Environmental Technology Transfer to Rural China

Thesis

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By

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Abstract

Over the last 20 years, Chinese farmers have changed manure and sludge handling. For more than 2000 years, human and animal waste was recycled as fertilizer. Beginning in the mid-1980s high yielding crop varieties required more fertilizer. In the shift to chemical fertilizer rather than recycle, farmers began to just dump sewage and manure. China needs improved rural environmental infrastructure. The project goal was to develop a model for environmental technology transfer to rural China. The model development considered technical, legal/policy and cultural factors.

The 2006 5-year plan set a vision of the New Socialist Countryside. Campaigns were considered, such as the restoration of the ancient Grand Canal that flows through Shandong Province and the south-to-north water diversion. Connections were established with faculty at both an agricultural university and an agricultural academy. A technology, sand bioreactors, was introduced through lecture and lab demonstrations. The technology can be easily constructed using local construction practices and materials and is a compliment to the well-established biogas digester program.

A model for environmental technology transfer was developed. The model recognizes the difference between the agricultural universities and the academies. The universities, once under the Ministry of Agriculture, were moved in the 1990s to the Ministry of Education. The academies remain under Agriculture and have access to extension agents and on farm demonstrations in the countryside. Connections to the agricultural academies, language skills and an appropriate technology that furthers the 5-year plan and campaigns is needed to be successful in technology transfer to rural China.

Dedication

My husband Larry and my children Earline and Mike.

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Fields of Study

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Chapter 1: Introduction

Clean air, soil and water are important to the long-term development and wellbeing of a nation and sustainability of agricultural production. By the late 1960's the American industrial movement fouled the environment to the point that rivers caught fire and smog darkened cities. As the urgent environmental clean up needs of urban America were addressed through the 1970's and 1980's the focus moved on to suburban and rural environmental concerns. Non-point source pollution, landfill siting for solid waste disposal and the loss of agricultural land to urban sprawl came into focus in the 1990's.

China's environmental problems caused by growth in industrial production and population increases mirror the path America has already taken. Balancing the need to produce food for an increasing population with the demand for housing and industrial development are shared by America and China. Economy (2007) in "The Great Leap Backward?" points out some of the environmental challenges China now faces. She writes about the severe air pollution in China due to the use of coal throughout China as its primary energy source. China has 16 of the world's 20 most polluted cities.

The year 1972 was a landmark in China's environmental movement. Two environmental disasters that year brought the problem to the attention of government officials and the public. Beaches turned black and a massive fish kill occurred in Dalian. That same year contaminated fish were sold in Beijing from a nearby, polluted reservoir (MacBean, 2007).

Researchers are making some progress on the design and construction of pollution treatment facilities. Steinfeld and others (2008) reported on a MIT Chinese energy survey in Greener Plants, Grayer Skies? They collected information on 299 coal-burning power plants all across eastern and central China. They found that as China is developing its power plant infrastructure, advanced "fluidized bed combustion" plants are being constructed. Since this technology operates at lower temperatures, fewer air pollutants are released. Fluidized bed combustion systems also operate with a wide range of fuels and fuel quality. China's power plants are also installing scrubbers on systems using older technology. Even with the advanced technologies, many plants are not meeting the relaxed emissions standards as compared to the US or EU. Even with state-of-the-art equipment installed, government programs do not provide either the incentives or the penalties to meet or exceed standards. The problem they found was the lack of operation of pollution control equipment due to cost of operation.

About 130 million households in rural China do not have toilets. Important scenic areas also do not have adequate sanitation facilities. Chinese youth and women's groups have taken the lead in improving rural sanitation, however, personnel training is needed (UN, 2003). Appropriate waste and wastewater treatment systems can be simple to operate and maintain, but the investment is waste management systems can easily be lost if operation and maintenance is overlooked.

China has a long history of fertilizing crops with human and animal wastes. In fact the need for the fertilizer value of manure was so great that an entire industry developed in China to collect human and animal waste from the cities. Records date back to the Song Dynasty. Xue (2005) studied the agricultural manual of Mr. Shen that recorded the agricultural practices of a large farm in Huzhou prefecture in the early 1600s. Xue outlines the practice of "nightsoil" collection from the cities to fertilize farm fields. Surprisingly farmers would travel several days to cities like Hangzhou to obtain the highest quality nightsoil to fertilize their crops. In wealthy areas, where people

consumed a lot of meat and fish, the waste was especially valuable due to its high nitrogen content. In the manual Shen writes “The effects of human waste is strong, and that of ox waste lasts long. They must be balanced in their application.”

Pig manure was especially important as a fertilizer in crop production to the point that peasants kept 1 or 2 pigs, even though pig raising was not profitable (Ellis and Wang, 1997). Xue (2005) presents Shen’s calculation of the cost benefit of pig production during the Ming Dynasty. Purchasing and raising 6 pigs resulted in a 20% loss in meat sales. However, taking into account manure value, those pigs produced more than a 10% profit.

Most interesting was the observation of the public health value of the practice of nightsoil collection. In 1930, John Lossing Buck (Xue, 2005) in a study of Chinese farms noted that nightsoil carries intestinal diseases. The practice served as the sewage system for urban areas to keep the cities and towns clean. Moving sewage onto farmland protected drinking water supplies. In the 1910s a Japanese study found Chinese cities like Jiangman, that had a nightsoil collection system, were cleaner than modern cities, like Shanghai.

King (1911) wrote about his travels through Japan, Korea and China to study eastern agriculture. King devoted a chapter of his book to the utilization of waste. For centuries Chinese agriculture had no possibility of using mineral fertilizer, therefore the nutrients in manure and human waste were critical to maintaining the race. He found, in China, one-sixth of an acre was needed to feed one person. The waste was so valuable to maintain adequate crop yield that a sewage broker paid $31,000 to have access to 78,000 tons of human waste in Shanghai with boats ready to transport it to farmers willing to buy the organic fertilizer. King also noted the importance of waste recycling to sanitation in the cities. The rapid collection and recycling of wastes eliminated breeding areas for flies. King points out the irony of the modern western practice of discharging sewage to the sea, lakes and rivers, wasting millions of pounds of fertilizer that is considered one of

the great achievements of the civilization. He also considered that wasting the fertilizer in the manure and sewage would have meant suicide to the Chinese, Japanese and Koreans.

During the Chinese Cultural Revolution of the 1970s, urban youth were sent to the countryside for "re-education". Dai Sijie (2002a, b) in the book and film "Balzac and the Little Chinese Seamstress" depicts in this autobiographical work his own re-education in Sichuan Province. The urban youth from Shanghai joined the peasants of a mountain village loading and carrying buckets of manure on their backs up the mountain to the agricultural fields. Dai, in his film, illustrates the drudgery of the work with the manure sloshing in the buckets and splashing on their heads. He also shows the value of the manure when one youth spilled his load only to be told he must collect it with his bare hands. In the novel Dai writes:

> *What we dreaded most of all was having to carry buckets of shit on our backs. These wooden buckets were semi-cylindrical in shape, and designed specifically for the transportation of all manner of waste, whether human or animal. Each day we had to fill the "back-buckets" with a mixture of excrement and water, hoist them onto our shoulders and clamber up the mountainside to the fields, many of which were situated at dizzying heights. With each step we could hear the liquid sewage sloshing in the buckets just behind our ears. The slurry would seep through the lid and trickle down our bodies until we were soaked.*

In response to the introduction of high yielding crops as a part of the "green revolution" in the 1980s, farmers had to apply chemical fertilizer to realize the high yields. Because this worked so well, farmers stopped recycling wastes to fertilize their fields and started to over apply chemical fertilizer (Huang et al. 2008). The runoff of excess fertilizer combined with the dumping of human and animal wastes has resulted in extensive water pollution throughout rural China.

Because of centuries of recycling of human and animal manure, China did not develop wastewater treatment infrastructure. The shift of viewing manure as a waste rather than a resource has resulted in extensive water pollution throughout the county. For nine centuries, traditional agricultural practices, including recycling of human and animal waste, sustained high productivity in China's Taihu Lake Region west of Shanghai. Taihu Lake is one of the largest lakes in China. In the 1960s nitrogen fertilizer was introduced to increase production to support the population that had grown to twice the region's historical maximum (Ellis and Wang, 1997). Taihu Lake is now highly polluted and eutrophic. The lake experiences large algal blooms and degradation of drinking water quality (Jin and Hu, 2003).

Sociologists have studied the diffusion of technology for decades. Rogers (2003) presented a 4-part framework for technology diffusion.

1. Characteristics of the innovation, is it:
• compatible with the user's lifestyle
• complex or simple
• possible to try it out first.
• easy to observe the impact.

2. Communication channels exist to get the information on the innovation out to potential adopters.

3. Time is needed for adoption. Some innovations are adopted quickly, while others slowly gain use. The time it takes to first learn about an innovation can impact the rate of diffusion.

4. The social system the innovation enters.

Before an innovation can diffuse it must first be introduced. Introducing a technology into and throughout a different culture requires knowledge of their technology transfer systems.

1.1 Research Objective

The objective of this research was to develop a model for environmental technology transfer to rural China. The proposed model considers the role of appropriate technology, legal and policy issues and the appreciation of culture. The technology being transferred to rural China is a wastewater treatment system known as a sand bioreactor.

2.0 Literature Review

2.1 Technology Transfer

Technology transfer is a necessary precursor to the adoption and diffusion of the technology. An adopter must first learn about the technology. Fliegel and Korsching (1999) summarized the work of Copp and others from their 1958 study of 175 Pennsylvania dairy farmers and presented their 5-step process of adoption.

Step 1. Awareness – hears of the innovation.
Step 2. Interest – feels the innovation is a workable solution to a problem.
Step 3. Acceptance – feels the innovation would be useful.
Step 4. Trial – tries the innovation.
Step 5. Adoption – continues using the innovation.

Research on the diffusion of innovations began in 1903 (Wejnert, 2002) and throughout the 1900s into the new century. Over 4000 research papers have been published on diffusion of innovations, technologies, methods, policies and reforms. Wejnert (2002) grouped diffusion variables into a framework.

1. Characteristics of innovations
    a. Public/private
    b. Benefit/costs
2. Characteristics of the first adopters
    a. Societal entity
    b. Familiarity with the innovation

    c. Status
    d. Socioeconomic
    e. Position in social networks
    f. Personal characteristics
3. Environment
    a. Geographical
    b. Culture
    c. Political
    d. Global uniformity

Lance and McKenna (1975) studied the success and failure in introducing technology to the non-western world. They examined fifty cases of attempts to introduce change in developing areas. They considered 10 categories of innovations and 7 strategies for adoption. The seven strategies included pressure, participation, education, utilitarianism, placement, empiricism, and the hands-off approach. Lack of understanding of values and social structure contributed to failure of adoption along with selection of the wrong innovations. Participation in the decision-making process with the innovation was the one strategy for success.

Two waste management technologies were examined in this project. One, biogas digesters, is already widely diffused and has been adopted in China. The other, sand bioreactors, have not yet been used in China.

Biogas Digesters have been used for decades in rural China. The need for energy provided an opportunity to once again view animal and human waste as a resource. Biogas generation from manure offered Chinese peasants an alternative cooking fuel to wood, coal or other fuels. In the 1920s, biogas technology was introduced in China to reduce the use of kerosene (Qiu et al. 1990). Promotion of anaerobic digester technology began in 1975 by the Chinese Communist Party (CCP) with the slogan “biogas for every household” (AD Community, 2009). The dissemination of how-to instructions in

digester construction began with the founding of the Chengdu Biogas Research Institute in 1979 (China Ministry of Agriculture, 2009).

Looking at the development of bioenergy technology in China, Lin (1998) presented the development of household biogas digesters from 1985 to 1995. Development remained steady at around 4,700,000 households for 7 years. The digester development began to increase in 1991 to reach 5,700,000 in 1995.

The Chinese government invested 61 billion RMB for rural biogas projects from 2003 to 2010 (Chen et al., 2010). In 2003 the Ministry of Agriculture in turn invested 840 RMB for the construction of household scale digesters in 22 Provinces. In 2004, 1 billion RMB was invested and by 2005 the amount grew to 2.5 billion RMB for household digester construction. For northwestern and northeastern areas 1200 RMB per household was made available as a subsidy. For the southwestern areas 1000 RMB per household and other areas 800 RMB per household was made available.

Anaerobic digestion to produce biogas is a natural breakdown process of organic material. It was first observed in lake sediments and takes place in a two-step process:

	Step 1		Step 2	
Naturally occurring Organic matter	→	Organic acids	→	Methane gas

Naturally occurring bacteria breakdown the organic matter first to organic acids and a different group of bacteria convert the organic acids to methane gas. Methane gas is also called natural gas and can be burned as a fuel.

Through the anaerobic digestion process, nutrients in the waste are conserved. Organic nitrogen is broken down making it more available for plant growth. The digested waste is converted to a liquid that can be pumped and applied through irrigation systems. Most

importantly, the wastes are stabilized changing the putrid odor of decomposing waste to an earthy odor similar to wet soil. Unfortunately, anaerobic digestion does not do the entire job of purifying wastewater. The effluent, with high levels of water pollutants, continues to be dumped into China's waterways. Rural China still needs an appropriate technology to complete waste treatment in concert with biogas generation.

Biogas from digesters is being used in China to operate special cook stoves (Gan and Yu, 2008). By burning biogas for cooking, the use of wood and charcoal, made from wood, has diminished. The use of biogas has, as a result, reduced both deforestation around villages and soil erosion. Biogas use has also reduced air pollution throughout China that was caused by the burning of wood and charcoal.

In their paper, Han and other (2008) outline the renewable energy policies that encourage the construction of household anaerobic digesters in Shandong Province. By capturing methane using digesters for use in cooking reduces greenhouse gas emissions. Methane is a 12 to 20 times more powerful greenhouse gas than carbon dioxide. The digestion process also greatly reduces the odors normally associated with animal manure and sewage. By digesting wastes, flies are no longer a problem in villages, offensive odors are eliminated, and the digested wastes are easier, safer and more "pleasant" to recycle as fertilizer on crops than raw, untreated wastes. The digested wastes are safer, because most pathogens present in sewage and manure are killed during the digestion process.

Wei (2007) in her thesis on the biogas program in rural China, found that education, income, and farm size are positively related to anaerobic digester adoption. Age was found to be negatively related to adoption. Of all of these factors, income had the most significant effect on adoption behavior. Use of biogas positively effected the household financial situation by savings on cooking time, electricity, and firewood. Gender division of labor was impacted by easing the time needed for cooking, firewood collection, and fertilizing. The community environment also benefited by the improvement of general cleanliness of the community and increased agricultural productivity.

Bi and Haight (2007) studied the use of anaerobic digesters and community development. They used questionnaires, face-to-face interviews and on-site observations to learn more about anaerobic digester diffusion, their operation and impact. They found leadership, education and the local economy as important factors. Government subsidies were significant in anaerobic digester adoption. The cost of digester construction at 1258 RMB (less than $200) gained a government subsidy of 32%, which increased the technology adoption.

To provide trained technicians to build and supervise the building of individual biogas digesters, the Chinese Ministry of Agriculture's Biogas Research and Training Center in Chengdu was established in 1979 (China Ministry of Agriculture, 2009). It has conducted over 42 national training courses, producing over 2300 trained technicians.

Sand Bioreactors are a wastewater treatment system appropriate for rural areas. Stricter stream discharge requirements are reducing the number of treatment options. Increasing construction costs make extensive sewer networks impractical. Large fluctuations in flow in recreational communities and some businesses upset the operation of traditional treatment systems. Communities and regulators are looking for new options.

One well established treatment option is a sand bioreactor, also known as a sand filter. Beds of sand have been used to treat wastewater in communities since the late 1880s (Mancl and Peeples, 1991). Dozens of communities in Massachusetts operated sand filters for wastewater treatment for over 40 years. The systems were eventually abandoned, not because they did not work, but when the communities grew and the land was converted to new uses.

Sand bioreactor technology was forgotten for a good part of the 20th century. The new activated sludge treatment technology was developed. Engineering programs around the

nation taught students about activated sludge systems that were smaller in size, but were more complicated and required more energy and skilled labor to build and operate.

During the 1980s, researchers looking for treatment systems that produced excellent quality effluent with lower energy and labor requirements “rediscovered” sand bioreactors. Advances in the technology both reduced the system size and increased the effluent quality. New strategies of wastewater applications, like dosing and recirculation, reduce the size of sand bioreactors. New artificial media have all been studied to improve effluent quality and make bioreactors easier to construct.

In almost all wastewater treatment systems, naturally occurring microbes grow and consume the pollutants in wastewater. Groups of microbes naturally colonize surfaces where it is easy for them to stay moist and have access to air and food. This process occurs on teeth, where biofilms grow in a moist environment with access to food and air. While brushing teeth removes the biofilm, it quickly grows again. This process also occurs in the soil under septic systems as long has the soil is well-structured, the microbes can grow on the aggregate surfaces and if the soil in not saturated, the empty soil pores provide the necessary air for the microbes. These same microbes will grow on other media, like sand, cloth, plastic, and a range of other materials.

Figure 1 illustrates the biofilm wastewater treatment process. The microorganisms form biofilms on the media surface. The biofilm microbes draw nutrients, organic matter, and oxygen from wastewater and air that passes through the media bed. The media also traps suspended solids. Sand and media bioreactor effluent is typically very clear with low biochemical oxygen demand (BOD_5) and ammonia levels.

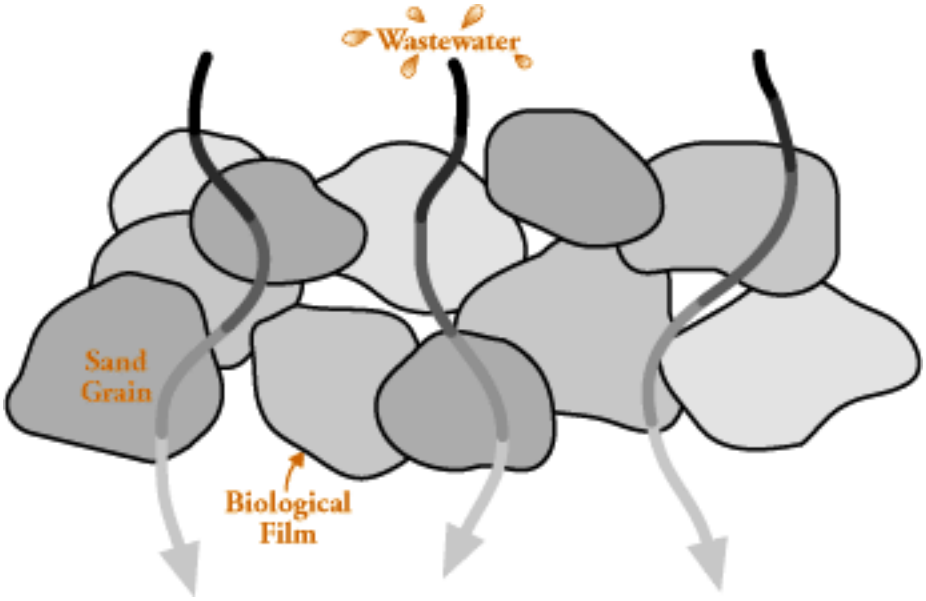

Figure 1. Microorganism growth on sand grains in sand bioreactor system (Mancl and Rector, 1999).

Care must be taken in applying wastewater to sand and media bioreactors. If saturated with water, the microbes are deprived of oxygen and the reactor will begin to clog. If continually overloaded, the media tends to clog. In this way they are fail-safe, requiring the owner or operator to take corrective action. A malfunctioning sand and media bioreactor backs up rather than release poorly treated effluent to a receiving stream.

Sand and media bioreactors respond well to gradual increases in wastewater loading. Therefore, they are very appropriate for new developments with a gradual build out rate. These bioreactors also tolerate fluctuations in flow, especially changes from a negligible flow to very high flows. In this way, they are appropriate for seasonal use and recreational areas. Research shows that sand bioreactors receiving no wastewater for 4 to 6 months can right away treat wastewater when put back into service (Kang et al. 2007; Tao et al. 2009).

Sand bioreactors are simple to construct (Figure 2). A shallow excavation is lined with a sheet of vinyl. A collection system is installed in the bottom and a wastewater distribution system is laid out as a series of pipe on the top. The excavation is filled with layers of clean gravel and sand that is graded and washed. Wastewater is applied to the surface of the sand in small doses using either a pump or a tipping pan.

Figure 2. Construction of a sand bioreactor at the OSU Molly Caren Agricultural Center. Excavation is lined with vinyl, filled with layers of sand and gravel. Wastewater is delivered to the distribution pipes in small doses by a pump operated with a timer. As a non-electric alternative a tipping pan can apply doses of wastewater by gravity.

2.2 Appropriate technology

The definition of environmental protection differs from place to place, so it is not surprising that China views environmental protection differently than the US. The International Trade Commission (2002) warns the foreign sector that the Chinese want to adapt products and approaches rather than follow strict guidelines for technology application. If something works well elsewhere, it may not be appropriate for China. Several factors effect considerations of an appropriate environmental technology for rural China.

Energy is a focus area in China. In 2009, China emerged as the leader in clean energy finance and investment (Pew Environmental Group, 2010) investing $34.6 billion. China has built a strong manufacturing infrastructure and developed export markets mostly in solar energy. While the country already has 52.5 GW of renewable energy capacity it has a high goal to meet domestic demand with a renewable energy targets of 30GW from biomass by 2020.

Han and others (2008) studied village scale renewable energy projects, called pyrolysis gasification. In this process, waste plant material (like rice straw, corn cobs, saw dust) is converted to a gas when first partially combusted at 800^{o} C in the absence of oxygen. The 2-part combustion process produces methane gas. The village-scale plants collect and store the gas in large tanks and install underground pipes to transport the gas to the village homes (Figure 1). In their study, Han and others examined 7 case studies in Shandong Province. They found that once constructed, air quality in Jinan, the Provincial capital, significantly improved. The pyrolysis gasification plants reduced the burning of crop residue and reduced the burning of fossil fuel. However, rural residents were unwilling to pay for the gas infrastructure of the pipelines and the special stoves. Some damaged the gas meters in their homes, so they would not have to pay for the gas they used. They found 4 of the systems no longer in operation in 2006 following their

construction between 1996 and 2005. One of the plants was being converted to burn gas for electric generation after only 1 year of operation.

Remais and others (2009) showed how the emphasis on energy could be leveraged to bring about disease control. They found that anaerobic digesters were effective in inactivating the eggs of parasites found in human and animal waste. This added another benefit to the growing rural energy program in Sichuan Province. In addition to the public health improvement, using an anaerobic digester to produce biogas from human and animal waste reduced household energy cost by 600 RMB per year. At that savings a digester would cover the capital cost of installation in 2 to 3 years. However, Remais and others reported that in villages that did not have government subsidies to build household anaerobic digesters, no digesters were constructed.

Labor was at the center of the Communist system. Until the early 1980s the concept of the iron rice bowl ensured work for everyone. Unfortunately, the concept was threatened by the rapid expansion of the Chinese population. The population control campaign began in the 1970s culminating with the 1978 one-child campaign adopted by the Fifth National People's Congress (Hsu, 1985). Birth control and population planning was considered one of 10 tasks to develop the China's economy.

In the development of an environmental technology export market plan for China, the International Trade Commission (2002) learned that while China has the capability to manufacture basic environmental protection equipment, but understanding of best practices may not be present. Environmental protection is considered costly and operation and maintenance is often neglected resulting in poor performance.

Water is becoming a critical issue in China. While most developing countries have 6500 cubic meters of water per person available, China has only 2500 cubic meters per person available for its 1.3 billion people (MacBean, 2007). Some parts of China have only 355

cubic meters per person available when 1000 cubic meters is the international definition of water scarcity (International Trade Administration, 2002).

The land area of China is similar to the US, but China has 5 times more people. China is about 9.5 million square kilometers (CIA, 2010) with about 15% of the land considered arable. The Chinese population as on July 2009 is 1.338 billion people. By comparison, the US (including Alaska) is 9.8 million square kilometers with 18% of the land arable. The US population is only 307 million people. The Chinese population is 4.36 times bigger with less total and arable land.

The 1990 Chinese Agricultural Census estimates 950 thousand square kilometers of crop land, or 10% of the land area of China. Landsat remote-sensing images estimate 1.4 million square kilometers of cropland or 15% and the Food and Agricultural Organization of the United Nations reports 13% (Frolking, et al. 1999).

Agricultural landscape mosaics of settlements, trees and cropland cover more that 2 million square kilometers of China. Ellis and others (2009) investigated fine-scale landscape changes using high-resolution ecological mapping. They found from 1945 to 2002, the built surface area of Chinese villages has increased by 7%. Roads, buildings and other structures are considered built surfaces. Two other findings were unexpected. They found a 9% increase in closed canopy trees and an 11% decline in annual crops. This represented a shift from annual to more diverse perennial crops along with the impact of tree planting campaigns and orchard development.

In the Peoples' Republic of China (PRC), the government owns all of the land. From 1949 through the 1970s, land was farmed collectively at the village or work unit level. Between 1979 and 1983, agriculture shifted to a family-based system. While the family did not own the land, local officials allocated land to families and they could manage the land for 15 years. In the late 1990s extended contracts for land to 30 years (Brandt et al. 2002).

Brandt and others (2002) conducted household and village surveys of 215 villages in 8 provinces to learn more about land management. They identified 5 types of land. Responsibility land was based on family size and provided the agricultural production to meet quotas. Grain ration land, also based on family size was to meet the consumption needs of the family. Small private plots have a long tenure in the family even dating back to the collective farms. Contract land can be rented by households. Finally reclaimed land had no previous cultivation. Brandt and others were examining the type of land and the land tenure as it impacted decision-making and investment. Application of manure and fertilizer, as an investment, was impacted by the type of land. They found that the application of organic fertilizer (from animal and human waste) was considered a long-term investment, since the benefit is expressed over several years. Most of the organic fertilizer is applied to private plots, both because they have a long tenure in the family and they are close to home.

2.3 Legal and policy issues

Environmental laws have been adopted in China over several decades. World attention was focused on the environment in the early 1970s. This was about the time China was starting to look at entering the world stage. The First United Nations Conference on the Human Environment was also held in 1972 in Stockholm and the People's Republic sent a delegation (Edmonds, 1999). Attendance at the conference marked China's reentry into international discussion and debate. China's contribution to the conference was minimal in new environmental policy, however it marked a first step in international cooperation (Broadbent, 1976).

In Beijing, the First China National Conference on Environmental Protection was held in 1973. Active policies, like recycling and public participation, were promoted by a group of experts and officials published a report in 1974. Broadbent (1976) went on to describe the national discussion. The fourth National People's Congress rated conditions in the

countryside as excellent. China will be able to handle both the pollution problem while developing the economy was the story in the September 1974 issue of the *Red Flag*. Pollution problems would be gradually solved and if rural industry damaged agriculture, the farms should be compensated. The conclusion was that the environment required management instead of reacting to pollution events. The result was the Environmental Protection Law of 1979, which started the legal basis for environmental protection (MacBean, 2007). Meanwhile the environment in China continued to deteriorate.

The 1989 Environmental Protection Law (Chinese Legislative Information Network System, 1989) became the foundation of China's environmental laws. It put forward four principles: environmental protection coordination, pollution prevention, polluter responsibility and coordinated environmental management. Discharge and emission standards were set by the National Environmental Protection Agency, with the allowance for local authorities to set stricter standards. Reporting requirements, timetables and fines were implemented through the "Three Simultaneous Steps" requiring design, construction and operation of projects be synchronized with the pollution treatment facility (MacBean, 2007).

On October 15, 2007, the CCP (Chinese Communist Party) held its 17th National Congress. The report from the congress included the policy of scientific development of a resource-conserving and environment-friendly society (You, 2008). Also in October, 2007, You (2008) reported the establishment of the first National Pollution Sources Census. While this seems like a step in the right direction, the source of the information for the census appears suspect and the penalty for violation low. Information for the census will be requested from the proprietor. If incorrect information is provided, they are subject to fines.

Also in 2007, a new law on Environmental Impact Assessment was implemented by the State Environmental Protection Agency (SEPA). It allows for a moratorium on environmental impact assessment approvals. If a region has exhausted its pollutant

discharge limits, all new applications are subject to a moratorium. In January 2007, SEPA issued four regional moratoria and 4 enterprise group moratoria.

In September 2008, the Chinese government's official website (gov.cn, 2008-09/11) reported the Ministry of Environmental Protection put 21 provincial-level leaders on notice that they would be held responsible for continued pollutant discharges into 7 main waterways. The targets these officials are missing are low – reducing discharges by only 10% over 5 years. The penalties for officials are equally low – 15 days administrative detention. However, demotion and dismissal are also possible.

The vice chairperson of the Standing Committee of the NPC, Chen Zhili, called for reforms to improve enforcement of Environmental Impact assessment laws (gov.cn, 2008-10/28). She blamed local governments for approving projects before passing environmental assessment review. In 2007, 280,000 projects were assessed nationwide. In Guangdong Province, 4811 projects were turned down because they failed the environmental assessment. She is asking for an independent assessment agency with national standards.

Laws do not play a big role in the management of rural China. While the laws may be broad, the International Trade Administration (2002) found that regulation is weak or non-existent. The agency concluded that environmental protection was not legally driven.

Cai (2004) studied the appeal system and how it shapes local government. If a citizen is unhappy with a local situation and the local official is unresponsive, they can appeal to a higher-level leader. Through surveys of rural households and studies of the appeals records, Cai concluded that appeals work to mediate social conflicts. The appeals system is a formal part of the Chinese party system. Local officials are appointed by the government and are promoted based on good performance. Citizen appeals deduct points. If too many points are deducted, the career of the local official is affected.

Cai (2004) goes on to describe the function of the appeal system. It serves as a part of its efforts against corruption. In 2003, eight issues were highlighted in the appeals records. Environmental pollution was one of the eight. In a survey of 745 peasants in Shanxi Province, 50 % would appeal to a high-level leader about an issue. Only 10 % would consult the law.

Five-year plans and campaigns direct all levels of government in China. Planning is an important part of Chinese governance and this planning is expressed in formal five-year plans. The first national five-year plan was adopted under Mao Zedong in 1953 (Edmonds, 1994). Currently China, under the leadership of Hu Jintao, is focusing on the development of the countryside where more than 50% of Chinese live. The concept of a new socialist countryside put forward by the Fifth Plenum of the 16th Communist Party Congress central committee in October 2005, appeared in the 11th five-year plan for the People's Republic of China (PRC) (Gov.cn, 2006).

Work on the new socialist countryside began right away after the 11th five-year plan was adopted. The targets were set at a central work meeting on rural development in December 2005 attended by Premier Wen Jiabao and Vice Premier Huang Ju. The document said (Gov.cn, 2005):

The principle of giving (rural areas) more and taking less (from the rural areas) must be fully implemented to promote the development of the rural areas in an all-around manner.

The first step was to waive the 2,600 year old agricultural tax effective January 1, 2006 (Gov.cn, 2008). This began a steady stream of new policies of rural development. Investments are being made in infrastructure, such as rural road construction and drinking water supply. Social programs are being established, such as insurance for miners and construction workers and increased subsidies for rural medicine. Agriculture is being

enhanced through investment in agricultural technology, farmland protection, an agricultural survey and agricultural information technology. Economic programs are planned to improve rural retailing networks. All this is directed to increase agricultural production and raise 23.65 million people out of poverty in 5 years.

When in rural China in 2007, it was easy to see the influence of the new socialist countryside campaign. Every home in a rural village had a poster (Figure 3) outlining the goals of the new Socialist farm village.

社会主义新农村的票准：生产发展，生活宽裕，乡风文明，村容整洁，管理民主。

(Roughly translated by Mancl)
New Socialist farm village standard:
• develop production,
• varied lifestyle,
• countryside cultured and civilized,
• village appears clean and
• democratically managed.

The 村容整洁 (village appears clean) goal is where the efforts and investment in rural infrastructure is being placed.

Even with China experiencing the global economic downturn, environmental protection remains a priority. On Nov. 10, 2008, the State Council (gov.cn, 2008-11/10) announced a new campaign related to monetary policy. The 10 major steps included 2 steps about environmental protection. One step was to speed-up construction of rural infrastructure, including methane digesters to protect drinking water. The other step was to enhance construction of sewage treatment facilities and energy conservation projects.

Figure 3. Poster stating the goals of the new socialist farm village. In a home in rural Shaanxi Province.

A campaign to protect the Grand Canal was announced in 2006 (Gov.cn, 2006 5/26). The 1,794 milometer long Grand Canal from Hangzhou to Beijing (Figure 4) was constructed in 610 AD. It is the oldest and longest human-made waterway in the world. At a three-day symposium in Hangzhou, 200 experts and officials called for unified planning for the entire canal (Gov.cn, 2006 5/23). In 2006 the Grand Canal was designated a Key State-level Cultural Relic.

In addition to its historical value, the Grand Canal is a part of the south-to-north water diversion bringing Yangzi River water to northern provinces. Development of the east route of the water diversion project through the Grand Canal began in 2002. To supplement the existing canal system, 54 pumping stations will be constructed to lift the diverted water over the Yellow River (Zhang, 2009).

The Grand Canal flows through Shandong Province and the Nansihu Lakes system is a part of the route. In 2006 Shandong Province planned to invest $1.17 billion to create a clean water corridor along the diversion (Gov.cn, 2006 6/28). Its objective is to resolve water shortages in northern China (Chen et al. 2009). Pollution remains high through Jiangsu Province. Fertilizer from 26,000 hectares of farmland runoff into Nansi and Dongping Lakes. Shandong Province closed paper mills and small alcohol production facilities to reduce waterway pollution. Investments are also made in the construction of wastewater treatment plants.

Four lakes in southern Shandong Province are combined to form Nansihu. Nanyang Lake, Dushan Lake, Zhaoyang and Weishan Lake are all connected to form the large water body Nansihu (Figure 5). Zhang and others (2004) studied the pollution of the Nansihu by examining the historical record found in the sediments. They divided the lake's history into four phases. The first phase showed close relationship between the lakes and the shifting Yellow River. Later phases showed the impact of the excavation of the Grand Canal and the deforestation in the area. The last 20 years revealed rapid and extensive pollution by organic matter and heavy metals. Nansihu is the largest producer of freshwater fish in Shandong Province.

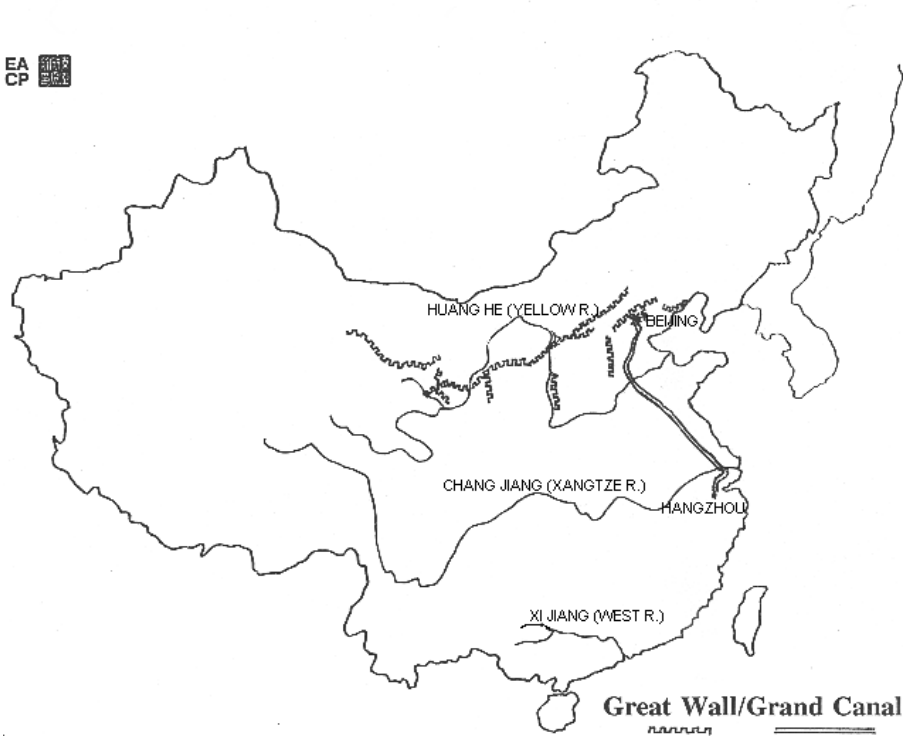

Figure 4. Map of the Grand Canal in comparison to the Great Wall of China (Asia for Educators. 2009. The Great Wall and the Grand Canal. Columbia University. http://afe.easia.columbia.edu/china/geog/M_Wall.htm.)

Local governments are important in the provision of environmental services in rural China. In his study of environmental law enforcement, van Rooij (2006) interviewed officials from the environmental protection agencies from the state, provincial, municipal and district level. Recognizing how difficult it is to get reliable responses from Chinese government officials, he sought out as many different sources as possible. He also conducted the interviews over a long time period to gain trust to gather information beyond the first polite and misleading answers. Through his work van Rooij found no direct proof of corruption, even though it is known to exist. However, van Rooij did

present a model for the ineffective enforcement of environmental laws within the Chinese government framework. He found:

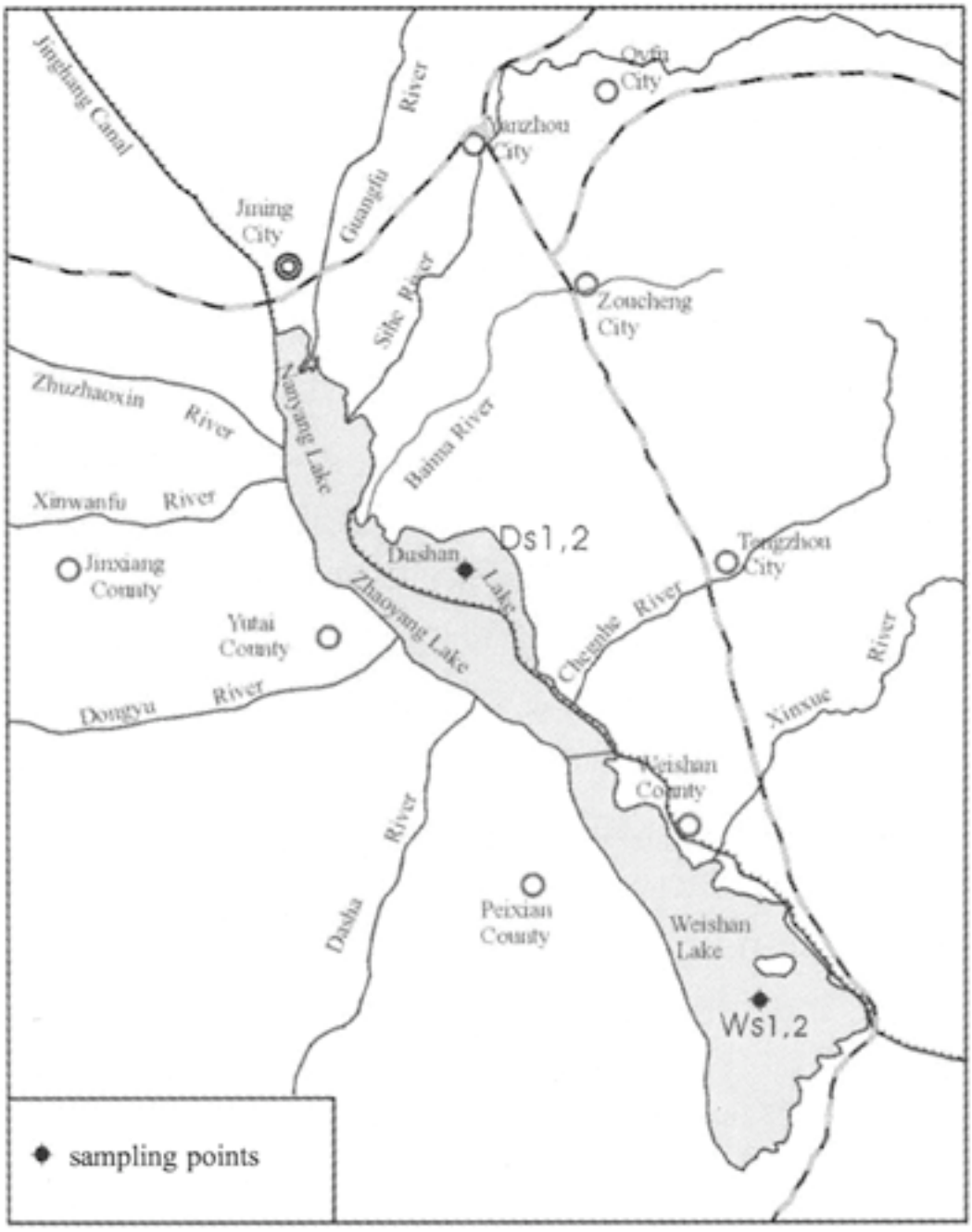

Figure 5. Nansihu Lakes in southern Shandong Provinces. The four lakes are Nanyang Lake, Dushan Lake, Zhaoyang and Weishan Lake (Zhang et al. 2004).

• Local protectionism – pollution occurs in rural China through complex chains of interdependencies. Large companies are linked to smaller suppliers, which are all linked to local labor, to sources of raw materials (like mines), to farms that supply food to the workers and buy the products, and so on. If enforcement action is taken against one link, a polluting small supplier, for example, the entire community is severely affected.

Local protectionism is a big problem in rural areas. It is not, however, as significant in urban areas where the interdependencies are not as strong. In urban areas, other employment options and supply chains are present.

• Local government leverage – environmental protection bureaus are funded at the local level. If funding is restricted, inspection and enforcement actions are difficult if not impossible. The bureaus are then limited to investigating complaints. If no one complains, no case is developed and enforced.

• Enforcement campaigns – are effective at incremental environmental compliance. The first, known as 十五小 (fifteen small) was launched in the early 1990s. In 1996 over 60,000 polluting enterprises were closed down. However, by 2001 30% of the enterprises have reopened. Even with a relapse, the campaigns continue into the 2000s. They are successful in increasing inspection and punishment.

Wang and others (2008) described the problems of water pollution control due to the close linkages between local governments and rural industry. In their literature review, they emphasized the problems of environmental monitoring of scattered village enterprises. Calculations show that each member of the Chinese environmental monitoring staff would be responsible for 111 rural enterprises if evenly assigned. They also pointed to the dispersed nature of environmental protection responsibilities at the national level. The Ministry of Water Resources, State Environmental Protection Agency, State Development Planning Commission, Ministry of Agriculture, and Ministry of Urban and Rural Construction all have jurisdiction over some element of

environmental protection. They termed the inability to enforce the strong Chinese environmental laws as an institutional design failure.

Educational institutions and agricultural extension are different in China than the land grant universities in America. Chinese agricultural scholars work in two different types of institutions, agricultural universities and agricultural academies. The agricultural universities are administered by the Ministry of Education and offer undergraduate and advanced degrees. The faculty advise graduate students and conduct research. The agricultural academies are administered by the Ministry of Agricultural and conduct agricultural research.

When first formed in the early 1950s, the agricultural education system was controlled through the central government through the Ministry of Agriculture (Liu and Zhang, 2004) modeled after the Soviet Union educational system. Changes in the system began in the late 1980s as agriculture was becoming decentralized. The university structure was transformed during the late 1990s when the administration of the agricultural universities was moved from the Ministry of Agriculture to the Ministry of Education. The goal was to enhance the curriculum and to bring both education and research into a more market driven orientation. At the same time, the regional agricultural educational institutions were shifted to provincial governments. The university funding structure also changed starting with charging tuition. Research funding, while still predominately provided by the Ministry of Agriculture at about 90%, also comes from the Natural Science Foundation, Ministry of Science and Technology and Research Funds for Young Scientists.

The Ministry of Agriculture now directly administers 45 institutions (MOA, 2010). One of them is the Chinese Academy of Agricultural Sciences (CAAS) established in 1957. In addition to the Beijing campus, CAAS has 38 research institutes in 17 different provinces. CAAS is the only agricultural academy with a graduate school that can confer a PhD degree (CAAS, 2001).

The Shandong Academy of Agricultural Sciences (SAAS) is an even older institution first founded by the Communists during the war in 1947 as the Shandong Institute for Agricultural Experiment. In 1948 the name and location were changed to its current name and location in Jinan. SAAS is a provincial academy with 1800 staff. PhDs and Master's degrees are held by 138 of the staff (CISTC, 2010).

Agricultural extension in China has gone through reform to mirror land reform in China (Yang, 1993). In the 1980s with the implementation of the Rural Household Contract Responsibility System, agricultural decision-making moved from communes to individual farmers. The clientele for extension in China grew from a small number of cadres running communes, brigades and production teams to millions of individual households. The extension system, under the Ministry of Agriculture, by the mid 1990s had one million employees with five areas of responsibility; experimentation, demonstration, extension, training and supplying inputs to farmers (Zhang and Kempenaar, 2009). Other government ministries and institutions have input into the extension system as well as private companies. However, the overall vertical administration from the national extension center to the on-farm demonstrations remains under the administration of the Ministry of Agriculture.

Yang (1993) describes the reform of the extension system into three levels. County Agricultural Technology Extension Centers merged crop cultivation stations and research institutes. Township Agricultural Technology Extension Stations were created and Agricultural Technology Demonstration Households were established. Extension remains under the Ministry of Agriculture and is implemented by provincial extension personnel. However, the extension technicians' salaries are paid by farmers. To generate income, the extension station charges for services, like diagnosis and prescription, and through technology contracts. The extension personnel get paid for the contract services after harvest – if it is successful. Because local extension offices are self-supporting, they sell agricultural inputs, like pesticides and plastic film, to supplement their income.

Hu and others (2009) surveyed 1245 extension staff that worked in county and township extension stations from 7 provinces. They found that agents spent an average of only 81 days per year teaching farmers. The source of their salary determined how much time they spent with farmers. If their salary came mostly from commercial activities, that is where they spent their time. Increasing the agent budget by 1000 RMB per year would result in an 11% increase in time spent with farmers.

Huang and others (2008) documented the success of a training program on fertilizer application in China working with agricultural extension agents. They demonstrated in their controlled study of 307 farmers in southern China that a combination of a training workshop and one-on-one in field guidance by extension agents was effective at reducing fertilizer waste.

A different approach to technology transfer for agriculture was established in the 1980s. Known as the SPARK Program, its primary objectives are to stimulate and modernize the rural economy and improve living standards (Oldham and Zhu, 1997). The SPARK program has spread to every Chinese province and supports rural development projects. State funding is provided for training and technical advice. Capital funds for projects are raised by participants, therefore the SPARK program tends to promote proven technologies. Much of their effort is in developing market outlets for rural enterprises.

2.4 Culture

Language is the primary barrier to communication between the Chinese and Americans. King (1911) wrote of the communication barrier when he traveled to China, Japan and Korea to observe eastern agriculture. Nothing is costing the world more, he wrote, than the inability to fully understand each other. He went on and called for a common language and argued that within three generations of public school instruction a world

language would be adopted. A common language would promote commerce, mutual confidence and friendship – even world peace.

Many Chinese university students began studying English as children and continue to study the language at the university. However, English is seldom used in the exercise of the Chinese government, so local officials do not need to master English. Artisans and builders of wastewater treatment system also have few opportunities to speak English. However, being able to read English is an advantage if they use or want to use technology from western countries.

Many Chinese scholars at Chinese universities have studied English. Starting in 1979, 50 Chinese students studied in the United States. By 2004 that number grew to over 60,000 students (Roberts and Tuleja, 2008). Students from China are the largest single group of foreign students studying in the US (Huang, 2005).

In a study of training programs in China, Roberts and Tuleja (2008) identified 6 challenges for native English-speaking instructors teaching Chinese learners.

- Learning styles – based on Confucian philosophy
- Written and oral proficiency – difficulties with articles, prepositions and tenses
- Interpersonal communication – classroom formality and respect for teachers
- Plagiarism and collaborative writing – borrowing ideas not perceived as cheating, students were taught to copy
- Inductive versus deductive reasoning – indirect approaches to save face
- Classroom management – responding to teacher questions and asking each other questions

Roberts and Tuleja (2008) concluded that learners did best in a teacher centered design format with reliance on formal lectures. Written notes and handouts were extremely important. With Chinese students who were fluent in English, native English-speaking

instructors must slow down, enunciate clearly, speak concisely, avoid slang and define new terms.

Huang (2004) surveyed 78 Chinese students attending an American university. He found six learning challenges posed by American professors teaching Chinese students.

- rapidness of English speech
- lack of clear pronunciation
- use of long and complex sentences
- colloquial and slang expressions
- undefined terms and concepts
- use of discourse makers (and, so, but, now, OK)

Huang (2005) went on to report that American professors can improve the learning outcomes of Chinese students by adjusting their teaching style.

- Lectures were not organized in the way the students expected – Chinese expect the teacher to make everything clear, including the difficult and important points.
- Follow the textbook - Chinese students rely on the textbook to help them catch up for what they did not understand in the lecture.
- Write on blackboard – in China important and difficult points are always written on the blackboard.
- Summarize the lecture.
- Student participation – Chinese students are not accustomed to classroom participation.
- Group work – Chinese students are not accustomed to group work.

Chinese students reported that they feel uncomfortable with student behavior in American classrooms. American students ask the teacher questions or make jokes in class. The Chinese consider this behavior rude and disrespectful. Chinese teachers are

the explainers and the students listen and take notes. As a result, Chinese students are uncomfortable with class participation as an individual or in a group. They are also afraid of making a mistake and losing face 丢面子.

In a commentary to the Canadian Medical Association, Tang (2010) wrote on the barriers to research in China. He wrote on the limited language skills of Chinese researchers, especially writing. Chinese research is unlikely to be published in international scientific journals due to poor English writing.

Connections are necessary to get things done in China. Cai (2004) wrote about managed participation in China. In a survey, 745 peasants were asked what they would do if their rights were encroached upon. While 50% would appeal to a higher-level leader, 21% would use their personal connections to seek mediation.

The traditional relationship system is called guanxi 关系. Seiligman (1999) described guanxi as the grease for the wheels in China. The term is translated as "relationships" but its context may be considered "connections". Connections are important in the US, but Seiligman considers guanxi a high art. The relationship network for the Chinese includes relatives, classmates, colleagues, neighbors and friends. The most important function of guanxi for an outsider, like a foreigner, is to gain access. Through a friend or colleague, one can gain an appointment or an introduction. To work in China, the first order of business is to establish guanxi.

Seiligman goes on to explain the eagerness some Chinese do favors for foreigners. In one way doing a favor is face-enhancing, since it shows that the person has means and abilities. The other is to build a "credit balance" for a future favor. Tang (2010) describes how faculty are able to use their connections to gain research funding.

Gold and other (2002) have studied guanxi extensively. The ties that they found create relationships are family, hometown and ethnicity. Attending the same school, serving in the same military unit and doing business together also forms connections. Guanxi must be produced, cultivated and maintained. They write that guanxi has with it a reciprocal obligation with no time limit on repayment. Also guanxi relationships are unequal. One party may have more power than the other.

In a study of the importance of banquets in Shandong Province, Shepherd (2005) suggests that all social, political and economic capital "hinges" on professional banquets. Professional banquets are small, 5 to 12 people, and are held in private dining rooms. These are the principle mechanism for accumulating guanxi. They serve as the frame for modesty, sincerity and mutual respect.

Finding a comfort zone is necessary in working in a new culture. Shepherd (2005) lists three possible responses to uneasiness:

1. Withdrawal – avoids cultural situations.
2. Takes a risk and is full participant in the cultural situation – prerequisite for learning.
3. Management of uneasiness – does not enjoy the cultural situation.

To be effective, learners must strive to take risks and become a participant. With each experience the zone of comfort grows and relationships strengthen as a foreigner becoming a part of the group.

Shepherd goes on to point out that the foreigner must find something in common with group members. The goal is to be an accepted outsider. Since meals are so important in the Chinese culture, knowing when and where to sit, how and when to toast, how to drink show initial understanding of the culture and a willingness to participate in the culture.

Chapter 3: Research Methods

Much of the research on the diffusion of environmental technologies focuses on technical impacts and benefits (Bi and Haight, 2007). In this inquiry, three groups of people were consulted to learn more about their role in adoption of waste treatment technologies: professors at Chinese educational institutions, professionals that build rural waste treatment systems and waste management professional who grew up in rural China.

3.1 Professionals at educational institutions – University versus Agricultural Academy

Working relationships were established at 2 Chinese agricultural educational institutions. At the Chinese Agricultural University (CAU), Dr. Dong Renjie conducts research on anaerobic digestion and wastewater treatment. Dr. Dong is a classmate of Dr. Zhao Lingying, a professor at OSU Department of Food Agricultural and Biological Engineering. An introductory meeting in 2006 was set up at CAU by the Chinese Ministry of Agriculture and the US Department of Agriculture. In 2008, during a three-week visit to the campus, a working relationship was established. Lectures on wastewater treatment were presented to Dr. Dong's research team over a three-day period. Half of a day was devoted to working with a graduate student to construct a laboratory scale sand bioreactor.

During the 2006 Chinese Ministry of Agriculture/US Department of Agriculture introductory trip, a visit was also scheduled at the Chinese Academy of Agricultural Sciences (CAAS). Dr. Liu Rongle, a soil scientist and CAAS vice president for graduate programs, was interested in the OSU rural wastewater treatment work. He extended an

invitation for a return visit to go to the countryside to learn more about the issue in China. The return visit was scheduled for 2007. Dr. Liu Rongle served as the escort to rural Shandong Province and a visit to the Shandong Academy of Agricultural Sciences (SAAS) in Jinan. Dr. Liu Ying, a national expert on anaerobic digestion, had just joined the SAAS faculty and was very interested in learning more about sand bioreactors. Lectures on sand bioreactors were presented to Liu Ying's research team. With Dr. Liu Ying's research team a sand bioreactor lab was constructed in 2009 and they have since expanded the lab.

Annual travel to China to visit educational institutions began in 2006. The goals of the trips were to meet faculty with interest in rural wastewater treatment and develop collaborations. Table 1 lists the trips to China and the contacts made.

Table 1. Annual trips to China to transfer wastewater treatment technology.

Date	Institution*	Contact	Activity
Aug. 2006	CAU	Dong Renjie	• Introduction and lab visit note: Dong is a classmate of traveling companion Zhao, an OSU colleague
	CAAS	Liu Rongle	• Introduction • Invitation to return to CAAS to further explore rural wastewater treatment
Aug. 2007	CAAS SAAS	Liu Rongle	• Returned to CAAS by invitation • Escorted to SAAS in Jinan to meet colleagues • Introduced to new SAAS faculty - Liu Ying • Field trip to model village – individual anaerobic digesters in a dairy village

			• Lectured ½ day at SAAS to Liu Ying's research team on sand bioreactors for wastewater treatment (in Chinese & English)
Aug. 2008	CAU	Dong Renjie	• Lectured 3 days at CAU to Dong's research team on onsite wastewater treatment (in Chinese and English) • Worked with grad student to construct 1 lab-scale sand bioreactor • Field trip to rural house – CAU wetland wastewater treatment system
		Liu Ying	• Traveled to CAU to meet and discuss further collaboration • Attended 3 day lectures • Attended field trip
Apr. 2009	SAAS	Liu Ying	• Lectured at anaerobic digester workshop in southern Shandong (in Chinese) • Field trip to view installation of new anaerobic digesters • Worked with Liu Ying's research team to: - Build sand bioreactor lab - Visit sites for sand bioreactor demonstration system - Develop sand bioreactor design with Chinese characteristics
	CAU	Dong Renjie	• Lectured to Dong's research team on sand bioreactors (in Chinese) • Field trip to village near Tianjin – CAU wetland wastewater treatment system
2010	SAAS	Liu Ying	• Village-scale sand bioreactor under construction

			• Sand bioreactor lab expanded • Planning sand bioreactor conference for Oct. 2010

*Three institutions were involved with the visits, Chinese Agricultural University (CAU), Chinese Academy of Agricultural Sciences (CAAS), and the Shandong Academy of Agricultural Sciences (SAAS).

Communication with research staff presented a challenge. While many faculty speak English, staff may not. Three engineers, Li, Yuan and Wang, from the Shandong Academy of Agricultural Sciences were assigned to learn more about sand bioreactors and begin to design the technology for demonstration purposes in China. One of the three engineers, Wang, was also assigned the task of constructing and operating a sand bioreactor lab at SAAS. Of the three, Li spoke some English, Wang spoke a little English and Yuan spoke no English. All had a range of abilities to read English. The agreement was made following a three-week visit in April/May 2009. The three engineers would send questions by email to the US in Chinese, because the investigator could read Chinese. Her response to the questions would be in English. In this way, the number of misunderstandings could be minimized, since each was writing in their native language.

Lectures on wastewater treatment technology were prepared in Chinese. However, the requests for more information went far beyond the prepared Chinese lectures. Additional lectures to meet the demand were presented in English following a special format.

- If time allowed, power-point slides were edited to include Chinese.
- Lecture was delivered slowly, with a pause between each sentence to allow time for translation.

• Language was kept simple, however when an important word or concept was presented, the speaker asked how it could be said in Chinese. The speaker and participants stopped to work together to find the meaningful Chinese word or phrase.
• Pictures and diagrams were used extensively in both the power point slides and on a blackboard.

Each visit included group meals to welcome and send off the investigator. Formal meals throughout the visits in Shandong also included local officials. The investigator was always seated as the honored guest. Every attempt was made to be a full participant by tasting all of the food, toasting and drinking with the host and the guests. The investigator delivered simple toasts in Chinese. Gifts from America were presented at the meals. Items for both women and men were prepared with 俄亥俄州立大学 engraved, embroidered or printed on each gift. The investigator also wore shirts with 俄亥俄州立大学 embroidered on them.

3.2 Professional builders of rural waste treatment systems

Construction practices were observed during two field trips. One field trip was on April 29, 2009 in southern Shandong Province as a part of the anaerobic digester workshop. Skilled artisans and their assistants were installing 6 new anaerobic digesters in a village. The other field trip, on May 12, 2009, was to view a wetland wastewater treatment system installation underway near Tianjin, a municipality adjacent to Shandong. The wetland wastewater treatment system is a patented process developed by Dr. Dong Renjie at the Chinese Agricultural University.

Important knowledge and skills were ranked by builders of waste systems. These people are skilled artisans that have been trained at the Biogas Research and Training Center in Chengdu, Sichuan Province. A group of builders were attending the workshop

in southern Shandong Province to learn more about the latest research in anaerobic digestion from the scientists and engineers from the Shandong Academy of Agricultural Sciences. The anaerobic digester workshop was conducted in a hotel in Zoucheng on April 29, 2009. The workshop focused on construction techniques for cold weather operation of digesters. Approximately 40 artisans, local officials and researchers were in attendance.

Participant surveys were distributed at the beginning of the workshop. The survey was written in Chinese. English was also included for easy review. The survey was granted an exemption for use by the OSU institutional review board for human subject research. A copy of the survey and the letter of exemption are in Appendix A. The survey listed knowledge, skills and abilities a person may need to know how to construct anaerobic digesters. Survey participants were asked to rank their view of the importance of each topic and rate their current knowledge. Rankings were from 1 to 5 with 3 as important or enough. A ranking of 1 was not important or extremely small knowledge. This technique was previously used to determine educational needs of consulting engineers in the US (Mancl et al. 1998).

Communication in rural China is challenging for an American. In preparation for the presentation of OSU technology to local officials, builders and researchers in rural Shandong Province, a presentation, power point and a handout was prepared. All three were prepared in Mandarin and were delivered by the US investigator. The presentation was drilled repeatedly to ensure that all of the tones were correct to minimize pronunciation errors. A copy of the handout is in Appendix B.

3.3 Waste management experts who grew up in rural China

Oral histories of experiences growing up in a rural village were obtained from waste management experts. Chinese born in the 1950s and 1960s experienced tremendous changes in government, agriculture and the environment in their rural village. All of the

experts grew up in Shandong Province. For this study, the experts were colleagues. The importance of having a personal relationship with the expert was pointed out by van Rooij (2006). He conducted interviews over a long time period to gain trust to gather information beyond the first polite and misleading answers.

Three experts were interviewed:
Dr. Dong Renjie, Chinese Agricultural University, Beijing
Dr. Yu Zhongtang, Department of Animal Science, Ohio State University, Columbus
Dr. Li Yebo. Department of Food, Agricultural and Biological Engineering, Ohio State University, Wooster

The interview guide is in Appendix C. The interview was approved for use by the OSU institutional review board for human subject research and the letter is also in Appendix C. The interviews were tape recorded and transcribed.

Chapter 4: Findings

4.1 Professionals at educational institutions – University versus Agricultural Academy

Following the three-week visit to Shandong Province in April/May 2009, the three engineers operating the sand bioreactor lab and designing and constructing the field demonstration bioreactors started sending questions. They followed the agreed upon format to send their question in Chinese and the response would come in English. Four months went by before the first question was sent. The question was appropriate and easy to answer, so the response was immediate. After the first positive experience five more questions came along with results from the lab. The questions from the engineers in Shandong are all included in Appendix D.

Questions included details on sand characteristics, loading rates and wastewater distribution systems. Preliminary data from the laboratory sand bioreactors was also shared.

Meetings with local officials were organized by the Shandong Academy of Agricultural Sciences. These consisted of tours of their community and a formal meal. Following the meals leaders from two communities offered their village to serve as a model for the construction of a sand bioreactor wastewater treatment system.

One village (Figure 6) had new apartment buildings, a village playground and an office building. However, it had no wastewater treatment system. Raw sewage was flowing from a large pipe behind the buildings discharging to a ditch. Unfortunately at this site,

no room was set aside for a wastewater treatment system making it impossible to build a sand bioreactor.

The second village is on Weishan Island (Figure 7). New apartment buildings are planned to replace the older homes. The sewage from the existing homes flows through a ditch directly into Weishan Lake untreated. The village is set back far enough from the lake to construct a sand bioreactor. Construction of a 700 square meter bioreactor in now underway (Figure 8).

At the Chinese Agricultural University the same prepared lecture was presented to the research team in 2009. A sand bioreactor was also constructed in the CAU lab in 2008. No follow up correspondence was generated from either activity.

4.2 Professional builders of rural waste treatment systems

Outreach to builders of anaerobic digesters has been through the Ministry of Agriculture. Centrally, the Ministry developed and operates the Biogas Research and Training Center in Chengdu (Figure 9). Extending research out into the country for continuing education is also provided through the Agricultural Academies.

Communication with builders was at the anaerobic digester workshop in Zoucheng in April 2009. All of the speakers were seated on a stage, separated from the participants by a head table complete with a formal floral arrangement (Figure 10). Power-point lectures were used exclusively in the morning session with no engagement with the audience. Questions were accepted and answered after each lecture. Even though a field trip was planned for the afternoon, speakers were dressed formally with suits for men and skirts with high-heels for women.

Figure 6. Untreated sewage discharged from new housing constructed in a village in southern Shandong Province. The wastewater is discharged through a pipe behind the village and accumulates in a ditch.

Figure 7. Weishan Island, southern Shandong Province.

During the sand bioreactor lecture presented by the investigator in Chinese, the Chinese host sat on the stage to clarify any parts of the speech that were unclear. He only made one comment in sharing the Chinese words for mg/l (hao ke/sheng 毫克 / 升). Dr. Liu also helped with translating questions and answers from the audience. He stated that the speech was very clear and no one would have trouble understanding the Mandarin presentation.

The reaction to the sand bioreactor talk presented in Mandarin was immediate. At the following luncheon with local government officials, the SAAS team and US visitor were invited to tour their village that afternoon to see their wastewater issues. They were ready to construct a bioreactor and pay for everything. The meeting Chair, Ms. Song from the Shandong SPARK program, also attended the trip to the village and reported to

her superior that sand bioreactors could be an important component in rural development. Following the workshop, a meeting was scheduled in Jinan with representatives from the SPARK program to learn more about sand bioreactors. The Chinese sand bioreactor talk was presented a second time. Unfortunately, the SPARK program did not provide any financial support for sand bioreactor construction.

Figure 8. Construction of a sand bioreactor on Weishan Island.

Figure 9. Biogas Research and Training Center of the Chinese Ministry of Agriculture in Chengdu, Sichuan Province.

Figure 10. Anaerobic digester workshop in Zouchang, Shandong Province.

Appropriate technology must be incorporated into existing construction networks. The current wastewater treatment system construction practices were observed in southern Shandong Province and Tianjin. Figure 11 illustrates the construction of an anaerobic digester and Figure 12 shows the construction of a septic tank – artificial wetland system.

Bricks were used to construct both types of systems. The bricks were carefully laid in a double wall pattern or with a curved dome for strength when buried. Once the bricks were positioned, the entire surface was coated with concrete to make the tanks water-tight.

Laborers, nearly a dozen, assisted skilled artisans lay the bricks by digging holes, delivering the bricks and hand mixing the mortar and concrete. No heavy equipment was observed on site.

Local materials were transported to the site by bicycle cart. Only a few materials were stacked for use. Everything was delivered just in time.

Safety issues were revealed during a field trip. The US investigator and a group of SAAS researchers went to see a newly installed waste system in Tianjin. The system had been installed following the patented process developed by Dr. Dong at the Chinese Agricultural University. The leader of the SAAS research team stepped on a concrete lid, only to have it collapse, sending his leg down into the sewage tank. (Figure 13).

Figure 11. Construction of small anaerobic digester, southern Shandong Province.

Important knowledge and skills was measured with a survey to workshop participants. They quickly completed it leaving very few questions unanswered. No one asked questions about the survey or how to complete it. Seventeen surveys were collected from the group of about 40 people in attendance. Seven of the respondents indicated that they had installed anaerobic digesters. Due to the low number of completed surveys, no statistical analysis was conducted.

The surveys were separated into 2 groups for consideration. One group had installed anaerobic digesters and the other group had not. The responses to the importance of each

topic and their current knowledge were different based on the installation experience. Table 2 summarizes the data.

No one ranked any of the items listed as not important. System builders rated all items as at least important. Nine topics were considered very important to extremely important by system builders with composite scores of 4.0 or higher. The corresponding current knowledge is listed in parentheses with 3 being enough and lower numbers indicating less than enough. These were:

- Safe construction practices (3)
- How to install a biogas stove (3.28)
- Identify quality construction materials (2.86)
- Operating a biogas digester safely (2.57)
- Energy benefits of biogas production (3.28)
- Determine best location for biogas digester (2.43)
- What factors affect biogas generation (3.0)
- Safe use of biogas (3.0)
- Identify quality feed stocks (3.0)

The others completing the survey had not installed anaerobic digesters. They rated all items between important and very important except one item, estimate biogas yield.

Builders only ranked 4 items as having more than enough knowledge. All other items were ranked enough or lower. The items that they knew more than enough about were:

- Understand regulations
- How to install biogas stove
- Energy benefits of biogas production
- Uses of biogas

Figure 12. Septic tank construction for wetland wastewater treatment system near Tianjin.

The others indicated that they knew more than enough about 6 items. While self declared knowledge of topics varied, the overall level of knowledge about anaerobic digesters was similar between the 2 groups with an overall value of 2.8. The differences between the 2 groups emerged in what they felt was important to know. For example safety was considered more important to the builders than the other who do not build anaerobic digesters. The builders had an overall importance value of 3.7 while the others rated safety at 3.4.

4.3 Waste management experts who grew up in rural China

Oral histories from waste management experts who grew up in rural villages presented a lifelong perspective on the changes occurring in rural China. Some key findings from interviews with experts are noted. The entire interview transcripts are in Appendix C.

History of waste management involved storage and carrying human and animal waste to the fields as fertilizer. Attitudes about agricultural production are still effected by historical incidents, like the Great Leap Forward. The experts have also witnessed the diminution and pollution of the local water resource during their lives in the village.

Figure 13. Broken and collapsed tank lid on a wastewater treatment system, Tianjin.

Table 2. Results of questionnaire distributed at anaerobic digester workshop April 29, 2009 in Zoucheng, Shandong Province.

	Importance		Current knowledge	
	Builders	Others	Builders	Others
	n=7	n=11	n=7	n=11
Understand regs	3.9	3	3.43	2.82
Understand gov. funding	3.14	3.45	2.71	2.82
How digesters work	3.57	3.3	3	2.09
Digester design	3.29	3.18	2.5	2.18
Safe construction practice	4	3.64	3	2.55
How to build digest	3.57	3.2	2.57	2.55
How to install stove	4.14	3.7	3.28	3.09
Quality construction materials	4.14	3.8	2.86	2.82
Manage labor	3.71	3.54	2.86	3.09
Operate digester	3.71	3.36	2.43	2.45
Teach how to operate	3.71	3.45	2.43	2.45
Safe operation	4	3.55	2.57	2.73
Energy benefits	4.14	3.64	3.28	3.09
Best location	4	3.55	2.43	2.64
When to empty	3.57	3.36	2.29	2.36
How to clean digester effluent	3.57	3.36	2.43	2.55
Factors generation	4.14	3.64	3	3.36
Uses of biogas	3.71	3.73	3.14	3.36
Network w/officials	3.43	3.18	2.71	2.82
Safe use of gas	4.14	3.91	3	3.27
Quality feedstocks	4.14	3.64	3	3
Biogas yield	3.28	2.55	2.71	2.82
Environmental benefits	3.71	3.45	2.71	2.91
Fertilizer value	3.43	3.27	2.57	2.64
How to calculate area & volume	3.28	3.27	2.71	2.82
Health benefits	3.43	3.27	2.71	2.82
Pathogens in digested waste	3.43	3.4	3	2.45
Cost of construction	3.43	3.3	2.57	2.36
Average value	3.70	3.42	2.78	2.75

"In the old days the village was very beautiful. There was a lake in front of the village. Dalouhu, a big lake. Going kind of north – no – going east to west about 10 KM long. And north/south it would be about 2 to 3 KM long. They have a lot of water, a lot of kind of plant, like bamboo, but not. Tough, ridged as bamboo. Can get as tall as the ceiling. And people did boating and fishing there. Very nice, when I was little I would do that even go swimming there. But after 2000, late 1990s, the city needed to make a reservoir to hold water. The lake is gone. Now they have a huge reservoir, only water." (Yu)

"Beside village there is a small river. In the past there always, from year round this water flows, with very clean water. But now, there is no water from upstream. But when we have rainfall, then the water is there. But in most time of the year, the water in the river is quite low."……"The waters are polluted in my village. But the water condition around the county is serious. The water condition in the county, surrounded by some villages… I mean the core part of the county… in those villages the water is polluted by some industry wastewater discharge. " (Dong)

"we can't get any water from the reservoir anymore…..
Yes, there is a well. So they do not have any irrigation." (Li)

"One of my younger sisters died during 1960s. When we were very, very young. So we, all the farmers know that food, the wheat and the corn, are the most important thing. So they store, they have their own grain storage area. And my father told me even we don't have any agricultural production for 3 years, we still have enough food." (Dong)

"Yeah, generally also winter. Also winter because that is the manure is mainly solid. In the winter they do not have much work, much to do. They will carry manure to the field for spring to use. Every morning, because that is a hilly area, it is not flat like here, we are in a mountain area. So every morning we used the bar, we do not even use a cart, we use the shoulder, you know, 2 things. Two buckets, one in front – one in back. But we

need to get a good balance. So that is very good exercise. Most of the people get up early morning in the winter, they carry the fertilizer to the top of the mountain or some other locations." (Li)

Environmental deterioration has been observed by the experts as they grew up in rural Shandong Province.

"The larger plastics will not be disposed of in the environment, because the businessmen go to the town to collect them, to buy them. But the plastic bags are still a problem. During the wind days and after the wind days you can see some plastic bags on the trees." (Dong)

"The air quality is so bad. It is the most noticeable. When I was little you always see blue sky, white clouds, you see birds. Now everywhere you go is, you know how it looks like. No difference between Jinan and my village. This either sunny or cloudy, it is hazy all the time. So the air quality is so bad." (Yu)

"2007 the village changed, totally changed. My old house is all gone. The new house is bigger house, is brick house. And still the sewage part is still very much like other part of the rural area. Even though Shandong is a better developed province, but the sewage in the rural village is flush everywhere. There is a big pit somewhere to store the sewage. Have mosquitoes, flies, get closer to the pit, it smells bad. They do not have any treatment system." (Yu)

Technology transfer was expressed as a combination of demonstration and government support. Farmers learn by seeing and can copy technology that has value.

"It is technology. Technology and the government support. The government, for sure, they are in support already for new kinds of construction. But it is not enough. The government support could be the demonstration. But the demonstration is not as good as

we expected. But the technology and demonstration, that is enough. The Chinese farmers are different from some farmers that I saw around the world. The Chinese farmers, when they see some things very good, they will automatically copy. They will learn, automatically learn that. Even if you don't have the money. If you do not have the financial support, they will use their own effort to learn and to copy the concept for their own life." (Dong)

Appropriate technology would best include bricks for construction. All three experts mentioned bricks as a local construction material and brick production as a local industry.

"The village I think had about 200 people. From the very beginning the only industry is production of bricks. They have soil good for bricks." (Li)

"2007 the village changed, totally changed. My old house is all gone. The new house is bigger house, is brick house." (Yu)

"And then, now, all of the houses are now constructed by the bricks. This is the house condition." (Dong)

"The village introduced some investment and found that need to be the risky things. Because the farmers said we don't know, they don't know, the farmers don't know how to run that industry. Finally the farmers found that to introduce that brick production factory to consume the soil, to convert the soil. And put in a larger furnace to use the coal to produce the bricks, destroyed the field. And all the farmers collect some money to support the factory and finally found no money, no benefit can get from it. So the farmers decided to get rid of and destroy that to recover that area to the crop field." (Dong)

Alternative energy is part of infrastructural development in the countryside. Villagers, as observed by those interviewed, were discouraged from using wood as an energy source.

"We do not have much wood resource. Very few, only you cut a tree, the main part of the tree you use for construction, to build homes. Then the branches you can use for cooking. That is very limited. Also, in the, we have some area, some people, but they have someone to watch, they do not like you to cut trees. Yeah, to watch. If not controlled, then all the trees used in a couple years" (Li)

"Yeah we had digester then. It was centralized, I think we collect the human waste of the whole village. …… Then the gas was used to meet the energy needs of these business such as lighting, heating, but it did not go to the individual family." (Li)

Confucian culture has a strong influence in rural China. The villagers are especially proud of their safe and friendly atmosphere.

" the first thing is to keep the culture, the Confucian culture. The core part of Confucian culture is to respect the parents and to be careful about the children. This is the culture. And to be very friendly and polite among the villagers. The forth one is to emphasize the education. This is the core points of the Confucian thought. So we need to keep this culture, so as to keep the village structure stable." (Dong)

"Yes, we are known for, in my village, people are very polite. You know, I told you that Dong Dou, the former village in Dong Dou, and separated into three small villages. Village Dong and my village Great Dong, and the other small village is Small Dong. So my village, Great Dong, used to be a legend, an oral story. In my village, the older brother founded the village, and all the people, all the persons in the village were very polite. There is no, I don't know of any thieves, any things stolen. Very safe, very quiet, and usually no argument among the neighbors." (Dong)

“So the small village life kind of relaxed. Everybody knows everybody - friendly and relaxed.” (Yu)

“You know in the rural area become, generally two things. In the village where I, the rural area, security something is much, much better than township or something. Everything in the small area, everybody knows, they know each other. (Li)

5.0 Discussion

Sand bioreactors are an appropriate technology for rural China. Observations of wastewater treatment system construction in rural China revealed that hand labor was predominately used. Bricks were the primary building material for tank construction. Sand bioreactor technology is well suited to this construction style.

Sand bioreactors match well with Roger's (2003) description of an innovation that is ready to diffuse. Sand bioreactors are simple, and compatible with the lifestyle of rural Chinese villages. Sand bioreactors are easy to try on a small scale. The lab scale bioreactors illustrate how well they work to treat wastewater (Figure 14).

Figure 14. Raw and sand treated wastewater from the lab scale bioreactor operated at the Chinese Agricultural University.

Alternative energy development is a major force in China today. Sand bioreactors, unlike anaerobic digesters, do not generate energy. However, they use very little energy in contrast to other wastewater treatment technologies. They help communities meet any environmental goals they have related to the new socialist countryside and compliment the anaerobic digester program in their ability to treat digester effluent.

Government subsidy that began in 2003 has accelerated the adoption of household anaerobic digesters. Lin (1998) found steady adoption of household digesters in the late 1980s. The adoption began to increase through the early 1990. However, Wei (2007) found that the government subsidy was an important factor in this technology adoption.

Remais and others (2009) looked at the benefits of technologies that produce energy, treat waste and protect the public health. Unfortunately, they found that even with multiple benefits government subsidies were still needed to encourage villagers to build anaerobic digesters. Bi and Haight (2007) also found that government subsidies were key to adoption. One of the experts (Dong) in his interview reinforced this point.

5.1 Planning

Planning is a major component of the Chinese governance structure. Since the founding of the Peoples Republic of China in 1949, the Chinese government has developed and operated under 5-year plans. The current 5-year plan has the improvement of rural China as its focus. Van Rooij (2006) found that enforcement campaigns, with their slogans, were effective at making progress on environmental regulation. In 1975, the Chinese Communist Party slogan “biogas for every household” (AD Community, 2009) began the movement to spread household anaerobic digester technology. The current campaign to create the “New Socialist Farm Village” includes the goal 村容整洁 (village appears clean) supports the investment and development of new environmental infrastructure in rural China.

The campaign to divert water from the Yangzi River to northern China impacts the investment in environmental infrastructure. Chen and others (2009) linked the water quantity goals to a campaign to improve water quality moving north through the restoration of the historic Grand Canal. The design and construction of sand bioreactors in the Weishan Lake area, a part of the Grand Canal route, is furthering the campaign to divert clean water to the north.

5.2 Leadership

Leadership at the community level fosters the development of biogas digesters in the countryside. Chinese in rural areas live close together in villages and these villages are being redesigned. Yu, in his interview, spoke of how his village has totally changed with the construction of new homes. Field trips revealed the construction of new apartment buildings to replace the traditional courtyard homes.

Only a few village leaders are including waste and wastewater management in their plans. Some movement may be coming from the villagers in reaction to increasing pollution. Yu and Dong both spoke of the growing pollution problems in their villages. However, a national initiative, like the water diversion projects, and the emphasis on water quality, seem to be a main motivator for environmental infrastructure development.

5.3 Outreach

Technologies cannot be adopted and diffused, if no one knows about them. Efforts to transfer research findings and providing training for builders of household anaerobic digesters, began with the founding of the Chengdu Biogas Research Institute in 1979 (China Ministry of Agriculture, 2009). In addition, the agricultural academies continue to conduct research and outreach instruction. The April 2009 workshop in southern Shandong Province was sponsored by the Shandong Academy of Agricultural Sciences,

and their new research was presented along with construction of six demonstration household digesters.

Outreach to system builders and local officials is very formal. In the April 2009 workshop, the presenters, researchers and professors, were separated from the participants by a stage. The presenters did not mingle with or eat with the participants. The Confucian culture as mentioned by Dong in his interview may be the root of this formality. This separation, however, can be problematic as demonstrated in the survey conducted at the workshop. Differences exist in what builders felt was important and needed to learn more and the researchers and officials who set the curriculum, but do not build systems.

The changing character of agricultural extension was described by Yang (1993). Because the local extension offices must be self-funded, only a small amount of time and effort is directed to outreach efforts. However, a framework does exist to transfer information from the agricultural academies and experiment stations to the countryside. Outreach is difficult from the agricultural universities. Universities are a part of the Ministry of Education and do not have outreach capability or responsibility. Even Chinese researchers at agricultural universities, must find a connection to the agricultural academies to extend their research to rural China.

Safety issues appear to be an important issue that the builders want to learn more about. They expressed the importance of safety in the survey responses. Unfortunately, the sample size from the survey was very small, at 17 total participants. This is due to the limited access to builders for an American researcher. It was also due to the IRB approved protocols that required voluntary participation. Therefore the Chinese workshop hosts could not require the participants to complete the survey. Additional trips to China with access to system builders will be needed to increase the sample size to conduct a statistical analysis of the responses.

An incident that occurred on a field trip illustrated the importance of the safety issue. A group of SAAS researchers went to see a newly installed waste system in Tianjin. The leader of the research team stepped on a concrete lid, only to have it collapse, sending his leg down into the sewage tank. The incident became an important story on the importance of safety in construction.

Chapter 6: Conclusions

The objective of this research was to develop a model for effective environmental technology transfer to rural China. The proposed model considers the role of appropriate technology, legal and policy issues and the appreciation of culture. The proposed model is presented in Figure 15.

6.1 Appropriate technology

The first step in the model to success in technology transfer is selecting an appropriate technology. For rural China an environmental technology must take into account traditional construction practices, the importance of labor, use of local materials and low power requirements. Water quality issues surprisingly, are secondary considerations. Sand bioreactors appear to be an appropriate technology for rural China. They can be constructed with hand labor using local materials. Little to no electricity is needed to treat the wastewater to exceed China's effluent requirements. The application of sand bioreactors is also not in conflict with the successful biogas digester program. Instead the technologies have the opportunity to compliment each other with sand bioreactors treating the wastewater that is discharged from digesters.

6.2 Connections

The next component presented in the model is connections 关系. Some type of contact is necessary to make an introduction into a Chinese institution. Classmates 同学 form strong connections, therefore an OSU colleague who graduated from the Chinese

Agricultural University was an important connection, especially since one of her classmates was on the CAU faculty.

Institutional connections are also important. OSU has a study abroad program with the Chinese Academy of Agricultural Sciences. Starting with that connection, an OSU faculty member could work to form connections with faculty who study a wide range of issues. The Chinese Academy of Agricultural Sciences also has a connection to the provincial academies. In this case, one of the CAAS faculty was a classmate of a member of the Shandong Academy of Agricultural Sciences and was able to make a connection.

Dining and drinking rituals are especially important in China in strengthening connections. Throughout the project, the American expert on sand bioreactors was expected to sit as the honored guest at formal luncheons and banquets. As the comfort level and experience grew in the role, so did the opportunities and information. An important level of trust was building through the sharing of food and drink.

While seeming to be a trivial thing, the exchange of small gifts helped to build relationships. Thoughtful gifts are the key. All of the gifts presented from America were printed, engraved or embroidered in Chinese. Every effort was made to find gift items made in America. The gifts were also personal. Cosmetic items for ladies and engraved cigarette lighters for men were presented bearing the university name 俄亥俄州立大学 which surprised the Chinese hosts.

Working relationships were created and nurtured through the technology transfer process. The American sand bioreactor expert made 2 trips to Shandong Province to work with the SAAS faculty and staff. Dr. Liu Ying, the head of the biogas program at SAAS made 2 trips to OSU to lecture and visit lab and field research sites. A member of Dr. Liu's research team, Wang, made 1 visit to OSU.

6.3 Agricultural educational institutions

Research on issues related to rural China occurs at a variety of institutions. Two very different institutions exist. All universities, including agricultural universities, are administered under the Ministry of Education. The agricultural academies are administered under the Ministry of Agriculture. If the goal is to conduct research relevant to rural China, both institutions have research responsibilities. However, if the goal is technology transfer to rural China, the agricultural academies have the direct pathways. Since they are a part of the Ministry of Agriculture, their research is extended through the extension network and the Ministry of Agriculture supports the construction of demonstration projects. As a foreign scholar, the agricultural academies are the gateway to rural China.

The agricultural academies are the closest parallel to the US land grant university system. With support through the Ministry of Agriculture, the academies not only conduct research, but also support the extension mission of the Ministry of Agriculture. The successful biogas digester program emerged and continues to be supported through the Ministry of Agriculture system.

The agricultural academies have the capacity to conduct workshops for small local builders and village officials. Even though these workshops seem too formal for an American, with the speakers separated from the participants, this format is part of the educational experience of the Chinese. The Chinese are comfortable with the separation and formality.

The formality observed in the workshop conducted in rural Shandong Province is an illustration of the relationship between teachers and learners. The Confucian teachings provide insight into the relationships of the Chinese to each other and what they value.

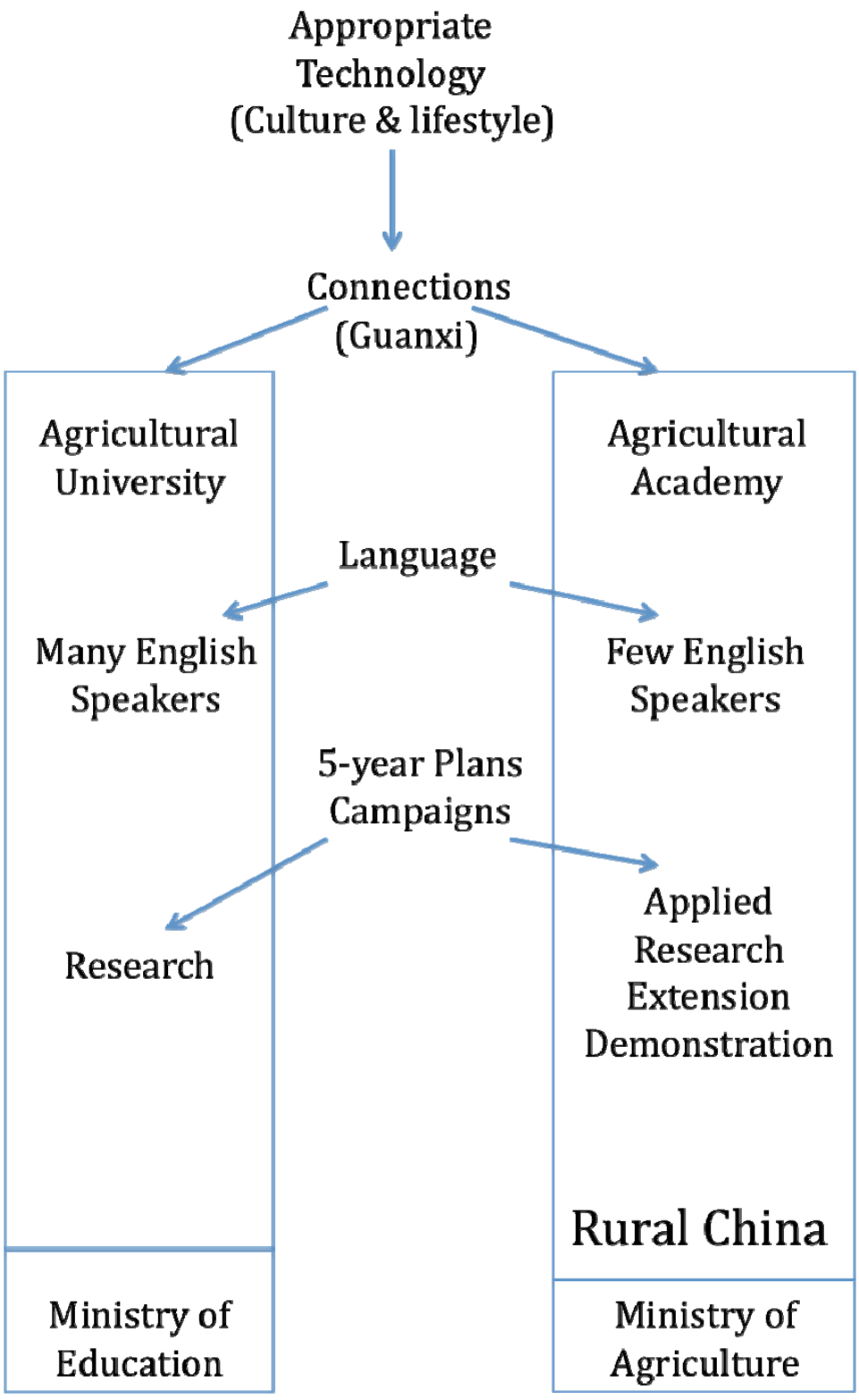

Figure 15. Model for success in technology transfer to rural China.

One of the experts (Dong) mentioned the Confucian culture when describing the role of young people in the family. The relationship between teachers and students, leaders and citizens all stem from Confucian thought. The value of order and kindness to others also comes from Confucian teachings. All of the experts talked about the safety and friendliness found in their rural village.

The agricultural universities are different. As a part of the Ministry of Education, they do not have support for outreach to rural China. Instead their focus is teaching and research. If the interest of an American is research, the universities are a wonder place to conduct collaborative research. If the goal is technology transfer, the agricultural universities provide an indirect avenue by helping to develop connections with the agricultural academies. Faculty in the agricultural universities are often classmates of academy faculty. They may also have professional connections if their work is similar. While working with an agricultural university is not a direct pathway to rural China, it gives a foreigner a place to start forming the necessary connections to follow the path to rural China.

6.4 Language

When an American works in China, a language barrier exists. Even though English reading, writing and speaking skills are developed in Chinese universities, everyone is most comfortable learning in their own language. An American must work to develop communication skills to work effectively with Chinese scientists.

Communication with the research staff at the Shandong Academy of Agricultural Sciences was facilitated by the use of written and oral Chinese. Recognizing the difficulties of trying to learn new concepts presented in a foreign language, questions and answers were presented whenever possible in Chinese. Huang's (2004) work with Chinese students studying in American coupled with the findings from this research offer some strategies for success.

- Handouts with pictures and diagrams are important to Chinese learners whether they are in Chinese or English.
- Power point presentations should include Chinese characters to help the listeners.
- Whenever possible, the presentation should be in Chinese. This project showed that with preparation and practice, an American can make an effective technical presentation in Chinese. Keeping the vocabulary and the sentences simple was one step, emphasis on pronunciation was the other step.
- Email correspondence is quick and accurate when each party can use their own language. Emails coming from China in Chinese can be more easily understood than a question posed by the Chinese in English. The response is the opposite. The English speaker can construct a simple and accurate response in English to be read by the Chinese. Electronic translators are useful in this setting, since each reader knows the context of the question.

The Chinese agricultural academies are different from the universities. Few English speakers work at the agricultural academies. Heavy reliance on translators interferes with technology transfer. It is worth the time and effort for the American to learn to speak – even a little – in Chinese.

Workers and community leaders in rural China seldom speak English and both groups of people are necessary to success in technology transfer. The local officials make decisions about the community's involvement in a demonstration project. The skilled work force must be confident in constructing the demonstration. At the workshop conducted in southern Shandong Province, both of these groups attended. The impact of the Chinese presentation of the American researcher was immediate and positive. Leaders of two villages asked to consider their communities for a demonstration.

6.5 Applied research

A critical step in technology transfer is applied research. Lance and McKenna (1975) found that participation is important to technology adoption and diffusion. An American style bioreactor, for example, is not ready for direct transfer to rural China. Sand bioreactor design and construction must be modified to fit the lifestyle in rural China. A Chinese person uses much less water than an American, therefore the wastewater flows would be smaller, but the wastewater would be much more concentrated. Wastewater flows are much lower in China at ¼ to 1/5 of the daily flow of an American household. Preliminary research suggests COD concentrations in mg/l are 2 to 5 times higher.

For effective technology transfer, applied research is required to modify the American design. Through collaboration with the Shandong Academy of Agricultural Sciences, this development is moving forward. Together OSU and SAAS are developing a 有中国特色的沙生物滤池 (sand bioreactor with Chinese characteristics). The layered sand bioreactor Kang and others (2007) developed is one way to treat the stronger wastewater without the risk of clogging. The lower flows will result in a bioreactor that is about ¼ the size of a comparable American household system. For example a system for a 3-bedroom home in Ohio would be 33 m^2 (360 ft^2). The same home in China could use an 8.4 m^2 (90 ft^2) layered bioreactor.

The three experts interviewed all discussed traditional brick construction in their villages. Brick construction was also observed on field trips. Bricks can be used to replace the vinyl liner used in American style bioreactors. The skilled labor is already in place to construct this style of system and the delivery networks for the local materials are already established.

Work with a professor at the Chinese Agricultural University was not fruitful. The same prepared presentations were shared with the research team in 2009. A sand bioreactor

was also constructed in the CAU lab in 2008. However, no follow up correspondence was generated from either activity. Since the use of sand bioreactors is applied research, this type of work was not a good match for the university.

6.6 5-year plan and campaigns

China's public policy is driven by the 5-year plan and campaigns. Rural wastewater treatment supports the 11th 5-year goal of a new socialist countryside. Providing improved sanitation is a part of the "village appear clean" campaign.

The development of demonstration projects at Weishan Lake support the water quality campaign of the south-to-north water diversion through the ancient Grand Canal. The Weishan area provides many opportunities for demonstration projects for individual homes, villages and farms.

China presents tremendous opportunities for environmental technology transfer. The central government planning is placing a priority on pollution control. Local officials are looking for low cost ways to manage wastes while still meeting their priorities of providing good housing and economic development.

Over the past 30 years, the Ministry of Agriculture has established the infrastructure for applied research and technology transfer in anaerobic digestion. Many technicians have been trained at the Biogas Research and Training Center and many are receiving continuing education through the agricultural academies. Experts agree that pollution problems are serious in China. By working within the existing extension system in the Ministry of Agriculture, new, appropriate technologies can be quickly introduced, adopted and transferred to rural China

Chapter 7: Recommendations for future work

This research inquiry opens the door to a larger research program in the culture of water pollution control in rural China. This project tested research methods in how to gather data from actors in the technology transfer system. It also tested theories of how an American can work through the Chinese institutions to transfer environmental technology.

• China is opening up rapidly in environmental technology as both a provider and a learner. Opportunities will grow in forming collaborations with Chinese institutions to reach rural China. New pathways and models can be proposed and evaluated.

• The survey for builders of biogas reactors worked well to assess what they know and what they feel is important to know. This information can be used to shape future educational programs. This study, due to constraints of access to builders and the US IRB protocols for human subjects resulted in a small sample. With continued visits to China, more surveys can be collected.

• The differences and similarities of the Chinese and US agricultural extension system can be explored. The history of collaboration between US scholars and the Chinese agricultural institutions would also be an interesting study.

• Educational materials are needed to aid technology transfer. Design manuals, material standards and testing procedures and construction instructional guides are all needed for a range of technologies. These materials need to be written in Chinese, not just translated from English.

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Appendix A: Questionnaire

建设农村的污水处理系统

Building Waste Treatment Systems in Rural China

感谢你有兴趣建设新设施使中国村镇干净和健康。

Thank you for your interest in building new things to make Chinese villages cleaner and healthier.

为了设计好培训课程，我们希望知道什么学识或技能您认为重要， 您现在已经知道多少。

So that we can do a better job of developing new workshops, we would like to know what information and skills you think are important and ho much you already feel you know.

请想一想以下这些学识或技能。圈出这些知识或技能对你有多重要 和 你的学识或技能程度。

Please think about the information and skills listed below and circle the word that best describes how important it is for you to do your job and how much you already know.

完成这个问卷您需要差不多十五分种。您可以略过一些回答，参加这个问卷调查纯属自愿。

The survey takes about 15 minutes to complete. You are free to skip any question and your participation is voluntary.

例子：

看地图	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
Read a map										
学识或技能	重要性？					我的学识或技能				

明白规章 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多
Understand regulation

明白政府的专款 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多
Understand government funding

怎么操作厌氧消化器 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多
How anaerobic digesters work

学识或技能	重要性？	我的学识或技能

怎么设计厌氧消化器 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多
How to design biogas digester

安全建设操作 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多
Safe construction practices

怎么建厌氧消化器 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多
How to build biogas digester

怎么安装沼气火炉 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多
How to install biogas stove

识别好的建筑材料 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多
Identify quality construction materials

怎么管理工人 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多
How to manage labor

怎么操作厌氧消化器 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多
How to operate anaerobic digester

教授厌氧消化器操作 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多
Teach person how to operate biogas digester

安全操作厌氧消化器 不重要 有一点重要 重要 很重 非常重要 非常少 很少 足够 很多 非常多
Operating a biogas digester safely

沼气生产对能量的益处 Energy benefits of biogas production	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
决定放置厌氧消化器最好的位置 Determine best location for biogas digester	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
什么时候清空厌氧消化器 When to empty biogas digester	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
怎么处理厌氧消化器污水 How to clean biogas digester effluent	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
什么因素影响沼气产量 What factors affect biogas generation	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多

学识或技能	重要性？					我的学识或技能				
沼气利用 Uses for biogas	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
联络地方的政府官员 Network with local government officials	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
沼气的安全使用 Safe use of biogas	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
识别好的填料 Identify quality feed stocks	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
估计沼气产量 Estimate biogas yield	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
沼气生产的环境效益 Environmental benefits biogas production	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
厌氧消化器污水的肥料价值 Fertilizer value of digested waste	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多
怎么计算面积和容量	不重要	有一点重要	重要	很重要	非常重要	非常少	很少	足够	很多	非常多

How to calculate area and volume

厌氧消化的公众利益 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多

Public health benefits of waste digestion

厌氧消化器污水里的病菌 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多

Pathogens in digested waste

厌氧消化器的成本 不重要 有一点重要 重要 很重要 非常重要 非常少 很少 足够 很多 非常多

Cost of digester construction

教育程度？

Education level?

你的年龄？

Your age

你建过厌氧消化器吗？

Have you constructed a biogas digesters?

没有

No

建过 - 在 2008 年您建了多少厌氧消化器？ _____

Yes – How many digesters did you build in 2008?

你建其他设施吗？

Do you build other things?

没有 No

建过 - 是什么？_____

Yes – what kinds of things?

你想要学习怎么建其他设施吗？_____

Do you want to learn how to build other things?

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April 27, 2009

Protocol Number:	**2009E0250**
Protocol Title:	**ANAEROBIC DIGESTION WORKSHIPS FOR RUAL CHINA—A SUCCESS STORY, Karen Mancl, Food, Agricultural, & Biologic Engineering**
Type of Review:	**Request for Exempt Determination**
ORRP Staff Contact:	**Cheri M. Pettey** **Phone: 614-688-0389** **Email: pettey.6@osu.edu**

Dear Dr. Mancl,

The Office of Responsible Research Practices has determined the above referenced protocol exempt from IRB review.

Date of Exempt Determination: 4/21/2009
Qualifying Exemption Category: 2

Please note the following:

- **Only OSU employees and students who have completed CITI training and are named on the signature page of the application are approved as OSU investigators in conducting this study.**
- **No procedural changes may be made in exempt research (e.g., recruitment procedures, advertisements, instruments, enrollment numbers, etc.).**
- **Per university requirements, all research-related records (including signed consent forms) must be retained and available for audit for a period of at least three years after the research has ended.**
- **It is the responsibility of the Investigator to promptly report events that may represent unanticipated problems involving risks to subjects or others.**

This determination is issued under The Ohio State University's OHRP Federalwide Assurance #00006378.

All forms and procedures can be found on the ORRP website www.orrp.osu.edu. Please feel free to contact the ORRP staff contact listed above with any questions or concerns.

Cheri Pettey, MA, Certified IRB Professional
Senior Protocol Analyst—Exempt Research

厌氧消化和污水处理

马可人
俄亥俄州立大学

这个村有一百栋房屋和四百个人。这个村子在美丽的湖边。以前湖里有很多鱼，但是现在湖水被污染。鱼死了，水的 味道是苦的。村子的污水排放到湖里。专家提议用机械污水处理系统， 因为城市采用机械污水处理系统。但是这个村必须购买机械污水处理系统，需要专家安装此系统， 而且机械系统用很多电。污水处理系统也产生很多淤泥。淤泥需要附加的处理。幸运的是这个村能用不同的污水处理系统.

在中国很长时间再循环粪肥和污水。有机废弃物能成为很好的肥料，但是很重，吸引苍蝇，而且有气味难闻。

现在很多村镇使用厌氧消化器处理废弃物。厌氧消化器很好操作，制造沼气，缩减用煤，也省钱。厌氧消化也同时消灭苍蝇，减轻气味和防止疾病。用厌氧方法消化废水怎么样？

厌氧消化器的排水是很好的肥料。排水含有大约 5000 mg/l 的有机物和 100 mg/l 氨。有机物氨对土壤很好。但是对水体有害， 是水环境污染物。在水里，氨可能杀死鱼类，鱼会死地

很快。小河如果有太多有机物，也会造成鱼类死亡。因为有机物分解需要氧气，氧气的消耗会导致鱼的死亡。

天气对有机物和氨有重要影响。温暖的水提高氨的毒性。比方说，水温是 5 度的时候，氨的安全浓度是 16 mg/l。 在水温是 15 度的时候 ， 氨的安全浓度是 7.3 mg/l。当水温达到是 30 度的时候， 安全的浓度只是 2.5 mg/l。氨也和 pH 关系密切。 pH 等于 8 时， 氨毒性更大。 在 pH 是 8 的时候, 水温是 5 度的时候，氨的安全氨的浓度是 1.6 mg/l。水温是 15 度的时候, 氨的安全氨的浓度是 0.73 mg/l。在水温是 30 度的时候， 氨的安全氨的浓度只是 0.27 mg/l。

厌氧消化器的排水是很好的肥料。土壤是最好的处理和回收利用污水的地方。土壤怎么处理污水？

因为土壤具有一定的构造。 土壤的粒子黏结在一起形成一定的结构，中间有孔隙。污水流过后，附着在土壤微粒表面的微生物开始生长并建立生物薄膜。这些微生物的生长可以消耗有机物和氨。

土壤里发生什么？这个是特写镜头土壤孔隙。土壤团聚体表面形成土壤空隙的墙壁。在团聚体表面，微生物附加而且生长建立生物薄膜。污水流过土壤结构表面。空气也注满孔隙。薄膜

微生物用空气的氧气转化有机物生成二氧化碳，氨生成硝酸盐。

微生物存在于污水和环境。每个细胞排出特别的化合物。如果这种化合物浓度足够高，微生物开始建筑生物薄膜 。这个过程能使微生物聚集。微生物排出”polysaccharides”建筑生物薄膜。”polysaccharides“ 是化合物有黏性。生物薄膜附着性很好。微生物住在薄膜和建筑菌落，他们能分工合作。生物薄膜是百分三十三的微生物细胞和百分六十七的水。

生物薄膜有很多好处。生物薄膜保护微生物抵抗抗生素和脱水。因为微生物分工，能降解很多种类的化合物。这张照片可以看见生物薄膜。

土壤自然形成不同的结构。细粒和微粒结构是最好的污水处理结构。空气和水容易流过粒状和小团块结构的土壤。块状和棱柱形结构也很好。结实和片状结构不好，不能处理污水。

土壤需要多深？深度至少要 60 厘米才能有效去除有机物和氨。土壤不能水饱和。如果土壤是水饱和的，生物薄膜就不能获得空气。生物薄膜需要有氧气才能去除有机物和氨。

有时建筑者挖地沟为了处理污水。地沟下土壤必须有 60 厘米深才能去除有机物和氨。如果地下水，岩石层和压石土层限制了水流和污水的处理，土壤需要更深。

如果土壤太浅，我们能干什么？如果土壤只有三十厘米深，污水没有完全的处理。土壤能用于污水处理吗？不能。 我们应该记住，自然的土壤有构造跟连贯的空隙。

那么能用沙？沙有微粒构造。 污水和空气能流通过沙。在沙生物薄膜生长。沙层上自然土壤层名字叫小丘系统。沙跟土壤同样能处理污水。

如果土壤还是太浅，我们怎么办？沙能不能去除有机物和氨？能。沙生物滤池能去除污染物，能处理污水和厌氧消化排水。

每天多次进水对沙生物滤池很重要。泵和倾斜盆都可以用来进水。每天进水一次，沙生物滤池能处理污水。但是每天两次，排水更加干净。阻塞怎么样？ 每天一次，有很多阻塞，每天十二次，阻塞很少。

生物薄膜多快能构建？我们比较杀菌跟接种的沙生物滤池。杀菌的沙生物滤池需要九十五天。新的沙生物滤池需要七到二十八天。

沙生物滤池的排水又干净又清澈。这种系统能处理从一户到全村的水量。在夏天和冬天都能运行。沙生物滤池用生物薄膜处理污水和厌氧消化排水。

现在，我们设计一个村子的污水处理系统。因为生物薄膜在沙粒上建筑，我们能建筑沙生物滤池。沙层是六十厘米深。沙粒很特别，应该不能太细又要粒径均匀。沙生物滤池系统建筑很容易。进水是每天四厘米。如果村子有四百个人用一百升，村子排出四万升。沙生物滤池系统需要一千平方米。沙生物滤池可以二十米宽，五十米长。排水很干净。

每个村子都需要污水处理，有干净的湖和健康的家庭。

Appendix C

Interviews

Interview Guide

China's rural villages

Leadership in providing a clean, sanitary living environment

Karen Mancl

I want to talk you about your experiences living and working in rural China. Because I don't want to miss anything, is it OK for me to tape our conversation? Following our discussion, I will transcribe the entire tape and send you a copy so you correct any errors or misunderstandings.

(If the respondent does not want to be taped – I will not conduct the interview)

Turn on tape recorder: Is it OK if I tape our conversation?

• How long did you live in a rural village?
Or
How much time have you spent in rural villages?

• Tell me about your last visit to a rural village.

- Has it changed from your earlier visits?

• What was the environment like? Can you paint me a picture?

- Visually? Condition of the buildings, roads, play areas…..
- Air quality?
- Water quality?
- Refuse and debris?
- Odors?

• What was the attitude of the village residents about their living conditions?

- What were they most proud of?
- What improvements were they working on?

- What types of investments were being made in the village?

• Did you know who the leaders were in the community?

- What were they like?
- Did you know how decisions are made in the village?
- Did you gain a sense of their priorities?

• What do you think China's rural villages should be doing to keep people from leaving for the city?

- Is it important to maintain rural villages in China?
- Is China on the right track to improve the quality of life in rural villages?
- What is needed?
    - Leadership
    - Technology
    - Resources
    - Money

• Tell me more about your work with Chinese villages.

- What are some of the emerging issues?
- Who are some of the leading people in your field?
- If you were to organize a conference on this topic – who would you invite to speak?

• I plan to go to China in the Spring – what do you think I should know about visiting a Chinese village?

Behavioral and Social Sciences Institutional Review Board

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April 27, 2009

Protocol Number:	2009B0103
Protocol Title:	CULTURE OF WATER POLLUTION CONTROL IN RURAL CHINA, Karen Mancl, Food, Agriculture & Biological Engineering
Type of Review:	Initial Review—Expedited
IRB Staff Contact:	Jacob R. Stoddard Phone: 614-292-0526 Email: stoddard.13@osu.edu

Dear Dr. Mancl,

The Behavioral and Social Sciences IRB **APPROVED BY EXPEDITED REVIEW** the above referenced research. The Board was able to provide expedited approval under 45 CFR 46.110(b)(1) because the research presents minimal risk to subjects and qualifies under the expedited review category(s) listed below.

Date of IRB Approval:	April 27, 2009
Date of IRB Approval Expiration:	April 13, 2010
Expedited Review Category:	7

In addition; the protocol was approved for a waiver of documentation of the consent process.

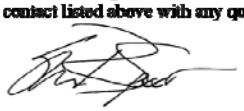
If applicable, informed consent (and HIPAA research authorization) must be obtained from subjects or their legally authorized representatives and documented prior to research involvement. The IRB-approved consent form and process must be used. Changes in the research (e.g., recruitment procedures, advertisements, enrollment numbers, etc.) or informed consent process must be approved by the IRB before they are implemented (except where necessary to eliminate apparent immediate hazards to subjects).

This approval is valid for one year from the date of IRB review when approval is granted or modifications are required. The approval will no longer be in effect on the date listed above as the IRB expiration date. A Continuing Review application must be approved within this interval to avoid expiration of IRB approval and cessation of all research activities. A final report must be provided to the IRB and all records relating to the research (including signed consent forms) must be retained and available for audit for at least 3 years after the research has ended.

It is the responsibility of all investigators and research staff to promptly report to the IRB any serious, unexpected and related adverse events and potential unanticipated problems involving risks to subjects or others.

This approval is issued under The Ohio State University's OHRP Federalwide Assurance #00006378.

All forms and procedures can be found on the ORRP website – www.orrp.osu.edu. Please feel free to contact the IRB staff contact listed above with any questions or concerns.



Shari R. Speer, PhD, Chair
Behavioral and Social Sciences Institutional Review Board

May 12, 2009
Dong Renjie- Chinese Agricultural University

Interviewer: So now we are on the tape recorder and I want to talk to you about your experiences living and working in rural China. Because I don't want to miss anything, is it OK for me to tape our conversation?

OK

Interviewer: Following our discussion I will transcribe the entire tape and send you a copy so you can correct any errors or misunderstandings.

OK

Interviewer: So you grew up in Shangdong

Yes

Interviewer: Was it in a rural village?

In a rural village.

Interviewer: And how long did you live there?

Until I finished my senior high school. I was born in 1964 and I left my village in 1981. And that year I went to the Shandong Agricultural University.

Interviwer: So what was the name of your village?

We call it Dong Dou. The village name is Dong Dou is of Huirong Township. The county name is Huijian.

Interviewer: Since I have never visited your village could you kind of paint me a picture of what your village is like?

The village is very small. The population has been very stable since, since the 1980s. The population is around 110 to 130. So a very small village. In this village we have a larger area for plant production. The agricultural field is large. But the field situation was not good, the soil was salty. So when I was a child, at that time it would rain, the rain was enough. So the salty soil was always the problem to effect the agricultural yield. It was very, very low. And total wheat production per year of the village, yield was around 20,000 – no 10,000 kilograms.

But with time went the rainfall was declining so the underground water (noise) the underground water level dropped down. And then the subsoil became very good soil for agricultural production. So now the agriculture production is very, very high. If we calculate the total village agricultural production, it is about dozens of times – 30,40 times as before.

Beside village there is a small river. In the past there always, from year round this water flows, with very clean water. But now, there is no water from upstream. But when we have rainfall, then the water is there. But in most time of the year, the water in the river is quite low.

Interviewer: So what does the village look like? Can you describe it visually? So there are about how many homes?

So I mentioned with 110 to 130 persons, so the village that's a, there are 20 to 30 homes. A very, very small village. I mentioned the village name is Dong Dou. Historically, it used to be three small villages. Oh, I made a mistake. Dong Dou is three times as I mentioned 110 to 130 people. There is about 400 people in Dong Dou. But now the Dong Dou has separated into three small village, as before. My village name is Da Dong – the Great Dong. So in Da Dong there are 110 to 130 persons in the village with about 20 to 30 homes. It is very small.

Interviewer: Are the homes close together or far apart?

Yes, yes very close. The whole village is located on a higher level of the soil. So the surrounding field is about ½ meters lower than the village.

Interviewer: So roads, playgrounds, other things in the village rather than the homes? Anything else in the village? Are the roads paved?

This is a very typical, rural village in Shandong Province. Very typical, poor rural village in Shandong Province. In Shandong you have places that are very rich. Here it is poor.

The soil, there is no stone, just soil. The road connection, the road system is quite good. There is this cross of 2 roads at the village. Connect to the neighbor villages and to the town. Now the road conditions are very, very good. I do not know the English words, so…

Interviewer: You can use the Chinese word.

This baiyou lu, use the byproduct of oil process. This dark colored, to paste down the road. During the summer, in the afternoon, when the temperature is very high, the road is quite soft. But now, anyway it covers the soil, so in the winter, in the summer, during the rain and the snow, so the transportation is quite good.

This is the policy of Shandong Province. We call it, all the road connections between the villages will be the hard covered road. This is the policy.

And besides I told you this is the poor, typical countryside rural village. That means we have the houses very close. They are, for each home, they grow about 1 to 3 pigs in the home. In the most cases, the pigs are not grew up inside the yard, but outside the yard. They have a very special pig house, very special pig house, for 1 to 3 pigs for each home.

Interviewer: And anything else, like restaurants, or shops or …

There are no restaurants. But there is one small shop. I mentioned there is this Dong Dou. They separated into three small villages. The other very small village, village Dong. In that village there is a larger, long-time shop. So usually all of the villagers go there to buy the goods, yes.

We don't have the restaurants, but in the countryside, but even when I was a child, some rural businessmen, yes, they rode on the bicycle and went to each of the villages to sell to the village some small things. And also including some food. The steamed bread. Right now steamed bread. Encouraging my parents, sometimes they buy the steamed bread. They do not make by themselves. They are getting older, so they buy the steamed bread. So they buy the cooking oil – the oil for food. And they buy some seed products, the fishes, and buy vegetables. So the business in the countryside is quite good. Very convenient for the villagers.

And some businessman go to the village to collect, to buy the agricultural products. The cotton, the corn, the wheat. They can go to the village to buy. There is a little lower price. And also villagers can go to the super market, go to the collective market. Every 5 days there is a collective market in the town and farmers sell their products there.

Interviwer: So the town has a market.

The town, every 5 days. In fact, the town is becoming much, much bigger. The current town is a combination of former 2 town. So every 5 days in the town, there is a collective market. Every 5 days, but the other days, there are similar markets in different places.

Interviewer: So what is the environmental quality like in this village? The air, the water.

The environmental quality, from my childhood, the air is no problem, it is very good. Always green, so in the summer everywhere it is covered by the trees and grass.

The waters are polluted in my village. But the water condition around the county is serious. The water condition in the county, surrounded by some villages… I mean the core part of the county… in those villages the water is polluted by some industry wastewater discharge.

But in my village, one pollution is the plastic. So the plastic bags are so popular. So also more and more farmers use the plastic to cover the soil to do the protected agricultural production. Every 2 years, the first year it is a very good cover. The second year it can be used, but then the plastic is a problem.

The larger plastics will not be disposed of in the environment. Because the businessmen go to the town to collect them, to buy them. But the plastic bags are still a problem. During the wind days and after the wind days you can see some plastic bags on the trees. But the environment is quite good.

Interviewer: So odors, you said people raise pigs. Is there any odor?

No odors. The farmers in my village, I told you, the pigs do not grow up inside the yard, but outside. They live in a very special, open ..not enclosed… but open pig house. 1 to 3 pigs is no problem. Air exchange is quite good. And the pig manure drops down, the pigs release the manure in a small area, in a special area. And then the farmers put regularly, not vey regularly, but every several months, to put some grasses with some soil into, there is a pool.

I don't know if you know or don't know, the pig house. I can't say it by word, but I can (draws pig house) it is quite clever design. This is the pig house, the pig sleeps here, this is underground, this is a small building, all brick construction. Just 3 square meters to 4 square meters.

And then the farmers dig down to the ground. This is also 3 to 4 square meters. This is a slope. So the pig can walk down to release the manure and comes back to sleep here. And here, is a feeding pot. So almost no odor. No bad smell released because they add the grass and soil so you know the pig will usually mix the manure with the pig's nose. So the manure will always be mixed with the soil and be treated by the microorganisms. So usually no odor.

But I visit, my village is a very typical, poor rural village. But I visited some special villages, very close to a pork processing plant, factory. And so it increased the pig production. So in each family, in each home, there were about 15 pigs. There that is a problem. In my village, no problem.

Interviewer: So I your village, is there anything special that your village is particularly proud of? Something that your village is known for?

Yes, we are known for, in my village, people are very polite. You know, I told you that Dong Dou, the former village in Dong Dou, and separated into three small villages. Village Dong and my village Great Dong, and the other small village is Small Dong. So my village, Great Dong, used to be a legend, an oral story.

In my village, the older brother founded the village, and all the people, all the persons in the village were very polite. There is no, I don't know of any thieves, any things stolen. Very safe, very quiet, and usually no argument among the neighbors. But I heard 1 time. This is our pride. Besides that, I don't know others.

That is, I think the best thing we are proud of.

Interviewer: Is the village working on any changes or improvements now?

Yes. When I was a child, the house was built of, with soil. So we put soil, we have a container and put soil in, and we press the soil to form the walls, so the wall is constructed of soil.

And later on when I was still a student, but older, the wall was constructed by the soil brick. The brick is the product of fire, with a coal fire. The second stage is the soil brick. And then, now, all of the houses are now constructed by the bricks. This is the house condition.

The second one is that each family has a, I think, larger by three times or four times, space than before.

The third one is that no one in the village has lack of food. Everybody is well, has a very good food supply. Because, when I was a child, in the 1960s, in China there was a disaster, a natural disaster, and all of the people were lacking food. One of my younger sisters died during 1960s. When we were very, very young. So we, all the farmers know that food, the wheat and the corn, are the most important thing.

So they store, they have their own grain storage area. And my father told me even we don't have any agricultural production for 3 years, we still have enough food. So this a very good, the other improvement.

The forth one is the money, the income, the cash income. When I was studying at the Shandong Agricultural University, a Bachelor degree student, let's say, in the 1980s, and my village used lots of, most of the field to grow the cotton. Because cotton is an economic plant. So the farmers can make money. And since then it set the stage, the performance jumped to the better situation.

The cotton situation now, even now the cotton production is not a main agricultural product. The farmers now become richer. Every low family has got the beautiful house. Every family has a beautiful house.

Interviewer: What kinds of investments are being made in the village?

The village introduced some investment and found that need to be the risky things. Because the farmers said we don't know, they don't know, the farmers don't know how

to run that industry. Finally the farmers found that to introduce that brick production factory to consume the soil, to convert the soil. And put in a larger furnace to use the coal to produce the bricks, destroyed the field. And all the farmers collect some money to support the factory and finally found no money, no benefit can get from it. So the farmers decided to get rid of and destroy that to recover that area to the crop field.

So this is one experience. The investment now is directly from the government. The government invests to construct the road. And the government gave the money to the farmers. Every, 2 times a year or more. My mother told me the one time is in the spring. In the spring farmers need to buy the ..for irrigation Some money directly into the farmers pocket to buy the diesel. And then move to the harvesting. Some money for the harvest. Because no one will go to the field and by hand harvest. They farmers pay money to buy the service of a combine harvesting.

And then now the government gives money to buy … not enough, but support farmers buy. And then the plowing of the soil, to plow the soil to make the tillage. For planting, the money for seed and fertilizer. So 3 times the money from the government. Not very big, but this is the Chinese government policy. Money will go directly to the farmer. And farmer should sign, to verify, OK, I received the money. This is very good policy to support our farmers.

But I don't know very clearly about this policy. I don't know 3 times or 2 times. But my mother told me of the money that comes to the farmers. But my mother is not a farmer. My mother and my father, my father used to be the teacher. And then about 20 years ago, at that time the farmer condition was not good. My father got salary from the government. And then there is a policy from the government to let my mother to become the non-rural resident. And so in my home even if they stay in the village, they are not farmers. So the money, any support for the farmers does not go to them.

Interviewer: What about the leaders in the community?

The leaders … when I was a child, the village leaders was very, very important. Because all of the farmers, they did not think. They just sleep, then breakfast, then they hear to the bell. The bell was made by the village leader. OK, the farmers get together, and to follow the leader's instructions. OK today we go to the field to do the pest control, or to do some small tillage, or to harvest by hand. So then it was very important.

And then, in 1980s, the crop field were separated, or distributed among all of the farmers. Each family can decide, make their own decision. And that was a shake to the farmers. Because they were used to be lazy and follow the instruction.

But now they need to think by themselves. They did not have the technology, they did not have the knowledge. That was a hard time for farmers for 2 years about, I suppose. Since then the productivity has increased very much.

And now the team leader's role declines. Because each family will make their own decision. So they don't need to follow the village leader's instruction.

And the second thing, in the hands of the village leader, there is not enough resource to handle the village. Because the money will go directly to the farmer. For sure the village leaders will report to the government. How many residents as farmers here. Give to the upper government the name list. So now all the crop field has been distributed among the farmers. And the government, central policies, they keep their right for 50 or 70 years. So the village leader cannot handle the resource. So their role declines.

But I know that in the past the situation was not so struggle. The village leader, his role used to be more important to handle the resource. This sometimes a corrupt leader would give some good resource to their own relatives. Or give more to their relatives. Or lessen the crop field rent by other village residents, so that the village office can have could have some money to handle. But now the government pays lots of attention to that. So the village leader, his role declines, very much.

Interviewer: Do you know if the leaders in your area are elected? Some villages have elections for their leaders.

Yes, yes. I want to say one thing more about village leader. The village leaders in the very rich villages. For example, the village has some industries and they really can make money. Then the village leader could be more important. But in my village has nothing.

Yes, the village leader has been, yes he was elected. And there is a law, intended to guide the election. The less important to villager is, the less important the election. So in my village, he is elected, but I don't think the elections is important.

Interviewer: Are people staying in your village or are they leaving to go other places?

The young guys. The young. When the son becomes, OK when the son drops from the school, usually they leave the village to the cities to make money. The cash is still a concern, or care, in my village. When the son goes to the cities for very hard work. For example, for construction. And he can get from 1000 to 2000 yuan per month. And each month he can put 500 to 1000 into an account and deposit that money. And this is still big cash money in the village.

I told you that farmers, they don't concern about their food. They don't concern about their living level. That means food, vegetable, sometimes meat, all is no problem. But if you want to be more and more modern, television and telephone, cell phone, computer, internet… In my village there is internet. You need to pay.

At the very big events, to the wedding, it is very, very important. If in the family, you have a son, you need to first see the parent, the day that you have the son, then you should start to think, to accumulate money, cash money to buy the bricks, to buy the

service to construct a new, very, very big house for the son and for the son's wife. So this is the big pressure for the parents.

Interviewer: So in your village are there many young men? Or have they all left.

After they married they will stay in the village for 30% of one year. They still need to go out to earn the cash for their son or their daughter. The 30% of the year to stay in the village for harvesting.

Interviewer: 30% or 50%

30% for harvesting and for the spring festival. So this, average 30%.

For the girls, the girls, before their marriage, some of them also go to the city. But you know, in Shandong Province, usually we don't like girls to leave the village. That is our culture. Confucian.

We know that in some village family, their girls are now in Beijing. And the neighbors, they don't say anything in front of their parents. But I heard something criticized. Say that the girls should not go to the city. She should stay in the village.

And after their marriage, usually they do not leave the village. I think you don't understand Confucian culture, is quite strange.

Interviewer: Do you think it is a problem that so many young people are leaving the villages?

Not so many are leaving or staying as in the past.

Interviewer: Do you think it is a problem?

No it is not a problem.

Interviewer: So what do you think is important – looking to the future – to maintain the rural character and the villages in China?

First is, in the near future, I do not think the countryside structure will change. As like it is to be in America. Because our agricultural population is so huge. There is no space in the city. Based on that hypothesis, the first thing is to keep the culture, the Confucian culture. The core part of Confucian culture is to respect the parents and to be very careful about the children. This is the culture. And to be very friendly and polite among the villagers. This is forth one is to emphasis the education. This is the core points of the Confucian thought. So we need to keep this culture, so as to keep the village structure stable.

And the second thing is to improve the village, we call this new countryside construction. We can improve the farmers living condition to keep them living in the village.

But still some technical problems there. So we cannot expect all of the farmers to use electricity for cooking. Electricity for lighting, but we cannot support, we cannot afford to support the farmers to use electricity for cooking. We cannot support the farmers use gas for cooking. We cannot support the farmers to drive the cars. This is dangerous, this is dangerous for the environment. But we should also think how to improve their life.

And to put their life much, much similar as in the city. For example, I don't use clean, but easy. Very easy energy. That is important. But where is the very easy energy? There is no clear answer. But now the China there is lots of research. Biogas is one option, but not always. The gasification is one option, but still some problems. And where are other options? I don't know – but for the new village construction there should be one thing is to keep the culture, with some modification. So we drop down some bad things but should keep the core. And that is second to let the farmers to have as easy life as in the city.

Interviewer: So what do you think it is going to take to, what resources is it going to take for that to happen? Is it technology or leadership, or … what kind of resources?

It is technology. Technology and the government support. The government, for sure, they are in support already for new kinds of construction. But it is not enough. The government support could be the demonstration. But the demonstration is not as good as we expected. But the technology and demonstration, that is enough.

The Chinese farmers are different from some farmers that I saw around the world. The Chinese farmers, when they see some things very good, they will automatically copy. They will learn, automatically learn that. Even if you don't have the money. If you do not have the financial support, they will use their own effort to learn and to copy the concept for their own life.

Interviewer: So tell me more about your work in Chinese villages.

My work. Several things. One thing, as you saw, is wetland wastewater treatment. I, that used to be my dream, to treat the very distributed, the household wastewater by, to borrow the concept from the very large constructed wetlands. And then, I now, we focus on that kind of wetland. But I think your sand filter, as you explained today very clearly, will be the other village option. So we can use the both technologies in the countryside wastewater treatment.

It is not possible to collect all the wastewater to a central plant. It is not possible. But to, now I found to treat the individual household wastewater is not economic. It is better to construct the village scale wastewater treatment facility. That is what we are doing now

in Tianjin. In there we do not treat the village scale, but several families together. We have semi-central treatment. This is the wastewater treatment.

I think the sand filter, sand biofilter together with the research in my laboratory, for the phosphorus removal, for the ammonia removal, that would be a very good integration. To guarantee the ground water environment.

The second is biogas. I turned from the household, small biogas plant to a very large-scale biogas plant. I mean the very large here is, in the Chinese situation, is about 300 to 1000 cubic meters. That is what we call very large. But in America, in Germany, in Europe, this is small. And for that biogas plant, our result now is for the effluent from biogas plant, the reuse, recycle on the livestock farm. So we want to minimize the freshwater input into the farm and minimize the wastewater or the effluent from the biogas discharged into the environment.

We have achieved that goal. Now we are doing the second research. To minimize to about 20% of the wastewater discharge, the effluent from a biogas plant, to discharge to the environment. We want to store in a lagoon. But now we need to know, we need to control the ammonia emissions into the air. To control the greenhouse gas emission. That is the biogas research.

The third one for the biogas plant is, I am now doing the GIS based, geographic information system in 5 provinces including: Beijing, Shandong, Yunnan, Chongqing, and Heilongjiang – it is a very cold region. After the project finished, on the internet there will be total, all of the biogas plants, larger than 100 cubic meter. Will be indexed, will be indicated on the web. And if you click on that point, than some information, technical information, who is the designer, the parameters, what is the current situation. Everything, technical things, will be shown on the web. And every plant, now in China we have about 8000 plants. 8000 is not a big number, so we can do that. So we start from 5 provinces, finally we will have all of the information for the whole country. In my proposal, including Taiwan, Hong Kong. In Hong Kong they will have biogas plant. Taiwan, Hong Kong, but in Macau there is no. Include everywhere, the whole of China, all the biogas plants will be indexed on the web. This is the second biogas.

And then I told you the biomass stoves. The biomass stoves are also used in the household. So I don't care about large scale biomass stovs, I just care about household. Because in China, there are 700 million farmers. And that means about 200 million households. And in each household would be 95% of the households are using biomass stove. Very small biomass stove for cooking, with some pollution. The pollution is dangerous to the women's eye. And dangerous for the kid's health, who are usually in the kitchen during the cooking.

So I did a project in south China, 5 provinces in south China. And we, for sure we found very serious pollution. Pollution that we could not see. We could not see, just the smoke we don't understand. But now we know the pollution is carbon monoxide, and H2S, 2

things, and some suspended particles. The suspended particles in this air, we cannot see, but they are still some suspended particles. That is my next, the suspended particles less than 2.5 nm. So when the particles are less than 2.5 nm that means we cannot see and even we cannot feel when we breath in. We can't feel. But that kind of particles goes down into the lung and can penetrate into the muscle. This is a big problem for cancer.

And now we have the household biomass stove combustion laboratory on the campus. And we test a system, the modern system from America, the United States. And test the stoves and give technical reports. But now we cannot publish because some of the stoves are still very, according to our standards, could not be used by the farmers. But when we have enough technical information we will give a report to the Ministry of Agriculture, to the local provinces, so that they know the situation. This is biomass stoves. Now we collaborate with the Washington University in St. Louis and Colorado State University for the biomass stoves.

And the last one is I intend to do. It is the algae, the small plants in water. I have analyzed the biomass development, the road map of the biomass development. At the beginning we use plant residues and some forest residues and even some wood in western countries. And then the biogas for the manure treatment, for the organic residues treatment in the city. And then we will find there is no biomass resource for energy. If you want to produce more biomass for energy, you need to grow in the soil. On the hill or on the sand area you need crop field. It is a big problem in China, we don't use the crop field for biomass energy.

OK, someone said we can use the area that we cannot grow the food. OK so but anything grow on the ground will consume water. The held water. I don't know it so clearly but every kilogram of wheat will consume about 80 kilograms of water. Huge, huge water consumption and evaporation. So in China anything linked to biomass production, the critical point is water shortage.

Algae even it grows in the water, but algae usually don't consume water. Water is the medium, just like fish. It grows into the water, in the water but we separate. Then we recycle the water. So in this process the water loss would be 20%. So 20% of water loss is very low, is almost zero compared with wheat production or corn production. So now this is actually our future, in the fall. I arrange some money from other projects to locate the money to support 2 scientists to do the research in my laboratory. This devise (shows me a machine in the room) is to do algae breeding. To control the temperature and the radiance flux. We are just going to start. That is what I am doing now.

Interviewer: So who are the leading people in your field?

Who? If we say the leading group, for the biogas one, I am one of them. Because now I am an expert for the Ministry of Science and Technology. And internationally, I have some reputation around the world. For biogas, I am one of the group, there are some others. For instance Wang…. In Qinghua University. And Dr. Cao Man he is at, he is

working in industry. He is the manager of the largest biogas company. He still also a professor. And some others, in the companies and the universities. This is biogas.

The biomass stoves, I am the first researcher for the household biomass stove. That was a very strange situation. 200 million households use biomass stoves, but no one does a study, did the research. And I learned from the Colorado State University, Dr. Brian Wilson, he is doing a study on biomass stoves. I asked him, why do that? In America you do not use them. He said, yes, in America we do not use. But in Africa they use. I copied his concept to set up a laboratory. But in China there is an industrial association. Biomass stoves industry association, Mr. Jiang Jinhao, Hao Fangzhou, they are the representatives for the association. That is biomass stoves.

And for the wetland, the household wetland, I am the first one. And I have a patent. And my patent was usually referred to. A very strange thing, one day I was doing my presentation, the wetland patent first pass by. So now the Ministry of Science and Technology at Beijing government, has given me some funding to do the extension for the household wetland. And if I take that very seriously, I can catch somebody. Because in Yunnan in south China, after my patent lots of household wetlands have been installed, constructed but even though it is hard to get, to ask them to pay to me. And I don't want to do that, so now I turn OK, for the household wastewater treatment, a wetland is very easy to construct, a small thing in south China. But it is very different in north China, in the cold area. So I turn, OK in the cold area there will be more technology. So now I am doing the other patent.

But for the wetland, if we talk about constructed wetland, large scale, there are lots of scientists are doing in this area. I cannot name all of them, but I know Professor Shan Boxin, the Chinese Academy of Science, he is doing something. And the other one, I forgot, in the Beijing Construction University. There is, I forgot, an associate professor, she is an expert and she designs wetlands, large-scale wetlands. And even is these Chinese Academy of Science there were some projects, some big, national projects to do the wetlands. So concerning the wetlands, lots of people doing. For household, as of now, only me.

The algae, we just started. And I know at Qinghua University is a professor. There is an academician at the Chinese Academy of Engineering, Madame Kuang – very old lady. She was guiding some researchers to so algae breeding to use algae to produce hydrogen. And use algae to produce oil. But I am a newcomer in this area so I do not know so much about it. But I collaborate with Brian Wilson at Colorado State University, he is doing also algae. And the Washington University of St. Louis, professor Pristwas he is also doing that. And there is a group to do the algae. And in Washington State University, there is professor Chen Shuli, he is isolated because of the pig flu. He is doing the algae and biogas.

So I think for the wetland and for the water treatment you are one of the very famous professor to do the extension in America. And in Ireland there is a professor Zhou

Yachen. He is doing the theoretical research. He does not do extension. He does the research in the laboratory and very, very excellent job he has done. So this is the things that …

Interviewer: Well that is an hour. And I don't want to take anymore of your time. Thank you so much, I learned a great deal, and learned a great deal about you.

June 18, 2009
Yu Zongtang, The Ohio State University

Interviewer: I want to talk to you about your experiences living and working in rural China. Because I do not want to miss anything, is it OK for me to tape our conversation?

Yes

Interviewer: Following our discussion I will transcribe the entire tape and send you a copy, so you can correct any errors or misunderstandings. So I asked you if it is OK to tape.

Yes

Interviewer: So how long did you live…Did you live in rural Shandong?

I grew up in a village, actually.

Interviewer: So how long did you live in that village?

I, until I went to college, about 20 years. Almost 20 years. The village is northeast of Jinan about 150 KM probably 200 KM. I grew up there. As a boy, then I attended high school and went to college in Jinan.

Interview: Which college?

The Shandong Teachers University. They call it Normal University. Shifan Daxue.

Interviewer: So have you been back to your village?

Several times

Interviewer: Can you tell me about the last time you were there?

The last time was two years ago – 2007. Of course everything changed. I left there in 1978. Then I went to college, moved to Qingdao to work, and of course I traveled back to visit my parents once a year or twice a year. Then I left China almost 19 years ago. So I go back less often, of course.

Interviewer: So what was it like in 2007?

2007 the village changed, totally changed. My old house is all gone. The new house is bigger house, is brick house. And still the sewage part is still very much like other part of the rural area. Even though Shandong is a better developed province, but the sewage in

the rural village is flush everywhere. There is a big pit somewhere to store the sewage. Have mosquitoes, flies, get closer to the pit, it smells bad. They do not have any treatment system.

Interviewer: So is the village bigger or smaller than when you were young, or about the same?

I don't know the population exactly, if it has decreased. Because a lot of young people have moved away. They went to college and moved to the city.

Interviewer: What is the environment like? Can you describe…I have never been to your village, can you paint me a picture. Describe what your village looks like?

In the old days the village was very beautiful. There was a lake in front of the village. Dalouhu, a big lake. Going kind of north – no – going east to west about 10 KM long. And north/south it would be about 2 to 3 KM long. They have a lot of water, a lot of kind of plant, like bamboo, but not. Tough, ridged as bamboo. Can get as tall as the ceiling. And people did boating and fishing there. Very nice, when I was little I would do that even go swimming there. But after 2000, late 1990s, the city needed to make a reservoir to hold water. The lake is gone. Now they have a huge reservoir, only water.

And the village has some land, mostly to north and south of the lake, now the south of the reservoir. And the people just go farming and care for their own land. Stuff like that. The younger people moved away, like my brother and sister, moved to the city to find job, to work. And people getting the life, materially getting better, it is very good, improved. Not care very much about the other parts.

Interviewer: Can you describe what the village looks like? When you were little and what it looks like now?

When I was little I had very good memories. The house was relatively old, but very comfortable. I remember our house had very thick wall. And very comfortable in summertime and warm in wintertime. But nowadays we have those brick walls, about this (shows with hands) wide. Some of the new houses have air conditioning. Some of them have not, have fan, ceiling fan. I remember in the summertime it can be very hot. Hotter than the older houses, because they have a fan, gate or yard, stuff like that. I am a person that prefers old stuff.

And younger people now, they just want more modern. Like my little niece, she speaks like, mimic the voice like speak on the TV. They lost their accent., like I used to have when I was little. Because in China, each part they have their own dialect, accent.

Interviewer: The Shandong dialect is very strong.

Right but, the younger people, they lost that. I don't know if that is good or bad.

Interviewer: How about the air quality in your village?

The air quality is so bad. It is the most noticeable. When I was little you always see blue sky, white clouds, you see birds. Now everywhere you go is, you know how it looks like. No difference between Jinan and my village. This either sunny or cloudy, it is hazy all the time. So the air quality is so bad.

And the water quality is, because the only noticeable difference is the big pits. The water, they use more water now. When I was little we do not have the running water. And the people went to a well to get their water. Now water run to village, so they can use more water. And I think it is free. Or only pay a little money for a whole year no matter how much you use. So the more water they use, the more sewage they generate, all run into the pit.

Interviewer: How about refuse or debris?

I remember, not far from my parents, there is a big ditch. They just dump there. They dump, put in a plastic bag. I don't know, later on are they going to cover that up or not. Like a landfill here, but the small ditch.

Interviewer: How about odors?

Odor, if you get too close to the big pits or this ditch where they use, it is pretty bad.

Interviewer: How about animals? Do you all have animals in your village?

Very little. We use, in my village, we use tractors, machinery stuff. We do not use animals for farm work anymore. Some families have a few cattle. But raise cattle for market, not use it for farm work. Some families have swine, pigs, tend to the pigs. And I think one or two families have poultry farms.

Interviewer: So what do they…how do they take care of their animals? How many do they have… how do they take care of them?

The cattle is, more families have cattle, cows. I think beef cows. But not dairy cows. Have four or five, I noticed. Swine, one family I know, he has about 5 or 6 pigs. So they take care of their animals by themselves.

Interviewer: What happens to the animal waste, do you know?

I did not ask. I think they probably use it as fertilizer. I did not ask, I did not pay attention to that.

Interviewer: What type of crops do they grow there?

The major crop in that part of the province is wheat. They grow wheat. Wintertime they sow the seeds, they already have snow. Called winter wheat. They have another seeding of corn. Wheat is number 1, corn is number 2. Some families plant cotton. And nowadays they grow trees. Somehow trees becomes profitable for farmer. Fast growing trees.

That is only for my village. Other villages, I have a relative, my aunt, my father's sister, my aunt right? In her village, they grow vegetables. In most villages they grow vegetables. They are very good at it.

Interviewer: Is there any industry in your village?

Not in the village. South of that, used to be a lake now a reservoir, one chemical company there and petroleum, there are oil wells there. And another company there, I think 2 or 3 south of that reservoir. And the kind of concern, I have not visited there, to see how they handle their chemical waste.

Interviewer: So in your village, what are people really proud of in your village?

What they are proud of is they have more money to spend. They have better house. And now everybody has a much better house than me. In the village everybody has TV. Most of them have a refrigerator. So they are kind of happy in that regard.

And they are not so happy it is very hard to put their kids into college, because the competition is tough.

Interview: Were they working … when you visited in 2007, were there any improvements being worked on in your village? New buildings, roads, water, electric.

The houses are pretty much built already. I did not see…only one on the east side of the village, one family, was building a new house. That is the only one I noticed.

The village is not so big. It is about 100 families, households.

Interviewer: Are there any investments being made in the village?

You mean the village investment?

Interviewer: Sure in infrastructure or I don't know.

When I was there they were talking about building a new village office or something. To expand the previous one. Other investment, I don't know, I didn't ask that.

Interviewer: Did you know the leaders in your village?

The village, what do you call it? The mayor or something, mayor whatever, is one person in charge. Then another person, the treasurer, kind of manages. In this villages families kind of function on their own. Not much they can do.

Interviewer: So the mayor and the treasurer….

I think only two persons.

Interviewer: So what were they like – the village leaders?

They are much like regular family. They do not have salaries. Probably they have some kind of benefit from the township – I don't know. They changed. When I went back there was a different guy. Now it changed to a new guy.

Interviewer: Was the leader elected?

Yes, based on what they liked, elected. Because there is not much benefit, so there is not a lot they can do. So that guy serve in that capacity, not a lot he can do.

Interview: So do you know how decisions are being made in the village?

I think they have some kind of discussion mechanism. When I was there, there were sometimes meetings. They have an audio system where they announce they are having some kind of meeting. You can hear it in the house. There is a speaker somewhere in the house. You can hear it. There will be a meeting blah, blah, where. I never attend them.

Interviewer: You never attend them?

Because I left there so long. People younger than 30, I don't know them. I left in 1978 and know the older people. The younger people, when I was there they were all so little. Now they grow up, I don't know many of them.

Interviewer: So do you know what the priorities are in your village? What are the most important things?

I think there is none, overall. They do not have a plan or long term goal of where the town will go or whatever. Individual families have to deal with their daily life. The season to plant the seeds, to harvest season. Very loose it seems, very loose.

Interviewer: So you mentioned that the young people are leaving, is that a problem?

I think they find more opportunities in the city, the urban area. They go to the bigger city to work. And some of them, they do not totally leave. Some of them don't really move,

they just work there. Like tend to their parents, or even just wife, periodically. The sons move away really to the cities.

Interviewers: So do you think that's a problem?

I don't see any problem. Unless you talk about the relationship between generations. In the old times grandma lived together with mom and dad, now they live apart, do not live under the same roof anymore. I think there is a change.

Interviewer: So do you think it is important to maintain these rural villages in China?

I don't know. So the small village life kind of relaxed. Everybody knows everybody - friendly and relaxed. Now people just rush trying to make more money – that is my impression. The topics often turn to how to make a better income. And when I was little that was not the case. So I guess that's the more capitalism I think, money driven society now.

Interviewer: So what do you think is needed to continue to improve rural villages?

I think the sanitation is a big part. If centralized sanitation system with pipelines, collect all the sewage to somewhere to be handled, that would improve the environment.

And other than that, the education probably. In rural areas, the percentage of students, high school students, that can get into college is lower than in the cities. Shandong Province is probably the most competitive province. Because this province always achieves the highest on the national entrance test. Qingdao in the province, always achieves the highest compared to Beijing, Tianjin, everywhere. So the competition is always intense to go to college. And in villages, in rural areas the percentage of high school students that can go to college is less, because of the high school, secondary school and elementary school education is not that good. The systems, the teachers are not as good as in the cities.

Interviewer: So why do you think that is? Why is Shandong different from the others, Tianjin, Beijing?

I don't know. Shandong and two Province, Shandong and Jiangsu Province, I think they are the highest. And then because of that some families send their children to a relative in Tianjin or to another province which have a lower cutoff score. So they can go to college and take tests there, not back home in Shandong.

Interviewer: So tell me about your work. What kind of work do you do?

Right now I do quite a few different things. I do microbiology in general. But my focus is microbiology in animals, humans. Also do a little bit of biomass conversion. For energy, try to develop effective-cost conversion of biomass solids to value-added

products. I have about 6 students, a post-doc, and one technician, usually in the lab. So right now the major focus is on bioenergy and microbiology in digesters.

So you know that the 3rd frontier project, right. Floyd Schanbacher, a few has digesters. And now some of the people in your department have small digesters. Li Yebo and Fred Michel, they have digesters in your building. Mike and Jay Martin are doing this. We are the first to do the "fancy" digesters, complicated, with the valves and controls and monitors, two big ones, 16,000 gallon, 4 small ones drum digesters. And a bunch of bench-top ones,. We try to study the microbiology. I try to learn the microbiology, how to improve the efficiency and the stability of the process. And Floyd Schanbacher is studying the management status.

Interviewer: So did you study this when you were in college?

When I was in college, I majored in microbiology. After that I was given a job. That was in 1981 or 82. At that time everybody would be given a job. I was given a job to teach microbiology in Qingdao technological university, in the civil and environmental engineering department. At that time the chair thought I need to learn engineering courses. So I spent 2 years taking all sorts of engineering courses. And then I taught for 5 years microbiology to college students until 1991. So my career is always in microbiology.

When I was in Qingdao, we worked with wastewater treatment. You know Qingdao Beer? They have onsite wastewater treatment system to treat the wastewater. That was fun. They make beer there. We could drink fresh and un-pasteurized beer.

Interviewer: So what are some of the emerging issues in your field? What are some of the things that are really important right now in your field?

In term of anaerobic digesters there are really quite a bit. I think the key issue is how to improve the digestibility of lignocellulose. It is my first guess. But Jay Martin think that low tech digester is also important. And then another aspect is how to monitor the digestion process – real time, online. Not use the out puts, like the biogas yield. Because the output is too late to monitor, or control the system. So I am trying to develop a system to monitor the performance and the stability of the system. This is one of my research foci.

Interviewer: So who are some of the leading people in your field?

The leading people in the field. Not many in the US. Most of them are in Denmark and Germany. In the US, some people do engineering type of work in the department of Civil Engineering. More toward the sewage sludge, municipal sludge treatment. The microbiology type of research, David Stahl, up in Washington, Seattle, Washington. They started pretty early and still do that. He is an established microbiologists one the aspects of anaerobic digestion. They started some years ago. I am still catching up.

Interviewer: In China? In China are there experts?

In China, probably in terms of digestion, probably Liu and his group in Chengdu. They have been around for quite a long time. But there is a new group in Beijing, right? Biogas something, in Beijing. There is another one in Qingdao. The one in Qingdao is Bioenergy or Renewable Energy Institute. Managed by the Zhongguo Kexue Yuan. Not agricultural sciences, science in general, Science Academy. They have a new institute in Qingdao. One part is about biogas. Some of the people were here last year when I was traveling. So we could not get together.

Interviewer: If you were going to organize a conference, on the work that you do, who would you invite?

There are so many people from the field who would have a track record. They would have several years of research and invite some people from the younger people. And cover all aspects of the digestion, biogas digestion. I have a few names, but I do not want to tell you – just kidding.

Interviewer: So I have been going to China now, this was my 4th trip.

You have developed a very good working relationship, collaboration very quickly. They are quite receptive.

Interviewer: Only 4 trips, that was really fast. I did not even meet Liu until my second trip. My first trip I met Liu Rongle at Chinese Academy of Agricultural Science and he escorted me to Shandong, the next year, when I returned. And he introduced me to Liu Ying. And that's when this collaboration, the seed was planted. So are there other things, that you think, that I need to know about rural China as I continue to work in rural China? Things that Americans would not know.

I can't think of anything specific. You probably know better than me, because every time I go back I spend probably a week, two weeks, one time after 2 years of … because I have other places to travel. Visit relatives, the topic often just focused on how the family is doing. Not so much on the stuff you just focus on. So, you probably know better than me.

Interviewer: Well I think that is all the questions I have, is there anything else you wanted to share?

I cannot think of anything else.

Oct. 22, 2009
Li Yebo, Food, Agricultural and Biological Engineering, The Ohio State University

Interviewer: OK, is it OK if I tape record you?

Respondent: No problem.

I: So, when did you, how long did you live in rural China? Did you live in rural China?

R: Yes, in rural China about 17 years.

I: And where?

R: Zibo, Shandong province,.

I: Where is that in Shandong?

R: A little east of Jinan, very close to Jinan. When you go from Jinan to Qingdao you should pass through it. The first stop is Zibo.

I: Just east.

R: Like a 50 miles, 60 miles from Jinan.

I: OK, and since I have never been to Zibo, could you tell me about it?

R: Zibo like a, it is famous for the pottery. That is the main industry I think, because of the kind of soil, they have the soil suitable for production of pottery.

I: What kind of pottery?

R: Any kind, also dishes, the ceramic dishes.

I: Do you have any of the pottery from there?

R: I don't think I have any, I haven't been back to China for 8 years.

I: For 8 years!

R: In the beginning I have a lot travels. After my family came to US, I did not travel back to China.,. Maybe when I go back I will get something. The pottery in Zibo is not the best in China. The best is in Jingdezhen, Zhangxi Province.

I: I have been to Yixing

R: Yes Yixing – south.

I: I bougt a
R: the black or brown color?

I: I bought, yeah, I bought the black or purple, a tea set.

R: We also have same thing, the tea set. It is the white kind.

I: White kind – cool. Like this – (Point to cup)

R: Is that ceramic? – like that

I: very interesting.

R: For this is very famous, also famous for Pu Su Ming, do you know Pu Su Ming? He wrote stories like ghosts ….

I: A poet?

R: Not poet. He wrote stories. Actually he wrote ghost stories to reflect society. He could not attack the government and the society directly in his story, then he uses ghost. What he said is something he did not like in reality. That is the most famous in Zibo. The characters he uses are fox or something else. In China the fox like someone die, they become a fox. You will find them very smart, the fox is very smart. Something like this.

They have different kind of characters, but no people. The fox or anything but reflect the fact is society.

I: What is your favorite story of his? Or a story you remember of his?

R: I think I am very familiar with the, in the high school textbook have a couple of them. Most of the time the fox like to hoax, like the US TV programs, the fox like to hoax. Hoax people, you know, especially like a student, when they are studying the fox try to hoax them off the right track – something like that. Different stories.

That are 2 famous things in Zibo. Zibo is a city, also have rural area. But not like other, mainly rural area. Even twenty years ago, Shandong only has Qingdao City, Zibo City ,zaozhuang City, Jinan City. All others are counties. But later most of the county changed their name to city. Zibo at the very beginning is a city.

I: Did you live in Zibo or in the rural areas around Zibo?

R: In the rural area.

I: So you lived in a village?

R: Yeah

I: Did the village have a name?

R: Yeah – Zhai jia ya

I: Tell me more about your village.

R: The village I think had about 200 people. From the very beginning the only industry is production of bricks. They have soil good for bricks.

I: I saw lots of brick production in Shandong.

R: Brick production, yeah. And there is no other major industry other than farming. And the main crops are corn, wheat in north, a corn/wheat rotation. And they also have a soybean, millet, In China the soybean planting is not like US, they plant soybean between the rows of corn.

I: Plant soybean between the corn. Very interesting.

R: I think the soybean may need less sun light in the later stage, . We don't have any river around. In China the major challenge of agriculture is lacking of water resources. We do not have any river. Actually in the whole township they have 20 village, we call a township. Only the township, during the Chinese Cultural Revolution, we were more centralized. They built a big, huge reservoir. The reservoir can deliver water, at that time it could be managed easily, to the water is distributed to different villages. I think in early 80s, they dig a well. The water is from the well, but mainly drinking water for human and animals, not for irrigation.

I: And now it is from the reservoir?

R: No,. it is from the reservoir in the 70's, I, when it was very centralized. After 81/82. the farming was more family based, it is not easy to control. The reservoir connected to a channel to bring the water to different villages. Because we are very far from the reservoir, someone near the reservoir get the water After the centralized system crashed , , the channel was also broken as there was no maintenance. so we can't get any water from the reservoir now..

I: So then you, the village drilled the well.

R: Yes, there is a well. but not for irrigation. They do not have enough water for irrigation of the farm land.

I: So the well provides water for the village.

R: Drinking water, yeah. And the well was very good. , we In 70's, we also had the digesters.

I: OK, the first digesters were built then?

R: Yeah we had digester then. It was centralized, I think we collect the human waste of the whole village. With some grass, they fed into the digester The digester was located in a yard, like a business corner, where the office of the village, the clinic, the elementary school were located. They also have a small industry, plastic molding. That is like everything, the center of the village. Most of the businesses are here. In that area they build a digester.

Then the gas was used to meet the energy needs of these business such as lighting, heating, but it did not go to the individual family.

I: So all the waste from the whole village went to this digester. And how did the waste get there? Was it carried there?

R: Carried

I: So the waste from the homes, human waste was carried to this digester.

R: We did not have the sewage sludge system.

I: It produced enough gas, to provide lighting…

R: Lighting and cooking. In this area they have some old people who do not have any family. I think there are someone lived in this area. Biogas is also used in their rooms for lighting and cooking. . So the village provides them everything.

I: So they have little stoves, and then they have the gas light.

R: They also have couple of guest houses here. When they have guest, they also use that for cooking. Like in China, you know, when someone comes, they generally provide meals for them. Such as lunch, so we will cook for them.

I: I know that they provide the lunch. I have had many meals, many, many meals.

R: For lunch, when I was in there everyday they have to cook something.

I: So are there animals in your village?

R: Yeah. Mainly every home has pigs, chickens

I: So does the waste from the chickens and pigs go to the digester?

R: No, because generally you know, the waste from the pig and the chicken was directly used as fertilizer., we use soil as bedding material.… we have lots of soil we can use for the brick production. They also carry, to haul to use for bedding, animal bedding. Everyday we need to carry the soils, twice a week we need to use the soil for bedding. I think they also produce a kind of compost, because not the right C to N ratio, it is not a perfect compost, but produce a better fertilizer. Can be returned to the land.

I: So they use straw or they use soil mixed with the manure?

R: Soil, they also have some straw, because generally the pig house has two regions, the resting area using straw as bedding, while soil is used as bedding for manure. The resting area is little higher, it is designed like this….(draws a sketch)

To collect the manure, but generally just have steps, to get down, the pigs … they know, have the manure here, but here generally they put the straw, like a bedding. The straw also comes down, so that is mixed. During summer they also put some graased in to the fertilizer ditch to help produce a better manure for fertilizer. They just, put the straw, grass in, mix with the manure directly.

In winter, because they put the wheat straw something here, somehow it can come down and mixed with manure.

I: So in the manure is removed in the spring?

R: Yeah, generally also winter. Also winter because that is the manure is mainly solid. In the winter they do not have much work, much to do. They will carry manure to the field for spring to use. Every morning, because that is a hilly area, it is not flat like here, we are in a mountain area. So every morning we used the bar, we do not even use a cart, we use the shoulder, you know, 2 things

I: A bar across your shoulders and then you have 2 buckets.

R: Two buckets, one in front – one in back. But we need to get a good balance. So that is very good exercise. Most of the people get up early morning in the winter, they carry the fertilizer to the top of the mountain or some other locations.

I: So you don't need to go to the gym. You carry the manure to the field everyday.

R: Yeah, everyday. You know because in winter you add lots of soil and grass, you couldn't smell anything. in the winter, just carry to the land on the top of the hill, so in spring they can use it. That is the most work we do for winter, the delivery of the fertilizer.

And also you know, before the family based business, the agriculture was centralized. It was literally based on how much volume you produced give you credit. Also have many people to produce more than try to add more soil, to get more volume. But they also check the quality of the fertilizer. You could not add too much soil.

I: So do they still do that today?

R: I don't know but I think they still do the same thing. They use lots of organic fertilizer. You know for the rural area, most people they like their own green food. They do not like fertilizer. They think it the organic tastes better. Especially for some special crops. The millet and something else, very special crops, if add fertilizer it tastes different. They can tell. So though they use lots of fertilizer, they still do same thing.

I: So does, do the people in the village grow vegetables, or do they just have gardens for their family?

R: Because of water each family we don't have much vegetable. Only have one, for rent, owned by the village, rented to the villager is somewhere to grow the vegetables. The community member can buy the vegetables from him.

I: OK, so one person in the village grows vegetables. And then the people who live in the village can buy.

R: Different families can rent. This is after it becomes family based, before the village, they have a part for the vegetables.

I: You have seen a lot of changes in your village then.

R: Yea, because after Chinese revolution, Chinese agricultural reform transformed the centralized to the family based.

I: When Deng became the leader.

R: Yeah, in 1980 our village starting from '79 or '80 from centralized and socialized to a kind of capitalized.

I: So how did people feel in your village when that happened?

R: I think they are happy. They have more ownership they can control. When it was centralized, everybody get the similar things. Something bad, they do not learn how to

work. But for yourself, hard work – if you have input, then you have output from the field. But for centralized system it is different. There was lots of waste of resources.

I: OK Tell me more about what the village looked like. The homes, how is the village organized? You said in the center these's the …

R: The village looks like this. (draw sketch) Here a little flat area. There is a small valley. Then the higher mountain. This valley is good. Here we have a plateau something – not very high. Also there is another village in the plateau area. But we have the valley, we have the mountain. We also have part of the village is here – part of the village is on the other side of the mountain.

But most of our land is in the valley. That is much better than that on the mountain, where the land is not good That is most of the delivery of the fertilizer, to the mountain.

I: So you deliver most of the fertilizer to the mountain.

R: That is the most difficult, for the plateau here you can use a cart or a tractor. It is much easier. We have families live along near the valley.

I: So what are their homes like?

R: The homes like generally, they have three rooms. When you get in you have the main room. Left side – right side generally we like to have smaller ones here, small rooms different door. Some family have two generations, or three generations. When they become old. Some of the house like this.

Some also have the traditional Chinese yard, maybe they have grandparents stay there, different family, but they live on the same yard. Or maybe parents live here, they have grandparents live here.

But for new house looks like this. You have your own yards. Like this, then you have your piglet in there, you have a kitchen something like this – on the side. Some of the bigger families, if you have 2 sons have to build 2 homes. China don't like north. They like south because the heat and the energy efficiency stuff. The other likes west. The east is not the worst. East in the morning you can get some sunlight. No people like this side – the north. Generally the gate comes in here. The gate comes in, the piglets are here.

Sometimes you have bigger family, your grandparents may live here, if you have 2 sons, this is for the most important people to live – that is what the yard looks like.

I: What are the homes built out of?

R: Bricks, lots of bricks. Generally from the very beginning, the lower is stone. We also have a mountain, so we have stone. Stone for like this level.

I: so about 3 or 4 feet high.

R: Yeah, than brick to top. We have this kind, not flat. Generally here the room is like this. Here the main house has this kind.

I: A pitched roof.

R: So in summer not too hot. And in winter it is not too cold. For this is flat.

I: Flat roofs for the pigs …

R: Yeah, for the pigs and the kitchen, it is flat. Generally what happens is that in summer it is too hot . We use the flat roof for drying the crops, something ..

I: Drying crops on the roof.

R: Yeah, when you collect something, like the soybean, when you don't have much, or small thing like sesame, or some other special crop, you put it on there on the cement. They can have their own, each family have their own. Otherwise the ground is soil. It may have some dirts, seldom have all cement, concrete. Not all concrete. So that is why it is flat, so they can use it for drying.

So you know they just have front door, the windows. In China, they seldom have windows here, they seldom have windows on the back.

I: That's the north side.

R: Yes, that's the north side. Also another family, that does not belong to them, so they do not want window facing other's yard … They seldom have, but some have. They seldom have.

I: So what was the environment like? The air quality, the water quality in the village?

R: The air quality in the village is good. The only pollution I think comes from the brick manufacturing. The water is fine, because we don't have a river.

I: So the well had good water?

R: Yes, the well is good. This is a mountain area, all surrounded by mountain. We don't have very centralized community. The water is pretty good. We generally say the water is like kind of sweet. Very good water quality, they don't have any treatment. You can drink.

I: How about refuse, debris, trash.

R: Oh, the family, the family generally they put the, most of their trash into the pig lot. The pig, how do you say that? The pig house?

I: I would say pig housing.

R: Because the bedding, when you clean up the yard you have leaves, they have trees, leaves or something. You clean up your vegetables, or use leaves they put into that.

I: You put leaves or vegetable scraps in with the pigs.

R: Everyone like to do here. They seldom use plastic. We have some plastic pages, but would even not put there.

I: so keep the plastic bags separate.

R: Or you have bottle, because of beer, bottles. Beer bottles in China you know we can sell. Recycle.

I: They recycle.

R: Only the bags, I don't know any uses. Metals they can sell and recycle.

I: You know they have they do not use those plastic bags anymore in China.

R: Really

I: When I am in China I have to take, you know, a bag with me to the store. Because they do not give plastic bags. They will give them to tourists. But I am not a tourist anymore. So I take my bag.

R: The wood or straw become fuel. Right now they use coal. But in my, where I was young, we use coal for in the winter for heating.

I: Use coal for heating.

R: Heating, also cooking. You know they have a stove, you can put something cooking. In your house you have a stove and you need to get the smoke something out. Generally it is like this, there is lots of heat, than is your stove. They have like much, like a tunnel, surrounded with metals. Gas then go out. That is for heating and also for cooking. This is for warming up something, something like some of the bread or something that you want to keep warm put that here. Like before lunch, you like to prepare an hour early, you can put your bread here so it would be warming up. That is something they use. It tastes good, like roast stuff.

I: So it is roasted.

R: Yes, very good. They try to save the energy. Try to use all of the energy.

Then they also use straw for cooking, for cooking in the kitchen. I mentioned they have kitchen, the also have this kind of stove for water something. But they also use, they also have other kind of burner for the biomass, for straw, for cooking.

In the old time all the corn stover, wheat straw they have other purpose. Wheat straw can be roof. They use it for roof. Most time, wheat straw collected near, you know to prepare to remove all the leaves, just leave the straw. The straw is like tubes, you know, good for roof. Use straw for roof. Not a good seal.

For organic fertilizer use it, or use the leaves from the wheat straw. Corn stover, they use mainly for fuel. After from the field, with crop rotation, after during the fall they collect it and put on the side to dry. Bring home for heating.

I: So they are not allowed to use wood?

R: We do not have much wood resource. Very few, only you cut a tree, the main part of the tree you use for construction, to build homes. Then the branches you can use for cooking. That is very limited.

Also, in the, we have some area, some people, but they have someone to watch, they do not like you to cut trees.

I: So people in the village watch?

R: Yeah, to watch. If not controlled, then all the trees used in a couple years.

I: So the leadership in your village, how was that? Tell me more about the leadership in your village.

R: For the leadership, before mainly centralized. Everything, they don't have corruption or something. It was controlled pretty well. But then, I don't know much, not much competition, they don't want to do that kind of job, because you have lots of work. They have, generally, they have some, the communists, the secretary called the, the secretary of the communists from the village. I don't know if you know that. Like at each of the university, they have a president. They also have one for the communists. Same thing in the village. Then you have a treasurer, something. They also have a member board.

I: So there is the secretary, there is a treasurer, and there is a member board.

R: There is another one called the village, like the president of the school. But the secretary of the committee is at the top, number 1.

I: Secretary of the party is number 1 in the village. And then there is a president who is number 2, the treasurer, and then there is a member board. And the member board has how many people?

R: 4 or 5. There is an election.

I: So the member board is elected, and the others are appointed by the party.

R: They are appointed, no only the secretary is appointed by the higher level. They can nominate, but still. And the president also has to be selected. The president is selected by the village. The board, they have 2 boards, one board belong to the president, more for management. The other board belong to the secretary. Those need to be communist members. They are selected by all of the community members. They are different groups.

I: So there are two boards.

R: This is much higher, but they don't do much things. So much is shared, like. The president and the secretary they are the same. Generally the president also vice secretary here. They are shared.

I: So does that work? Does that leadership work?

R: That the old system in China, it's OK. That's what it looks like.

After become family based. They have much more power. The economy is more open, they have much power, they can make more money. They have strong competitions for both secretary and….. Even the secretary is appointed by the, they must pass the board

vote. But there are lots of competitions. In China the village is very difficult to be really democratic, something, because family based.

Like in my village we have three family, three family. Like we have the main village we have the same last name.

I: Your village all have the same last name.

R: I mentioned the mountain. That is a different family. They have a different last name, they are a different family. They are the same family, they are combined with 2 bigger families. We are all the same 2 families. But, I don't know, very early, they separate. Even same Li, same family. The last family name we are not the same group. Now is up to, who has the larger group. Which family has large group, then someone from here can be selected to be president or something. There is more trust there from their family.

I: What is the name of the family on the mountain?

R: Qing, you know Qing shi Wang? The dynasty is Qing, they have same family name.

I: So you haven't been back to the village for, when was the last time you were there?

R: Many years, my family already moved out from that village for 18 years. My parents not live there anymore.

I: Where do your parents live now?

R: In a township. The mountain is maybe 20 miles away, most centralized township. But actually no good. They have traffic to my old village is not good. The village has 1 road. Also when I went back home, we only have the buses only have 6 shuttles you must catch on time. Because I have 2 younger bothers, we are all out. My parent have other relatives live near in township. They moved to the township.

Same city, just more central. Like here you have Wooster, just more like Wooster a larger community. More industry or something, more factory. The air quality is terrible. I think they have different kind of pollution. It kills the corn around. There is dust, traffic. The traffic is a huge problem. It is not designed well. Because in the very beginning, the road pass through the township, then they build like a highway and still pass. The problem for my parents is red light. When they need to pass the road, especially during night something, they don't have a bypass or traffic light or something. That is terrible. My aunt her sister in law was died due to the traffic. My same aunt she's, the daughter of her brother also died by the traffic. Another aunt was hit by a car. And there are lots, sometime in China, that's a problem. Someone needs to take care of that. They need to have 35,000 yuan or something, have an accident they can settle. That is a huge problem. Especially during night someone hit and run away. They drive very fast at night, but can't see.

I don't like my parents living there. In Zibo City where my brother lives, the traffic, the air quality, there are so many factories. But most of the factories are chemical. They call it the cost of economic development. Ten years ago, fifteen years ago, we try to attract different types of investment. Most of this investment, they are not allowed in the central

city or in other countries. They have pollution, high energy cost, the development don't like to go there. Like the cost.

I: So your village is the population the same now as it was when you lived there?

R: Yeah, like in China you know min gong? Some of the farmers work in the city. But for our area, in the north, in our area, they seldom go out. They will go out, but like in my new township, they work over there. Not like in Sichuan Province, they are working in Guandong or ..

In our area they don't like to do that a lot.

I: So you don't have as big a problem as the young people leaving.

R: No, they are still with their families there. They are still there, they just work in the township like they work in Wooster. They can still travel everyday or by bus go home. Take a bus or just a bike.

I: So why do you think that is in Shandong? At least north Shandong. That the young people are not leaving.

R: Shandong has good economics. They do not need to go out. Also Sichuan, at work lots of people from Sichuan go to other province. The economics in Shandong Province is pretty good.

I: So you have people coming to Shandong to work.

R: Around where my parents live, there are lots of people from Sichuan. Sichuan and also the village. The village, they also have people to work over there. So close so they can travel everyday. They still can take care of the farming or something.

I: I want to back up a minute and talk about the anaerobic digester you were telling me about in your village. It was there when you were living there. Do they still use an anaerobic digester today?

R: I think after, it worked first when the village was centralized. Because, I don't know, generally the urine, human urine do not go to the pig house. The urine was collected. They use some urine and some straw. They do not use this pig manure, because the have the soil, to add to the fertilizer for the soil. Because the urine has very low solids. The urine …..

I: So do they still use digesters in your village?

R: No

I: What do they use for energy? They use coal?

R: They use coal, even fifteen years ago they mainly use coal. They seldom use biomass.

I: Tell me more about, you went to school in Shandong. In Jinan?

R: No, Zibo.

I: So when did you start studying waste management?

R: Study?

I: Graduate school or as an undergraduate?

R: Some in graduate school, I think. My undergraduate school mainly machinery, agricultural machinery.

I: So where did you go to graduate school?

R: The China Agricultural University.

I: And that is when you started working with …

R: I first started working on the processing, mainly area previously I work on processing area. For the processing, the agricultural produce processing. But I work on the waste for food processing, like the Distillers grain. DDGS for the beer industry. After you process beer you have the residues. That's the first thing, I work on the processing and the drying. We dry it first. That is the same reason we try to use it for other purpose. To have a different kind of waste, like the starch in the … industry. We also have the waste.

Before I moved to Ohio I did not work much on manure.

I: OK, so you mostly work on food processing waste before you came to Ohio.

R: Manure, the sewage sludge that's the.., In China I did work on something, composting of the manure.

I: You know I travel to rural, I am starting to travel more to rural China and to the villages in rural Shandong. What do you think I need to know about rural Shandong to be more comfortable and more effective? When I travel to Shandong and I work in the villages, what do you think I need to know?

R: You know in the rural area become, generally two things. In the village where I, the rural area, security something is much, much better than township or something. Everything in the small area, everybody knows, they know each other. Try to ask who is that. The other they will be very alert to you. So you need to at least someone you need to let know you will be there, Should be the first thing you need to do. Then be very nice, let then show you around. It is not good if you go and not know someone and go there, they will be very alert, they don't know who you are. Then they will only think you are in China, they will think you are someone who will try to hurt them or are Zhongguo meiguo yiyang. You need someone to bring you there.

I: Are there other things I should do?

R: Maybe, maybe I think if you ask me and mention my name in Zibo at the University of Technology. He is the Dean of College of Light Industry and Agricultural Engineering. They have food science, agricultural engineering, things like that.

I: And he is, the man who will be here in December?

R: He left this morning. He like you, invite you to visit there. Then at the village he can, to go to village you can.

I am planning to go back to China next July. If you have same time I can show you. Maybe I can go back to the village or something. I will bring you there, you can see.

I: That would be wonderful. Anything else you want to tell me about or make sure I know about rural Shandong?

R: Not much. The Shandong in China, the people generally is nice. In China we say the south people are very smart, we say that, good at, you know, planning or something. The people from the northeast are rough, fighting, robbing, always happen. In Shandong we are generally much better. Henan near us, have lot's of robbery, they steal your wallet, that always happen.

I: We call it pick-pocket.

R: But when we have trouble, steal away from them. Don't try to settle something, they will hurt you. Many fighting, that is what I know, if you try to help, you get in trouble.

The people at my age, we have brothers, sisters, we know how to take care of others. We know know much considerate. But the young people, in China, In Shandong Province most of the family, even in village, have 1 child. Only allowed to have second with .. I Don't know, the younger generation my be difficult too.

I: Well thank you.

R: You're welcome.

Appendix D

Sand Bioreactor Questions from China

Sept. 24, 2009

马教授：

您好！您工作忙吗？生活好吗？上次您来山东辛苦地为我们指导工作，非常感谢！

您走后就给您写信问候您，但由于邮箱错误一直没发送成功，今和刘英老师核对邮箱后才又给您发此信（您邮箱中的阿拉伯数字 1 我误认为是字母 l 了）。您指导我们对南四湖微山岛的污水如何进行处理，我们收获很多，因为要错过降雨高峰，我们近日开始建设。也希望您有机会再来山东，看看我们的建设工程，看看您的技术指导对减少农业面源污染的作用，看看南四湖清澈的湖水。

您上次说有关于 roof 的不同的设计及应用的照片，如果您方便，抽空发给我学习学习好吗？非常感谢！请代我向您的家人问好！

祝：工作愉快，身体健康！

李彦
山东省农业科学院土壤肥料研究所
86-0531-83179141

Oct 12, 2009

马教授您好：

好久不见，非常想念您！

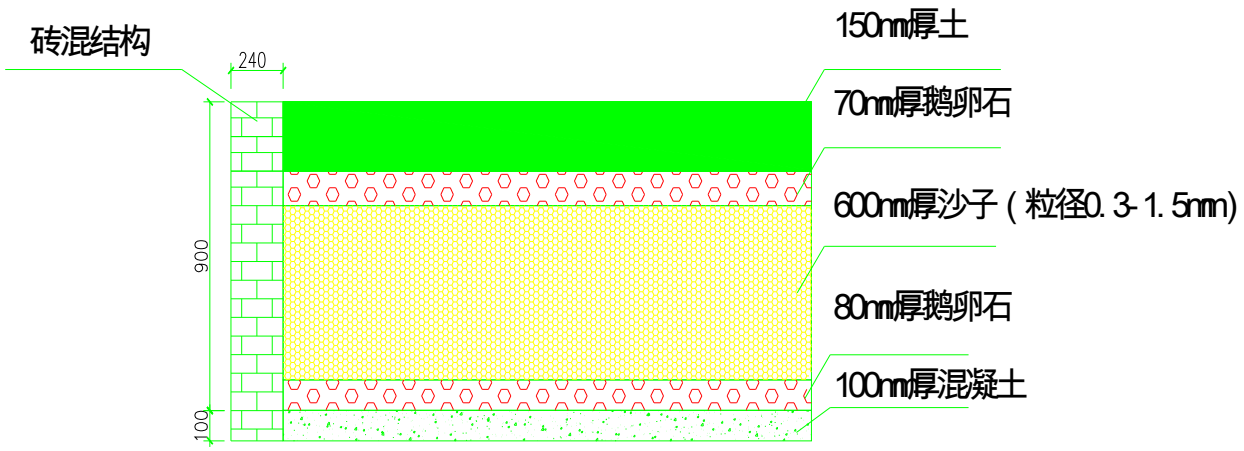
我们目前已打算在微山岛上（您上次来咱们一起去过）建设砂生物滤池，主要想建设两种模式：

1、住宅小区生活污水处理（不包括厕所粪便污水）：

住宅小区情况：共 8 栋楼，入住人数合计 1100—1200 人，生活污水量按 25L/人·d 计算，污水量共计 27.5m3/d，住宅小区建设时所有生活污水集中排放。

预处理池情况：砂生物滤池前设计一沉淀池和一调节池。沉淀池容积为 11.25m^3，长、宽、高分别为 3m，2.5m，1.5m，调节池容积为 22.5 m^3，长、宽、高分别为 6m，2.5m，1.5m。

砂生物滤池情况：打算在住宅小区生活污水集中排放处采用您的技术建设砂生物滤池，使生活污水经砂生物滤池处理后达标排放流入南四湖中。根据污水总量（27.5m3/d）及砂生物滤池处理污水的要求，每天进水 4 次。每次 1cm，计算砂生物滤池面积为 687.5m2，设计砂生物滤池长和宽分别为 44m 和 16m，深为 100cm，上面种植草坪。示意图如下：



2、单户生活污水处理（不包括厕所粪便污水）

生活污水量按 25L/人·d 计算，每户 4 口人污水量共计 100L/d，设计砂生物滤池面积为 2.5 m^2，建设地下式，砂生物滤池上面种植草或菜。

针对这两种建设模式，有几个问题向您请教：

1、住宅小区生活污水处理（不包括厕所粪便污水）：

（1）根据污水量建一个长和宽分别为 44m 和 16m，面积为 704m^2 的砂生物滤池是否可行？是否需要分开建 2 个或 3 个？布水我们采用管道，用泵计量。

（1）0.3—1.5mm 细砂的上下两层分别为 70mm 厚和 80mm 厚的卵石可行吗？

（2）我们想在砂生物滤池上面种植草坪，这就需要在卵石上面覆土，覆多厚的土层比较合适？我们初步设计 150mm 土层是否可行？覆土后种植草坪如果下雨会不会把覆土冲进沙里面，是否会影响污水净化效果？

（3）我们这次建的砂生物滤池面积很大，0.3—1.5mm 细砂就需要 422.4m^3，全部要筛要洗，工程量特别大，再就是砂的粒径小了就容易堵，我在实验室做的实验严格按照每天 4 次每次 1cm 进水就堵过，想请教您别的粒径的沙您做过试验吗？是否可行？

2、单户生活污水处理（不包括厕所粪便污水）

（1）2.5m^2 砂生物滤池我们是建在地下，请问出水该如何排出？如果砂生物滤池底部不用水泥直接是泥土，处理后的水靠下渗入地下，时间长了会不会堵塞？

October 15, 2009

马教授您好：

好久不见，非常想念您！请您百忙之中对我们的砂生物滤池建设给予指导把关，不胜感谢！

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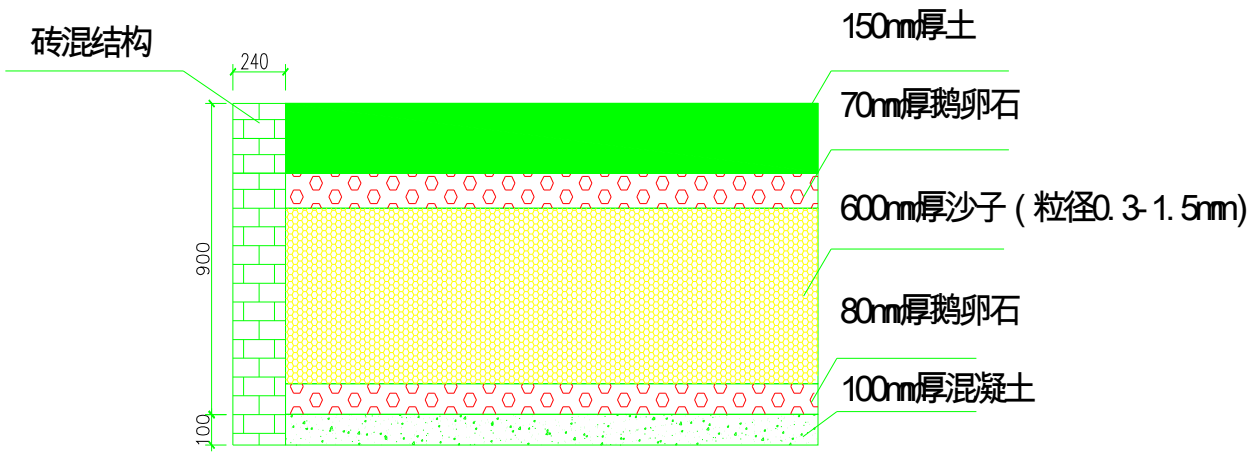

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生活污水量按 25L/人·d 计算，每户 4 口人污水量共计 100L/d，设计砂生物滤池面积为 2.5 m^2，建设地下式，砂生物滤池上面种植草或菜。

针对这两种建设模式，有几个问题向您请教：

1、住宅小区生活污水处理（不包括厕所粪便污水）：

（1）根据污水量建一个长和宽分别为 44m 和 16m，面积为 704m^2 的砂生物滤池是否可行？是否需要分开建 2 个或 3 个？布水我们采用管道，用泵计量。

（1）0.3—1.5mm 细砂的上下两层分别为 70mm 厚和 80mm 厚的卵石可行吗？

（2）我们想在砂生物滤池上面种植草坪，这就需要在卵石上面覆土，覆多厚的土层比较合适？我们初步设计 150mm 土层是否可行？覆土后种植草坪如果下雨会不会把覆土冲进沙里面，是否会影响污水净化效果？

（3）我们这次建的砂生物滤池面积很大，0.3—1.5mm 细砂就需要 422.4m^3，全部要筛要洗，工程量特别大，再就是砂的粒径小了就容易堵，我在实验室做的实验严格按照每天 4 次每次 1cm 进水就堵过，想请教您别的粒径的沙您做过试验吗？是否可行？

2、单户生活污水处理（不包括厕所粪便污水）

（1）2.5m^2 砂生物滤池我们是建在地下，请问出水该如何排出？如果砂生物滤池底部不用水泥直接是泥土，处理后的水靠下渗入地下，时间长了会不会堵塞？

October 16, 2009

马教授您好：

您刚出差回来辛苦了！谢谢您这么快回信指导。因为我正在北京出差，所以我和王艳琴分别给您去了信，再向您介绍详细情况并请您给予指导。

我们计划在村庄建设砂生物滤池，目前可以做到雨水和污水的分离，只处理污水就行，但是我们不能实现在房屋旁建多个小的，因为没有空间。目前可用的场地是集中在入湖前的位置（在我们上次看到的旁边位置），可供建 800m^2 的一个大的砂生物滤池，是否可行，净化效果会好吗？是否需要在其中进行分隔？但如果这样会增加成本。

另外我们担心的一个问题就是堵塞的问题，因为在实验室的试验出现过堵塞现象，因为砂的粒径（0.3~1.5mm）很小，所以容易出现堵塞，可否适当放大砂的粒径，您是否有这方面的成功经验，是否可行，如果可行，多大合适？还有一个原因就是我们能得到砂材料的粒径多分布在 1.5mm 以上，所以需要特别多的砂才能筛出我们需要的量，增加了很多劳动成本。

您回信中谈到的雨水冲洗的问题，如果建成，砂生物滤池可以接到从天空的降雨（当地降雨量约 700mm/y），雨水应该很少从其它区域流过来，因为有专门收集雨水的水沟，直接入湖了，这样可否实现对砂生物滤池的冲刷？

您说的单户设计方案是刘英老师有还是刘兆辉所长有？

非常感谢您！

李彦

祝您健康快乐！

October 27, 2009

马教授您好：

非常感谢您对我们遇到的问题的细心指导，我们已经决定月底开始动工，在南四湖湖心岛建设 3 个小型（单户）的，并且建造一个处理 1100 人出水的沙生物滤池工程，在这期间我会把国内工程建设过程的一些图片发给您，还请您多指导！

实验室我又做了 4 个模拟实验，过段时间我也会定期把一些实验数据和照片发给您。

现还有一个问题向您请教，就是我们想在沙生物滤池上面种植草坪，以更好地实现绿化。我们现在初步选了两种，一种是苜蓿草，一种是羔羊茅草，但这两种草长成后的根扎得特别深，能达到 1-2.5 米，如果种植这些的话沙滤池里面会不会布满草的根？会不会导致砂滤池堵塞？因沙层上面卵石和覆土大约有 15-20cm 深，如果种植根系不发达的植物，根系进入不到沙滤池里面，是否会影响植物对 N 和 P 的吸收？

December 12, 2009

马教授您好！

首先非常感谢您对我们技术的指导，1 月底刘英老师去您那我也跟着过去，到时还请您多指导砂生物滤池处理生活污水技术。

现在我们在南四湖湖心岛已经建成 700m^2 砂生物滤池，主要处理 1100 口人生活污水，近几天砂子已买，共 400m^3，砂子已洗，很干净。但我们用 0.3mm 和 1.5mm 的筛子过筛后，大约有 80%的砂子粒径介于 0.3mm 和 1.5mm 之间，还有约 20%的砂子粒径大于 1.5mm，可能介于 1.5mm—10mm 之间，具体情况请您看看我发给您的照片 017，上面的筛子孔径为 1.5mm，下面的筛子孔径为 0.3mm,未筛出小于 0.3mm 的砂子。

现在问题是：400m^3 的砂子如果要全部过筛的话，需要耗费大量的人力物力，如果不筛直接进入砂滤池的话您觉得可行吗？在处理污水时会不会出什么问题？

谢谢您！