John Ogonowski and Doug Bereuter *Farmer to Farmer* Program

Volunteer Trip Report Cover Sheet

Name of Volunteer: _Joseph P Van Rossum _____

Country of Service: _Nicaragua_____ Dates of Trip: September 5 to 18, 2009___

Persons Assisted Directly[1] (male):	26		Persons Trained[2] (male):	45
Persons Assisted Directly (female):	1		Persons Trained (female):	5
Persons Assisted Directly (total):	27		Persons Trained (total):	50

Recommendations Made by the Volunteer:[3]

Please summarize the recommendations you made to the groups/organization(s) you assisted. Details of the recommendations should be included in the trip report – this is a summary table only.

Recommendation	Host
Implement water conservation measures	**Rivas Dairy**
	San Francisco Coop
	Coop Masiguito
	Coop at San Jose de los Remates
Exclude rainwater from wastewater treatment system	**Coop San Felipe**
	Coop at San Jose de los Remates
Take into account wastewater treatment capacity when considering expansion of operations	**Coop at San Jose de los Remates**
	Coop San Felipe
Test wastewater effluent prior to using to irrigate crops	**Coop Masiguito**
	Rivas Dairy

[1] **Persons Directly Assisted** receive face-to-face or hands-on technical assistance, training or advice from the FTF volunteer.

[2] **Persons Trained** are the number of individuals to whom you have provided technical/instructional training *in a more "formal" setting:* classroom, workshop, institute/university or on-the-job setting)

[3] **Recommendations Made by the Volunteer** indicates what recommendations were made to the host groups/organizations. The definition of "recommendation" is quite subjective, but might include an improved procedure, a technological or management innovation, a useful product or marketing tool, etc. Volunteers might make numerous detailed recommendations.

Final Report to Partners of the Americas Farmer to Farmer Program

Volunteer: Joe Van Rossum
Country: Nicaragua
Dates: September 5 – September 18, 2009
Primary Purpose: Evaluate and provide recommendations related to the treatment of wastewater at milk collection centers and milk processing plants.
Additional activities: Instruct students in the preparation of compost to be used as a soil amendment and evaluate farm waste handling.

Executive Summary:

Wastewater treatment systems serving the dairy industry in Nicaragua are generally low-tech in nature and rely upon gravity and anaerobic organism to remove contaminants. The sites visited with systems in place were generally in good operating condition, though one or two appeared to be operating at or above their design capacity. The seasonal variation in milk production has an impact upon wastewater treatment systems as well. Systems need to have adequate capacity to handle peak flows while still operating well at lower loading rates during periods of lower production levels.

Common recommendations related to wastewater treatment within this report include:

- Adopt water conservation measures: reducing the volume of water used for processes and cleaning will reduce the volume of wastewater that will need to be treated.
- Put in place measures to exclude rainwater from entering wastewater treatment system.
- Treated wastewater to be used for irrigation should be tested for pathogens and nutrients and applied to crops based upon need.
- Facilities looking to expand operations should take into account wastewater treatment capacity and needs during expansion planning.
- Treatment systems need to be designed for peak flows of wastewater rather than average flows.

The assignment also included constructing two compost piles for the production of a compost soil amendment to be utilized at a future date for vegetable gardens. The intent was to construct the piles with equal parts of green plant materials, brown plant materials, and animal manure. I found it difficult to collect the necessary volume of manure as most animals are being raised in a pasture setting resulting in the manure being disbursed and difficult to gather.

Background:

Dairy farmers in Nicaragua often lack the equipment necessary to cool milk on the farm and therefore are reliant upon local milk collection centers to receive and cool their milk. Activities related to the milk receiving process include washing milk processing equipment and the washing of delivery containers. This wash water along with spilled milk and rejected milk can cause harm to human health and the environment if it is discharged directly to water bodies or land surfaces. All but one of the facilities visited during the assignment had some sort of treatment system in place. Most commonly found were anaerobic septic type systems that discharged to soil surfaces. The other type of system found in use at the time of the assignment were lagoon based systems that rely upon algae and facultative bacteria to treat the wastewater.

Facility managers were looking for information regarding the proper operation of existing treatment systems as well as advice related to system expansion and care. Another common interest is the reuse of the treated wastewater to irrigate crops.

This assignment also included a visit to a swine operation to evaluate the current waste handling system and to provide guidance as the farmer is investigating a possible expansion in the number of swine being raised on the site.

Activities and Results:

Rivas Milk Collection Center

Site visited 6 September 2009

Report

The wastewater treatment plant consisted of the following treatment steps:
Solids settlement tank

- Tank to remove grease (floatables) – manager indicated much grease still passes through – possibly temperature related
- Septic tank (anaerobic)
- Imhoff tank –
- Filter tank being installed – see written notes for diagram, the tank appears to be designed to be "flooded" I am unsure how this will facilitate the transition from anaerobic to aerobic conditions needed in the facultative pond. The media in use was a lava rock with many pores,
- Facultative pond – The manager indicated the pond took 30 days to fill at the current production level. This should be a sufficient residence time, but the pond had a significant red color to it. The manager indicated property owner adjacent was concerned with this and its impact as the effluent flowed through his property
- Sludge removed from tanks is/will be dried in a shallow tank. Manger was looking for guidance on use.
- The manager stated the pH of the water in the pond/lagoon was in the 6-8 range, he was concerned that acid conditions were a problem. pH was lower at the head of the lagoon than at the time the water leaves the pond. I believe this is indicative of the wastewater being anaerobic upon entering the lagoon. If the pH is in the 6-8 range I do not see this as an issue that would need to be addressed.

Recommendations:
Water conservation measures in the processing plant will reduce loading on treatment system. Workers should use only the volume of water necessary to complete tasks. Hoses should not be left running for convenience sake. Note: as I did not view the inside of the entire plant this recommendation is general in nature and a good practice to have in place.

Can milkcan rinse water be added to the waste milk tank? The plant appeared to have a steady stream of users picking up waste milk to feed animals. Adding the initial milkcan rinse water to the waste milk tank would reduce loading to the treatment plant. This may cause problems with current waste milk users if they feel the waste milk is being diluted.

Imhoff tank must be properly managed. The filter tank being installed will be sensitive to excess solid should they carry over from the Imhoff tank. Treatment system operator should take care to maintain proper operational conditions to avoid problems with the filter tank when it is place into operation.

If pH leaving the Imhoff tank is consistently below 6.5 this may be an indicator the system is overloaded and the combination of the septic and Imhoff tank are not reducing oxygen demand as designed. pH can be adjusted using a slurry of hydrated lime and water (up to 5kg of lime to 10 liters of water).

Dried solids/sludge from tanks. This material certainly can be applied to land being used for agricultural purposes. Ideally the sludge would be tested for nutrient content and applied at rates for the cropland it will be applied to. In the absence of testing:

- Spread dried material thinly <2 cm-incorporate into the soil if possible
- If applied to pasture – apply in an area after it has been grazed and keep cattle out of area for a minimum of 30 days. Do not apply to crops to be used for human consumption. The sludge may contain pathogens. Care must be taken in handling and when applying to the land

The filter tank appears to be designed to be "flooded" I am unsure how this will facilitate the transition from anaerobic to aerobic conditions needed in the facultative pond. The media in use was a lava rock with many pores; the filter should help to reduce the waste load currently being sent to the pond/lagoon.

Treated waste water from the discharge of the lagoon could be used to irrigate plants. Application rates of the water should be matched to the soil types being irrigated. Also, although treated, the wastewater may have some pathogens present care should be taken so as not to contaminate plants that will be used for human consumption. (If further information is needed on this topic please contact me.)

The plant manager also indicated problems with waste plastic from packaging cheese. Film plastic can be a difficult waste to deal with. It may be beneficial to discuss the problem with the supplier of the plastic film to see if the supplier may be able to take back the waste plastic for recycling.

Milk Collection Center – Under construction:
This center is in the final stages of construction. Work has been completed on a system to treat wastewater. A septic tank combined with a filter/drainfield has been put into place.

One observation I made during the visit was there appeared to be no way to inspect or clean out the septic tank. When the system is put into use solids will be sure to accumulate inside the tank and these solids will have to be periodically removed from the tank. If the solids are not removed they can carry-over into the filter bed and cause it to become blocked and fail.

Rivas follow-up questions:

1. Please advise on the operation of Imhoff tank?

While there are no mechanical parts in an Imhoff tank, it still requires some care to ensure it is operating properly. This is a basic guide to the operation of the tank, attention should be given to the following:

a. Daily removal of grease, scum and floating solids from the sedimentation compartment.
b. Weekly scraping of the sides and sloping bottoms of the sedimentation compartment by a rubber squeegee to remove adhering solids which may decompose.
c. Weekly cleaning the slot at the bottom of the sedimentation compartment. This can be done by use of a chain drag.
d. Periodic reversal of flow where provided for in the design of the tank.
e. Control of the scum in the scum chamber, by breaking it up, hosing with water under pressure, keeping it wet with supernatant from the digestion compartment and removal if the depth approaches two to three feet.
f. Removal of sludge should be done before the sludge depth approaches within 18 inches of the slot in the sedimentation compartment. It is better to remove small amounts frequently than large amounts at long intervals. Sludge should be

removed at a slow regular rate to avoid coning (i.e. the formation of a channel through the sludge) which would permit partially digested sludge and liquid held in storage above the digested sludge to be withdrawn from the tank. The height of the sludge in the sludge compartment should be determined at inlet and outlet end of the tank at least once a month.

g. After each time that sludge is removed, the sludge pipes should be flushed and drained to prevent sludge from hardening in and clogging the pipes.
h. Prevention of "Foaming". Every effort should be made to prevent "foaming" because correction after the condition arises is sometimes difficult. "Foaming" is usually associated with an acid condition of the sludge and in such cases may be prevented or corrected by treatment with lime or sodium bicarbonate to counteract the acidity of the sludge. There are a few simple measures which may, under certain circumstances, remedy or improve the condition.

    1. The use of hydrated lime or sodium bicarbonate added to the gas vents will usually aid in correction. The pH value of the resulting sludge and lime mixture in the digestion compartment should not exceed 7.6.
    2. Removing the tank from service where possible for a few days and allowing it to rest will sometimes improve conditions.
    3. Agitation of the gas vent area with a water hose or paddles will sometimes help.

Source: http://water.me.vccs.edu/courses/ENV149/Imhoff.htm

2. Specifics on the reuse of effluent to irrigate fruit trees on the property.

The use of wastewater effluent to irrigate fruit trees or other plants should follow any applicable Nicaraguan regulations. Of primary concern is microbial contamination of the crop. Effluent should only be applied to the fruit trees only if it can be done in a manner that does contaminate the fruit that will be consumed by humans. When operating properly the lagoon system in place will certainly reduce the pathogens present in the wastewater, testing for E. coli and other pathogens may be necessary to determine the level of bacteria present at the discharge of the lagoon.

Application techniques should also be used that do not allow the effluent to come in contact with the fruit. Irrigation practices such as flood, furrow and drip irrigation should be used rather than spray irrigation. It will also be beneficial to stop irrigation prior to harvest. The length of time will be dependent upon pathogen concentrations, but even a one to two week period before harvest has been shown to be effective at reducing any pathogens that may be present (reference: http://www.who.int/water_sanitation_health/wastewater/gsuweg2/en/index.html)

Application rates should match the uptake requirements of the particular crop the water is being applied to. In addition to water use application rates should also take into account nutrient (N, P, K) needs of the crop as well. I would recommend contacting local agronomy experts familiar with the crops being grown.
Reference document: WHO – Guidelines for the safe use of wastewater, excretia and greywater.
http://www.who.int/water_sanitation_health/wastewater/gsuweg2/en/index.html

Recommendations:

a. Test to determine pathogens and nutrients present in treatment system effluent (UNA soil and water lab)
b. Consult with agronomy specialist to determine application rates based upon test results.

Milk Collection Center at San Jose de los Remates

Site visited 9 September 2009

The collection center currently receives milk from 84 members who combine to deliver an average of 2,500 gallons of milk per day. Milk is received in milk cans at a small receiving dock area that has two doors. The center markets its milk to two different processors; milk for each processor is received at a different door in the receiving area. After the milk

cans are emptied they are taken to another area where they are washed and then returned to the farm that delivered them. The milk cans and equipment are cleaned using a mixture of a detergent and chlorine solution.

The wash water and any spilled milk current flow into the gutter of the adjacent street and flow down an incline where it eventually ends up in a small stream. The plant manager indicated they use approximately 2,000 gallons of water per day as well as 250 gallons of cleaning solution. The cleaning solution is purchased in bulk and there were no labels on the storage containers; thus I was unable to determine the strength or composition of the cleaning solutions. The collection center is interested in installing a treatment center to deal with the wastewater so it will reduce the impact on the local stream.

The center currently has some space for a treatment system, but the managers of the center have been talking to neighboring property owners about the possibility of purchasing property for expanding the plant. The managers estimate a total of 150 farmers in the area who could possibly deliver milk to the center. Any treatment system installed at the center should take this into account.

Recommendations:

Water Conservation:
During the visit to the collection center I observed wash hoses being left running when not in use. Wasterwater treatment systems are designed on the basis of hydraulic (flow) and BOD (biological oxygen demand) loading. While reducing the volume of water used will not impact total BOD loading, it can reduce the size of the system and thus the capital investment in treatment equipment.

Measures should also be taken to not allow rainwater to enter the treatment system at collection points. This can be accomplished by placing drains inside the center, or some other mechanism to exclude rainwater and runoff from being collected for treatment.

Determine how waste is being generated, can steps be taken or procedures put in place to reduce the amount of milk being wasted?

Site Considerations:
Depth to Bedrock in the area around the collection center? The depth that can be excavated may have an impact on the type of system that can be used.

While there appears to be sufficient gradient (or slope) for a septic system it would be a good idea to survey the site to confirm adequate gradient is at the area chosen for the system.
Process Considerations:
The maximum flow will also need to be determined. The system should be sized so as to handle peak loads of flow and waste. If the system is undersized treatment will be incomplete.

Size of the system should be large enough for solids to be removed and the dissolved organic waste to be degraded by the bacteria in the septic system. 1 cubic meter equals 264 gallons. Septic systems are generally designed to have a certain number of days residence time. This is the time it takes for water to move through the system.
How can the flow to the treatment system be spread out over more time? Milk is currently being received during the morning and within a small period of time. Sending all the waste water to a treatment system in such a short period of time could have a negative impact upon the efficiency of any system.

If a septic system is put in place it would have to be "seeded" with solids from a system that is operation. It will be important to get a volume of sludge from the bottom and top of the other system in order to have the right bacteria for treating the wastewater.

Association Expansion: As the Association hopes to be able to attack additional farmers to join the design of the treatment system should take this into account. The initial system chosen could be sized to accommodate the expected growth. Another possibility would be to put in a system now to accommodate current volumes of wastewater plus the growth that is anticipated in the next 2-3 years. After the system reaches capacity a second system could be put in parallel to the first system. If this plan is chosen the initial installation should include space and possibly pipe connections with expansion in mind.

Treated water from the system certainly can be used to irrigate plants. Application rates should be determined based upon soil type and plant needs. Also, although treated, the wastewater may have some pathogens present care should be taken so as not to contaminate plants that will be used for human consumption.

Operating Procedures and Training – The system that is put into place should include information regarding the operation and maintenance of the system that is installed. The information should include information about monitoring the system for proper operation as well as what to look for in the form of problems typical to the type of system installed. Training in the operation and maintenance of the system would be a good idea as well.

Cooperative San Felipe RI Collection Center

Site visited 11 September 2009

At this milk collection center an average of 1,600 gallons per day of milk are collected and cooled. The peak inflow of milk occurs in winter and is approximately 2,400 gallons per day. The center is interested in expanding operations at this facility to include the processing of some milk products such as cheese.

Treatment System:
The treatment system in place at the center is a septic system with a solids settling basin, grease floatation chamber followed by septic tank treatment. In this case the water leaving the septic tank is directed to a drain field that appeared to be aerobic in nature. The system had no foul odors.

Recommendations:

As the treatment system appeared to be in good operating condition my recommendations are minimal

- Currently the treatment system is receiving all rainwater that is falling onto the receiving pad at the front of the building. I would recommend installing a valve or similar device that will be open when milk is being received or the pad is being cleaned and closed at all other times.
- There was some milk and wash water in the receiving pad area that was not being captured by the collection drains. I would recommend repairing the drain trenches or making the slightly deeper so they will be better able to collect the spilled milk and wash water.

Reception pit at front of milk receiving area

Plant expansion:
As planning continues with expanding the collection center to include processing milk products I would recommend investigating the operating capacity of the treatment system to be able to treat additional wastewater that will result from the expansion of the operation. The center is already planning to divert whey to animal feed which will certainly reduce the volume and strength of the waste to be treated.

The plans for the expansion should also include measures that will minimize the amount of wastewater the process will generate. Turning hoses off when not in use or adding nozzles to wash down hoses are examples of practices that can be used. The less wastewater that is generated the less the treatment system will need to handle.

Treatment System for Camoapan Dairy Processing

Site visited 12 September 2009

The treatment system for the Camoapan Dairy processes 10,000 gallons of water per day from the operation of the dairy as well as two milk collection centers. The system currently in place utilizes a reception tank that acts as a settling tank. The wastewater is then pumped to one of two lagoons (facultative ponds) where bacteria and algae are utilized to treat the wastewater. The ponds are unlined thus the water is seeping into the soil. Flow to a particular pond continues until excess “fat” is observed floating on the surface of the lagoon.

There also has been an investment in another treatment system; an activated sludge batch reactor. This system was not in use at the time of the site visit due to mechanical issues with the air system. Staff also indicated the system had operated for only three months before failure and was expensive to operate due to high electrical costs ($80,000)
The managers also indicated a desire to use the treated water to irrigate crops during summer months.

Options:

1. Repair existing system and determine what caused the failure of the unit. The main cost to operating this system is the electrical cost of pumping air into the batch reactor to treat the waste water. The current operating procedure is

based only on time rather than upon volume of waste being treated. Seasonal variations in production (milk deliveries) impact the flow and loading (DBO5 and DQO) to the plant.

It may be beneficial to put into place equipment to monitor daily flow to the plant as well as to institute testing for DBO5 or DQO or plant influent and effluent. This information could be used to reduce the amount of time the air system needs to be in operation and thus reduce to the cost of operating the system or;

2. Investigate converting existing system to a trickling filter system and utilize existing ponds as final treatment or "polishing" ponds to capture any solids that may leave the filter. A trickling filter utilizes a chamber filled with a media (such as stones or rocks) on which bacteria grow and extract nutrients from wastewater as it passes over the media. Just like the existing system a trickling filter is an aerobic system that relies upon air inlets at the base of the filter media to introduce oxygen into the treatment system.

   This type of system will require a pump to recirculate filter effluent to ensure adequate treatment of the water as well as to ensure filter media remains damp during period when little of no wastewater is coming from the dairy processing plant. The cost of operating this system is related to the volume of wastewater that needs to be recirculated in order to achieve the desired level of treatment. The cost to pump the wastewater can be calculated ahead of time using an equation. This cost can then be compared to the operating cost of the batch reactor.
   The size of the trickling filter needed will need to be determined. The size needed is a function of the surface area and depth of filter media needed to treat the volume and strength (DBO5 loading rate) of the wastewater.

Use of Effluent to irrigate Crops:
If the treated water is to be used for irrigation it may be best to line the treatment ponds with an impervious material so the water does not drain into the soil below the ponds.

The use of wastewater effluent to irrigate crops or other plants should follow any applicable Nicaraguan regulations. Of primary concern is microbial contamination of the crop. Effluent should only be applied to the crops only if it can be done in a manner that does contaminate the crop that will be consumed by humans or animals. While operated properly the treatment system in place will certainly reduce the pathogens present in the wastewater, testing for E. coli and other pathogens may be necessary to determine the level of bacteria present at the discharge of the lagoon.

Application techniques should also be used that will limit the effluent contact with the crop. Irrigation practices such as flood, furrow and drip irrigation should be used rather than spray irrigation. It will also be beneficial to stop irrigation prior to harvest. The length of time will be dependent upon pathogen concentrations, but even a one to two week period before harvest has been shown to be effective at reducing any pathogens that may be present (reference: http://www.who.int/water_sanitation_health/wastewater/gsuweg2/en/index.html)

Application rates should match the uptake requirements of the particular crop the water is being applied to. In addition to water use application rates should also take into account nutrient (N, P, K) needs of the crop as well. I would recommend contacting local agronomy experts familiar with the crops being grown.
Reference document: WHO – Guidelines for the safe use of wastewater, excretia and greywater.
http://www.who.int/water_sanitation_health/wastewater/gsuweg2/en/index.html

Recommendations:

c. Test to determine pathogens and nutrients present in treatment system effluent (UNA soil and water lab)
d. Consult with agronomy specialist to determine application rates based upon test results.

Coop San Francisco Collection Center

Site visited 13 September 2009

This collection center collects milk from farmers to remote to deliver to the main collection center in Camoapa. The center receives an average of 1,800 liters of milk per day. Milk is delivered in plastic barrels as well as the traditional milk cans. Collection center has a well that is 68 meters deep as well as a lagoon based wastewater treatment system. Wastewater is only being collected from the interior of the collection center. The front pad of the center is collected and directed via pipe to a near drainage area. I was also informed that the well is not currently able to provide a consistent flow of water, only 15 minutes of running before it is exhausted. They are currently considering upgrading the well in some way.

The treatment system consisted of:

1. Solids settling basin. Approximately 1meter x 1 meter in size and is cleaned out every 8 days. Solids removed are left on the ground next to the basin.

2. Basin for removal of floatables. Approximately 1meter x 2.5 meters in size, again this basin is cleaned out every 8 days.

3. A second settling basin the same size as the first basin.

4. After the second settling basin the wastewater in directed to an unlined lagoon for treatment. I was told the pond has not yet filled and if and when it did the flow would be directed to another lagoon. The second lagoon did not yet have a pipe leading to it, but a trench has been dug.

The system appeared to be in good operating condition and no foul odors associated with the system. Water was leaving the system through evaporation or through infiltration into the soil.

Recommendations:

- The current well is located within 40 to 50 meters of the treatment lagoon and within 10 to 12 meters of the outhouse used by center staff. As the lagoon and outhouse discharge to the soil it would be beneficial to maximize the distance from the well to the lagoons and outhouse to reduce the risk of contaminating the well water. If the decision is made to re-dig the well I would recommend moving it to a location that is further away from the lagoons and outhouse.

Well location relative to centers outhouse

- Solids removed from the settling and floatation basin should not be left on the soil next to the basins. I would recommend bringing them to a nearby pasture and spread in an area that is relatively flat.
- As the center has constructed two treatment basins I would recommend Alternating between the two basins rather than waiting until one is full or overloaded to make the switch. One possible rotation plan would be to switch lagoons each eight days when solids are removed from settling basins.

Amando Fernandez Farm Visit

Site visited 16 September 2009

This farm visit was to observe the current system in place for handling the manure and run-off from the swine operation on the farm. Currently there is an average of 50 swine on the farm at a time. The swine are kept on a concrete pad that contains manure and rainwater that falls on the pad. The solid manure is removed on a regular basis and spread on a nearby pasture. Liquids resulting from urine, washing, and rainwater are directed to a basin with a screen to remove large solids before traveling via a pipe by gravity to a small lagoon down gradient from the concrete pad. At the time of the visit the lagoon was dry. The person giving us the tour said this was typically the case except for periods of heavy rain.

I suspect the lagoon currently receiving the liquid from the concrete pad is unlined and is allowing the water to drain directly into the ground and possibly contaminating the ground water in that area as there was exposed bedrock adjacent to the lagoon.

The current system in place appears to be doing a good job of protecting the stream that is adjacent to the swine pens.

Swine rearing area relative to stream

The farmer is hoping to expand the number of swine on the farm and is looking for recommendations on improving handling of the manure

Recommendations:

- I would recommend continuing the practice of removing manure solids from the swine pens and applying this manure to pastures as a fertilizer and soil amendment. This practice reduces the solids and nutrients that leave the lot with rain or washwater. Applying the manure to soil also helps to increase soil organic matter, which is below average in many parts of the country.

- I recommend lining the lagoon with an impervious material such as a plastic liner or compacted clay. This is necessary to minimize groundwater contamination. When full the pond can be emptied and applied to pastures.

Expansion Recommendations:

- The current system does very well in containing the waste from the swine. This system could be increased in size to handle additional swine. The system should be sized based upon the number of animals being raised and the expected liquid (rainfall on concrete pad) handling needs. Generally, growing-finishing swine weighing 21 to 100 kg can be expected to generate 0.39 to 0.45 kg of waste per day on a dry matter basis. (Brumm, M.C., A.L. Sutton, and D.D. Jones. 1980. Effect of season and pig size on swine waste production. Transactions of the ASAE 23:165–168.)
- Another alternative would be to investigate anaerobic digestion of the swine manure. The size of the system would need to correspond with the number of swine expected to be added in the expansion. The anaerobic system would certainly generate methane that could be used onsite, but there will still be a need to handle the residual liquid and solids from the system.
- Vance Huagen, University of Wisconsin Extension, Crawford County may be able to provide additional information on methane production systems.

Eskimo Dairy Plant

Site visited 17 September 2009

The Eskimo Dairy processing plant located in Managua processes milk into various products such as ice cream, cheese, and packaged fresh milk. The plant uses 400 cubic meters of water today as part of its manufacturing process. After minimal treatment wastewater is discharged to the Managua sewer where it is treated by the city's treatment works. Whey from the cheese making process is diverted from the sewer to be used as an animal feed.

Currently the only pretreatment measures in place are screens at various locations around the perimeter of the building and a basin where floatables are removed prior to discharge to the city system. The plant has invested in a Dissolved Air Floatation system designed to treat 100 cubic meters per day. The unit is not currently in service due to variations in flow and pH make the operation of the system inefficient and difficult to operate.

Existing pretreatment system, not currently in operation

Water conservation: The plant appeared to have many measures in place to conserve water. The manager who led the tour pointed out some of the measures to ensure excess water is not used. The manager also shared that the plant has other measures in place to reduce waste from the plant. These efforts to minimize water use and reuse waste, such as whey, reduce the amount of waste that needs to be treated. I commend these efforts and encourage further efforts to reduce waste.

Wastewater pretreatment: The plant currently has limited space available for expanding operations much less the installation of a wastewater pretreatment system. Due to space limitations I would recommend looking only at systems that rely upon physical processes to reduce the strength of the wastewater being discharged to the sewer system. The lack of space would make any biological system installed to be susceptible to flow surges as well as changes in pH.

The facility currently has a system in place that removes many solids at various collection points around the plant as well as a tank that facilitates the removal of floatable solids. Removal of accumulated solids at these points on a regular schedule should continue to occur so as to minimize carry-over of solid to the sewer system.

If the facility wants to further investigate options I would recommend looking at systems that utilize centrifugal force or screening technologies. These systems generally have smaller footprints and may meet the needs of the facility. Systems should be evaluated based upon solids removal efficiency as well as cost (energy, maintenance, labor) required to operate.

Compost Production:

The other volunteer traveling with me was providing instruction in soil analysis. One common denominator of all the different soils observed was the lack of soil organic matter. Organic matter in the soil provides many benefits including; maintaining soil structure, loosen compacted soil, stimulates soil biological activity, and enables soils to better hold onto nutrients. Compost will be an invaluable product that can applied to vegetable gardens to improve yields as well as soil and plant health.

While in the San Jose de los Remates I trained a group of individuals the basics of compost pile construction and care. During the visit the group constructed two compost piles on separate farms. The piles were approximately one cubic meter in size and were constructed utilizing materials found nearby. The basic recipe for compost was to combine equal parts of green plant materials, brown plant materials and animal manure. The other key ingredient is to apply an ample amount of water with a goal to achieve a 50% moisture level. After the piles were constructed they were covered with plastic sheeting as a way to control moisture levels within the piles. Within a few days the piles will begin to heat up. This heat will aid in the production of the compost as well as inactivate any weed seeds that may have been present in the materials used to construct the pile.

Students were also instructed in the care or management of the compost piles. Piles are to be turned or mixed on a weekly basis for six weeks or until the pile is no longer self-heating. Students were also told of the need to ensure moisture levels are maintained in the proper range. To asses moisture level students were told to squeeze a handful of material, if water was squeeze out of the material it is too wet; if the material falls apart upon opening of the hand, the material is too dry.

Finally we discussed how to utilize the compost. Compost can be mixed into soil or applied to the top of the soil. When mixed into the soil apply 2 inches of compost and mix with the top 6 inches of top soil. When used as a top-dressing up to 3 inches of compost can be applied to the soil.

An additional product of this activity was video footage that was shot during the construction of the second compost pile. The footage has been compiled into a nearly thirteen minute long video that could potentially be used to instruct others in the construction of compost piles.

Follow up:

The need to improve wastewater treatment facilities may be needed as Nicaragua's dairy industry continues to mature and expand. The current level of treatment technology in place requires minimal operational knowledge and oversight. If more advanced treatment technologies are to be put into place the operators of these systems will be in need of training related to operation and monitoring of the systems. It may also be necessary to provide information about the cost of operating treatment systems during the design phase of the systems. The managers at the Camoapan Dairy indicated they were surprised at the amount of time and energy costs associated with the operation of their new

treatment system. They indicated the cost was prohibitive and had reverted to using the lagoon based treatment system that had been previously used by the plant.

There also may be future opportunities for the milk collection centers and processing facilities to form partnerships with their communities to deal with wastewater issues. The Eskimo Dairy plant is an example of the processing facility working with the local treatment works to manage the wastewater from their operations. Facilities in more rural parts of the country may be able to cooperate with their communities to provide wastewater treatment facilities to manage waste from residential sources in addition to the waste from the dairy industry.

Appendix –

Photos from various sites visited during assignment.