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Full Length Research Paper

Smallholder dairy production in Southern Vietnam: Production, management and milk quality problems

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The aim of this study was to investigate the prerequisites for dairy production at smallholder farms in Southern Vietnam and to identify the strengths and weaknesses in management at farm level. Data on milk production, management routines and heat stress were collected during farmer interviews and field observations on 120 smallholder dairy farms. Individual milk samples were taken from 360 cows. The average herd contained 12 animals (ranging from 2 to 17), dominated by lactating cows. The main dairy breeds were Holstein Friesian crossbreeds, mostly at F2, F3 and F4. The mean Temperature-Humidity Index was 81 (range 75 to 97) in the morning and 85 (range 72 to 104) in the afternoon and the mean respiration rates for cows were 54 (range 30 to 102) and 70 (range 35 to 116) breaths per minute, with mean rectal temperatures of 38.8°C (range 38 to 39) and 39.3°C (range 38.3 - 40.9). The milk somatic cell count (SCC) was high in all farms, averaging 1, 300, 000 cells/mL. The strength of the dairy producers was their willingness for further education, as 80% of the farmers attended training courses, while poor udder health and heat stress were the most pronounced problems.

Key words: Milk quality, questionnaire, smallholder dairy farms, milk somatic cell count.

INTRODUCTION

Dairy production was introduced to Southern Vietnam during the 1980's when the domestic demand for dairy products increased significantly (Tam, 2004). The Vietnamese government has been promoting the development of dairy cattle production since 2001 (Do and Hoang, 2001). Dairy production started in the districts in the vicinity of Ho Chi Minh City and was initially at backyard level, with very few milking cows per household. Although a few large-scale, modernized dairy farms (that is, more than 100 cows per farm) have been established in the peri-urban areas, small dairy farms still dominate the dairy systems, contributing 90% of the total milk volume (Huyen et al., 2006). However, the smallholder systems have a low milk output per animal and provide relatively poor quality milk (Falvey and Chantalakhana, 2001).

To improve and increase dairy production, national breeding programs for dairy herds have been introduced. The use of new reproduction techniques has facilitated cross-breeding local breeds with breeds from the temperate countries and the Holstein Friesian (HF) breed is the dominant breed in breeding programs(Falvey and Chantalakhana, 2001). Artificial insemination (AI) has been widely used for rapid upgrading of dairy cows and crossbred HF cows are now the main dairy cattle breed in Southern Vietnam. Short training courses for farmers (Cai, 2002; Luthi et al., 2006) have contributed to the increased number of cattle and higher milk production.

Domestic milk production only satisfies 20% of the local consumer demand in Vietnam and as a result, milk powder is imported, mainly from Australia and New Zealand (Cai, 2002). The Vietnamese government has declared that dairy production must increase and has set a goal for domestic production to cover 40% of the national demand by 2010 (Do and Hoang, 2001). Breeding programs alone are insufficient to meet this

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Figure 1. Map of Vietnam with study area: Ho Chi Minh city, District No.1 and Cu Chi districts. Adapted from http://www.vietnambudgettour.com/webplus/viewer.print.asp?aid=116 and l=EN

goal; therefore, animal management at the farm level, including feeding and milking management must improve.

The objective of this study was to investigate the pre-requisites for improving dairy production on smallholder farms and to identify the strengths and weaknesses in management at farm level.

MATERIALS AND METHODS

Study sites and farm selection

The survey was carried out in the area around Ho Chi Minh City, which is located in Southern Vietnam. The mean maximum and minimum air temperatures are 33.3 and 25.9°C, respectively, while the mean maximum and minimum relative humidities are 81 and 68%, respectively. Annual rainfall averages between 1,500 to 1,600 mm and there is a rainy season between May and October. The area includes 54% of all the dairy cattle in Vietnam.

The individual farms that participated in the survey were located in two peri-urban districts, Cu Chi and District Number 12, which have at least 1,000 dairy farms each and situated between 20 and 40 km from the center of Ho Chi Minh City (Figure 1). Maps as well as secondary data pertaining to the socio-economical situation and dairy production of farms in these districts were collected from district and village offices to identify research sites. In each district, 60 smallholder dairy farms were randomly selected. These 120 farms represented approximately 6 % of smallholder dairy farms in the two districts.

Data collection

Direct interviews based on a questionnaire and field observations using a protocol were used to collect milk production and farm management data. The questionnaire consisted of 56 questions related to household, cow breed and breeding, feeding system and management, milk production capacity and milking routines and management. The questionnaire was pretested in the field and modified before being used to guide the official interviews. Interviewers used the questionnaire to interview representatives from each household who were knowledgeable about dairy production on their farms. Each interview lasted for about three hours. The interviewers also requested an additional farm visit to take field observations, milk and feed samples and any other necessary measurements. A protocol was used during farm visits for observations of hygiene, feed and water, milking routines and

Table 1. Herd structure on smallholder dairy farms (n = 120) in Southern Vietnam.

Cow category	Number of cows, Mean (SD)	Proportion of the herd, (%)	Generation
Lactating cows	6 (5.4)	50.0	F2, F3, pure HF
Dry cows	1 (2.1)	8.0	F2, F3, pure HF
Heifers	2 (2.7)	17.0	F3, pure HF
Calves	3 (3.4)	25.0	F3, pure HF

SD = standard deviation, HF= Holstein-Friesian.

practices as well as general farm conditions.

Sampling and analyses

Milk samples were randomly taken from 20% of the healthy cows, according to the farmers, on each studied farm. This corresponded to a total of 360 individual milk samples. These samples were collected during one afternoon milking and preserved using bronopol. The samples were then analyzed for fat, protein, lactose, dry matter (DM) and solid non-fat according to the mid-infrared spectroscopy method (Farm Milk Analyzer, Miris AB, Uppsala, Sweden). Milk somatic cell count (SCC) was determined on the farms, directly following sampling, by the fluorescent method, using a DeLaval cell counter DCC (DeLaval, Tumba, Sweden).

The respiration rate and rectal temperature of the selected cows were measured twice, at 08:00 and 14:00, on the same day milk sampling took place to determine the animals' state of heat stress. Air temperature and relative humidity were recorded at the same time.

Statistical analyses

The data were analyzed using SPSS for Windows version 14.02 (SPSS Inc., ©1989-2005). After categorizing and coding the data, descriptive statistics including mean, median, frequencies, maximum value, minimum value and range were produced. Quantitative variables were compared using t-tests to test for significant differences ($P < 0.05$) between the two districts. Chi-squared tests were used for categorical variables. Milk SCC was divided into two categories: < 400,000 and > 400,000 cells/mL milk.

According to Scharm et al. (1971) cows with SCC > 400,000 cells/mL milk are positively correlated with subclinical mastitis, while cows with < 400,000 cells/mL are negatively correlated. Milk SCC data were $\log_{10}$ transformed prior to analysis to compensate for a skewed distribution.

RESULTS

Farmers' socioeconomic profile

Of those farmers managing the dairy farms, 41.7% had elementary school, 35.8% junior high school, 20% senior high school, 0.8% vocational schools and 1.6% college or university education. Almost all of the dairy farm owners (90.8%) were full-time farmers, and the remaining 9.2% worked as local officials, teachers or retailers. There was a wide variation in dairy farming experience, ranging from 2 to 30 years, with 60.8% of the farmers having 10 to 20 years experience. Dairy farmers in District Number 12 had significantly ($P < 0.001$) more years of experiences compared with farmers in Cu Chi district, with 13 and 9 years on average, respectively. In both districts, extension centers organized 1 to 3 day annual training courses in dairy practices. Most of the farmers (79.2 %) attended these or other training programs in dairy production, while 20.8% had not attended any training and learned how to dairy farm from their neighbors or from trial and error.

Description of the land holding and dairy herds

On average for both districts, the dairy farm holding was 4,700 m^2. The average total land holding per farm in Cu Chi district (7,300 m^2) was larger ($P < 0.001$) than in District Number 12 (2,700 m^2). There were differences ($P < 0.001$) in the farm area allotted to pasture and crops between Cu Chi (2,600 and 4,200 m^2, respectively) and District Number 12 (2,400 and 1,000 m^2, respectively). Furthermore, 72.4% of the dairy farmers in Cu Chi district and 10.0 % in District Number 12 did not own land for either pasture, or crops.

There were three main categories of dairy-based farms in the area: farms with dairy cattle only (77.5%), farms with dairy cattle and crop production (20%) and farms with dairy cattle and other animals (2.5 %). The main breeds of dairy cattle were HF crosses (95.8%) with only a small percentage of the farms having crossbred Sindhi (4.2%). The farmers kept between 2 and 50 cows with a majority of the households owning between 2 and 17 cows (mean = 12). Around 25% of the herds contained 1 to 5 cows, 39% 6 to 10 cows and 36% more than 10 cows. Lactating cows made up the majority of all the herds (Table 1). Both total land owned and pasture land owned were positively correlated with herd size ($r (120) = 0.25$, $P= 0.007$ and $r (120) =0.30$, $P< 0.001$, respectively). The number of lactating cows on the farms correlated positively with the farmer's experience in dairy production ($r (120) = 0.25$, $P = 0.006$).

Description of feeding

Dry matter intake and the proportion of different feed types for lactating cows and heifers are presented in

Table 2. Feed types and intake for lactating cows and heifers on dairy farms (n= 120) in Southern Vietnam.

Feed type	Lactating cows Mean (SD) (kg DM)	Proportion of the feeds, (%)	Heifers mean (SD) (kg DM)	Proportion of the feeds, (%)
Roughage	6.4 (1.6)	46.8	4.1 (1.1)	60.9
By-products	2.7 (0.5)	19.5	1.3 (0.4)	19.2
Concentrates	4.6 (0.9)	33.7	1.6 (0.3)	23.0
Total, kg DM/cow/day	13.7	100	6.8	100

SD= standard deviation, DM= dry matter.

Table 2. In general, farmers fed their milking cows twice a day, with concentrates before milking and with roughages such as green grasses and rice straw after milking. Farmers used green grasses from fallow land, their backyard or from the pasture to feed the lactating cows. The grass species commonly grown in the backyard were *Panicum maximum* and *Pennisetum purpureum*. Some pastures were established in wetland areas characterized by acid and infertile soil, where the farmers could not grow any crops. However, grass species used for pastures were wild species and adaptable to the wetland conditions. The cows were fed between 20 to 40 kg of roughage per day, depending on the availability of grasses and rice straw, stage of lactation and amount of commercial concentrates. Brewery by-products and commercial concentrates were mixed with water and given as protein supplementation. The typical consump-tion of commercial concentrates was 4 to 6 kg per day, depending on milk yield. Around 76% of the farmers fed their cows 3 to 6 kg rice straw each evening. The cows were usually offered commercial mineral blocks in the barn, but only 8% of the farmers gave their cows mineral blocks *ad libitum.* Heifers were typically fed the same feedstuffs, but around only half as much as the cows.

After feeding, concentrate residues were removed and troughs filled with water for free access during the day. However, it was observed that the water had fermented in 45% of the troughs and, in those cases, the cows did not drink water at all. According to data from the inter-views, the cows were offered 20 to 60 L water per day, depending on how farmers fed concentrates (mixed or dried). Only 35.8% (43 farms) of dairy farmers provided fresh water *ad libitum* in a separate trough for the cows and 51.7% (62 farms) provided less than 30 L of water per cow and day, as measured by the interviewer.

Milking routines and milk quality

Hand milking was practiced on 90.4% of the farms, whereas 9.6% of farmers used milking machines. Different hand milking techniques were used: 78.3% used full-hand, 20% thumb-in and 1.7% used stripping. In herd sizes of 16 to 20 cows, the milking tended to be done by machine. Farmers usually cleaned the cows' udder with water before milking, although almost none of the observed farmers used any solutions for cleaning the teats. Neither did they perform post-dipping after milking, except in cases of mastitis. In both districts, the cows were milked twice a day at 04:00 to 06:00 and 15:00 to 17:00. On 34% of the farms, laborers were employed for milking, while 66% of the farms managed the milking using family members. On those farms where machine milking was practiced, teat cups were dipped into a solution of sodium hypochlorite (NaClO) after milking as a way of cleaning the equipment. If the teat cups and devices were dirty, the farmers cleaned the equipment using brushes and sanitized with NaClO. The cows and barns were cleaned twice a day, when the farmers prepared for milking.

Farmers delivered their milk to the collection centers after milking. According to the survey, the average daily milk yield was 16 kg/day/cow, and this did not differ between districts. Milk yield and quality records were managed by the milk collection centers and therefore no data, apart from those received from the farmers, were available for individual cows. Milk quality was an important consideration for 88.9% of the farmers, who all emphasized the milk fat content, whereas 11.1% did not consider milk composition. The average fat, protein, and lactose contents were 4.1, 3.2, and 4.7%, respectively. However, there was a wide variation in milk composition among farms (Table 3) and even among cows.

Milk SCC was observed to be high on most farms in both districts, on average 1,300,000 cells/mL. Sixty-nine percent of the cows had SCC> 400,000 cells/mL, while 31% had SCC< 400,000 cells/mL. There was a significant negative correlation (P= 0.02) between observed milk yield and SCC in the milk. The higher the milk yield, the lower the SCC (Table 4). There were significantly more cows with SCC> 400,000 cells/mL compared to cows with <400,000 cells/mL (χ^2 = 19.31, P < 0.001).

Neither herd size (χ^2 = 3.828, P = 0.15) nor hired labor (χ^2 = 1.834, P= 0.18) significantly affected SCC in the milk even though tendencies were observed for both. In herds with 1 to 5 cows, 47% of the tested cows had SCC < 400,000 cells/mL, while in herds 6 to 10 and more than10 cows, 31 and 19% had SCC < 400,000 cells/mL, respectively. In herds where the farm families did all the milking, 35% of the tested cows had SCC below 400,000 cells/mL, while 24% of the cows had SCC < 400,000

Table 3. Milk composition and the somatic cell count in milk on smallholder dairy farms (n = 120) in Southern Vietnam.

Quality	Mean	Range	SD
Fat (%)	4.1	2.8 - 5.5	0.54
Protein (%)	3.2	2.8 - 3.9	0.15
Lactose (%)	4.7	3.7-5.3	0.25
DM (%)	12.6	9.6 - 14.2	0.79
SNF (%)	8.6	7.0 - 9.3	0.32
SCC (cells/ml)	1,300,000	3,700 - 4,160,000	900,000

SD= standard deviation, DM= dry matter, SNF= solids-not-fat, SCC= somatic cell count

Table 4. Milk yield and somatic cell counts in the milk from 360 dairy cows in Southern Vietnam.

Milk yield (kg/day)	No. of cows	SCC < 400,000	%	SCC> 400,000	%
<13	78	13	16.7	65	83.3
13 – 16	153	51	33.3	102	66.7
>16	129	47	36.4	82	63.6

SCC= somatic cell count

cells/mL in herds milked using hired labor. A numerical difference was observed in milk quality due to the age of cows. More cows with SCC < 400,000 cells/mL milk were observed for cows in their second lactation, while cows in at least their third lactation had more often SCC > 400,000 cells/mL. More than 70% of the cows with SCC > 400,000 cells/mL milk were lactating for the first time.

Reproduction and calf rearing

There was a difference in artificial insemination success for heifers and lactating cows. Of lactating cows, 47.5% were inseminated 3 to 4 times and 43.4% were inseminated 5 to 7 times per pregnancy. The farmers usually sold their cows if they failed with artificial insemination more than 7 times. Consequently, 27.5% of the lactating cows lactated more than 12 months, 50% lactated up to 10 months and 14.2% only produced milk for 7 to 8 months. Heifers were artificially inseminated for the first time when they were 12 to 20 months old and they calved at 22 to 29 months old. On average, heifers were artificially inseminated 1.5 times. The percentage of successful artificial inseminations at the second service was 82.5%.

Male calves were sold after birth, while female calves were recruited to replenish the herds. Considering calf rearing methods, 72.5% of dairy farms provided the calves with buckets of milk and the other 27.5% used restricted suckling methods. The female calves were fed 2 or 3 times per day at milking time with a total amount of 4 to 6 kg milk. The interview data were not compared with field observations. However, it was observed that farmers fed their calves 6 to 8 kg milk/day to encourage fast growth (data from 46 farms) . Ninety-percent of farmers responded that saleable milk yield increased if the calves were raised by artificial rearing methods. At the same time, there was no significant correlation between calf-rearing method and milk yield or milk quality in the survey data.

Heat stress

During the interviews, 59% of dairy farmers reported that lactating cows showed symptoms of heat stress during the onset of the dry season, whereas 40% of dry cows and less than 12% for heifers showed the same symptoms. A higher number of farmers (83.4%) reported that lactating cows were sensitive to an increase in temperature during the day. Almost none of the farmers applied any cooling system to regulate the dairy barn environment. The mean Temperature-Humidity Index (THI) was 81 (range 75 to 97) in the morning and 85 (range 72 to 104) in the afternoon. The cows' mean respiration rates were 54 (range 30 to 102) and 70 (range 35 to 116) breaths per minute and the mean rectal temperatures were 38.8°C (range 38 to 39°C) and 39.3°C (range 38.3 - 40.9°C) in the morning and afternoon, respectively (Table 5).

DISCUSSION

One prerequisite for improving farm management is the possibility for knowledge transfer from advisors to farmers. From the interviews it became clear that most of the farmers had more than 10 years of experience in dairy farming and more than 90% of the farm owners

Table 5. Heat stress indicators in dairy cows on smallholder dairy farms (n=120) in Southern Vietnam.

Parameter	n	Mean	Range	SD
THI, 08:00	117	82.6	75.3-96.6	4.28
THI, 14:00	117	85.9	72.1-104	5.40
Breathing rate, 08:00	360	55	30-102	14.20
Breathing rate, 14:00	360	71	10-116	19.70
Rectal temp., 08:00	360	38.7	38.0-39.0	0.39
Rectal temp., 14.00	360	39.0	38.3-40.9	0.56

SD= standard deviation, THI= Temperature-Humidity Index.

actually worked on the farm. This makes it easier for advisors to improve dairy production since the advice goes directly to the dairy farmer. That the number of cows was positively correlated with farmer experience in dairy production indicates a production development process in the studied area. The willingness to attend further education and insight into its importance was indicated by the high percentage of farmers (80%) attending training courses.

From the survey it became clear that udder health was one of the most important issues that needed improvement. This was obvious with respect to the high SCC in milk on the studied farms. High SCC affects both milk quality and milk yield (Harmon, 1994). In the present study, a negative correlation between milk yield and SCC was observed. Although there was a wide variation among farms, most of the cows had high SCC, which is an indication of poor udder health. It has been suggested that healthy udder quarters should have milk SCC below 100,000 cells/mL (Kitchen, 1981; Smith et al., 2001). In the present survey, SCC averaged 1.3 million cells/mL milk with a large standard deviation. Since cows with clinical signs of mastitis were excluded from sampling, subclinical mastitis can be concluded to be a major problem in the survey area. The actual cause of the high SCC is unknown and needs to be investigated in more detail. Milk SCC is influenced by housing, feeding, hygiene and milking routines (Scharm et al., 1971; Klastrup et al., 1987). Several of these factors could have contributed to the high milk SCC.

The frequency of cows with SCC < 400,000 cells/mL was lower in smaller farms and farms where the family members performed all the milking. This observation is in agreement with the findings of Thomas et al. (2004), who surveyed dairy buffalo farms in India and found that small herds where the milking is done by hand had a lower prevalence of mastitis. In the present study, most of the farms practiced hand milking, so the high SCC cannot be related to the use of milking machines. However, different hand milking techniques were used and either thumb-in, or stripping was practiced in more than 20% of the observations and both of these techniques can cause injury in the teat mucous. Another explanation could be the routines prior to milking (Rhone et al., 2007). It was reported in this survey that teat dipping was only done when the cows had mastitis, but teat dipping should to be done for all cows in the herd during all milkings to reduce the occurrence of mastitis (Van Schaik et al., 2005). By regularly practicing teat dipping the rate of new intra mammary infections could be reduced by about 50% if the infection is caused by contagious pathogens. Post-teat dipping is less effective at preventing mastitis caused by pathogens from the environment (Fang and Pyörälä, 1995). The kind of bacteria that causes the problems observed on the farms in the present study is unknown.

In this study, dairy cows lactating for the first time had a higher frequency of SCC < 400,000 cells/mL milk, while cows in their second lactation were healthier and thereafter, the problem increased again with age. The cows that develop mastitis during their first lactation are probably removed from the herd and therefore, never reach their second lactation. It has been reported that the prevalence of intramammary infection is high in peripartum dairy heifers (Olivier and Mitchell, 1983; Pankey et al., 1991). Since the farmers in our study were not aware of the problem of subclinical mastitis, it is likely that cows lactating for the first time are not treated sufficiently for mastitis.

It was observed that the cows experienced heat stress in the hot and humid climate. Many of the farmers claimed that the lactating cows suffered especially from heat stress. This was confirmed by measurements taken on the milk sampling day. The mean THI was 83 in the morning and 86 in the afternoon. Values greater than 78 have been shown to cause distress. At that point lactating cows are unable to maintain normal body temperature (McDowell et al., 1976). THI values have been set in a previous study: values between 78 to 83 mean “danger” and above 84 “emergency” (USDC-ESSA., 1970). Lactating dairy cows prefer ambient temperatures between 5 and 25°C and at temperatures above 26°C they can no longer adequately regulate body temperature and enter heat stress. High relative humidity further reduces respiratory and surface evaporation, which results in a rise in rectal temperature. This temperature increase leads to reduced feed intake and lower milk production (Johnson and Vanjonack, 1976). The cows in the present study had high rectal temperatures and respiration rates, indicating that they were suffering from heat stress. Cows normally take 15 to 30 breaths/minute.

Respiration rates reaching 116 breaths/minute, as observed in some cows in this survey, is a clear indication of heat stress (Stowell, 2000).

Heat stress in dairy cows is breed-specific with tropical breeds being less responsive to thermal stress than *Bos taurus* cattle like Holstein-Friesian. The dominant breed on the farms surveyed was an F3 generation crossbreed. As much as 87.5% of the genetic makeup in such cattle originates from the Holstein breed and this could be a reason for the high number of cows that experienced heat stress. Moreover, it is known that heat stress is a major contributing factor to low fertility in hot climates, which could explain the low artificial insemination success in the current survey. Cavestany et al. (1985) demonstrated that high environmental temperatures are associated with low breeding efficiency, due to a variety of factors. Besides lowered progesterone secretion and oocyte quality, there is also increased embryo mortality (Wolfenson et al., 2000). Access to large amounts of drinking water is essential for milk production in tropical environments. Water intake increases during heat stress due to increased water metabolism, but water intake is also a way of cooling. Furthermore, water is the principal component in milk and a severe restriction will lead to reduced milk yield. To alleviate heat stress, cows in the surveyed area should be given free access to drinking water, since heat stress is apparent and increases water requirements (Beede and Collier, 1986). Surprisingly, only 36% of the farmers provided their cows with fresh drinking water *ad libitum*. Moreover, only 8% of the farmers gave their cows *ad libitum* access to minerals. Minerals are important to avoid a deficiency in major monovalent ions (sodium, potassium and chlorine) that is common among heat-stressed animals. It is widely accepted that heat stress reduces voluntary feed intake (Fuquay, 1981; Collier et al., 1982) which affects digestive functions as well as the quantities of minerals consumed.

The average milk composition for fat, protein and lactose was in line with what has been reported earlier (Jeness, 1985); however, the large variation is noteworthy. The low fat and protein levels indicate that feeding might be a problem. Low fat content could be a result of too little roughage in the feed (Davis and Brown, 1970) or of incomplete milking. Bouraoui et al. (2002) also reported that summer heat stress reduced milk yield and lowered milk fat and protein. A majority of the farmers fed their cows with rice straw during the evening to improve the milk fat content. However, rice straw has a low concentration of crude protein and was probably not subjected to any treatment. Urea- treated fresh rice straw, for example, markedly improves the nutritional value of the feed (Man, 2001). In fact, it is especially important to improve the nutrient values in the feed, because feeding costs account for 40 to 60% of the total cost of dairy farming. Low protein content also indicates a lack of digestible energy in the feed (Kaufmann, 1976).

Low lactose levels are usually related to clinical mastitis (Claesson, 1965) and increased levels of milk SCC (Berglund et al., 2007). The low lactose levels observed in milk samples in this survey further strengthen recommendations for improved udder health. Milk yield was solely recorded by the milk collecting center, where-by several farmers paid no attention to the importance of keeping their own farm milk records. For management purposes, regular milk recordings could be a way to improve feeding as well.

The findings of the study suggest that although HF at F3 predominated, heat stress is still a serious problem. The heat stress of the HF crosses resulted in many pro-blems related to reproductive capacity, milk quality and production. These challenges need to be further studied with respect to their implications under smallholder dairy management.

Conclusions

The study showed that certain prerequisites exist for improving dairy production in Southern Vietnam, since farmers were willing to attend further education courses. One of the main challenges to dairy farming in Cu Chi District and District Number 12 is to improve the udder health status of the cows on smallholder farms. Milk SCC was relatively high on all of the farms studied and in all stages of lactation. The high SCC could be associated with milking management and probably stems from unhygienic milking practices in combination with heat stress. Steps should also to be taken to alleviate the heat stress reported in dairy cows on smallholder farms in southern Vietnam.

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