



**Pro-Poor
Livestock
Policy
Initiative**



International
Farm Comparison
Network IFCN

The Economics of Milk Production in Chiang Mai, Thailand, with Particular Emphasis on Small-Scale Producers

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PREFACE

This is the twentieth of a series of Working Papers prepared for the Pro-Poor Livestock Policy Initiative (PPLPI). The purpose of these papers is to explore issues related to livestock development in the context of poverty alleviation.

Livestock is vital to the economies of many developing countries. Animals are a source of food, more specifically protein for human diets, income, employment and possibly foreign exchange. For low income producers, livestock can serve as a store of wealth, provide draught power and organic fertiliser for crop production and a means of transport. Consumption of livestock and livestock products in developing countries, though starting from a low base, is growing rapidly.

The study applies a method of economic analysis developed by the International Farm Comparison Network (IFCN) which is based on the concept of 'typical farms'. Three broad farm types were selected to represent typical farms in the region. These systems consisted of stall-feeding farms, holding five, fourteen, twenty-one and hundred seventeen crossbred dairy cows. The farms were located in three districts of the sub province Mae-On. Each farm is described in detail with assets, production costs, profits and other economic information presented both graphically and in the text. In addition, the study presents a preliminary analysis of the dairy chain in the city of Chiang Mai. And finally, a policy analysis, using the PAM methodology, is executed for these typical farms.

We hope this paper will provide useful information to its readers and any feedback is welcome by the author, PPLPI and the Livestock Information, Sector Analysis and Policy Branch (AGAL) of the Food and Agriculture Organization (FAO).

Disclaimer

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Keywords

Milk production, Chiang Mai, Thailand, Poverty Reduction, Dairy, Farm Economics, Policy.

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1. EXECUTIVE SUMMARY

Introduction

The main purpose of this study was to gain insight into the household and farm economics of small-scale dairy farmers in Chiang Mai, and to obtain estimates of their costs per unit of output in milk production so as to gauge their potential for improvement and vulnerability to international competition. In order to ascertain possible developments in the dairy sector and to broadly identify areas of intervention that favour small-scale dairy producers, the study examines the potential to improve milk production of different farm types. A case study approach is used, the aim being to obtain qualitative insights rather than quantitative extrapolation.

Methodology

The methodology applied for the economic analysis was developed by the International Farm Comparison Network (IFCN) and utilises the concept of typical farms. Farm types are determined by regional dairy experts taking into consideration (a) location of the farm, (b) farm size in terms of herd size and (c) the production systems that make important contributions to milk production in the region. The first category of farms (small) was chosen to represent the size that is close to the statistical average. The other farm types defined represent larger farms to allow the exploration of potentials for economies of size in the region, or a different dairy production system. Management levels on the typical farms are average to slightly above average compared to other farms of the same type. Data was collected using a standard questionnaire and a computer simulation model, TIPI-CAL (Technology Impact and Policy Impact Calculations), was used for biological and economic simulations of the typical farms. A farm to farm comparison was carried out to identify differences between farm types in Chiang Mai.

Results

Milk production in Thailand

In the last decade, the Thai government has implemented key policy and market adjustments to enable its relatively young dairy sector to take off. From 1996 to 2003, the Thai milk production doubled, the milk yield per dairy animal per year increased by a factor of 1.7, the number of dairy animals rose by 10 percent higher while the Buffalo population shrank to 60 percent of its 1996 level.

With an average herd size of 20 head, Thai dairy farms achieve a milk yields of above 3,000 kg milk per dairy animal per year, which is 95 percent of the average yield of New Zealand dairies. In 2003, the Thai contribution to the world milk output is a mere 0.1 percent. Protected from international competition, in 2004, the Thai farm gate price of 0.29 US\$/litre was 1.8 times higher than that in New Zealand, for instance.

Analysis of 'typical farms' in the area of Chiang Mai, Thailand

Based on the IFCN methodology, four farm types were identified as 'typical' and were subjected to detailed analyses. The very small dairy farms (TH-5) with 5 crossbred cows, 0.8 ha land, family labour only and milking by hand; the small farm (TH-14) with 14 crossbreds, 2.1 ha land, family labour only and 1-bucket milking machine; an average size farm (TH-21) with 21 crossbreds, 0.6 ha land, family labour and 2-bucket milking machine; and finally, a large farm (TH-117) with 117 crossbreds, 3.0 ha land, family and hired labour and a 3-bucket milking machine.

Dairy production systems

Crossbred cows (Holstein F. with local breeds) are the main type of dairy animals. The crossbred cow is found to be ideal to capitalize not only on the strong demands for milk and beef, but also on the higher-than-world-market prices that Thai producers get for these two outputs. Buffaloes are used only for draught power and do not contribute to milk production in the region. The majority of the dairy farms are run with family labour while medium-sized farm with crop activities and larger ones tend to have hired labour. Grazing of fallow and forest land can be seen at certain times of the year, but typically dairy farms keep animals confined all year long. Feed rations are based on agricultural by-products such as rice bran, rice polish, broken rice and pulses meal. Commercial cattle feed is also used by all types of farms, including mineral mixes and injectable vitamins. Milking is done with a small locally manufactured machine and imported pipeline and portable milking buckets. In terms of energy corrected milk (ECM), production per dairy animal ranges from 3,150 to 3,380 kg per year.

Household comparison

Household incomes range from 4,000 US-\$ to 23,000 US-\$ per year. Income structure is quite diverse and includes non-cash benefits (milk for family consumption and farm uses) and off-farm income (milk transportation services and employment).

Whole farm comparison

The returns from farming range from 6,000 US-\$ to 135,000 US-\$ per year. The dairy contributes 100 percent to the whole farm returns since only forage crops are grown and fed on the farms. Net cash farm incomes, from 2,500 US-\$ to 23,000 US\$ per year, closely follow the same trends across farms as that of farm returns.

Comparison of the dairy enterprise - Costs of milk production

TH-21 has the lowest costs of milk production at 19 US\$ per 100 kg ECM whereas the largest farm has the highest at 23.5 US\$. TH-21's lower costs are attributable to lower opportunity costs for family labour and land factors.

These costs of milk production are slightly above those of the New Zealand milk price. Lowering these costs would mean that these farm types could compete with imports of dairy products and also to produce milk for export, provided international quality standards can be achieved and the dairy chain being internationally competitive.

Dairy chain in Chiang Mai

Unlike in South Asian countries such as India and Pakistan, 95 percent of the milk produced in the Thai province of Chiang Mai is captured by the formal sector. The rest is sold from farmer to retailer or the final consumer.

Comparing the formal versus informal dairy chains, the formal sector pays farmers 8 percent higher prices, but also gets 1.5 to 1.8 times higher consumer prices than the informal sector for liquid milk. Furthermore, the formal sector's UHT and pasteurised milks have 3.15 to 2.23 times the margin of those from the informal sector.

Farmers' shares in the consumer prices are 38 and 47 percent for UHT and pasteurised milks in the formal channels; while they are 65 percent in the informal ones. These results show that farmer shares in the UHT channel are relatively low when compared to its counterparts in Bangladesh and Orissa, India (with farmers' share of 52 and 45%).

Policy analysis of typical dairy farms in Chiang Mai

The PAM results show that the farms receive about 30 percent higher output prices (milk and beef) while they also pay about 20 percent higher prices for their tradable inputs (mostly from duties on feed imports) than they would under free market conditions. In addition to that, due to policies, these farms' costs for using domestic factors of production (land, labour and capital) are only 68 percent of the value that would prevail if the market were undistorted.

These policies and market conditions mean that for each 1 US\$ profit made by the farmers, they receive net supports of 1.80 US\$ and 1.19 US\$ for the smallest and largest farm respectively. TH-21 is the exception receiving only 0.66 US\$. This clearly shows that while all of the farms require heavy supports, the smallest farm is capturing being by far the largest reward from the policies in place.

Finally, these results point to both the urgency for and the great opportunities to improve farm efficiency, competitiveness and gain comparative advantage through corrective policy actions.

Conclusions

The present study of four typical dairy farming systems in Chiang Mai clearly shows that:

- 1) The dairy sector in Thailand in general and in Chiang Mai in particular has experienced tremendous development over the last decade. This development has been driven by the increasing domestic demand for dairy products coupled with strong support to milk (and beef) producers through governmental policies.
- 2) For the studied farms the costs of milk production only range from 19 to 24 US\$/100 kg milk, which is an intermediate cost level by IFCN comparisons (Dairy Report, 2004). For world competitiveness, however, these farms need to bring their production costs below 18 US\$, the cost of production achieved by low-cost-producers in India, Pakistan, Argentina, etc. (Dairy Report, 2004).
- 3) Supportive policies and partnerships with the private sector have quickly developed a formal dairy sector / chain with the infrastructure to collect, process and distribute over 95 percent of domestic milk production. This formal sector, through a system of dairy cooperatives, pays farmers higher milk prices than the informal channels and provides them with farm inputs and services otherwise not available or too costly to small-scale farmers.
- 4) Through a PAM analysis this study shows that the dairy farms greatly benefit from a farm gate milk price, which is over 1.5 times higher than the world market price and from policies that result in dairy farmers having to pay only about 70 percent of the cost of domestic factors of production. Both of these factors (protected milk price and subsidized domestic resources) seem to strongly discourage attempts to increase farm efficiency, particularly for small-scale producers. On the other hand, farms are taxed on their tradable inputs, which increases production costs. The PAM results suggest that significant gains in farm efficiency and competitiveness could be achieved through policy reform.
- 5) Study results show that there are great opportunities to increase small-scale farms' efficiency and competitiveness. If the creation of a vital and competitive dairy sector is an important policy goal, support given to the smallest farm type could be cut by about 50 percent through policy reform and still allow the small-scale dairy farmers to make a lucrative profit. However, in order to eliminate the other half of the support granted to this farm type, significant productivity increase and cost reductions must occur at the farm level. Therefore, policy reform must be accompanied by programs increasing farm competitiveness through raised production efficiency.

2. OVERVIEW - MILK PRODUCTION IN THAILAND

2.1 Thailand - Dairy in the global context

World milk production

Thailand's domestic milk production covers about 40 to 50 percent of the national ready-to-drink dairy products. This situates the country as one of the biggest importer of milk powder in the world. In 2003 Thailand produced 732,000 tons, which represented 0.12 percent of the total world milk production. In another perspective, Thailand reached about 0.50, 0.84 and 0.95 percent of the European Union, India and USA total milk productions respectively.

Dairy farm structures

For Asian standards, Thai farms keep large herds. The average farm size is estimated at 20 dairy animals per farm, which is just above 70 percent of the average size of a dairy herd in Germany.

Milk yields

Thailand's milk yield of 3,000 kg per cow is relatively low when compared to international standards (Germany with 6,000 and US with 8,000 kg). Interestingly, the Thai yield is very close to that in New Zealand. Finally, when compared within Asia, Thai farms are high producers due to mainly high concentrate use and better genetics.

Live animals

For 2003, FAO reports that Thailand counts with about 6.3 and 1.6 million cattle and buffaloes, respectively. This total herd size is equivalent to 54 and 84 percent of the total head count of Germany and New Zealand respectively.

Milk prices

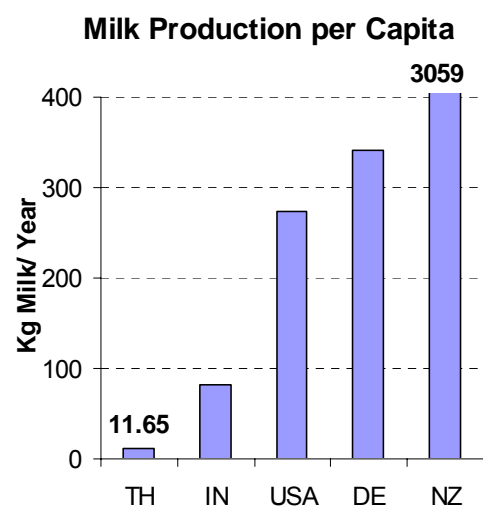
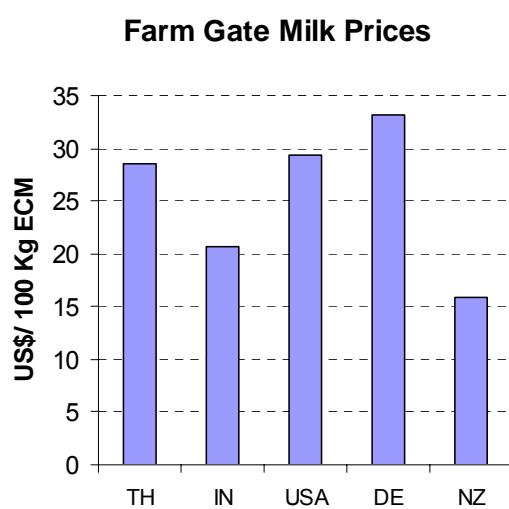
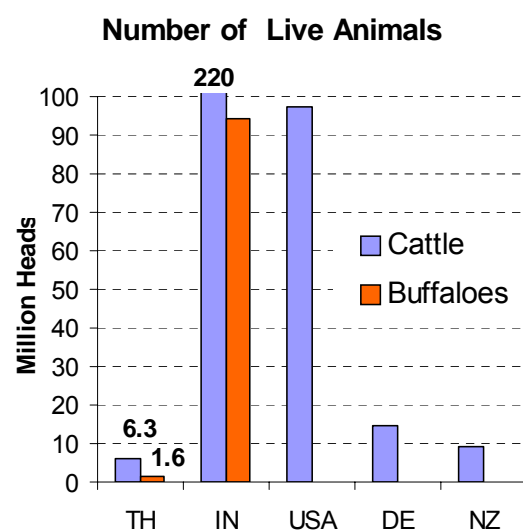
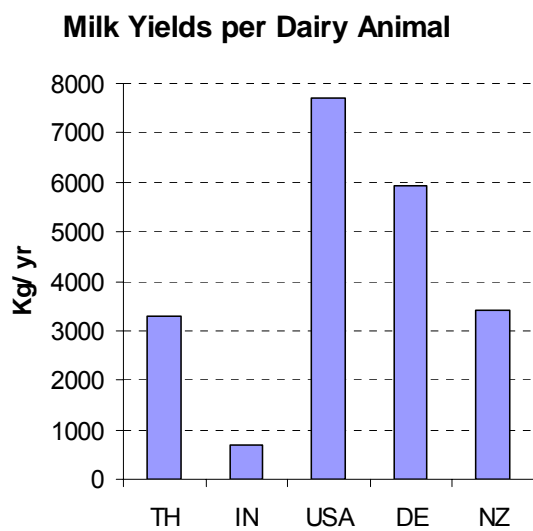
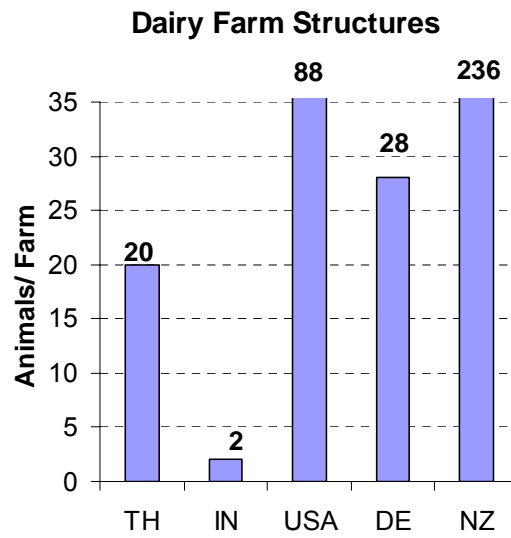
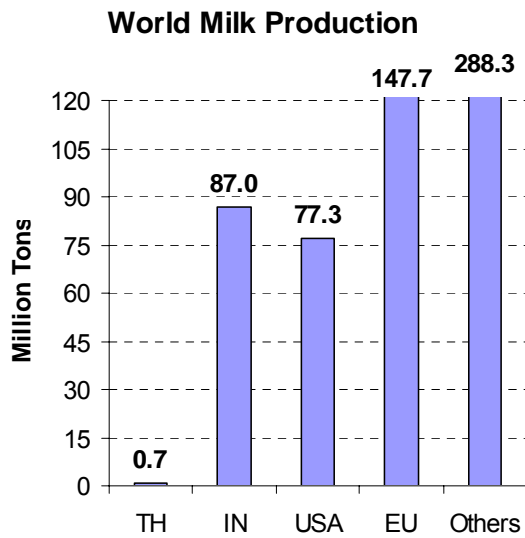
Thai farmers receive a milk price well above where the world milk price might be set (around 20 US\$/100 kg). Among major milk producing countries only US and the EU farmers get higher milk prices than the Thai dairy farmers. While Thai farmers receive 14 percent lower prices than German milk producers, they get 80 percent higher prices than NZ farmers.

Milk production per capita

Thailand is not a major milk producing country, but a major milk powder importer. Therefore it is not surprising that despite the fast growth of the Thai dairy industry, national figures of 2003 reveal a low per capita milk production of about 12 kg/year. This per capita production level stands at around 14 and 0.4 percent of the level of India and New Zealand.

* Explanations of variables: year and sources of data:

- Milk Production per Country (for year 2003): The Thai Department of Livestock Development (visited on 11/6/04) & FAO (2004) at <http://faostat.fao.org> "last updated February 2004".
- Average Farm Size (2000), Milk Yields per Dairy Animal (2002), Number of Live Animals (2003) and Milk Production per Capita (2002): The Thai Department of Livestock <http://www.ldl.go.th> checked on 11/6/04 & Hemme et al. (2003).
- Farm Gate Milk Prices (2003): IFCN Dairy Report 2004



2.2 Recent dairy developments in Thailand

Milk production

From 1996 to 2003 Thai milk production increased by 190 percent. The growth trends can be differentiated into two phases: (1) 1996 -2000 with a steady growth at slightly above 5 percent per year; and (2) 2000 - 2003, where the growth rate reached 15 percent per year due to dairy promotion projects led by the Department of Livestock Development.

Regional milk production

Thailand's Central Plains, where the main demand centre Bangkok is located, have traditionally been the dominant milk producing region with over 65 percent of the total production; followed by the North East with about 25 percent. It should be noted that although all areas have increased production, the North Eastern region has increased its production share (from 20 to 23 percent) while the Central Plains have lost share (from 71 to 67 percent) in the time period between 1999 and 2001. This relatively rapid growth in the North fits well with the approach of the Thai government to utilize dairy to increase the gross income of the North-Eastern region, whose income is the lowest in the country.

Development of daily milk yield

Daily milk yields per animal have grown by 165 percent from 1996 to 2003. From 1996 to 2001, the growth rate of milk yield was at about 4 percent per year. In contrast, during 2002 and 2003, milk yield grew at a high rate of 17 percent per year. Milk yield increases have been driven by a clear policy goal (mainly years 2002 - 2003) of the Department of Livestock Development to increase local milk production.

Number of dairy animals

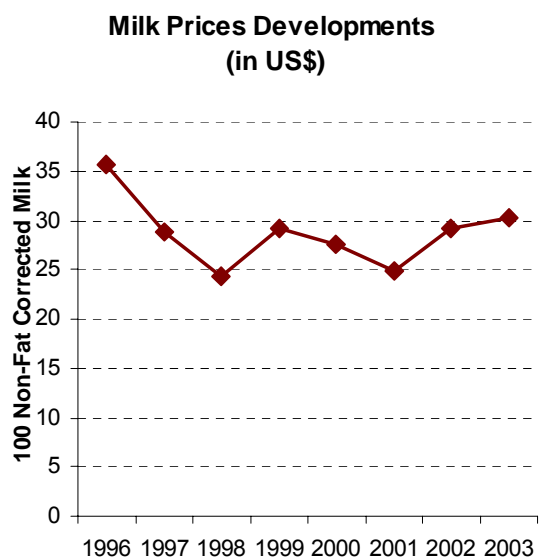
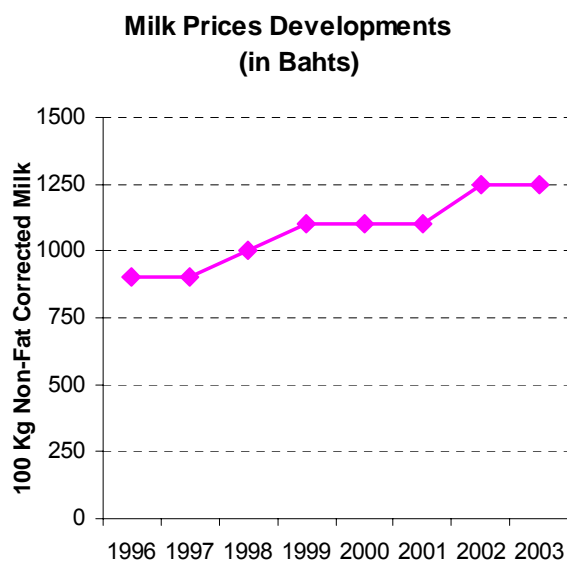
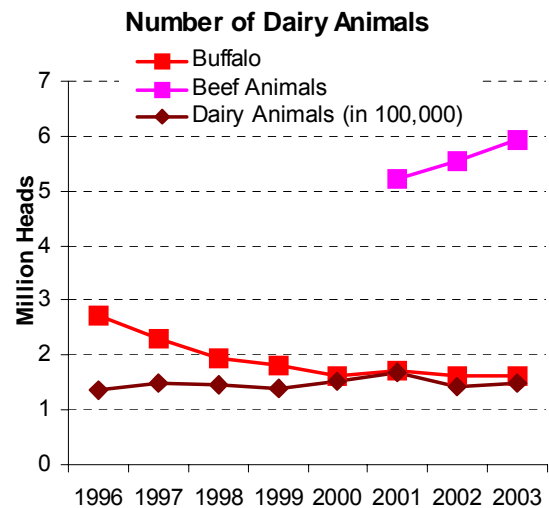
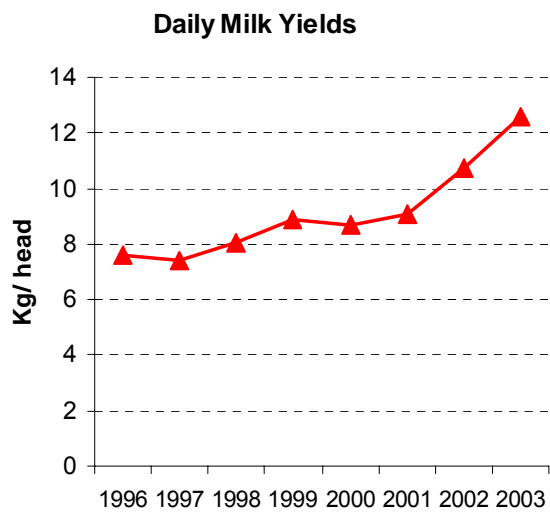
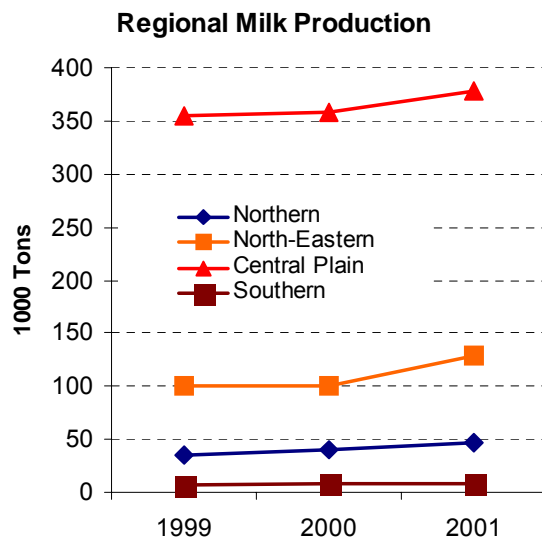
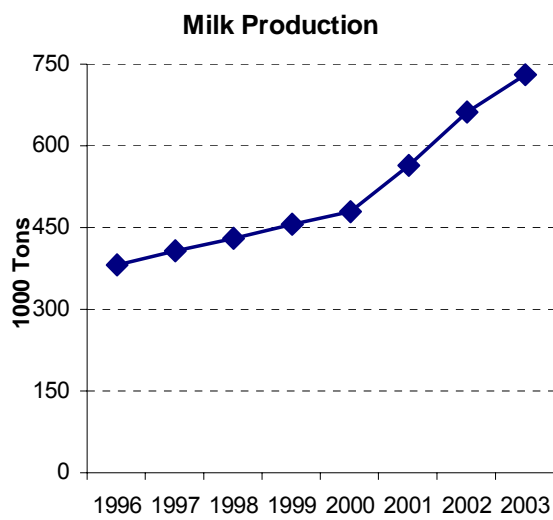
In 2003, Thailand has less than 60 percent of the Buffaloes as in 1996. This decrease is driven by two main trends: (1) Buffaloes, whose main purpose is draught power, are increasingly replaced by machinery, and (2) raising beef cattle for meat, instead of buffalo meat, is promoted by the government, the final product being much more appealing to the end consumer. On the other hand, the number of beef and dairy animals have increased by 15 (from 2001 to 2003) and 10 percent (from 1996 to 2003) respectively.

Milk prices

In nominal terms, Thai milk prices increased by 40 percent from 1996 to 2003, which may have been influenced by the Asian financial crisis, with the devaluation of the Baht during the same period. However, when considering inflation, milk prices have decreased by about 15 percent over the same period.

Explanations of variables: year and sources of data:

- Milk Production & Regional Milk Production: Agricultural Statistics of Thailand Crop Year 2001/02.
- Development of Milk Yields & Number of Dairy Animals: Thai Department of Livestock Development.
- Milk Prices: Co-operative records, Personal communications, and SBC bank records (all examined between 11/6/04 and 30/6/04).



2.3 Recent dairy developments in Chiang Mai

Milk production

While milk production in Thailand as a whole increased by 15 percent between 2002 and 2003, the province of Chiang Mai surpassed the 20 percent per year mark for the period 1999-2003. Viewed from another perspective, it has taken Thailand as a whole 8 years (1996-2003) to double its milk production whereas Chiang Mai doubled it in just 5 years (1999-2003).

Number of dairy animals

A relatively small number of purebred Holstein Friesian cows is held for crossbreeding purposes. The vast majority of the national dairy herd is constituted by crossbred cows. The most popular crossbred dairy animals in Chiang Mai are 75 to 90 percent Holstein Friesian.

As a whole, the dairy herd increased by 50 percent between 1999 and 2003. The dip in numbers in 2002 was due to the closing down of the Phu Ping local dairy company. Farmers sold their animals and switched to other activities. It was in 2003 that the Chaiprakarn and Meaon dairy cooperatives started operating and farmers returned to their dairy activities by purchasing animals from other regions.

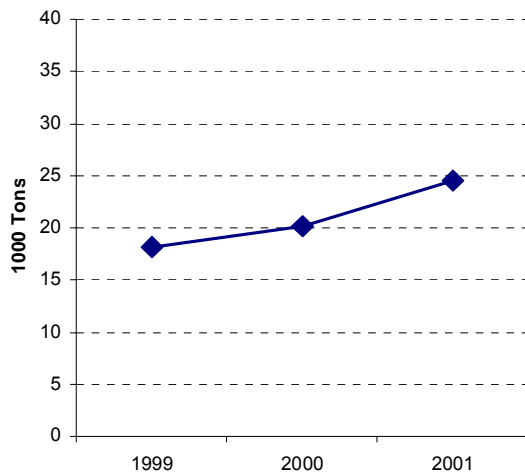
Development of milk yields

The average milk yield per dairy animal has increased by 15 percent between 1999 and 2003 in Chiang Mai. The efforts of the Department of Livestock Development from 2000 to 2002 show an increase in yield of up to 6 percent per year.

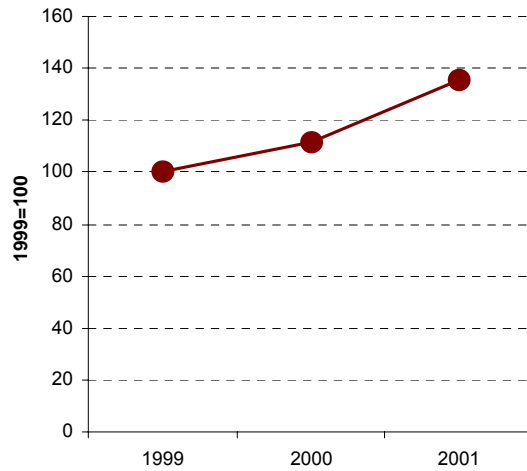
Explanations of variables; year and sources of data:

- Milk Production, Development of Number of Dairy Animals, and Development of Milk Yields: The Thailand Department of Livestock Development at <http://www.ldl.go.th> & Records of Regional Dairy Co-operatives, both accessed on June and July 2004.

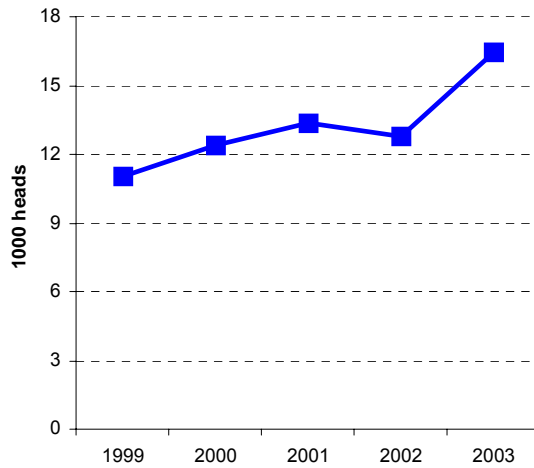
Chiang Mai Milk Production



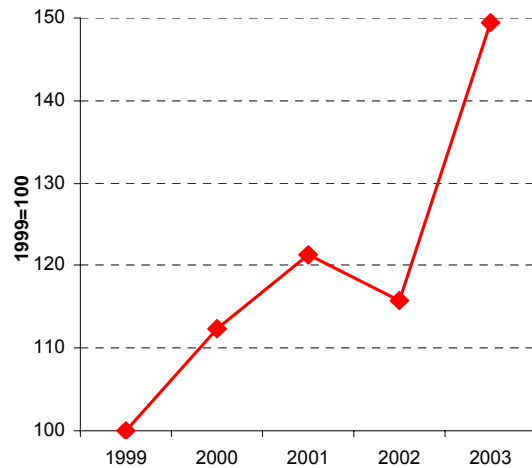
Growth of Chiang Mai Milk Production



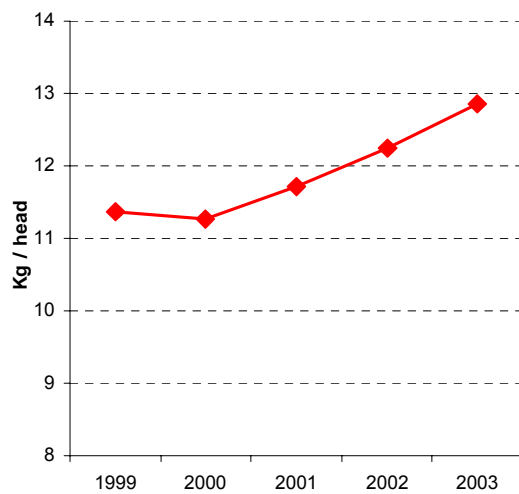
Size of Chiang Mai's Dairy Herd



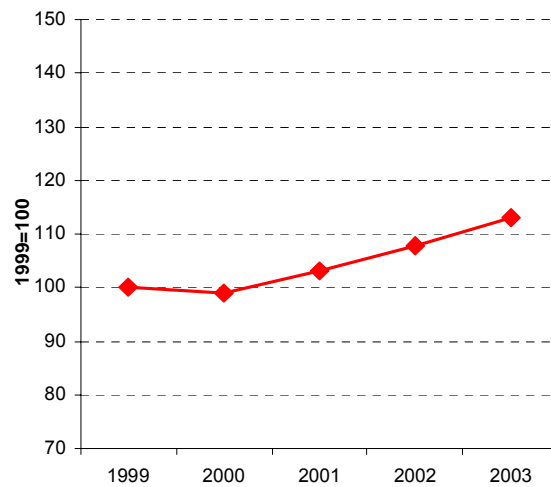
Changes of Chiang Mai's Herd Size



Chiang Mai Daily Milk Yields



Growth of Milk Yields



2.4 Thailand natural conditions and farm structure

Thailand natural conditions (rainfall and temperatures)

Thailand with a total land area of 513,115 sq. km enjoys a tropical climate with three distinct seasons: hot and dry from February to May (average temperature 34 degrees Celsius and 75% humidity); rainy with plenty of sunshine from June to October (average day temperature 29 degrees Celsius and 87% humidity); and cool from November to January (temperatures range from 32 degrees Celsius to below 20 degrees Celsius with a drop in humidity). Chiang Mai, for instance, can become chilly around New Year, with night-time lows of 11-13 Celsius. However, daytime temperatures are in the high 20s, reaching the mid-to-high 30s in April.

Regarding rainfall, in Bangkok and the Central Region, rain averages about 200 mm per month from May to October. In the North and North-Eastern regions, rain averages 170 mm for those months. The country's yearly rainfall averages 1,200 millimetres.

Farm structure in Thailand

Around 70 percent of the farms in Thailand keep less than 20 head of cattle. This can be largely explained by farmers' lack of investment capital for (high-producing crossbred) dairy animals, farmland, and dairy equipment to expand their operations beyond 14 to 20 head/farm.

The type of farms with more than 20 cows include stanchion and free stall keeping. Most of them can be found in the central part of Thailand (Mouk Lek area). These farms also prefer to have high producing crossbreed cows, because of their ease of management and higher profitability. Thailand, as a whole, counts with small farms, of which 75 percent have less than 5 ha. This is very consistent with land sizes in Pakistan and Bangladesh where 70 percent of the farms have less than 5 ha of land.

Chiang Mai farming conditions

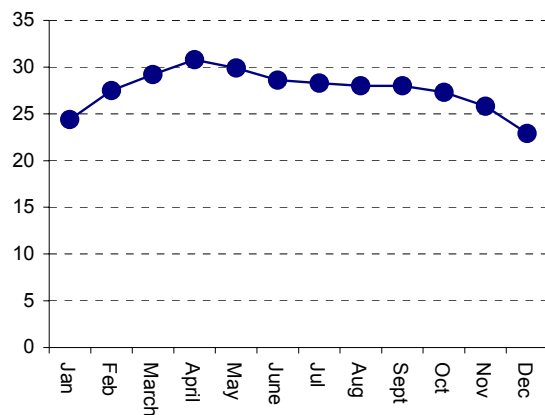
The farms selected for this study are located in the province of Chiang Mai (in the north), sub-region of Meaon, in the rural districts of Ban Nonghoi, Ban Sahakorn 2, Ban Sahakorn 4, and Ban Shakorn 7.

In general, the temperature in Chiang Mai is lower than that of the country as a whole, especially the cool season (a difference of more than 5 Celsius). The main sources of water supply are rainfall and well-based systems, which are composed of many natural and man-made irrigation canals. Most farmers find it necessary to irrigate their fields during the period of January to April. Approximately 50 percent of the farmland of Chiang Mai requires irrigation. More than 90 percent of the land area in Chiang Mai is owned by farmers. However, most of them have small landholdings (mainly due to shortage of capital), which becomes a major limitation to farm expansion.

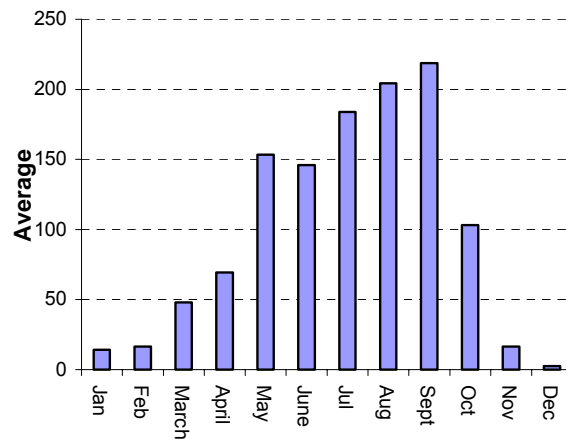
Explanations of variables; year and sources of data:

- Temperature and Rainfall: <http://www.worldclimate.com>, accessed on September, 2004, and using data from the Phetchabun weather station in North West Thailand.
- Thailand Dairy Herd and Land Structures: <http://thecity.sfsu.edu/~sustain/hossain.html>; accessed on June 23, 2004.

Temperatures in Thailand (°C)



Rainfall in Thailand (mm)



Thailand Dairy Herd Structure						
Herd Size	Heads	1 -- 5	6 -- 10	11 -- 20	> 20	Total
Farms	No.	2558	3259	6275	5801	17893
Farms	%	14.29	18.21	35.06	32.42	100

Source: <http://thecity.sfsu.edu/~sustain/hossain.html>; website seen by authors on June 23, 2004.

Thailand Land Structure (year 1987)						
Land Holdings	Ha	< 1	1- < 3.0	3 -- 4.9	> 4.9	Total
Households	%	16.60	41.40	16.30	25.70	100

Source: <http://thecity.sfsu.edu/~sustain/hossain.html>; website seen by authors on June 23, 2004.

3. IFCN ANALYSIS OF DAIRY FARMS IN CHIANG MAI

3.1 Description of the 'typical' farms in Chiang Mai

Although milk production in Chiang Mai is derived mostly from one type of production system, the number of dairy animals held per farm varies significantly. Using the IFCN methodology and the varying herd size in the region, four typical farms are identified in three main milk producing districts of the province. One farm from each category has been analysed. This and the next page provide a brief but detailed description of the four farms.

5-cow farm (TH-5)

Location: Farm located in rural area with 0.8 ha of own land.

Activities: The farm keeps 5 crossbred cows and feeds crop residuals, grasses and high-protein concentrates. Lactating cows are supplemented with a mineral mixture. The family consumes about 2 percent of the milk produced on the farm, the surplus (98 percent) being sold to the local dairy co-operative. It raises its own heifers for replacement. Dairy farming and off-farm employment are the sources of family income.

14-cow farm (TH-14)

Location: Farm located in rural area with 2.1 ha of own land.

Activities: The farm keeps 14 crossbred cows and delivers 100 percent of its marketable milk to the local dairy co-operative. Lactating cows are supplemented with a mineral mixture. The farm raises its own replacement heifers. Own-farm employment is practically the only source of income.

21-cow farm (TH-21)

Location: Farm located in rural area with 0.6 ha of own land.

Activities: The farm keeps 21 crossbred cows and delivers 100 percent of the milk produced to the local cooperative. The feed bases are crop residues, grasses and high-protein concentrates. Lactating cows are supplemented with a mineral mixture. Replacement heifers are raised on the farm. Sources of income are firstly dairy farming and secondly off-farm employment.

117-cow farm (TH-117)

Location: Farm located in rural area with 3.0 ha of own land.

Activities: The farm keeps 117 crossbred cows and delivers 98 percent of its milk to the local dairy cooperative. The feed bases are crop residues and high-protein concentrates. Lactating cows are supplemented with a mineral mixture. The farm raises its own replacement heifers. Sources of income are firstly dairy farming and secondly off-farm employment.

Farm	Units	TH-5	TH-14	TH-21	TH-117
Land owned	ha	0.768	2.1	0.6	3.0
Land rented		No land	No land	No land	No land
Dairy enterprise					
Milk animals	No.	5	14	21	117
Breed		Crossbred	Crossbred	Crossbred	Crossbred
Liveweight	kg	500	500	500	500-600
Milk yield	Kg ECM/cow	3152	3342	3227	3385
Fat and protein content	%	3.77/3.14	3.77/3.14	3.77/3.14	3.77/3.14
Marketable milk sold	%	98*	100	100	98
Land use Dairy enterprise					
Land use for dairy	ha	0,77	2,10	0,60	3,00
Milk produced per ha	kg/ECM/ha	20522	22283	112957	132002
Stocking rate***	cows/ha	6,5	6,7	35,0	39,0
Labour					
Full time employees	persons	0	0	0	6
Share of family labour	(% of total)	100	100	100	18
Hours per milking cow	(h/cow/yr)	1200	480	320	284
Buildings					
Housing type		Metal roof + no walls + concrete feeder and floor	Cement tile roof + no walls + concrete feeder and floor	Cement tile roof + no wall + concrete feeder and floor	Cement tile roof + no wall + concrete feeder and floor
Built	year	2000	2003	2000	2001
Milking					
System		Hand + bucket	Machine (pipeline + one portable)	Machine (pipeline + two buckets)	Machine (pipeline + three buckets)
Calves/Animal/Year	head	0.92	0.85	0.80	0.800
Length of lactation	days	280	280	290	300
Collection centre	distance in km	3	5	2	1
Herd management					
Dry period	months	2	2	2	2
Breeding	method	Artificial	Artificial	Artificial	Artificial
Feeding times	per day	2	2	2	2
Death rate	% cows	2	7	2	3
Cow culling rate	%/year	5	7	10	25
Feeding					
Feeding systems		Tied-stall food	Tied-stall fed	Tied-stall fed	Free-stall fed
Roughage feed source		Rice straw + Rutzi**	Corn stem + Jumbo (grass)+ Rice straw (sometimes)	Corn stem + Rice straw (sometimes)	Corn stem + Rice straw (sometimes)
Concentrates fed		commercial feed (16-18% protein)	commercial feed (16-18% protein)	commercial feed (16-18% protein)	commercial feed (16-18% protein)
Concentrate use in total	T per cow	1.08	1.928	2.05	2.03
Concentrate input	g/kg ECM	309	536	590	597
Calf rearing					
Death rate of calves	%	10-20	10-20	10-20	20
Weaning period	months	3	3	3	3

Notes: *Dairy farm families typically prefer to sell all their fresh milk and then purchase pasteurized and/or UHT milk.

**Rutzi refers to a tall grass (relative of Napier grass).

3.2 Farm comparison: Household approach

Size of the household - labour utilisation

The farm families have about four members, which is found to be typical in the region. Family labour utilisation in off-farm activities is higher (up to 35 percent) for the two larger farms.

In the case of TH-5, the man transports other farms' milk production to the co-operative daily. For TH-21, the husband is employed by the dairy co-operative whereas for TH-117 hired labour frees the wife to work independently as a dressmaker from home.

Household income levels

Household income increases along with farm size. The household income shown here includes the net cash farm income, the off-farm salary and the value of manure and milk used in the household. The incomes range between 4,000 to 24,500 US\$ / year.

Household income structure

Except for TH-14, the shares of off-farm incomes decreases as farm size increases. TH-14 has no off-farm labour utilisation. Non-cash benefits are usually larger for smaller farms. However, Thai farmers drink little milk in general and if they do, there is a strong preference for milk bought-in for home consumption. Of all farms only TH-5 does consume some of its own milk. The high non-cash benefit for TH-117 is due to its feeding 5 tons per year of its marketable milk to its calves.

When non-cash benefits are included, the net farm incomes account for 66 to 100 percent of the household incomes for farms TH-5 and TH-14.

Household living expenses

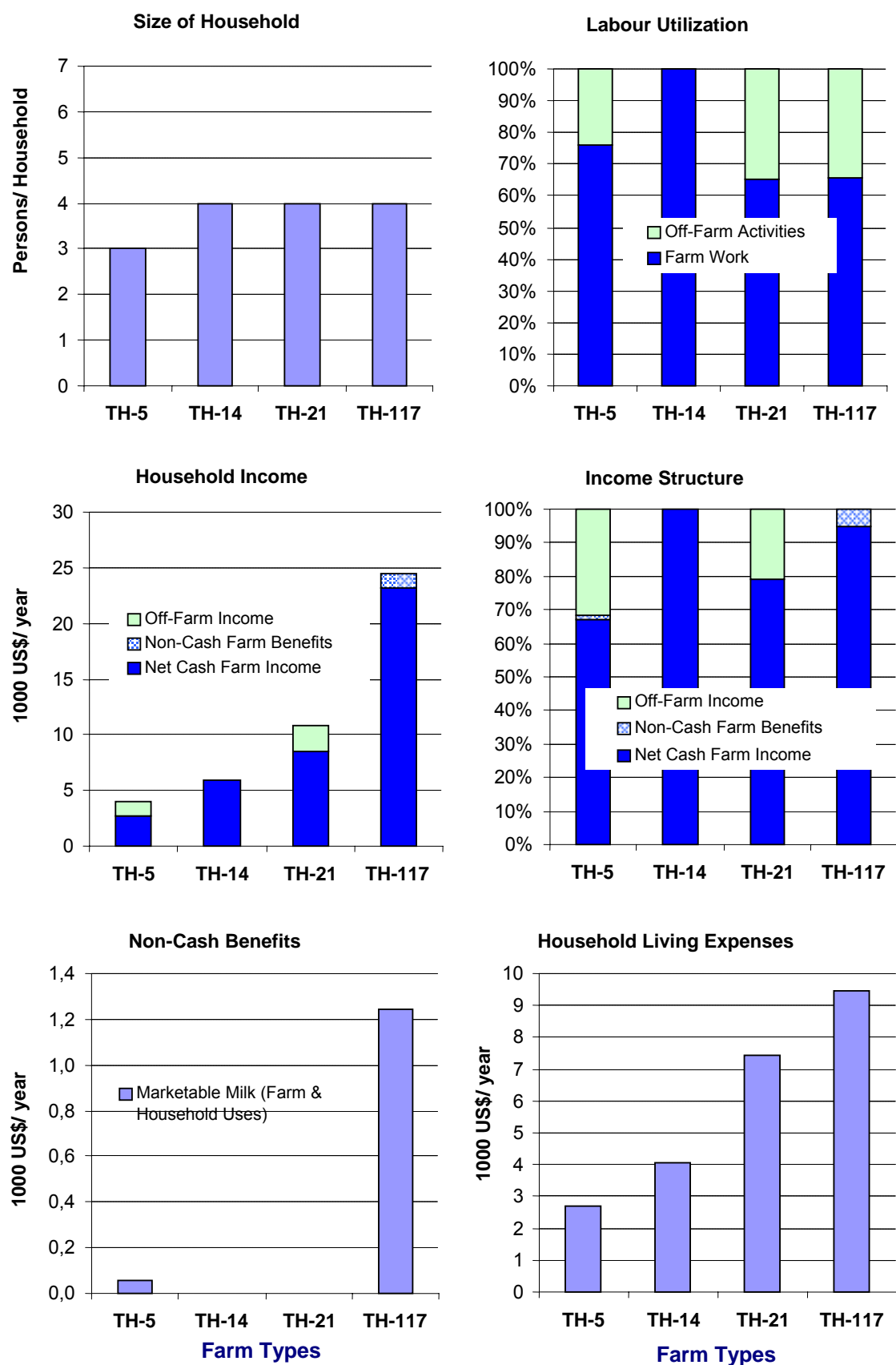
Household living expenses follow the pattern of household income (larger farms having higher living expenses). All farms are able to cover the family living expenses. Although living expenses proved difficult to collect, the families spend between 2,700 and 9,500 US\$/year. For example, in TH-5, the family spends around 900 US\$/person/year (2.5 US\$/person/day).

Household equity growth

When living expenses are subtracted from the total household incomes, all farm households make a surplus ranging between 1,200 to 15,000 US\$/year.

Explanations of variables; year and sources of data:

- Size of the household: People living together in one house as a family
- Labour utilisation: Family labour used to generate income
- Household income: Includes cash and non-cash incomes from farm and off-farm activities
- Off-farm incomes: Includes all salaries for all family members
- Non-Cash Benefits: Milk used for family consumption and feeding calves.
- Household living expenses: Minimum annual cash expenses for the family to maintain the current living conditions.
- Sources of Raw Data: IFCN data collection based on expert estimations and statistics, year 2003.



3.3 Farm comparison: Whole farm approach

Farm returns

Farm returns range from 6,000 to 137,500 US\$ per year, increasing with scale. Interestingly, none of the farms make returns from crops, but from other farm activities. As other farm activities, TH-14 has poultry and Mango fruit sales whereas the two larger farms sell manure as fertiliser. TH-21 obtains the largest share of returns from the sale of manure.

Net cash farm income (NCFI)

The net cash farm income ranges from 2,650 to 23,200 US\$/year. The NCFI follows the same trend as that of the farm returns.

At first glance, profit margins appear to decline with scale. The profit margin for the smallest farm is 44 percent whereas for the largest it is 17 percent. Interestingly, TH-14 and TH-21, being the two most similar farms in these group, show very similar profit levels at 33 and 32 percent. This could imply that expansion from 14 to 21 dairy animals maintains about the same relation between increased farm net income and farm costs (no economy of scale effect).

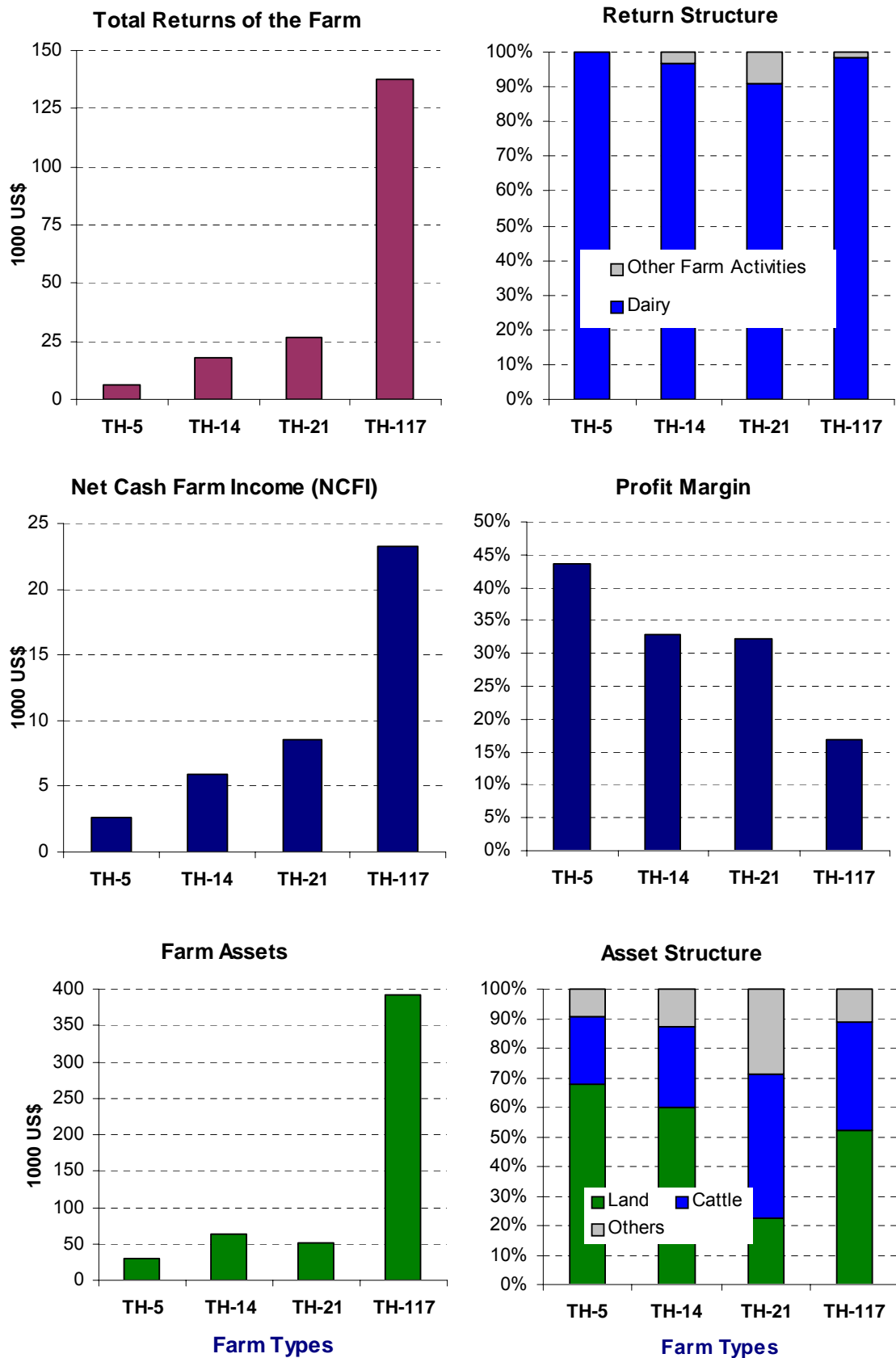
Farm assets

Asset values range from 30,000 to 393,000 US\$. Although TH-14 has fewer cows than TH-21, it has over three times the land area, which explains its higher value of assets.

On a whole farm basis, except for TH-21, land is the most important asset representing between 52 to 68 percent of the farms' asset pool. In the case of TH-21 dairy animals are the major asset representing about 50 percent. Other assets refers to machinery, buildings and cash-on-hand.

Explanations of variables; year and sources of data:

- Farm returns: Sales from all farm enterprises.
- Other farm activities: Poultry and fruits sales.
- Profit margin: Net cash farm income divided by total farm returns.
- Farm assets: All assets related to the farm (land, cattle, machinery, buildings, etc.)
- Sources of Raw Data: IFCN data collection based on expert estimations and statistics, year 2003.



3.4 Farm comparison: Dairy enterprise approach

Cost of milk production

TH-21 has the lowest costs of milk production at 19 US\$ per 100 kg ECM whereas the largest farm has the highest at 23.5. TH-21's lower opportunity costs are driven mainly by lower labour costs of family labour (no hired labour), and to a lesser extent, lower land costs; besides, its high non-milk returns (like beef and livestock returns), which are subtracted to the Other Costs are relative high, bringing costs of milk production only that low.

Return structure

The returns between the farms differ between 39 and 37 US\$ per 100 kg milk for TH-5 and TH-14 respectively. Differences in milk returns can be explained by price differences. Non-milk returns are a result of selling livestock and manure (shown as Other Returns). Only TH-21 has significant returns from manure sales, which make total returns for TH-21 as high as TH-5 (around 39 US\$)

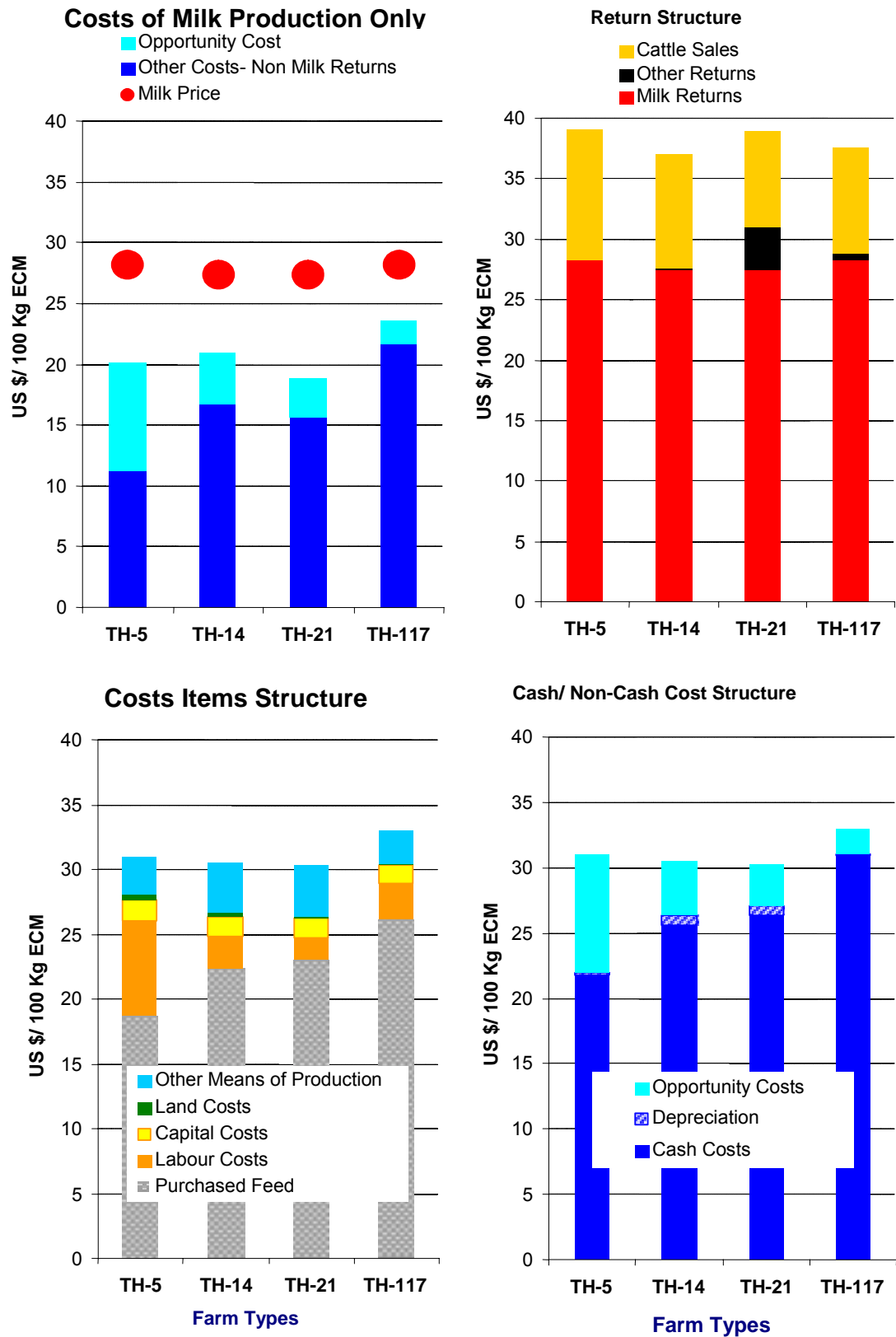
Cost structure of the dairy enterprise

The observed economies of scale of the first three farms seemed to be driven by decreases in labour costs, and to a lesser extent, land costs. TH-117 labour costs are similar to those of TH-14 as a sign of high labour employment and/ or relative low mechanisation, despite the size of the farm.

As expected the share of cash costs increases with the size of the farm.

Explanations of variables; year and sources of data:

- Calculations for these graphs: see Annex A2 & A3.
- Sources of Raw Data: IFCN data collection based on expert estimations and statistics, year 2003.



Dairy farm income and profit margin

All four farm types cover their costs from the profit and loss account and produce a farm income, which ranges from about 6.50 to 17 US\$/100 kg for TH-117 and TH-5. Although TH-14 may be expected to have a higher farm income than TH-21, the latter realises additional (non-milk) income from the sale of animals and cow manure (as fertiliser).

Profit margins fall with scale. They vary between 51 percent for the smallest farm, and 25 percent for the largest farm.

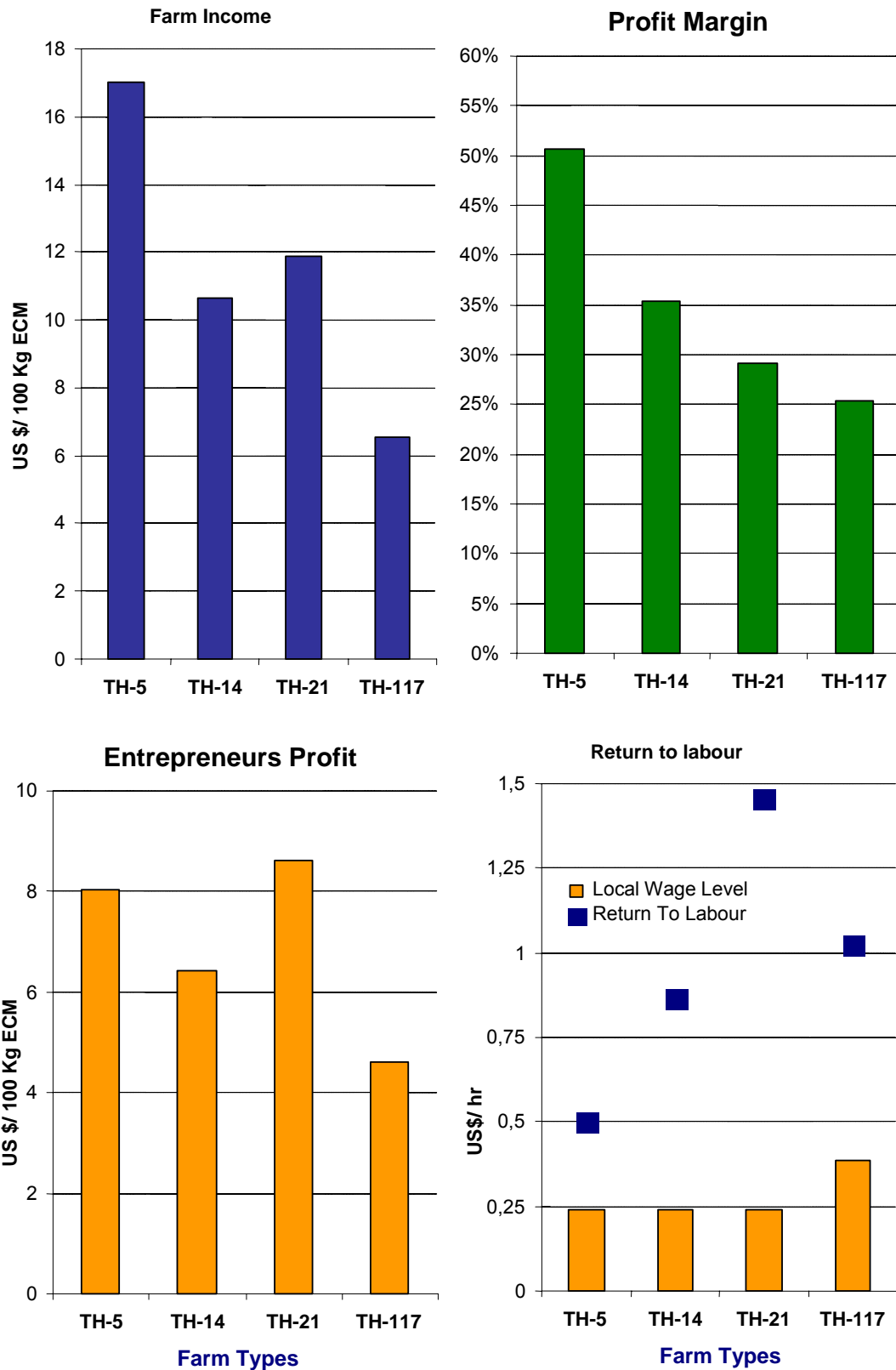
Entrepreneurial profit and return to labour

All the farms cover their full economic costs and generate an entrepreneurial profit of 4.5 to 8.5 US\$/100 kg ECM. Note the impact of non-milk returns obtained by TH-21 on its entrepreneurial profit; without the latter, TH-21 and TH-14 would achieve very similar profit levels, around 6.5 US\$/100 kg ECM.

Furthermore, all farms have higher returns to labour (wage level earned by working on the dairy farm) than the wage level prevailing in the farm vicinity.

Explanations of variables; year and sources of data:

- Calculations for these graphs: see Annex A2 & A3.
- Other returns: Value of manure sold out.
- Sources of Raw Data: IFCN data collection based on expert estimations and statistics, year 2003.



Labour costs

Labour costs per kg of milk produced fall as scale increases. They go from a high 7.25 US\$/100 kg ECM produced for TH-5, to a low 0.46 for TH-117. Note that TH-14 has one-third of the labour costs of TH-5, but still 1.5 times those of TH-21. This indicates the potential for these farm types to lower labour costs.

TH-117 is the only farm that has cash expenses for labour while the other farms exclusively use family labour.

The two larger farms require a similar number of labour hours per cow per year, so the cost difference per milk produced is mainly due to differences in yields and labour prices.

Land costs and 'stocking rates'

As with factor labour use, the four farm types form two distinct groups. The two smaller types apply a more extensive use of resources while the two large ones have intensified. TH-21 and TH-117 incur one-fifth of the land costs of the smallest farm. Similarly, the larger farms hold between 35 and 39 dairy cows per hectare while the smallest only keep 6 to 7 head per hectare.

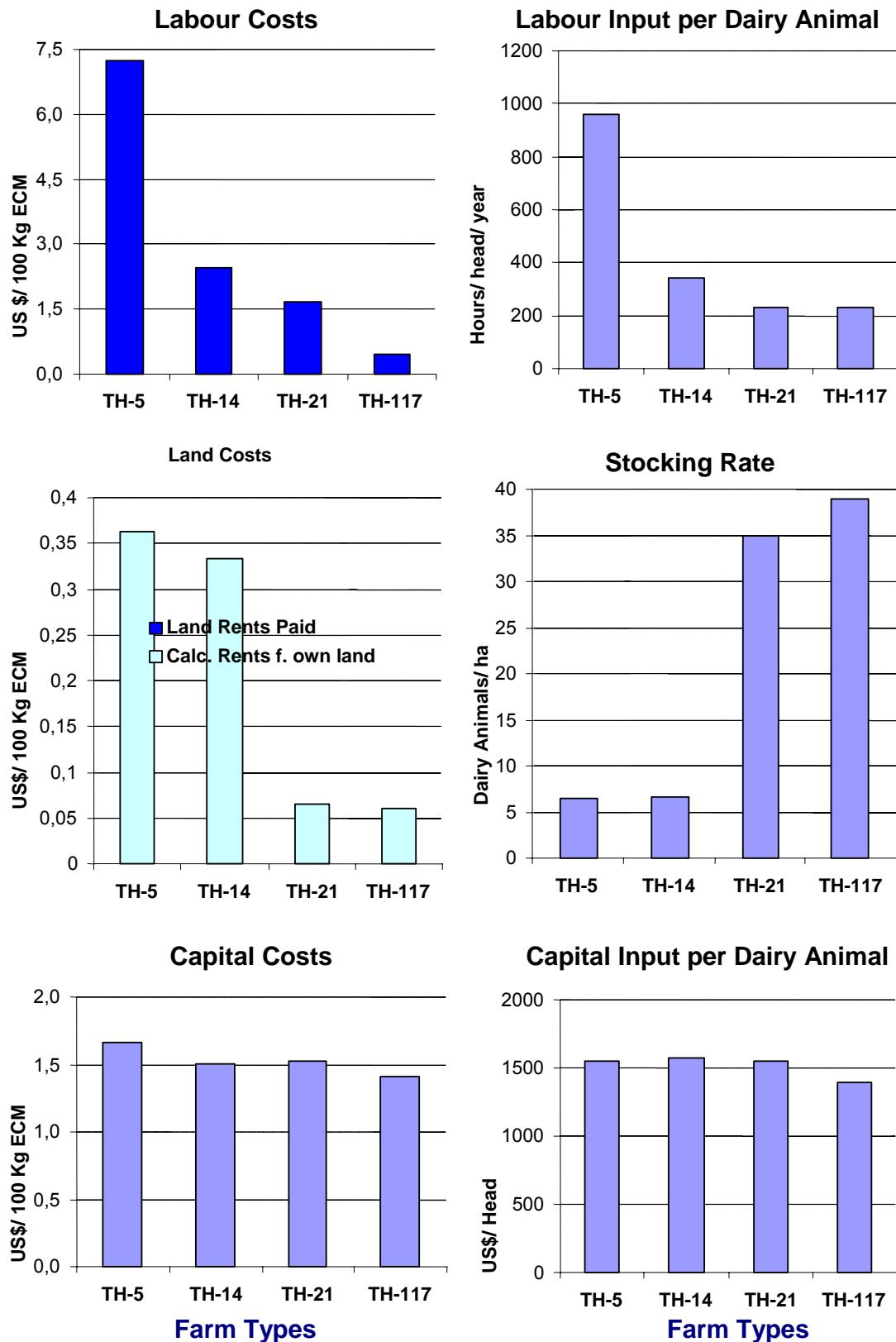
Clearly there is large potential for TH-14 to follow TH-21 in its intensification trend toward TH-117, starting with the more effective use of its resources. Furthermore, similar gains from these moves should be realisable for TH-5 as well.

Capital costs

The capital costs per dairy animal are quite similar for all farms, about 1.5 US\$/100 kg ECM. The capital investment per dairy animal is also similar, around 1,500 US\$ per head. There are, however, differences in the form of major asset holdings. This is due to smaller farms having mostly long-term assets (mainly land) while the larger farms have invested more in operating assets (buildings, equipment and animals).

Explanations of variables; year and sources of data:

- Calculations for these graphs: see Annex A2 & A3.
- Stocking rates: Number of dairy (adult) cows / land size (ha) allocated to the dairy enterprise only.
- Sources of Raw Data: IFCN data collection based on expert estimations and statistics, year 2003.



4. ANALYSIS OF THE DAIRY CHAIN IN CHIANG MAI

4.1 Main dairy distribution and marketing channels in Chiang Mai

It is estimated that 95 percent of the milk produced around the city of Chiang Mai flows through dairy co-operatives, considered as the formal channels. These co-operatives move the liquid milk down to the processors, shops and finally the consumer. The remaining 5 percent is sold by the farmers to small local retailers or directly to end consumers.

Dairy co-operatives provide collection points. Another function of the co-operatives is to market processed dairy products, obtained from the formal processors, back to their members.

Fluid milk

In Chiang Mai, fluid milk is collected by the co-operatives (paying farmers an average of 11.0 Bath/kg milk) and sold to private and government milk processors (charging both around 12.5 Bath/kg milk). Direct farm sales are discouraged by the similar or slightly lower price obtained, which can be explained by consumer preference for the flavour of UHT and pasteurised milk. This strong flavour preference also explains why small/scale dairy farmers in Chiang Mai often sell all their marketable milk (to the co-operative) and then purchase pasteurised milk (also from the co-operative shop) for their own consumption.

The 'Dairy Fresh Milk Company' is the only private company in the area. The authors estimated that the private and government dairy processors handle 60 and 10 tons of milk produced in Chiang Mai per day, respectively.

Processed dairy products

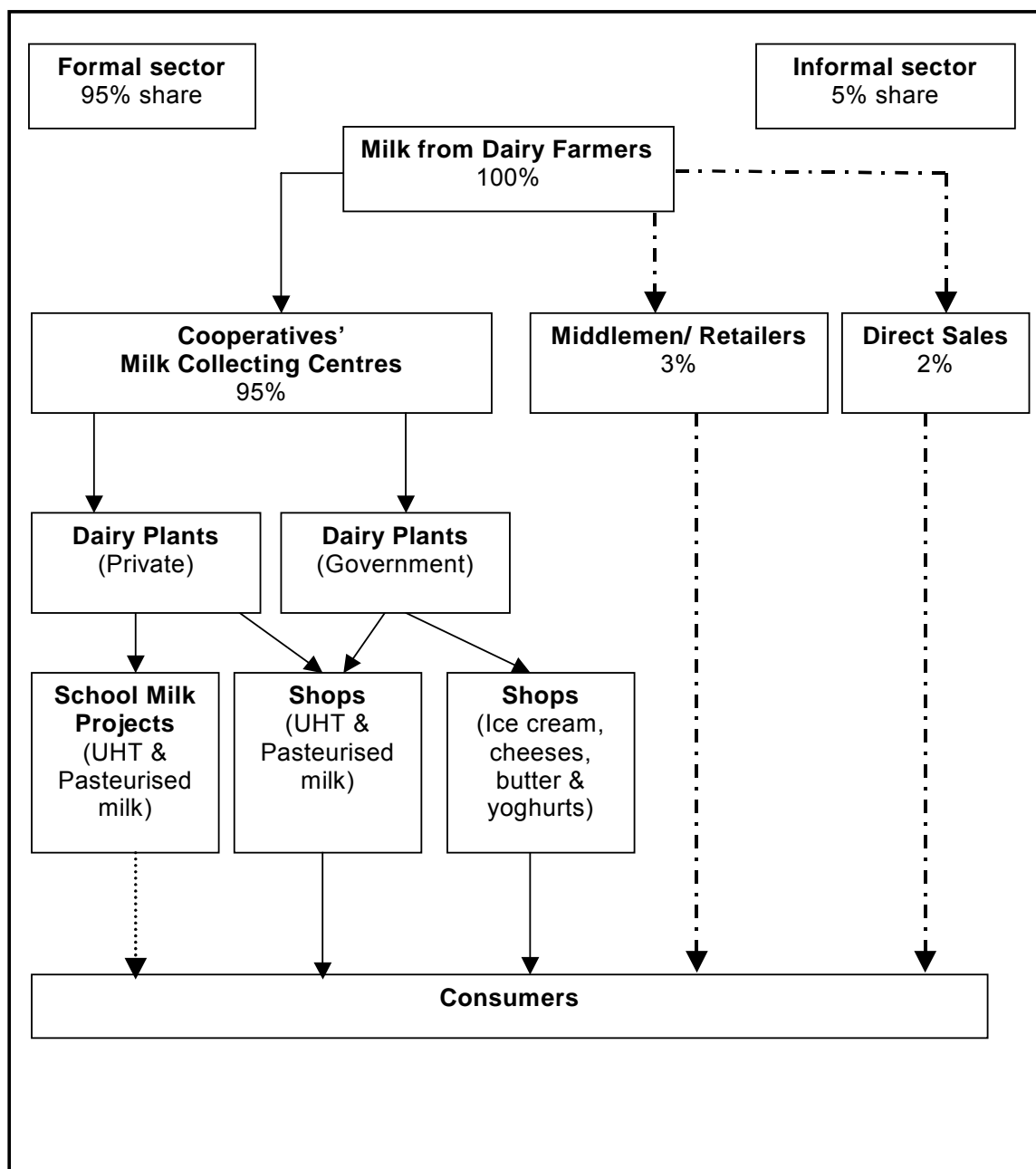
In Chiang Mai, most of milk from local dairy co-operatives is sent to the private dairy processor. This company uses most of the milk (60 tons/day) to produce UHT and pasteurised milks. The dairy company then transfers these milks to local shops and schools for their school-milk programs.

The government dairy processors produce UHT and pasteurised milk too, but the bulk of the milk they purchase is destined to produce higher value dairy products such as ice creams, yoghurts, butter and cheeses, yoghurts being by far the most popular of their dairy products.

For the packaging, dairy processors use tetra pack for UHT and plastic bags for pasteurised milks. Consumers' preference for these two liquid milks is based on (good) taste and smell, availability (found in small shops all over the city), reasonable price and high awareness of the nutritional value of dairy products.

In the informal market, boiled milk is the top dairy product, which appeals to customers who consume fresh milk. Some local candies (milk bars, caramel, etc.) can be also found in the informal sector, but their sales volume is relatively insignificant.

Simplified diagram of the distribution channels for domestic milk in Chiang Mai



Source: Personal Communications; on February, 2004.

4.2 Margins in the dairy chain: Farmer to consumer

Milk processing and retailing cannot be analysed in detail in this study. The estimates of margins rely on farmers' and consumers' price information. For practicality and comparability of the estimation of margins in the dairy chains, it is assumed that each dairy channel buys one kg of non-corrected milk, processes it into their most popular (fluid) milk product, and sells it to the typical end-consumer. Therefore, these dairy chain calculations should be seen as an exploratory exercise intended to support other sections of this study.

The dairy channels

UHT milk: Processors buy milk at 4.12 percent fat and sell it as 3.20 percent Ultra-Heated-Treated and packed milk.

Pasteurised milk: Processors buy milk at 4.12 percent fat and sell it as 3.20 percent pasteurised and packed milk.

Direct sale: Farmers deliver fresh milk at 4.0 percent fat directly to consumers' homes.

Milkmen: Private intermediaries buy from farmers at 4.0 percent fat and delivers to consumers.

Input costs of the dairy chains

The formal sector pays farmer 8 percent higher prices than the informal one. Milk prices are 0.26 and 0.24 US\$/kg of 4.12 percent fat milk in the formal and informal sectors.

Returns of the dairy chains

The return per kg milk processed by the formal channels is between 1.50 and 1.85 times that obtained by the informal traders. The formal channels have a return of 0.67 US\$ for UHT and 0.55 US\$ for pasteurised milk per total milk produced from the initial kg milk processed. The higher premium for UHT milk is largely due to its longer shelf life and conveniently-sized packaging, in packs of 250 and 300 ml. Pasteurised milk comes in bottles of 450 to 830 ml, which is less appealing to local consumers.

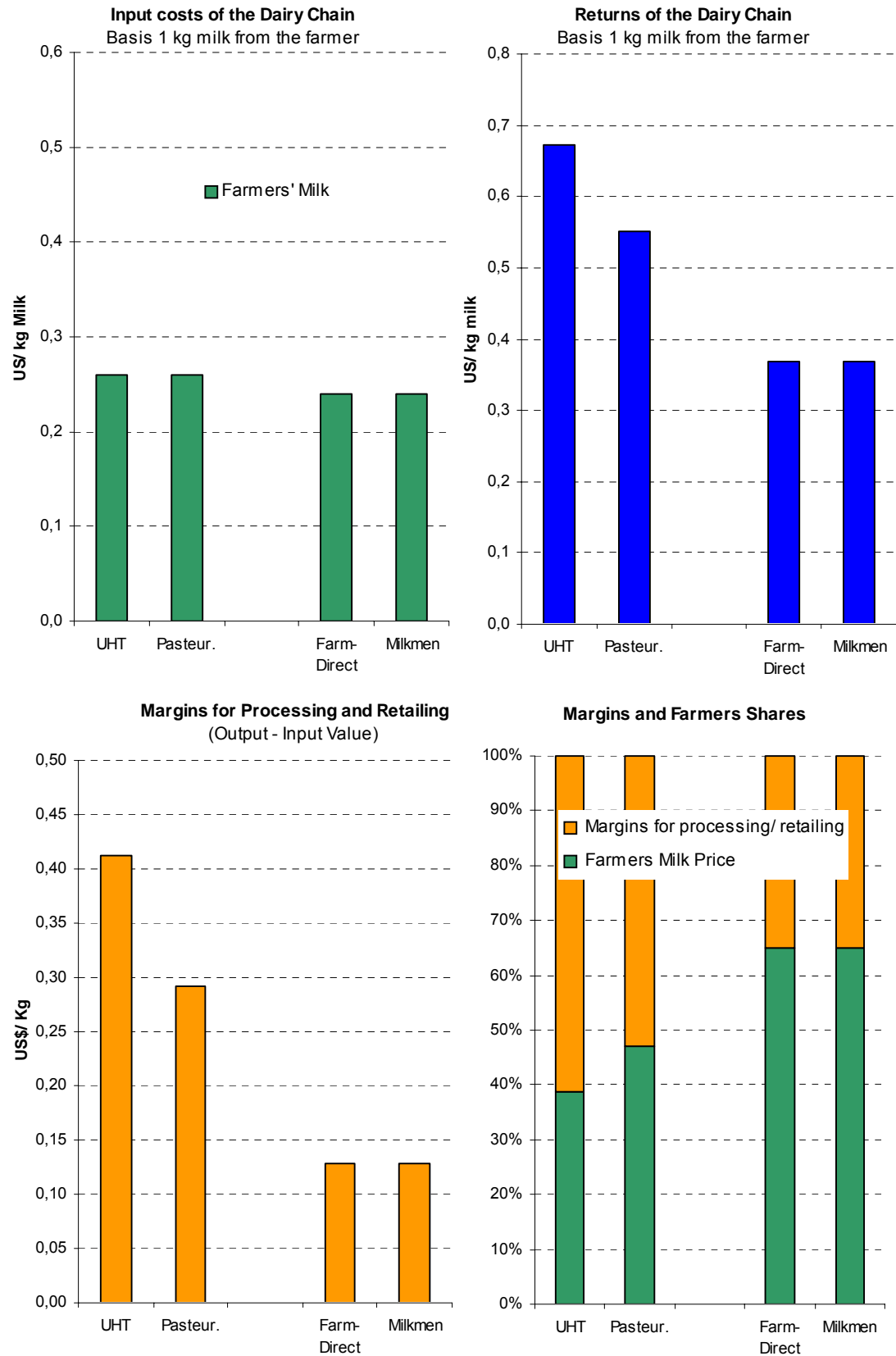
Informal traders obtain 0.37 US\$/total milk processed from the initial kg milk produced / purchased.

'Margins' for processing and retailing

(For this estimation margins are defined as the difference between the returns of the dairy chain and the input value of raw milk) The formal sector UHT and pasteurised milks have 3.15 to 2.23 times the margin of informal (unpasteurised) milk. The margins attained from processing and retailing vary between 0.41 and 0.13 US\$/kg milk. Although dairy companies in Chiang Mai make margins at the level of European dairy chains (0.30 - 0.50 US\$/kg), the issues of milk quality, processing and retailing costs seem to make final profit margins much lower in Chiang Mai than in Europe.

Farmers' shares

The farmers' share in the final consumer price is 38 and 47 percent for UHT and pasteurised milks of the formal channels, while it is 65 percent in the informal ones. These results show that farmers' share in the UHT channel is relatively low compared to similar estimates made for Bangladesh and Orissa, India (with farmers' share of 52 and 45%). For the pasteurised milk channel, which is mostly handled by the government dairy plants, the farmers' share is comparable to that in other countries.



5. POLICY ANALYSIS FOR TYPICAL DAIRY FARMS IN CHIANG MAI

The policy analysis matrix (PAM), developed by MONKE & PEARSON (1989), can be used as an instrument for empirical analysis of agricultural policy. With the help of a PAM it is possible to quantify the impact of applied policies measures and market structures on commodity systems. This quantification is based on the comparison of 'private' prices, which are the actual farm gate prices, with 'social' prices, that can be understood as the prices that would prevail in perfectly functioning markets that are not influenced by policy measures and other distorting market structures.

The PAM approach is a very flexible instrument to measure and evaluate competitiveness and the influence of policy measures on different levels of aggregation. As the approach is simple and easily understandable, particularly for policymakers, it was applied to the typical Thai dairy farms studied. The following results were produced by a policy tool within the IFCN-Model, the development of which is part of an ongoing PhD-Project¹. For further details on the methodology and data, please refer to Annex A4.

Competitiveness analysis

Valuing the costs of all family resources at private prices, all four dairy farm types are highly profitable under the existing commodity system, costs, prices, state intervention and technology since they make entrepreneurial profits from 8 to 4 US\$ / 100 kg milk in the case of the smallest and largest farms respectively.

Applying estimated social prices however, only TH-21 makes a profit, which is attributable to a higher return from sales of manure as organic fertiliser. At social prices, the loss made by the other three farms is -6 US\$ / 100 kg milk for the smallest farm and -1 US\$ / 100 kg milk for the other two farms.

The divergences between private and social profits represent the so called 'net transfer' and give an indication of the monetary transfers Thai society incurs to permit these dairy farms to operate and make the current levels of private profit. Note that the smallest and largest farm types require external support in the order of 14 and 5 US\$ / 100 kg milk respectively.

These divergences are mainly generated by two factors: first, all the farms receive higher private prices for their outputs than those prevailing in the world market, and second, they all pay lower private prices for domestic factors of production than would be the case without policy intervention. For TH-5, this support amounts to 17 US\$ / 100 kg milk, which, however, due to government taxes on the tradable inputs used is brought down to 14 US\$ / 100 kg milk. The increases in prices for tradable inputs are mostly due to import duties on feed. Note that the support per 100 kg milk through low prices for domestic factors decreases as herd size increases, because use of tradable inputs, which are taxed, increases as farm size increases (and thus larger farms pay more taxes) while use of domestic factors decreases.

For all farms except TH-21, at social prices, the returns are lower than the cost of producing 100 kg milk. This suggests that under the existing system, Thailand has a comparative disadvantage in milk production, which is counterbalanced by national policy measures. Without this support, milk production would be discontinued.

¹ STOLL, J. (2005): Development and application of methods to measure the influence of agricultural policy on farms - an extension of IFCN-Model. Discussion paper Nr. 19, Institute of Agribusiness. Giessen.

Competitiveness analysis of the typical dairy farms

Farm Type		Total Revenue	Costs		Profit
			Tradable Inputs	Non-Tradable Inputs	
TH-5	Private Prices	39	15	16	8
	Social Prices	30	12	24	-6
	Divergences	9	3	-8	14
TH-14	Private Prices	37	24	7	6
	Social Prices	28	20	10	-1
	Divergences	9	4	-3	8
TH-21	Private Prices	39	24	7	9
	Social Prices	32	20	10	3
	Divergences	7	4	-3	6
TH-117	Private Prices	37	27	6	4
	Social Prices	29	23	7	-1
	Divergences	8	5	-1	5

Notes: All figures are given as US\$ / 100 kg ECM milk.
 The exchange rate used: 1 US\$ = 42 Baht
 Private Profits for TH-21 = 8.7, but rounded to 9

Analysis of comparative advantage

An important application of the PAM is the possibility to compare the results of different production systems nationally and internationally. The necessary information is obtained by taking the ratio of different identities of the PAM. These ratios provide information about the comparative advantage and the level of protection (positive or negative) of the different farms / production systems.

The Private Cost Ratio (PCR) is an indicator for comparative competitiveness. The ratio indicates how much the production system of interest can afford to pay for the domestic factors of production and still remain competitive. The results for this ratio show that dairy farming is profitable for the farmers as they produce more value added than their domestic resources cost. In other words, from the milk returns the farmers can pay for all tradable inputs and are still left with 43 to 68 percent of the returns to pay for the domestic resources used (which leaves high profits).

The Domestic Resource Cost Ratio (DRC) is defined as the PCR, but uses the social prices. With the exception of TH-21, all farms have DRCs above 1, indicating that they have a comparative disadvantage as their returns are not high enough to cover the costs of tradable inputs and of domestic factors (both at social prices). TH-21's high sales of manure maintain social returns high enough to make a profit.

The Nominal Protection Coefficients for Outputs and Inputs (NPCO and NPCI) are indicators for price distortions. In the case of Thai farms they show that producers are protected for the outputs (NPCO>1) while they are paying taxes for the tradable inputs (NPCI>1). Policy distortions and market conditions result in private prices for outputs and inputs to be around 30 percent and 20 percent higher respectively than would be the case under undistorted market conditions.

The Effective Protection Coefficient (EPC), which combines the effects of price distortions in output and input markets, indicates that the Thai producers gain from the current market conditions and policies (EPC>1). The EPCs are well above 1 for all farms, which shows that the impact of protecting the output prices is greater than that of taxing the tradable inputs. Note that the EPC does not consider the cost of domestic factors.

The Producer Support Estimate (PSE) shows the level of transfers accruing from divergences in private and social profit as a proportion of the private (distorted) value of farm returns. The PSEs range from 36 to 14 percent from the smallest to the largest farm respectively.

The Net Support (NS) ratio provides an indication of the proportion of the private profit that is derived from profit divergences resulting from policy measures and other market conditions. Except for TH-21, the farms are recipients of net support. The latter is equivalent to 1.2 times the private profits in the case of TH-14 and TH-117, while TH-5, with an NS of 1.8, receives 1.8 US\$ as net support for every 1 US\$ of private profit.

2. Comparative advantage analysis of the Typical Dairy Farms.

Indicators*	Typical Dairy Farms			
	TH-5	TH-14	TH-21	TH-117
PCR	0.68	0.51	0.43	0.58
DRC	1.35	1.14	0.77	1.13
NPCO	1.29	1.30	1.20	1.20
NPCI	1.20	1.20	1.20	1.20
EPC	1.36	1.52	1.20	1.59
PSE	0.36	0.21	0.15	0.14
NS	1.81	1.19	0.66	1.19

*Note: For the abbreviations see the last table below.

2.1 Structure of the PAM Matrix

	Total Revenue	Costs		Profit
		Tradable Inputs	Non-Tradable Inputs	
Private prices	A	B	C	D
Social prices	E	F	G	H
Divergences	I	J	K	L

2.2 Reading the ratios

Indicators	Formula	Description
PCR	$C/(A-B)$	Private Cost Ratio
DRC	$G/(E-F)$	Domestic Resource Cost
NPCO	A/E	Nominal Protection Coefficient on tradable Outputs
NPCI	B/F	Nominal Protection Coefficient on tradable Inputs
EPC	$(A-B)/(E-F)$	Effective Protection Coefficient
PC	D/H	Profitability Coefficient
SRP	$(D-H)/E$	Subsidy Ratio to Producers
PSE	$(D-H)/A$	Producer Support Estimate
NS	L/D	Net Support

Policy scenarios for TH-5

The PAM analysis in the previous section indicates that TH-5, TH-14 and TH-117 type farms are socially unprofitable and require high levels of support to make (high) private profits. The aim of this section is to use the PAM approach to assess the impact of possible policy reforms on the private and social profitability of small TH-5-type farms. The scenarios selected assume full elimination of: (1) price protection for the farm outputs, (2) taxes for tradable inputs, (3) subsidies for the domestic factors employed, and (4 and 5) combinations of the preceding. Note that the authors do not attempt to make policy recommendations, but that the aim only is to provide initial insights about the impact of general policy directions.

Under the Status Quo TH-5 manages to make a private profit of 8 US\$/ 100 kg milk. In order to make this profit, this farm type requires support in the order of 14 US\$/ 100 kg milk, which allows it to cover its (negative) social profit of -6 US\$/ 100 kg milk.

Scenario 1: When TH-5 receives world market prices for its outputs, its private profit is -1 US\$/ 100 kg milk produced. Under this scenario, a target private profit must be set for this farm type and some other type of support is required to assist the farm to reach the selected private profit figure. On the other hand, note that the farm support decreased from 14 to only 5 US\$/ 100 kg milk, which means that output price protection represents 64 percent of the total support to this farm.

Scenario 2: Eliminating taxes on the tradable inputs would increase both TH-5's private profits and its support requirements by 2 US\$. This scenario seems to be the least indicated to be pursued under the current conditions.

Scenario 3: If TH-5 had to pay the full cost of the domestic factors used in milk production, its private profits would shrink to half (from 8 to 4 US\$) while the support required decreases by 57 percent (from 14 to 6 US\$). Furthermore, note that TH-5's social profit would increase by 50 percent (from -6 to -3 US\$) under this scenario.

Scenario 4: Elimination of output price protection and taxes on tradable inputs simultaneously would allow TH-5 to make an attractive private profit (2 US\$/ 100 kg milk) while it would cut down the support required by 43 percent (from 14 to 8 US\$).

Scenario 5: Elimination of taxes for tradable inputs in combination with having to pay the full costs of domestic resources diminishes private profit by 25 percent (to 6 US\$/ 100 kg milk) while the support required decreases by 36 percent (from 14 to 9 US\$).

The above results show that TH-5's social loss of 6 US\$/ 100 kg milk can be reduced by half by charging the full cost for the domestic factors of production used by this farm type. Likewise, the value of support transferred to this farm type can be decreased by up to 43 percent (from 14 to 8 US\$/ 100 kg). This clearly indicates that through policy action, this farm type's social profitability and support requirements can be greatly improved. However, policy measures are not sufficient to make this farm type socially profitable and independent of support and this farm type also needs to become more competitive by increasing productivity and decreasing production costs.

Since these scenarios assume 100 percent elimination of taxes, protection and/or subsidies, the next step would be to identify the degrees, speed and combination of factors that may be most appropriate to gradually diminish and finally eliminate the current market distortions while allowing dairy farmers to maintain attractive private profits.

PAM Policy Scenarios for TH-5

		Private prices	Social Prices	Divergence
Status Quo	Revenue	39	30	9
	Tradable Inputs	15	12	2
	Non-tradable Inputs	16	24	-8
	Profit	8	-6	14
Policy Scenario 1: No Protection for Outputs (Details: Prices down to 0.73, 0.88 and 0.93 for milk, beef and livestock)	Revenue	30	30	0
	Tradable Inputs	15	12	2
	Non-tradable Inputs	16	24	-8
	Profit	-1	-6	5
Policy Scenario 2: No Taxes for Tradables Inputs (Details: Prices down to 0.83, 0.83 and 0.88 for fuel, feed and fertilizers)	Revenue	39	30	9
	Tradable Inputs	12	12	0
	Non-tradable Inputs	16	24	-8
	Profit	10	-6	16
Policy Scenario 3: No Subsidies for Domestic Factors (Details: Prices increased up to 1.50 for each labour, land and capital)	Revenue	39	30	9
	Tradable Inputs	15	12	2
	Non-tradable Inputs	20	20	0
	Profit	4	-3*	6
Policy Scenario 4: No Protection for Outputs + No Taxes for Tradable Inputs (Details: Combination of Scenario 1 and 2)	Revenue	30	30	0
	Tradable Inputs	12	12	0
	Non-tradable Inputs	16	24	-8
	Profit	2	-6	8
Policy Scenario 5: No Taxes for Tradable Inputs + No Subsidies for Factors (Details: Combination of Scenario 2 and 3)	Revenue	39	30	9
	Tradable Inputs	12	12	0
	Non-tradable Inputs	20	20	0
	Profit	6	-3*	9

Notes: *Due to the effect of fully paying for Labour and Capital.
 All figures are given as US\$ /100 kg ECM milk.
 The exchange rate used: 1 US\$ = 42 Baht.
 Consider that numbers are rounded.

6. CONCLUSIONS

Dairy development in Thailand

From 1996 to 2003, Thai milk production has doubled, milk yield per dairy animal per year has increased by a factor of 1.7, and the number of dairy animals has grown by 10 percent. On the other hand, the Buffalo population has declined to 60 percent of its 1996 level.

Dairy farming in Chiang Mai

The economic results for the typical farms show that (1) the costs of domestic factors of production per litre of milk decreases as the farm size increases (land and labour costs per litre of milk are 5 and 3 times higher for the smallest farm compared to those of the largest) while (2) costs of tradable inputs (feeds, machinery, medicine, etc.) per litre of milk, which are taxed, are higher for the larger farms.

The net results are that the smallest and largest farms have costs of milk production of 20.0 and 23.5 US\$ per 100 kg ECM milk. All three farm types cover their full economic costs and generate an entrepreneurial profit of 4.5 to 8.5 US\$/100 kg ECM.

Lastly, all farms have higher returns to labour (wage level earned by working on the dairy farm) than the wage level prevailing in their vicinity.

Dairy chain in Chiang Mai

Unlike in South Asian countries such as India and Pakistan, 95 percent of the milk produced in the Thai province of Chiang Mai is handled by the formal sector. The remainder is sold by farmers to retailers or final consumers.

The formal sectors pays 0.26 US\$/kg of 4.12 percent fat milk and sells UHT and pasteurised milk for 0.67 and 0.55 US\$/litre. The informal sector pays 0.24 US\$/kg of 4.12 percent fat milk and sells the milk at 0.37 US\$/litre.

The margins attained from processing and retailing lie around 0.41 and 0.13 US\$/kg milk for the formal and informal sector respectively.

Finally, farmers' shares in the consumer prices are 38 percent for UHT and 47 percent for pasteurised milk in the formal sectors, while it is 65 percent in the informal sector. Going by these results, farmer' shares in the UHT channel are relatively low when compared to similar estimates for Bangladesh and Orissa, India (with farmers' share of 52 percent and 45 percent).

Dairy policy analysis in Chiang Mai

The results of this study show that, based on private prices, the typical dairy farms considered cover their production costs and produce attractive entrepreneurs' profits. However, a look at the PAM results using social prices shows that with the exception of TH-21, the analysed dairy production systems have comparative disadvantages and require heavy support to make their current private profits. TH-21's high non-milk returns offset its costs of milk production, thereby increasing the farm's profitability.

How and to what extent are dairy farms supported? The PAM shows that the farms receive about 30 percent higher output prices (milk and beef) while they also pay about 20 percent higher prices for their tradable inputs (mostly from duties on feed imports) than they would under free market conditions. Additionally, the farms benefit from policies that 'undervalue' domestic resources (labour, land and capital) and thus promote their utilization (see Annex A4 for more details). These policies depress the cost of domestic resources to around 70 percent of the value that would be expected to prevail in undistorted market conditions.

Which farm type is most heavily supported? The PAM analysis reveals that for each 1 US\$ profit made by the farmers, TH-5 receives a net support of 1.81 US\$ while the support received by TH-14 and TH-117 is in the order of 1.19 US\$. (TH-21, not requiring support, is the exception.) This clearly shows that while most farms require heavy support, the smallest farm type (TH-5) by far benefits most from the policies in place.

What are the implications of the PAM results? As a relatively young industry, the Thai dairy sector is still growing through increase in farm numbers (rather than growth in farm size), which are mostly small enterprises. The promotion of socially unprofitable dairy farm types is not in the best interest of either Thailand nor its farmers. Therefore, further development of the sector should rely heavily on setting and implementing a policy framework at the national and industry level that will provide adequate support for dairy farms to improve their socio-economic efficiency.

Finally, the significant differences between private and social profits, particularly for farm type TH-5, indicate a high degree of imperfection in the market. The latter implies a high potential to increase competitiveness of the sector through the right policy actions. Furthermore, the results of the policy scenarios investigated clearly show that the socio-economics (comparative advantages) of farm type TH-5 can be significantly improved through various policy interventions.

In this chapter, we will present the methods and sources of information used to collect data about the dairy sector in Hanoi and how the costs of production for the selected typical production systems are calculated.

This project has followed the framework used by the International Farm Comparison Network (IFCN). IFCN is a world-wide association of agricultural researchers, advisors and farmers. These participants select typical agricultural systems in key production regions in their individual countries. In 2004, the number of participating countries extended to 31 countries with 86 farm types that represent more than 70 percent of the world milk production.

Within this scientific Network, FAL-Federal Agricultural Research Centre (Germany) through its Institute of Farm Economics is acting as the co-ordination centre for scientific issues.

The central objectives of IFCN are:

- 1) To create and maintain a standardised infrastructure through which production data of the major agricultural products (milk, beef, wheat, sugar, etc.) and from major producing regions of the world can be effectively compared and discussed.
- 2) To analyse the impact of the structure of production, technology applied and country-specific policies on the economic performance of agribusinesses, their costs of production and global competitiveness.

In order to achieve these objectives, IFCN employs the following methods and principles:

Direct contact with the production protagonists. A team of advisors and farmers is put together to set up the typical production models and to revise the final results. This approach brings the results closest to reality.

The principle of 'Total Costs'. IFCN considers both direct costs and margins, and the indirect (fixed) costs (i.e. depreciation and interests of the infrastructure used) and the opportunity costs for owned assets and production factors (i.e. family labour, land, capital).

A single and homogeneous method is utilised to calculate the costs of production for all participating countries. The IFCN standard is not the only truth, but a) it is scientifically correct, b) it includes all the existing production costs, and c) it creates transparency and international comparability in the arena of costs of agricultural production. Each IFCN member and client can reorganise the costs at his convenience and present them in the particular format of his country while he maintains an internationally comparable set of results.

The concept of setting (regional) typical agricultural models. A team of country experts, advisors and producers is formed to identify and set up the typical regional production models for each agricultural product. Typical production models must represent the common production structures in the region or country.

In the case of dairy production, for example, a working team composed of advisors, consultants and producers is formed as a panel. The first working step is to define the typical milk production systems of the major dairy regions in country. This model may be a 4-cow farm, feeding mostly cut grasses to fully confined animals, combine milk production with some other agricultural activities such as wheat and rice production in 3 ha of irrigated owned land, and milking is done by hand twice a day.

The second working step is to collect all the needed information from these typical models. For this, IFCN has developed a standard questionnaire. It is crucial that these

data collected should neither reflect an individual farm (too many particularities may hurt the ability to generalise the results) nor be an arithmetic average (an average does not show much about the technology and the economics involved). The typical model should rather represent real and common situations of the region and show clearly the predominant technology and infrastructure. Such models will be preferred by analysts. The model TIPI-CAL (Technology Impact and Policy Impact Calculations) is utilised for the simulations of these typical models and the calculations of their costs of production. TIPI-CAL can be easily shared with all IFCN members since it is a spreadsheet in MS-Excel. This model is a combination of production (physical data) and accounting (economic data). TIPI-CAL also consists of both a structure of costs of production and a simulation component (without optimisation). The simulations can be done for a period of up to 10 years in order to evaluate the growth, investments, policies or market conditions. For each year, TIPI-CAL produces a 'Profit and Loss Account', a balance and cash flow statement.

Allocation of costs of production. When the typical milk production systems have several agricultural activities besides dairy, fixed costs and expenses (i.e. depreciation) are distributed to each activity according to their use. For example, the depreciation of the machinery, which is used, for the dairy and the crop enterprises is allocated according to the hours worked in each.

Data about farm and off-farm household economics. IFCN takes into account all activities of the typical production systems, plus all the off-farm incomes and expenses realised by the owner and his family. This more complete picture of the typical model is necessary to obtain reliable information about the current economic situation of the model (and the household) and about the future of the farm (simulations).

All the methods and principles above have been applied in this project. The IFCN fieldwork experience supports that the analysis of costs of production shows no significant difference between the participation of one advisor and a 'full panel'. Therefore, it was decided that an IFCN scientist first visit each and every model, talk with the owners to collect project-specific information, analyse the data and then have the results cross-checked by local experts and farmers.

The analysis of costs of production and the competitiveness of the typical models and its graphs follow the same structure as those in the 'IFCN Annual Dairy Report'. The main objectives of this report is to analyse and document the main typical milk production systems in the province of Chiang Mai. Therefore, this report shows the comparative world position of the Thai dairy industry and its potential, margin analysis of dairy chains in Chiang Mai, a comparison of the costs of production for the main milk production systems in Chiang Mai province, and a section on the policy situation affecting these specific farms.

For more information about IFCN, visit <http://www.ifcnnetwork.org> and <http://www.ifcndairy.org>

Cost calculation

The cost calculations are based on dairy enterprises that consist of the following elements: Milk production, raising of replacement heifers and forage production and / or feed purchased for dairy cows and replacements.

The analysis results in a comparison of returns and total costs per kilogram of milk. Total costs consist of expenses from the profit and loss account (cash costs, depreciation, etc.), and opportunity costs for farm-owned factors of production (family labour, own land, own capital). The estimation of these opportunity costs must be considered carefully because the potential income of farm owned factors of production in alternative uses is difficult to determine. In the short run, the use of own production factors on a family farm can provide flexibility in the case of low returns when the family can chose to forgo income. However, in the long run opportunity costs must be considered because the potential successors of the farmer will, in most cases, make a decision on the alternative use of own production factors, in particular their own labour input, before taking over the farm. To indicate the effects of opportunity costs we have them separated from the other costs in most of the figures.

For the estimations and calculations the following assumptions were made:

Labour costs

For hired labour, cash labour costs currently incurred were used. For unpaid family labour, the average wage rate per hour for a qualified full-time worker in the respective region was used.

Land costs

For rented land, rents currently paid by the farmers were used. Regional rent prices provided by the farmers were used for owned land. In those countries with limited rental markets (like NZ), the land market value was capitalised at 4 per cent annual interest to obtain a theoretical rent price.

Capital costs

Own capital is defined as assets, without land and quota, plus circulating capital. For borrowed funds, a real interest rate of 6 per cent was used in all countries; for owner's capital, the real interest rate was assumed to be 3 per cent.

Quota costs

Rent values were used for rented or leased quota. Purchased quota values were taken as being the annual depreciation of values from the profit and loss accounts.

Depreciation

Machinery and buildings were depreciated using a straight-line schedule on purchase prices with a residual value of zero.

Adjustments of fat content

All cost components and forage requirements are established to produce ECM (Energy Corrected Milk with 4.0 percent fat and 3.3 percent protein).

Adjustment of VAT

All cost components and returns are stated without value added tax (VAT).

Adjustment of milk ECM (4 and 3.3 percent fat and protein)

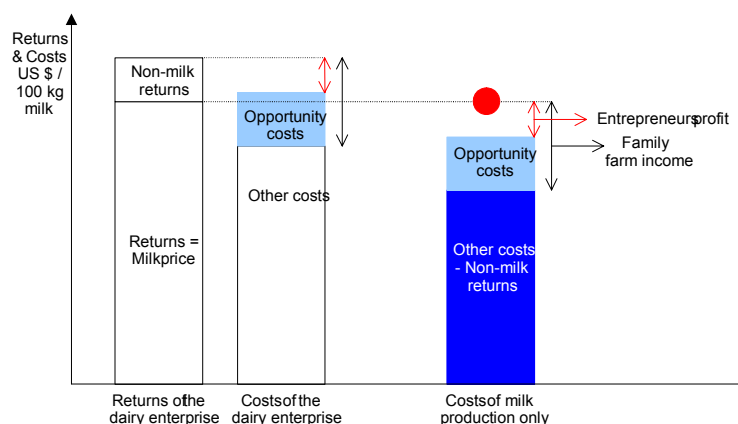
The milk output per farm is adjusted to 4.0 percent fat using the following formula:
$$\text{ECM milk} = ((\text{milk production} * 0.383 * \text{fat in percent}) + (\text{milk production} * 0.242 * \text{protein in percent}) + (\text{total marketable milk output} * 0.7832)) / 3.1138$$

Farm economic indicators (IFCN method)

+ Total receipts =	
+ Crop (wheat, barley, etc.)	
+ Dairy (milk, cull cows, calves, etc.)	
+ Government payments	
- Total expenses =	
+ Variable costs crop	
+ Variable costs dairy	
+ Fixed cash cost	
+ Paid wages	
+ Paid land rent	
+ Paid interest on liabilities	
= Net cash farm income	
+ Non cash adjustments =	
- Depreciation	
+/- Change in inventory	
+/- Capital gains / losses	
= Farm income (Family farm income in Dairy Report 2001)	
- Opportunity costs =	
+ calc. interest on own capital	
+ calc. rent on land	
+ calc. cost for own labour	
= Entrepreneurs profit	

A3 DESCRIPTION OF IFCN RESULT VARIABLES

Cost of milk production only



Method

The total costs of the dairy enterprise are related to the total returns of the dairy enterprise including milk and non-milk returns (cattle returns and direct payments). Therefore the non-milk returns have been subtracted from the total costs to show a cost bar that can be compared with the milk price. The figure beside explains the method.

Other costs: Costs from the P&L account minus non-milk returns (cattle returns and direct payments, excl. VAT).

Opportunity costs: Costs for using own production factors inside the enterprise (land * regional land rents, family working hours * wage for qualified workers, capital: Own capital * 3 percent).

Returns of the dairy enterprise

- Milk price: Average milk prices adjusted to fat corrected milk (4 percent excl. VAT).
- Cattle returns: Returns selling cull cows, male calves and surplus heifers + /- livestock inventory (excl. VAT).
- Other Returns: Sale/home use of manure.

Costs by cost items

- Costs for means of production: All cash costs like fuel, fertiliser, concentrate, insurance, maintenance plus non-cash costs like depreciation for machinery and buildings (excl. VAT).
- Labour costs: Costs for hired labour + opportunity costs for family labour.
- Land costs: Land rents paid + calculated land rents for owned land.
- Capital costs: Non-land assets * interest rate (equity * 3 percent, liabilities * 6 percent).
- Quota costs: Payments for rented quota and depreciation for quota bought.

Cash and non-cash costs

- Cash Costs: Cash costs for purchase feed, fertiliser, seeds, fuel, maintenance, land rents, interest on liabilities, wages paid, vet + medicine, water, insurance, accounting, etc (excl. VAT).
- Depreciation: Depreciation of purchase prices for buildings, machinery and quotas (excl. VAT).
- Opportunity costs: Costs for using own production factors (land owned, family labour input, equity).

Economic results of the dairy enterprise

- Farm income per farm: Returns minus costs from P&L account of the dairy enterprise.
- Farm income per kg milk: Farm income per farm (dairy enterprise) / milk production
- Profit margin: Share of farm income on the total returns: Farm income divided by the total returns.
- Entrepreneurs profit: Returns minus costs from P&L account of the dairy enterprise - opportunity cost allocated to the dairy enterprise.
- Net cash farm income: Cash receipts minus cash costs of the dairy enterprise or: Farm income + depreciation
- Return to labour: Entrepreneurs profit plus labour costs (wages paid plus opportunity costs) divided by total labour input.
- Average wages on the farm: This figure represents the gross salary + social fees (insurance, taxes, etc.) the employer has to cover. Calculation: Total labour costs (wages paid plus opportunity costs) divided by the total hours worked. To calculate this the number of hours worked by the employees and the family has been estimated by experts.
- Labour input: The estimation of hours worked and the valuation of these hours is extremely difficult especially in family farms. In the IFCN network this method will be intensively discussed and improved during the next workshops.
- Labour costs: Paid wages and opportunity costs for own labour of the dairy enterprise.
- Land costs: Paid land rents and opportunity costs for own land (calculated rent) of the dairy enterprise.
- Stocking rate: Number of cows / ha land.
- Capital costs: Paid interests and opportunity costs for own capital (excluding land capital and quota capital). For equity 3 percent and for liabilities 6 percent interest rate is used in all countries. This reflects the method of "capital using costs" developed by Isermeyer, 1989.
- Capital input: Total Assets (land, buildings, machinery, cattle)/ number cows.

A4 SOCIAL PRICES FOR THE PAM ANALYSIS: ADJUSTMENT FACTORS

1. Tradable inputs

Farm Outputs	Trade Status (Imported or Exported)	Tariffs (for Imports & Exports)	VAT (Value Added Tax)
Milk	Imp	20% in quota rate & 42% out of quota.	7%
Livestock	Imp	None (pure breeds for breeding)	7%
Culled Animals	Imp	5%	7%
Farm Inputs			
Maize (for feeds)	Imp	20% or 2.75 Baht /kg whatever is lower (>52.60% out of quota)	7%
Soybean (for feeds)	Imp	5% (119% out of quota)	7%
Fish meal	Imp	10%	7%
Minerals (for feeds)	Imp	15%	7%
Broken rice	Exp	None	7%
Tapioca	Exp	None	7%
Salt	Exp	None	7%
Semen			
Veterinary Medicine & Injectable Vitamins and Minerals	Imp	30%	7%
Maize (seed)	Imp	2.75 Baht/kg	7%
Fertilizer (NPK; Urea)	Imp	5%	7%
Machinery	Imp & Exp	30 and 7% respectively	7%
Electricity	Exp	None	7%
Gasoline and Diesel	Imp	30%	7%

Tariffs are used to assess the direction and degree of the effect of policies for tradable goods for the study farms. Since the tariffs are not the only factors distorting the national dairy sector, the PAM results only assess the effect of distortions caused by such tariffs. A more complete assessment will require a closer look at services (such as transportation, insurances, etc.) and related programs in order to identify further distortions and their effects on the study farms. Therefore, at this point, we analyse the effect of the tariffs imposed to these specific tradable goods while other conditions are assumed to be undistorted.

Source: <http://mkaccdb.eu.int/cgi-bin/wtdtar/wtdsearch.pl> (last updated 6 of August, 2004).

2. Domestic (production) factors

Domestic Factors	Policies & Effects on Prices	Adjustment Factor
Labour	<p>Companies get a quota to import alien workers. Once registered in a province, workers can be moved across provinces and companies. Registered alien workers need an official permit to move from one province to another (keeps wages low).</p> <p>Gangs find ways to move alien registered workers at 1.5 to 3 times the official legal transfer fees (keeps wages low).</p> <p>Illegal unregistered workers from the devastated economy of Myanmar are a major issue in Thailand (keeps wages low).</p> <p>Migrant workers are said to be underpaid and to often be unfairly dismissed if they make any claim (keeps wages low).</p> <p>For comparison, note that Thai labour law has a minimum wage of 20 Baht/hour while processed fluid milk sells for from 35 up to 45 Baht/litre.</p>	<p>Conclusion: Without these regulations and their effects <u>labour prices in Thailand would go up.</u></p> <p>How much higher?</p> <p>For the first three farms, the family would earn wages of 10 Baht/hr if they worked off farm. If the labour market constraints were removed, one could expect an increase in their family labour prices but not yet reaching the minimum legal wage of 20 Bath. Expert estimations agree that wages for these three families labour may go up to 15 Baht/hr (or 150% of what is now).</p> <p>For the large farm, labour cost is 16.17 Baht/hr and reaching the minimum wage level means an increase of 24%. However, abundant labour supply would keep it below minimal wages. So wages hired labour will come up to 18 Baht (or 112% of what is now).</p> <p>Finally, the policy of minimal wage is artificially high and often not applied. <u>Eliminating this policy and others would bring wages up</u>, but they would remain below the 20 Bath/hr in the region under study.</p>
Land	<p>Over 30 per cent of the 5.5 million households in the agricultural sector have insufficient land to derive a livelihood (in the Northern Region, this is considered to be less than 1.6 hectares). The Thai land policy, mainly through Land Titling Program, attempts to establish a free land market by improving access to land as a primary means of alleviating poverty. A free land market is expected to increase retention or transfer of land to small-scale farmers and stimulate the supply of cheap formal credit to both rural and urban sectors. To assure that wealthier investors</p>	<p>Conclusion: without these regulations and their effects <u>land prices in Thailand would go up.</u></p> <p>How much higher?</p> <p>Reliable data for land market prices in Thailand are hard to find. However, a more reliable rent land price is accessible and taken here as an indicator of the land market value. One finds land rent price for both government land (whose policies are to land prices low) and the rent price of private land (which reflects free market conditions and whose prices are comparable to those</p>

	<p>don't run to purchase land and bring prices to levels unreachable for the poor and landless, Thailand poses restrictions to (1) foreign land ownership and (2) within the country, it allows for practices such as common land ownership, where individual owners can sell land only to their respective community committee for a (low) pre-set price, which assures the poor access to land (keep land prices low).</p> <p>Other Thai ways of adjusting the land market to discourage the hoarding of land and to promote smallholder acquisition and retention of land are: progressive land taxation, land zoning while having extremely low taxes on agricultural lands, less than 0.25% of the land value (keep land prices low).</p> <p>Alleged corruption in land allocation throughout the country has fuelled multiple land occupation by various communities. This creates a disincentive for major investors to purchase land (keep prices low).</p> <p>The IMF has contended, regarding to land, that the kinds of restraints that Thailand had imposed to prevent a crisis interfered with the efficient market allocation of resources.</p>	<p>in other Asian countries).</p> <p>The Department of Treasury and private individuals, the major landowners, rent land out to farmers. While the government has a fee of 2,400 to 3,000 Baht/ ha/ year, private landlords get over 8,000. Then, the rent price of private land is 3 times that of public land.</p> <p>This huge rent price difference may be mostly explained by three factors: 1- the better soil and infrastructure of private lands, 2- the government conscious practices of making land accessible to small-scale farmers and the poor, by keeping low land rent prices, and 3- the fact that renting or purchasing land in Thailand carries considerable risks since most land have not titling and land occupations are a familiar threat to private land investments.</p> <p>If government land would have (1) better infrastructure like roads and irrigation canals and (2) land titles would be granted, one would expect that a free land market would emerge. In this free land market, land would be allocated to the most profitable use, which together with low risk to investments would bring land prices up to about 6,000 Bath/ ha/ yr. (2 times as its current price). Government land rent prices would not reach as high as private land simply because the majority of renters are resource poor and will pull the price down.</p> <p>For private land, rents might stay same or decrease very little. In addition, the ratio of land prices of Thailand is stable after the economy crisis since 1996.</p> <p>Following this reasoning, the adjustment factor for land is that if all these constraints are eliminated, the market value of land in Thailand would be 150% of what it is today.</p>
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Capital (Interest Rates)	<p>The Bank of Agriculture and Agriculture Cooperatives (BAAC) has been since 1966 charged with providing low-interest loans to farmers. The BAAC lends to small farmers at interest rates between 6.5 and 10% depending on the borrowers' credit worthiness and loan duration with small amounts requirement of borrower's asset guaranty.</p> <p>The capital prices in the province of Chiang Mai varies from 10 to 15% in the formal private banking sector.</p>	<p>Conclusion: without institutions like the BAAC providing subsidized loans to small-scale farmers, interest rates would be <u>HIGHER</u>. How much higher? The three smaller typical have a loan for the BAAC at 6.5% interest rate. In the local capital market they would have to pay over 10% for a similar loan (1.5 times higher).</p> <p>This means that without lenders like the BAAC, <u>farmers would have to pay 150% of what they pay now</u> for borrowed money.</p>
References used	<p>For labour: www.thailabour.org For Land: www.landaction.org For Capital:</p> <ol style="list-style-type: none"> 1. Tanya Limkhumduang, Benchaphun Ekasingh, Boonserm Cheva-Isarakul and Kamol Ngamsomsuke. 1998. "Dairy Farmer's Productivity and Capital Need in Chiang Mai Province." Agricultural Economic Report No. 46. Multiple Cropping Centre. Faculty of Agriculture, Chiang Mai University. 2. The MRL of the Bangkok Bank. 3. The authors' own survey database. 	

The information on policies and their application have been drawn from literature reviews while estimates of their effects are based on expert opinion. All effects are aggregated into one 'Adjustment Factor', which will be used by the IFCN PAM model for each non-tradable factor. These adjustment factors indicate the direction and degree to which the private costs/prices of these factors diverge from their respective social costs/prices.

A5 DAIRY CHAIN CALCULATIONS

		Formal Milk Channel		Informal Milk Channels	
		Cooperatives	Government	Direct sale	Milkmen
Variables	Units				
Dairy Processing activities based on 1 kg milk bought from the farmer					
INPUTS					
1- Milk from the farmer					
Quantity	Kg	1	1	1	1
Fat Content	% estimation	4.12	4.12	4.12	4.12
Protein Content	% estimation	3.4	3.4	3.4	3.4
FARMERS MILK PRICES	US\$	0.26	0.26	0.24	0.24
2- Other Inputs					
Input type	Name	XX	XX	XX	XX
Quantity added	Kg	0	0	0	0
Input price	US\$/ Kg	0	0	0	0
Costs of added Input	US\$	0	0	0	0
OUTPUTS					
Main Product	Description	UHT	Pasteur.	Farm-Direct	Milkmen
Quantity	Kg	1.2	1.2	1.03	1.03
Fat Content	%	3.2	3.2	4	4
Protein Content	% estimation	3.28	3.28	3.3	3.3
Retail Price	US\$/ Kg	0.56	0.46	0.36	0.36
TOTAL CONSUMER PRICES	US\$	0.67	0.55	0.37	0.37
MARGINS					
Sum of all Returns	US\$	0.67	0.55	0.37	0.37
-Farmers Milk Price	US\$	0.26	0.26	0.24	0.24
FINAL MARGINS	US\$	0.41	0.29	0.13	0.13
Notes:					
For these calculations, we assumed to have taken 1 kg milk; paid local milk market prices; processed it (local prices for inputs) to produce the main product ; and retailed all the outputs locally to get the total consumer prices.					
Processing details were not available and authors' assumptions were made based on similar analyses.					