A Descriptive Survey of Dairy Farmers in Vinh Thinh Commune, Vietnam

Thesis

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Abstract

The Vietnamese dairy industry is a relatively new, rapidly changing system that has offered significant benefits to individual farmers. Because different areas in Vietnam have varying types of opportunities and constraints, farmers face unique challenges in their respective regions of the country. The objective of this study was to describe dairy farms in Vinh Thinh commune, Vinh Phuc province, in order to determine the needs and challenges pertaining to public health of dairy farms in this area.

A randomly selected sample size of 25% (31/125) of the farms in Vinh Thinh commune was chosen for this study. Interviews were conducted in July and August of 2007. The questionnaire contained forty-nine questions in the following five categories: general information, veterinary care, milking routine, animal husbandry and worker hygiene. Twenty to thirty minute oral interviews were conducted in Vietnamese and responses were recorded on the questionnaire by staff of the National Institute of Veterinary Research (NIVR).

Farms in Vinh Thinh commune were relatively new (mean = 6 years old) with somewhat inexperienced dairy farmers. Farms were small (mean= 4.6 cows/farm), producing moderate amounts of milk per cow (average of 15.2 kg/cow/d), and yet were also the main source of income for 96.8% of farmers. Regarding animal health and hygiene measures of public health concern, 40% or fewer farmers screened their animals for important milkborne pathogens such as Tuberculosis, Brucellosis and Leptospirosis;
6.5% of farmers reported using the California Mastitis Test; and 61.3% of farmers regularly practiced post-milking teat-dipping of their dairy cows.

This study reveals the following needs of farmers in this region of Vinh Phuc province: additional education in the areas of animal hygiene and disease prevention, consistency in farmer implementations of hygiene practices, a greater availability and/or utilization of veterinary care and the need to determine further barriers to the success of this type of small dairy farms. This information will be useful to better allocate the resources available to dairy farmers of Vinh Thinh commune. Similar studies should continue to be conducted in order to adequately monitor the state of the developing dairy industry in rural Vietnam and surrounding countries and aid in bringing these systems to more stable and sustainable levels.
Dedication

Dedicated to my parents, Keith and Dee, and to Elise, Chris and Ellen. Thank you for your continual love and support.
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Fields of Study

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Chapter 1: Introduction

The Vietnamese dairy industry is a relatively new, rapidly changing industry that has offered significant benefits to individual farmers. Because different areas in Vietnam have diverse opportunities and constraints, farmers face unique challenges in their respective regions of the country. This presents a need for examination of the situation of dairy farmers in a variety of locations, in order to assess the effectiveness of measures that have already been taken to support the dairy industry while identifying possible shortcomings in the current systems. Additionally, there is a need for a closer assessment of public health issues, such as milk quality/food safety, zoonotic disease transmission and preventive measures through appropriate vaccination and hygiene. The objective of this study was to examine the dairy situation in Vinh Thinh commune, located in Vinh Tuong district of Vinh Phuc province and to determine the needs and challenges pertaining to public health of the dairy farmers in this area.
Chapter 2: Literature Review

The face of today’s global dairy industry is changing. The technological advances in large-scale production have dominated production systems of more developed nations, while small-scale dairies have gained prominence in the developing world. In order to incorporate these small-scale production systems into the larger global dairy industry, a working knowledge of the benefits and challenges of small-scale dairy farms is necessary. To optimize the development of small-scale dairies, the effects of management practices, farmer training, culture, environmental issues as well as milk safety and the potential risk of milkborne diseases are aspects that must be examined.

Worldwide milk production and consumption

Milk has long been considered an important part of a healthy diet in many regions of the world. Milk contains many of the micronutrients necessary for proper growth and nutrition. Children and adults who lack access to these nutrients run the risk of improper development and diminished health, and this problem is likely of greatest concern in areas of the world where milk is least available to potential consumers.

As the global population increases, the global dairy industry must keep up with the increased demand for milk. Although developed countries typically have highly concentrated and industrialized dairy production systems, much of the developing
world’s dairy farms are smaller operations. As new, and often small, dairy industries are forming around the world, an understanding of their needs and challenges is crucial to translating the knowledge that has been accumulated regarding animal husbandry (defined as “the production and care of domestic animals”), milk safety and hygiene and environmental responsibility in a way that is relevant to the culture, geography and economic constraints of small dairy farmers in diverse regions of the world.

Part of the changing face of the global dairy industry is due to the fact that developing countries are playing a larger role in the increased production of animal products, with the greatest increase taking place in the production of poultry, pigs, eggs and milk. As these nations seek to develop production systems that are most appropriate to their respective geographies, economic constraints and cultures, an understanding of these systems must be fostered by the global dairy industry in order to incorporate them into the global market in a way that is safe for consumers and beneficial to producers.

Due to recent concerns about pesticide use and animal husbandry methods as they relate to food safety, there has been an increased interest in food products’ places of origin. This further increases the importance of understanding food production methods worldwide, as more people are exposed to a greater number of food products from diverse regions of the world.

Over the decade from 2007-2017, the Food and Agricultural Policy Research Institute (FAPRI) projected a 20.1% increase in world milk production, primarily due to increased milk production per cow. Milk production is projected to increase by 102.9 million metric tons (mmt), with 44.6% of the increase in Asia (mostly India and China)
and 32.9% in the Americas (mostly the United States and Brazil). Additionally, milk is projected to become more widely available in many chiefly importing countries, and dairy product trade is projected to increase over the next decade. This continued projected growth of both milk production and dairy trade in the coming years underscores the importance of an understanding of the global dairy industry as a whole.

Milk production and consumption in Asia

**Overview of the Asian Dairy Industry.** The Asian dairy industry is growing and diverse. Individual production systems differ in size, management practices and economic constraints due to a variety of geographies, economies and cultures.

Although growth in dairy consumption is projected over much of Asia, dairy production capabilities are not equal across various regions of the continent. While Japanese and South Korean dairy production systems have improved through government support and economic growth, systems in China and India, though larger than their Japanese and Korean counterparts, are not as efficient in comparison. According to a United States Department of Agriculture (USDA) Foreign Agricultural Service (FAS) 2007 report, Japan and South Korea had dairy cows producing 9.19 and 9.23 tons of milk/cow/yr, respectively, while China and India had dairy cows producing 4.04 and 1.13 tons of milk/cow/yr, respectively. Chinese and Indian dairy systems are expected to improve in efficiency through technological advances and government support. Meanwhile, Southeast Asian countries are not able to satisfy domestic demands for fresh
milk and are highly dependent on imports, even with the implementation of governmental support programs. Due to the unique needs, values and constraints of individual Asian nations, the most beneficial dairy production system may vary from region to region.

While large-scale production systems with greater milking efficiency per cow have been quite effective in building dairy production in wealthier countries such as Japan and Korea, poorer Asian nations may reap a greater benefit, at least for the time being, with small-scale dairy production systems. Small-scale dairy farms are able both to increase the amount of fluid milk available to the surrounding community and provide economic benefits to individual local dairy farmers. Livestock ownership can provide a food source, means of employment and cash reservoir for many of the world’s poor in areas in which land availability is limited. At least 70% of the world’s poor use livestock as part of their income source, and many developing Asian nations have seen improvements in the living conditions of their rural poor through livestock ownership. Small-scale dairy farms have been a resourceful way to advantage both the community and the farmer in many Asian nations. However, though each dairy farm must be tailored according to the needs and resources of the farmer and surrounding community, it is also important to establish standard food safety protocols that can be implemented by all production systems. For example, food safety measures such as Hazard Analysis and Critical Control Points (HACCP) to reduce the risk of producing unsafe milk products have been necessary to implement in Indian tropical dairy farming systems in order to make dairy products more marketable for export to other nations.
Assurance of safe dairy products is not only important to the consumer, but to the producer as well, as this can expand the potential markets available for his or her product.

Nevertheless, milk consumption in Asia lags behind much of the rest of the world. Asian milk consumption levels overall are lower than those of western nations, and southeast Asian nations trail behind their northern and western counterparts in milk consumption levels (Tables 1 and 2). Although the 2003 FAOSTAT numbers and the World Dairy Products: FAPRI 2008 Agricultural Outlook projection numbers are somewhat contradictory (milk consumption in China, India and Vietnam was projected by FAPRI to decrease in comparison to the FAOSTAT 2003 data), these two sets of data still show a lower level of milk consumption in Asia, particularly in Southeast Asia.

Although Japan and South Korea have higher milk consumption rates than most other Asian countries (excluding India), consumption in these countries is no longer increasing, while milk consumption in developing nations, such as China and Southeast Asian nations, is expected to increase. Increased consumption in Japan and South Korea was largely due to economic growth and government school milk programs. Many other Asian countries share cultural and dietary values like those of Japan and South Korea, and so it is likely that some of these countries may show similar trends that influence milk consumption.

Influences on milk consumption in China When considering which factors are most influential in determining milk consumption levels in developing regions of Asia, it is helpful to consider milk consumption trends occurring in China. China’s rapidly
developing economy can be compared to those of South Korea and Japan in past decades, while still containing many of the rural elements and economic constraints seen in many of the less developed countries of Southeast Asia, such as Vietnam. In the past decade, various studies have identified economic, demographic, geographic and technological factors that play a role in China’s milk consumption habits.11, 23-26

First of all, economic factors seem to be the most influential elements in milk consumption trends in China, as individuals with higher income levels/socioeconomic status have a greater likelihood to consume more milk and to consume it more frequently. This trend is likely to continue as the income of many individuals in China continues to rise.11, 23-25

Demographic factors such as age and education are noteworthy as well. A study done in urban Qingdao found that younger and older consumers were more likely to buy milk than middle-aged consumers due to the openness of the young to trying new things and the health-consciousness of the old.26 Also significant, education has been correlated with increased consumption of dairy products other than fluid milk,24 and government efforts to educate the public through school milk programs and public campaigns to improve nutritional knowledge aid in increasing milk consumption.11

Geographical location is also related to milk consumption. China’s more populous coastal regions have experienced the largest degree of milk consumption, with the larger coastal cities’ milk consumption levels increasing by a factor of ten from 1995-2005.23 Moreover, city residence itself has been shown to have an impact on milk consumption, as a 2005 study found that urban Chinese students were more likely to
drink milk daily in comparison with rural students (68.7% vs. 38.5%). In addition to the above, proximity to modern supermarkets can affect milk consumption, as a 2008 study revealed that fluid milk consumption in urban Qingdao, China was related to frequency of visits to modern market areas selling milk, and negatively affected by increased distance from such markets.

Lastly, access to technology has been influential in rates of milk consumption amongst individuals in China. Technology, whether allowing connection to the media, availability of transportation or attainment of modern in-home conveniences, has increased accessibility to milk and milk products for many Chinese consumers. Advertising, for example, has contributed to increasing the consumption of products other than fluid milk that are less familiar to the Chinese diet. The adoption of Ultra High Temperature (UHT) treatment of milk also has increased consumption, allowing milk to be transported over greater distances to reach more consumers, and accessibility to modern home appliances such as refrigerators has been shown to be positively correlated to increased milk consumption.

As China and countries in Southeast Asia gain higher levels of income and become more aware of the healthful benefits of dairy consumption through government school milk programs and public education efforts, dairy consumption levels are expected to continue growing. Particularly in developing nations with increasing levels of income, governments can potentially promote a healthy level of milk consumption by actively educating their citizens in the importance of milk consumption and by facilitating access to milk products.
History of the dairy industry

The history of Vietnam’s dairy industry can be divided into three main periods: 1923-approximately 1960, approximately 1960-1975 and 1975 to the present. During the first period between 1923 and 1964, tropical dairy breeds from India (Red Sindhi, Sahiwal, Thaparker and Ongole) were imported into Vietnam and bred with local Vietnamese Yellow cattle. In the South, these dairy cattle were concentrated in the Saigon (Tan Son Nhat) region while in the North the cattle were in the Bachmai-Hanoi (Vinhtuy) region. These dairy herds were approximately 300 cows per herd, yielding about 2-3 kg of milk/cow/day. This milk was pasteurized, packaged and distributed to consumers, and milk was generally consumed in the form of sweetened condensed milk or powdered milk.

The next period of the dairy industry took place from 1954-1975. State dairy farms in the North were established during this period, such as Ba Vi dairy state farm in Ha Tay province and Phu Dong state farm in Hanoi. In the 1960s, Vietnam began to import Black and White dairy cattle from China (originating from the Netherlands), crossing these with Laisind cattle (Red Sindhi x Local Yellow cattle) and distributing these cattle amongst the growing number of state farms. These F1 crosses produced 1800kg milk/300 days of lactation.

In 1970, the Cuban government established Moncada Frozen Semen Center and imported Holstein Friesen cows from Cuba (originally from Canada) to the Moc Chau dairy state farm and Red Star Dairy Cattle Breeding Centre, also located in the Moc Chau
area (in the central mountainous region of Vietnam), which has an appropriate climate for this breed. During this period, dairy herds in the North were mainly in state-run farms in Son La, Ha Tay, Ha Noi and Ninh Binh provinces, with three dairy cooperatives in the Hanoi area.

In the South, the Australian government assisted with setting up a liquid semen artificial insemination station in Tan Son Nhat under the Colombo aid program and also supplied Jersey cows to the Dairy Centre in Ben Cat, which was discontinued due to the Vietnam War/American War. Both crossed dairy cows and tropical breeds were in the Saigon area at this time, some in privately owned farms. Additionally, milk processing factories such as Foremost, Nestle and Ong Tho existed in Bien Hoa (a suburb of Saigon) during this time, producing milk products from imported milk powder.

The third period, from 1975 to the present, has been a period of transition for the Vietnamese dairy industry. 1975-1985 was marked largely by a transition from large state farms to household farms, and this subsequently resulted in the dissolution of some of the state farms due to inefficiencies and lack of market for their products. Particularly in 1976, the movement of dairy cattle into the Lam Dong region in central Vietnam was significant for the expansion of the industry. Dairy farms that remained in existence (such as Ba Vi and Moc Chau) processed their milk into products such as sweetened condensed milk or milk cakes. The milk market was also suffering at this time, for despite the expansion of the industry into new regions of the country, the war and fragile economy during this period limited the production and consumption of milk products.
From the 1980s, many of the state farms began to change by contracting out small farms, often to state farm employees.\textsuperscript{33} Even during the late 1980s and early 1990s, the dairy industry was undergoing considerable transformation from a state-owned enterprise to a more market-oriented production system. In 1991, 90% of dairy cattle herds in the Hanoi area were state-owned; by 1993, 61.4% of dairy herds were owned privately.\textsuperscript{16}

From 1986 to 1999, the average growth rate of the dairy industry was 11%, and after Decision 167 (described in Table 3) from 2000-2004 the average herd growth rate was 27.8\%, with 94\% of dairy cattle kept on small farms\textsuperscript{27, 30} of 3-20 cows/farm, although there were still larger farms in existence.\textsuperscript{27, 33} Today, Vietnam’s dairy industry continues to be dominated by small farms.\textsuperscript{19}

**Quantity, structure and distribution of dairy herds** Vietnam’s dairy population comes from both tropical and temperate breeds. In 1999, Vietnam’s native Yellow cattle made up 75\% of the cattle population.\textsuperscript{34} These cattle are well-suited to the local climate, can tolerate poor husbandry practices and are disease-resistant,\textsuperscript{34} but are low milk producers.\textsuperscript{35} Laisind cattle, originating from a cross between native Yellow cattle and Red Sindhi (a dairy zebu breed originating from India),\textsuperscript{36} were bred in order to improve the milk and meat production capacity of the native Vietnamese cattle.\textsuperscript{31, 33} Laisind cattle comprise 19\% of the total Vietnamese cattle population\textsuperscript{37} and 25\% of the northern and central cattle population.\textsuperscript{38} Although their milk yield is low, Laisind cows are very resistant to the environment and thus ideal for less experienced dairy farmers and for those with limited incomes.\textsuperscript{16} With their general hardiness and increased milk production
relative to Yellow cattle, the Laisind cattle have become the foundation for Holstein Friesen and crossbreeding of foreign breeds in general.\textsuperscript{33, 38}

Holstein Friesen cattle, and to some extent, Jersey cattle have contributed to increasing the milk production of the Vietnamese dairy industry,\textsuperscript{33} however, pure Holstein Friesen cattle are not well-adapted to the climate in much of Vietnam. Research has shown that the regions of Moc Chau and Lam Dong in central Vietnam are the most appropriate areas for dairies with Holstein Friesen cows, while crossbreeds of Holstein Friesen and Red Sindhi cows are more appropriate for areas outside these central regions.\textsuperscript{16, 27} Furthermore, if the percentage of foreign blood in dairy cattle reaches a level above 75% (outside of the central region of Vietnam), cattle become less productive and experience a decline in overall health.\textsuperscript{31} Even so, Holstein Friesen dairying has spread to areas outside of the Moc Chau and Lam Dong regions, and from December 2001 to July 2004, Vietnam imported approximately 10,000 Holstein Friesen cattle from Australia (90%), New Zealand (9.2%), the United States (1.7%) and Thailand (0.1%).\textsuperscript{27}

By 2004, the number of dairy cattle in Vietnam was 5.12 times the number in 1995 (from 18,700 head to 95,800 head) and the milk yield in 2004 was 7.22 times the 1999 yield.\textsuperscript{27, 39, 40} Also in 2004, Vietnam had approximately 19,805 dairy farms, with 35.6% in the north and 64.4% in the south. Thirty-six percent of these farms had 1-5 cows, with 98% of farms having 20 cows or less, and the average farm size in northern Vietnam was 4.3 cows/farm.\textsuperscript{41} Additionally, as of July 2005, out of a total dairy cow population of 107,690 cows, 15.16% were HF, 24.18% were ½ HF (F1), 26.12% were ¾ HF (F2), 20.36% were 7/8 HF (F3), 13.93% were >7/8 HF (F4) and 0.25% were Jersey
Today, dairy farming in the Mekong River Delta near Ho Chi Minh City and in the Red River Delta near Hanoi is developing quickly, as these densely populated areas increase the demand for fresh milk.27

**Milk processing** In northern Vietnam, milk is generally marketed through collecting centers (81%), with only 19% marketed to private shops and small processing companies, often with farmers acting as middlemen who collect and sell their own milk to private companies.33, 44 Collecting stations are an important aspect of the milk market, “by centralizing, testing and chilling milk prior to delivering it to processors and/or retailers”.33 Additionally, dairy farmers who register with collection stations can be eligible for benefits from ongoing projects involving artificial insemination, vaccination, herd check and treatment free of charge.16

**Training** From 2001-2005, training related to dairy cattle was made available by the activities of the National Institute of Animal Husbandry (NIAH), the National Agricultural Extension Center (NAEC) and the Japanese International Cooperation Agency. NIAH and NAEC are both agencies under the Ministry of Agriculture and Rural Development (MARD). NIAH was responsible for implementing the National Project on Dairy Cattle Breeding Development, and JICA implemented the Project of Improvement of Artificial Insemination (AI) Technology.27, 33, 45

Under MARD, the National Institute of Animal Husbandry’s Project of Dairy Cattle Development has provided 82 training courses in four areas: Breeding and
selection, Artificial insemination technical training, Feeding and management and Record keeping with the Vienna Development Method. First, breeding and selection courses gave recommendations for crossing Sindhi cattle with Holstein Friesen crossbreeds, breeding assessment, herd selection and record keeping. Next, the area dealing with improving artificial insemination (AI) technique gave instruction regarding cow reproductive anatomy and physiology, heat detection, pregnancy detection, AI procedures, improving cow reproductive performance and reproductive diseases. Thirdly, the area of dairy cattle feeding and management addressed breed management, diet, dairy production technique training, milking procedure, milk processing (on-farm), hygiene and common diseases of dairy cattle, growing high yield grass and processing and usage of Agro by-products for dairy cattle feed. Finally, the Vienna Development Method (VDM) dairy breeding management is software designed by NIAH to assist farmers in dairy management.\textsuperscript{27, 45} In addition to the above, the National Agricultural Extension Centre (also under MARD), in conjunction with the National Veterinary Institute, Ba Vi Cattle and Forage Research Centre of the NIAH and other institutions provided 35 courses on dairy farming technique and 8 courses on veterinary care for dairy cattle.\textsuperscript{27, 45}

JICA’s Project for Improvement of Cattle AI Technology had three main areas of involvement. First, the project organized 8 courses in 11 provinces involving cattle AI technology. This work additionally resulted in improvements in dairy management.
which have, in turn, increased the economic efficiency of dairy farming. Finally, this project has allowed research to be conducted on cross-breeding dairy cattle with milk yields greater than 4000 kg/lactation.27

Government Support Two major government policies affecting the dairy industry were the Prime Minister’s Decision No. 225/1999/QD-TTg (December 10, 1999) and Prime Minister’s Decision No. 167/2001/QD-TTg (November 26, 2001). Decision 225 made provisions for “approval of breeding livestock and forestry plants” from 2000 to 2005, while Decision 167 made provisions for the development of the dairy industry in Vietnam from 2001-2010.27 Specifically, Decision 167 outlined goals of the Vietnamese dairy industry, including the following:

1. to meet domestic consumption demand
2. to develop dairy farming in areas able to support the industry with feed and milk processing facilities
3. to facilitate good breeding practices
4. to allocate funding that will allow farmers to develop land for pasture for the cattle to forage
5. to equip processing facilities and provide “purchasing networks” and contracts that are beneficial to farmers
6. to develop further research
7. to provide financial support
8. to set up beneficial tax policies and insurance funds for dairy farmers.46

Dairy Cattle Cooperatives Dairy cattle cooperatives can be a valuable opportunity for farmers lacking the means or desire to store and sell their own milk. Generally, a cooperative buys milk from the dairy farmers and sells it to a milk processing company.16 Farmers join cooperatives on a voluntary basis and are responsible for the management of their own farms and the quality of the milk that they sell. There can be outside benefits
to cooperative membership as well. For example, in 2004 in the 88-member Long An-Duc Hoa Dairy Cattle Cooperative (located in southern Vietnam), members had opportunities to obtain loans, buy stock from Vinamilk, receive a commission from the Tan Sanh feed processing factory and participate in technical training courses delivered by various agencies.47

In Vinh Phuc province, communes (rural administrative areas) containing larger quantities of dairy farms formed cooperatives. These cooperatives are responsible to collect and purchase the milk from the dairy farms twice each day. After collection, the milk is transported to a milk processing factory. Because the number of cooperatives in Vinh Phuc province has recently declined, the leftover quantity of milk is collected by a private company.48

**Disease Presence** The presence of disease and disease-causing agents on small dairy farms can be damaging not only to the cows, but also to the farmer financially, to the environment and to individuals exposed to agents through contact with the cows, manure or milk products.49 It is important to consider the implications of diseases such as mastitis as well as parasitic diseases and milk-borne diseases in a small dairy production system.

Mastitis has become a significant problem to dairy herds in tropical regions.50 While crossbreeding foreign, high-yield dairy cows with local cattle has increased milk production, the increased stress of high milk production, as well as the physical changes in udder size, increase the likelihood that crossbred dairy cows will develop mastitis infections.50 The economic effects of mastitis are two-fold, as farmers suffer economic
losses both from the costs of materials needed to control the disease and from the loss of milk that is not produced and therefore not sold.\textsuperscript{51} Mastitis is not only the most concerning disease of cattle from an economic standpoint, but its presence on a farm brings an environmental impact as well, as infected cows require more resources (such as medications and more food relative to the amount of milk produced) while producing milk less efficiently.\textsuperscript{52}

Treatment and control of mastitis among small dairy herds in Vietnam calls for appropriate application of mastitis control techniques for a specific area. As for any infectious disease, treatment and control of mastitis starts with good hygiene, which is especially important in hot and humid regions such as Vietnam. Dipping teats (the practice of disinfecting the teats after milking in order to reduce the risk of mastitis pathogens entering the udder)\textsuperscript{53} after milking has been shown to reduce mastitis spread to other cows\textsuperscript{54} in addition to being an important part of reducing the risk of mastitis in individual cows.\textsuperscript{55} Additionally, bedding can be an important source of environmental mastitis\textsuperscript{56} and should be used appropriately in order to avoid increasing the risk of mastitis to dairy cows. Although the disease agents of mastitis may be similar across the globe, the ideal methods to prevent and control mastitis, as well as the economic costs incurred,\textsuperscript{50, 51} may vary across different regions and production systems. A 2006 study in India explained that examination of “socioecological factors” to determine the best way to approach mastitis control in a specific region, production system and species should reduce the cost of controlling this disease.\textsuperscript{50} It is therefore advisable to study the dairy production system in a specific region in order to best design a plan for mastitis control.
Parasitic and milk-borne zoonotic disease agents should be identified and controlled in small dairy farm regions. The close proximity of various species of animals as well as human living quarters increases the likelihood of potential exposure of both animals and humans to infectious agents and therefore should warrant reducing the risk of infection to be a high priority. It will be important to identify the most prevalent and most dangerous organisms present in a given dairy production system in order to implement treatment, control and farmer education where most needed.

The infection prevalences listed below in Table 4 are for cattle in northern Vietnam. Some of the cattle were outdoor grazers, while others were confined (noted in table). This table highlights the need for preventive measures to be taken against agents of prevalent diseases, especially *P. multocida, L. interrogans, Strongyle spp., Fasciola, Paramphistomum, Giardia and B. bigemina*. Agents such as *L. interrogans*, and *B. abortus* are of zoonotic concern as well, as these are milk-borne diseases.

**Milk Price.** The delicate balance between the milk price a farmer receives and the expenses he or she must pay makes dairy farming an economically uncertain venture. In fact, because dairy farming requires such a high initial investment and involves a period between lactations during which farmers will have a reduced quantity of milk to sell, wealthier farmers have a greater opportunity to enter into dairying in comparison with their poorer counterparts. Vietnam’s milk price relative to costs to farmers should be considered in determining the economic feasibility of dairying for small dairy farmers.
The milk price in Vietnam has remained stagnant and is low in comparison to the milk prices of other nations. According to the International Farm Comparison Network (IFCN) Dairy Research Center, the Energy Corrected Milk (ECM) price in Vietnam (approximately 3,500 Vietnamese dong (VND)/L, or approximately 0.245 U.S. dollars/L, according to the 2002 Interbank exchange rate) remained constant from 1996-2002, and declined 32% when accounting for inflation. Additionally, at the time of the study, the NIAH estimated that companies in China and Thailand paid a milk price 12% higher than that paid by most companies in Vietnam.

Farmers often have multiple sources of income, including the sale of milk as well as the sale of heifers. Furthermore, the sale of heifers is often a more important source of income to the farmers than the sale of milk, and when farmers are not able to sell calves from their dairy cows at a high price, the price paid for the farmers’ milk especially contributes to the overall economic success of dairy farming for individual farmers. During the first half of 2005, the price of fresh milk at dairy farms in Ha Noi and Vinh Phuc provinces was 3300 VND/kg (0.198 U.S. dollars in the first 6 months of 2005) and 3150 VND/kg (0.189 U.S. dollars) (“farm-gate price”), respectively, while milk prices at the Vinamilk and Hanoi Milk processing plants were 3600-3800 VND/kg (0.216-0.228 U.S. dollars) (“factory-gate price”). Additionally, imported milk products are taxed...
10-30%, depending on the product, leaving the price of milk (after being imported as a powder and refined) as 5889 VND/kg (0.353 U.S. dollars in September of 2005[^5]).[^27]

Not only milk price, but costs of production are of significant importance to the economic viability of a dairy farm. The most significant cost to dairy farmers are feed (38-70% of expenses) and the purchase of animals.[^33] Concentrate comprises 70% of cost of feed, while roughage makes up 30%.[^59] Additionally, lack of animal husbandry knowledge and lack of veterinary care have hindered the development of an economically sustainable dairy industry, as disease and poor practices can greatly diminish the financial returns on a small dairy farm.[^33]

**Economic benefits to dairy farmers and demand for fluid milk.** Today, there is an increasing demand for fluid milk production in Vietnam, and small-scale dairy farming has become a lucrative occupation for many individual farmers.[^19],[^60] A 2002 study in Vinh Phuc province found that 59-70% of the production value of the 30 farms studied was obtained from dairy farming.[^61] A study of northern Vietnamese farmers in Ha Tay province showed that 40% of the farmers reported at least a 50% increase in income, while only 10% reported experiencing a decrease in income.[^62] Further, some farmers have chosen to enter the dairying profession specifically for the economic benefits, as a 2003 survey of farmers in Cu Chi district of Ho Chi Minh City reported that 45.9-47.3% of those surveyed chose dairying as a means to a stable income, and 37.1-37.6% chose dairying as a means to a high income.[^33] As explained by Nguyen, the “livelihood

diversification” that comes with dairy farming not only gives farmers a greater variety of income possibilities (such as selling milk, selling manure, breeding cows), but also creates more jobs due to the variety of tasks that can be undertaken. Although risky, the potential financial rewards of dairying have drawn many new farmers into this business.

Not only are there rewards for running a dairy business, but there is an increasing demand for milk in Vietnam, and a wide gap between this demand and the nation’s milk production capacity. In 2003, although milk consumption had increased to 4.5 times that of 1995 and the average domestic fresh milk production per cow in Vietnam increased to 6.09 times that of 1995, Vietnam was still importing 84% of its milk, even with these increases. Milk production per cow in Vietnam lags behind that of more industrialized nations. In Vietnam in 2005, milk yield from F1 cows was 7-12 kg/day, from F2 was 11-15 kg/day and from F3 was 12-16 kg/day. The average yield of all crossbred cattle was about 12.5 kg/day, or 3800 kg/lactation, while in comparison, the average U.S. milk yield in 2005 was 23.2 kg/day, or approximately 7080 kg/lactation, according to the New York Milk Production Historic Data.

Although Vietnam is increasing its level of milk production through government support and other aid programs, there is still a wide gap between the country’s production capabilities and its consumption demand. Further study of Vietnam’s current dairy production systems is warranted in order to determine animal husbandry, veterinary and public health issues that could be limiting the production capabilities and affecting the quality of the dairy industry.
Chapter 3: Materials and Methods

This study was completed with the assistance of veterinarians in the Department of Hygiene at the National Institute of Veterinary Research (NIVR) in Hanoi as well as with the assistance and cooperation of community leaders and veterinarians of Vinh Thinh commune. Use of data collected from interviews was approved by the Institutional Review Board at The Ohio State University (Figure 3).

Study location

Vinh Phuc province (2007 population: 1,190,400)\(^6\) is adjacent to the capital of Hanoi, and located in northern Vietnam’s Red River Delta (Figure 1). The approximately 1370 km\(^2\) province is divided into districts which include 152 communes, wards and towns\(^6,66\). The district of Vinh Tuong is in the southern portion of Vinh Phuc province and has a land area of 142 km\(^2\) and a population (2003) of 189,970. The study location was Vinh Thinh commune (Figure 2), located in the southern part of the district of Vinh Tuong.\(^6\) At the time of the study, community veterinarians reported the population of Vinh Thinh commune to be 10,281 people in 2,200 households. The primary occupation was reported to be agriculture, and there were 125 dairy farms and 393 dairy cows reported to be in the commune.\(^7\)

\(^6\) Personal communication from Chu Thanh Huong
\(^7\) Personal interview conducted with Vinh Thinh community veterinarians on 21 August, 2007.
Dairy farming in Vinh Phuc province began in 2001 as a result of the Vietnamese government’s Decision 167/2001/QD-TTg. Dairy farmers have received free artificial insemination materials, 40% of the support necessary for raising grass, assistance for training of farmers and farm workers, facilities needed for the dairy farms and foreign project involvement such as the Japan International Cooperation Agency (JICA). According to a report from Vietnam’s General Statistics Office, from 1 Aug 2006-1 Aug 2007, Vinh Phuc province had a total of 718 heads of dairy cattle (525 of these were lactating cows) and produced 1,091.8 tons of milk. This accounts for 4.0% of the total dairy cow population and 4.4% of milk production in northern Vietnam.

Study Design

A sample size of 25% (31/125) of the farms in Vinh Thinh commune was selected for this study.

\[
\text{Sample size} = \frac{Z^2 \times (p) \times (1-p)}{c^2} = \frac{(1.96)^2 \times (0.5) \times (1-0.5)}{(0.16)^2} = 0.9604 = 37.52
\]

\[
\text{Correction for finite population} = \frac{SS}{1 + (SS - 1)} = \frac{37.52}{1 + (37.52 - 1)} = 29.04
\]

These farms were randomly selected by the community leaders in the Vinh Thinh commune local office. Once selected, the survey teams approached the farmers. If the pre-selected farmers did not want to cooperate or were not at home at the time of the visit, farmers next door were recruited for the study instead.

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8 Personal communication from a veterinarian at the National Institute of Veterinary Research, Hanoi, Vietnam
Interviews were conducted on July 30, 2007 (7 farms) and August 8, 2007 (24 farms). On July 30, a team of veterinarians from NIVR and the author met with community leaders and veterinarians at a Vinh Thinh community building for an initial meeting before dividing into groups and conducting interviews. Milk safety and hygiene surveys used to interview farmers were comprised of questions from a previous survey used by NIVR, as well as additional food safety and hygiene questions that were added by the author.

Occasionally, the farmers either refused to provide an answer or the interviewer chose to skip certain questions that he or she did not feel comfortable asking because of cultural reasons. This resulted in a reduced sample size for these particular questions, and this is noted in the Results.

The final questionnaire (Figure 4) contained forty-nine questions in the following five categories: General information, Veterinary care, Milking routine, Animal husbandry and Worker hygiene. The questionnaire is included in the appendix. The questionnaire was written in English, while interviews were conducted in Vietnamese by three groups of veterinarians (with 1-2 veterinarians per group) from NIVR. Answers were given orally and then recorded on the questionnaire, either in English or Vietnamese. After the interviews, all Vietnamese responses were translated into English by the author.

Interviews lasted approximately twenty to thirty minutes and were conducted in the homes of the farmers (except for 1 farmer, who was interviewed on another farmer’s farm), located on the premises of their farms. Typically, brief tours of the facilities, either by the farmer or self-guided, were possible either before or after the interview took
place. Occasionally information included in the survey was taken from the author’s personal observations, and this information is noted in the Results section.

A total of 31 interviews were collected, and the data obtained was organized and coded in Microsoft EXCEL. Descriptive statistics, graphs and correlations were obtained via Microsoft EXCEL as well. Correlations were calculated for years of farming experience compared with farm land area, years of experience and likelihood of cattle disease testing and years of experience and quality of pre-milking hygiene practices.
Chapter 4: Results

I. Dairy Systems Description

a. Description of dairy farms. Dairy farms in Vinh Thinh commune were recently established and family-run. Farmers reported a mean of 6 years of dairy farming experience, beginning in the year 2000, with a minimum of 1 year and a maximum of 7 years of experience (Figure 5). All (100%, 31/31) of the farmers reported living on the dairy farm premises, and 96.8% (30/31) of farm workers were also household members (rather than hired workers). Additionally, 96.8% (30/31) named farming as their primary source of income, and 96.8% (30/31) of the farmers named farming as their primary occupation. When asked whether they wanted to expand their farms (increase the number of dairy cows), 71% (22/31) of the farmers stated that they wanted to expand, yet 41% (9/22) of these farmers mentioned barriers that would keep them from expanding, although they desired to expand their farms.

b. Herd Description. Individual farms in Vinh Thinh commune generally had few cows, and these small herds were largely made up of the Holstein Friesen (HF) breed. As the most common breed in this commune, HF cattle made up 74.1% (106/143) of cows owned by interviewed farmers. Other reported breeds include crossbreeds of HF with a tropical breed, 23.8% (34/143), and Australian Friesen
Sahiwal, 2.1% (3/143). Farmers reported a mean of 4.6 cows per farm (range: 2-20 cows per farm). According to community leaders, the farm with 20 cows was considered to be unusually large for this area, and the mean cows/farm excluding the farm with 20 cows was 4.1. In general, dairy farmers with more experience tended to have a larger herd size (Figure 6). There was an average of 2.39 lactating cows (range: 0-11) per farm. Reported average milk yields/day were between 10 and 25 kg/cow/day, with a mean of 15.2 kg/cow/day (4636 kg/cow/305d). Farmers reported milk yield numbers from memory, not directly from records, but they are close to HF numbers reported by MARD in MISPA (4500 kg/cow/305d in 2002 and 4600 kg/cow/305d in 2003). Average milk yield was shown to be positively correlated with years of farming experience (Figure 7).

**c. Description of farm facilities.** The surveyed farms generally consisted of very small areas of land (Photograph 1) using new or previously built facilities that were similarly constructed. Family living quarters were adjacent to barns, often next to the kitchen area. Land area of the farms ranged from 7-200 m², with a mean of 29.4 m² and median of 20 m². The 200 m² farm was quite large in comparison to the rest of the farms in the study, and the mean land area excluding this farm was 23.7 m². A positive correlation existed between land area of the farms and time (in years) farming (Figure 8). Fifty-seven percent (17/30) of farmers reported using newly built facilities for their dairy farms, while 36.7% (11/30) reported using previously built (for other intended purposes) facilities and 6.7% (2/30) of farmers reported
using both new and previously built facilities. All of the farmers provided dry and shaded areas for dairy cattle, and none of the farmers provided bedding on top of the concrete floors. According to an NIVR veterinarian, the lack of bedding (Photograph 2) was mainly due to hygiene issues (bedding can be a source of environmental mastitis).\textsuperscript{56} The barns were typically open on one or more sides, often with open spaces in the walls or between the wall and ceiling to allow for ventilation (Photographs 3 and 4).

II. Animal Health and Husbandry

\textbf{a. Herd health practices.} Although most farmers 90\% (28/31) considered their herds to be healthy, a comparative few 38.7\% (12/31) actually had periodic health checks for their cows. Not only was there a lack of health monitoring, but there was also a lack of isolation practices if cows did become ill, as only 12.9\% (4/31) of the farmers reported isolating their sick animals from the rest of the herd.

\textbf{b. Vaccination and disease testing.} Although farmers gave vaccinations and tested for many important diseases, there was a great deal of variation in which diseases different farmers vaccinated against or tested for. Farmers vaccinated dairy cows for Foot and mouth disease (90\%, 28/31), Pasteurellosis (87\%, 27/31), Brucellosis (29\%, 9/31) and Leptospirosis (29\%, 9/31); and 6.5\% (2/31) of the farmers reported giving
no vaccinations to their cattle. Of interest is that relatively few farmers vaccinated their cows for Brucellosis or Leptospirosis, two important milk-borne zoonotic diseases.

Farmers tested dairy cows for Tuberculosis (40%, 12/30), Brucellosis (37%, 11/30) and Leptospirosis (33%, 10/30). Additionally, only 6.5% (2/31) of farmers reported using the California Mastitis Test. A positive correlation was found between length of farming and the likelihood of farmers testing their cows for some important milkborne zoonotic diseases. Among the farmers with 7 years of experience, 42.9% (3/7) had their cattle tested for Brucellosis and Leptospirosis; among farmers with 6 years of experience, 40% (6/15) had their cattle tested for Brucellosis and 33.3% (5/15) had their cattle tested for Leptospirosis; and among farmers with 5 years of experience or less, only 22.2% (2/9) tested for Brucellosis and Leptospirosis (Correlations were 0.96 and 0.99, respectively). Finally, of the 22 farmers that did not vaccinate against Brucellosis, 50% (11/22) also did not test for Brucellosis, and of the 22 farmers that did not vaccinate against Leptospirosis, 54.5% (12/22) also did not test for Leptospirosis.

c. Antibiotic usage/dry cow therapy. Relatively few farmers (12.9%, 4/31) reported administering antibiotics to their cows for reasons other than mastitis treatment. Conversely, most farmers (77.4%, 24/31) reported using some type of dry cow therapy (defined as “the use of intramammary antibiotic therapy immediately after the last milking of lactation …[which] can decrease the number of existing
intramammary infections and/or prevent new infections during the early weeks of the dry period.”

They use various antibiotics, such as Mastiject®, Lancomicin®, Kanomicin®, Choloxam®, and Penicillin.

d. **Presence of additional animals.** Other animals (dogs, cats, chickens/ducks, pigs and beef cattle) were commonly present on the farms (author observation), with some of these animals wandering from farm to farm. Seventy-one percent (22/31) of the farms had other animals besides dairy cattle on the premises. Eighty-one percent (25/31) of farmers reported no presence of rodents, 19.4% (6/31) reported some rodents and no farms reported the presence of many rodents. In general, rodents were not considered to be a significant problem to farmers, and an NIVR veterinarian explained that this was due to a scarcity of extra feed on the farms to attract rodents.

e. **Feeding practices and manure disposal.** The limited land availability makes both production of food for cows and disposal of animal waste important issues to consider. Although all (31/31) farmers reported feeding grass to their cows, with 100% (31/31) of the farmers growing all or a portion of their own grass, it is also necessary for the farmers to purchase or mix additional feed for their cows. Farmers reported using a variety of types of feed, including mixed foodstuff (comprised of maize and cassava with vitamin supplements) (84%, 26/31), cassava (23%, 7/31), maize (16%, 5/31), rice powder (16%, 5/31), corn (13%, 4/31), beer dregs (leftover grain after making beer) (13%, 3/31), dried fish powder (3%, 1/31), soybeans (3%,
Only 24 farmers provided additional details about grazing practices of their cattle, and 100% (24/24) reported that the cattle stayed in their barns all day. Concerning waste disposal, farmers disposed of manure by using it as fertilizer, biogas, fuel or feed (such as feed for fish).

III. Milking Procedures

a. Cleaning and Disinfection. Most farmers (58.1%, 18/31) reported cleaning the concrete floor of the barn 3-4x/day, although 38.7% (12/31) reported cleaning more than 5 times per day, and 3.2% (1/31) reported cleaning the concrete floor only 2x/day. Interestingly, farmers with less experience seemed, on average, to clean the concrete barn floor more frequently. Fifty-six percent (5/9) of farmers with 5 years of experience or less cleaned the barn floor over 4 times per day, while only 46.7% (7/15) of the 6 year group and 14.3% (1/7) of the 7 year group cleaned the barn floor this frequently.

To clean the concrete barn floor, water alone was reported as the cleaning agent used for 36% (9/25) of farmers, while 56% (14/25) reported using a combination of water and Benzalkonium (BKA) (using BKA from 1x/d-1x/mo and using water the rest of the time) and 8% (2/25) reported using BKA only.

To clean equipment, workers’ hands and cows’ udders before milking, most farmers used BKA solution (64.5%, 20/31), although 25.8% (8/31) used only water for pre-milking hygiene. Farmers with more experience seemed to have better pre-
milking hygiene practices. In the 7 year group, 85.7% (6/7) used some type of solution (other than water) for pre-milking hygiene, in the 6 year group the number was 73.3% (11/15) and in the 5 years or less group, 66.7% (6/9) used a solution other than water for cleaning equipment (Correlation = 0.985). Finally, only 61.3% (19/31) of farmers regularly dipped the teats of their dairy cows.

b. Milking practices. The milking practices of Vinh Thinh commune are largely dependent on human labor and community cooperation, as little automated machinery is used and most farmers do not have the capacity to store their milk on-farm. 96.8% (30/31) of farmers reported milking by hand, with only one farmer reporting milking by machine.

c. Milk handling and collection. Most of the farmers (86.7%, 26/30) reported that they collect the milk from their cows into plastic containers. The milk is then poured through a filter into an aluminum container (according to community leaders, both plastic and aluminum containers were provided by the Belgium Project). Milking containers are cleaned at least twice per day with detergent/soap (54.8%, 17/31), BKA (35.5%, 11/31), water alone (6.5%, 2/31) or alcohol (3.2%, 1/31).

Farmers (31/31, 100%) in Vinh Thinh commune do not separately store their own milk after milking, but rather, it is directly transferred to the community collection station (owned by one of the interviewed farmers) in a small tank by motorbike or

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9 General Questions about Vinh Thinh Community, 2007
bicycle. Farmers listed the time until milk was cooled to be between 0 and 45 minutes, with a mean of 7.16 minutes. They are able to cool the milk in such a short amount of time due to the close proximity (a few minutes’ drive by bicycle or motorbike) of the milk collection station.

Because milk is taken to the milk collection station almost immediately after milking, it is not necessary for most farmers to know the temperature of their milk in the bulk tank. When asked, 74.2% (23/31) of farmers did not report a milk collection tank temperature, and 22.6% (7/31) said that the tank temperature was 4 degrees Celsius. The farmer who owned the milk collection station (3.2%) (1/31) reported that the tank temperature was 3 degrees Celsius in the summer and 4 degrees Celsius in the winter. This is likely the most reliable answer since this farmer was responsible for cooling the milk in the bulk tank.

Likewise, after collection, most farmers (74.2%, 23/31) did not know the time to pasteurization for the milk, as this step also occurred after the farmers had delivered their milk to the collection station. Six and one-half percent (2/31) of farmers said that the time to pasteurization was 1 day or less and 19.4% said that time to pasteurization was 1-2 days. The farmer who owned the collection station stated that milk was pasteurized no more than 24 hours after being delivered to the collection station.

Only 12.9% (4/31) of farmers interviewed were able to name the products their sold milk was made into, leaving 87.1% (27/31) of farmers that did not know how their milk was used. Of the 12.9%, the clearest response came from the owner of the
milk collection station who stated that the milk was made into pasteurized fresh milk, powdered milk and Ultra High Temperature (UHT) milk.

d. Contamination of milk. If contamination is known to have occurred on the farm, farmers reported that they threw away milk (54.8%, 17/31), used as animal/plant food (32.3%, 10/31), used as biogas (3.3%, 1/31), or took no action (3.3%, 1/31). 38.7% (12/31) of farmers stated that their milk has not been contaminated. Many of the farmers reported more than one of the possibilities described above to handle contaminated milk.

IV. General Hygiene

Although much of this section concerns behavior outside the milking/animal care arenas, it is important to examine general hygiene issues (such as personal and kitchen hygiene) and to assess their potential influence on disease transmission and milk quality. The small land area of these farms, coupled with the presence of family living quarters adjacent to barns makes non-milking hygiene a relevant area of focus as dairy workers are at risk of exposure to zoonotic infectious agents.49

a. Personal hygiene and disease control practices. Ninety-seven percent (30/31) of farmers reported that they washed their hands before and after milking, with 77%
(24/31) washing with soap and 81% (25/31) drying their hands with a clean towel after washing. Although 97% (29/30) reported handwashing after handling raw meat, only 91% (21/23) reported handwashing before eating or cooking in general. Only 87% (20/23) of the farmers reported handwashing after using the WC/restroom (Figure 9). Concerning worker disease control practices, 58.1% (18/31) of farmers reported that dairy workers do not work if they are sick, while 29% (9/31) do work and 12.9% (4/31) sometimes work if they are sick.

b. Kitchen Hygiene. Due to most (30/31) farm workers being household members, it is of interest to consider the potential of kitchen hygiene affecting disease transmission to dairy cattle, or how cattle diseases could contaminate food in the kitchen. Eighty-one percent (25/31) of farmers reported that the same people who milk the cows also prepare food. Eighty-six percent (24/28) of farmers reported that raw meat is separated from fruits and vegetables during food preparation, 93.5% (29/31) said that fruits and vegetables are washed before eating and 77.4% (24/31) reported washing eggs before eating as well.

V. Farmer milk consumption

Only 80.6% (25/31) of farmers consumed their own milk, and of these 25 farmers, 84% (21/25) consumed milk as pasteurized (boiled) liquid, 44% (11/25) as unpasteurized liquid and 44% (11/25) as yoghurt (made at home or locally). Some
farmers reported consuming more than one type of milk product. Those farmers not consuming their own milk said that they did not like to drink milk (66.7%, 4/6), that it was too expensive to drink (16.7%, 1/6) or that they preferred to purchase milk products (such as yoghurt)(16.7%, 1/6).

VI. Assistance for dairy farmers

Dairy farmers in northern Vietnam have received support from both the Vietnamese government and foreign aid, in the forms of education/training, financial support and agricultural supplies (Table 1). The following information obtained from the interviews is different for different farmers, largely because some of the aid occurred only for limited amounts of time and not all farmers were farming at the times this aid was available.

Eighty-nine percent (24/27) of the farmers reported receiving some type of training, and 14% (4/29) of the farmers reported receiving some type of advanced training that provided certification. Thirty-nine percent (12/31) of farmers reported receiving full vaccine support, while 29% (9/31) received partial support. Forty-two percent (13/31) received full semen support, while 29% (9/31) received partial support for obtaining semen. Only 3.2% (1/31) of the farmers reported currently receiving low-interest loans (data is only for loans currently received- most low-interest loans were discontinued 2 years prior to the interview). Nineteen percent (6/31) reported
receiving financial support, 22.6% (7/31) reported receiving veterinary care and 22.6% (7/31) reported receiving BKA. All categories are for support received at any time since the beginning of the dairy farming project, except for the low-interest loans category.

VII. Farmer concerns/suggestions:

The farmers involved in this study took the opportunity at the end of the interviews to voice their suggestions, concerns and desires for not only their individual farming situations, but also for the dairy farming community around them. Farmers’ concerns included (Figure 10) the need for training and education (including animal husbandry and disease recognition) (54.8%, 17/31), low milk price (29%, 9/31), financial constraints to farm expansion and improvement (25%, 8/31), the need for support/aid to provide equipment and supplies (25%, 8/31), the need for increased availability of veterinary services (16.1%, 5/31), the need for a Biogas facility (3.2%, 1/31), the need for a community of education and outreach among dairy farmers (3.2%, 1/31) and the availability of land for expansion (3.2%, 1/31).
Chapter 5: Discussion

The objective of this study was to examine dairy farms in Vinh Thinh commune in order to determine the needs and challenges pertaining to public health of the dairy farmers in this area. The interviews yielded information regarding the state of farmer knowledge and use of animal husbandry practices and veterinary care, as well as perceived constraints to individual dairy farm development that can provide valuable insight to further strengthen the small farm dairy industry in Vinh Thinh commune.

Farms in Vinh Thinh commune were relatively new (mean = 6 years old at time of study) with somewhat inexperienced dairy farmers. Farms were small (mean= 4.6 cows at time of study), producing moderate amounts of milk per cow (average of 15.2 kg/cow/d), and yet were also the main source of income for 96.8% of farmers. Because many northern Vietnamese farmers depend on dairy farming for a sizeable portion of their income, production losses from even one or two cows on a small farm raise concern of significant economic losses potentially suffered by farmers.

Of interest is that in several areas, farmers with more experience tended to report more success and better decisions regarding animal health in comparison with less experienced farmers. The positive correlation observed between the average daily milk yield, land area of farms, likelihood of testing cows for Brucellosis or Leptospirosis and likelihood of using some type of cleaning solution (other than water) for pre-milking
hygiene compared with the number of years spent farming suggests that experience and possibly educational opportunity could increase the success of Vinh Thinh dairy farmers. Another possible explanation for these trends is that because wealthier farmers had more opportunity to enter the dairy industry in comparison to their poorer counterparts (due to their being better able to afford the high initial investment and dry periods without milk), more successful farmers might also have been wealthier farmers who were able to begin dairy farming earlier and might also have had advantages in other areas, such as increased access to education or veterinary care, due to their higher levels of wealth.

**Animal Health.** Although farmer education has been a priority of both the Vietnamese government and international organizations, there are still important missing pieces in the spectrum of husbandry knowledge the farmers possess, and the level of knowledge varied among the farmers of this study. The farmers’ usage of veterinary care, vaccinations and disease testing was also inconsistent among farms interviewed. Although some farmers practiced good animal husbandry habits, many did not, and the adjacency of farms to one another heightens the concern of infectious agent spread, especially when farmers do not consistently provide important preventive care and hygiene for their cows.

There was variation in how frequently Vinh Thinh dairy farmers vaccinated against certain diseases. Although most farmers vaccinated against diseases such as Foot and mouth disease (90%, 28/31) and Pasteurellosis (87%, 27/31), it is concerning that only
29% (9/31) vaccinated against Brucellosis and Leptospirosis, as these are two important milkborne diseases. This possibly could be due to a lack of resources available to the farmers to allow them to vaccinate, or it could be due to a lack of education regarding the public and animal health risk that these diseases represent.

The small size of most dairy farms is alarming in the context of potential disease outbreaks, as a loss of production in one or two cows could represent illness in one-third to half of a farmer’s dairy herd, the main source of income for most Vinh Thinh dairy farmers. Mastitis is a particularly important disease because of potential negative economic effects on dairy farms due to loss of production and cost of treatment.\textsuperscript{50, 51} Only 6.5% (2/31) of farmers reported using the California Mastitis Test, which is disquieting, considering the potential economically devastating effects of this disease to a single farmer with a small herd.

In addition to the lack of widespread use of the California Mastitis Test, several important milkborne zoonotic diseases were infrequently tested for as well. Tuberculosis, Brucellosis and Leptospirosis were only tested by 40% (12/30), 36.7% (11/30) and 33.3% (10/30) of the farms, respectively. Of additional concern is that roughly half of the farmers who did not vaccinate against Brucellosis and Leptospirosis did not test for these diseases either. The lack of vaccination, coupled with the lack of testing for Brucellosis and Leptospirosis make it difficult to assess the presence and effects these diseases may be having in the human and animal populations and thus might make implementation of effective control programs difficult.
Milk Quality Issues. Although commercially sold milk undergoes pasteurization, a notable amount of raw milk is consumed locally (44% (11/25) of the 25 farming households that consume their own milk consume unpasteurized milk), which could pose a health risk to these consumers, according to two U.S. studies. Further, only 61.3% (19/31) of farmers regularly dipped the teats of their dairy cows, and this low level could lead to increased risk of mastitis transmission among cows in a herd. There was also variability in how consistently disinfectants/appropriate cleaning agents were used. While many farmers used these products regularly as a part of their pre-milking and floor-cleaning regimens, other farmers disinfected their facilities and equipment less frequently or used only water as a cleaning agent. It would be helpful to determine whether this information points to a lack of available resources to obtain adequate amounts of cleaning solution, resulting in farmers rationing usage, or a lack of education about the importance of consistent cleaning with appropriate agents or some other reason.

Public Health concerns. The small area of farms and closeness of animal and human living quarters make proper animal management crucial. A majority of the farmers (71%, 22/31) reported that animals other than cows (such as chickens, cats and dogs) were often free to roam the neighborhood, and this could present further opportunities for cross contamination of the environment.

Personal hygiene is an important consideration for workers on any dairy farm, and its importance is perhaps even more pronounced in the case of small-scale dairies in
which farm workers are often family members. Additionally, as 80.6% (25/31) of farmers reported that milkers also prepare food for the family, it is important to consider the potential disease transmission that could occur between the kitchen and the barn. In these situations of relatively close contact between animals, humans and food products, it is important to consider personal hygiene measures and disease control practices on the farms, as these habits could also decrease the risk of zoonotic disease among farm workers.49

Farmer concerns/suggestions. Small dairy farmers in Vietnam face numerous challenges, yet the concerns and suggestions that they described in the interviews can help give direction to efforts aimed at improving dairy farming in Vinh Thinh. Especially in light of the percentage of farmers (41% (9/22)) who desired to expand their farms but stated constraints that would prevent them from doing so, it will be important to examine these challenges, determining the most effective ways to promote growth for both the individual farmer, as well as the regional dairy industry as a whole.

Pitfalls to the study. Due to time constraints, the author did not have the opportunity to select and randomize the study sample of farmers to be interviewed, therefore farms in this study were randomly selected by Vinh Thinh community leaders. Although this method of choosing sample farms could introduce some degree of bias, the study farms correlated well with aspects of reports describing typical dairy farms in this area of Vietnam. Farmers’ responses regarding assistance received,27, 45, 71 milk yield,69 types of
feed used and constraints to expansion\textsuperscript{60} were similar to other published findings and thus lend support to the interpretation that the sample farms were reasonably representative of dairy farms in the region. Additionally, it would have been helpful to have asked the number of workers per farm during the interviews, in order to assess the percentage of the Vinh Thinh population included in the study.

Regarding the handwashing questions for which eight of the farmers either declined to provide an answer or the interviewer chose to skip, there was a reduced sample size that could have made the data less reliable. Additionally, if these types of questions caused anxiety to the farmers, this could have introduced some degree of bias in the responses of the farmers that did answer these questions. Although these particular handwashing questions were less effective than hoped at eliciting personal hygiene information, the knowledge that they produced some level of discomfort in this cultural setting is valuable in itself. First of all, this knowledge illuminates the need to find ways of gathering accurate data in a way that does not require study subjects to stretch beyond their cultural and personal comfort levels. It has been suggested by medical interpreters that an increased awareness of potential sources of misunderstanding, as well as a more conversational style of interview (rather than asking direct questions) might be more appropriate to some cultures.\textsuperscript{74} Another study suggested that cross-cultural survey questions would better serve those in need if they were relevant to the lives of the interviewees,\textsuperscript{75} and this requires some knowledge about the daily lives of the study population. Although the survey questionnaire was reviewed by Vietnamese researchers prior to the interviews, obtaining more in-depth knowledge regarding the implications of
some of the questions or the interview style might have made the interviews more effective at eliciting information in this cross-cultural context. Secondly, the hesitancy in answering these hygiene questions could be due to insufficient hygiene practices that the farmers are aware of but unable or unwilling to alter, therefore making personal hygiene a potential weak point in these dairy production systems that should be further examined.

Another potential pitfall to this study involved small communication barriers. Although the NIVR staff graciously assisted in translation between Vietnamese and English, it is possible that some of the questions asked or answers given in the survey were not understood in the way that they were originally intended. In addition to potential communication issues due to language, because interviews were oral and given by different interviewers, there could have been some individual bias in how questions were asked and answers recorded, thus affecting the data. To address these potential communication issues, the author reviewed the survey data with the respective researchers conducting the interviews in order to confirm the meaning of any unclear or unexpected responses given.

**Conclusions and Recommendations.** After examining the data collected during the farmer interviews, four main areas stood out as needing improvement in the dairy farms in this commune. The need for more farmer education, the need for consistency in farmer knowledge and implementation of hygiene practices, the need for greater availability and/or utilization of veterinary care and the need to determine further barriers to the success of small dairy farms in Vinh Phuc province are discussed below.
First of all, although farmers have received education from both the Vietnamese government and foreign agencies, still more is needed. It would benefit farmers to become more knowledgeable about important diseases and how to prevent, recognize and test for them. Farmers should be familiar with milkborne and zoonotic diseases, including their transmission and their effects on human health. Further, mastitis in particular should be addressed, as it is such a widespread dairy disease and can have a significant economic impact. Continued outreach from both Vietnamese governmental and foreign organizations is warranted in order to continue improving in the area of farmer education.

Next, there is a need for consistency/standardization among farmers regarding both knowledge and implementation of animal health and hygiene practices. Training for farmers was not consistent for all farmers interviewed, although this may have been due to farmers entering the dairy industry at different times. Cleaning and disinfection practices were also not consistent across farms, and the provision of agricultural supplies varied across farms as well. Particularly due to the mixing of milk from many farms at the collection station, it is important that all farms consistently have effective hygiene measures in place.

Thirdly, besides contact with veterinarians from National Institute of Veterinary Research or other organizations conducting projects in the area, few farmers had adequate routine veterinary care. Especially when considering the relatively small amount of dairying experience these farmers have had, regular veterinary herd checks should be emphasized in Vinh Thinh commune. In addition to allowing potential herd
health problems to be detected earlier, regular health checks provide an additional opportunity for farmer education on an individual level, as the veterinarian will be able to comment on the condition of the cows and the facilities as he or she sees them.

In addition to the above, it is also important to identify other barriers that could be impeding the farmers’ success in dairying. Not only is it necessary to identify these issues, but also to determine why they are barriers to success. For instance, it will be important to examine whether the deficiency in certain practices is due to a lack of resources to implement these habits, a lack of knowledge of their importance or some other reason. Continued research should be conducted to determine the ideal allocation of resources to dairy farmers in Vinh Thinh commune in order to bring this industry to a more stable and sustainable level.
References


8. Merriam-Webster Online Dictionary. Animal husbandry. Available at:  


17. Delgado CL. Rising consumption of meat and milk in developing countries has created a new food revolution. J Nutr 2003;133(11 Suppl 2):3907S-3910S.


39. Agricultural Department, Ministry of Agriculture and Rural Development (MARD). Yearly growing trend of cattle herd.


80. Chu Thanh Huong. Personal communication.
Appendix: Figures, Photographs and Tables

FAOSTAT 2003

<table>
<thead>
<tr>
<th>Country</th>
<th>Milk consumption (kg/capita/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>43</td>
</tr>
<tr>
<td>South Korea</td>
<td>13</td>
</tr>
<tr>
<td>China</td>
<td>14</td>
</tr>
<tr>
<td>India</td>
<td>41</td>
</tr>
<tr>
<td>Thailand</td>
<td>9</td>
</tr>
<tr>
<td>Vietnam</td>
<td>5</td>
</tr>
<tr>
<td>Cambodia</td>
<td>3</td>
</tr>
<tr>
<td>Australia</td>
<td>103</td>
</tr>
<tr>
<td>United States</td>
<td>118</td>
</tr>
</tbody>
</table>

Table 1: FAOSTAT milk consumption data from the Food and Agricultural Organization for various nations in 2003.
## FAPRI 2008 Agricultural Outlook (Projected)

<table>
<thead>
<tr>
<th>Country</th>
<th>Milk consumption in 2007 (kg/capita/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>35.4</td>
</tr>
<tr>
<td>South Korea</td>
<td>31.0</td>
</tr>
<tr>
<td>China</td>
<td>8.8</td>
</tr>
<tr>
<td>India</td>
<td>36.1</td>
</tr>
<tr>
<td>Thailand</td>
<td>14.0</td>
</tr>
<tr>
<td>Vietnam</td>
<td>1.5</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.6</td>
</tr>
<tr>
<td>Australia</td>
<td>108.2</td>
</tr>
<tr>
<td>United States</td>
<td>92.5</td>
</tr>
<tr>
<td>European Union</td>
<td>69.4</td>
</tr>
</tbody>
</table>

*Table 2*: Projected Agricultural Outlook of the Food and Agricultural Policy Research Institute of milk consumption for various countries in 2007.
<table>
<thead>
<tr>
<th>Source</th>
<th>Type of assistance</th>
</tr>
</thead>
</table>
| Vietnam Belgium Dairy Project1068          | • Cold tanks for collection station  
• Plastic containers for holding milk during milking  
• Aluminum containers for filtered milk being transported to collection station  
Agencies involved: MARD and Belgian Technician Cooperation (BTC)                                                                                                                                                                                                                       |
| National Agricultural Extension Centre26, 44 | • Dairy skills training courses for technicians and farmers  
• Veterinary health training courses  
Offered in cooperation with the National Veterinary Institute, Ba Vi Cattle and Forage Research Centre of the National Institute of Animal Husbandry and provincial institutions                                                                                                                                                  |
| Project for Improvement of Cattle AI Technology1126 | • Training courses in cattle artificial insemination (AI)  
• Training course in mastitis control and treatment  
• Training course in disease treatment skills  
Offered by the Japan International Cooperation Agency                                                                                                                                                                                                               |
| Government policies (national level)  
Investment policy and credit 26, 44        | • Investment: for both the national government and local authority’s budget:  
  1. Supplied frozen semen and liquid nitrogen for AI free of charge  
  2. Supplied the vaccines of high-risk diseases for dairy cattle free of charge  
  3. Provided financial support towards the interest rate of credit loans for contracted dairy farmers. The interest subsidy was for 2 million VND/dairy cow and lasted for the first three years after buying the cow.  
  4. Provided 200,000 VND/F1 male calf for the first three years of the project.  
  5. Subsidized the costs of training and transferring of dairy farming techniques  
• Credit invested by the national plans:  
  1. Created farmer access to credit loans for the building of milk collecting stations and milk-processing units from the Development Investment Assistant Fund according to investment assistance policy  
  2. Increased the budget for the Bank for the Poor and the National Target Program for providing employment for poor families and credit for dairy farmers.                                                                                                                                 |

Table 3: Training and support offered by Vietnamese government and foreign institutions. (continued on next page)

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10 Personal interview conducted with Vinh Thinh community veterinarians on 21 August, 2007.
11 Personal interview conducted with Vinh Thinh community veterinarians on 21 August, 2007.
Table 3 continued

<table>
<thead>
<tr>
<th>Source</th>
<th>Type of Assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government Decisions</strong>&lt;sup&gt;12&lt;/sup&gt;&lt;br&gt;26, 32, 44</td>
<td>• No. 225/1999QD-TTg (December 10, 1999)&lt;br&gt;-“Approval of breeding livestock and forestry plants at the period of 2000-2005”&lt;br&gt;• No. 167/2001/QD-TTg (November 26, 2001)&lt;br&gt;-Regarding “measures and policies to develop dairy farming in Vietnam at the period of 2001-2010”</td>
</tr>
<tr>
<td><strong>Provincial level policies</strong>&lt;sup&gt;26&lt;/sup&gt;</td>
<td>- Organized educational/training opportunities&lt;br&gt;- Issued financial and related policies according to the different needs of each province. Many provinces have carried out the following priority policy for dairy households:&lt;br&gt;  - Subsidize 2-3 million VND to farmers buying a crossed red sindhi cow for AI with dairy bull semen&lt;br&gt;  - Subsidize 5-7 million VND to farmers when buying dairy cows. The rest of the money needed can be borrowed from the Bank without interest from 1-3 years&lt;br&gt;  - Financially support the cost of building a cow shelter&lt;br&gt;  - Financially support the cost of growing grass for dairy cattle&lt;br&gt;  - Financially support the cost of milk transportation and collection</td>
</tr>
<tr>
<td><strong>Community level training given by District and Community Veterinary Department experts from institutes, universities and foreign projects</strong>&lt;sup&gt;13&lt;/sup&gt;</td>
<td>- Approximately 10 community training courses offered per year&lt;br&gt;  - Infectious diseases and mastitis are discussed&lt;br&gt;  - Additional training courses offered in response to outbreaks&lt;br&gt;Four levels that give training:&lt;br&gt;  1. Government&lt;br&gt;  2. Province&lt;br&gt;  3. District&lt;br&gt;  4. Community</td>
</tr>
</tbody>
</table>

---

<sup>12</sup> Personal interview conducted with Vinh Thinh community veterinarians on 21 August, 2007.
<sup>13</sup> Personal interview conducted with Vinh Thinh community veterinarians on 21 August, 2007.
<table>
<thead>
<tr>
<th>Agent</th>
<th>Prevalence</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M. bovis</em></td>
<td>Dec 2002: 2%</td>
<td>Ha Tay province</td>
</tr>
<tr>
<td></td>
<td>Mar 2003: 0.7% (seroprevalence)</td>
<td></td>
</tr>
<tr>
<td><em>B. abortus</em></td>
<td>Jun 2002: 5%</td>
<td>Ha Tay province</td>
</tr>
<tr>
<td></td>
<td>Dec 2002: 0.9% (seroprevalence)</td>
<td></td>
</tr>
<tr>
<td><em>P. multocida</em></td>
<td>90% (seroprevalence)</td>
<td>Ha Tay province</td>
</tr>
<tr>
<td><em>L. interrogans</em></td>
<td>25% (seroprevalence)</td>
<td>Ha Tay province</td>
</tr>
<tr>
<td><em>Theileria</em></td>
<td>15% (seroprevalence)</td>
<td>Ha Tay province</td>
</tr>
<tr>
<td><em>Fasciola</em></td>
<td>22% (fecal egg output)</td>
<td>Hanoi (freely grazing Vietnamese yellow cattle)</td>
</tr>
<tr>
<td><em>Strongyle</em></td>
<td>68% (fecal egg output)</td>
<td>Hanoi (freely grazing Vietnamese yellow cattle)</td>
</tr>
<tr>
<td><em>Cooperia</em></td>
<td>Present in coprocultures</td>
<td>Hanoi (freely grazing Vietnamese yellow cattle)</td>
</tr>
<tr>
<td><em>Haemonchus</em></td>
<td>Present in coprocultures</td>
<td>Hanoi (freely grazing Vietnamese yellow cattle)</td>
</tr>
<tr>
<td><em>Oesophagostomum</em></td>
<td>Present in coprocultures</td>
<td>Hanoi (freely grazing Vietnamese yellow cattle)</td>
</tr>
<tr>
<td><em>Trichostrongylus</em></td>
<td>Present in coprocultures</td>
<td>Hanoi (freely grazing Vietnamese yellow cattle)</td>
</tr>
<tr>
<td><em>Fasciola</em></td>
<td>39% of adult cows (fecal egg output)</td>
<td>Hanoi (confined dairy cattle)</td>
</tr>
<tr>
<td><em>Paramphistomum</em></td>
<td>82% of adult cows (fecal egg output)</td>
<td>Hanoi (confined dairy cattle)</td>
</tr>
<tr>
<td><em>Giardia</em></td>
<td>50% of calves &lt; 3 mo. (fecal cyst output)</td>
<td>Hanoi (confined dairy cattle)</td>
</tr>
<tr>
<td><em>Cryptosporidium</em></td>
<td>0% (fecal egg output)</td>
<td>Hanoi (confined dairy cattle)</td>
</tr>
<tr>
<td><em>Anaplasma marginale</em></td>
<td>28% (presence of <em>A. marginale</em> antibodies)</td>
<td>Hanoi (confined dairy cattle)</td>
</tr>
<tr>
<td><em>Babesia bigemina</em></td>
<td>54% (presence of <em>B. bigemina</em> antibodies)</td>
<td>Hanoi (confined dairy cattle)</td>
</tr>
<tr>
<td><em>Neospora caninum</em></td>
<td><em>N. caninum</em> specific antibodies found in 30% of milk samples</td>
<td>Hanoi (confined dairy cattle)</td>
</tr>
</tbody>
</table>

**Table 4**: Prevalences of dairy cattle disease agents found from two studies in northern Vietnam. The first five rows of prevalences given by Suzuki are from information collected in a study in Ha Tay province in northern Vietnam. The next six rows of prevalences given by Holland are from information collected in a study among Vietnamese yellow cattle in Hanoi that were able to graze fairly freely. The final seven rows of prevalences given by Geurden are from information collected in a study of dairy cattle around Hanoi that were generally kept confined.
Figure 1: Vinh Phuc Province (highlighted)
Figure 2: Districts of Vinh Phuc Province. Vinh Thinh commune is located in the southern portion of Vinh Tuong district, marked by the box and arrow.
Figure 3: Institutional Review Board Approval of Exemption from The Ohio State University
Survey for milk safety and hygiene on dairy farms in Vinh Phuc province, Viet Nam

Date ___________ Location ________________________________________________

Interviewer ______________________________________________________________

I. General Information:
1. Head of household: _________________________________________________
2. Address: __________________________________________________________
3. Occupation: _______________________________________________________
4. Primary source of income: ___ Dairy cattle – milking ___ Dairy cattle – breeding
   Other, please explain: ________________________________________________
5. Began raising dairy cattle (year): ______
6. Size of farm: _______, Breed: ______________
7. Desire to increase size of farm , ___ No; ___ Yes, please state reason __________
   ____________________________________________________________________
8. Number of lactating cows: ________, Milk yield (kg/day): ______________
   Highest yield: ______________, Lowest yield: ______________
   Reasons for yield decrease: ___________________________________________
9. Cattle housing: Area (m2): ________; ___ Newly built, ___ Utilized
10. Does anyone live on the dairy farm?
    ___ Yes, How far is the house from the barn? __________________________
    ___ No
11. Do the farmer or workers have any type of certification/training?
    ___ Training- what type?_____________________________________________
    ___ Certification- what type? __________________________________________
    ___ No

Figure 4: Questionnaire used for farmer interviews.
Figure 4 continued

12. *Are all of the workers household members? ___ Yes, ___ No- please explain: ____________________________________________

13. **What type of support do you receive, from whom, and how often?
   ___ Financial, explain: _______________________, how often: ________________
   ___ Veterinary care, explain: ______________________, how often: ______________
   ___ Training, explain: _______________________, how often: _________________
   ___ Other, explain: ___________________________, how often: ________________

II. Nutrients:
1. Type of grass used: ___________; ___ Grown by owner, ___ Natural pasture
2. Type of feed used: _____________; ___ Mixed by owner, ___ Purchased- where purchased?
3. Vitamins and other supplements given: _______________________________________
4. Source of water: ___ Deep well water, ___ Cleansed-deep well water; Water quality examination (and result)? ______________________________

III. Veterinary Medicine:
1. Health status of the herd: ____________________________________________
2. Isolation of sick cows from healthy cows? If so, where and for how long?
3. Periodic health check: ___ No, ___ Yes – by whom? _______________________
4. Vaccinations given: ___ Brucellosis, ___ Leptospirosis, ___ Other – list: __________
   ___ _____________________________, ___ None – why not? _______________________
5. Mastitis: ___ Have basic understanding of, ___ Can differentiate between a clinical and subclinical case, ___ Do CMT test- how often? __________________________ Number of cows suffering from mastitis: ______, Therapy: _______________________
6. ___ Used antibiotics for other purposes than mastitis treatment in the past month- for what purpose? ____________________________________________
7. Veterinary expenses per year (VND): ______________________________
8. Are cows tested for other milkborne pathogens?
   ___ Cows are tested for Brucellosis, ___ Cows are tested for Tuberculosis
   ___ Cows are tested for Leptospirosis, ___ Other- please explain: __________________

Continued
IV. Milking:

1. ___ Milk by machine
   ___ Milk by hand

2. Use good hygiene practices for udders, equipment, workers’ hands, etc. before milking:
   ___ Yes- what process? ________________________________________
   ___ No- why not? ____________________________________________

   Decontamination solution used: ________________________________

3. ___ Dip teats after milking- solution used: ______________________

4. ___ Agalactosis therapy- describe: ______________________________
   ____________________________________________________________

5. In what type of container is the milk collected during the milking process?
   ___________________________________________________________
   Is this container cleaned/disinfected between milking periods?
   ___ Yes, how often? ____________________ What process and solution used? __________

6. Where are these containers kept between milking periods?
   ___________________________________________________________

7. Where is the milk stored before leaving the farm? (check all that apply)
   ___ In a refrigerated tank, ___ In a filtrated tank, ___ In an open container
   ___ In a closed bulk tank, ___ Other- please explain: _____________________

8. After milking, how long until milk is cooled in a refrigerated tank? __________
   Temperature? ____ , How long until pasteurized? ____________________

9. Where does the milk go after leaving the farm? ______________________
   What type of products will the sold milk be made into?
   ___ Pasteurized milk, ___ Non-pasteurized liquid milk
   ___ Powdered milk, ___ Fresh cheese, Pasteurized or not? __________
   ___ Another dairy product. Please describe: _________________________

10. Does the farmer consume his/her own milk?
    ___ Yes, ___ No
    If yes, how is the milk consumed?
    ___ Pasteurized (boiled), fresh milk, ___ Unpasteurized (raw) milk
    ___ Turn milk into cheese or other dairy product
    ___ Other. Please explain: _______________________________________
    If no, why not?
    ___ Do not like to drink milk, ___ It is too expensive to drink milk
    ___ Other reason. Please explain: ________________________________

11. How is milk transferred from farm to collection station? ___motorbike, ___bicycle, ___truck
    Continued
Figure 4 continued

12. What type of container is used for transfer? _____________________________

13. If the milk is contaminated beyond the acceptable level, what do you do with the milk?

________________________________________________________ What changes
do you make to solve the issue? __________________________

V. Animal Hygiene:

1. Are any other animals (wild or domestic) often on the farm? _______ What type(s)
of animal(s)? ___________________________ How many? ____________

Where do they go/live?

___ In the family’s house, ___ In the barn
___ The animals go into both the house and the barn

2. **Are there rodents on the farm?

___ Many – where? _____, ___ Some– where? _____, ___ None

3. Do cattle have a dry, shaded area to rest?

___ Cattle have a dry area to rest, ___ Cattle have a shaded area to rest

*Do cattle graze in a yard or stay in a barn all day?

___ Graze ___ Stay in barn all day ___ Other, please explain: ______________

**Is any type of bedding used (besides concrete)?

___ Yes- what type? _____________________________

___ No

How often is the concrete floor cleaned each day?

___ Several times, ___ Only before milking (2x), ___ Before and after milking (4x)

___ Other- please explain: _____________________________


*What is done with the cow manure? ___ Used as fertilizer, ___ Other, explain:_____

VI. **Milker Hygiene:

1. When do milkers wash their hands?

___ Before eating or cooking , ___ Before milking, ___ After milking

___ After using the WC

2. Do milkers wash their hands with soap?

___ Yes, ___ No, ___ Sometimes

3. After washing, do milkers dry their hands with a clean towel?

___ Yes, ___ No, ___ Sometimes

4. If milkers are sick, do they still go to work?

___ Yes, ___ No, ___ Sometimes

Continued
Figure 4 continued

Kitchen Hygiene:

1. Do the milkers prepare food during the day?
   ___ Yes, ___ No, ___ Sometimes

2. Do you keep raw meat and fruits/vegetables separated in the kitchen?
   ___ Yes, ___ No

3. Do you wash your hands and utensils with soap and water after handling raw meat?
   ___ Yes, ___ No

4. **After eating, how long until you put the food back into the refrigerator?
   ____________________________________________________________________

What is the temperature of your refrigerator? ____________________________

5. Do you wash fruits, vegetables, and eggs before cooking and/or eating?
   ___ Wash fruits, ___ Wash vegetables, ___ Wash eggs
   ___ Do not wash fruits, vegetables, or eggs before cooking or eating

Requests, Questions, or Comments of Household:

1. ____________________________________________________________________

2. ____________________________________________________________________

3. ____________________________________________________________________

4. ____________________________________________________________________

* Denotes a new question not included in original survey questionnaire.

** Denotes a non-grammatical change in wording of a question from the original survey questionnaire.
Figure 5: Years of dairy farming experience of each farmer, as of July/August 2007.

Figure 6: Years of dairy farming experience vs. herd size of farms.
Figure 7: Length of farming experience vs. average milk yield.

Photograph 1: Photograph taken from the entrance to the main living area of the farmer’s family. To the right is the cow barn.
Figure 8: Length of farming experience vs. land area of farm.

Photograph 2: Photograph of a concrete floor typical of most dairy cow housing facilities.
Photograph 3: Ventilation holes can be seen in the middle of the brick wall, as well as near the ceiling (in addition to ventilation provided by the lack of a wall where the photograph was taken).

Photograph 4: Ventilation provided by the lack of walls on 3 sides and space between the back wall and ceiling.
**Figure 9:** Handwashing practices reported by farmers. Note that the third category is out of 30 observations and the last two categories are out of 23 observations.
Figure 10: Suggestions given by farmers during the interviews. Farmers desired increased training opportunities, a higher milk price, financial support, support for equipment/supplies, increased availability of veterinary services, construction of a Biogas facility, cooperation and teaching among farmers within the dairy community and increased availability of land. All categories are out of 31 observations.