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Potential of *Leucaena* spp. as a feed resource for ruminant animals in Thailand

Potencial de especies de Leucaena *como recurso forrajero para rumiantes in Tailandia*

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Abstract

While *Leucaena leucocephala* grows wild in Thailand, some *Leucaena* spp. have been introduced and evaluated for their edible forage yield and quality. Experiments on appropriate management were performed in different environments and productivity was found to be affected by species or cultivar. Environmental conditions, plant spacing, age of plant and cutting height significantly affected growth and performance. Edible forage yield was in the range of 5–6 t DM/ha/yr. Most species and cultivars contain high protein concentrations and are suitable for use as feed supplements as well as total ration for livestock. The effects of leucaena feeding on livestock are shown in lower mortality and increased productivity. While the leaf meal processing of leucaena for livestock feeding is increasingly recognized and practiced, cultivation of this crop is still minimal and insignificant. The role and importance of leucaena for livestock production, as well as its nutritional quality and factors which limit its use, are reviewed. The need for increased cultivation and integration of leucaena into local farming systems is emphasized. There is an urgent need to increase research support for the efficient cultivation of leucaena and an education campaign to dispel concerns about toxicity aspects.

Keywords: Livestock feeding, management, shrub legumes, utilization.

Resumen

A pesar de que *Leucaena leucocephala* crece en forma silvestre en Tailandia, se han introducido algunas otras especies de *Leucaena* para evaluar su rendimiento y calidad forrajera. Se realizaron experimentos sobre manejo apropiado en diferentes sitios y se encontró que la productividad es afectada por especie o cultivar. Las condiciones ambientales, la distancia entre plantas, la edad de la planta y la altura de corte afectaron significativamente su crecimiento y desempeño. La producción de forraje comestible estuvo en el rango de 5–6 t materia seca/ha/año. La mayoría de especies y cultivares registraron altas concentraciones de proteína cruda y se consideraron aptas para uso en alimentación de rumiantes tanto como suplemento como ración total. La alimentación de ganado bovino con leucaena se manifiesta en una menor mortalidad y mayor productividad animal. Si bien el potencial de leucaena para uso como harina de hoja en vez de forraje fresco es cada vez más reconocido y practicado, la adopción como cultivo es aún mínima. El rol y la importancia de la leucaena para la producción animal, así como su calidad nutricional y los factores que limitan su uso, son revisados. Se enfatiza la necesidad de incrementar el cultivo y su integración en los sistemas de producción agropecuarios locales. Además debe incrementarse la investigación para mejorar la eficiencia del cultivo de leucaena y apoyar campañas de educación para disipar las preocupaciones de los productores sobre posibles efectos tóxicos de la leucaena.

Palabras clave: Alimentación animal, leguminosas arbustivas, manejo, utilización.

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Introduction

Thailand is located at the center of peninsular Southeast Asia occupying 513,120 km^2; development has been generally based on agricultural production, which employs 49% of the labor force. Forty-six percent of the total land mass is engaged in the agricultural sector, of which 47% is incorporated in paddy fields, as rice is the most important crop grown in the country (Office of Agricultural Economics 2018). However, livestock production is very important to the Thai economy; beef cattle, dairy cattle, goats and buffalo are the most important ruminant livestock. In 2017 there were 4,876,228 beef cattle, 584,357 dairy cattle, 1,029,924 buffalo, 652,964 goats and 45,628 sheep (Department of Livestock Development 2018). Most ruminant livestock farmers in Thailand are small-holders; beef cattle farmers own approximately 6 cattle/farm and dairy farmers keep approximately 33 dairy cattle, while goat farmers have approximately 12 goats. Beef cattle are fed primarily grass plus agricultural and agro-industrial by-products, while dairy cattle are fed grass, rice straw and concentrates. Although many species of herbaceous legumes have been introduced and evaluated for use as a protein source in animal production systems, only 2–3 species are used commercially. The leguminous tree *Leucaena leucocephala*, native to Guatemala and Mexico, was introduced to the Philippines and Southeast Asia, including Thailand, during the period 1565–1825. It was previously used in Thailand for reforestation but was introduced to Thailand as an animal feed in 1962.

Agronomic evaluation under cutting

Manidool et al. (1976) compared 10 varieties of *Leucaena leucocephala* introduced from Australia, Hawaii, Ivory Coast, Taiwan, El Salvador and New Guinea in Pakchong, Northeast Thailand, where mean annual rainfall is 1,145 mm. With cutting 3 times per annum cv. Ivory Coast produced the highest leaf yield (9,500 kg DM/ha). These initial evaluations failed to lead to recommendations for use by farmers. Cultivar Cunningham was also introduced from Australia in 1972 and is the most widely used cultivar in Thailand. The leucaena psyllid, *Heteropsylla cubana* (Homoptera: Psyllidae), infests both the 'common' and 'giant' types of leucaena (*L. leucocephala* ssp. *leucocephala* and ssp. *glabrata*, respectively) resulting in leaf loss, which depresses yields. While all types of leucaena in Thailand are susceptible to the psyllid attack, the degree of damage ranges from moderate to severe throughout the country. Infestation is seasonal, occurring from October–November to April–May (Napompeth 1990).

In an attempt to counter the psyllid, resistant species and varieties of leucaena have been selected or bred. In 1996 *Leucaena* spp. from Oxford Forestry Institute (OFI) and from Australia were introduced to Thailand by Department of Livestock Development (Bureau of Animal Nutrition 2018). Eight accessions of *Leucaena* spp. were evaluated for psyllid resistance and edible forage yield during April 1996–March 1999, when planted in rows with spacing of 1 × 0.5 m (Figures 1 and 2). Three accessions, *L. pallida* OFI 137/94 (CQ 3439), *L. diversifolia* CPI 46568 [in Hughes (1998) listed as *L. trichandra*] and *L. leucocephala* K376, exhibited high psyllid resistance, but edible forage yield of *L. leucocephala* K376 (12.2 t DM/ha/yr) was higher than those of *L pallida* OFI 137/94 (9.2 t DM/ha/yr) and *L. diversifolia* CPI 46568 (4.2 t DM/ha/yr) with 17.7% crude protein (CP) (Thinnakorn et al. 2003).

Additional experiments on psyllid resistance and edible forage yields of leucaena were conducted in the central part of Thailand in Petchaburi Province (20 varieties), and in the northeastern part of Thailand in Nakhonratchasima Province during 1997–2001 (17 varieties). Both sites used cv. Cunningham as control. The best cultivar in Petchaburi was *L. leucocephala* hybrid K584 × K636, while good yields were obtained with *L. leucocephala* cv. Cunningham, *L. leucocephala* OFI 34/92 and *L. leucocephala* K636 (now = cv. Tarramba) (Polbumrung et al. 2003). In Nakhonratchasima performance of *L. leucocephala* OFI 34/92 was better than that of the other 16 accessions in terms of edible forage yield (8.3 t DM/ha/yr) and quality (22.5% CP). Leucaena was destroyed by psyllid infestation in a short period during the dry season (December–February) and *L. leucocephala* OFI 34/92 recovered better than the other accessions (Phaikaew et al. 2005). These results have been confirmed by Rengsirikul et al. (2011).

Crop management

Leucaena leucocephala OFI 34/92 produced annual yields of edible forage of 6 t DM/ha from 1.5 × 0.25 m spacing (Srisomporn et al. 2015). Research on different cutting intervals and cutting heights in Petchaburi Province in central Thailand indicated that leucaena can achieve annual yields of 24 t DM/ha at 100 cm cutting height and 25.7 t DM/ha with 10-week cutting interval (Ratchadapornvanitch et al. 2015). Chotchutima et al. (2016) reported that sulphur application (187.5 kg gypsum/ha) led to an overall higher total edible biomass yield (4.5 t/ha/yr) than without sulphur (2.3 t/ha/yr). The maximum rate of P fertilization (750 kg triple super-

phosphate/ha) produced the highest leaf, branch, woody stem and total biomass yields.

Figure 1. Evaluation of *Leucaena* spp. at Pakchong.

Figure 2. Experiment on the effect of row spacing on forage yield and quality of leucaena at Pakchong.

Chemical composition

Crude protein concentration in *Leucaena* spp. is high, ranging between 18.0 and 27.9% in different species and cultivars (Phaikaew et al. 2005; Table 1). Dry matter digestibility (nylon bag technique) at 48 h was in the range 43–80%. Ratchadapornvanitch et al. (2015) reported that, as in most plant species, CP concentration of leucaena decreases with increase in the cutting interval, declining from 21% for 6-week cutting interval to 16% for 12-week cutting interval. Ca concentration was 1.4% and P was 0.2%.

Animal production

Leucaena leucocephala is a valued fodder for ruminants, e.g. cattle, buffalo and goats. It can be grazed, fed fresh as cut-and-carry forage or conserved as hay or silage for feeding later. A number of studies have been conducted to evaluate the potential of leucaena to improve animal performance. A long-term study over 4 years in Srakaew Province in the eastern part of Thailand assessed the effects on reproductive performance of breeding does of feeding fresh *L. leucocephala* as the sole diet. Five crossbred Anglo-Nubian yearling does (20–25 kg body weight) and a 30 kg yearling buck were housed in a 10 × 10 m pen and fed only fresh leucaena leaf. Over the 4 years there were 54 kiddings resulting in 92 kids (38.9% single births, 51.8% twinning and 9.3% triplets). Mortality of kids at parturition was 3%. Average birth weight was 2.01 kg and weaning weight at 3 months was 9.43 kg. These data indicate that feeding fresh *L. leucocephala* for 4 years to breeding does should not affect their reproductive performance. They showed no symptoms of mimosine toxicity. The feeding regime was continued with some of the male goats to assess growth performance. Initial weight was 16.43 kg and final weight after 176 days of feeding was 26 kg, giving a growth rate of 54.6 g/d and a feed conversion rate of 13.3 g DM/g gain (Janthibordee and Kodepat 2009).

In a second study crossbred Anglo-Nubian goats rotationally grazing *Paspalum plicatulum* were supplemented with leucaena silage ad libitum or 14% CP commercial concentrate at 1% body weight. Conception rates, percentage of births and number of twins were higher on the leucaena treatment than on the concentrate treatment (Ted–arsen et al. 2017). In an experiment in Prachuapkhirikhan Province, 20 crossbred goats were used to compare the responses from feeding supplements of leucaena silage and commercial concentrate at 0.5, 1.0 and 1.5% body weight. Intakes of organic matter and CP and daily growth rates were greater for the leucaena treatment than for the concentrate groups, but the lowest feed cost was for the 0.5% concentrate supplement (Sengsai et al. 2015). Beef cattle receiving rice straw plus 4 kg of fresh leucaena leaves had significantly higher daily growth rates and total DM intakes than animals fed rice straw treated with urea-molasses (3% urea and 10% molasses). No symptoms of toxicity were observed during the feeding period of 364 days (Sanitwong et al. 1983). Buffalo fed dehydrated sugarcane tops supplemented with fresh leucaena leaves (12 kg/hd/d) gained 0.7 kg/hd/d more than buffalo fed dehydrated sugarcane tops alone (Sanitwong et al. 1986).

Table 1. Nutrient composition and dry matter digestibility (DMD) of edible material of different *Leucaena* species (Phaikaew et al. 2005).

Species	% (DM basis)							% DMD
	CP	ADF	NDF	Lignin	Hemicellulose	Mimosine	Tannin	(48 h)
L. leucocephala ssp. *glabrata* cv. Cunningham	23.1	23.7	34.7	8.2	11.1	3.2	0.9	75
L. collinsii ssp. *zacapana* OFI 56/88	24.6	23.2	35.0	6.4	11.9	2.4	0.5	75
L. collinsii OFI 52/88	25.0	25.5	36.2	8.5	10.7	3.2	1.8	73
L. diversifolia OFI 83/92	21.8	23.0	34.1	10.3	11.1	2.9	2.1	72
L. diversifolia ssp. *stenocarpa*[1] OFI 53/88	20.2	27.0	38.0	11.4	11.0	2.1	2.3	52
L. esculenta ssp. *esculenta* OFI 47/87	18.4	23.3	34.7	8.6	11.4	1.1	3.2	65
L. esculenta ssp. *paniculata*[2] OFI 52/87	22.3	24.9	38.0	10.0	13.1	1.6	0.9	67
L. lanceolata OFI 43/85	23.2	25.0	37.9	7.7	12.9	3.1	1.0	74
L. lempirana OFI 6/91	22.5	25.9	38.9	10.5	12.0	2.3	0.4	71
L. leucocephala ssp. *glabrata* OFI 34/92	22.2	23.9	35.9	8.6	12.1	3.3	1.1	80
L. macrophylla ssp. *nelsonii*[3] OFI 47/85	23.9	31.0	43.3	11.8	12.3	2.9	0.9	53
L. multicapitula OFI 81/87	23.6	35.4	44.0	3.5	3.6	2.4	0.5	58
L. pulverulenta OFI 83/87	20.0	25.4	35.9	12.0	10.4	2.2	3.4	44
L. salvadorensis OFI 17/86	19.8	29.3	42.2	10.0	12.8	2.0	0.3	69
L. shannonii ssp. *magnifica*[4] OFI 19/84	19.9	29.8	41.5	11.0	11.7	1.9	0.3	68
L. trichodes OFI 61/88	27.9	25.7	39.3	9.5	13.7	3.3	0.3	65
L. pallida OFI 137/94 (CQ 3439)	21.4	26.0	36.4	10.4	10.4	1.6	2.7	59

[1]In Hughes (1998) listed as *L. trichandra.* [2]In Hughes (1998) listed as "*Leucaena?* hybrid". [3]In Hughes (1998) listed as *L. macrophylla* ssp. *istmensis*. [4]In Hughes (1998) listed as *L. magnifica*.

Use of leucaena in farming systems

Leucaena is fed to animals in many forms in farming systems. Where it grows naturally, farmers have evolved feeding systems utilizing freshly harvested leucaena for feeding goats and cattle ad libitum, while in some areas wild leucaena is collected, chopped and ensiled (Phaikaew et al. 2012). Leucaena leaf meal is also fed as a supplement for dairy cows consuming grass. A number of farmers actually produce dried leucaena leaf for sale in different areas. One farmer in Nakhonratchasima Province produces dried leucaena leaf and sells it to dairy farmers in his area as well as to the commercial feed industry, which uses it for poultry feed. The amount of leaf meal produced is 80–90 t/month. Initially he alone harvested wild leucaena but the increasing demand for dried leucaena leaf for animals led to an increase in the number of leucaena producers and a decrease in the availability of wild leucaena. He planted about 2 ha of leucaena on his own land which he harvested every 2–3 months. This reduced his cost of production by reducing the cost of fuel to find and harvest wild leucaena. He also buys from other farmers who collect wild leucaena, while he does the processing, i.e. chopping and drying, before selling it to the feed industry (Chantarasiri et al. 2018). In Lopburi Province, farmers collect wild leucaena and sell it to a company, which then processes it. While the company has their own leucaena field of cv. Tarramba, established with seed bought from Australia, they encourage farmers to plant Tarramba for sale to the company. The company sells leucaena leaf meal as well as concentrate feed containing leucaena, and produces 50–80 t/d of leucaena leaf meal.

Constraints to leucaena production and adoption

While wild leucaena is used by livestock farmers in many places, its cultivation by farmers is limited. Establishment of leucaena is limited by the ready availability of wild leucaena and the fact that most farmers own less than 8 ha of land, which they use for diverse purposes. Another factor limiting cultivation of leucaena is the possibility of low germination in the field and slow seedling growth. To stimulate planting of leucaena the Department of Livestock Development commenced a project called 'Planted leucaena as edible fence'. Since people consume young leaves and seed pods of leucaena as a vegetable, if farmers plant leucaena they can harvest these components for food for the family, while the remainder will be left as feed for their animals. As part of the project leucaena seed can be obtained via livestock officers located in every province.

Unfortunately there is no satisfactory project implementation plan. While many farmers throughout the

country feed their animals with leucaena, some are reluctant to do so because of the risk of mimosine toxicity, which might result in deaths of animals or decreased reproductive performance. While the purpose of pointing out possible toxic effects of mimosine is to make farmers aware of potential risks, it is important not to discourage the use of leucaena to feed ruminant animals. An education plan is needed to stimulate its use.

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(Note of the editors: All hyperlinks were verified 20 August 2019.)

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