Agricultural wastes as dairy feed in Chiang Mai

Sompong SRUAMSIRI

Faculty of Agricultural Production, Maejo University, Chiang Mai, Thailand

ABSTRACT

Dairy farming in Chiang Mai was established in 1965 by the Thai–German Dairy Project and was subsequently taken over by Department of Livestock development in 1970. Starting from 1979, the Dairy Farming Promotion Organization of Thailand also supports the development of dairy farming in northern Thailand. However, dairy farming in Chiang Mai still faces numerous problems. At present, farm sizes are relatively medium, with an average of 23.75 cattle/farm (cows, heifers and calves). Almost all dairy farmers are member of a dairy co-operative that provides them with an artificial insemination service, supplies of concentrated feed, loans and a center for collecting milk. The average pasture area is 0.3 ha/farm. The main feed resources are green forage from the farm pasture, public areas and roadside pastures, which are abundant only in the rainy season. The farmers are forced to use crop by-products as roughage in the dry season, especially rice straw, even though its nutritive value is limited due to its low digestibility, low nitrogen and low mineral and vitamin content. To improve the nutritional value of crop by-products, physical and chemical treatments are implemented. Agro-industrial wastes such as pineapple waste, sugarcane molasses, the peel, husk or silk of sweet corn and baby corn are also used as dairy feed.

Key words: agricultural waste, agro-industrial waste, Chiang Mai, dairy co-operative, dairy farming.

INTRODUCTION

Dairy farming in Chiang Mai was established in 1965 by the Thai–German Dairy Project, which aimed to promote the development of dairy farming through extension services and a training program. The Thai–German joint venture was successful in demonstration, and extension work and operated a dairy processing plant from 1965 to 1977. After that, their activities were taken over by the Department of Livestock Development (DLD), a government agency that is in charge of livestock production. The DLD further developed dairy farming in Chiang Mai by operating regular training programs for dairy farmers, establishing milk collection centers and providing extension services such as artificial insemination (AI) services, veterinary services and consultations on dairy farm management. Since 1979 the the Dairy Farming Promotion Organization of Thailand (DPO) initiated a dairy farming program in northern Thailand. The DPO has taken responsibility for promoting dairy farming activities in Chiang Mai, focusing mostly on promoting milk processing and milk marketing. Currently, the DPO and DLD continue playing a significant role in dairy promotion, training, extension services, processing and milk marketing in northern Thailand.

CURRENT STATUS OF DAIRY FARMING IN CHIANG MAI

Although dairy farming in Chiang Mai has been established for more than 35 years and has received many supporting programs from the government, dairy farming is still not yet successful. According to Pahanit
et al. (2003), and Silman and Sruamsiri (2006), the farms are relatively medium in size, with an average number of 23.75 dairy cattle/farm. Almost all the farmers are members of dairy co-operatives, which provide an animal healthcare service, an AI service, supplies of concentrate feed, loans, and centers for collecting milk. The farmers started their farms by purchasing pregnant cows. Most of the farmers (87.30%) are male, aged 48.89 years on average and poorly educated (63.69% only completed primary school). Generally, the farm family consists of four members, of whom only two were working on the farm. They raised mostly crossbred Holstein–Friesian with an average number of cows/farm of 9.96 head, and an average milk production/day of 12.41 kg/head. The average land area used for pasture was 0.3 ha/farm and none mixed concentrate feed for their own stock. The major problems and constraint faced by dairy farmers in Chiang Mai included insufficient roughage, the high cost of concentrate feed, mastitis and a low conception rate.

Dairy farmers in Chiang Mai (Fig. 1), as in many other provinces in Thailand, face major problems in insufficient nutrient supplies for dairy cattle, such as a lack of water in the dry season, low quality roughage, insufficient sources of roughage, and a lack of knowledge of feed quality and dairy nutrient requirements (Langhans et al. 1995). Traditionally, dairy farmers feed their cattle with green forage and pasture as the principal source of roughage and supplement this with concentrate feed. The ratio of concentrate feed to milk production is 1:2–1:3 (w/w). Roughage, the main feed resource, is abundant in the rainy season but scarce in the dry season. Although silage or hay is a good source of roughage in the dry season, most farmers make no attempt to preserve roughage. However, many available forms of agricultural waste and agricultural by-products, e.g. rice straw, corn stover, soybean straw, soybean pod, soybean hull, sugarcane tops and bagasses can also be utilized as dairy feed in the dry season (Table 1). The shortage of roughage in the dry season forces farmers to use rice straw as their main cattle feed. However, the value of this feed is limited by its low voluntary intake, low digestibility and low nitrogen, mineral and vitamin content. Generally, rice straw is fed to dairy cattle and ruminant species in nearly all dairy farms, especially in the dry season when no green forage is available. Also during this period farmers have to supplement more concentrate feed to lactating animals to get enough milk, which consequently results in higher costs of feed. To improve the palatability and nutritive value of rice straw, several treatments have been widely used such as chopping and/or soaking it in water or a salt solution, which slightly increase feed intake and its digestibility. Rice straw treated chemically, particularly with ammonia using fertilizer-grade urea, is also well accepted by dairy farmers in the northern part of Thailand, especially in Chiang Mai province. Currently urea-treated rice straw is used as roughage for milking cows in some dairy farms (Promma et al. 1993). To produce urea-treated rice straw, 4–6 kg of fertilizer grade urea is measured by its air-dry weight and dissolved in 100 L of water. The solution is then poured onto the layer of rice straw before covering it in a plastic sheath for between 10 days to 4 weeks (Promma et al. 1993). Although the ammoniation of rice straw can increase animal production by increasing feed intake, protein content and digestibility, it has been confirmed that the full production potential will be achieved only when an appropriate amount of protein source is supplemented.

For farmers, in practice, untreated rice straw is used as roughage source. Many techniques have also been applied to increase the feed intake and digestibility of untreated rice straw; (i) supplementation with by-products of local crops such as rice bran (fine or coarse), corn meal or other local crop by-products; (ii) spraying the rice straw with a mixture of urea and molasses solution (1:10:10 or 1:5:7.5:10 w/w/w), which is one practical method of improving the quality of the untreated rice straw; (iii) supplementation of urea in mineral mixed blocks or salt licks; (iv)
supplementing with concentrate feed; and (v) supplementation with legume leaves such as leucaena leaves (*Leucaena leucocephala*), or supplementation with agro-industrial by-products (Cheva-Isarakul & Kanjanapruhipong 1987; Promma *et al.* 1988; Cheva-Isarakul *et al.* 2002).

**Figure 1** Factors affecting dairy production.

*Soybean straw, soybean pod and soybean hull*

Soybean is one of the major cash crops in Chiang Mai province. The harvesting time occurs in the dry season between March and May, exactly at the time when
Green forage is shortage. In the soybean field, soybean straw and soybean pods are usually left as waste when seeds are mechanically harvested and separated. Soybean straw is a major by-product, and is composed of the stems, leaves and pods. The nutritive value of soybean straw is higher than rice straw but lower than soybean pods and hull. As the average protein content in soybean straw is about 5–8% of dry matter and the digestibility of most of its nutrients is about 30–60%, it is a suitable roughage source for cattle both as fresh and ensiled material. The palatability of untreated soybean straw is low because of its relatively hard stem. One of the most practical way of utilizing soybean straw and soybean pods in dairy cattle feeding system is as a roughage source and supplemented with protein sources or feed concentrate, or used as supplemental roughage. Sanitwong et al. (1997) reported that their experiment with lactating cows showed that dry matter intake, 4% FCM (fat corrected milk) milk production and milk fat content were significantly increased when the animals were fed with soybean pod husks (soybean straw) as a supplemental roughage to rice straw. To improve the nutritive value of soybean straw and pods, treating it chemically with (fertilizer grade) urea and spraying it with a urea-molasses solution are also suggested. Siri et al. (1994) studied the protein content of rice straw when treated with urea and combined with soybean straw. The protein content of the roughage was increased in urea-treated rice straw mixed with a large amount of soybean straw. Sruamsiri et al. (1994) and Sruamsiri (1999) compared the live weight gain of dairy cattle at different physiological stages (weaning, growing and replacement heifer). When the cattle were fed on soybean straw or urea-treated soybean straw as a roughage source supplemented with concentrate feed, the live weight gain of these cattle was equal to being fed on fresh grass but better than being fed on rice straw or urea-treated rice straw supplemented with concentrate.

The soybean hull is a by-product from the soybean oil and soybean meal industry that is usually used by dairy farmers for dairy feed. It contains very little soluble carbohydrate but its crude protein content varies from 9 to 14.5% of dry matter. Its physical properties are light, flaky and bulky. The nutrients in the soybean hull are, however, highly digestible even though it contains about 50% acid detergent fiber. According to Gerngang (2003), the soybean hull consists of 88.71% dry matter and the nutrient content on a dry matter basis was 95.142% organic matter, 11.42% crude protein 3.57% ether extract, 24.75% crude fiber, 39.07% neutral detergent fiber and 27.78% acid detergent fiber. The results from nylon bag technique studies show that 9.5% of the soybean hull is soluble but the insoluble portion is easily degraded by microbial fermentation. Its potential degradation was 99.32% with 0.05 fractions per hour of rate of degradation. In practice, farmers also use soybean hull as a supplemental feed or mix it with concentrate feed.

**Corn stover, corn husk, corn cobs**

The main waste from maize production that is available for roughage source, is the corn stover (the stalk and leaves after harvesting), the corn husk, the leaves and the cobs. Currently, in maize producing areas (sweet and baby corn producing areas) the stover is usually harvested and chopped for use as roughage for dairy cattle. For dairy production, corn stover could be used as a roughage source both in its fresh and in ensiled form. Stover from baby corn production has a higher nutritive value than corn stover from sweet maize production.

### Table 1  Major feed source for dairy cattle in Chiang Mai

<table>
<thead>
<tr>
<th>Source</th>
<th>Feed source</th>
<th>Period</th>
<th>Feeding technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasture</td>
<td>Grasses, legumes</td>
<td>July–November</td>
<td>Roughage</td>
</tr>
<tr>
<td>Public area</td>
<td>Native grasses, tree and shrub legumes</td>
<td>July–November</td>
<td>Roughage</td>
</tr>
<tr>
<td>Rice field</td>
<td>Native grasses and rice stubble</td>
<td>November–May</td>
<td>Roughage</td>
</tr>
<tr>
<td>Crop residues</td>
<td>Rice straw, corn stover</td>
<td>January–December</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td></td>
<td>Soybean straw or pod husks</td>
<td>March–May</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td></td>
<td>Sugarcane tops</td>
<td>December–April</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td>Agro-industrial waste</td>
<td>Pineapple waste</td>
<td>November–April</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td></td>
<td>Vegetable soybean</td>
<td>May–September</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td></td>
<td>French beans</td>
<td>May–September</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td></td>
<td>Tomato waste</td>
<td>April–May</td>
<td>Supplemented feed</td>
</tr>
<tr>
<td></td>
<td>Corn husk, silk and peel</td>
<td>November–May</td>
<td>Roughage and supplemented roughage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Feed source</th>
<th>Period</th>
<th>Feeding technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasture</td>
<td>Grasses, legumes</td>
<td>July–November</td>
<td>Roughage</td>
</tr>
<tr>
<td>Public area</td>
<td>Native grasses, tree and shrub legumes</td>
<td>July–November</td>
<td>Roughage</td>
</tr>
<tr>
<td>Rice field</td>
<td>Native grasses and rice stubble</td>
<td>November–May</td>
<td>Roughage</td>
</tr>
<tr>
<td>Crop residues</td>
<td>Rice straw, corn stover</td>
<td>January–December</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td></td>
<td>Soybean straw or pod husks</td>
<td>March–May</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td></td>
<td>Sugarcane tops</td>
<td>December–April</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td>Agro-industrial waste</td>
<td>Pineapple waste</td>
<td>November–April</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td></td>
<td>Vegetable soybean</td>
<td>May–September</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td></td>
<td>French beans</td>
<td>May–September</td>
<td>Roughage and supplemented roughage</td>
</tr>
<tr>
<td></td>
<td>Tomato waste</td>
<td>April–May</td>
<td>Supplemented feed</td>
</tr>
<tr>
<td></td>
<td>Corn husk, silk and peel</td>
<td>November–May</td>
<td>Roughage and supplemented roughage</td>
</tr>
</tbody>
</table>
Sugarcane by-products

Normally, by-products from sugarcane plantations and the sugar industry are sugarcane tops, sugarcane leaves, bagasse and molasses. Sugarcane tops and leaves are by-products that can be used as roughage for cattle, and their nutritive values are rather higher than rice straw (Fig. 2). In Chiang Mai, sugarcane is harvested in the dry season from January to March every year. Bagasse is not commonly used as cattle feed, due to its high lignin and cellulose content. To use bagasse as roughage, chemical treatment is required to improve its nutritive value. Molasses is widely used as a supplemental feed or in silage for ruminants because it is a good source of soluble carbohydrate for rumen microbes. Research work in Thailand has shown that molasses could be used as a supplement to animal fed with crop residue base rations and mixed in concentrate feed, in a solution with urea, in a salt lick, in a urea molasses block and in a multi-nutrients block composed of urea, molasses, minerals, natural protein and vitamin (Kongngoen, Cheva-Isarakul & Chairatanayuth 1993).

Legume leaves

Interest in the use of legume leaves as a protein source in animal feed has increased greatly during recent years, particularly the utilization of leaves from trees and shrub legumes. Legume leaves are becoming a component of ruminant feed, especially as a protein supplement. In Chiang Mai there are a number of trees or shrub legumes that have the potential to be used as cattle feed, such as *Leucaena leucocephala*, *Acacia mangium* and Pigeon pea.

*Leucaena* is the most popular legume species in dairy feeding. In addition, fresh leucaena leaves can be used as a protein supplement in low quality roughage. Leaf meal from leucaena can also be used in the commercial feed industry, but adulteration and its mimosine content (anti-nutritive factor) are the problems in using leucaena in animal feeding. The protein content of the meal vary from 14 to 18% in dry matter, according to the adulteration of the branch, the stem, or other plant leaves (ter Meulen & El-Harith 1985; Shelton & Brewbaker 1994; Kumar & D’Mello 1995; Lamchoun 1998). Leucaena leaves are also a good source of β-carotene, which, when fed as a protein supplement, is important for reproduction for dairy cow fed with rice straw as basal roughage (Lumchuan et al. 1997). Ensiling with 20% rice bran is an appropriate method of preserving it. This decreases the mimosine content of the leaf meal and increases its β-carotene content, which act as an antioxidant and vitamin A precursor (Lumchuan et al. 1997; Jaurena & Pichard 2001; Songsee et al. 2005).

*Acacia mangium* is a fast growing tree whose leaves can also be used as cattle feed. The protein content of acacia leaves is normally lower than from *Leucaena* species. In practice, these leaves are used in a fresh or dried form as a protein supplement for dairy cattle, especially for animals fed with low quality roughage. The dried leaves can also replace leucaena leaves in concentrate feed without any affect on animal production (Sruamsiri 2000, 2001).

Pigeon pea is a perennial shrub which demonstrates good growth even under semi-arid condition. In its chemical composition, the pigeon pea has a rather high protein content so that it is suitable for feeding ruminants. No significant difference in performance was observed when dairy cattle were fed with pigeon pea as a green fodder and leaf meal as a protein source in their concentrate (Seetakoses & Siri 1987; Seetakoses & Sruamsiri 1988; Seetakoses et al. 1990).


Fruit crops and vegetable by-products

Pineapple waste

Pineapple waste is a by-product from pineapple production and cannery plants, consisting of the crown, core, peel, leaves and waste from flesh trimming. These wastes are seasonally available in Chiang Mai and Lampang province. Farmers currently use pineapple waste as cattle feed because of its palatability. This waste is high in moisture content and soluble carbohydrate, so it decays very quickly. However, cattle prefer fermented pineapple waste to fresh waste, which is high in acidity. Drying and ensiling are preservative methods that are commonly accepted by farmers. Ensiling pineapple waste or pineapple waste mixed with rice straw can retain its nutritive value very well (Choopheng et al. 2005; Jitramano et al. 2005). Dried pineapple waste and ensiled pineapple waste can be used as supplemental roughage and can be replaced 50% of roughage in the total mixed ration for dairy cattle without adversely affecting animal production.

Banana stem

Banana stems are high in moisture content but are widely used as feed in dairy farms, especially in the dry season. The stems are sliced and chopped before being ensiled with rice bran. Normally they are used for cattle feed in the fresh form or ensiled form for feed supplements.

Vegetable waste

Vegetable waste from the cannery industry is composed of under-graded vegetables from export products, especially vegetable soybean, French beans, sliced baby corn and carrots. This waste is high in both digestibility and moisture content. It can be used as a replacement in concentrate feed for dairy cows without any affect on their growth and milk production. Sruamsiri et al. (2002) reported from their digestibility study with dairy cattle using a nylon bag technique that vegetable soybean, French beans and unseeded soybean were high in dry matter digestibility. The potential degradability was 100, 100 and 99.6%, respectively.

REFERENCES


