any actual marketing activity that took place.** No marketing analyses were performed prior to beginning this project. The main objectives are to reduce phosphorus discharge and reduce Salmonella exposure to the abattoir at market time. Objectives of the project did not include marketing of alternative products, though this did occur. We looked at potential byproduct suppliers prior to starting this venture. We looked at those companies that could supply product in Kansas, Minnesota, Iowa, Nebraska, South Dakota, Ohio, Indiana and North Carolina. The marketing activities in our focus were getting farm sites to participate and food processing companies to allow us to use their byproducts. The first year of the project required multiple visits to multiple farms, multiple meetings and multiple food production companies.

Discussion of Quality Assurance

Describe the steps taken to ensure that data from the project are valid. Include: Project site description: characteristics of the site, sample locations, rationale for locations, map. Project site options were limited in that project site participants were less agreeable to taking part than we thought they would be. We began at site one, a contract finishing site that was used for one of Sioux Nation Ag Center's pig owning clients. All equipment installation, maintenance and as it ended up, daily liquid feeding observations were done by FERMENTATIONEXPERTS Inc. The desire to make the liquid feeding system work was not shared by the site one farm site owners. The desire to make it work was shared by all of us involved in the grant project; FERMENTATIONEXPERTS Inc, Sioux Nation Ag Center and the owners of the pigs. Unfortunately the pig owners were 300 miles away, had their own duties to take care of and relied on the farm site owners to perform daily husbandry duties with the pigs. The farm site one owners were more comfortable using conventional dry feeding practices. Farm site two owners have been great. They are trying every day to make the system work. They are succeeding. Farm site two owns the site and the pigs. The farm manager has a great need to insure the liquid feeding system does what it is supposed to. This is not the same with farm site 1 owners. Their desire is to procure high fertilizer value from the barns that they own. Even without owning the pigs, they benefit from receiving the manure. As it turns out, they feel that the liquid feeding system is reducing the amount of available nutrients in the manure that they want for their fields. This is true, in that value for phosphorus still exists in their soil type. Hence, reduced phosphorus (good for us and the environment) is not necessarily good for them. They eventually chose to not allow further liquid feeding of swine on their farm. It was not ONLY due to the manure nutrient issue. There were still health issues and nutrition supply issues that were part of the first project start-up growing pains. They were quite patient, but eventually had to make the decision they did. They provided us with a worksheet that suggested they were losing $6.29 USD per pig space per year due to reduced manure nutrient yield. This analysis was severely flawed.

- **Sampling design. Include the precision level of measurements, completeness (will data be sufficient), how samples and measurements truly represent what is occurring, and comparability (can the project situation be compared to real-life situations).** Data collected looks poor. As I write this I am still trying to figure out how to use it if we can at all. Because of project equipment move-arounds, reluctance of site one to continue, and the time needed for closeouts to be generated, we are just getting into the data collection time period that should be meaningful. Data is presented raw to the best of our ability. I cannot see a way to report meaningful data at this time.

- **Sampling procedures: Describe collection methods, collection frequency, equipment used, volume or amounts sampled, and how samples are handled, stored, and transported.** Manure collection was made in site one and site two during normal manure nutrient field application times. There was not a good time to regularly go in and sample manure, as there is not a manure agitation, mixing and removal time outside of when it needs to be done. Manure is removed from the under-barn deep pit manure storage areas usually in the fall just after harvest. If they chose to remove some manure in the spring prior to planting, that can happen also. Site three is a different story. We were able to obtain this barn that removes manure from the under-barn shallow pig manure storage area. The shallow pits are emptied into a larger outside earthen manure storage basin. We developed a way to go into the shallow pits by using braided wire rods with collection devices on the ends. The rods were dipped into the shallow pit and multiple small samples were pooled into the final test samples. This data will be ongoing and be relatively easily obtainable. The problem is site three just became functional and data collection will be later than the time frame of the project allows. Salmonella samples were obtained from sites one, two and three. Once again, data collection of groups is just getting started decently. Because of the ways the groups are arranged, twice yearly collection is going to be correct on each of sites two and three. Thirty samples were collected from finishing groups of pigs to check for antibodies to Salmonella species. The Salmonella ELISA testing was performed at the University of Minnesota Veterinary Diagnostic Laboratory.

- **Custody procedures: Describe chain-of-custody procedures for samples and data.** Chain of custody procedures for manure samples and blood samples are described: Manure samples were either dropped off directly at the labs or sent via USPS overnight to the labs. Submission forms for samples were specific for each lab. Date, site, test requests, and payer of test costs were all listed. Test results were emailed to Monte Fuhrman. Test results were observed and stored on two computers and on a monthly backup disc. Sample submission form examples are included in the appendices.

- **Calibration: What, if any, field equipment will require calibration & how will it be done.** PH meters were used early in the study and were calibrated by Mike Swanson, chemist and COO at Sioux Nation Ag Center. The pH meters were replaced with pH paper later in the study. The pH meters and papers are used to help insure that appropriate fermentation is taking place in the fermented liquid feed. There was no field equipment used in the manure or Salmonella testing.

- **Sample analysis, quality control: Cite analytical procedures to be used in the field or laboratory, sub-sampling or sample preparation, units of measure to be used. Describe limits of detection. Describe quality control processes.** Manure samples sent to the Olsen Biochemistry Laboratory and the South Dakota Agricultural Laboratory used methods and quality control as follows:

  A. Total Solids or dry matter: Unit III section 2. Sample is dried at 55 deg for 16-24 hours.
  B. Total nitrogen: Unit III section 3. Total nitrogen by combustion (adapted from AOAC 990.3) Unit III section 3.3 from manure methods book. For quality control, a known control sample is included in each analysis run. Due to small sample size, duplicates are also run. LOQ is 0.008%
  C. Ammonium Nitrogen: Unit III section 4 Ammonium Nitrogen: Unit III section 4.1 Ammonium-N determination by distillation (adapted from AOAC 973.49 & EPA 350.2). There is no purchasable QC at present. One duplicate sample is run every 6 sample (usually the one that appears least homogenous). LOQ is 0.005%
  D. Phosphorus & Potassium: Unit III section 5 & 6. Manure samples are ashed at 550 degrees for 4 hours as described in section 5.2. Ash is then dissolved in an acid solution for analysis. The

potassium is determined by atomic absorption analysis – section 6.2 (AOAC 968.08; 931 modified). The phosphorus is determined colorimetrically similar to section 6.4 (AOAC 968.08; 931; 935.13 modified).The LOQ for phosphorus is 0.02%. The LOQ for potassium is 0.003%.

For quality control for potassium and phosphorus, a known control sample is included in each analysis run. An AAFCO check sample is used with known average results from all participating labs. A duplicate analysis is also done as an additional check.

University of Minnesota Salmonella exposure testing procedure from Devi Patnayak: The procedure used was Swine Salmonella Antibody Test Kit from Idexx. This ELISA allows rapid screening of swine serum samples for the presence of antibodies to a broad range of Salmonella serogroups indicating swine herd exposure to the bacteria. Quality control: The positive and negative controls provided with the kit are verified to make sure they follow required criteria. For a sample to be positive, the S/P (sample to positive) ratio of sample should be greater than 0.500 or OD% should be greater than 20%. All samples having S/P ratio under 0.500 or OD % under 20% are considered negative.

- **Discuss data reduction, analysis, review, and reporting: How raw data is converted and presented, who reviewed it, and how the final presentation was derived.** Raw data from manure sampling and serum sampling is presented 'as is' in an excel spreadsheet. Comparisons are not made. Group production closeouts are reported 'as is' but not compared. Data is severely lacking. Data has been reviewed by Monte W. Fuhrman and Robert Fischer and we do not have enough data points to make any true comparative observations. Data collection is continuing.

Findings

Enumerate the physical and economic findings of the project. Show how the findings did or did not support the goals of the project. Goals of the project are 1) to show phosphorus reduction in manure nutrient under the barns that are fed controlled fermented liquid feed, 2) show that Salmonella exposure in CFLF fed pigs does not occur and 3) provide education for potential users of CFLF. We did provide many meetings, both in groups/meeting situations and at individual farms. We had numerous folks tour the CFLF sites. I was able to attend the drainage water management meetings put on by USDA on October 11, 2011.We were unable to show that Salmonella exposure does not occur in CFLF fed pigs. We were not able to show that phosphorus excretion is reduced in CFLF fed pigs. The reason for the last two is we were not able to generate enough data points so far. Data generation is continuing.

Conclusions and Recommendations

Summarize the conclusions to be drawn from the project, recommend how the technology should be studied further, how it should be brought into common usage, or why the technology is deemed not useful. If the technology is recommended for common usage, include operation and maintenance recommendations. Identify the next steps in bringing this technology to the field. The bacteria Lactobacillus rhamnosus strains will need to be tested in accordance with the FDA group in charge of direct fed microbials to livestock. When we were in discussion with that group, an estimated cost of $200,000 was needed to get close to an FDA approval for the safety studies on the "new" bacteria classification. Data points are continuing to be generated at site 2 and site 3. As enough data is compiled, analysis can be done. I would recommend to ourselves to continue to record the data on this project until enough is available for an analysis.

Appendices

· Testing methods on manure at SD Agriculture Laboratories AND previously Olsen Biochemistry Laboratory was as follows:

A. Total Solids or dry matter: Unit III section 2. Sample is dried at 55 deg for 16-24 hours.
B. Total nitrogen: Unit III section 3. Total nitrogen by combustion (adapted from AOAC 990.3) Unit III section 3.3 from manure methods book. For quality control, a known control sample is included in each analysis run. Due to small sample size, duplicates are also run. LOQ is 0.008%
C. Ammonium Nitrogen: Unit III section 4 Ammonium Nitrogen: Unit III section 4.1 Ammonium-N determination by distillation (adapted from AOAC 973.49 & EPA 350.2). There is no purchasable QC at present. One duplicate sample is run every 6 sample (usually the one that appears least homogenous). LOQ is 0.005%
D. Phosphorus & Potassium: Unit III section 5 & 6. Manure samples are ashed at 550 degrees for 4 hours as described in section 5.2. Ash is then dissolved in an acid solution for analysis. The potassium is determined by atomic absorption analysis – section 6.2 (AOAC 968.08; 931 modified). The phosphorus is determined colorimetrically similar to section 6.4 (AOAC 968.08; 931; 935.13 modified).The LOQ for phosphorus is 0.02%. The LOQ for potassium is 0.003%.

For quality control for potassium and phosphorus, a known control sample is included in each analysis run. An AAFCO check sample is used with known average results from all participating labs. A duplicate analysis is also done as an additional check.

University of Minnesota Salmonella exposure testing procedure from Devi Patnayak: The procedure used was Swine Salmonella Antibody Test Kit from Idexx. This ELISA allows rapid screening of swine serum samples for the presence of antibodies to a broad range of Salmonella serogroups indicating swine herd exposure to the bacteria. Quality control: The positive and negative controls provided with the kit are verified to make sure they follow required criteria. For a sample to be positive, the S/P (sample to positive) ratio of sample should be greater than 0.500 or OD% should be greater than 20%. All samples having S/P ratio under 0.500 or OD % under 20% are considered negative.

LIST of files attached to this report as appendices

Detailed Budget Explanation CIG

Data for grant 20131007.xls **Laboratory, manure nutrient and closeout raw data**

Maps of farm sites 20131028 **Maps of the site locations**

By-Product Pricing.xls **Worksheet Dr. Fischer used to determine pricing**

By-Product Diet costs.xls **Worksheet Dr. Fischer used to determine diet costs**

Dry feed comparison to liquid feed costs example.pdf **Worksheet Dr. Fischer used to determine pricing**

(Folder) Kitchen pictures 1-22 Rustic Acres Pictures of Rustic Acres Kitchen set up

Dry Matter Results Rustic Acres Aegis 20120701 (for example) Example of a dry matter analysis. These were done on multiple potential feed stuffs and feed samples.

5460_VF_Jim Andrews FUNKI Quote Quote for site 1 construction equipment

FUNKI ENGLISH QUOTE 5488_SonD_Agromek Dale's farm Quote in English for a different potential site

Aco Funki final invoice for J and S Andrews 20110105 Final quote for equipment from Funki for site one. Did not include all costs. Costs are logged in F.E. book keeper office.

Invoice for a system in the container that was earmarked for wingspan ended up at Rustic Acres 20110222 This is the final invoice for the equipment that was earmarked for a site that did not develop and was rerouted to site two, Rustic Acres Colony.

20111027 container contents Proformafaktura_90106708 Example of an invoice for equipment coming into the USA.

Wingspan Specifications and Quote 2010 Specifications and quote from Big Dutchman for Wingspan system that eventually was place at Rustic Acres Colony.

Fermentations Experts Equipment Expenditures 2-29-12 Book keeper file of equipment expenditures.

Final Grant Federal Monies Request Final report submitted by bookkeeper for documentation of grant monies expenditures.

Manure Sample Submission Form Typical form used to submit manure nutrient sample requests. Manure samples were included with the forms.

Minnesota Submission Form for Salmonella Exposure Typical form used to serum samples to U of M for Salmonella Elisa testing. Serums were included with the submission forms.

Dry Matter Book Dry Matter measurements on some feed stuffs

Technology Review Criteria

・**A description of the technology (process, method, equipment, or proprietary item) or measure.** Controlled Fermented Liquid Feeding is a process whereby human food processing company byproducts are utilized in feeding swine. First, the byproduct, if applicable, is inoculated at the food processing company plant point as immediately after food manufacture process as possible. Lactic acid forming bacteria then ferment the byproduct and multiply in numbers. This byproduct which contains nutrients for the pig contains huge numbers of lactic acid forming bacteria. This byproduct is then used as an inoculant for on-farm feed products that are additionally fermented. CFLF only works if the initial fermentation of food byproducts at the plant level is successful.

・**An explanation of how this technology or measure will accomplish one or more of the purposes of an existing standard.** According to research cited[1], fermented grains release a significant amount of free available phosphorus from the inositol phosphate molecule resulting in less phosphorus excretion in manure from animals eating the grains and more phosphorus availability to the animals. This results in reduced or NO additional phosphorus addition to the pig diets<u>. Little or no extra phosphorus has been added to the diets for the pigs in this project</u>. It should result in less measurable phosphorus in the manure of pigs fed CFLF feed. However, we have been unable to show that so far in this project.

・**Process monitoring and control system requirements, if applicable.** Monitoring of the process includes pH measurement, feed "tasting", pig response to feed, occasional dry matter measurement and initial and occasional feed stuff nutrient determinations. There are times when feed stuffs spoiled and were not fermented appropriately. The "yeast bubble test" is used to determine if yeasts, rather than bacteria, have taken over the microflora of the fermentation. Lactic acid fermentation produces very little gas. Yeast fermentation produces much gas. Some non-fermentable feed components required antioxidant treatments to prolong shelf life. The quality of the feed is determined by pig acceptance. The diets are formulated for appropriate nutrient content. The challenge is to insure the pigs always like it. It happens that pigs like the taste of lactic acid fermented feeds. For instance, lactic acid forming bacteria are used in yoghurt, pepperoni, cheese, kimchi, sour milk, sauerkraut and other foods to lower the pH and improve the taste and sometimes change the texture of the foods.

・**An example of warranties on all construction materials, equipment, or applied processes not covered by other NRCS Conservation Practice standards.** There were no warranties on any of the equipment as per Thomas Pedersen.

・**An operation and maintenance plan that includes performance monitoring requirements and a replacement schedule for components that will not last for the practice lifespan.** Valves are changed as they lose ability to function. Maintenance items that fail are kept onsite.

・**Estimated installation and annual operation cost.** Provided by Jayne Myrabo in appendix.

・**Contact information for individuals that have implemented this technology successfully.** Successful users of the technology in the USA are: Leonard Decker--Phone 605 480 2006 Address--24243 456TH AVE, MADISON**,** SD, 57042. Edwin Wipf--Phone at Shannon Colony 605

480 3561 43945 Address--Highway 34 , Howard, SD 57349. Jens Legarth Denmark--Phone +4523349334 Address--Vorbassevej 12 – 6622 Bække.

・**Independent, verifiable data demonstrating results for the use of the measure, equipment, facility or process in other similar situations and locations.** For the producer, CFLF is associated with lower feed costs, better feed conversion and growth performance with improved animal health [Jensen/Mikkelsen 1998]. A recent paper shows fermented liquid feeding reduces the phosphorus requirement in pig rations and results in lowered inositol bound phosphorus levels in the manure nutrient in the intestines from test pigs.[1]

・**The credentials of the individual collecting the data along with a disclaimer of any conflict of interest on the part of the individual.** I, Monte W. Fuhrman, BSc, DVM collected the data, insufficient to this point as it is. 605 310 3232. 1812 N. Cliff Ave. Sioux Falls, SD 57103. I have no conflict of interest harvesting this data. I work for Sioux Nation Ag Center. I do some work for Fermentationexperts Inc., USA.

・**Contact information for the technology provider.** http://fermentationexperts.com/ Jens Legarth. Denmark--Phone +4523349334 Address--Vorbassevej 12 – 6622 Bække.

Bibliography:

[1]Blaabjerg, K., Jorgensen, H., Tauson, A.-H., Poulsen, H.D. Heat treatment, phytase, and fermented liquid feeding affect the presence of inositol phosphates in ileal digesta and phosphorus digestibility in pigs fed a wheat and barley diet. The Animal Consortium, 11 Feb 2010 pp 876-885.

[2]FERMENTATIONEXPERTS video 2009-2013. Web link: http://fermentationexperts.com/home-en-US/