宮崎大学農学部研究報告 53(1・2) (1−10) (2007)
Bulletin of the Faculty of Agriculture, University of Miyazaki 53(1・2) (1−10) (2007)

Improvement of Pasture Production and Sustainability under Smallholder Condition in Thailand

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(Accepted on January 26, 2007)

Summary : Livestock production in Thailand has progressed considerably in the past 1-2 decadses while it is mainly dependent on smallholders, who have a limited forage field and pasture and their yields are also low. Current problems of forage production in Thai smallholders are dedicated and a promising approach for smallholder is proposed to improve the sustainable pasture production in this paper. Due to rainy and dry seasons in Thailand, forage production is majored from rainy season, while *Panicum maximum* cv. Natsukaze can be a promising species for high yield in the cooler dry season. Actually, it is often seen for smallholders that poor soil fertility combined with the lack in prompt fertilization reduce pasture production and its persistence. Also, poor seed bed preparation, limited fertilizer supply, frequent and close cutting or heavy grazing reduce production and persistency of forages and pastures. In dairy farming, shortage in herbage supply to animals is replaced by the increase in concentrate feeding, which results in lower profit margin. Extension of appropriate information is essential for the energetic smallholders to improve forage and pasture production, such as the suitable tropical pasture and forage species at the site, prompt cutting and grazing managements, correct fertilizer rate and closing paddocks in the drying season. The successful inclusion of tree legume with tropical grasses is proposed for both grazing and cut-and-carry systems with greater net profit on dairy cattle grazing than the sole grass treatment.

Key words : Forage production, Pasture management, Smallholder, Thailand, Tropical grass.

Introduction

Thailand has approximately 350,000 head of dairy cattle, 5,550,185 head of beef cattle and 1,624,919 head of buffaloes, which results in a large demand for good-quality pasture. This livestock production is mainly operated under smallholders who are largely dependent on forages for the feed supply. With the assistance of government agencies such as the Department of Livestock and Develop-ment (DLD), and the Dairy Promotion and Organization (DPO) of Thailand, greater number of farmers are now involved in the cultivation of improved forages, especially for those who are raising dairy cattle as reflected in the increased areas of improved pasture from 191,290 ha in 2002 to 220,274 ha in 2005. However, the ratios of pasture area to the number of beef, dairy cattle and buffaloes are still low, which are only 0.07, 0.12 and 0.08 ha/head, respectively. According to DLD (2005), the central region has the highest ruminant animal number/farm, followed by the northeast and northern regions while the southern region is the lowest (Table 1). These data suggest that most Thai farmers can be classified as small farm holders. As the grassland farming is mainly found on those farms that are raising dairy cattle, the average area for such farming is only 0.4-4.8 ha/farm, while the size of farm is varied from place to place. This indicates that there is limited land for pasture production and production of forages and pasture for dairy farming is low, varying between 6.3-10.9 t/ha/year.

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Table 1. Ruminant animal number/farm in various regions of Thailand in 2005.

Type of livestock	North	Northeast	Central	Southern
Beef	11.9	5.1	14.0	4.4
Dairy cattle	15.0	21.0	21.5	13.6
Buffalo	7.8	3.6	9.8	5.9
Goat	33.2	20.7	39.6	5.0
Sheep	27.3	3.9	43.9	3.6

Source : Department of Livestock Development (DLD) (2005).

Table 2. Area and yield of forage field and pasture[1].

Site	Area		Yield (t/ha/year)		
	ha/farm	ha/head	Farm	Experimental trial[2]	Species
Pranburi	2.4	0.32	10.0	—	—
Chaum	1.5	0.23	10.9	18.8	Guineagrass
Patananikom	1.5	0.20	10.7	28.7	Buffelgrass
Muaklek	3.5	0.23	10.1	30.7	Paragrass
Ratburi (small farm)	0.4	0.25	8.5	—	—
Ratburi (medium farm)	0.6	0.08	8.2	18.9	*P. Atratum*
Ratburi (large farm)	1.0	0.06	9.1	—	—
Pakchong	4.8	0.30	<6.3	27.5	Paragrass
Sakonakhon	1.6	0.22	8.1 (Fresh)	27.3 (Fresh)	Sorghum
Chaum	1.2	0.30	—	24.9	Dwarf napier
Central region (11 Provinces)	2.4	0.16	—	22.1	Setaria
Khonkaen	2.5	0.25	—	—	

Source : [1] Tudsri (2004). [2]At research station.

These yielding data in the farm level are significantly lower than the yields recorded in the experimental trials (Table 2).

Also the communal grazing areas, which are commonly a significant source of forage for grazing stock, decreased from 890,914 ha in 2002 to 468,366 ha in 2005 due to heavy demands for ploughable cropping land.

Ⅰ. Current Problems of Forage Production in the Small Farms

1. Climate and soil

Thailand is in the hot humid tropical region where the annual average rainfall is more than 1,000 mm. The rainy season, which lasts five months, begins in the middle of May and extends to the middle of October (except in the southern part). The problems in agriculture, therefore, are not related to the amount of rainfall but rather to the inappropriate rainfall distribution and the length of dry period without rain. Most parts of Thailand are faced to a dry season of 5 to 7 months, which makes it very difficult for many forage plants to grow and survive. As a result, pasture yields in the dry season are very low even though ambient temperatures are quite favorable for growth in these periods (March-April). Obviously, the longer the dry season, the greater the problem of soil moisture stress. Thus, the major dry matter yields of grass and legume are obtained from the rainy season (Tudsri & Kaewkunya 2002).

Temperature is not a problem for tropical grass and legume species. The only time when temperatures for tropical forage plants become limiting is in the cool season in the north and northeast regions or in the areas near the mountain or at high altitudes when the temperatures fall below 15°C. The opti-mum temperature for tropical grasses is around 35°C and for tropical legumes almost 30°C.

Most soils in Thailand have nutrient deficiencies. These soils are acid (low pH), with low organic matter, low cation exchange capacity (CEC) and are low in nitrogen, phosphorus, potassium, sulfur and many other trace elements, as shown in Table 3.

When soil fertility is low, the yield of forages is low. Forages are commonly grown on the poorest soils as the better fertility soils are used to grow food and cash crops. Farmers usually apply very little or no fertilizer and so the pasture is very deficient in nutrients, especially nitrogen. Most farmers cut their forages rather than grazing pastures, and therefore dung and urine are not returned to the pastures. Each

Table 3. Major limited nutrients for forage and pasture in soils of various regions of Thailand.

Region	Soil series	Major limitation	Examined species
North	Hang Dong	N, P, Mg, Ca	Purple guinea
	Mae Sai	N, P, Mg, Ca	Purple guinea
	Ranu	N	—
	Lumpang	N, P, K	—
Northeast	Ubon	N, P, K, S	*Paspalum*
	Pakchong	N, P, S	—
	Chaiyaphum	N, P	—
	Mahasarakam	N, P, K	—
Central	Humkrapong	N, P	—
	Chainan	N	—
	Kumpangsaen	N	—
	Ratburi	N, P	—
South	Ban Ton	N, P, K	Ruzigrass
	Vi. Sai	P, K, Mg, Cu, Mo	Verano stylo, Centro, American jointvetch
	14 soil series derived from different parent materials	P, N, K, S, Ca, Cu, Zn	Maize

year the pastures get poorer and poorer and finally they often are dead.

2. Limited area for forage and pasture production

As mentioned earlier, most Thai farmers have limited land for pasture production, even in dairy farming (Table 2). The land area for pasture production per head of stock is only 0.2 ha (Tudsri 2004). The majority of the land is planted for cash crops. Thus, the land area per farm is also only 1.95 ha. Such pasture areas do not produce an adequate amount of feed for their animals but traditionally the village buffalo and cattle or even dairy cattle are allowed to graze the public grazing land, roadside and paddy bunds or forest areas. In dairy farming, therefore, concentrate supplements are the major source of feed in order to maintain milk yield. As a result, 60 % of the variable cost for milk production is attributed to concentrate feeding.

3. Species

Improved pasture species have much better potential to give higher production than the native species, as demonstrated in Table 4 (Tudsri & Sawasdipanit 1993). Thus, the cultivated pastures in Thailand are totally dependent on improved species such as ruzigrass, paragrass, guineagrass, napiergrass, Verano stylo, Thaphra stylo and Centro. Many farmers lack in knowledge of these improved forage species or where to buy the seed. Thus, farmers often grow the wrong species on their land. For examples, some farmers try to grow ruzigrass on low-lying soils that can become waterlogged or even flooded during the wet season. But ruzigrass is not adapted to the waterlogging condition and thus dies. Sometimes legume seeds are sown, that are still dormant before seed dormancy has not been broken. On other occasions legume seeds that require inoculation prior to sowing have not been inoculated and in some cases inoculum may not even be available. Further more seed of the improved species may not always be available or may be in short supply. Thus it can be seen that there are many constraints that hamper the keen farmer and restricts the rapid development of a highly productive pastured system.

Table 4. Dry matter production of some native and improved grasses.

Type of grass	Species	Yield (t/ha/year)
Native	*Imperata*	1.3
	Ischaemum	3.1
	Chrysopogon	6.3
Improved	Napiergrass	31.9
	Paragrass	22.4
	Guineagrass	27.0
	Ruzigrass	19.1

Source : Tudsri & Sawasdipanit (1993).

Table 5. Effect of seedbed preparation on early dry matter production of ruzigrass (*Brachiaria ruziziensis*) and pearlmillet (*Pennisetum americanum*) (kg/ha).

Cut	Seed bed preparation	Ruzigrass		Pearlmillet	
		Drill	Broadcast	Drill	Broadcast
First	Fine	3550	1400	6170	4020
Second	Fine	—	—	2340	2790
First	Normal	1950	890	2480	1590
Second	Normal	—	—	2330	2860
First	Rough	1640	860	2810	1560
Second	Rough	—	—	2550	3020

Source : Watkin & Sukpitaksakul (1992).

4. Establishment and management

1) Establishment

The requirements to achieve good seed germination and pasture establishment are often overlooked by stock farmers. For example, Tudsri *et al.* (1991) reported that most of the farmers at Pakchong district, Nakhon Ratchasima grew grass and legume species under poor to medium seedbed preparation. Often farmers plough the soil only once, where weeds are still prevalent, and then they sow the seed into this poorly prepared field. The weeds quickly regrow and smother out the emerging forages. Nearly all grass or even legume seeds are very small in size and are slow to germinate compared to weeds and other crops like maize, rice and soybean. Some forage seedlings are also not particularly vigorous and so cannot compete with weeds. The importance of seedbed preparation on the establishment and early production of ruzigrass and pearlmillet was well demonstrated at Muaklek district by Watkin & Sukpitaksakul (1992), as shown in Table 5.

2) Fertilizer management

Most farmers apply only the basal mixed fertilizer of nitrogen, phosphorus and potassium without prior soil determination. After each cutting or grazing, most of farmers apply very little or no fertilizer at all. Therefore, yield from these pastures is often less than 6 t DM/ha/year with poor persistence at only 1-3 years.

3) Grazing and cutting managements

Many farmers tend to graze their pastures with too high stocking rate and without spelling the pasture to allow recovery. As a result, the pasture become overgrazed and the good species disappear to be replaced by weeds. In some farms severe soil erosion can also occur. The reason given is that they do not have enough land for their cattle feeding.

Under the cut and carry system adopted by most farmers, the pastures are often cut too frequently and too close to the ground. Thus, the yields become low after 2-3 years of establishment and show poor persistency. In some cases, farmers cut when the grasses are very tall and stemy, and hence low in protein concentration and of low digestibility. They are obviously too fibrous and not suitable for animal feeding.

5. Socioeconomic problems

Socioeconomic matter is another important problem that needs to be considered. The improvement and management of forage require investment of money and labor and therefore depend on several factors including the availability of land, accessibility to finance, knowledge and continued support, farmer attitude and economic return from animals using pastures.

Ⅱ. An Approach to Improve and Sustain Pasture Production

In spite of all these problems mentioned above, pastoral farming in Thailand has nevertheless made significant progress over the past 30-40 years in both the beef and especially the dairy sectors and particularly in the large farms with greater areas, resources and facilities. This has been achieved by giving attention and putting greater research effort into finding and developing better grass and legume species ; by better pasture establishment techniques ; by appropriate and judicious fertilizer programmers and by recognizing the importance of correct pas-ture management to achieve improved production and especially pasture quality for livestock production.

Table 6. The mean minimum temperature (°C) during November-February (2000-2001) for various areas where dairy farms are situated.

Location	Nov	Dec	Jan	Feb
Suwanvajokasikit	18.6 (11.9−22.9)	19.8 (14.1−22.0)	19.0 (15.0−23.1)	19.6 (16.8−23.4)
Muaklek	17.1	18.4	18.4	18.5
Ratchaburi	18.1	16.1	18.1	17.1
Kanjanaburi	16.3	17.1	18.1	19.1

Source : Tudsri *et al.* (2002a).

1. Species

There is a considerable variation among improved forage species in their ability to tolerate low soil fertility, drought, waterlogging, and shading stress. Farmers must plant the right species in the right place. However, most Thai farmers grow paragrass, ruzigrass, guineagrass, napiergrass or pangolagrass. These species have their own individual weak points. For example, paragrass and ruzigrass show poor persistence under long dry conditions while guineagrass and napiergrass are more tolerant under drought. Not many farmers consider such factors. They tend to grow grasses according to the plant materials that are available. Even in drier areas they still unwisely prefer to grow paragrass because grass material is readily available. Thus, the yield of these species is low and persistence is poor (1-3 years) because they are not well suited to their drier areas. Hence, it accentuates greater feed shortage problems. Tudsri *et al.* (1996) reported that dry matter yield of paragrass was much lower than dwarf napiergrass and purple guineagrass under infrequent cutting. Even with frequent cutting, yield of paragrass was only 50 % of dwarf napiergrass and purple guineagrass (Sukkagate *et al.* 1994 ; Tudsri *et al.* 1996). In the later work at Pakchong, Tudsri *et al.* (2002a) showed that napiergrass produced a higher dry matter yield than ruzigrass.

Hare *et al.* (1999a) recommended *Paspalum atratum* cv. Ubon for wet areas as an alternative to paragrass. This species has better performance under wet and dry conditions than paragrass or even ruzigrass. Research work of this species in the central region slowed that it had greater yield and drought tolerance than paragrass but the quality was lower in terms of protein concentration.

Following a series of trials, Tudsri *et al.* (unpublished) was also able to release a new cultivar of *Panicum maximum* for saline soil areas. Tudsri & Kaewkanya (unpublished) also reported the better performance of siratro and Verano stylo under lateritic soil in the northeast Thailand. *Pennisetum purpureum* cv. Muaklek is also well suited to areas of high soil fertility (Tudsri *et al.* 2002d).

Table 7. Dry matter yield of four guineagrass cultivars under field conditions between November-February (2000-2001).

Cultivar	Dry matter yield (t/ha)
TD58	1.50
Gatton	1.20
Natsukaze	2.50
Natsuyataka	1.25

Source : Tudsri *et al.* (2002a).

Shortage of winter-feed is a major constraint to dairy production from the tropical grasses in Thailand. Pasture production is low during this period (November-April) due mainly to lack of precipitation and lower temperatures. Even when soil moisture is adequate, the growth of these species is still significantly depressed (Hongyantarachai *et al.* 1992). Due to relatively cool conditions from November-early February, ambient temperatures often fall to 14°C as shown in Table 6, which is well below the optimum level for growth of tropical grasses (35-40°C) (Whiteman 1980). One ap-proach to increase winter production is to grow subtropical grasses as demonstrated by Tudsri *et al.* (2002c). The most promising species is guineagrass (*Panicum maximum*), cv. Natsukaze, which was introduced from Japan in 2003 (Table 7). Commer-cial forage crops such as speed feed and Jambo are also useful in this situation. Average dry matter yield of 4.5 tons/ha was easily obtainable in cool season under Pakchong area (Tudsri *et al.* 1991).

From the above discussion, it can be seen that the farmers can, given adequate guidance, choose the most appropriate and suitable grass and legume species for their respective areas.

Table 8. Total and component yields (kg DM/ha).

Species	1st grazing (1/12/87)			2nd grazing (8/2/88)			3rd grazing (18/3/88)		
	Total	Ruzi	Hamata	Total	Ruzi	Hamata	Total	Ruzi	Hamata
Hamata	1206	—	1206 (100%)	263	—	263	413	—	413
Hamata+50 cm row of ruzigrass	1575	681 (43%)	894 (57%)	388	388 (87%)	50 (13%)	688	669 (97%)	19 (3%)
Hamata+25 cm row of ruzigrass	1981	1300 (65%)	681 (35%)	619	594 (95%)	25 (5%)	638	625 (98%)	13 (2%)

Source : Wongsuwan & Watkin (1990).

2. Establishing grasses with tree legumes rather than herbaceous one

To date, many scientists and farmers alike have successfully established forage legumes in their pastures, but few have been able to retain and maintain the production over years. This is particularly so in the situation where the grass component is aggressive due to better rainfall condition, higher soil fertility or added fertilizer causing a significant and rapid reduction in the legume component by shading from the grass component. This is well illustrated by Wongsuwan & Watkin (1990) who established an excellent pasture of ruzigrass/*Stylosanthes* cv. Hamata at the first grazing (Table 8). However, by the third grazing at 3-4 months later, the legume component had virtually disappeared. This disappearance was not the fault of the legume per se as shown by the good growth of the pure legume stand but due to strong competition from the ruzigrass.

Hare *et al.* (1999a) also grew several mixed pasture of grasses and legumes in the relatively dry and infertile soils of the northeast of Thailand and also found that it is difficult to maintain legumes in mixed pastures, which decreased rapidly after 2-3 years of establishment. Until we can find the answers to successfully maintain legumes in mixed pastures, it is recommended that farmers should grow the desired, high quality forage of herbaceous legume as separate pure stands, and cut and feed it manually to the livestock.

There is, however, the opportunity to successfully grow grass/legume pasture of tree legumes rather than herbaceous legumes as shown by Tudsri *et al.* (2002a). Their results indicated that dry matter yields from these mixtures were not different from grass alone, except with the dwarf napiergrass (Table 9). They also found that the best results were obtained from growing grasses in alternate rows with legumes at the spacing of 100 cm between rows (Table 10) (Tudsri & Kaewkunya 2002). They also found that the optimum cutting interval of these mixed pastures was depended on the type of associated grasses. For ruzigrass and napiergrass cv. Taiwan A25, a cutting interval of 40 days was recommended while the cutting interval for dwarf napiergrass/leucaena should not be extended more than 30 days as shown in Table 11 (Tudsri *et al.* 2002b).

Table 9. Mean total dry matter yield (t/ha) of three grasses grown with leucaena over three years without irrigation.

Treatment	Grass	Legume	Total
Ruzigrass	8.0	—	8.0
Dwarf napiergrass	15.4	—	15.4
Napiergrass	13.2	—	13.2
Leucaena	—	8.6	8.6
Ruzigrass+leucaena	7.4	2.0	9.4
Dwarf napiergrass+leucaena	12.0	0.7	12.7
Napiergrass+leucaena	10.6	1.6	12.3

Source : Tudsri *et al.* (2002b).

Table 10. Effects of row spacing of leucaena on total dry matter yield (t/ha) of grass, leucaena and grass+leucaena (mean over three grass species).

Row spacing (m)	Grass	Leucaena	Grass+ leucaena
1	10.7	2.4	13.1
2	13.9	1.0	14.9
3	15.1	0.5	15.6

Source : Tudsri & Kaewkunya (2002).

The beneficial effect of the inclusion of tree legume in the pasture was also well demonstrated by Tudsri *et al.* (2001). Under grazing conditions, cows grazing on ruzigrass/leucaena mixture or ruzigrass supplemented with lablab produced higher milk yield and fat concentration than the cows grazing ruzigrass only with added nitrogen fer-tilizer. For the economic analysis, they also showed that the inclusion of the legume achieved greater net profit than the sole grass treatment, as shown in Table 12 (Tudsri *et al.* 2001).

Table 11. Effects of cutting interval and associated grass species on total dry matter yield (t/ha) of leucaena (mean over three years).

Treatment	Cutting interval (days)			Mean
	20	30	40	
Leucaena grown with				
ruzigrass	1.8	1.6	2.0	1.8
dwarf napiergrass	1.7	1.7	1.2	1.5
napiergrass	1.6	1.8	1.7	1.7

Source : Tudsri *et al.* (2002d).

Table 12. Effects of pasture production system on milk production (kg/head/day), milk fat (%) and net profit (Baths/head/day).

Treatment	Milk production (4 % fat)	Milk fat (%)	Net profit (Baths/head/day)
T_1	11.9	4.0	95
T_2	13.6	4.2	109
T_3	14.4	4.5	115

T_1 : Ruzigrass alone ;
T_2 : Ruzigrass mixed with leucaena ;
T_3 : Ruzigrass supplemented with lablab.
Source : Tudsri *et al.* (2001).

3. Fertilizers

It is obvious that the fertility of the soils throughout Thailand is generally inadequate to meet the nutrient needs of productive, improved pasture, and hence regular application of N, P, K and S fertilizers and even trace elements, on occasions, is necessary. This deficiency has also been increased by the common cut-and-carry system, which has been practiced for many years with negligible return of manures to pasture.

Experimentally grass response to the added nitrogen has been recorded up to 750 kg N/ha/year. A regular monthly application of 40-60 kg N/ha during the rainy season applied to the productive soils of the Central region is recommended to achieve an optimum pasture production. However, most Thai farmers apply much less than that level (Tudsri & Sawadipanit 1993).

Hare *et al.* (1999b) has studied the effect of nitrogen on the production of *Paspalum atratum* cv. Ubon on infertile seasonally wet soils in northeast Thailand. They found that nitrogen application at 20 kg N/ha every 30 days throughout the wet season increased dry matter yields by nearly 90 % in one trial and over 250 % in a second trial. Applying higher rates (40 and 80 kg N/ha) every 30 days increased dry matter yield further but the increased dry matter yield per unit of N applied was reduced. The yield response (kg DM/kg N) in the wet season ranged from 18 (fertilized at 480 kg N/ha/year) to 69 (120 kg N/ha/year). However, nitrogen rate of 80 kg N/ha every 30 days was necessary to maintain crude protein concentration in the whole plant above 7 %.

4. Cutting and grazing managements

It is also essential to recognize the relative importance of cutting or grazing managements in endeavoring to produce and utilize high quality pasture. Pasture quality in the tropical area is extremely important and difficult to maintain at the high quality. It is paramount, as stated by Lekchom *et al.* (1989), to feed leafy, high quality pasture in order to achieve high intake and thereby high milk production. Although as stated by these workers, it is possible to achieve high milk production by feeding high level of meal concentrate, the cost of such a feeding practice is extremely high and allows little profit margin. They fount that by feeding and placing greater relevance in properly managed high quality pasture along with a much lower input of expensive meal concentrate, they could reduce the cost of milk production significantly and achieve a much higher profit margin.

Watkin & Sukpitaksakul (1992) noted that strip grazing of adequately fertilized ruzigrass, guineagrass and green panic every 24-27 days during the rainy season provided the cows with high leafy pastures of relatively high crude protein (12-15 %) and digestibility (60-65 %). The pastures were utilized when it reached 50-60 cm height and grazed down to approximately 15 cm on a dairy strip basis. Such pastures maintained an average growth rate of 80 kg DM/ha/day.

In a pure stand of Verano stylo, Tudsri *et al.* (1988) showed the importance of frequent grazing to ensure the development of a productive, leafy and high quality pasture. Under frequent grazing (every 4 weeks), the yield of Verano stylo was almost 12 ton /ha, composed with only 7 ton/ha under infrequent grazing (every 8 weeks). In the following year, it was observed that this legume was capable of persisting and providing valuable production for at least 3 years.

Grazing or cutting management plays an important role in determining yield, quality and longevity of the pasture. Tudsri *et al.* (2002d) reported that grassland farmers tended to cut or graze their pasture to a very low level (0-10 cm) from the beginning of wet season and continued throughout the drought period. This lead to a reduction in pasture yield during subsequent regrowth in the following wet season, as demonstrated by Tudsri & Kongsanor (1992), Tudsri *et*

al. (2002b) and Tekletsadis *et al.* (2004). These authors suggested that optimum cutting height for all napiergrass cultivars and ruzigrass should not be lower than 20 cm in order to achieve good and quick regrowth. Farmers should also refrain from frequent cutting of their pasture in the dry season if they desire to produce maximum yield and get maximum benefit from their pasture in the subsequent wet season.

5. Fresh grass forage farming

Forage production in paddy field has been practiced in some areas such as Nong-Pho in the Central region of Thailand for 1-2 decades by using paragrass. In 2002, the Thai government promoted forage production and encouraged marketing, by supporting 6,280 farmers to produce hay and silage instead of rice and regular cash crops. Approxi-mately 2,480 farmers cultivated pangolagrass replacing rice in lowland, which was called in Thai as "Na Yaa". Another 3,800 farmers cultivated grasses and legumes appropriate for upland areas. During October 2002-July 2003, farmers obtained a total income of 111 million baths from 49,555 ton of forage dry matter produced. Fresh grass and legume, silage and hay of grass and legume are the main products to sell (Table 13).

In 2005, the paddy pasture project has been scaled up to grow forage for sale in 43 provinces over an area of 3,415 ha by 221 groups of farmers with 6,607 members. This has included many forage species grown for sale and has resulted in a noticeable benefit to the small farm's income. The recommended species in each region are presented in Table 14.

Table 13. Pasture production in the paddy field in 2002－2003.

Type of products	Production (t DM/year)
Fresh grass	98,039
Grass hay	18,000
Grass silage	1,536
Fresh legume	1,770
Legume hay	216
Legume silage	123
Total	49,556

Source : Phaikaew (2006, personal communication).

Table 14. Recommended pasture species for fresh-cut forage, silage and haymaking.

Region	Grasses	Legumes
Central	Pangolagrass	Cavalcade
Northeast	Purple guineagrass	Cavalcade, Thaphra
	Pangolagrass	Stylo
North	Purple guineagrass	—
	Banagrass Pangolagrass	—
South	*Paspalum* *P. plicatutum*	

Source : Phaikaew (2006, personal communication).

Ⅲ. Conclusions

1. Farmers must plant the tropical forages and pastures in the right place.
2. Farmers must cut or graze forages and pastures at the right time.
3. Farmers must provide the fertilizer at the correct rate.
4. Farmers must close the paddock during the dry season.
5. Farmers must grow leucaena (tree legume) rather than herbaceous legumes.

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タイの小規模畜産農家における持続的な粗飼料生産の開発

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要　約

タイの畜産業は，過去数十年にわたって大きく発展してきたが，その主体は小規模畜産農家が担っているため，飼料畑や草地の面積が狭く，その収量性も低い．本報では，タイの小規模畜産農家における飼料生産の問題点を詳述し，持続的な飼料生産体系を開発するための有望な方策を提起する．タイの季節は雨季と乾季に明瞭に分かれるため，飼料生産は雨季にほぼ限定されるが，冷涼で乾燥した季節でも生産性の高い草種として，ギニアグラス品種ナツカゼが選定された．小規模畜産農家の実際栽培では，播種前の耕起・整地が不十分であったり，低肥沃度の土地に対する施肥量が不足していたり，頻繁で低い高さの刈取りや強放牧を行うのが常であるために，飼料畑や草地の収量性が低下し，永続性も３年以内と極端に短くなっている．酪農では粗飼料供給量の不足のため，濃厚飼料の給与量を増やさざるを得なくなり，純収益の低下をもたらしている．飼料畑や草地の開発に関する適切な情報，例えば，その地域に適した飼料作物・牧草の草種，適切な採草・放牧管理方法，妥当な施肥量，乾季における放牧・採草利用の停止などを，生産意欲のある農家に的確に普及することが重要である．マメ科飼料木を暖地型牧草と混植することにより，採草・放牧の両体系ともにイネ科牧草の単播草地に比べて，酪農における純収益が増加したことから，優良事例として提示された．

キーワード：小規模畜産農家，草地管理，粗飼料生産，タイ，暖地型牧草