Environmental Conditions and Resource Management in Smallholder Dairy Farms in Thailand. I. Production Systems and Management of Resources

P. Skunmun, J. Boonsom, S. Kaewsuwan and C. Chantalakhana[1]
Kasetsart University, Bangkok 10900, Thailand

ABSTRACT : This study aims to make detail examination of smallholder dairy farming systems in the Nongpho Dairy Cooperative. Forty-three dairy farms were selected from three geographical areas i.e. irrigated area, municipality area, and factory area. Within each area some number of sample farms were selected from each of the three levels of farm and animal crowdedness (very crowded, crowded, and not crowded farms). Detail data were collected during 1996 to 1997, they were socio-economic conditions of the sample farms and farmers, dairy production systems and management of resources (animals, barn, feeds, stocking rates, herd structure, animal body conditions, milk yield and milk quality, manure and farm wastes management, and other related items). Detail information useful for the improvement of farm production efficiency were discussed. It was very clear that much improvement of smallholder dairy production can be achieved if the recommendations given by this study were implemented. (*Asian-Aus. J. Anim. Sci. 1999. Vol. 12, No. 2 : 215-219*)

Key Words : Smallholder Dairy Farming, Resource Management, Production Systems, Milk Production and Milk Quality, Animal Wastes

INTRODUCTION

Dairy development in Thailand began about four decades ago. Presently, most dairy farms can be generally classified as smallholder dairy, which are also very common in most developing countries, especially in Southeast Asia (Chantalakhana, 1995). Detail information about farming practices including the management of resources in smallholder dairy farms are lacking and much needed in order to improve their efficiencies and profitability. Most available information so far, both in Thailand and other Southeast Asian countries, were related to general socio-economic and production profiles but lacked in-depth farm data (Kanchanaprutipong, 1990; Ekasingh, 1997; Thongpan, 1997) which can be used to pinpoint strengths and weaknesses of dairy farm operation. This study, which is part of the main research project aiming to investigate the environmental conditions and the status of resources management of dairy farms, intends to obtain basic information on farming practices and the management of resources of some selected smallholder dairy farms.

MATERIALS AND METHODS

A. Site of investgation and farm samples

The sample farms used in this study were located around Nongpho sub-district, Ratchaburi province, all of them were members of the Nongpho Dairy Cooperative which is the largest and one of the oldest dairy cooperatives in Thailand. The detail description of the Nongpho Dairy Cooperative (NP) had been described by Chantalakhana (1995). Forty-three NP dairy farms were purposively chosen to study environmental conditions, as well as other related detail information on production systems. The sample farms were chosen from 3 areas: (a) Irrigated area where irrigation canals were available and existing dairy farms tended to be more congested, (b) Municipality area where certain public facilities, such as road, telephone, and sewage system were available, and (c) Factory area where some manufacturing factories existed among dairy farms and they could compete for certain resources such as labor and water supplies during certain time.

From within each specified area three groups of sample dairy farms were chosen according to 3 different levels of farm crowdedness i.e. (1) very crowded, (2) crowded, and (3) not crowded. These levels of crowdedness can be described as the followings.

- **Very crowded farms** (NP1) were those situated among many nearby neighboring farms, with relatively small farm area, high stocking rates, cow barn commonly attached to the house, and no constructed waste disposal system.

- **Crowded farms** (NP2) were those farms under similar conditions as that for NP1 but with relatively less degree of congestion.

- **Not crowded farms** (NP3) were those with relatively larger farm area, cow barn usually being distant from the house, and with better or easier maintenance of farm cleanliness and waste management.

The number of sample farms are shown in table 1.

Table 1. Number of experimental farms classified by areas and levels of crowdedness

Farm area	Levels of crowdedness			Total
	NP1	NP2	NP3	
A	5	7	3	15
B	4	6	4	14
C	5	5	4	14
Total	14	18	11	43

[1] Corresponding Author: C. Chantalakhana.
Received April 4, 1998; Accepted October 10, 1998

B. Data collection

1. Data concerning socio-economic background of farm families and general farming practices were recorded at the beginning of this study (November 1996) through farmer interview at farm site using a prepared questionnaires as well as direct observation or data collection by project technicians.

2. Other farm data collected in this study were :

(1) Animal stock : herd structure or composition, body condition score.
(2) Animal housing and management : stocking rates, animal management systems, barn cleanliness score, labor use, etc.
(3) Feeds and feeding : sources of roughages, water supplies.
(4) Milk and milking : milk yield, milk quality, milking methods, sale, etc.
(5) Manure and wastes : management, utilization, sale, possible pollution.

The details of data collection are given in the next section.

RESULTS AND DISCUSSION

A. Socio-economic background of sample farms

Formerly most NP farmers were traditional paddy farmers before they switched to dairy farming about four decades ago. After several years of dairy farming, one dairy farm could expand into two or three or more dairy farms within the same plot of land due to traditional family expansion, and eventually most of these dairy farms became very crowded. As shown in table 2, the sample farmers have been in dairy farming from 18±9 to 19±7 years.

Table 2. Some background data of NP farmers

Item	Nongpho		
	NP1	NP2	NP3
Ave age of farmers, yr	52±14	45±14	49±12
Education, grade 4 (%)	57	92	67
No. of family members	5.4±2	4.5±2	4.8±1
Percent farmers received training	86	78	83
Family labor, hd	3.1±1	2.7±1	2.8±1
- male	1.3	1.3	1.3
- Female	1.8	1.4	1.5
Local residence, yr	>50	31-50	31-50
Average land holding	1.0	0.6	0.9
- Within village, ha	(0.03-5.8)	(0-2.4)	(0.02-2.4)
Length of dairying, yr	18±7	19±7	18±8
No. of farms	14	18	12*

* One of these farms gave up dairy farming shortly afterward.

Most of these farmers completed only fourth-grade education and had received some dairy training which was offered traditionally by the NP Dairy Cooperative. The average size of landholding per farm, not including land owned by some of the farmers outside their farm, were 0.6 to 1.0 ha. Farm labor came almost totally from family labor, except some extra labor for taking care of occasional needs, for instance when a family member being away from home.

B. Dairy production systems and management of resources

1) Dairy barn and management. Ninety five percent of the 43 sample farms had an area of less than 0.32 ha for family housing and dairy raising, not including forage growing areas of some farms which were usually distant or isolated from the barn area. All of NP1 farm areas were less than 0.16 ha, while only 83% of NP2 and 58% NP3 farms had the average of dairying area smaller than 0.16 ha. The average numbers of dairy cows per farm were 22.7, 26.2, and 19.3 for NP1, NP2, and NP3 groups of farms, respectively. Milking cows as well as some dry cows were kept in free-stall barn which also served as milking parlor. Fifty to 89% of the farms kept milking cows tied to their stall at all time, while some farms (5 to 35%) let the cows outside the barn part of the time on day, only a few farms had small pasture plot for milking cows to rest outside the barn partly during the daytime.

All cow barns had no wall and were commonly constructed with tile roof and cement floor with open stalls for individual cow. Feeds and water were given to cows in the same feed trough. Most cow barns were either attached to the farm family house, or under the house in case of a two-storey house, or only a few meters away from the house, while some barns even shared the same roof of the family house (see details in table 3).

Table 3. Sites of dairy barn in relation to farmer's house

Barn site	NP1	NP2	NP3	Total
Within the house	1	1	-	2
Under the house	4	2	-	6
Attached to the house	7	5	3	15
1 m from the house	1	2	1	4
2-5 m from the house	-	6	4	10
7-14 m from the house	1	2	2	5
100 m from the house	-	-	1	1
Total	14	18	11	43

2) Stocking rates. The data on stocking rates reported here were the records of dairy animals and area of each farm collected in February and May 1997. The farm area (A) was measured in square meters (m^2) covering one piece of land used for raising dairy animals including animal barns as well as family housing, but not including isolated forage plot in other site away from the farm, if any. The total number of dairy animals (T) and the total number of milk cows both dry and milking (C) were used to calculate stocking rates. Since dairying area of each farm was

rather small and being measured in square meter, hence, for convenience of calculation two estimates of area (m^2) per animal were computed i.e. (1) A/T or area per animal for total stock and (2) A/C, as shown in table 4.

Table 4. Area (m^2) per dairy animal in NP farm.

Area	A/C[1]			A/T[2]		
	NP1	NP2	NP3	NP1	NP2	NP3
February 1997						
A	97	173	106	47	78	63
B	30	140	168	17	74	95
C	69	70	199	32	41	127
AVE	66	128	156	32	64	94
May 1997						
A	93	167	101	48	78	62
B	31	140	162	17	80	89
C	62	66	201	32	41	133
AVE	62	125	153	32	66	94

[1] Area (A)/No. of mature cows (C).
[2] Area (A)/Total number of dairy animals (T).

These figures obviously reflected the degrees of crowdedness of NP dairy farms. In general, for typical dairy farming at least 1/2 to 1 ha of land per cow is required for milk production including forage or pasture area, but for these NP farms due to continuing expansion of family dairy farms in the same plot of land as well as increasing number of cows per farm, the area per dairy animal had become extremely small. Sources of roughages used for dairy feeding had to be sought from other areas outside the farms, while farm environmental quality and sanitary conditions for the farmers and other people in neighboring areas could be affected due to excessive animal wastes and pollution (Chantalakhana et al., 1995).

C. Dairy cows

Almost all dairy cows in NP farms were high grade Holstein-Friesian (HF) crosses resulting mainly from artificial insemination of local dairy cattle with imported frozen semen. The original local dairy were derived from *Bos indicus* dairy breeds, such as Red Sindhi and Sahiwal, by crossing with the local cattle. Most of the dairy cows in NP farms were 75% HF or higher, many of them can be regarded as local HF or Thai HF.

1. Herd structure.

The data used in this study were the records of all animals of different sexes and ages in each of the sample farms collected in February 1997, which consisted of the following classes of animals ; (1) milking cows or cows in milk at the time of recording, (2) dry cows, (3) pregnant heifers, (4) young heifers (>12 m of age), (5) heifer calves (4 m to 12 m) , (6) female calves (from birth to 4 m), and (7) male animals (practically all male calves at birth up to 4-5 days of age). The details on herd composition are shown in table 5. The average number of dairy animals per farm were 22, 26, and 19 for NP1, NP2, NP3, respectively, with the average percentages of milking cows of 43, 48 and 52, accordingly. The average percentages of replacement females were high (40-46%), while culling rates of dairy cows were low, since dairy breeding stocks were regarded by farmers as their valuable asset and saving. However, keeping of replacement females at high rates created various management problems including high costs for feeding, over crowdedness of animals per unit area, difficult waste management, etc. Custom or hired rearing of these replacement animals would relieve farmers of such burden and stress.

Table 5. Composition of dairy herds in NP farms

Area	Ave. number animals/farm[1]				Replacement female[2]		
	NP1	NP2	NP3	AVE	NP1	NP2	NP3
A	22.2	27.6	21.0	24.5	47.7	41.0	36.5
	(43)	(48)	(52)	(47)			
B	23.2	27.8	13.2	22.4	43	49.0	43.7
	(44)	(44)	(51)	(45)			
C	22.8	22.4	24.0	23.0	50.9	39.3	32.3
	(42)	(56)	(57)	(51)			
AVE	22.7	26.2	19.3	23.3	47.5	43.4	36.3
	(43)	(48)	(54)				

Herd structure	NP1	NP2	NP3
Ave. number of animals	20.1	23.3	19.3
% Milking cows	43	48	54
% Dry cows	8.5	7.4	9.0
% Heifers[3]	24.8	19.9	18.9
% Female calves	22.6	23.5	17.4
Total[4]	98.9	98.8	99.3

[1] Percentage of cows in milk in bracket.
[2] Young and pregnant heifers and female calves.
[3] Pregnant and non-prenant heifers.
[4] Descrepancies due to rounding and exclusion of percentage for male calves.

2. Body condition scores.

The data on average body condition scores of dairy cows, including cows in milk and dry cows, in each farm were evaluated using the scoring system as recommended by Edmonson et al. (1989) i.e. score of 1 (very thin body condition) up to 5 (extremely fat). The body condition scores indicated the level of animal management and feeding provided by farmers, as reflected by cow health and body conditions. Two dairy extension workers were used to evaluate an average body condition score of dairy cows in each farm in February, April, and June 1997. The average body condition scores for NP1, NP2, and NP3 farms in February, April, and June are shown in table 6.

Table 6. Average body condition scores of cows in sample farms

	NP1	NP2	NP3
February	2.14	2.14	2.14
April	2.18	2.13	2.16
June	2.64	2.73	2.51

The average body condition scores of the three farm groups within each month were not much different, they ranged between 2.1 to 2.7 which were below optimal score of 3, especially in February and April when sources of roughages became limited both in terms of quantity and quality, as compared to those in June (early rainy season). The average scores in June were slightly above 2.5, however better feeding and cares of dairy cows were still needed in order to improve general body conditions to a more satisfactory level.

D. Milk yield and milk quality

The average milk yield per cow of each farm was observed during February, March, and April 1997, as shown in details in terms of three-month averages. It can be seen that the level of milk production per cow at NP farms was relatively low, with averages of only 7.4, 7.8, and 8.2 kg/cow/day in February, March, and April, respectively, and an overall average of 7.8 kg, inspite of the fact that most of these farms have been in operation for two decades or more. This indicated clearly that better animal feeding and cares as well as culling of genetically low-producing cows were necessary in order to improve production efficiency of these NP dairy farms. Many of these high-grade HF cows appeared to produce up to 15 kg of milk per day or higher under current level of feeding and management, which indicated that genetic selection through good milk recording system can improve farm productivity substantially within a relatively short period of time. But so far milk recording and genetic selection have not been practiced by farmers. The differences of average milk yield per cow among groups of NP1, NP2, NP3 farms, as well as among areas A, B, and C were very small (see table 7).

Table 7. Average milk production per cow in sample farms

Area	Three-month average milk yield per cow (kg)			AVE
	NP1	NP2	NP3	
A	8.1	8.3	5.6	7.7
B	7.1	7.6	9.0	7.7
C	8.2	7.1	9.7	7.9
AVE	7.8	7.6	8.2	7.8

An examination of milk quality produced by these farms was based on the data of milk testing during May to September 1996. Milk tests were conducted by laboratory technicians of the NP Cooperative based on, (1) barn cleanliness, (2) butterfat percentage, (3) milk specific gravity, (4) dirt in milk, and (5) bacteria count, see details in table 8. Milk prices per litre or kg paid to farmers were based on the standard price set by the Cooperative plus an extra or premium price based on the quality of milk of each farm. The average prices of milk per kg received by farmers in the three areas during the period of study are shown in table 8, which appeared to be more or less similar. These prices of milk indicated good milk quality, and were well accepted by the farmers in terms of farm income and profits.

Table 8. Milk quality criteria and their averages

Milk quality criteria	Quality standard	Averages of milk qualities		
		Area A	Area B	Area C
1. Barn cleanliness score[1]	1 to 10	8.82	8.74	9.21
2. Butterfat percentage[2]	3.50	4.28	4.17	4.11
3. Specific gravity[3]	1.027	1.055	1.100	1.030
4. Dirt in milk, grade[4]	1-6	1.24	1.29	1.25
5. Bacteria count, grade[5]	1-6	1.87	1.77	2.01
Milk price/kg (Baht)[6]	8.00	8.87	8.88	8.84

[1] Add Baht 0.01 to milk price per kg for each score.
[2] Add Baht 0.03 for every 0.1% above 3.5% BF.
[3] Add (or deduct) Baht 0.02 for every .001 specific gravity above 1.027.
[4] Grade 1 to 6 (grade 1 add Baht 0.34/kg milk, grade 2 add 0.15, grade 3 add 0, grade 4 deduct 0.15, grade 5 deduct 0.50, grade 6 reject).
[5] Grade 1 to 6 (grade 1 add Baht 0.35/kg milk, grade 2 add 0.25, grade 3 add 0.15, grade 4 deduct 0.05, grade 5 deduct 0.15 or reject, grade 6 deduct 0.50 or reject).
[6] Exchange rate was Baht 26 = US$1 at or reject the time of this study.

The figures in Table 9 show average qualities or prices of milk for three NP groups (crowdedness) and three areas of farms. There appeared to be no important difference among groups and areas, and average milk qualities were at satisfactory level, with an overall average of 8.86, while 8.00 was a standard.

Table 9. Average qualities or prices of milk of sample farms

Area	NP1	NP2	NP3	AVE
A	8.85	9.01	8.75	8.87
B	8.94	8.87	8.83	8.88
C	8.88	8.79	8.84	8.84
AVE	8.89	8.89	8.81	8.86

E. Manure and other farm wastes

Cow manure is another important product produced by dairy farms, both in terms of smallholder farm's income and problem for waste management. Cows of 450 kg body weight at NP farms produced wet manure of about 6% of the body weight or 27 kg, therefore, each NP farm of an average size in terms of number of animals varying in body weights would produce about 1/2 metric ton of wet manure per day (85% moisture). Cow manure was removed from the barn everyday and

stored near cow barn where it was to be spread and sun dried in open area over soil surface. Much of dry manure (approximately 15% moisture) was commonly sold to crop farmers in other locations for used as fertilizer at about Baht 1 or less per kg at farmgate. Chemical analyses of wet cow manure for N, P, and K showed that the value of N in manure ranged from 0.96 to 2.12%, P from 0.33 to 0.79%, and K from 0.47 to 0.87%.

It was estimated that from the total number of about 4,000 smallholder NP farms 2 million kg or 2,000 tons of cow manure were produced daily, plus approximately equal amount (by weight) of waste water and other liquid wastes such as animal urine. These animal wastes if not properly managed and utilized could create pollution problems to farm environment and surrounding areas (Tietjen, 1987 ; Archer and Nicholson, 1992 ; Daliparthy et al., 1995 ; Wood and Hattey, 1995 ; Paik et al., 1996). The status of cattle wastes management and utilization in smallholder NP farms is shown in figure 1.

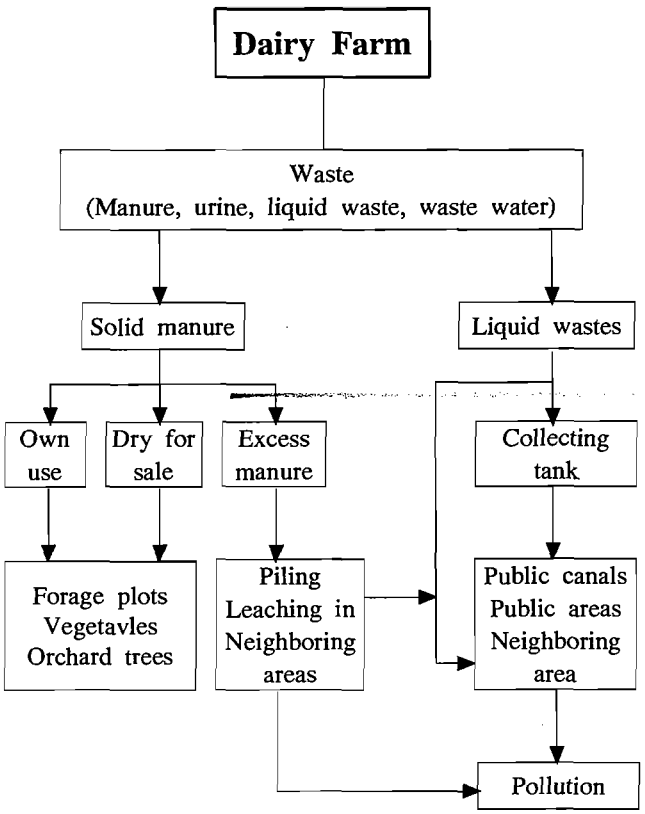

Figure 1. Use of dairy wastes and their excess on smallholder farms

ACKNOWLEDGEMENTS

This research project has been financially supported by the Thailand Research Fund (TRF) through the TRF Senior Research Fellow Program. The TRF is an autonomous research funding agency of the Government of Thailand.

REFERENCES

Archer, J. R. and R. J. Nicholson. 1992. Liquid wastes from farm animal enterprises. In Farm Animals and the Environment , edited by Clive Phillips and David Piggins, CABI, U.K. p. 325-344.

Chantalakhana, C. 1995. Dairy development in Thailand : A case of small-farm production for urban consumption. In Supply of Livestock Products to Rapidly Expanding Urban Populations, edited by W. Y. Kim and J. K. Ha, Seoul National University, Seoul, Korea. p. 282-292.

Chantalakhana, C., R. Korpraditsakul, P. Skunmun, and T. Poondusit. 1998. Environmental conditions and resource management of some smallholder dairy farms in Thailand II. Effects of dairy wastes on water and soil (Submitted to AJAS for publishing).

Daliparthy, J., S. J. Herbert and P. L. M. Veneman. 1995. Excess dairy manure management: Impacts on ground water quality. In Animal Waste and the Land- Water Interface , edited by K. Steele, Lewis Publishers, N.Y. p. 355-362.

Edmonson, A. J., I. J. Lean, L. D. Weaver, T. Parver and G. Webster. 1989. A body condition scoring chart for Holstein dairy cows. J. Dairy Sci. 72 : 68-78.

Ekasingh, B., K. Tong-ngarm, B. Cheva-issarakul, B. Cheva-issarakul and S. Promma. 1997. Socio-economics and production systems of dairy farmers in Northern Thailand. Research Report, Chiang Mai University, Chiang Mai. p. 119. (In Thai).

Kanchanapruttipong, J., S. Timpatpong, P. Boontongsaen and S. Satalavarang. 1990. A survey of dairy farming in Thailand. Research Report, Kasetsart University, Bangkok. (In Thai).

Paik, I. K., R. Blair and J. Jacob. 1996. Strategies to reduce environmental pollution from animal manure : Principles and nutritional management - A Review. Asian-Aus. J. Anim. Sci. 9(6):615- 635.

Thongpan, P. 1997. Dairy Cattle raising in Southern Thailand with emphasis on gender analysis. M.S. Thesis, Prince of Songkla University Library, Songkhla. (In Thai).

Tietjen, C. 1987. Influence of faecal wastes on soil, plant, surface water and ground water. In Animal Production and Environmental Health, edited by D. Strauch, Elsevier Science Publishers B.V., Amsterdam. p. 203-216.

Wood, C. W. and J. A. Hattey. 1995. Impacts of long-term manure applications on soil chemical, microbiological, and physical properties, in Animal Production and Environmental Health, edited by D. Strauch, Elsevier Science Publishers B.V., Amsterdam. p. 419-426.