6

The harvesting and marketing of milk from smallholder farms

This chapter explains how returns for raw milk depend on milk quality and composition, how milk is marketed via informal and formal schemes in different Asian countries, and the role of cooperatives in smallholder dairy development.

The main points in this chapter

- Milk composition, quantified by contents of milk fat and solids not fat, is very much influenced by feeding management.
- Milk quality is very dependent firstly, on the preparation for, and the process of, milk harvesting, and secondly, on the post harvest handling of raw milk.
- Milk grading schemes provide for a matrix of milk payments, but with vastly different standards for different countries in South and East Asia
- In Asian countries with a long history of milk consumption, raw milk has traditionally been marketed through informal networks, whereas Asian countries where milk has only in recent years become part of the diet, have developed formal marketing systems.
- Dairy cooperatives provide a useful marketing process as they increase the bargaining power of individual farmers and provide a sound infrastructure for dairy development, as has been shown in India and Thailand.

This chapter discusses some of the key local issues affecting the farm gate milk price, such as milk composition and quality and the type of marketing infrastructure established in the farmers' locality. It provides an example of how two countries – Malaysia and Indonesia – provide price signals to improve the marketability of the raw milk via incentives and penalties for achieving set standards for milk composition (contents of milk fat and solids-not-fat) and milk quality (bacterial contamination and temperature). Milk composition is largely controlled by feeding management. Milk quality, on the other hand, is the result of firstly, the preparation for and the process of milk harvesting and secondly, the post harvesting handling of the raw milk.

Milk is the most perishable of all farm produce. Unlike other animal products such as meat, milk is frequently harvested in very unhygienic conditions where, all too frequently, the current practices of cleaning and sterilising the containers used for its collection and transportation leave much to be desired. Not only is bacterial contamination in buckets and milk cans a major problem, but because the tropical environment encourages rapid growth of these bacteria, the prolonged time delays in cooling the milk to 4°C, reduce its quality even further. The government legislation controlling milk harvesting systems in countries with developed dairy industries, ensure a consistently superior milk quality that is just not currently possible in most of the dairy smallholdings throughout Asia.

The very diverse history of consuming dairy products throughout South and East Asia has led to a wide range in marketing systems, and some of these will be described in this chapter. For countries with a long history of milk consumption (either as raw milk or dairy products), informal milk markets have evolved over many decades, whereas countries with shorter histories have chosen more formal marketing structures, such as through dairy cooperatives or direct sale to milk processors. Dairy cooperatives have good track records in dairy development programs in some countries such as India and Thailand.

The larger national and international issues affecting the farmers' return for delivering a quality product to the market place, are discussed in Chapter 7. This book does not discuss value adding to milk via the manufacture of the myriad of dairy based products that are produced in the farm kitchens and dairy cooperatives throughout South and East Asia.

6.1 Improving unit returns for milk

Sanderson (2004) argues quite rightly that there is absolutely no point in focusing on nutrition, breeding and other improved herd management if the infrastructure of the industry is not in place to ensure that the raw milk is supplied to the milk processor in a clean and safe manner. Too often, particularly in warm climates, breakdowns in milking hygiene have led to serious outbreaks of food poisoning. Even for dried milk products such as powder, the processing costs can be dramatically increased and the longevity of the end product can be markedly reduced in raw product with high levels of bacterial contamination.

6.1.1 Milk composition

Milk is produced in the mammary gland by the udder tissue. About 500 L of blood pass through the udder to produce one litre of milk. Blood delivers water, glucose, fats and amino acids to the udder where the cells in the udder tissue use these substrates to form and secrete milk.

For smallholder dairy cows, the typical ranges of milk constituents are:

- Water: 87.5–89.5%
- Milk solids: 10.5–12.5%

Figure 6.1 A well-equipped milk testing laboratory at a dairy cooperative in Thailand

- Milk fat: 3.0–6.6%
- Milk lactose: 4.8%
- Milk protein: 2.6–4.4%
- Minerals: 1.0%.

The key measures used to describe milk composition are the concentrations of milk solids (called total solids, TS, or total dissolved solids, TDS), milk fat and milk protein. Because lactose and mineral contents are very stable, milk protein is often estimated using Solids Not Fat (or SNF). The methods of testing for milk composition are:

1. TS: calculated from the density of raw milk, measured with a hydrometer adjusted for milk temperature.
2. Milk fat: traditionally measured in the laboratory using a centrifuge to separate out the milk fat which had been coagulated with a strong acid solution, although more modern techniques allow for rapid measurements.
3. SNF: calculated from TS and milk fat.

The level of fat and protein in milk varies with many factors such as the breed of cow, stage of lactation, body condition and the diet. The importance of feeding management is highlighted in Table 6.1 which summarises its influences on the concentrations of milk fat and milk protein.

Table 6.1 Effects of feeding management on milk composition

Feeding management	Milk fat	Milk protein
Maximum intake	Increase	+ 0.2 to 0.3% units
Increase grain feeding frequency	+ 0.2 to 0.3% units	Small increase
Underfeed energy	Little effect	– 0.1 to 0.4% units
High fibre	Small increase	– 0.1 to 0.4% units
Low fibre	–1.0% units or more	+ 0.2 to 0.3% units
Low protein	No effect	Decrease if marginal
Excess fat	Variable	– 0.1 to 0.2% units
Grinding/pelletising of concentrate	– 0.1 to 0.2% units	Little effect
Heat stress	Variable	– 0.1 to 0.3% units
Restrict water	Increase	Increase
Improving body condition at calving	+ 0.1 to 0.3% units	Little effect

As already mentioned, improving milk composition, or the content of milk fat, protein or SNF, can increase unit milk returns. Each South and East Asian country has developed its own unique milk pricing structure, which incorporates premiums and penalties based on milk composition. Countries with developed milk analytical laboratories can test for milk fat and protein (and even lactose) while less developed countries test for milk fat and SNF. Other countries only use TS in their pricing structure. Examples of such payment schedules are presented in Tables 6.2 and 6.3.

6.1.2 Milk quality

Milk quality refers to the level of various contaminants in milk, be they bacterial, chemical or any other adulterations that can be detected. However, in many South and East Asian countries, the 'term milk' quality covers milk composition, hygiene and adulteration.

Adulteration of milk can be intentional or unintentional. Intentional adulteration occurs when farmers add compounds to the raw milk, such as water and sugar, in an attempt to increase its volume and at the same time, maintain its density, so the hygrometer will not detect changes in specific gravity. If successful, such farmers will receive a higher payment for volume with a similar payment for estimated total solids content. Organoleptic (or taste) and alcohol tests can normally detect such adulterations with the resultant penalty, or even outright rejection. Antibiotics can also be classified as intentional adulteration, occurring when farmers do not follow the recommended drug withholding periods following animal treatments. Tests for antibiotics and inhibitory substances are now routine in most Asian countries.

Consumer confidence in dairy products is currently a very sensitive issue, following the intentional adulteration post-farm gate of melamine, such as was first detected in China during August 2008. This has had dire consequences on consumer acceptance of raw milk in many Asian countries, to the detriment of the innocent dairy farmers in these countries as well as in China.

Unintentional contaminations can occur either from within the milking cow, such as mastitis, or more usually following milk harvesting. The somatic cell count detects mastitis while an initial screening can be done using the Californian (or Rapid) Mastitis Test.

Inferior milking hygiene is the major cause of poor milk quality and can occur on-farm, through poor cleaning and sterilising practices of milk harvesting equipment or post-farm gate, due to unclean milk handling and storage equipment and delays to cooling.

The key to any successful domestic milk production system is the establishment of a satisfactory milk harvesting, storage and transport infrastructure. Milk must be harvested in a clean and hygienic manner and cooled as quickly as possible, if it is to have any value for processing. There are a variety of measures of milk contamination following harvest, transport and storage such as Total Plate Count (TPC), Methylene Blue Reductase Test and Resazurin Test. TPC is measured in millions of colony forming units per ml milk (M/ml). These tests and the key principles of good milking hygiene practices are fully described in the final report on our Indonesian and Malaysian milking hygiene workshops (Moran *et al.* 2004).

6.1.3 Examples of two milk grading schemes

To give examples of the magnitude of measures of milk composition and quality on unit returns of milk from smallholder dairy farmers, the 2007 payment schedules for raw milk in Malaysia and the 2005 payment schedule for a milk processor in Indonesia are presented in Tables 6.2 and 6.3. Smallholder dairy industries are very different in these countries in that the infrastructure to handle raw milk post-farm gate is very poor in Indonesia, leading to considerable bacterial contamination once milk leaves the farm.

The Malaysian government rewarded farmers for high TS but penalised them for high TPC levels, with levels over 1 M/ml being severely penalised. The milk processor in Indonesia also used TS and TPC as measures of milk quality while, because of the problems with maintaining milk temperature during transport, it included a bonus for milk below 6°C.

Milk produced in Indonesian still suffers from low TS% and very high TPC levels. In 2005, the base payment was given to milk with 11.3% TS, 20–30 M/ml TPC and 6–8°C, compared to 11.5% TS and 0.20 M/ml TPC in Malaysia in 2007. Note the marked difference in acceptable TPC levels in raw milk from these two countries.

Table 6.2 Milk quality payments used in 2007 by Malaysian government

Grade	TS (%)	TPC (M/ml)	TS bonus (MR/kg)	TPC penalty (MR/kg)	Final price (MR/kg)
A	>12.5	<0.20	+0.15	–	1.50
B	11.75–12.49	<0.20	+0.05	–	1.40
C	>11.75	0.20–0.50	–	–0.15	1.20
D	>11.00	050–1.00	–	–0.30	1.05
X	–	>1.00	–	–0.85	0.50

Source: DVS, (pers. comm.)
TS, total solids; TPC, Total Plate Count; MR, Malaysian ringgit
Base price is 1.35 MR/L for milk with 11.5% TS and 0.20 M/ml TPC

Table 6.3 Milk quality payments used in 2005 by an Indonesian milk processor in West Java

Milk composition		Milk quality			
TS (%)	Bonus (Rp/kg)	TPC (M/ml)	Bonus (Rp/kg)	Temp (°C)	Bonus (Rp/kg)
<10.7	–25	<1	100	>8	–10
10.7–10.9	–20	1–3	75	6–8	0
11.0	–15	3–5	50	<6	10
11.1	–10	5–10	40		
11.2	–5	10–15	20		
11.3	0	15–20	10		
11.4–11.6	20	20–30	0		
11.7–11.9	30	30–40	–10		
>12.0	40	>40	–20		

Source: Moran *et al.* (2004)
TS, total solids; TPC, Total Plate Count, temp, temperature; Rp, Rupiah
Base price is 1720 Rp/kg

One session in our milking hygiene workshops is called 'Milk quality makes money' (Moran *et al.* 2004), because of the large financial benefits arising from improved milking hygiene practices. For Malaysian farmers, improving milk grade from D to A (see Table 6.2) through reducing TPC levels from 0.50 to 0.20 M/ml will increase unit milk price by 25%. For farmers with poorer milk harvesting practices, improving milk grade from X to C, through reducing TPC levels from more than 1.00 M to less than 0.50 M/ml, will increase unit milk price by 300%.

Financial benefits are less clear in Indonesia because milk quality is not monitored for individual farmers, just for the dairy cooperative they supply. If such a cooperative handling 30 t/d of raw milk can reduce TPC levels from 30 M/ml to 5 M/ml, it would generate an additional 3% from milk sales, or 45 M Rp/m. Reducing TPC levels from 30 M/ml down to 1 M/ml would generate an additional 6%, or 90 M Rp/m. As well as returning some of these premiums to individual farmers, there are many opportunities to invest in better milk handling equipment and practices, such as those suggested by workshop participants and reported by Moran and Miller (2004).

6.2 Formal and informal milk markets

Milk marketing through the dairy value chain takes place in many ways. The term 'dairy value chain' refers to the stages through which milk and dairy products pass from the farmer to the consumer. Milk markets are often categorised into two main types, informal and formal. Some of the key features of these markets are:

- Informal markets are usually small-scale, local markets involving few participants. The milk is more often sold as a raw product, hence not processed. For the consumer these traditional markets are at the lower cost end where price is considered to be more important than milk quality. Most people think of informal milk marketing as

the direct sale procedure by a middle man, who collects the raw milk from the farmer then sells it directly to the consumer.

- Formal markets are usually medium to large-scale, more distant markets involving more participants where the milk is processed prior to sale. For the consumer, they are at the higher cost end where quality and food safety are important. Most people think of formal milk marketing as the process by which raw milk is bulked and chilled after collection from many farmers prior to transport to the milk factory where it is processed, package and distributed to a dairy reseller, either a small or large retailer.
- Where formal market chains are established, they frequently handle more product. However, informal markets normally return a higher unit price to the farmer. Informal and formal markets often overlap as farmers or farmer organisations seek several market outlets.
- Informal markets provide opportunities to value add the raw milk at the village level, whereas formal markets commonly use more industrial methods. Such kitchen-based value adding is a great provider of labour, as Hooten (2008) reported that informal markets employed five times more people per 100 kg milk throughput than did formal markets. In addition, they earned more than the minimum wage, usually the basis of payment in formal industrial processing.
- Most population growth in developing countries will be amongst urban, rather than rural dwellers, and they are better served by formal milk markets, particularly as consumers become more affluent.

In countries with a culture of consuming dairy products, traditional informal markets play a key role in dairy development, such as in Pakistan (where they comprise 98% of marketed milk), India (76%) and Sri Lanka (40%). They are not a result of lack of investment in formal market channels or of non-reinforcement of national milk standards. Rather they thrive because of the continued strong demand for the products and services they offer. Investment in formal dairy processing facilities, both in private and public sectors, has often failed, leading to underutilised capacity with the market surviving on subsidies or abandoned milk processing plants and cooling facilities. For example in Pakistan, one major processor has a shortfall of over one million litres per day in processing capacity. The only sustainable way to source milk is through offering a competitive price with the informal market, which does not always occur.

In some cases there is a strong demand for traditional products by high income consumers as well as the resource-poor, so growth in disposable income may not necessarily reduce demand for traditional products. Furthermore, formal market structures are not necessarily required to stimulate dairy development. In fact, formal market share can be less a result of market forces but rather due to public investment decisions. Poorly managed formal market institutions provide less effective linkages between farmers and consumers than the traditional informal market. Because of their lower cost structures, traditional markets can more easily offer price incentives to both producers and consumers.

The traditional informal markets have clearly provided an effective functional link between farmer and consumers which respond to consumer demands and certainly should not be regarded as market failures. Moreover, these markets serve the needs of

small-scale farmer and resource-poor consumers and in addition, they provide good employment opportunities and better market access in areas with poor infrastructure and long distances between producers and consumers. Because traditional products are not easily substituted, they provide a good buffer to dairy imports. However, urbanisation will reduce their role because of the higher costs of mass supply (Hooton 2008).

Public policy makers should engage constructively with traditional markets rather than oppose them directly, particularly as demand for food safety will grow with disposable incomes. Policies should allow the continued functioning of such markets, yet support increased milk quality and food safety. Policies that simply oppose and attempt to police such markets are likely to impact negatively on small-scale farmers, consumers and small-scale market agents. The key features of informal markets are continued demand for 'traditional' products and processing and the lack of 'modern' health standards.

Adulteration of raw milk with liquids (ice or water) and thickeners (such as chalk), once collected from the farm, prior to direct sale to consumers is an all too common feature of informal markets and this will be difficult to stop. However, the consumer knows all too well the potential for sickness if this milk is not boiled prior to consumption or used to make traditional dairy products (such as ghee or yoghurt). Apart from paying for the milk 'additives', the individual consumer treats the adulterated product with due respect, ensuring a relatively safe food. However, this is not always the case as was evident from the 2008 China incident when melamine entered the food chain due to milk processors being unable to guarantee food safety.

Market forces will influence the degree of acceptance from particular milk marketing middle men. However, it would be difficult, in fact nigh impossible, for governments to enforce food safety standards on such an informal marketing structure, although Hooten (2008) is optimistic that from experiences in Africa, quality and efficiency issues can be addressed through training and certification and by working closely with milk trader groups.

6.3 The role of dairy producer cooperatives

Most farmers sell their products to businesses which are much bigger than their business. Consequently, in many countries, farmers attempt to increase their bargaining power by forming cooperatives. Cooperatives are jointly owned by farmers, membership is usually voluntary and members are supposed to receive benefits in line with the extent of their ownership of the cooperative. Historically, cooperatives have failed because of two major factors. Firstly, the marketing services the cooperative were set up to improve were already done efficiently by competing marketers. Secondly, if the cooperative succeeded and raised net returns to members, the benefits went to both members and non members in the form of higher prices and increased competition. Thus an incentive was created for producers to reap the benefits without incurring a cost of being a member. This is why governments introduced 'compulsory cooperatives' called marketing boards.

Producer cooperatives for processing and marketing of milk have proved viable and sustainable in high income countries of northern Europe, North America and Australia. Cooperative dairies have also been established successfully in some developing countries, such as the Anand Milk Producers Union (AMUL) in India.

With AMUL, a producer-based organisational structure was adopted, with village level primary producer societies delivering milk to district unions for processing and product manufacture, that in turn were grouped into state level federations charged with coordination of marketing functions. During the 20-year program, average milk procurement through cooperatives increased from less than 2.5 Kt to more than 11 Kt, 7% of India's total milk production. The informal market still handles over 85% of India's milk. As a result of AMUL and other dairy development programs, India is now self-sufficient in raw milk supplies.

Dairy cooperatives play a significant role in fostering dairy development in many developing countries in Africa (Kenya) and South-East Asia (Indonesia, Thailand), primarily by providing a stable market environment and delivering services to farmers.

Collective action by producer organisations can reduce transaction costs in markets, achieve some market power and increase representation in national and international policy forums. For smallholders, such organisations are essential to achieve competitiveness. They have expanded remarkably rapidly in number and membership, often in an attempt to fill the void left by state withdrawal from marketing, input provision and credit, and to take advantage of democratic developments in civil governance. For example, in Africa between 1982 and 2002 the percentage of villages with producer organisations rose from 8 to 65% in Senegal and from 21 to 91% in Burkina Faso. The Indian Dairy Cooperative Network has 12.3 million individual members, many of them landless and women, who produce 22% of India's total milk supply.

In spite of any successes, producer organisations' effectiveness is frequently constrained by legal restrictions, low managerial capacities, exclusion of the poor and failure to be recognised as full partners by the state. Donors and governments can assist by facilitating the right to organise, training leaders and empowering weaker members, in particular women and young farmers. However, providing this assistance without creating dependency remains a challenge.

In summary, dairy cooperatives:

- Play an important role in providing a base for service delivery to farmers, stable agricultural knowledge systems for uptake of improved technology and increased management skills among farmers.
- However, they may be no more effective than other market channels in linking poor farmers to output markets. Pakistan illustrates very dramatically that strong market growth can occur in the absence of dairy cooperatives.
- Their development is heavily dependent on transparent cooperative management. To be sustainable, they require honest and effective investment of resources and must be accountable to the interests of farmer members. Political and governmental influences need to be minimised.
- They often cannot easily tap into the strong demand for traditional products and raw milk, and generally remain tied to demand for formally processed products. While traditional demand remains the driving force, dairy cooperatives face the same growth impediments as the formal private sector.
- Investments can be effective and pro-poor, if they are well managed, remain independent of any strong political forces and are linked to strong demand. Because

of these constraints, they should not be the primary focus of dairy developmental efforts. Rather they should be a part of a mix of market channels, including the formal private sector and the small-scale traditional sector.
- Other less formal forms of farmer groups, such as self-help groups, can play important roles in local cases.
- Not all governments encourage dairy cooperatives and not all farmer groups want to be part of them.

6.3.1 Types of services offered by dairy cooperatives

Nong Pho in the Rachaburi province of Thailand, is one of the oldest dairy cooperatives established in Asia. It was established in 1971 and now has over 4000 farmer members. Chantlakhana and Skunmun (2002) list its services as follows:

- Purchasing and processing raw milk and dairy products.
- Marketing and distribution of milk and dairy products.
- Cooperative credit and loans.
- Farmer training on dairy farming and cooperative practices.
- Feed mill and dairy concentrate feeds.
- Providing AI services and other technical advice.
- Selling dairy tools and equipment.

The farmers are organised into 32 different zones with each zone electing a group leader. Of these 15 are annually elected by overall members to form the Executive Committee, whose duties include policy formulation as well as overseeing the management of the cooperative services.

Most farms are within a 20 km radius of the processing plant, with the most distant being 30 km. Raw milk is delivered twice daily either by the farmer or a middleman who collects the milk from the farmer. Farmer payments are made every 10 days based on milk composition (total solids and milk fat) and milk quality (bacterial contamination). About half the milk is pasteurised into plastic sachets and the remainder is ultra high temperature (UHT) treated into hard packs.

The feed mill produces 100 t/d (in 1992) of formulated concentrates for feeding to stock, which is sold to farmer members on credit with payment deducted from their milk cheques. The AI service uses both local and imported semen. Animal health services are provided by both university and government veterinarians with farmers paying only for the drugs. Cooperative fees are based on unit volume charges of the daily farm milk output.

The success of dairy cooperatives depends on four types of factors, namely:

1. Technical inputs: The primary requisites consist of suitable dairy breeds, availability of good quality feeds (especially roughages) and clean water, good farm management and herd husbandry and appropriate animal health.
2. Institutional support: These include credit agencies, farmer training facilities, milk collection and processing centres and research and extension services. Extension services provide AI, health care and farmer technical training. Research is directed

Figure 6.2 Delivering the milk to a collection centre in Sri Lanka

towards problem solving, socio economic and policy issues as well as technical constraints. The infrastructure to better utilise agro industrial wastes for livestock feeding is another common constraint to smallholder farming.

3. Government policies: In many countries these include import regulations requiring importers of dairy products to source local milk in a particular purchase ratio, and promotion campaigns and school milk programs to encourage consumption of fresh milk. Other policies in Thailand include diversification schemes to convert rice paddies to dairy farms.
4. Socio economic initiatives: There are many initiatives influencing the success or otherwise of smallholder dairy farming and the farmers' decisions to expand and improve their operations. These include the availability of capital investment, farm gate milk prices, land prices, labour availability for farm workers, off-farm wages for dairy farming family, farmer education and training and the retail milk price for consumers.

The success of farmer cooperatives in Thailand can be measured in terms of key performance indices on smallholder dairy farms (Chantalakhana and Skunmun 2002). Milk yields have increased from 8–10 kg/cow/d to 10–15 kg/cow/d (or 4500 kg for a 300-day lactation) and calving intervals have been reduced from 15–16 months to 12–13 months.