PLANNING DAIRY DEVELOPMENT PROGRAMS IN ASIA

Proceedings of a Symposium held at AAAP Congress, Bangkok, Thailand

Thursday 29 Nov 2012
Planning Dairy Development Programs in Asia

Proceedings of a Symposium held at 15th AAAP Congress, Bangkok, Thailand

29 November 2012
Symposium Program

11.00 to 12.00 h: Opening session

Introduction to Symposium; Dr C Devendra, Chairman, Symposium Steering Committee

Welcome Address; Dr. Joachim Otte, Senior Animal Production and Health Officer, FAO Regional Office, Bangkok

Key note address; Chaiyan Lohapanwong, Big companies, small farmers: Are there grounds for sustainable marriage?

Key note address: Thomas Reardon, Supermarket revolution in Asia: Myths and realities of smallholder’s integration in modern value chains.

12.30 to 13.00 h: Lunch

13.00 to 15.30 h: Regional presentations

John Moran & Jan Brouwer, Planning dairy development programs in tropical Asia

Sayef Nasir & Bjorn Wille, Development of dairy hubs in Bangladesh

Dinghuan Hu, Fan Ruiyang, Lim Ting & Liu Bing, Exploring the causes of rapid development on China’s dairy industry


Suneerat Aiumlamai, Khwanchai Kreausukon & Narong Wongnen, Dairy production and the marketing system in Thailand

Tjeppy Soedjana, Indonesia’s dairy industry in 2020: An initiative towards 50% self sufficiency

15.30 to 16.00 h: Tea break and poster session

16.00 to 17.00 h: Moderated panel discussion

Panelists: Peter Wynn, and dairy specialists from India, Indonesia, Philippines and the private sector

17.00 to 18.00 h: Asia Dairy Network

Vinod Ahuja, Brian Dugdill, Nancy Morgan and Thanawat Tiensin, APHCA Dairy strategy and ongoing Smallholder Dairy Development Program in Asia and the Pacific
Launch of Asia Dairy Network (ADN) and Website
Launch of FAO e-modules on feeding management
Discussion on the next steps for Asia Dairy Network

18.00 h: Closing

Summary: John Moran
Closing remarks: Metha Wanapat John Moran
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Welcome to the Dairy Symposium

We offer a warm welcome to all the participants of the symposium “Planning dairy development programs in Asia” which is an integral part of this, the 15th AAAP Animal Science Congress, being held during November 2012 at Thammasat University, Rangsit Campus in Bangkok, Thailand. The AAAP Congress is a regular feature of scientific exchange amongst Asian and Australasian animal scientists with featured Symposia allowing for more concentrated and focused interactions between animal and commodity specialists. In this case it is between farmers of commercial milk producing animals and other stakeholders in the region’s milk supply, processing and distribution industries.

This Symposium will provide an ideal opportunity for dairy production, processing and policy making specialists to share their knowledge and aspirations to ensure future dairy development programs will lead to more milk and improved profits to Asian dairy farmers, particularly small holders, so that these countries can become more self-sufficient in dairy products.

Dairy farming would have to be one of the most sophisticated forms of livestock production in the world and regional development programs should only be undertaken after careful and logical planning and with expectations of a long term investment before profits accrue. To be successful, such programs must involve sourcing, or at least seeking support from, personnel with proven experience in both dairy farming practices and dairy farm business management. Much can be learnt from the litany of failed dairy development projects throughout tropical Asia so these mistakes will not be repeated, as unfortunately occurs all too often.

The objectives of this Symposium are as follows:

- To provide a forum to identify barriers, failures and successes in dairy production from cattle and buffaloes in tropical and temperate Asia
- To discuss and formulate guidelines, strategies and policy to enhance improved production
- To promote closer collaboration between countries and the private sector, including investments, in dairy development programs
- To determine the formation of an Asian Dairy Network
- This network will serve to accelerate information exchange, shared experiences, collaboration in technology application and development programs, capacity building, monitoring and assessment of progress and impacts through regular meetings.

This Symposium is the end result of many hours of hard work by your Steering Committee which consisted of:

- Dr Devendra, Consulting Tropical Animal Production Specialist, Malaysia, Chairman
• Prof Peter Wynn, McCaughey-CSU Professor of Animal Production, School of Animal and Veterinary Sciences, Charles Sturt University, Australia
• Dr. Vinod Ahuja, Livestock Policy Officer, FAO Regional Office for Asia and the Pacific, Bangkok
• Dr. Harinder Makkar, Animal Production Officer, FAO Rome
• Dr John Moran, International Dairy Adviser, Australia, Technical editor
• Prof Wanapat, Khon Kaen University, Thailand as Chairman of AAAP 2012 Organising Committee

We trust you will all gain something special from this gathering of like-minded people and that the written proceedings will provide useful reference material for future writings and discussions, in particular relating to activities of the newly formed Asia Dairy Network.

John Moran
(Technical Editor)
Welcome Address

by

Joachim Otte

Senior Animal Production and Health Officer and Secretary, Animal Production and Health Commission for Asia and the Pacific

It is my pleasure to participate in this inaugural part the symposium on planning dairy development in Asia and to welcome you on behalf of the Animal Production and Health Commission for Asia and the Pacific (APHCA) and the Food and Agriculture Organization of the United Nations (FAO). I congratulate the symposium steering committee for pulling together an impressive symposium program and acknowledge the contribution of Nestle and AusAID for sponsoring young scientists from around the region to attend this symposium and the congress.

FAO, as you are aware, is mandated to work for improving food and nutrition security and the livelihoods of poor people worldwide. FAO recognizes that milk has a special role to play in this for its many nutritional advantages as well as providing income for millions of small-scale farmers. In addition, FAO has estimated that for every 100 litres of milk produced locally, up to five off-farm jobs can be created in related industries like collecting, processing and distribution.

Indeed, milk production has been one of the most celebrated success stories in Asia. In 2010 Asia's milk production crossed the 250 million tonnes mark, meaning that the region’s milk production has grown more than five times since the 1970s. Over this period, annual demand for milk has grown from 20 kilograms (kg) to almost 70 kg per capita per year. As a result, Asia region has emerged as a major player in global dairy production and consumption. Aggregate consumption gains in dairy products in Asia over the past decade have exceeded twice the annual global average. Over the last few decades, Asia region has seen strong growth in consumption of liquid milk and processed dairy products. Asian consumers have generated nearly half of the global dairy product demand over the past few decades but in many countries in the region production has lagged behind. Growing demand conditions provide an attractive opportunity for developing Asian nations to further consolidate the gains by investing in measures to enhance productivity, quality and market access. The potential is indeed immense and if there is one thing that is certain about milk, it is that its demand will continue to grow in future. How that demand is met, who captures the benefits and how one uses this opportunity to support livelihoods and improve nutrition, will depend on the policy, institutional and technology choices we make.

With increasing complexity of dairy production and distribution, constantly changing consumption demands, deepening regional and global integration, diverse expectations from the sector and growing public health and environmental concerns, the region faces many challenges in dairy development. Some of these include
• Improving productivity along the cow-to-consumer dairy food chain and at farm level
• Enhancing returns from milk production by improving access to input services and enhancing raw milk quality.
• Improving the organisation of smallholder milk producers to improve their bargaining power and reduce market risks
• Encouraging private sector investment in dairying along the post-harvest value chain
• Maximising smallholder earnings from dairying in a manner that minimizes harm to soil health and contribution to water and atmospheric pollution
• Understanding, more closely, the contribution of Asian dairy animals to global greenhouse gas emissions and climate change and identification and implementation of incentive based mitigation measures
• Engaging, strategically and pro-actively, with global and regional dairy players and promoting interests of Asian dairy producers and consumers

Fortunately, Asia also has a rich diversity of experiences and models to address these challenges. Over the last few years FAO in partnership with CFC (Common Fund for Commodities) and APHCA (Animal Production and Health Commission for Asia and the Pacific) has taken the lead in distilling lessons from Asian dairying experiences by facilitating dialogue and experience sharing among key players. This process included undertaking lessons learned studies, complete value chain studies in selected countries, and multi-stakeholder workshops to discuss and evolve an action agenda for Asia's dairy sector. The process culminated in the formulation of a dairy development strategy for Asia. The strategy document is available on APHCA website.

Among other things, the strategy identifies creation of an Asia Dairy Network to share information about dairying in Asian countries. Through a process of stakeholder consultation, APHCA has developed the vision and mission for this network and has committed to create a web-based platform that, it is hoped, will emerge as the key reference point for Asia dairy related information.

APHCA is developing this web platform in partnership with Chiang Mai University and I am happy to note that this afternoon we will be able to get a glimpse of this website although it is still a work in progress. The website allows all those interested to become member of the Asia Dairy Network. We also invite ideas and suggestions on further development of this web platform. More important, however, we invite interested individuals and institutions to become a contributing member either as a focal point in your country to provide relevant information and / or to promote the cause of smallholder dairy development. FAO remains committed to working with all stakeholders and hopes together we can make visible contributions towards improving livelihoods and nutrition. Welcome once again and I wish everyone productive and exciting deliberations.

Thank you.
Supermarket revolution in Asia: Myths and realities of smallholder’s integration in modern value chains

Thomas Reardon

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This short summary paper has been extracted from some of the Thomas Reardon’s publications by Peter Wynn.

**Traditional markets**

Up until 100 years ago the majority of food found its way from the farms, waterways and oceans to the dinner plate in homes by so-called traditional routes. The basis for these involved food being collected from small-holder farms and either sold fresh or modified by grinding, in the case of grain, or churning in the case of cream to make butter or animals were simply slaughtered to provide fresh meat. Village traders bought many of these products from farmers and on sold them to commercial traders, who in turn developed markets and other retail outlets to service the needs of the public. These so-called “wet markets” invariably are overflowing with small individually owned stalls or pushcarts or more permanent small shops. Since the food is fresh and in a raw state and refrigeration is limited by poor power supplies, products have short shelf life usually of a single day. Most notably at least 95% of produce passing through these markets is produced locally as transport infrastructure is most often lacking preventing modern day transport from transferring produce large distances on any one day. These marketing chains can be long and convoluted and service a social function in any rural community by firstly providing employment and secondly by providing a flow of finance associated with loans passing back up the chain to the farmer to sustain his productivity.

**The industrial revolution and changes to our food supply**

In developed countries over the past 100 years and in certain developing countries over the past 30 years, there has been a rapid transformation of the food supply system which coincided with the advent of the industrial revolution. The most notable changes have been in the downstream retailing sector and the mid-sector food processing and wholesaling segments: these changes have also affected the supply and costs of inputs to the farmer. Food processing has been revolutionized with the development of large scale first stage processors like Bunge and Swift and second stage processors like the multinational dairy company, Nestle. This has provided an efficient flow of quality product to larger scale commercial outlets or supermarket chains dominated by a small number of intra- and international operators. These may include typical European outlets like Carrefour and Tesco or international fast food chains such as McDonalds.
Similar transformations have now been seen in developing countries over the past 30 years in Latin America, Asia, Eastern Europe and certain countries of Africa. Many pundits have found this surprising since it has been commonly thought that the economics of demand would clash with the characteristics of the modern sector’s supply of retail services. Traditional marketing chains seemed an immovable part of the social fabric of agrarian societies in which poverty was pervasive.

However now we are finding in some markets the co-existence of traditional, intermediate-transitional and modern value chains, which have been established in equilibrium.

Although the changes observed are thought in part to be due to government intervention, less than 5% are due to this imposition, while 95% remains in the hands of the private sector. Similarly the cost of food at retail outlets is thought to be dominated by the cost of product at the farm gate. However careful analysis shows that 50-70% of the cost of food is actually generated between the farm gate and the consumer and that this proportion is increasing.

At the same time history has shown that the key sectors of the food industries have been consolidating, with the top 20 companies in the USA increasing their share from 25% of the market in 1954 to 50% in 1995. This effect has been much more marked in the meat sector, with the top 3 increasing their share in the USA from 30% in 1978 to 86% in 1994. Observations to date are showing that this trend is occurring much faster in developing countries, although the effects are more difficult to quantify.

**Supermarkets and the future of food retailing**

The rapid growth of the supermarket sector is based on the opportunity cost of time and the cost and time for transport in an ever sophisticated community mostly in our sprawling urban areas. Higher female employment rates seem to contribute to both an increase in disposable income per family and also an increased demand for a greater diversity of products only available in a one stop outlet like a supermarket.

The ability to store food in the home with refrigeration has decreased the time spent by the house wife in the traditional wet markets and provided the opportunity to store a greater diversity of perishable products in the home. Customs and traditions change as, for example, pasteurized milk removes the need to boil the product sold through the traditional milk outlets as the end point of traditional marketing chains. Wet markets are more likely to retain their market share until basic services like electricity are supplied reliably for rural communities.

We cannot forget that wet markets and small-shops provided the principle outlets for food in Europe and the USA prior to the advent of supermarkets. Traditional standards are unlikely to prevail in communities where affluence is on the rise. In China’s 5 largest cities 79% of processed foods are now sold in modern retail outlets, while 50% of staples like rice are sold similarly.

The consequences for society in developing countries may be dramatic. Foreign direct investment by large international supermarket chains like Walmart where they
introduce their aggressive marketing policies are destined to have major effects in large Asian markets like India. To date the Indian government has resisted the temptation to allow them into their marketplace for fear of the unknown.

There is little doubt that the survival of the millions of small-holder farmers and the traditional marketing chains that they are dependent on to link them to consumers are at risk in this ever changing world. Government policies should be driven by caution to ensure that social upheaval resulting from rapid change in the way food is delivered to consumers does not exacerbate the poverty that pervades rural populations in developing countries world-wide.

Further reading


Reardon, T. and Timmer, P.C. The economics of the food system revolution [www.resource.annualreviews.org](http://www.resource.annualreviews.org) June 18 2012.
Planning dairy development programs in tropical Asia

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Abstract

There has been a history of dairy development programs in tropical Asia that have either failed or required major revisions, for a variety of reasons. There have been obvious biological factors such as overestimating the level of performance of milking stock, or underestimating the required farm inputs to achieve targets for milk production and reproduction. All too often these programs suffer because of incorrect assumptions on the impact of the tropical environment on cow comfort, animal health, feed quality or cow appetites. However the most common reason is the lack of proper planning, both long and short term. This review discusses planning requirements for three scenarios, namely regional programs, “greenfield” sites and troubleshooting problems on existing farm developments.

Keywords: dairy development programs, on farm dairy programs, planning

Introduction

The last 20 years of dairy research, development and extension in many Western countries has produced quite sophisticated dairy production systems. Herd sizes have grown, efficient feeding systems have evolved and many farmers routinely monitor test results on their cows for milk production, composition and quality and for mastitis. They then use this information for making decisions on culling milking cows and for breeding genetically improved stock. High labour costs have led to much mechanisation, such as machine milking, forage conservation and feeding stock, while cows grazing at pasture are able harvest their own forages more efficiently than can farmers. Low population pressures, hence relatively cheap land, have allowed farms in Western countries to expand in both size and cow numbers.

Unfortunately this has not been the case for small holder dairy farmers in most Asian countries. Being in the tropics, feed quality suffers from high temperatures, humidities and often strongly seasonal rainfall patterns. Dairy cows are temperate animals with thermo neutral (comfort) zones closer to 10°C than to 30°C. Furthermore, high humidities reduce feed intakes which exaggerate the adverse effects of high fibre forages on appetite. A good measure of heat stress, the
Temperature Humidity Index, shows milking cows in the lowlands of the humid tropics to be in the “high stress” and “reduced performance” zones for much of most days throughout the year. Many dairy specialists correctly argue that potentially high performance dairy breeds, such as Friesians, may not necessarily be the best cattle genotype for tropical regions, except in highland areas or those with low humidities.

There are many socio-economic reasons why the efficiency of small holder dairy farming in Asia has not greatly improved over the last two decades. Granted, numbers of cows has greatly increased in most Asian countries, largely through government support for social welfare and rural development programs. The increased demand for milk (accentuated through school milk programs) and the concept of national food security are the driving forces behind most dairy development initiatives. However in terms of feed inputs per kg of milk produced or farm milk outputs, improvements have been slow. This is demonstrated by the inability of virtually all dairy industries in SE Asian to markedly improve their self-sufficiencies in milk over the last 10 years (Moran 2009) hence reduce their reliance on imported dairy products.

In addition to the above biological constraints, the other major problem to achieving national dairy development production targets has unfortunately been a common human failing, namely an inability to properly plan for such initiatives, in the short as well as the long term. This paper discusses this problem at three levels, firstly at a regional dairy program level, secondly a “greenfield” or new farm development level and thirdly, trouble shooting an existing dairy farm that is not performing, even to expectations. Many regional dairy development projects involve the construction of a series of medium to large scale dairy farms (say from 200 to 1000 milking cows) frequently on a “greenfield” site or one with little existing dairy infrastructure. The third level occurs all too often when poor planning has resulted in a new or existing farm that does not achieve realistic production and profit targets.

The importance of long term planning is paramount in any dairy development program. We often hear the comment “Failing to plan is planning to fail”. Unfortunately this applies to much of the dairy development around tropical SE Asia.

**Planning dairy programs**

**Regional dairy programs**

A common problem with many regional dairy development programs is the desire to introduce the stock long before the infrastructure has been fully prepared to support them. Importing pregnant dairy heifers provides a small window of opportunity for their eventual calving and milk production, but all too often this window is too small to prepare for their change to a lactating cow, requiring optimum feeding and herd management to settle into their new, often more hostile, environment.
Figure 1 lists ten steps that should be followed in any large scale regional dairy development program. It is essential to organise markets, milk processors, physical and social infrastructure before introducing stock. The actual cost of milk production cannot be determined until the stock are on site and their actual, rather than their predicted, levels of performance and required inputs can be quantified.

An additional step that overrides the success of all those in Figure 1 is a planned and ongoing supply of finances to ensure each step actually occurs “on time and on budget”. This requires a long term commitment from financiers well before the program starts. This budget must incorporate realistic levels of cow performance based on local

![Diagram of the ten steps to be followed in any regional dairy development program](image.png)
Information or estimates and not those from other, generally temperate and hence less stressful, environments. The budget obviously needs to incorporate a cash flow as well as long term loan repayments and should not plan for any profits for several years into the programmed development.

A “greenfield” or new farm development site
Converting a greenfield site into a profitable and sustainable dairy farm also requires careful planning. The steps to take are similar to those in Figure 1 except that several of them would be taken for granted. For example, one would assume that there is an existing market and milk processors (Steps 1 and 2) or at least one that will definitely develop in time to utilise the raw milk from the new farm. Ensuring a sustainable feed supply (Step 3) and suitable staff (both managerial and general farm staff, Steps 4 and 5) are essential prior to introducing the stock. Step 6, training the staff, could be taken for granted as that would have been ascertained prior to the project starting. The basic facilities must be constructed before the stock arrive. Of greatest importance, the assurance of sufficient and timely supply of finances is essential to ensure the project does not stall at any step along the way.

Probably the most important decision that needs to be made for a greenfield site is the proposed stocking capacity, that is the number of milking cow units to be maintained per ha of forage production area. One milking cow unit is one adult cow plus 20% of its replacement heifer, that is assuming a 20% replacement rate per annum. The farm should aim to supply as much of the annual forage requirements as possible, to give the farm management team more control over the supply and quality of such forages than if they have to be purchased off farm. The hardest part of this decision process is the assumption of annual growth rates of such forages. This has been discussed in detail by Moran (2005), who has concluded that to ensure all forages can be grown on farm, such target stocking capacities should range from 7 to 10 milking cow units per ha forage production area. Once this has been decided, then a more realistic calculation can be made of the total tonnages of forage that need to be purchased. The annual requirements for the other major dairy feed, namely concentrates (either formulated or sourced as raw ingredients) also needs to be ascertained so that long term sources can be assured early in the project.

Net cash flow means an estimate of farm expenses as well as farm income. The majority of cash is generated by the sale of milk. The shape of the lactation curve (Moran 2005) means that this can only be consistent from month to month with careful planning to source dairy stock at several times during the early years of the project, and not all at once. All too often such greenfield projects fail altogether or require major cash flow revision because all the stock were introduced at the same time.

Hitting the “white wall”
The above highlights a classic scenario where “new” farmers enjoy a rapidly increasing cash flow when all cows calf down over a short time frame. The farmer often then increases his cash input, sometimes into lower priority investments, neglecting the most important ones, such as maintaining a high quality (hence high intake) ration as cows approach mid and late lactation and ensuring optimum reproductive performance (using fertile bulls rather than depending entirely on artificial insemination and ensuring all field staff develop skills in heat detection). Persistency of milk production
(as quantified by the average monthly decline in milk yield from peak) is one of the often neglected, key measures of success of a feeding program. It should be of the order of 8% rather than the all too common 12% or more (Moran 2005).

All too often herd milk production rapidly decrease as cows move into their less productive phases of their lactation phase, reduced cash flows follow and the farm's net income declines to such an extent that it's long term viability may be at risk. Such scenarios are rarely made public as national pride can be at stake, hence it is often repeated by new, inexperienced investors in dairy development.

**Trouble shooting an existing dairy farm**

This can cause the biggest problem because errors in design and construction of facilities, shortfalls in supplies of feeds, particularly forages, and inadequacies in managing the stock may have already introduced constraints on potential cow and farm performance. We will discuss this using a theoretical case study based on an actual situation.

A 150 milking cow free stall barn farm was established using pregnant grade Friesian heifers, all imported at the same time, in a hot humid environment in tropical SE Asia. Insufficient area was allocated to forage production and very few staff had had much experience with tropical dairy farming. Within its first 5 months of operation, milking stock were suffering from severe weight loss, stock (cows and calves) were dying, milk yields fell to average only 7 kg/d, cows were not cycling post-partum and there were increasing new cases of mastitis occurring every month.

Over the following 5 months the farm management, with consultant advice, were prepared to invest in a series of farm improvements which had dramatic beneficial effects of cow and farm performance. Milk yields and body condition increased and the cows started cycling. These farm improvements included:

- Developing more area for forage production
- Introducing a mixer wagon to allow for blending the ingredients and mechanical feed delivery
- Concentrating on ration formulation to balance energy, protein and other nutrient supplies
- Introducing a fermentable energy and a rumen degradable protein source
- Incorporating a small amount of rice straw in the diet to provide physically effective fibre
- Formulating lower cost rations to reduce feed costs
- Improving new born calf hygiene and colostrum feeding
- Routinely Californian Mastitis Testing cows followed by antibiotic treatment of subclinical mastitis cases and culling chronically infested cows
- Purchasing bulls for natural mating, rather than planning to practice artificial insemination
- Installing a water sprinkler system and cooling fans for better climate control
- Introducing recording systems, using both note books and computer software, to more closely monitor daily management practices
- Establishing a computer system to quantify milk income less feed costs and the proportion of feed consumed by non-productive stock each day
- Selling off bull calves and cull stock
- Initiating regular faecal and blood sampling and vaccination protocols for better disease management
- Using pregnancy diagnosis and record keeping for better reproductive management
- Importing pregnant stock with a range of expected calving dates
- Improving on farm biosecurity

Over a 12 week period, following these improved management practices:
- The number of cows dying decreased from 5 per week to zero
- Feed intakes increased from 8.4 to 15.0 kg DM/cow/day
- Average milk yields increased from 6.4 to 13.6 L/cow/day
- Body condition scores improved from 2.3 to 5.6 units (out of 8)
- The farm manager signed the consultant up for a further period
- The owner was seen more often with a smile on his face

**Importing dairy stock from overseas**

Very rarely, if at all, can dairy development programs rely on natural increases of heifers to populate the new regions. Calf mortalities are just too high in most SE Asian countries. For example, Moran (2011) reviewed the published data concluding that a range of 15 to 25% pre-weaning and early post-weaning mortality rates would be typical on many tropical dairy farms, in contrast to the 3 to 5% considered normal on well managed dairy farms in developed temperate countries. Such high mortality rates would also be indicative of large numbers of surviving calves that have suffered permanent health problems leading to reduced lifetime performance. Therefore the only way to source more dairy stock to improve farm and regional milk outputs, assuming they can be fed adequately, is through an active program of importation. Australia and New Zealand seem to be the countries of choice, although Thailand also has an active dairy heifer export market especially to Malaysia and Vietnam.

When considering importations of dairy heifers, there are two major decisions to be made, namely what genotype is the most suitable and what age should they be on arrival. Unfortunately all too often, the first is considered a “given” by many decision makers who plan dairy development policies. That is, they must be “black and white”! If the dairy region is in the highlands (say above 800 to 1000 m above sea level) and or in a region without extremes in temperature and humidity, this is often the correct decision. However there seems little point in requesting Friesian heifers out of dams that have produced 5000 L milk per lactation, because it is highly unlikely that the imported heifers or their progeny will be managed well enough to achieve such milk yields, particularly if they are to be run on smallholder farms. In most cases, any dairy genotype imported from a developed country is likely to be of higher genetic merit than the typical milking cow in tropical Asia.

Jerseys or their crosses should be seriously considered in tropical dairy systems when climate constraints are apparent and/or when feeding and herd management is very much sub optimum. They are smaller, hence have lower maintenance requirements, have better climatic tolerance (due both to lower milk yields and physical characteristics such as sweat gland density and skin colour) and often better reproductive performance. In areas where premiums encourage farmers to produce
milk with higher solids content, Jerseys also outdo Friesians. There are other dairy breeds that seem to perform better than Friesians in the torrid tropics such as Brown Swiss, or synthetic breeds such as Australian Friesian Sahiwals or the Girolanda (from Brazil), while the purebred Sahiwal (from Pakistan) justifies further consideration.

The other decision to make is whether to import pregnant heifers or yearling (virgin) heifers. Pregnant heifers are the most favoured because farmers get “two for the price of one”, assuming the foetus is a dairy genotype. In addition as the heifer is pregnant (at least diagnosed as pregnant) she does not have to be mated soon on arrival at her new home where there is no guarantee that she will easily conceive. However with only a few months to adapt to her new environment, there is also no guarantee that that heifer will become a long term member of the milking herd once she calves down. All too often one hears stories of very high numbers (up to 30 or 40%) of imported heifers being culled and slaughtered after having only one calf. The most likely reason is that her poor feeding management post-calving and her higher genetic propensity to utilise body reserves to produce milk, have combined to result in anoestrus for many, many months post calving. Such animals have become very expensive dairy beef animals.

Lastly and of equal importance when importing dairy stock into tropical Asia, are issues of animal health. All countries, both importing and exporting countries have disease management protocols. Such protocols must be strictly enforced and regularly reviewed, in case of new disease outbreaks in countries of origin. Foot and mouth diseases and brucellosis are the two most commonly talked about but there are others to consider. In one recent example, two diseases, namely bovine viral diarrhoea (BVD) and infectious bovine rhinotracheitis (IBR) were isolated in virtually every aborted foetuses arising from one importation. These can have long lasting adverse impacts on cow performance so require additional surveillance to ensure they do not enter the country with the consignment.

Conclusions

Dairy farming would have to be one of the most sophisticated forms of livestock production in the world and should only be undertaken after careful and logical planning, and with expectations of a long term investment before profits accrue. To be successful, such development programs must involve sourcing, or at least seeking support from, personnel with proven experience in both dairy farming practices and dairy farm business management. Much can be learnt from the litany of failed dairy development projects throughout tropical Asia so these mistakes will not be repeated, as unfortunately occurs all too often.

References


Development of Dairy Hubs in Bangladesh

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Background

According to IFCN (International Farm Comparison Network) there are approximately 4.2 million dairy cows and approximately 1.4 million dairy farmers in Bangladesh. The average milk production is around 3.6 litres per day per cow. There is a mix of cows in Bangladesh between cross breeds and local breed. Our estimation is that the local breed can produce up to 7 to 8 litres of milk per day, while the crossbreed can peak at 26 to 27 litres.

In general, the milk quality in Bangladesh can be considered poor and at Chatmohar the area that PRAN established their first dairy hub the bacteria level was 7.2 million when their activities commenced. This level we view as quite common in Bangladesh and with this high bacteria count leads to a very short shelf life for both pasteurized and ultra-high temperature (UHT) packaged milk.

In response to some of the problems outlined above, PRAN Dairy Ltd is investing in dairy hubs, through which the company can get access to more and better milk for processing. As part of the development of a nation-wide network of dairy hubs, PRAN is also facilitating training of farmers and experts to improve the milk supply (in terms of quantity, quality and seasonality).

PRAN has the ambition to help increase Bangladesh’s milk production from the present 1.75 billion litres per year to exceed 3.5 billion litres by 2025. The idea is to double production by increasing cow yields and not the number of cows. By 2025, PRAN expects milk powder imports in Bangladesh to be fully replaced by locally produced and collected milk. PRAN has estimated that 60 dairy hubs are needed to reach this goal, involving one million small scale dairy farmers. This, we hope, could become a combined goal between the dairy industry and the government in Bangladesh.

The Dairy hub model has successfully been implemented both in Bangladesh and Pakistan, and a first dairy hub is currently being implemented in India. A number of other countries have also shown interest in developing dairy hubs. Tetra Pak, with support from its sister company DeLaval and the Tetra Laval Food for Development Office, assists dairy customers who are interested in sourcing more and better milk from small holder farmers, in the development of dairy hubs.
The Dairy hub model

Dairy hub infrastructure and services
A dairy hub is a milk collection centre and collection network combining collection of small holder milk with services and training for the farmers. A dairy hub consists of a main milk collection centre and several village milk collection points (see illustration below).

Thousands of farmers can be linked to the dairy hub collection network. The dairy processor collects the milk from the hub and takes it to a dairy for processing. Combining collection of small holder milk with services and training for the farmers, the dairy hub concept builds on the one herd concept and is private sector driven.

Each dairy hub employs approximately 80 full time staff, whereof several staff work alongside the small dairy farmers to ensure transfer of international best practices of nutritional management and milk production.

Within the same area of the main milk collection centre, the main operational office and training centre for the dairy hub are located. Vaccines, medicine and concentrate are made available by the dairy hub to the dairy farmers at cost. The dairy hub also provides numerous other services which include establishment of key infrastructure to facilitate dairy farming and training programmes to improve competence in feeding practices, animal care, better health, hygiene and modern farming practices. The educational programme is a key part of the Dairy Hub model, which imparts modern knowledge and helps farmers in increasing the yield per animal.
**Dairy hub training modules**

Tetra Pak and DeLaval have developed 15 training modules as listed below. These have been made available for the staff and the small holder dairy farmers covered by dairy hubs in Pakistan and Bangladesh.

- Importance of water
- Fodder
- Wheat straw enrichment
- Silage (fodder pickle)
- Hay making
- Balanced ration
- Dairy farming as an enterprise/business
- Heat stress
- Breeding
- Calf rearing
- Diseases and health
- Mastitis
- De-worming
- Mechanized dairy farming
- Vaccination

The initial training focuses on increasing the dairy production among the small holder dairy farmer for them to achieve profitable production. Experience show that when this step has been achieved, strong trust and relationship is created between the small holder dairy farmer and the staff engaged by the dairy hub. Typically, the field staff involved with the training of the small holder dairy farmers will spend 80% of his or her time at the small dairy farms and 20% attending to office work.

**Dairy hubs in Bangladesh**

**Dairy hub investments**

PRAN has established and implemented 2 dairy hubs and another 3 dairy hubs are planned and to be implemented by the end of 2016. A dairy academy is also in the process of being established in order to support the training activities needed to effectively support the operation of the 5 dairy hubs and hubs to follow in the coming years. University teachers and the government's extension services staff will also be able to benefit from training at the dairy academy.

**Dairy hub implementation start-up**

When starting up a dairy hub, initial priority is given to four focus areas, listed below in priority order.

1. **Increase milk production and collection to reach milk volumes that make the dairy hub investment financially viable**

A first priority when starting up the operation of the dairy hub is to reach a milk collection volume that justifies the investment and the operational costs of the dairy hub. The goal for the processor is to reach an average litre cost for collected milk that does not exceed the cost for collecting milk without the dairy hub. The national average cost of milk collected for processing is used as a benchmark.
In the dairy hub business model, the dairy hub is seen as a business entity buying milk from farmers and selling milk to the dairy. The margin has to cover the financial cost for the investment and the operational costs.

Based on experiences from Pakistan and Bangladesh, a dairy hub needs to collect around 40,000 litres of milk per day to break even financially. The payback time for the investment is around 2-3 years if this volume can be achieved. To reach these volumes within the first 12-18 months, the dairy hub must be located in a region where a critical mass of small holder milk production already exists and where communities of farmers are interested in being connected to the dairy hub network.

2. **Improve profitability of the small dairy farmers through nutritional management and cows comfort.**

   The entire dairy value chain has to be profitable to ensure sustainability, including profitability for the small dairy farmer. The work to achieve profitability among the small dairy farmers commences at an early stage during the start-up of the dairy hub. Profitability for these dairy farmers is achieved gradually and improved feeding and nutritional management is one of the first steps. With improved feeding and nutritional management, milk yields and profitability increase. The objective is for all small dairy farmers forming part of a dairy hub to achieve a production level where dairy farming becomes their primary source of income.

3. **Improve milk quality**

   The general milk quality in Bangladesh is low and needs to be improved to achieve product safety for the consumers of the product. In addition, improved milk quality will extend the shelf life for both UHT and pasteurized milk. By extending the shelf life, safe packaged milk can be distributed throughout Bangladesh. The milk quality is measured at each step in the dairy value chain to identify the areas of potential improvements and corrective actions are then introduced.

4. **Improve animal health**

   Animal health is crucial for sustainable development of milk production. Training modules in diseases and health include areas such as mastitis, de-worming and vaccination. A lot of focus is put on preventive measures, such as improved hygiene, to avoid diseases and health problems among the cows. Through the dairy hub, veterinary services are made available to all farmers.

**Selected achievements for the first Dairy Hub in Bangladesh**

The following are examples of achievements for Dairy Hub number one, located in Chatmohar District, after 15 months implementation:

- Average milk yield per cow per day has increased from 5.79 litres to 7.91 litres, an increase by 37%
- Total plate count (TPC) has decreased from 7.2 million to 2.8 million, a decrease by 56.4%
- Somatic cell count (SCC) has decreased from 350,000 to 300,000, a decrease by 14%
• Monthly average income per farmer has increased from USD 99.66 to 132.61, an increase of 33%
• Total number of people who are engaged in milk production and related activities in the dairy hub area are 2,580
• There are a total of 438 females engaged at the dairy hub
• A total of 112 additional dairy farmers are now having dairy production as their primary source of income rather than as secondary income
• Total daily collection has reached maximum cooling capacity of 30,000 litres a day

Data collection and evaluation
To follow up results, milk production data and other information need to be collected on a regular basis. Base line data is collected before implementation starts. In PRAN’s dairy hub projects, data on milk production is collected on individual cow level. The data being collected is data such as, milk production, bacteria count, gender, training, and income levels.

Expected results
Based on experience from the first dairy hub, it is estimated that the yearly income of approximately 7,500 small dairy farmers will increase by at least 50%. Based on an initial monthly average of USD 100 per month, their total income is expected to increase from USD 9,000,000 to USD 13,500,000 per annum. It is estimated that a total of 12,500 people will be engaged in milk production and related activities in the area of the 5 dairy hubs.

By the end of 2016, the following outputs are expected:
• A training academy in operation effectively supporting the training needs of the initial 5 dairy hubs
• 5 dairy hubs in operation having met or exceeded the expectations of all dairy farmers covered by these dairy hubs, an expected total of 7,500 farmers.
• Increased small scale dairy farmers’ average income with minimum 50%
• Increased milk yields per cow at targeted farms with an average of minimum 50%
• Increased number of small holder farmers in PRAN’s supply network.
• Increased collection of locally produced milk for industrial processing with a minimum of 42 million litres per annum
• Improved small holder milk quality from an average of 7 – 9 million bacteria to less than 1 million for the milk being collected by the 5 dairy hubs
• Increased knowledge about efficient and sustainable milk production among government extension services staff and university teachers

Role of the private sector
PRAN, a privately owned food processing company in Bangladesh, is the main implementer and has undertaken most of the financial burden for the implementation of the initial two dairy hubs. This represents the investments in all operational cost, additional cooling capacity and other hardware. Tetra Laval and has provided guidance to PRAN during the project design and the project implementation. Tetra Laval has in
addition made available their extensive dairy production know-how and is currently co-funding an international dairy expert based full time in the dairy hub area.

Through PRAN, the farmers have access to market. Their milk is processed and packaged and sold on the market through PRAN’s extensive distribution network. Without this link to the private, industrial dairy sector, small holder farmers would have difficulties growing and developing their production.

**Potential role of the public sector**
The start-up cost of a dairy hub is substantial, since typically one dairy hub will employ approximately 80 full time staff. It is estimated that a dairy hub reaches break even for its operation after 2 to 3 years. Many of the full time dairy hub staffs are engaged in extension services to the smallholder dairy farmers. This is an area where support from the public sector or donors would be welcome to reach as many farmers as possible.

As soon as the small holder dairy farmer has reached profitability, he or she might want to acquire additional dairy cows, introduce mechanized milking or make other investments. Micro finance loans, guarantees or other financial arrangements to support these areas would also be welcome.

**About the Tetra Laval Group**

**The Tetra Laval Group** consists of three independent industrial groups.

- **Tetra Pak** is a world leading supplier of systems for processing, packaging and distribution of milk, juice and other foods as well as a world leader in the aseptic technology. UHT-treatment (Ultra High Temperature) and aseptic packaging means that the most sensitive foods can be kept for months without losing their taste, nutrients and freshness, and without the need for preservatives and chilled distribution.

- Tetra Pak’s sister company **DeLaval** is the world-leading supplier of equipment, systems and accessories for animal breeding and milk production.

- **Tetra Laval Food for Development Office (FfDO)** is the arm of the Group that coordinates and makes available the extensive knowledge and experience in nutrition and agricultural development programmes that the group has gathered over the years. FfDO initiates and supports such programmes in partnership with governments, development agencies, funding organisations, NGOs and customers. The value chain model – from cow to consumer – is the base for development programmes.
Exploring the causes of rapid development of China’s dairy Industry

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³College of Economics and Management, Shenyang Agricultural University;

Abstract
China’s dairy industry developed rapidly after the opening-up and reform, and has been meeting the demand of citizens to dairy products. This paper summarizes the successful experience of China’s dairy industry from the perspective of historical development: technical progress enhanced the release of dairy producing potential, which broke the barrier of dairy products circulation in different areas, thus ‘Dairy transport from west to east areas’ could be achieved; dairy products processing enterprises played the role of pushing in the development of dairy industry; in fields of dairy cattle feeding and raw milk processing, the supply of raw milk has been increased through organizational innovation; efficiency in the purchase of raw milk has also been improved through innovation in purchase model, especially the establishment of models such as dairy farmers’ professional cooperative as well as dairy feeding community and so on has enhanced the improvement of raw milk quality.

Keywords: dairy products, China’s dairy industry, development of dairy industry, causes to success

Introduction
The opening and reform in the end of 1970s had provided opportunities for China’s dairy industry to develop rapidly. The total output of dairy products (mainly milk) had increased from 971 thousand tons of 1980 to 37,480 tons of 2010, which means the output has increased 34.7 times in the past 30 years. Common people could not consume milk in 30 years ago, but now not only the output of milk products could meet the demands of both rural and urban citizens, but also there are hundreds of different products for consumers’ free choice. (Zhu Juan, etc. 2007).

From the perspective of development, this paper illustrates every stages of China’s dairy industry, analyzes the major reasons which promoted the development of China’s dairy industry in each stage; also mentioned is the problems existing, especially the reason and mechanism initiating food safety problem. This paper is not only a summary to the development of China’s dairy industry; more important is to teach the experience of China to other developing countries for reference.
Production and consumption of China’s dairy

In history, China’s milk production is very low. The total output of milk in China is 889 thousand tons, with per capita level of only 0.99 kg. In the end of 1970s, the opening and reform began, and China’s dairy industry got an opportunity to develop. On one side, government policies push the development of dairy industry; on the other side, with the increase of income, consumers began to be capable to buy milk products. Most important is the productive capability of producing enterprises had been rapidly improved (Yan Jingchen, 2004; Lu Haixia, Zhang Lijun, 2007). The total output of dairy products is presented in Figure 1 and the quantity of dairy consumption per capita of urban citizens is presented in Figure 2.

Data resource: China Statistical Yearbook.
Dairy production development in different regions

Urban dairy industry

In Chinese history, the areas where special dairy cattle are earliest used to produce milk are in five opening up coastal cities. China has a history of 6000 years of agricultural cultivation. The purpose farmers raise cattle is mainly for plough and cart-pulling. Farmers had no habits of drinking milk. After the failure in First Opium War in 1842, the Qing Dynasty was forced to open up five coastal cities (Guangzhou, Xiamen, Fuzhou, Ningbo, and Shanghai) for foreign business. To drink milk, foreigners living in these cities introduced milk cattle from Europe. Since then, China began with milk production.

For the one-and-half century time from Opium War to 1980, the dairy production in China is mainly concentrated in cities and surrounding area, especially big-scale city; which is mainly affected by history reasons. When founding the new China in 1949, there are already 64 dairy farms, feeding 4127 milk cattle. In the end of 1970s, the number of milk cattle in Beijing, Shanghai, Tianjin, and Nanjing had separately increased to 16000, 20000, 5000 and 3000.

Then opening-up and reform in 1978 stimulated the huge hidden productivity of China. Remarkable rapid economic growth had increased consumers’ income, which made them capable to consume dairy products. Peoples’ demand for dairy products is increasing rapidly, especially consumers in middle and large scaled cities (Jialianxin, Sun Zhongcai, 2004; Dinghuan Huetc, 2006).

Although the increase in consumption demand has stimulated development of dairy production in urban areas; however, after entering into 1990s, the development of dairy production in urban areas slowed down, affected by the expanding of city scale. Some dairy farms which located in suburban areas had to be closed or moved to other places to avoid influencing environmental hygiene, because some dwelling houses were built nearby. The expansion of city scale stagnated urban dairy industry or even caused backward going. For example, the total output of milk in Shanghai is 260 thousand tons in 2001, but it fell to 247.1 thousand tons in 2010. During corresponding period, the total output of milk in Nanjing fell from 86.83 to 80.8 thousand tons; Hangzhou fell from 45.69 to 41.4 thousand tons, Fuzhou fell from 40.58 to 22.0 thousand tons, and Guangzhou fell from 47.63 to 55.5 thousand tons (see Table 1).

Urban dairy industry only developed to some extent in two cities of Beijing and Tianjin. The dairy output increase from 429 thousand tons in 2001 to 751.7 thousand tons in 2010 in Beijing; while during corresponding period, the output in Tianjin increased from 241 to 652 thousand tons (see Table 1).

However, the consumption of urban and rural citizens of China has been increasing. It is becoming more and more difficult for metropolitan city to fulfill the self-sufficiency of

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1 'Milk cattle and dairy industry 'Shanghai Local Chronicles. http://www.shtong.gov.cn/node2/node2245/node71385/node71396/index.html
2 'Milk cattle and dairy industry 'Shanghai Local Chronicles. http://www.shtong.gov.cn/node2/node2245/node71385/node71396/index.html
milk. Therefore, they need to rely on milk from other regions to supplement the supply (see Table 2).

### Table 1. Milk output of 36 cities in '000 tonnes (2001-2010)

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>429.0</td>
<td>550.8</td>
<td>632.9</td>
<td>700.4</td>
<td>642.0</td>
<td>619.3</td>
<td>622.4</td>
<td>663.8</td>
<td>673.7</td>
<td>751.7</td>
</tr>
<tr>
<td>Tianjin</td>
<td>241.0</td>
<td>335.9</td>
<td>432.3</td>
<td>542.4</td>
<td>634.1</td>
<td>682.7</td>
<td>672.1</td>
<td>697.5</td>
<td>682.9</td>
<td>652.0</td>
</tr>
<tr>
<td>Shanghai</td>
<td>260.0</td>
<td>279.8</td>
<td>270.5</td>
<td>252.0</td>
<td>237.6</td>
<td>220.9</td>
<td>220.4</td>
<td>232.9</td>
<td>232.9</td>
<td>247.1</td>
</tr>
<tr>
<td>Nanjing</td>
<td>86.8</td>
<td>99.4</td>
<td>107.7</td>
<td>136.7</td>
<td>118.6</td>
<td>151.4</td>
<td>130.1</td>
<td>90.3</td>
<td>93.4</td>
<td>80.8</td>
</tr>
<tr>
<td>Hangzhou</td>
<td>45.7</td>
<td>61.1</td>
<td>63.7</td>
<td>67.6</td>
<td>51.7</td>
<td>42.9</td>
<td>41.2</td>
<td>38.2</td>
<td>41.4</td>
<td></td>
</tr>
<tr>
<td>Ningbo</td>
<td>12.0</td>
<td>14.1</td>
<td>18.7</td>
<td>22.3</td>
<td>20.2</td>
<td>23.6</td>
<td>21.2</td>
<td>17.2</td>
<td>19.4</td>
<td>22.1</td>
</tr>
<tr>
<td>Fuzhou</td>
<td>40.56</td>
<td>41.3</td>
<td>41.1</td>
<td>31.6</td>
<td>40.0</td>
<td>25.7</td>
<td>25.9</td>
<td>32.0</td>
<td>24.8</td>
<td>22.0</td>
</tr>
<tr>
<td>Xiamen</td>
<td>1.9</td>
<td>0.7</td>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
<td>1.0</td>
<td>1.3</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>Nanchang</td>
<td>40.8</td>
<td>44.3</td>
<td>47.3</td>
<td>61.4</td>
<td>64.5</td>
<td>41.1</td>
<td>40.7</td>
<td>40.8</td>
<td>46.5</td>
<td>44.0</td>
</tr>
<tr>
<td>Guangzhou</td>
<td>47.6</td>
<td>51.6</td>
<td>45.0</td>
<td>34.1</td>
<td>40.7</td>
<td>44.4</td>
<td>47.0</td>
<td>51.9</td>
<td>53.0</td>
<td>55.5</td>
</tr>
<tr>
<td>Shenzhen</td>
<td>41.4</td>
<td>28.6</td>
<td>28.6</td>
<td>36.9</td>
<td>37.0</td>
<td>16.4</td>
<td>34.0</td>
<td>37.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data resource: China's dairy production statistics.

### Dairy transport from west to east areas

The so-called ‘dairy transported from west to east areas’ means to transport dairy products from northwest China into the market of middle and coastal areas of China. In 1980s, with the abolishment of planned purchase and marketing by the state, the arbitrary restrictions in dairy products circulation have been cancelled. Thus, dairy products could be distributed freely in different areas according to market laws. However, except the changes in system, it is also necessary to solve the long-term freshness retaining of dairy products, especially of liquid milk, through technical approaches, to achieve free circulation of dairy products in different areas. China is vast in territory, and traditional pasteurized milk could not be transported from one place to another (Dinghuan Hu etc., 2004).

To make it easier to illustrate, this paper divides China into three regions according to geological and natural characteristics: (1) eastern coastal region (shorten as coastal region); (2) middle region and (3) western region. Coastal region includes Beijing, Tianjin, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Hainan and Guangdong. The characteristics of coastal region are: population concentration (occupies 29.2% of the total population of China), developed industry and commerce, income per capita is higher than other two regions. However, the dairy industry in coastal region is restricted, because of reasons including: feeding capacity, feed supply, labor cost and environmental conditions. Middle region includes Liaoning, Jilin, Hebei, He’nan, Anhui, Jiangxi, Yunnan, Guizhou, Sichuan,
Chongqing, Shanxi, Shaanxi and so on. The agriculture in middle region is mainly planting; the development of manufacture and commerce is lagged behind. Consumption of dairy products is also lower than coastal region because of lower income level. Western region means Heilongjiang, Inner Mongolia, Ningxia, Gansu, Qinghai, Xinjiang and Tibet. The western region has a vast territory and is rich in feed resources (the grassland area of Inner Mongolia, Tibet, Qinghai and Xinjiang occupies separately 66%, 81%, 96% and 50% of the total land area in each province), climate is cold and suitable for feeding dairy cattle; meanwhile, there are pastoral nations living in western region in history, which means people there have more experience in feeding ruminant.

The supply and demand of dairy products is imbalance in the coastal, middle and western region, as is apparent from Table 2.

1. **Coastal region.** The population is concentrated and industry is developed as well, places suitable for feeding dairy cattle is not much; therefore, supply of dairy products is obviously inadequate compared with demand. In 1980, the population of coastal region accounts for 33.6% of the total population in the country, while the output of dairy products only accounts for 34.2% of the total. The imbalance between supply and demand is even more obvious until now. In 1990, the population of coastal region accounts for 33.7 of the total population in the country, while the output of dairy products proportion is 22.1% of the total; in 2000, population proportion is 35.0% while output of dairy products proportion is 21.7%; in 2010, population proportion is 37.5% while output of dairy products proportion is 14.3%.

2. **Middle region.** In 1980, the population of coastal region accounted for 54.1% of the total population in the country, while the output of dairy products only accounted for 32.5% of the total. In 1990, population proportion was 54.0% while output of dairy products proportion was 24.6%; in 2000, population proportion was 52.8% while output of dairy products proportion was 28.2%; in 2010, population
proportion is 50.4% while output of dairy products proportion is 32.5%.

3. **Western region.** The supply of dairy products is more than demand. In 1980, the population of coastal region accounted for 12.3% of the total population in the country, while the output of dairy products only accounted for 43.4% of the total. In 1990, population proportion was 12.2% while output of dairy products proportion was 53.3%; in 2000, population proportion was 12.3% while output of dairy products proportion was 50.1%; in 2010, population proportion was 12.1% while output of dairy products proportion was 53.1%.

Compared with other two regions, in western region, not only is the supply of raw milk sufficient, but also the producing cost per capita of raw milk is lower than that of other two regions. In 2011, the producing cost is 145.31 Yuan per 100 kg of raw milk in coastal region, while that of middle region is 122.42 Yuan and in western region is 103.94 Yuan. In 2005, producing cost of raw milk is 162.48 Yuan in coastal region, 150.01 Yuan in middle region and 118.71 Yuan in western region. In 2010, producing cost of raw milk is 269.67 Yuan in coastal region, 217.62 Yuan in middle region and 207.50 Yuan in western region (see Table 3).

**Table 2. Proportion of population and output of dairy products in three regions**

<table>
<thead>
<tr>
<th></th>
<th>Coastal Region</th>
<th>Middle Region</th>
<th>Western Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>33.6</td>
<td>24.1</td>
<td>32.5</td>
</tr>
<tr>
<td>1985</td>
<td>33.7</td>
<td>25.6</td>
<td>26.8</td>
</tr>
<tr>
<td>1990</td>
<td>33.7</td>
<td>22.1</td>
<td>24.6</td>
</tr>
<tr>
<td>1995</td>
<td>33.7</td>
<td>22.6</td>
<td>23.5</td>
</tr>
<tr>
<td>2000</td>
<td>35.0</td>
<td>21.7</td>
<td>28.2</td>
</tr>
<tr>
<td>2005</td>
<td>35.6</td>
<td>17.1</td>
<td>27.6</td>
</tr>
<tr>
<td>2010</td>
<td>37.5</td>
<td>14.3</td>
<td>32.5</td>
</tr>
</tbody>
</table>

Data resource: China’s dairy production statistics, China Statistics Yearbook.

Western Region is superior in the supply quantity and purchase price of raw milk, but the key problem is how to transport liquid milk to other two regions. The preserve period of traditional pasteurized milk is too short to be suitable for long-term transportation. The UHT milk appeared in 1961 to solve the above problem (Li Tong, 2008).
Table 3. Comparison of milk output, producing cost and purchase price in three regions ('00 kg, Yuan)

<table>
<thead>
<tr>
<th>Year</th>
<th>Item</th>
<th>Coastal Region</th>
<th>Middle Region</th>
<th>Western Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Output per dairy cattle</td>
<td>6122.0</td>
<td>5021.3</td>
<td>5182.0</td>
</tr>
<tr>
<td></td>
<td>Producing cost</td>
<td>145.3</td>
<td>122.4</td>
<td>103.9</td>
</tr>
<tr>
<td></td>
<td>Purchase price</td>
<td>201.5</td>
<td>177.7</td>
<td>157.9</td>
</tr>
<tr>
<td>2002</td>
<td>Output per dairy cattle</td>
<td>6627.5</td>
<td>5062.8</td>
<td>5263.7</td>
</tr>
<tr>
<td></td>
<td>Producing cost</td>
<td>138.0</td>
<td>144.6</td>
<td>102.2</td>
</tr>
<tr>
<td></td>
<td>Purchase price</td>
<td>203.7</td>
<td>188.5</td>
<td>147.8</td>
</tr>
<tr>
<td>2003</td>
<td>Output per dairy cattle</td>
<td>6773.7</td>
<td>4803.0</td>
<td>5417.2</td>
</tr>
<tr>
<td></td>
<td>Producing cost</td>
<td>143.1</td>
<td>131.1</td>
<td>109.1</td>
</tr>
<tr>
<td></td>
<td>Purchase price</td>
<td>205.9</td>
<td>188.1</td>
<td>157.9</td>
</tr>
<tr>
<td>2004</td>
<td>Output per dairy cattle</td>
<td>5809.8</td>
<td>4982.0</td>
<td>5240.2</td>
</tr>
<tr>
<td></td>
<td>Producing cost</td>
<td>159.4</td>
<td>141.5</td>
<td>114.8</td>
</tr>
<tr>
<td></td>
<td>Purchase price</td>
<td>196.6</td>
<td>184.0</td>
<td>159.2</td>
</tr>
<tr>
<td>2005</td>
<td>Output per dairy cattle</td>
<td>5465.2</td>
<td>4821.8</td>
<td>4776.7</td>
</tr>
<tr>
<td></td>
<td>Producing cost</td>
<td>162.5</td>
<td>150.0</td>
<td>118.7</td>
</tr>
<tr>
<td></td>
<td>Purchase price</td>
<td>198.9</td>
<td>186.3</td>
<td>154.5</td>
</tr>
<tr>
<td>2006</td>
<td>Output per dairy cattle</td>
<td>5730.1</td>
<td>4933.4</td>
<td>4718.9</td>
</tr>
<tr>
<td></td>
<td>Producing cost</td>
<td>160.4</td>
<td>150.4</td>
<td>137.9</td>
</tr>
<tr>
<td></td>
<td>Purchase price</td>
<td>193.4</td>
<td>195.2</td>
<td>159.4</td>
</tr>
<tr>
<td>2007</td>
<td>Output per dairy cattle</td>
<td>6777.5</td>
<td>4963.5</td>
<td>4727.2</td>
</tr>
<tr>
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<td>Producing cost</td>
<td>203.8</td>
<td>172.0</td>
<td>169.4</td>
</tr>
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<td></td>
<td>Purchase price</td>
<td>230.1</td>
<td>212.9</td>
<td>213.7</td>
</tr>
<tr>
<td>2008</td>
<td>Output per dairy cattle</td>
<td>6495.3</td>
<td>5267.1</td>
<td>4816.2</td>
</tr>
<tr>
<td></td>
<td>Producing cost</td>
<td>223.1</td>
<td>188.6</td>
<td>182.6</td>
</tr>
<tr>
<td></td>
<td>Purchase price</td>
<td>275.5</td>
<td>248.6</td>
<td>242.9</td>
</tr>
<tr>
<td>2009</td>
<td>Output per dairy cattle</td>
<td>6155.7</td>
<td>5542.6</td>
<td>5073.8</td>
</tr>
<tr>
<td></td>
<td>Producing cost</td>
<td>247.6</td>
<td>195.3</td>
<td>174.9</td>
</tr>
<tr>
<td></td>
<td>Purchase price</td>
<td>278.8</td>
<td>261.8</td>
<td>235.1</td>
</tr>
<tr>
<td>2010</td>
<td>Output per dairy cattle</td>
<td>5999.1</td>
<td>5325.3</td>
<td>5092.5</td>
</tr>
<tr>
<td></td>
<td>Producing cost</td>
<td>269.7</td>
<td>217.6</td>
<td>207.5</td>
</tr>
<tr>
<td></td>
<td>Purchase price</td>
<td>318.6</td>
<td>291.3</td>
<td>278.3</td>
</tr>
</tbody>
</table>

Data resource: Compilation of Cost and Benefit Data of Agro-Products Nationwide, 2002-2011.
In the end of 1980 and beginning of 1990s, UHT milk was once imported into China as high-end consumer goods. They were put into high-end market, such as shops for overseas Chinese in which foreign exchanges are required to be used. As an imported product, the quantity of UHT milk is very small and failed in becoming popular. In the middle of 1990s, Shanghai Bright Dairy Products Company introduced equipment to produce UHT milk from abroad. However, the producing cost of raw milk in areas nearby Shanghai was very high, thus the price of UHT milk was limited. On the other side, the perspective of UHT milk did not get enough attention from the decision-making level of the company; therefore, domestic processed UHT milk was still not accepted by Chinese consumers (Luo Bingrui, Bai Xue, 2006).

In the end of 1990s, the market of UHT milk changed. At this time, a very small dairy processing company located in Inner Mongolia – which was Yili Dairy Processing Company found out the market potential of UHT milk with quick sight. In end of 1990s, Yili introduced production line and packaging materials of UHT milk from abroad, and with the advantages of sufficient raw milk supply in western region, the UHT milk produced by Yili successfully entered into market. UHT milk of Inner Mongolia represented by Yili firstly entered into the market of coastal region where the income of consumers was higher. With the rapid expansion of market, UHT milk is gradually accepted by consumers of middle region and rural areas (XuRui, Zhan Qiang, 2004; Sang Wanbang, 1996).

In 2000, the output of UHT milk only accounted for 14.2% in the output of total output of liquid milk. Two years later, this proportion increased to 53.5% in 2003, which surpassed the proportion of pasteurized milk; and the proportion was 65.2% in 2004, 68.5% in 2005, 71.5% in 2006 and 75.9% in 2007. This means within four people who drank liquid milk, there are three drank UHT milk (see Figure 4).

The main reasons why UHT milk could be accepted by Chinese consumers are:
• the shelf life of UHT milk is as long as 6 months and is convenient to be stored; consumers could store and consume under the condition of room temperature
• consumers could get mellow and creamy taste through the seasoning of processing
companies⁴ (Sun Yong, 1990)

- UHT milk is superior in price because of the low cost of raw milk in western region, even adding the transportation cost
- China was experiencing a rise in economic in the end of 1990s, while most of new-added consumers drank UHT milk (Fang Wei, 1996; Han Qinghua, 2001; Yu Weijun, 2006).

With the expanding market of UHT milk, the demand for raw milk has increased rapidly. For farmers in Western region, the economic benefit of feeding dairy cattle is higher than other agro-products. Thus, more and more farmers began to feed dairy cattle (Li Zhiqiang, 2002). Meanwhile, lower-quality raw milk could be processed into UHT milk because of adopting high-temperature sterilization technology. Lower technological threshold made more farmers with lower-level feeding technology as well as storage facilities could produce milk; which improved the raw milk producing capacity of western region rapidly (Wang Lianmeng, 2000; Chen Yongping, etc., 2004; J. Mottar, M. Naudts, 2005; Zhang Ping, 2009; Lu Ruina, 2011).

**Development and function of dairy processing enterprises**

*Concentration of dairy processing enterprises*

As mentioned above, to meet the demand of a small amount of consumers, the dairy processing enterprises are mainly concentrated in middle and large cities in earlier time, especially in large coastal cities. Meanwhile, the scale of China’s dairy processing enterprises is very small, for example, there are 760 dairy products processing enterprises nationwide in 1998, of which more than 90% are with the capacity to process more than 100 tons fresh milk per day (Li Yifang, 1998).

After entering into 1990s, China’s dairy products processing enterprises began to be divided. Part of them which were occupied with the advantages of technology, market and raw material stood out from the crowd with rapid expansion of scale as well as producing capability. While others which were lack of competitiveness were either eliminated or been merged as sub-company of processing plant of large-scaled enterprise. According to the data released by AC Nielsen, the market share of three giant dairy enterprises – Mengniu Yili and Bright are separately 30.3%, 23.1% and 8.7%. These three dairy products processing enterprises occupies 62.1% of market share in nationwide.

Currently, China’s scaled dairy products processing enterprises could be divided into two major types: urban dairy products processing enterprise and resource-oriented dairy products processing enterprise. Urban dairy products processing enterprise is developed on basis of original state-owned dairy products processing enterprise. The characteristics of this type are: with longer developing history, owns market superiority in located city. Thus, generally these enterprises could get financial and policy support from local government. Typical representatives are Shanghai Bright Dairy Products Company and Beijing Sanyuan Dairy Products Company. Typical representatives of

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⁴Most of Chinese consumers lack the experience of drinking pasteurized milk, they could not tell natural creaming flavor from artificial relished creamy flavor.
resource-oriented dairy products processing enterprise are Yili and Mengniu of Inner Mongolia and Sanlu Dairy Group in Hebei Province. Yili Group started as a small state-owned dairy farm in Hohhot. In 1983, the company was transformed into a fresh milk processing company by the government. In 1995, the company got support by the government and was listed, which made the company be capable to expand scale through social capital. As a dairy products processing enterprise in western region, Yili is far away from coastal market, and is impossible to expand its market through fresh milk.

Therefore, Yili firstly introduced technology to produce ice-cream and established sales network in Beijing and Shanghai. With competitive raw material and continuous development of new varieties, Yili developed into the biggest ice-cream producers in nationwide, and kept ranking No. 1 in the producing and sales volume rank list. In 1999, Yili introduced UHT milk processing technology, with marketing experience and network in ice-cream, the UHT milk produced by Yili entered into market of coastal and middle region. The sales volume of UHT milk of Yili ranked No. 1 in the nationwide. In 2004, the prime operating revenue of Yili was 8.735 billion Yuan, being nominated in ‘Top 500 enterprises of China’ (Tang Ji, 2001).

The predecessor of Sanlu Dairy Group in Henan Province is ‘Xingfu Dairy Industry Producing cooperative’ founded in 1956. In 1983 the company took the lead in developing and producing formulated milk powder. Because a huge amount of rural labors went to work in urban areas, the infants of these labors were left in villages and were cared by elders in home. Thus, great demand for infant milk powder appeared then. The sales volume of milk powder produced by Sanlu kept ranking No. 1 in nationwide for 14 years. In 2006, Sanlu was appraised as No. 1 in the dairy industry in ‘Top Hundred Enterprises of China’ list by Forbes. The brand value of Sanlu was 14.907 billion Yuan. However, the melamine event happened in 2008 caused serious social influence and led the company broke out (Qi Yuchun, 2009).

After entering in to 21st century, with the speed-up development of China’s dairy products processing enterprises, the concentration of enterprises also came with skyrocket-increase. In 2002, the overall daily processing capability of dairy products of the top four companies – Yili, Mengniu, Bright and Sanyuan is 16081 tons, which accounts for 24.9% of the total in nationwide; in 2006, the overall daily processing capability of dairy products of the top four companies is 91203 tons, which accounts for 52.1% of the total in nationwide; in 2010, the overall daily processing capability of dairy products of the top four companies is 95119 tons which accounts for 65.1% of the total in nationwide (see Table 4).
Another feature of China’s dairy products processing enterprise is territory expansion, which means the enterprises expand the approaches to get raw milk and become closer to consumer market. Large-scaled dairy products processing enterprise began to invest and construct processing plant in origin areas of raw milk and major consumer cities, or just purchase local enterprises.

In 2002, Yili had 6 dairy products processing plants in 5 provinces, and increased to 15 processing plants in 9 provinces. In 2002, Mengniu had 4 dairy products processing plants in 3 provinces, and increased to 14 processing plants in 9 provinces. In 2002, Bright had 13 dairy products processing plants in 9 provinces, and increased to 17 processing plants in 10 provinces. In 2002, Sanyuan had 9 dairy products processing plants in 4 provinces, and increased to 11 processing plants in 5 provinces (see Table 5).

Table 4. Processing capability of the top 4 dairy enterprises

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2006</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Processing Capability (ton/day)</td>
<td>%</td>
<td>Processing Capability (ton/day)</td>
</tr>
<tr>
<td>Yili</td>
<td>1700</td>
<td>2.6</td>
<td>15980</td>
</tr>
<tr>
<td>Mengniu</td>
<td>2750</td>
<td>4.3</td>
<td>16957</td>
</tr>
<tr>
<td>Bright</td>
<td>8874</td>
<td>13.7</td>
<td>10727</td>
</tr>
<tr>
<td>Sanyuan</td>
<td>2757</td>
<td>4.3</td>
<td>3867</td>
</tr>
<tr>
<td>Top 4 in total</td>
<td>16081</td>
<td>25.0</td>
<td>47531.0</td>
</tr>
<tr>
<td>Nation in Total</td>
<td>64635</td>
<td>100.0</td>
<td>91203</td>
</tr>
</tbody>
</table>


Table 5. Distribution condition of top 4 dairy products processing enterprises

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yili</td>
<td>Mengniu</td>
</tr>
<tr>
<td>Beijing</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Tianjin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hebei</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Shanxi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inner Mongolia</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Heilongjiang</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Shanghai</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Zhejiang</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anhui</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Jiangxi</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Henan</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hubei</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hunan</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Guangdong</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sichuan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaanxi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In total</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

Diversification of products produced by enterprise

In the second decade after entering into 21st century, one of the most significant development trends of China’s dairy industry is the rapid increase in the variety of products. Considering about the reasons, on one side, the room for growth of liquid milk consumption is becoming smaller, it is impossible for consumers to drink several cups of milk per day, so it is only available to attract consumers expanding consumption through increasing the variety of products; on the other side, the added-value of yoghurt and milk beverage is higher than liquid milk, so as the profit margin (Zhao Yunping, Zhang Hongsheng, 2006). Truth is that the key for this diversification is the improvement in R&D capacity of enterprises.

The author of this paper had done investigation in large-scaled supermarket such as Carrefour, Wu-Mart and Wal-Mart in Beijing, about the dairy product varieties. Yili has 123 kinds of dairy products for sale in Carrefour, 111 kinds of products in Wu-Mart and 116 kinds of products in Wal-Mart. Sanyaun has 68 kinds of dairy products for sale in Carrefour, 71 kinds of products in Wu-Mart and 75 kinds of products in Wal-Mart. Mengniu has 67 kinds of dairy products for sale in Carrefour, 90 kinds of products in Wu-Mart and 69 kinds of products in Wal-Mart. Bright has 32 kinds of dairy product for sale in Carrefour, 26 kinds of products in Wu-Mart and 41 kinds of products in Wal-Mart (see Table 6).

Table 6. Dairy products variety for sale in supermarket

<table>
<thead>
<tr>
<th>Sales venue</th>
<th>Variety</th>
<th>Yili</th>
<th>Sanyuan</th>
<th>Mengniu</th>
<th>Bright</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrefour</td>
<td>Pasteurized Milk</td>
<td>0</td>
<td>15</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>UHT Milk</td>
<td>17</td>
<td>18</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Milk beverage</td>
<td>19</td>
<td>8</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Yoghurt</td>
<td>31</td>
<td>24</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Ice-cream</td>
<td>32</td>
<td>0</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Milk powder</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Cheese</td>
<td>14</td>
<td>3</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>In total</td>
<td>123</td>
<td>68</td>
<td>67</td>
<td>32</td>
</tr>
<tr>
<td>Wu-Mart</td>
<td>Pasteurized Milk</td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>UHT Milk</td>
<td>11</td>
<td>15</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Milk beverage</td>
<td>22</td>
<td>9</td>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Yoghurt</td>
<td>32</td>
<td>27</td>
<td>33</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Ice-cream</td>
<td>24</td>
<td>0</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Milk powder</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Cheese</td>
<td>10</td>
<td>2</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>In total</td>
<td>111</td>
<td>71</td>
<td>90</td>
<td>26</td>
</tr>
<tr>
<td>Wal-Mart</td>
<td>Pasteurized Milk</td>
<td>0</td>
<td>19</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>UHT Milk</td>
<td>18</td>
<td>20</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Milk beverage</td>
<td>23</td>
<td>9</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Yoghurt</td>
<td>35</td>
<td>27</td>
<td>23</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Ice-cream</td>
<td>19</td>
<td>0</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Milk powder</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Cheese</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>In total</td>
<td>116</td>
<td>75</td>
<td>69</td>
<td>41</td>
</tr>
</tbody>
</table>

Data resource: investigation of author in supermarkets of Beijing in 2012.
In Table 6 we can also find another trend is that: the product variety of urban dairy products processing enterprise and resource-oriented dairy products processing enterprise is tending to be the same. Mengniu and Yili, with headquarters in Inner Mongolia, also produce pasteurized milk and milk beverage, except for UHT milk, ice-cream, milk powder and cheese. Similarly, urban dairy products processing enterprise such as Beijing Sanyuan and Shanghai Bright also produce UHT milk, ice-cream, milk powder and cheese, except for pasteurized milk.

**Feeding of dairy cattle and purchase model of raw milk**

**Dairy cattle population**

In history, the population of dairy cattle had been small all the time. In accordance with statistics document, the dairy cattle population in nationwide is only 160000 heads in 1957, which means every 5000 people only shared one dairy cattle. Until 1970s, the dairy cattle population is still not enough, which is only 380000 heads in 1973. However, after entering into 1980s, with the development of economics, the dairy cattle population increased rapidly. The total population of dairy cattle is 0.614 million in 1980, 1.627 million in 1985, 2.691 million in 1990, 4.887 million in 2000, 12.161 million in 2005 and 15.971 million in 2010, which means every 81 people shared one dairy cattle in 2010 (see Fig 5).

During this period, dairy cattle population in different regions increased rapidly. In coastal region, the total population of dairy cattle is 314 thousand heads in 1990, 337 thousand heads in 1995, 592 thousand heads in 2000, 1457.3 thousand heads in 2005 and 2060.1 thousand heads in 2010. In middle region, the total population of dairy cattle is 517 thousand heads in 1990, 1113 thousand heads in 1995, 1304 thousand heads in 2000, 3718.1 thousand heads in 2005 and 4771 thousand heads in 2010. In western region, the total population of dairy cattle is 1648 thousand heads in 1990, 2743 thousand heads in 1995, 2873 thousand heads in 2000, 6997.2 thousand heads in 2005 and 9053.5 thousand heads in 2010 (see Fig 6).

![Fig 5. Dairy cattle population](image-url)

Dairy cattle feeding models
The dairy cattle feeding model differs between coastal region and western region (Yuan Hongwan, 2011). Because the difference in historical conditions, in coastal region where urban dairy industry was taken as center in previous time, the major dairy cattle feeding model is dairy farms directly affiliated to dairy products processing enterprises; while in western region where the dairy products processing industry was weak in previous time, the major model is small-scaled family dairy farm. In the latter phase of first decade after entering into 21th century, with the continuous attention of both government and consumers pay to the food safety problem of dairy products, the dairy cattle farm were gradually expanded (Lu Jianguo, Wang Guizhu, 2011).

1. Dairy farms directly affiliated to dairy products processing enterprises
In coastal region, most of the dairy products processing enterprises with state-owned background have their own dairy cattle farm. On one side, dairy cattle farm is historical property; on the other side, with the condition of concentrated population, severe lack of land resource and higher labor cost, it is very difficult to get milk resource from abroad areas. Therefore, dairy products processing enterprises in coastal region pay a lot of attention in developing their dairy farms. In the following we will introduce this model, taking Shanghai Bright Dairy Ltd., Co. (shorten as ‘Bright; in the following) and Beijing Sanyuan Food Ltd., Co. (shorten as ‘Sanyuan’ in the following).

The predecessor of Bright is the state-owned Shanghai Milk Company founded in 1956. The government entrusted Bright to be in charge of all the state-owned and private dairy cattle farms of Shanghai at that time. In 1996, Shanghai Milk Company and Hong Kong Shanghai Industrial Holding Limited co-established Shanghai Bright Dairy Ltd., Co, each of them with 50% of shareholding. Currently, Bright has 21 own dairy farms, mainly distributed in suburban areas of Shanghai, Jiangsu Province and Zhejiang province, with a total dairy cattle population of more than 30000 heads, and could produce 96000 tons of raw milk per year. Besides, Bright has established long-term cooperative relationship with more than 500 scaled dairy farms. Since 2008, Bright
stopped purchasing raw milk form small-scaled farmers, and realized to support 100% raw milk from its own dairy farms, in which 25% is from suburban areas of Shanghai (Peng Lingling, 2012; Qian Yinhao, 2009).

Sanyuan is a Sino-Foreign joint venture joint-stock enterprise which operates mainly in dairy industry, but is also engaged in McDonald fast food. The predecessor of Sanyuan is the state-owned Beijing Milk Station founded in 1956. Beijing Sanyuan Food Ltd., Co was founded in 1997 and was changed into Beijing Sanyuan Food Limited Liability Company in 2001. 70% of its raw milk is from 28 dairy farms of Beijing Sanyuan Lvhe-Dairy Company. Lvhe-Dairy and Sanyuan both belong to Capital Agricultural Group. Lvhe-Dairy has a dairy cattle population of 41000 heads, and can produce 180000 tons of raw milk per year.

2. Small-scaled family dairy farms
In the Western region, with the rapid development of local dairy enterprises and continuous increase in the demand to raw milk, a multitude of small-scaled family dairy farms are developed. Although western region has superior environment to feed dairy cattle, however, because of backward economy, farmers don’t have money to buy dairy cattle. Therefore, most of the earlier family farms are developed under the support of processing enterprises and government. The most common model is processing enterprises loan money to farmers or supply farmers with dairy cattle on credit, and then farmers pay back to the enterprises with raw milk. This model not only solves the problem that farmers could not afford to buy dairy cattle, but also guarantees the raw material supply to enterprises.

For example, in 2001 Yili found that the grassland in Dorbod Mongol Autonomous County of Heilongjiang Province is very suitable for feeding cattle; however, there are no farmers there who feed dairy cattle. Yili began to develop dairy cattle industry there, together with the local government. Guaranteed by local government, Yili provide loan to farmers for buying cattle. Though this model, Yili developed hundreds of thousands of farmers to feed dairy cattle, and farmers pay back to Yili with raw milk they produced. With the same model, Yili helped more than 5 million farmers of Heilongjiang, Inner Mongolia, Liaoing, Hebei and Anhui Province to become raw milk producers (Huang Yikun, 2007).

Compared with Yili, Sanlu develops more models to help farmers buy dairy cattle: (1) given each dairy cattle a price, the company rent dairy cattle to farmers for feeding and farmers should pay one third of their milk sales income to Sanlu as rent. Generally, farmers could pay off all the rent in three year, after that, the cattle belong to farmers; (2) the company sells their cattle to farmers with a discount of 30% off in price; (3) when farmers buying cattle, 50% of the money are paid by farmers themselves, while the other 50% will be paid through loan from bank, with the company on credit.

**Purchase models for raw milk**
Raw milk is perishable product, and the quality of milk is better when the time period from milking to processing is shorter. A problem which all the processing enterprises in western region have to consider is that, how to collect the milk produced by scattered farmers as soon as possible.
In earlier time, the approach to collect raw milk is that, processing enterprises send tanker to each farmer’s house to collect. With the increase in number of farmers, as well as another problem that some farmers add water and other things to milk which seriously affected the quality of milk, processing enterprises implemented innovation in collaborate model. Currently, there are 4 main models: (1) ‘farmer + milk station + company’ model; (2) ‘farmer + dairy farmers’ cooperative + company’ model; (3) feeding community model; (4) enterprise owned dairy farm model.

(1) ‘Farmer + milk station + company’ model
This is the most common and widely-used model in the earliest stage. Dairy products processing enterprise established milk station in each village. The milk station is equipped with milking and storage equipment. In accordance with the time schedule, farmers lead their dairy cattle to the station every day for milking. The station will collect raw milk together and transport to enterprises directly with tanker. The enterprise pays money back to farmers regularly through the station.

The investment to build a milk station is around 700000 RMB, and the cost to supervise station workers is also very high; this is a great burden to processing enterprises. Thus, excepting for their own milk station, processing enterprises also purchase milk from contracted milk station.

The directly-affiliated milk station is invested and constructed by the enterprise, so it is also under the operation of enterprise. Contracted milk station is invested and constructed by private personnel (including those which were built by company but then rented to private personnel), processing enterprises sign contract with milk station to order milk, and milk station sells raw milk purchased from farmers to processing enterprises. Although contracted milk station could save investment fund for enterprises, it is still difficult for them to control the quality of raw milk. The reason of melamine events happened in 2008 is because that, to increase profit, the milk station added water into raw milk and add melamine to avoid inspection.

(2) ‘Farmer + dairy farmers’ cooperative + company’ model
Scattered farmers are difficult to be supervised, thus, processing enterprises help dairy farmers to establish cooperative, and try to supervise membership farmers through farmers’ organization. Since 2006, Yili began to implement establishing dairy cooperatives in Inner Mongolia, together with local government. Within the cooperative, ‘uniformly management, uniformly milk collection, uniformly feed ingredient, uniformly improved dairy cattle, uniformly epidemic prevention, as well as uniformly selling’ is carried out. The success of Inner Mongolia dairy farmers’ cooperative, makes Yili promote this ‘farmer + dairy farmers’ cooperative + company’ model to Heilongjiang and Shandong and other areas (Xiao Shaoqiong, 2006).

(3) Dairy cattle feeding community model
Concentrated feeding means to concentrate small-scaled dairy farms scattered in different places, which is beneficial for quality supervision and environmental protection (Meng Zhaoren, 2005). Therefore, both the processing enterprises and local government are interested in promoting this model. The land area of dairy cattle feeding community is around 15 ha. There are dairy cattle house, unified milking equipment as well as management office built in the community. Each
community could accommodate 50 to 100 dairy households. Generally, the farmers operate feed separately, while milking and selling are unified.

(4) Enterprise owned dairy farm model
Dairy feeding communities need more investment, and there are three common models:

a.) invested by dairy processing enterprises
The feature of this model is that, the upfront input was undertaken by processing enterprises. For example, Mengniu invested 4.34 million Yuan in Helin County of Inner Mongolia, and there are 52 dairy households entered and be stationed in. Mengniu sold the cattle house to households at a price of 70000 Yuan, and invested 0.7 million Yuan to construct milking equipment and leased the business to others. All the milk produced in this community is purchased by Mengniu. Another example is that, Yili construct similar community in Tumd Banner of Hohhot, with a land area of 12 ha and total investment of 10.76 million Yuan. The feeding community could accommodate 500 dairy cattle and produce 4 tons of milk per day. Yili also rent the cattle house to households which are stationed in (dairy project office of MoA, 2004).

b.) invested by real estate developers
Real estate developer thinks optimistically about the profit margin of dairy cattle feeding community and invests money to construct this kind of community. After the construction of cattle houses finished, there are mainly three approaches for using: one is to sell directly to dairy farmers; a second is to provide the cattle house to farmers for free, but the milk produced by farmers must be sold directly to the station owned by the developer, and the developer gets back the investment through the price difference between purchase and selling milk; a third one is to lease the community to farmers, and the rent will be deducted through the sales income of farmers (dairy project office of MoA, 2004).

c.) co-invested by government, enterprise and farmers
This model is quite popular in western region. For example, the land area of Yulin dairy cattle feeding community is 13 ha, could accommodate 1500 heads of cattle. The investment of this community is 6.8 million Yuan, in which 5.04 million Yuan are used to construct cattle house. Farmers will pay and buy the cattle houses, and the investment to milk station, which is 0.7 million Yuan will be paid by Yili (processing enterprise). Hydropower road in the community is invested and constructed by government, which is 1 million Yuan. And the milk produced in this community is all purchased by Yili.

Dairy cattle feeding community is superior than scattered farmers in field of dairy cattle feeding technology and quality control. It is convenient to carry out selective breeding, epidemic prevention and feed storage, because of the concentration of cattle herd. Moreover, the community is equipped with technical personnel to guide. Therefore, the milk output of dairy feeding community is higher than that of scattered farm (Li Baozhu, 2004; Tang Lixin, 2009; Zhao Zhuo, 2009).
Summary
It has been 30 years for the supply of China's milk products developed from significant inadequate to basically meet the demand of consumers. Technological improvement, such as the introduction of UHT milk processing technology, had broken the circulation barrier of liquid milk in different areas, which had released the producing potential of dairy industry in western region. Dairy products processing enterprise had been played positive pushing role in the development of China's fairy industry. China has implemented innovation in the feeding of dairy cattle as well as the processing of raw milk, which increase supply of raw milk; the innovation in purchase model improved the efficiency in raw milk purchase, in which the establishment of models such as founding of farmers' cooperative and dairy feeding community has played positive role in improving the quality and raw milk.

However, what we should also pay attention is that, there are many loopholes existing in China's dairy products supply chain, especially loophole in food safety. In the melamine events happened in 2008, 20 enterprises and 31 batches of products are involved in, melamine were detected in milk powder produced by a number of well-known enterprises including Yili, Mengniu, Bright and Yashili. The melamine event arose high attention of different countries, and also worried wide consumers with the food safety problem in domestic milk products.

In the second decade after centering into 21th century, how to optimize dairy products supply chain, as well as how to improve the organizational system and supervision level of supply chain, are becoming the new challenges faced by China's dairy industry.

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Effect of improved extension services on adoption rates and farm economics of small holder dairy farmers in Pakistan

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Abstract
The objective of the study is to demonstrate the effect of improved extension services on adoption rates and farm economics of small holder dairy farmers in Pakistan. During the first two years of the project a simple approach of extension targeting male farmers was used. Whereas in the second phase of the project a whole family approaches targeting all the family members was utilized. The effect of improved extension services on adoption rates and farm economics was collected on a monthly basis from the farmers. These farmers were working in the districts of Kasur, Okara, Pakpattan, Jhelum and Bhakkar within the Punjab province. Preliminary results indicated significantly higher (P < 0.05) adoption rates when extension services were provided using the whole family approach (50%) compared to the simple approach (14%) after one year of both phases. Improved extension services have significantly increased (P < 0.05) the farm income of small holder dairy farmers. Overall there was about $US100/month increase in the income of small holder dairy farmer. In conclusion, this study indicates that improved extension services have a significant impact on adoption rates resulting in an increase in farm economics of small holder farmers. The data generated from this study will be helpful to devise better strategies for improved extension services in order to optimize the dairy production of small holder farmers and will have a ripple effect on the others to follow.

Key words: Extension services, adoption rate, farm economics, small holder farmer, dairy

Introduction
Pakistan, like many developing countries, has an agrarian rural based economy. Livestock is a major contributor to the national (12%) and agricultural (50%) economy (Pakistan Economic Survey, 2006). The livestock sector has been recently declared as one of the fastest growing sectors and provides improved livelihoods for more than 35 million people with farmers/households deriving 30 to 40% of their income from livestock.
Milk remains the major contributor to income derived from livestock. The value of milk alone exceeds the combined value of wheat, rice, maize and sugarcane in the country. Milk is produced under different production systems namely, rural subsistence smallholding, rural market oriented smallholding, rural commercial farms and peri-urban dairying. It is estimated that around 70% of the dairy households in Pakistan still operate under conditions of subsistence by maintaining herds of three or four animals (Burki et al., 2005). The productivity of livestock is still lagging behind its potential level. In order to meet the requirements of a rapidly growing population, dairy production needs to be increased. This can be done by adopting modern techniques of dairy farming. New technologies developed by researchers are disseminated among the farmers through an effective extension program.

The role of extension has been to provide research-based education and information to the production sector. The most important management areas on a dairy farm are feeding and forages, udder health, reproduction, calf raising, and herd health (Dahl et al., 1991a). Problem solving in these areas requires a broad base of knowledge and expertise, and often the implementing agency must organize a multidisciplinary team of extension specialists or other professionals to assist producers (Dahl et al., 1991b). Services to the dairy sector are being provided by government agencies and a range of NGOs, and virtually all services providers who interact with the farmers are veterinarians or para-veterinarians who perform vaccination, treatment and A.I. Limitations in the extension service and the research/extension interface are considered to be bottlenecks in the development of the dairy sector. In particular the style of communication between farmers and extension staff, the information available to extension staff, the number of skilled extension staff and a failure to consider problems and solutions in a whole-of-farm systems context are important limitations. Thus the major objective of this study is to demonstrate the effect of improved extension services on adoption rates and farm economics of small holder dairy farmers in Pakistan.

Materials and Methods

In 2007, an Australian Centre for International Agricultural Research (ACIAR) research project LPS/2005/132 was commenced with the aim of increasing dairy production through improved extension services. Small dairy farmers having 4-10 (buffalo and/or cattle) for production were the main target group for this project. During the first phase of the project a simple approach of extension targeting male farmers was used. In 2011, ACIAR extended this research project for an additional five years. The project is currently working in five districts of Punjab (Okara, Pakpattan, Kasur, Jhelum, Bhakkar) and two districts (Thatta and Badin) of Sindh province. During this second phase of the project a whole family approach targeting all family members was utilized. A number of innovative ways of extension have been adopted including the use of video practices, demonstration plots, problem based learning, stage drama, radio and TV shows to improve the effectiveness of the program. Benchmark data were collected on whole farming systems from 228 farmers during the first phase and 292 farmers during the second phase of the project. Subsequently, at the end of every year data have been collected to monitor the impact of these initiatives on the rate on the rate of extension message adoption. In order to analyze the farm economics, data was collected from 10 primary leading farmers, two from each of our project district of Punjab annually.
The project placed emphasis on a comprehensive interdisciplinary educational program of meetings, workshops and trainings of both farmers and extension workers. Basic husbandry, nutrition, and calf management were the initial subjects addressed during both phases of the project. Adoption rates between the whole family approach and simple approach after one year of both phases were analyzed using a Chi-square test. Similarly, adoption rates of various modules at the start and after one year of project phase-II were analyzed using a Chi-square test. Comparisons of various average monthly incomes of small holder farmers were analyzed using a t-test. Statistical analysis was carried out using SPSS (Version 10.0) with P < 0.05 regarded as significant.

Results

Adoption rates (50%) were significantly higher (P < 0.05) by more than three-fold when a whole family approach was implemented compared to the simple approach (14%) after one year of both phases (Figure 1). Comparison of adoption rates of various modules (animal husbandry, basic concepts of nutrition and calf nutrition) at the start and after one year of the second phase is shown in Figure 2. Untying animals and giving free access to water together with twice daily cleaning of sheds were readily adopted, however investing in infrastructure in the form of shed construction was not as easy for farmers (Figure 2a). Offering fodder ad libitum, feeding concentrate and Improved extension services have significantly increased (P < 0.05) the farm income of small and mineral mixes were perceived as being easy and of direct benefit to productivity: in contrast feeding cotton seed cake was not (Figure 2b). Irrespective of the message for calf rearing feeding colostrum, offering concentrate and sufficient milk and water were perceived as being readily adoptable messages (Figure 2c). Overall there was about US$ 100/month increase in the income of small holder dairy farmer (Table 1).

Figure 1. The difference in adoption rates (%) of extension messages following the use of a traditional “male only” extension approach (phase 1) as compared with a whole family approach (phase 2).
Figure 2. The difference in adoption rates (%) of specific extension messages following the use of a traditional “male only” extension approach (phase 1, 2011) as compared with a whole family approach (phase 2, 2012). 2a: watering cleaning and shed construction; 2b: aspects of animal nutrition; 2c aspects of calf feeding
Table 1. Comparison of various average monthly incomes of small holder farmers

<table>
<thead>
<tr>
<th>Survey</th>
<th>No. of milking animals</th>
<th>Land (Acers)</th>
<th>Dairy income/month (Rs)</th>
<th>Crops income/month (Rs)</th>
<th>Income from other sources/month (Rs)</th>
<th>Total income/month (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>2</td>
<td>6.7</td>
<td>7161\textsuperscript{a}</td>
<td>5172\textsuperscript{a}</td>
<td>4710\textsuperscript{a}</td>
<td>17043\textsuperscript{a}</td>
</tr>
<tr>
<td>2012</td>
<td>2.2</td>
<td>6.7</td>
<td>12758\textsuperscript{b}</td>
<td>9358\textsuperscript{b}</td>
<td>5400\textsuperscript{b}</td>
<td>27516\textsuperscript{b}</td>
</tr>
</tbody>
</table>

\textsuperscript{a,b} Means with a different superscripts within a column are significantly different (\( P < 0.05 \))

**Discussion**

To our knowledge this is the first report which clearly describes the effect of improved extension services on adoption rates and farm economics of small holder farmers in Pakistan. Higher adoption rates (50%) were achieved when we introduced a whole family (male, female and children) approach compare to simple approach (14%) relative to the traditional male only approach to extension. An effective extension program with participation by the whole family is highly desirable to enhance farm productivity. Many organizations aiming at improving small holder dairying fail to appreciate this fact and ignore women and children in their training and skills development programmes. Women normally cannot leave their home and families for a few days to participate in training programmes and usually require female trainers for effective communication. Thus during the second phase of the project we arranged parallel sessions for women and children co-ordinated by women trainers. This approach, along with training of the male farmers resulted in higher adoption rates.

In order to demonstrate the role of children in rural communities this project initiated a buffalo calf raising competition among the children of farmers (10-16 years) in Pakpattan district. These results demonstrated that under field conditions the average daily buffalo calf live weight gain (431 gm/day) was comparable to many controlled studies in various leading research institutes of Pakistan (Bhatti et al., 2009; Iqbal and Iqbal, 1992). These findings clearly indicated that we can effectively enhance animal productivity through the active involvement of children in our extension program.

In the present study, adoption rates of various modules at the start and after one year of project phase-II are significantly higher. Possible reasons of high adoption rates other than the whole family approach are the implementation of the innovative ways of extension like video practices, demonstration plots, problem based learning, stage drama, radio and TV shows. Innovative methods of extension played a significant role in order to achieve higher adoption rates. While devising training programmes, one should keep in mind that “Seeing is believing” and “Farmers do not have ears, they only have eyes.”

The present study clearly demonstrated that improved extension services resulted in significantly increased farm income for small holder dairy farmers. There was an average increase of about $US100 in monthly income after one year of effective extension. Farmers were shown to have adopted basic husbandry and improved nutrition practices. Providing ad-libitum access to water and feeding resulted in the increase of approximately 1 lit/animal/day (Warriach et al., unpublished data) However, there is a need to investigate further the effects of various adoption rates on the productivity and farm economics of small holder farmers. In conclusion, these
preliminary results indicate that improved extension services have a significant impact on higher adoption rates resulting in an increase in farm incomes of small holder farmers.

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References


Dairy production and the marketing system in Thailand

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Abstract

Thai dairy farming has been carried on over 50 years and was initially run as a smallholder dairy farming system. However, more recently it has developed into a more intensive production system. Initially, crossbred Holstein Friesians cattle were raised under tropical conditions. Feeding practices using crop residues and rice straw are widely used, which affected milk production, milk quality, fertility and health. The implementation of standards at farms, milk collecting centres and factories as well as herd health and production management programs are the keys to success. The outcome of these will increase healthy dairy cattle herds, improve milk production and quality, reduce contamination by hazardous substances and then lead to safe milk consumption. The dairy farming and milk industry in Thailand is affected by the high cost of production and market competition. Improve milk quality and cost effectiveness must be considered a priority as well as the promotion of increased consumption and exportation of dairy products.

Keywords: dairy production, milk quality, dairy farming, milk marketing, Thailand

The development of dairy farming in Thailand

From the 1940s until the early 1950s, dairy farming in Thailand was considered unimportant. It was mainly represented by small scale dairy cattle producers of Indian or Pakistan origin, who lived in suburban areas of Bangkok. At this time, most dairy products were imported (mainly powdered milk) and consumption of fresh whole milk was very limited. Promotion of dairy cattle rearing was experimental and carried out by the Department of Livestock Development (DLD), the Ministry of Agriculture and Co-operatives (MOAC).

During late 1950s, groups of farmers formed dairy cooperatives in the central region of the country, such as Ratchaburi (Nong Pho) province. During the 1960s, several dairy development projects were implemented including Thai government projects and projects supported by foreign aid, such as the Thai-German Dairy Project in Chiang Mai province and the Thai Danish Dairy Project in MuakLek, Saraburi province. The later project was offered Danish cattle from His Majesty the King of Denmark to His Majesty...
the King of Thailand. In 1962, the Thai-Danish Dairy Farm was established and a demonstration dairy farm was also set up at the Royal Palace, Bangkok, which was named the Royal Chitralada Dairy Farm under the Royal Chitralada Projects. At this time, only 1-5 cows were present on each farm.

After several years of dairy promotion in various parts of the country, many problems and solutions had been identified and lessons had been learned about poor milk yield associated with lack of knowledge and technology for dairying in tropics. Problems associated with milk marketing and distribution to consumers were also identified. The milk processing industry began to develop and expand its products for drinking, using both fresh and recombined milk. In 1971, the Thai-Danish Dairy Farm was handed over to the MOAC and became the Dairy Farming Promotion Organization of Thailand (DPO). DPO and DLD have played a significant role in dairy development in Thailand along with other agencies. Their primary objectives were to strength dairy farming, introducing technology to farmers and to organize dairy cooperatives in the central region. Nong Po Dairy Cooperative in Ratchburi province was set up in 1977 and received strong support from the Thai Royal project and became the largest dairy cooperative. Other dairy cooperatives were established throughout Thailand with strong support from the government. The cooperatives engaged in activities such as the operation of milk collection centres, the processing and sale milk to other processors, the operation of feed mills, the purchase equipment used in farming, the provision of extension services and education to farmers and the facilitation of Bank loans.

The infrastructure associated with dairy development was increasingly supported by both the government and the private sector. However, marketing of fresh milk remained a problem for dairy farmers, as dairying expanded to all regions of the country. Fresh milk still faced competition from recombined milk, which used imported powdered milk. The dairy business in Thailand dramatically increased in early 1980s until 1990s and local milk production increased with consumer demand for drinking milk. Imports of powdered milk also increased during this period (Chantalakhana and Skunmun, 2001). Competition among dairy producers is an important issue of concern for farmers and producers, particularly small holder dairy farms, cooperatives and dairy plants. Food producers should focus on branding as well as food quality and safety. Better raw milk quality, large-scale transport and more efficient logistics would improve the competitiveness of the business and better incomes would lead to a sustainable dairy industry in Thailand (Aiumlamai et al., 2006; Parinyasutinun et al., 2009).

**Dairy cattle population and production**

In 2011, the number of dairy cattle, milking cows, and farmers in Thailand were estimated at 560,659 head, 243,089 head which were replacement heifers, reaching 45% on most farms. A total of 20,645 farms located in 4 regions were recorded, although 60% occurred in the central part of the country. The number of dairy cattle and the total milk production are shown in Table 1 (www.oae.go.th, 2011). As dairy farming has been supported and promoted by Thai government for the past many decades, the number of farms, number of dairy cattle, and the total amount of milk production has gradually increased and dairy farms have been dispersed throughout of country. From 2001 to 2010, the number of dairy cattle and the total amount of milk
production has increased by 4.26% and 5.37%, respectively. Most dairy farms in Thailand are smallholders with an average of 28 dairy cattle and 12 milking cows (www.dld.go.th, 2012).

Table 1. Number of dairy cattle and milk production in Thailand, 2001 – 2010

<table>
<thead>
<tr>
<th>Year</th>
<th>Dairy cattle (000 head) (%) Change</th>
<th>Milk production (000 tons) (%) Change</th>
</tr>
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<tbody>
<tr>
<td>2001</td>
<td>365</td>
<td>588</td>
</tr>
<tr>
<td>2002</td>
<td>377</td>
<td>660</td>
</tr>
<tr>
<td>2003</td>
<td>393</td>
<td>732</td>
</tr>
<tr>
<td>2004</td>
<td>445</td>
<td>843</td>
</tr>
<tr>
<td>2005</td>
<td>497</td>
<td>888</td>
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<tr>
<td>2006</td>
<td>522</td>
<td>803</td>
</tr>
<tr>
<td>2007</td>
<td>495</td>
<td>729</td>
</tr>
<tr>
<td>2008</td>
<td>494</td>
<td>786</td>
</tr>
<tr>
<td>2009</td>
<td>495</td>
<td>841</td>
</tr>
<tr>
<td>2010</td>
<td>525</td>
<td>914</td>
</tr>
</tbody>
</table>

Source: The Office of Agricultural Economics, 2011.

About 90% can be classified as small holder dairy farms with mixed crop-livestock farming systems in most areas. Many dairy farms have recently expanded to intensive dairy farming systems with more than 50 dairy cattle and 20-30 milking cows in each farm.

The tropical Holstein breed

Almost all Thai dairy cows are crossbreds between Holstein Friesian and Zebu breeds (Sahiwal, Red Sindhi or Native Zebu). At present, most of these animals are of a F3 or F4 of Holstein blood line more than 87.5% which were called the Tropical Holstein breed. This crossbreed accounts for up to 80% of the dairy cattle in Thailand. Genetic evaluation of dairy cows has been carried out by DLD and DPO to estimate breeding values (progeny test) associated with the master bull programme (DLD, 2010; DPO, 2010). The Thai-Tropical Holstein breed has been selected for genetic potential related to optimal dairy production, long life in a tropical environment, trouble free health and maximum profit. The average milk production from DLD Sire Summary 2010, was 3,851±1,050 kg/lactation (305 days of lactation) with percentages of fat and protein at 3.60± 0.69 and 3.14±0.44, respectively, while the average age of first calving was 32.4±6.0 months. During the past 10 years, Thailand has continuously exported dairy cattle to other ASEAN countries, such as Vietnam, Malaysia, Philippines and Myanmar.

Extension services: Artificial insemination and health care

The AI service uses frozen semen from tested bulls and proven sires from DLD and DPO. They import pure bred frozen semen of pedigree bulls from many countries, such as the USA, Canada, Australia, New Zealand, and Japan, which is offered to farmers. Health care services have been provided by veterinarians and para-veterinarians under DLD, DPO, the various co-operatives, the Veterinary Teaching Hospital, and the private sector. The reproductive performance of dairy cattle in Thailand was lower than that targeted for dairy cattle in general, as days open and conception rates were 140-200 days and 20-60%, respectively. Several factors affect fertility in dairy cattle in Thailand including; nutrition deficiency, improper feeding management, reproductive disease, heat stress,
inappropriate artificial insemination and herd health services. Studies have shown that during the hot and humid season, in which the temperature and humidity index (THI) was higher than 75, that the conception rate significantly decreased. In addition, the presence of brucellosis, leptospirosis, ureaplasmosis, IBR, BVD, and neosporosis in dairy cattle has reported in several studies in Thailand as well as blood parasites, which affects health and production.

The goal of the National Diseases Control Program, which is under DLD regulation, requires that all cattle be free of brucellosis, tuberculosis and para-tuberculosis and testing be done at least once a year. The vaccination program for foot and mouth disease (FMD) and haemorrhagic septicaemia have been regularly provided to dairy farmers, given at least twice a year and once a year, respectively. In the bull centres, the Disease Control Program is performed under the recommendation of the O.I.E. Bulls are tested regularly for infectious diseases and diseases transmitted via semen and bulls have to be free of brucellosis, leptospirosis, tuberculosis, paratuberculosis, infectious bovine rhinotraceitis, bovine viral diarrhoea, campylobacteriosis, trichomoniasis, mycoplasmosis, and ureaplasmosis.

Feeds and feeding management

Feeding practices in Thailand in smallholder farmers are simple and depend on available of forage in different seasons. Two major types of feed are roughage and concentrate. Due to some limitations, few farmers grow forage crops for their cattle. Common forages are Mauritius, Ruzi grass, Guinea grass, and Napier grass. Contrarily, the large portion of dairy farmers harvest grass from public places or purchase agricultural by-products, such as baby corn stalks, baby corn peel, sweet corn stalks, sweet corn peel, sugarcane tops, and rice straws. Rice straws are fed to dairy cattle in areas with water shortages, where grass cultivation is less practicable. Dairy farmers usually purchase concentrate from private companies or dairy cooperatives but some make their own concentrate using available feed components from the area. Basically, the components of concentrate are rice bran, corn, cassava chips, brewery meal, and soybean meal. In general, milking cows are usually fed with concentrate two times daily around milking time.

Shortages of fresh roughage during the dry season commonly occur and rice straw is commonly used 6-8 month per year in many regions. Supplements of concentrate are offered to most dairy farms separate from roughage and as a result the concentrate to roughage ratio is often too high. Performance of cows in milk production, milk quality, reproduction and growth are directly related to feeding practices and nutrition. Limited food supply and quality leads to problems in feeding management and about 60-70% of the cost of dairy farming is feed. Unfortunately, few studies have been done on metabolic profiles that monitor subclinical ketosis (negative energy balance) and subclinical acidosis (Aiumlamai, S. 2005; Aiumlamai, 2010).

Milk quality and food safety

The National Bureau of Agricultural Commodity and Food Standards (TACFS) established the Thai Agricultural Standard on Good Agricultural Practices (GAP) for dairy cattle farming as a guide for operators on how to maintain efficient and hygienic
practices to keep healthy dairy cattle and avoid contamination by hazardous substances. This should produce raw milk that is safe for further processing and the creation of products for consumption. This GAP standard for dairy cattle farming was introduced in 1999 and was voluntary (TACFS, 2009). Good Manufacturing Practice (GMP) was also introduced to the milk collecting centers of co-operatives for food safety purposes in 2005 (TACFS, 2005). At dairy processing factories, dairy products have been certified by Food and Drug Administration (FDA) since 1979. The Department of Livestock Development (DLD) used bulk milk sample analyses to monitor milk quality and composition at the farm level, with an emphasized in mastitis control using incentive pricing since 2001.

In 2010, bulk tank milk from dairy cooperatives was sampled by DLD and found that milk from 42% of dairy farms contained average somatic cell counts (SCC) higher than 500,000 cells/ml. The examination of milk components showed that in 20% of the farms, average of fat and protein contents that were less than standard, 3.2% and 2.8%, respectively and also an average total solids percentage was less than 12.0% in 50% of the farms. Over 90% of dairy farms used milking machines, which were mostly the bucket type (about 90%). The pipeline milking system is slowly increasing in popularity with no automatic milking systems used at the moment. Quality and production of milk are the main targets for farmers in Thailand, but are affected by a major mastitis problem.

**Mastitis**

Mastitis is still recognized as the most important problem in dairy farming in Thailand. Several studies were conducted in Thailand, *Staphylococcus aureus, Streptococcus agalactiae,* coliforms, environmental streptococci and coagulase negative staphylococci (*Streptococcus uberis*) were reported as microorganisms causing clinical and subclinical mastitis. (Aimumlamai et al., 2000; Aimumlamai, 2011). Data from the university animal hospital indicated that mastitis was the most prevalent disease (26.2%) in dairy cows in the Mae-on district, Chiang Mai province. In 2011, a survey aiming to determine mastitis pathogens in dairy farms was undertaken in Sansai district, Chiang Mai province (Dairy Clinic, Department of Food Animal Clinic, Faculty of Veterinary Medicine, Chiang Mai University). The data indicated the following rates of infection: coagulase-negative staphylococci (31.2%), *Streptococcus uberis* (20.8%), *Streptococcus agalactiae* (11%), and *Corynebacterium spp.* (11%) in cows with subclinical mastitis. Antimicrobial susceptibility of mastitis pathogens from subclinical mastitis on dairy farms in Sansai district was tested. Antimicrobial susceptibility tests showed that subclinical mastitis caused by CNS were most sensitive to amoxicillin+clavulanic acid, enrofloxacin, gentamicin, trimethoprim+sulfonamide, and cefotaxime. *Streptococcus uberis* and *Streptococcus agalactiae* were most sensitive to amoxicillin, amoxicillin+clavulanic acid, enrofloxacin, and cefotaxime. Furthermore, subclinical mastitis caused by *Staphylococcus aureus* was most sensitive to amoxicillin+clavulanic acid and streptomycin, but all were resistant to amoxicillin, gentamicin, oxytetracycline and trimethoprim+sulfonamide.

Factors affected milk quality and quantity in Thailand were studied in the central region of Thailand (Rhone et al., 2007). Results of this study suggested that heat and humidity stress may lower milk yield during summer and rainy seasons. Large farms had higher
somatic cell counts than small and medium sized farms. Monthly milk yield per farm per cow tended to decrease and somatic cell count tended to increase during the study period. Few studies on the effects of nutrition on mastitis have been done; however, supplementation of selenium and vitamin E had a positive effect on udder health by reducing SCC and increasing cure rates of clinical mastitis (Suwanpanya et al., 2005). These reports indicate that milk quality must be the main concern for the Thai dairy industry since it reflects farm and feeding management styles, especially in small holder dairy farms. Nutrition is also one of the main causes for lower total solid in raw milk. Milk hygiene, mastitis control program, appropriate milking machines and farm management are the main factors causing mastitis in Thailand.

**Health related problems in dairy cattle**

Information from health services in Khon Kaen dairy hospitals was been reported (Aiumlamai, 1999; Aiumlamai et al., 2006). Similar health problems in dairy cows, heifers, and calves in Mae-on district, Chiang Mai province were reported by Faculty of Veterinary Medicine, Chiang Mai University. The data from 2011 showed that mastitis (26.2%), metabolic problems (16.9%), metritis (11.7%), and lameness (10.7%) were the most common problems. For dairy heifers, other major problems included respiratory infections (32.7%), parasitic infestations (13.5%), and lameness (11.5%). Furthermore, data indicated that diarrhoea (45.7%) was the most prevalent disease in calves.

**Milk marketing in Thailand**

The Thai dairy industry plays a key role in running business both by purchasing all milk from farmers and by distributing products to the consumers. Data from DLD, DPO and Department of Co-operatives Promotion (DCP) showed that in 2009-2010, Thailand had 152 milk collection centres which included dairy cooperatives, the Cooperative Dairy Club of Thailand, farmer groups, colleges and 18 centres with processing plants. In the entire country, there were 60 pasteurized milk processing operators and 17 UHT milk processing operators.

From 2010 to 2011, the number of dairy cattle and milking cows increase by 5.90 % and 3.14 %, respectively, while the average increase for 2007 and 2011 was 3.08% and 1.60%, respectively. Table 2 shows data for dairy cattle, milk cows, milk production, milk consumption, and imported dairy products in Thailand during 2007 to 2011. The predicted values for milk production and consumption in Thailand in 2011 was 930,860 tons and 938,000 tons, respectively. The average changes from 2007 to 2011 were 6.61% and 1.70%, respectively (www.oae.go.th 2012). Although the number of dairy cattle and milking cows gradually increased, milk production has not met consumer demand in the country. Consequently, Thailand has to import milk products, especially milk powder, from others countries, including New Zealand, Australia, USA, Netherland, France, Czech Republic, Ireland, Canada, and Germany. Thailand has imported dairy products worth more than 15,000 million baht each year, except in 2009, and the average increase from 2007 to 2011 was 6.60%. However, Thailand also exports milk products, such as sweetened condensed milk, sterilized drinking milk and evaporated milk, to neighbouring countries, mainly Malaysia, Singapore, Cambodia, Indonesia, Laos, Philippines, and Myanmar.
Table 2. Data for dairy cattle, milk cows, milk production, milk consumption, and imported dairy products in Thailand.

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011*</th>
<th>Average change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy cattle (heads)</td>
<td>492,304</td>
<td>490,938</td>
<td>492,560</td>
<td>523,770</td>
<td>554,668</td>
<td>3.1</td>
</tr>
<tr>
<td>Milking cows (heads)</td>
<td>291,965</td>
<td>290,683</td>
<td>293,287</td>
<td>301,071</td>
<td>310,522</td>
<td>1.6</td>
</tr>
<tr>
<td>Milk production (tons)</td>
<td>729,098</td>
<td>786,186</td>
<td>840,691</td>
<td>914,388</td>
<td>930,860</td>
<td>6.6</td>
</tr>
<tr>
<td>Milk consumption (tons)</td>
<td>917,360</td>
<td>825,624</td>
<td>912,500</td>
<td>934,674</td>
<td>938,000</td>
<td>1.7</td>
</tr>
<tr>
<td>Imported dairy products (million baht)</td>
<td>16,195</td>
<td>17,898</td>
<td>9,662</td>
<td>15,390</td>
<td>15,795</td>
<td>6.6</td>
</tr>
</tbody>
</table>

Note: * predicted values
Source: The Office of Agricultural Economics, 2012

Milk and related dairy production plays an important role in improving farmers’ income, the national economy, and nutrition for public health. The amount of raw milk produced in Thailand is inadequate and does not meet the demand of domestic consumption. Although the government has a dairy extension program to help expand dairy farming, the amount of imported milk powder and milk products has increased year by year to keep up with demand. As a whole, the market size for drinking milk products in Thailand for 2011 was 1,068.9 million liters in which 655.4 million liters was sold in commercial markets and 413.5 million liters (about 38% of raw milk) was used in school milk programs. Milk products increased 0.36% from 2010. Growth of milk consumption during the 5 year span of 2006-2010 averaged 2.32%. Growth slowed for a short period in 2008 due to food safety concerns in the Asian market, i.e. the melamine scandal in China and falling demand for flavoured milk. During the flood at the end of 2011, at least 3 factories producing UHT were flooded and some of them took more than 6 months to repair equipment and return to full production. Raw milk from cooperatives, which had a MOU with these companies could deliver to other companies. All of the raw milk produced could not processed by the remaining milk factories, during the flood and for some months later.

Farmer milk prices and factory prices

The food chain in milk production in Thailand was set up under DLD regulation. The pricing system for milk at dairy factories is determined by % fat, % protein, % SNF, % TS, Freezing pt., MB, SPC, LPC, coliform count, somatic cell count (SCC) and antibiotic concentrations (Devotest) as outlined by TACFS. At dairy cooperatives and milk collection centres (bulk tank milk) price was established by MB, antibiotics, % fat, and a few coops added SCC and certified farm standards by DLD. In 2009, TAFCS suggested raw milk standards as following: milk composition: protein, solid not fat and total solid must not be less than 2.8%, 8.25% and 12%, respectively. Cleanliness and contaminations, freezing point is (-0.520)°C – (-0.525)°C, specific gravity at 20°C is 1.028, time period of colour change of methylene blue over 4 hours or resazaurin test at 1 hour less than 4.5. Total bacterial count, coliform count, thermophilic bacterial count and somatic cell count must not more than 400,000 cfu/ml, 10,000 cfu/ml, 1,000 cfu/ml and 500,000 cell/ml, respectively. Antibiotic testing by the Delvo test or equivalent must be negative.
Raw milk price and imported milk powder have affected the dairy industry in Thailand. The farm price is set by the milk collection centres, which belong to the cooperatives, state enterprise and private sector. Farmers may get 1-1.5 baht per kilogram lower than the factory price, which depends on milk quality such as percentage of fat, bacterial concentration, farm inspection, farm certification. Factory prices are set by the Thai Milk Board with government cabinet approval. The price of raw milk changed to 12.5 baht /kilo in 1998, and increased more than 30% within 15 months from 13.75 baht to 18.00 baht during 2007 and 2008 and subsequently decreased 8.33% from 18.0 baht to 16.50 baht within 6 months. The government supported the farmers but the price went downed to 17.00 baht per kilogram in 2010 and it increased to 18.0 baht again in 2011. Prices increase and decrease depending on milk quality. On average, the consumption per capita in Thailand is 14 kg per year in 2011 and Thais are drinking more and more dairy products as seen by the growth in per capita consumption (www.oae.go.th, 2012). Dairy products were represented around 33% in traditional trade, 41% in super/hypermarket trade and 26% in convenience store trade (AC Nielsen Retail Index 2008).

**The school milk program in Thailand**

The school milk program was launched in 1994 to improve children's health in school children living outside urban areas. Approximately 38% of the milk used in school milk was pasteurized or UHT products. The children 4-6 years old from kindergarten receive 200 cc of pasteurized or UHT milk during each school day over 120 days per year. In 2003, children in kindergarten and primary school up to 4th grade, (4-10 years old-5,961,373 persons) received free milk 230 days a year with the total budget of 6,819.03 million baht. All children from grade 4 to 6 (4-12 year olds-7,953,635 persons) receive free milk 260 days/year in 2011. Pasteurized and UHT milk consumed was around 413.5 million litters costing 14,475 million baht was used in school milk program. Students can get milk during the school about 200 days/year and they can take it home for 60 days, during the vacation between the semesters.

The objective of this project was to make Thai children healthy and intelligent, increase average weight gain and height, and to support Thai dairy farmers by make use of milk in the country. The drive to increase the number of days to provide milk to the children and the number of classes receiving milk happened when farmers and the cooperatives had surplus raw milk. Raw milk must be used in school milk program because the government only allowed factories that bought raw milk from the cooperatives and had a MOU with the cooperatives to provide milk to this program. The number of children that they could sell to depended on the MOU and the committee of the school milk program.

**Opportunities for the Thai dairy industry and ASEAN**

Government regulators (MOAC, DLD, DPO, DCP and FDA) and Milk Board of Thailand play important roles in increasing production and quality of milk in the country. Meanwhile increased competitiveness among manufacturers and increased trading arrangements represent marketing opportunities for the future. Government policies support the development of dairy farming and industry in Thailand and the policies that have been implemented have had positive impacts on dairy production. MOAC strongly
supported dairy farming and business, while DLD, DPO and DCP provided dairy training, education, health services, diseases control, progeny testing for proven sires, feed mills as well as Bank loans to dairy co-operatives. Most farmers receive credit from the Bank of Agriculture and Agricultural Co-operatives (BAAC) and commercial banks. In 1985, the Ministry of Commerce developed regulations on dairy manufacturing related to the ratio of fresh milk to recombined milk and skimmed powered milk. The school milk program launched in 1994 increased the consumption. The Thai government established the Dairy Board in 2008 which consisted of representatives from government, factories, advisors and farmers. This resulted in a focus on raw milk management, the school milk program and quotas and tariffs on imported milk products.

Knowledge management and the continuing education for farmers and dairy extensions are very important and have to be supported both by government and the academic community. Increased feed production and development of feed conservation have to be considered to maintain adequate feed which leads to improve milk quantity and quality. Farmers need to act as managers and consider farm profit and cost effectiveness in relation to milk quality and production. Therefore, the productivity of dairy farming in Thailand needs to be improved and herd health and production management programs might be a tool to succeed. Medium and large scale dairy farms will give better profits and seem to be the future of dairy farming industry in Thailand. Pricing systems need to be revised as they have important impacts on milk production, quality and image. Increasing consumption of drinking milk and exportation of dairy products also need to be considered.

The development of tropical breeds and the quality of milk products in Thailand have clearly shown that there is considerable potential for the dairy industry, which has sustained milk product exports to ASEAN countries over numerous years. Considerable experience and knowledge related to dairy farming and milk processing under tropical conditions has also been attained. Therefore, we would like conclude that the dairy industry in Thailand could be a source of food security for the region and a primary source of knowledge for other ASEAN countries developing their own dairy industries.

References


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Indonesia’s dairy industry in 2020: An initiative towards 50% self sufficiency

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Abstract

The Government of Indonesia (GOI) has been very proactive over the last couple of decades in developing the republic’s milk industries. For example, back in the 1980s, government intervention included the mandatory inclusion of small holder dairy farmers and milk cooperatives, which contributed to the current structure of the industry. In order to achieve the national objective in providing at least 50% domestic milk production by 2020, improvements are required in many important components of dairy farming such as breeding, feeds and feeding, husbandry management, diseases control, as well as marketing. Presently, Indonesia's milk demand is 75% fulfilled by imported milk and milk products accounting for USD 700 million per year with only 25% coming from domestic supplies. Expanding domestic milk production, therefore, has become one of national immediate objectives to substitute for imported milk. However, the dairy industry has yet to become an economically predominant industry, and it is still playing a role as just one component of the livestock subsector. This review describes the diversity of approaches required for Indonesia to achieve its somewhat optimistic domestic dairy production targets.

Introduction

The Government of Indonesia (GOI) has been very proactive over the last couple of decades in developing the republic’s milk industries. For example, back in the 1980s, government intervention included the mandatory inclusion of small holder dairy (SHD) farmers and milk cooperatives, which contributed to the current structure of the industry. This structure identifies that there are many farmers who rely on dairy farming for their income. On the other hand, milk processors have enjoyed government protection. The reasons being, that the need for developing a national milk industry was not only due to economic reasons, but also to provide domestic sources of animal protein, to improve farm income, and to create job opportunities. The industry is still dominated by small farmers, where income distribution and job creation can directly influence the backward and forward linkages with other industries. Naturally, the dairy industry has high multiple impacts with other industry in which milk is a raw material (Soedjana and Priyanti, 2003).
Domestic fresh milk production grew significantly during the period of 1980-2001 at an average of 8.2% per year. This was due mainly to the protection and support offered to the milk industry through the implementation of several government policies. During this period, the population of dairy cattle had increased from 103,000 heads in 1980 to 354,000 heads in 2000, an annual growth rate of 5.6%. This dramatic increase in the population of dairy cattle was due mainly to a special credit program for imported dairy cows, and the Presidential Support Program which distributed dairy cattle to small-scale farmers. In the period of 2007-2009, annual increases in the gross domestic income from livestock subsector reached 3.1% and the absorption of the labor force increased by 3.8%. Improvements in dairy production before 1998 relied on government policy and intervention, product marketing, import policy, and milk processing plants having to absorb domestic fresh milk production as one of the conditions to be met prior to executing any dairy importations (Soedjana and Priyanti, 2003).

During the reformation era following the Asian Financial Crisis, agreements with the International Monetary Fund (IMF) caused traditional dairy farmers to be on their own and directly "face-to-face" with more advanced dairy industries in the international markets. Presently, Indonesia’s milk demand is 75% fulfilled by imported milk and milk products accounting for USD 700 million per year. Expanding domestic milk production, therefore, has become one of national immediate objectives to substitute for imported milk. At the same time, milk and milk products exports are promoted as the industry reaches competitive prices in the international market. However, the dairy industry has yet to become an economically predominant industry, and it is still playing a role as just one component of the livestock subsector. Presently annual per capita domestic milk consumption is considered low (11.1 kg) compared to those in the neighbouring countries such as in the Philippines (20 kg), Malaysia (23 kg), Thailand (25 kg), Singapore (32 kg) and India (75 kg). Indonesia provides for its domestic consumption through annual imports amounting to 1.64 million t of milk raw materials, mainly from Australia and New Zealand, which account for about 70% of the total domestic consumption (Anon, 2011).

In the spirit of self-sufficiency through increasing domestic milk production, the GOI has launched an initiative to produce at least 50 percent of the national consumption from domestic supplies by 2020. The year 2020 was considered realistic, since it is believed that during this time, Indonesia’s human resources will be developing accordingly, while the country’s natural resources should support all the necessary inputs. There is also an expectation during this period that more extensive implementation of free trade will stimulate domestic production. In other words by 2020, eight years from now, the global free market should ensure good progress toward self-sufficiency in milk consumption and, at the same time, Indonesia should improve its domestic dairy industry performance. This time span is really challenging for the industry to accelerate its milk production and cows’ productivity along with progressing increases in household incomes, to stimulate the potential demand for milk and milk products.
Current standing

The most recent livestock statistics and livestock census (Anon, 2011) indicates that by 2010 dairy cattle population reached 597,213 heads, which is considerably small compared to the total human population. Most of the dairy stock (99.2%) are found on the island of Java among 192,160 farm households, with average farm size of 3-4 heads per household with average daily milk production around 11.5 L/head of milking cow. Of these households engaged in dairy farming, 183,189 were involved in dairy husbandry, 7,986 households dealt with breeding while 985 households were dairy cattle traders.

In 2011, dairy cattle population were spreaded over East Java (49.6%), Central Java (25.1%), and West Java (23.4%), with a total of 592,520 head (99.2%) found on Java Island. The rest of the stock were located on Sumatera (2,383 head or 0.4%), on Bali and Nusatenggara (189 head or 0.03%), on Kalimantan (363 head or 0.1%), and on Sulawesi (1,741 heads or 0.3%). This population can also be further broken down into sex (21.1% male and 78.9% females) and physiological status of the animals, namely steers (9.4%), female calves (12.4%), young male (8.4%), heifers (15.6%), bulls (3.3%), and cows (51.0%).

The main production areas on the island of Java are represented by the district of Pangalengan and Lembang in West Java, Boyolali in Central Java, and Pujon in East Java. These production areas contribute to the total domestic milk production of 775,780 t (20%) compared to the total domestic demand of 3,946,460 t, which leaves the consumption gap of imported milk to 3,170,680 t (80%), a considerable amount of imported volume. Value of milk imports has increased from USD 637 million in 2007 to USD 665 million in 2008, USD 570 million in 2009, USD 815 million in 2010, and USD 658 million in 2011 (Anon, 2011), or on the average of USD 700 million per year during the last two years.

With the average daily milk production of 11.5 L/head and an average lactation length of 271 days, average production is 3,139 L per lactation. Current annual national per capita milk consumption is 11.1 kg fresh milk equivalent, which is far below those observed in Malaysia, Thailand, Singapore and the Phillipines which have reached more than 20 kg. This may be related to the low daily milk production and poor herd replacement of milking cows. Furthermore, farmers receive poor price incentives to produce more volume and also good quality milk, such as reducing the total plate counts (TPC) to below 1 million. In addition, many farmers are reluctant to keep their calves, with import costs for replacement stock being relatively high. Furthermore, Achjadi (2012) found that reproduction diseases such as brucellosis, IBR and BVD lead to low calf crops, while mastitis reduces milk quality. Since the average farm size is only 3-4 heads per farmer, farm record keeping is negligible, so there is slow pogress in quality improvement, making it difficult to fund additional capital expenditure, leading to inefficient production practices and low farm income.

Moreover, the scarcity of land availability on Java, where most of the dairy cattle are located, has limited the supplies of dairy cattle forages, and unfortunately very few dairy stakeholders are yet willing to invest in dairy businesses outside Java. Establishing new dairy rearing business units can be one of the answers to this problem.
The domestic milk production has long been influenced by farm size, farmer's knowledge and technical know-how, cost of concentrate feeds and fresh farm milk price, which most of the time is not attractive when compared to the cost of producing milk on SHD farms. This unbalanced revenue-cost for producing milk results in stagnant production and disincentives for expansion.

The production potential of individual cows can still be improved, as indicated by the district ranges in current average milk yields, lactation lengths and entire lactation yields, which were respectively 9.0 L/d, 277 days and 2423 L in Central Java, 11.4 L/d, 270 days and 3103 L in East Java and 13.9 L/d, 268 days and 3847 L in West Java. West Java is then the the most productive area, producing 58% more milk per cow per lactation than in Central Java. Overall improvements are then a real challenge to be resolved by the year 2020 if productivity is to reach the 15 L/cow/d target which is one of the many requisites for Indonesia to be able to substitute 50% of its milk import volumes.

In terms of the need for farmers institution and capacity building, Indonesia has established dairy cooperatives throughout the dairy regions in Java. The primary cooperative are coordinated through the Regional branch offices, and at the national level, these regional offices are coordinated by the National Union of Dairy Cooperative (GKSI). GKSI then coordinates 95 primary cooperatives through regional offices in West Java (22), Central Java (23) and East Java (50). Presently there are 127,000 farmer members and 1,500 dairy farmer groups who manage some 375,000 stock producing a total 1.5 to 1.6 million L/d (GKSI, 2012). GKSI has 351 cooling units, 375 transfer tanks, 450 operational marketing vehicles, 85 feed and concentrate factories, and 3 milk processing plants. The processing plants are ISAM in West Java (with a production capacity of 100 t/d), in Boyolali, Central Java (200 t/d), and Sekar Tanjung in East Java (250 t/d). Moreover, farmer members of GKSI can produce some 140,000 calves annually (Anon, 2012c).

GKSI (2008) fully supports the government initiative towards its 50% self-sufficiency target by 2020, and this is documented in its "100-100-1000-10,000 concept", which is described below. The union owns all the potential resources to support this self-sufficiency initiative. In return, GKSI expects the government to provide supports in terms of inter-ministry policy for the development of dairy farming, as well as policy on land procurement for forage production, concentrate feed production, breeding and credit schemes.

**Plan of action**

GOI is very enthusiastic to achieve the 50% self-sufficiency status by 2020. This effort of course, has to be done through improvement in many areas of dairy husbandry since 2011, into the near future in 2015 and by 2020. Therefore, it is important to focus on the following prioritised missions at the national level, namely:

- campaigning to drink fresh milk
- improving hygiene milk handling and good production practices
- mandatory implementation of the National Standards (SNI) on fresh milk from 12 percent to 20 percent participation of dairy farmers (Anon, 2012b)
- controlling reproductive diseases, including zoonosis
optimising application of artificial insemination (AI) and embryo transfer (ET)
• improving forage production and feed concentrates
• reducing calf mortality
• extending dairy production areas
• promoting village breeding centers
• increasing farm sizes
• improving farmers’ institution (Anon, 2012b).

The GKSI (2008) “100-100-1,000-10,000 concept” towards 50% self-sufficiency is to:
• provide 100 hectares of land
• to support an additional 100 dairy farmers
• with a total of 1,000 head of milking cows
• which will produce 10,000 kg of milk per day.

Other products arising from the GKSI (2008) document include:
• 1,000 calves per year with 10% mortality rate
• 20 tons of organic fertiliser per day
• biogas production, equivalent to 2.5 liters of kerosene for every 3 head of dairy cows
• additional proposed areas of land can be identified at a location close by the current production areas where the government can take action in the relocation process
• these areas will be managed by the dairy cooperative with relevant and capable personnels in terms of technical, extension services, milk collection, and spatial management.
• the cooperative will contribute in terms of farmer participation, provision dairy cows, and milking equipment
• the use of the proposed land area will be through concession agreements
• the land will be equipped with facilities and infrastructure from the the central and local government.

Major action plans which are within the agenda of the Directorate General of Livestock and Animal Health Services (DGLAHS) (Anon, 2012a) include improvement of breeding animals via:
• accelerating the provision of breeding cows via increased production of frozen semen and embryo through
  o intensifying the application of artificial insemination and embryo transfer
  o optimising the role of technical units owned by both central and local government
  o strengthening the role of dairy farmer groups
  o strengthening financial capital for dairy business
• zoning of dairy breeding stock and improving genetic quality through
  o government support on zone development
  o utilization and maintenance of animal genetic resources
  o performance tests
  o partnerships in research and technology development
• application of standard quality of semen and breeding animals through
  o certification, regulation and supervising breeding practices
• investments, credit scheme for breeding purposes.
To achieve the national 50% self-sufficiency goal by 2020, improvements are required in many important components of dairy farming, such as:

- breeding stock
- feeds and feeding
- husbandry management
- diseases control
- marketing.

Following the human population projection which will increase from 240.33 million in 2011 to 254.98 million in 2015, and 274.55 million in 2020, DGLAHS has targeted the ratio of domestic milk production to milk imports to be progressively improved from 20:80 in 2011 to 35:65 in 2015, and 54:46 in 2020. The domestic demand for milk is expected to increase from 3.9 thousand t in 2011 to 4.3 thousand t in 2015, and 5.1 thousand t in 2020. Therefore, domestic milk production will need to be increased up to 1.5 thousand t in 2015 and 2.8 thousand t in 2020.

Consequently, additional number of the dairy cows are required from currently at 110,090 head (2011), to 195,680 head in 2015 and 359,810 head in 2020. Eventually, there is a need to increase the total dairy cattle population from 597,213 head in 2011 to 968,380 head in 2015, and 1,780,590 head by 2020 (Anon, 2012a). In addition, the dairy cattle population must be increased by 9% per year to 697,500 head by 2014. Target improvements in daily milk yields are from the current 10 L/cow/d to 15 L/cow/d, with herd sizes upscaled to 7-10 head/farm (Anon, 2012b).

Concluding remarks

The initiative towards 50% self-sufficiency in milk production by 2020, is indeed not an easy task for all the stakeholders of the dairy industry. Eight years is not long enough to significantly improve domestic milk production from the current 20% to 50% of the total consumption. It is more a challenge than opportunity.

Complementing the above efforts towards 50% self-sufficiency, the following action plans are considered necessary:

- Encouraging national government agencies to conduct an integrated promotion towards fresh milk consumption
- Helping dairy industry to push the application of Fresh Milk Scheme Distribution
- Building effective partnerships with local government institutions through the Ministry of Home Affairs to encourage the development of integrated dairy farms outside Java
- Encouraging local governments to revitalise the dairy farm businesses that already exist
- Encouraging local governments to provide a larger budget to develop the dairy farm businesses
- Fighting for a non-conventional sources of funding for the dairy farm business
- Fighting for credit schemes with term loan programs and interest rates that are feasible for dairy farm businesses
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Smallholder dairy development in Asia and the Pacific

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Introduction

Consumption of milk and milk products has grown rapidly in Asia and the Pacific region, making it the strongest growing region for dairy product consumption during the last three decades. Asian consumers have generated nearly half of the global dairy product demand over the past three decades. While production has responded to growing demand, it has still fallen short of consumption gains. Consequently, net imports of milk and milk products in the region are up 3-fold over this period. (Table 1). Recent OECD-FAO Agricultural Outlook estimates that the demand for milk and milk products in the region will touch almost 320 million tonnes by the year 2021 (OECD-FAO, 2012). This means the region will need to increase milk availability by another 75 million tonnes within this decade and this will need to occur against the backdrop of increasing resource scarcity, rising food and feed prices and growing environmental concerns.

Two more characteristics of Asia Pacific region are of specific relevance in the context of growing demand for milk and milk products.

- First, the region is home to two thirds of the world’s poor and undernourished people and in some countries the proportion of undernourished children exceeds half the total child population. Given that milk is a good source of energy, protein, vitamins and minerals, a daily glass of milk for Asian children can significantly boost their nutritional levels.
- Second, over 80 percent of dairy animals in the region are raised by backyard or small-scale farmers who are a critical and unique ingredient in the region’s dairy landscape (Box 1).
Table 1: Production and trade of milk: Asia and the world

<table>
<thead>
<tr>
<th>Countries/regions</th>
<th>Production (million tonnes)</th>
<th>Net imports—milk equivalent (million tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Asia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>32.8</td>
<td>46.4</td>
</tr>
<tr>
<td>Pakistan</td>
<td>7.44</td>
<td>9.01</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Nepal</td>
<td>0.6</td>
<td>0.7</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>0.14</td>
<td>0.24</td>
</tr>
<tr>
<td>East and Southeast Asia</td>
<td>7.4</td>
<td>10.9</td>
</tr>
<tr>
<td>China</td>
<td>2.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Japan</td>
<td>4.76</td>
<td>6.50</td>
</tr>
<tr>
<td>South Korea</td>
<td>0.05</td>
<td>0.45</td>
</tr>
<tr>
<td>Myanmar</td>
<td>0.15</td>
<td>0.33</td>
</tr>
<tr>
<td>Indonesia</td>
<td>0.17</td>
<td>0.25</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.004</td>
<td>0.03</td>
</tr>
<tr>
<td>Vietnam</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Mongolia</td>
<td>0.22</td>
<td>0.24</td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Other global dairy producers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>53.1</td>
<td>58.2</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>7.4</td>
<td>12.1</td>
</tr>
<tr>
<td>Brazil</td>
<td>28.2</td>
<td>32.1</td>
</tr>
<tr>
<td>Germany</td>
<td>22.9</td>
<td>27.9</td>
</tr>
<tr>
<td>New Zealand</td>
<td>6.0</td>
<td>6.7</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>13.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Netherlands</td>
<td>8.2</td>
<td>11.8</td>
</tr>
<tr>
<td>Mexico</td>
<td>4.1</td>
<td>7.2</td>
</tr>
<tr>
<td>Argentina</td>
<td>4.2</td>
<td>5.3</td>
</tr>
<tr>
<td>Australia</td>
<td>7.8</td>
<td>5.6</td>
</tr>
<tr>
<td>Canada</td>
<td>8.3</td>
<td>7.4</td>
</tr>
<tr>
<td>World</td>
<td>391.8</td>
<td>465.6</td>
</tr>
</tbody>
</table>

*Figures in parentheses are percentages to total consumption.

Source: FAOSTAT
The existence of a vibrant smallholder-managed dairy sector combined with a favourable medium term market outlook is good news since the poor generally tend to be much more important in smallholder dairy production than in crop production. Furthermore, animals are typically more equitably distributed than land in many of these areas and dairying is also more labour intensive than crop production and provides a remunerative outlet for family labour. These characteristics imply that growth in smallholder dairy will have a more direct impact in poverty reduction than the same increase in crop production. Thus, if production can match the growth in demand, dairying can emerge as an engine of poverty alleviating growth with all other nutrition related benefits.

Challenges for the future

These opportunities, however, come with their share of challenges. With growing scarcity of human and natural resources in the region, the production costs and margins for milk are under tremendous pressure. Measures, both technological and institutional, to reduce cost of production must therefore become a major objective of governments wishing to promote smallholder dairy production. This will require priority action on technology development towards improving genetics and nutrition of ruminant animals in the specific context of Asian countries. Beyond production, massive investments are required in the region for setting up market infrastructure and promoting organizational platforms that can support smallholder dairy producers.

Smallholder dairy producers and other small entrepreneurs in the dairy value chain also suffer from poor access to credit and high interest rates. This discourages investment in the sector and possibly creates a non-level playing field with large producers. Furthermore, dairy production and processing often requires intermediate term credit, something the banks are generally unwilling to finance. In this context, micro-credit schemes can help facilitate technology adoption, enterprise modernization, and product quality improvements. There are also several other innovations in value chain financing that can facilitate new opportunities for value chain development (Ahuja and Staal, 2012).

While the challenges are numerous and there are no off-the-shelf technological and institutional solutions that can be applied in all different contexts, the region certainly has a number of successful models and initiatives that can serve as sources of

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**Box 1: How do smallholders feature in various countries?**

- **India**: 70 million households have dairy cattle, 52 million linked to smallholders (13 million to coops).
- **China**: 2 million dairy farms in 2005 with farms < 20 cows accounting for 65% of milk production.
- **Philippines**: 13,077 families engaged in smallholder dairy with employment of 17,020.
- **Pakistan**: 55 million smallholders
- **Mongolia**: 2 million farmers in 2006 (80% hold dairy cattle).
- **Sri Lanka**: 70% of 3.5 million smallholder own dairy cows.
- **Bangladesh**: 80 million households are smallholder dairy farmers.

Source: FAO RAP publication 2008/10
lessons for formulating future strategies and programmes for dairy development. To capitalize on those experiences and to generate guidance on good practices for smallholder dairy sector in Asia, the Animal Production and Health Commission of Asia and the Pacific (APHCA), the Food and Agriculture Organization of the United Nations (FAO), and the Common Fund for Commodities (CFC), initiated a comprehensive process of stakeholder consultation to distill lessons from Asian experiences and to outline elements of a strategy for future development. This involved meetings and workshops with participants from over 17 counties representing national government agencies, cooperative societies, dairy industry groups, independent research institutions, private companies and dairy producers. The consultative process culminated in a regional dairy strategy and investment plan for smallholder dairy development. The strategy document is available on APHCA website (www.aphca.org). Key aspects of the strategy are summarized below.

The vision and mission

The strategic vision for smallholder dairy development, as elaborated by stakeholders, is, “Asian milk for health and prosperity”. This vision rests on the mission statement to improve the competitiveness of smallholder Asian milk producers to provide more and better quality milk and dairy products for Asian consumers.

Strategic objectives

The strategic objectives, also developed by the stakeholders, are:

- A glass of Asian milk a day for every Asian child.
- Regional self-reliance and enhanced dairy food security.
- Smallholders better linked to markets and enabled to become commercial dairy entrepreneurs.
- More efficient, productive, profitable and responsible (socially and environmentally) dairy chain
- Regional and national recognition of the multiple benefits of smallholder dairy

Key strategic issues

Achievement of the above outlined strategic objectives requires addressing a wide range of issues. These were identified by the stakeholders as follows:

- develop human resources and knowledge management in the smallholder dairy sector and its supporting organizations;
- better engage the private sector in both the formal and informal sub-sectors;
- support the smallholder sector to become more productive and more profitable;
- improve the sector’s competitive position, including competitiveness in dairy product markets and competitiveness for factors of production;
- position smallholder dairy development as an instrument for rural poverty reduction and improved food security and nutrition;
- facilitate the creation of an enabling institutional and regulatory framework;
• improve the safety and quality of the product through a pricing system which provides strong incentives for farmers and other value chain actors to improve product quality;
• enhance market access through both formal and informal market channels and better meet consumer needs and affordability;
• finance development of the sector, including investments by smallholders, small and medium enterprises, cooperatives, governments, NGOs, community organizations and corporations, as well as public investments in infrastructure and support services; and
• ensure that the dairy sector develops in a socially and environmentally responsible manner.

Strategic pillars

The Strategy addresses the challenges and objectives outlined above through strategic interventions under four mutually reinforcing pillars as prioritised and ranked during the consultative process (Figure 1).

Figure 1: The strategic pillars of smallholder dairy development in Asia
Source: Dudgill and Morgan 2008.

Pillar 1: Human resource development and knowledge management

Investing in people is essential for sustainable development. The region has considerable human resource development experience in the region, including experience with hands-on, knowledge-based, vocational training. There are also good examples of farmer-to-farmer learning. This is particularly effective for disseminating
improved technologies and promoting hygienic milk production. Taking training into the field also allows more farmers and their families, especially women, to participate.

To promote experience and information sharing across the region, the strategy proposes to establish an electronic information network. This network can serve as a repository of good practices pertaining to smallholder dairy development. There is already a wealth of information, advice and materials available and this can be channelled through this network.

**Pillar 2: Improving the productivity and competitiveness of smallholder milk producers**

With growing scarcity and completion for natural resources, smallholders must produce milk efficiently to profitably compete in a price and quality conscious market. The key constraints to improving productivity and profitability of smallholder milk production in the region are: (i) feed availability (ii) shortage of improved stock, (iii) insufficient management skills, and (iv) access to affordable credit. The challenge therefore is to invest in technology development and dissemination; and providing support to subsistence smallholder milk producers to become small commercial dairy farmers.

Various forms of collective action have long been a central mechanism for improving the market access and productivity of smallholder producers. These platforms enhance the bargaining power of small producers in the markets, create new opportunities for improving their management skills, and facilitate access to higher quality and more reliable inputs and services (Ahuja and Staal, 2012). In the context of smallholder dairy, the Asia region has rich experiences with collective models supported both by public and the private sector. In addition, the region can draw on a number of diverse and commercially competitive smallholder dairy chain models that can serve as important source of lessons in design of future programs and strategies for dairy development. A sample of such models is listed in Box 2.

**Box 2: Some of the models**

- **Philippines**: Dairy Development Zones (targeted development based on priority indicators)
- **Pakistan**: Haleeb case (private sector linkages to smallholder holders)
- **India**: Anand model (based in Gujarat), linked to Operation Flood activities
- **Thailand/Bangladesh**: strong role of cooperatives (supported by development interventions)
- **China**: Inner Mongolia/Heilongjiang—examples of third part milk collection stations; dairy barns, private sector investment linkages to smallholders.
- **Vietnam**: strong dairy development through government support (down to local levels) supported by privatization of markets
- **Mongolia**: total cow to consumer approach; strong socio-cultural aspects, each link in dairy chain has to be sustainable and profitable; generic branding/marketing

Source: Dudgill and Morgan 2008.
Pillar 3: Strengthening the linkages between farmers and consumers to deliver a quality product at a fair price

An efficient value chain linking input and service provision to production to processing to distribution are essential for any sector or sub-sector of economy and the same is also true of smallholder dairy. Strategic public and privately financed investments are required in setting up market infrastructure that can support smallholder producers.

The region has a myriad of market and value chain arrangements for dairy, ranging from village milk vendors to traditional unorganized processors to highly sophisticated and integrated supermarkets. The emergence of supermarkets and their impact on production landscape has been a subject of intense policy debates in the region but the informal and traditional markets are largely neglected by public policy. According to some estimates, nearly 80 percent of consumers actually purchase milk and milk products in informal markets. These markets are often mediated by informal networks and are full of imperfections. Finding ways to overcome some of these imperfections can potentially stimulate investment in these markets and value chains and unlock hitherto unexploited potential for small producers. In addition to improving the bargaining power of smallholders by exploiting scale economies and improved access to information and technology, institutions such as producer cooperatives and member organizations can also be instrumental in overcoming some of these market imperfections and asymmetries. But this is unlikely to happen in absence of explicit policy and investment support from Governments in which favours the strengthening of producer organizations and the provision of technical and business advisory services (Ahuja and Staal, 2012). Attention needs to be additionally placed on the strengthening of livestock services (feeding, breeding, health, management, credit etc), reputation building through labelling or branding programmes, and improving access to information with respect to pricing and product quality.

Pillar 4: Enhancing the enabling environment

There is no blueprint model to promote smallholder dairy. The approaches and interventions need to be tailored to the local context while at the same time being cautious of not promoting smallholder dairy in areas where smallholders are not competitive, where markets are not lucrative or where the enabling conditions do not favour investments in smallholder operations. The risks and opportunities (differentiated by market demand, production practices, geography, and access to markets, inputs and services) are also influenced by more macro or broader issues such as trade regulations, government agriculture and investment policies, and institutional support.

The main aims of this pillar under the strategy are to identify and promote institutions and policies that are critical to enhancing the bargaining power, market access, and incomes of small farmers. It is essential to strategically incorporate national and sub-national actions and interventions within the regional strategy. The true success indicator in this context will be explicit recognition by senior decision makers/governments of the role of smallholder dairy in agricultural development policies and programmes.
Beneficiaries

The strategy is designed with the explicit objective of transforming smallholder milk producers in rural communities. Potential direct beneficiaries include some 200 million smallholder families, or nearly one billion people. Women dairy operators play a leading role in the sector in nearly all countries in the region. Within the target group, the strategy places special emphasis on the empowerment of women by ensuring they have equal opportunities under all the strategy pillars.

The majority of the actors in smallholder dairy value chains are private entrepreneurs: milk producers, collectors, processors, service providers, finance and micro-finance institutions, regulatory institutions and industry associations etc. While the strategy is focussed on smallholder milk producers, urban consumers and specifically children will benefit through the availability of more and safer dairy products. The strategy also targets policy-makers and legislators, national dairy bodies and all the actors along the value chain, including larger scale milk producers and processors. The private sector is recognized for its crucial role in promoting productivity and market enhancing measures and hence are seen as an important partner in future operations.

Finally, it is essential that governments recognize the potential of smallholder dairy systems to reduce poverty, undernourishment, and generate economic growth. This recognition needs to translate into a long term vision for developing the sector which includes a budgeted investment plan, joining public and private financing.

In conclusion, the smallholder dairy sector in the Asia Pacific region currently offers significantly under-exploited opportunities for job creation and livelihood opportunities than are currently being realized. This regional dairy strategy provides a unique, regionally focused diagnosis of the critical needs for public goods and complementary private activities. If implemented, the strategy could become a key contributor for enhancing the livelihoods of millions of rural poor and improving nutritional status of children and future generations in the region.

References

