SHRUBS AND TREE FODDERS FOR FARM ANIMALS

PROCEEDINGS OF A WORKSHOP IN DENPASAR, INDONESIA, 24 – 29 JULY 1989

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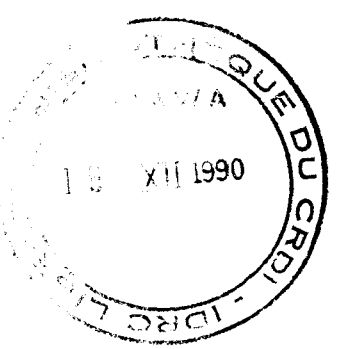

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Abstract

This publication presents the results of an international meeting held in Denpasar, Bali, Indonesia, 24–29 July 1989, that focused on the use of shrubs and tree fodders by farm animals. Through 26 papers, the workshop addressed feed-resource availability, use by ruminants and nonruminants, processing methodology, economics, and development issues. These aspects and the current knowledge on shrubs and tree fodders were further highlighted by country case studies detailing prevailing situations and policy matters. A special session was held to discuss the successful development and results achieved in the three-strata forage system in Indonesia. The workshop concluded with important working group discussions on the priorities for further research and development, and on the potential for the wider use of shrubs and tree fodders in the developing world.

Résumé

Cette publication présente les résultats d'une rencontre internationale tenue à Denpasar, Bali, Indonésie, du 24 au 29 juillet 1989 et qui a porté sur l'utilisation des arbustes et fourrages végétaux par les animaux d'élevage. Les 26 communications qui y ont été présentées traitaient de la disponibilité des ressources alimentaires pour les animaux, de leur utilisation par les ruminants et les non-ruminants, des méthodes de transformation, des aspects économiques et des questions du développement. Ces sujets et les connaissances actuelles sur les arbustes et les fourrages végétaux ont ensuite été étudiés plus à fond dans le cadre d'études de cas de divers pays exposant les circonstances particulières de chacun et les questions liées aux politiques. Une séance spéciale a porté sur la mise en place et les résultats des systèmes de production de fourrages végétaux en trois strates en Indonésie. L'atelier s'est terminé par d'importantes discussions des groupes de travail sur les priorités de recherche et de développement pour l'avenir et sur les possibilités d'utilisation élargie des arbustes et des fourrages végétaux dans les pays en développement.

Resumen

Esta publicación presenta los resultados de una reunión internacional celebrada en Denpasar, Bali, Indonesia, del 24 al 29 de julio de 1989, y la cual centró su atención en la utilización de forrajes elaborados a partir de arbustos y árboles para alimentar a animales de granjas. En 26 trabajos presentados al seminario, los participantes abordaron temas tales como la disponibilidad de recursos alimentarios y la utilización de los mismos por rumiantes y no rumiantes, metodologías de procesamiento y cuestiones de economía y desarrollo. Estos aspectos y el conocimiento que se tiene actualmente sobre los forrajes de arbustos y árboles se vieron subrayados aún más por estudios de casos por países en los que se detallaron situaciones existentes y cuestiones de políticas. Se celebró una sesión especial para discutir el desarrollo y resultados exitosos alcanzados en Indonesia con el sistema de forraje de tres niveles. El taller concluyó con importantes discusiones de los grupos de trabajo sobre las prioridades existentes en el campo de la investigación y el desarrollo y sobre el potencial que encierra la amplia utilización de arbustos y árboles en el mundo en desarrollo.

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Session IV: Country Case Studies

Session V: Processing, Methodology, and Economics

Availability and use of shrubs and tree fodders in the Philippines

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Abstract *— Shrubs and tree fodders are unpopular among livestock farmers in the Philippines; this is because the country has underdeveloped dairy and beef industries and an import dependence on meat and milk. This implies that only a low livestock population can be supported by the available feed resources. This paper examines the role of ipil-ipil (*Leucaena leucocephala*) in livestock and poultry feeding in the past decade. The economic importance in relation to the multiple uses of the tree is discussed, together with the attention given to ipil-ipil by the government. The effects of* Heteropsylla cubana *infestation and the concept of crop diversity and integrated land management are presented. Characteristics and nutritive values of shrubs and tree fodders (with emphasis on* Gliricidia sepium*) are given and the role of this feed resource in future livestock development is discussed.*

Résumé *— Les paysans philippins qui élèvent du bétail n'aiment pas les arbres et les arbustes fourragers. Cela s'explique par le fait que le pays n'a qu'une industrie laitière et du boeuf de boucherie sous-développée et compte sur les importations de viande et de lait. Seul donc un petit cheptel peut être entretenu par les ressources disponibles en fourrage. L'auteur se penche sur le rôle joué par l'ipil-ipil (*Leucaena leucocephala*) dans l'alimentation du bétail et des volailles au cours de la dernière décennie. Il aborde l'importance économique de l'arbre en rapport avec les multiples usages de ce dernier et l'attention que le gouvernement lui porte. Il présente les effets de l'infestation à* Heteropsylla cubana *et le concept de la diversité culturale et de la gestion intégrée des terres. Enfin, il donne les caractéristiques et la valeur nutritive des arbustes et des arbres fourragers (s'attachant surtout à* Gliricidia sepium*) et discute du rôle de ce type de fourrage dans l'évolution de l'élevage.*

Resumen *— Los ganaderos de las Filipinas no usan comúnmente árboles y arbustos forrajeros, ya que el país ha desarrollado insuficientemente las industrias de la carne y de la leche, y depende de la importación para satisfacer la demanda de ambos productos. Esto implica que con los recursos alimenticios disponibles solamente puede tener una baja población ganadera. Este trabajo examina el papel del Intsia Bijuga (*Leucaena leucocephala*) como alimento avícola y ganadero de la década pasada. También, trata de la importancia económica respecto a la multiplicidad de usos de los árboles, y de la atención que dispensa el gobierno al Intsia Bijuga. Se consideran los efectos de la infectación con* Heteropsylla cubana *y se presenta el concepto de diversidad de los cultivos y explotación integrada de tierras. Se dan las características y los valores nutritivos de los arbustos y árboles forrajeros (con énfasis en el* Gliricidia sepium*) y también se trata el papel que desempeñará este recurso alimenticio en el desarrollo futuro de la ganadería.*

Introduction

Shrubs and trees have provided valuable fodder to domestic animals likely since the time of their domestication (Brewbaker 1985). This is particularly so in countries that have a progressive livestock industry coupled with problems of feed supply. The Philippines has strong swine and poultry production, which is well supported by a feed-milling industry. Beef and dairy production, however, lag far behind, with 50 and 99% of meat and milk requirements, respectively, being import-dependent. Whereas the beef and goat herds of the country are either grazed on open grasslands or tethered on marginal lands, dairy animals are supported by a very limited area of improved pastures, competing with other commodities for feed resources, and rely on crop residues during the dry season.

Tree fodders in the Philippines are largely contributed by ipil-ipil (*Leucaena leucocephala*). Except for this species, the concept of shrubs and tree fodders is new to livestock farmers, and the vast majority of researchers in the Philippines. Despite the widespread presence of leguminous and nonleguminous shrubs and trees in the country, their potential as fodders has not been explored; this also applies to most crop residues. The lack of popularity of shrubs and tree fodders in the Philippines is due to two main reasons: the problems encountered with ipil-ipil over the last two decades and the underdeveloped beef and dairy industry.

This paper reviews the Philippine livestock industry in relation to the feed resource situation, and recounts the contributions of ipil-ipil over the last 20 years. It also discusses promising substitutes for ipil-ipil and the challenges that face the livestock industry (BAI 1988).

Feed resources and the livestock industry

In the last 8 years, the Philippine human population increased from 48.1 to 58.7 million; the cattle population, however, decreased. The population of ducks and goats increased at a much higher rate (Table 1). As a result, the country depends on imports for its domestic meat and milk requirements (Table 2). In 1987 alone, the Philippines spent 157.7×10^6 USD on imported dairy products, which accounted for 99% of total dairy consumption. The underdeveloped dairy and beef industry translates into a lack of pressure to use and develop feed resources for ruminants.

Table 1. Human and livestock populations ($\times 10^6$) of the Philippines.

Population	1980	1984	1986	1988	Average annual growth rate, (%)
Human	48.1	53.4	56.0	58.7	2.5
Livestock					
Buffalo	2.87	3.02	2.98	2.93	0.3
Cattle	1.88	1.85	1.81	1.60	-1.9
Goats	1.67	2.36	2.18	2.06	3.1
Pigs	7.93	7.61	7.27	7.52	-0.6
Chickens	52.76	59.21	53.00	55.94	0.9
Ducks	4.72	5.76	5.21	6.27	3.9

Source: NEDA-NCSO (1987), BAI (1988).

Table 2. Livestock production, imports, and annual per-capita consumption of various commodities in the Philippines in 1987 and their annual growth rates (AGR, %) for the 1980s.

Commodity	Production		Imports		Per-capita consumption (kg)
	$\times 10^3$ t	AGR	$\times 10^3$ t	AGR	
Dairy, liquid milk equivalent[a]	11.5	0.5	1 360	5.8	27.2
Beef	90.5	3.2	4.4	25.2	1.3
Carabeef	45.3	3.3	—	—	0.6
Goat meat	34.9	10.0	—	—	0.4
Pork[b]	623.4	4.8	1.0	39.3	8.9
Chicken	164.0	1.7	—	—	3.1
Duck	4.3	–2.2	—	—	0.1

Source: BAI (1988).
[a] Under dairy, CIF (cost of insurance and freight) value is 157.7×10^6 USD (6.5% growth).
[b] Under pork, export value is 3 080 t (160.3% growth).

Table 3. Land use and production of major crops and their residues in the Philippines.

Land use/crop	Area ($\times 10^6$ ha)	Main product ($\times 10^6$ ha)	Residue ($\times 10^6$ ha)
Total land	30	—	—
Pasture land	1.1	—	—
Arable land	11.3	—	—
Rice	3.2	8.2	8.2
Corn	3.3	3.5	3.5
Sugarcane	0.4	3.2	0.6
Coconut	3.3	3.0	—[a]

Source: FAO (1985), NEDA-NCSO (1986).
[a] Assuming a carrying capacity of 0.25 animal units/ha, 0.8×10^6 animal units can be carried under coconuts (1 animal unit = 1 adult buffalo).

A common characteristic in animal holdings among Asian countries is the predominance of small-scale farmers. In the Philippines, 87% of cattle and 99% of carabaos (swamp buffaloes) are in the hands of small-scale farmers, who largely depend on marginal lands as their source of animal feed. Subtracting the number of cattle and carabaos held by backyard farmers from the animal population data presented in Table 1, there is a balance of about 240 000 large ruminants kept in commercial farms and ranches. In relation to the total pasture land of 1.1×10^6 ha (Table 3), this provides a low stocking rate of 0.21 head/ha. This stocking rate could be at least tripled by introducing leguminous trees. For the small-scale farmer, rice, corn, and sugarcane alone generate 12×10^6 t/year of crop residues (Table 3); these are also currently neglected. Trung (1987) estimated that 4.8 million more cattle and carabaos could be raised on fodder under coconuts and residues from the major crops.

In summary, the Philippines has considerable untapped feed resources. The current ruminant population could be more than doubled by improving the carrying capacity of permanent pastures, fully using crops residues, and introducing shrubs and fodder trees in marginal lands and pasturelands. The most recent policy guidelines from the Department of Agriculture on livestock, with an emphasis on dairy development (BAI 1988), suggest that forages from shrubs and trees will play an important role in supporting local livestock production in the future.

Ipil-ipil: the wonder tree

Among Asian countries, the Philippines and Indonesia have made the most use of ipil-ipil (*Leucaena leucocephala*) (Napompeth et al. 1987). Until the devastating infestation in the mid-1980s of *Heteropsylla cubana*, ipil-ipil was found throughout the Philippines: in the forest for reforestation, in marginal lands for producing animal feed, and in the cities for shade. Because it is a fast-growing multipurpose tree, it has been considered as a miracle or wonder tree. Among its many uses, its value as feed is perhaps most widespread, producing leaf meal and fodder for ruminants.

Origin, habitat, and varieties

Although ipil-ipil is an old crop in the country, its large-scale production was triggered in 1969 by the improved varieties of the giant K lines from the collection of Dr James L. Brewbaker of the University of Hawaii (Mendoza 1984). Under Philippine conditions, ipil-ipil grows best at an elevation of up to 460 m above sea level. It grows on almost any type of soil with annual rainfall ranging from 400 to 800 mm. However, it does not tolerate acidic conditions (pH 5). Ipil-ipil can withstand prolonged drought, but not waterlogged soils. From among 125 accessions, including 70 foreign introductions, many breeding and agronomic trials have been conducted to determine suitable varieties and management practices (Mendoza 1984). There are two recommended types for the Philippines: the Salvador type (also known as Hawaiian Giants K8, K28, and K67) and the Peruvian type. The Salvador type is tall with large leaves, pods, and seeds, and thick branchless trunks, more suitable for timber, wood products, and industrial fuel than for fodder. The Peruvian type is also tall but has extensive branching, even low down on the trunk. These plants have small trunks, but produce high-quality foliage on their branches, with large leaflets and pods.

General uses and economic importance

In the Philippines, there are six main uses of ipil-ipil:

- as a source of wood,
- for reforestation and erosion control,
- as greenery and for shade,
- as fertilizer,
- in agroforestry, and
- to produce animal feed.

Wood produced from ipil-ipil makes good fuel and charcoal, roundwood (poles and posts), banana props, lumber, veneer and plywood, parquet flooring, particleboard, fiberboard, pulp and paper, and dissolving pulp. Ipil-ipil is one of the fastest growing hardwood species in the Philippines with annual growths ranging from 24 to 312 m/ha or 13 to 150 "bone dry" t/ha, depending upon site quality and strain (PCARRD 1980a).

Ipil-ipil is a good forerunner in reforestation. It can be planted successfully in grassland areas, preparing the land for other, more favoured species. Well-established ipil-ipil shade out undergrowth, eliminating combustible materials under them. Ipil-ipil also serves as a windbreak in typhoon-prone areas like Batanes, the Bicol region, and Quezon.

Being a leguminous plant, ipil-ipil is an excellent source of organic fertilizer. It can either be intercropped or grown immediately after harvest. This has been successful with coconut, coffee, tea, fruit trees, banana, corn, sorghum, rice, and other agricultural crops (PCARRD 1980a). Leucaena foliage as green manure provides organic matter that increases aeration, water retention, insulation, and cation exchange capacity. The leaves of ipil-ipil contain about 0.6% nitrogen (N) in terms of green weight or 4.3% in terms of dry weight.

The progressive backyard beef production in Batangas province is attributed to the use of ipil-ipil, known in the area as "lepili." Small-scale farmers in Batangas pound ipil-ipil foliage and then mix it with water, rice bran, and salt. The liquid mixture is then drenched to individual cattle. This method of feeding is known locally as "supak," and is also practiced in other parts of the country.

The most significant contribution of ipil-ipil to small-scale farmers is in the production of leaf meal. This has become a cottage industry for many families, particularly those in Central and Western Visayas and Northern Luzon. Farmers simply cut and gather ipil-ipil branches. The leaves are dried under the sun along roadsides and front yards and then threshed by families for extra income. Some of the feed mills in the Philippines have buying stations for dried ipil-ipil leaves in the barrios (villages). The price depends on the colour, dryness, and purity of the product.

It is estimated that with 5% ipil-ipil leaf meal in swine and poultry feeds, the yearly requirement for this leaf meal among commercial feed millers is 50 000 t. In 1980, local leaf meal production was 20 000 t (PCARRD 1980b). Limited amounts of ipil-ipil pellets have also been exported to Japan. Export, however, is regulated to give priority to local consumption.

Financing ipil-ipil production

The Development Bank of the Philippines (DBP) launched a smallholder tree-farming project in 1978 with *Albizia falcataria* and *Leucaena leucocephala* as the principal species (the former was introduced in 1972). This project aimed at providing adequate and timely credit assistance to small-scale farmers with landholdings not exceeding 50 ha, either owned or leased, and intended for the propagation of fast-growing trees, especially on poor or marginal areas. After 3 years, the project benefited 237 farmers cultivating an area of over 3 000 ha, with the total amount of money loaned at 6.5×10^6 PHP (Diaz 1984) (in July 1989, 19 Philippine pesos [PHP] = 1 United States dollar [USD]). The maximum loan given to a farmer is 2 500 PHP/ha with an estimated gross income of 5 000 to 9 000 PHP over a period of 4 years for leaf meal and charcoal production, respectively. Diaz (1984) further pointed out that for every hectare of ipil-ipil plantation, the employment generated is equivalent to 4 500 PHP, which, for the 3 000 ha in this project, generated over 13.5×10^6 PHP.

Research and development on fodder production

Many research projects on ipil-ipil production and use have been undertaken by different institutions in the Philippines over the past 15 years. The main findings and recommendations are presented here.

Ipil-ipil cultivation

Mendoza (1984) drew the following six conclusions on management and yield following a decade of research at the University of the Philippines at Los Baños:

- Use only seeds with known purity and ability to germinate. Mixed or uneven stands tend to depress yields and make harvesting difficult.
- Plant in well-drained, near-neutral soil. Otherwise, provisions should be made to approximate these conditions.
- For high population density (250 000/ha), the optimum cutting height is 15 cm and the best cutting frequency is 60 days.
- For spaced plantings, optimum density per hectare is 10 000 to 20 000, with at most 1 m cutting height and 60 days cutting interval.
- The wood types (K8, K28, and K67) could also be managed for forage, provided they are planted at high densities and clipped more frequently (45–60 days).
- Annual dry matter yields ranging from 10 to 25 t/ha are possible depending on the combination of inputs and management techniques employed.

Ipil-ipil in agroforestry

Although ipil-ipil has been widely intercropped by Filipino farmers with a number of agronomic and horticultural crops, little attention has been paid to the fodder generated in these systems. The tree is simply treated as a source of green manure, shade, and nitrogen for the main crops, e.g., coffee, tea, cacao, rubber, young coconut, pepper, vanilla, citrus, pineapple, cassava, sweet potato, peanuts, papaya (PCARRD 1980a; Nguyen 1987).

Mabbayad et al. (1984) recommended the use of single hedgerows (2 m apart) intercropped with corn. This method eliminated inorganic fertilizer without affecting the yield of corn grain. Yields of 35.6 t/ha fresh forage were obtained after 16 months and five prunings with two corn intercrops. Nguyen (1987) demonstrated the workability of intensive agroforestry systems on land with a 15% slope in which ipil-ipil was intercropped simultaneously with papaya, pineapple, sweet potato (followed by peanuts), and cassava in contour furrows. This intensive system improved soil characteristics (except pH), completely controlled surface runoff and soil erosion, and increased productivity of the crops. This system generated 20 t/ha of green forage in 18 months. Kang et al. (1984) likewise recommended alley cropping as a stable alternative to shifting cultivation using ipil-ipil and other tree species intercropped with maize, cassava, and cowpea. In

this system, 15–20 t/ha of fresh prunings (5.0–6.5 t/ha dry matter) was produced with five prunings per year.

Ipil-ipil was used in these research projects primarily to maintain soil fertility for the food crops. It should, nevertheless, be pointed out that the forage generated in those systems, in addition to the crop residues available at harvest time, pose a very good opportunity for enhanced livestock production, particularly in upland areas.

Ipil-ipil fodder for ruminant production

In small farms, ipil-ipil for cattle feeding is normally grown in hedgerows to avoid using land valued primarily for crop production. In the hilly areas of Batangas province, ipil-ipil is intercropped with "atis" (*Anona squamosa*) and used extensively as cattle feed. Farmers observed that "atis" plants grown with ipil-ipil produced bigger fruits. A case study (Moog 1984) in Batangas involving a farmer with 2 ha of ipil-ipil planted in rows 3 m apart and anona trees between the rows showed that 20 growing cattle could be supported. Harvesting every 40–60 days, the farmer shared the extra feed with his neighbours and prevented the anona plants from being shaded. Moog (1984) observed that cattle fatteners in Batangas fed 350-kg steers at a daily rate of 5–20 kg fresh leucaena/head and obtained an average daily live weight gain of 0.5 kg, which could be increased to 0.8 kg with rice bran and other concentrate supplements. Without ipil-ipil and other supplements, cattle would gain about 0.3 kg daily.

The introduction of ipil-ipil to cogon (*Imperata cylindrica*) grassland to increase stocking rate has been studied (Moog et al. 1980). In a 315-day grazing trial involving swamp buffaloes, stocking rate doubled from 0.75 to 1.5 animal units/ha with the introduction of ipil-ipil (1 animal unit = 1 adult buffalo). Average daily gain and total weight gain likewise increased from 0.22 to 0.35 kg/ha and 51.1 to 167.9 kg/ha, respectively. The authors did not recommend further increase in stocking rate to 2 animal units/ha because of possible pasture depletion from overgrazing. One hectare of Guinea grass–ipil-ipil mixed pasture can support two and five head of grazing cattle during the dry and rainy seasons, respectively. An average daily gain of 0.5 kg/head could be expected, which is equivalent to 440 kg live weight/ha per year.

The use of ipil-ipil as a supplement to rice straw has been studied extensively in the Philippines using growing goats (Arinto 1979; Rasjid and Perez 1980), growing dairy heifers (Trung et al. 1984), and lactating cows (Trung et al. 1986). Likewise, ipil-ipil has been used to supplement protein-deficient but energy-rich corn silage for dairy cattle (Tables 4 and 5) (Trung et al. 1985; Escaño and Trung 1986). For cows in early and mid-lactation fed complete diets containing 60% dry matter from corn silage, replacing the concentrates (40% of diet dry matter) with ipil-ipil (20–30% of diet dry matter) did not alter milk production and feed efficiency. With rice straw levels ranging from 35 to 50% of total diet, ipil-ipil was included fresh, dry, or as leaf meal at 40–50% to replace conventional concentrate mixtures. In growing–fattening trials, when ipil-ipil partially replaced the concentrate (up to 72%), no significant changes in average daily gain (0.50–0.58 kg) were obtained. Feed efficiency was not as good in diets containing ipil-ipil as in those with concentrates (15.6 vs 11.9 kg/kg); however, the lower costs of the former offset the relative disadvantage in efficiency (4.6 vs 10.3 PHP/kg weight gain, respectively).

Table 4. Ipil-ipil as a supplement to rice straw for growing animals.

Diet[a]	Dry matter intake ($g/kg^{0.75}$)	Average daily gain (g)	Feed/gain
Philippine goats, 84 days[b]			
30% RS + 70% I	64.8a	35.7b	12.6b
30% RS + 50% I + 20% RB	71.8a	68.6a	7.7a
30% RS + 50% I + 20% M	70.4a	50.0ab	10.5b
Crossbred replacement dairy heifers, 180 days[c]			
35% RS + 65% C	95.3b	500a	11.9a
35% RS + 45% I + 20% C	131.3a	580a	15.6a

Note: Mean values in the same column for the same animal followed by the same letters are not significantly different ($P < 0.05$).
[a] RS, rice straw; I, ipil-ipil; RB, rice bran; M, molasses; C, coconut cake.
[b] Source: Rasjid and Perez (1980).
[c] Source: Trung et al. (1984).

Table 5. Ipil-ipil as a supplement to rice straw or corn silage for crossbred lactating cows.

Diet[a]	Dry matter intake (kg)	Daily milk yield (kg)	Feed/milk
Whole first lactation[b]			
35% RS + 65% C	9.45a	1 822a	1.09a
35% RS + 45% I + 20% C	12.65a	2 083a	1.53a
First 120 days of lactation[c]			
60% CS + 40% C	8.79a	7.37a	1.21a
60% CS + 20% I + 20% C	9.68a	7.60a	1.36a
96-day midlactation[d]			
60% CS + 40% C	10.62a	10.00a	1.06a
60% CS + 30% I + 10% C	10.80a	9.90a	1.09a

Note: Mean values in the same colomn for the same lactation stage followed by the same letter are not significantly different ($P < 0.05$).
[a] C, coconut cake; I, ipil-ipil; RS, rice straw.
[b] Source: Trung et al. (1986).
[c] Source: Trung et al. (1985).
[d] Source: Escaño and Trung (1986).

Likewise, with a complete lactation length involving first-calved dairy heifers, Trung et al. (1986) did not find significant differences in milk yield, milk composition, milk quality, or prepartum and postpartum reproductive performance between the cows fed ipil-ipil diets and control diets. Income above feed cost was higher when ipil-ipil replaced 72% of the concentrate mixture.

Toxicity of ipil-ipil because of mimosine or its metabolized form, DHP

(3,4-dihydroxypyridone), has not been encountered in the Philippines. For swine and poultry, this is due to the strict 5% upper limit for ipil-ipil leaf meal observed by commercial feed millers (PCARRD 1980b). Long-term feeding trials with cattle did not result in any ill effects on productive and reproductive performance (Tables 4 and 5). Likewise, Arinto (1979) fed Philippine goats with rations containing 0 to 75% ipil-ipil and reported better growth rates for goats with higher ipil-ipil levels without adverse effects on various reproductive parameters.

Psyllid infestation

Psyllid infestation, which is caused by *Heteropsylla cubana* or jumping plant lice, was observed simultaneously in the provinces of Cebu, Laguna, Batangas, and Rizal in February 1985. By September, the pest was present in huge numbers throughout the country. In 1985, the majority of ipil-ipil trees in the Philippines were almost completely defoliated.

Three national meetings among administrators, researchers, and extension workers were held in 1986-87 to assess the extent of the damage and to identify preventive and control measures. Pollisco (1987) synthesized the meetings and concluded that *H. cubana* infestation in the Philippines is nationwide. The total area of ipil-ipil infested by the pest nationwide is not available, but estimates of over 3 000 ha in Northern Luzon, 450 ha in Visayas, and 2 600 ha in Mindanao have been suggested. Because of even rainfall distribution, the degree of damage in Mindanao was not serious. No records have been made available for the provinces of Cebu and Southern Tagalog, where the infestation has been considered the most severe.

The National Electrification Administration (NEA) has 22 tree plantation projects nationwide. Massive attacks by ipil-ipil psyllid on NEA plantations were reported during the first quarter of 1986. In the second quarter of the same year, 18 sites were confirmed to be infested, ranging from mild to almost 100% infestation. Less affected were those areas belonging to "type C" climate, (rain sufficiently distributed throughout the year, with at most 4.5 dry months). Immediate actions of NEA included cutting down the trees, chemical spraying, and introducing alternative fast-growing species: *Acacia mangium*, *Acacia auriculaeformia*, *Gmelina* spp., *Eucalyptus* spp., *Gliricidia sepium*, and alibangbang or *Bauhinia* spp. (Pollisco 1987).

Ipil-ipil infestation has been claimed to affect the environment directly through microclimatic modification. It is a hindrance to reforestation and afforestation activities, as well as a problem to watershed management. Indirectly, it can increase the depletion of remaining forests as farmers substitute ipil-ipil with other species. Stabilized sloping uplands may likewise be seriously affected, thus further aggravating soil slippage and erosion in these uplands, which can cause siltation in the lowlands and water reservoirs. In areas where ipil-ipil is a major species for reforestation, the absence of leaves increases penetration of solar radiation, thereby heating the soil. The increased soil temperature causes higher mortality of plants, abnormal microbial activity, slower evapotranspiration, and reduced air humidity (De Guzman 1987a). The fallow period required in shifting cultivation to regenerate nutrients may become longer. In extreme situations, upland areas may

become unproductive and end up as grassland. Similarly, pastures may be overgrazed because of the over-dependence of the livestock industry on ipil-ipil.

The area most dramatically affected by the infestation is the livestock sector. The following accounts indicate the severity of the problem (De Guzman 1987b):

- About 2 000 ha of ipil-ipil, managed by the Manila Seedling Bank Foundation in Novaliches, Rizal, has produced no leaf meal since August 1985. A normal annual income of 8×10^6 PHP is expected from leaf meal production.
- Bureau of Animal Industry reports indicate that in Barrio Malimatoc, Mabini, Batangas, where small farmers use ipil-ipil as the major feed for cattle, psyllid infestation caused a drastic feed shortage for all 31 farmers surveyed. Lower quality feed substitutes such as banana leaves and trunks, corn stover, and coconut fronds were used. Consequently, 23 farmers claimed that their animals lost weight, 9 said their cattle became sick, 4 reported death of animals, and 26 reported a loss of profits. The number of animals owned by these farmers dropped from 116 to 53.
- In Cebu, three associations of ipil-ipil farmers, with a total of 770 members, each used to harvest 6–8 t/month of dried leucaena leaves. None has been harvested since the psyllid outbreak. One pelleting plant in Cebu reduced its work force from 50 to 4, and several plants in the same area stopped operations temporarily. Transactions in the livestock market eventually decreased.

Efforts have been made to alleviate the situation: i.e., chemical controls, biological controls, breeding, and introducing resistant species and accessories. Whereas the first three measures are still subject to research, the last measure has not contributed much because of the cost and lack of appropriate seeds. In Los Baños conditions, *Leucaena macrophylla*, Hawaiian hybrid (K67), and *Leucaena collinsii* have field tolerance (De Guzman 1987b). Studies are being conducted worldwide to determine the resistance of ipil-ipil and other legumes to the psyllid (e.g., Sorensson and Brewbaker 1987).

Substitutes for ipil-ipil

The Philippine experience with psyllid infestation demonstrates the dangers of depending on one leguminous tree, such as ipil-ipil. The concept of crop diversity and integrated land management for subsistence farmers is now seriously recognized by researchers and policymakers. Many shrub and tree species have been tried as replacements for ipil-ipil in contour hedges or plantations (Tables 6 and 7).

The tree that appears to be attracting the most attention is *Gliricidia sepium*. Known locally as "kakawate" or "madre de cacao," gliricidia is found in the Philippines from 6° to 19° N and at altitudes from sea level to 900 m in the four climatic types (Perino 1979). Gliricidia grows in most adverse sites, including areas where ipil-ipil does not thrive. It is a drought-resistant species that sheds its leaves during the dry season (November to April), when green feed is badly needed. This drawback is overcome by lopping the tree 2 or 3 months before the onset of the dry

Table 6. Promising shrub and tree species as substitutes for ipil-ipil in the Philippines.

Species	Comments[a]
Acacia villosa	• Rapid growth and good biomass production; tolerant to drought and infertility. • Prolific seeding, may become an aggressive weed; questionable fodder value. • Being recommended in Mindanao.
Albizia falcataria	• Introduced to small tree farmers ahead of ipil-ipil (1972 vs 1978). • Experience elsewhere indicates tolerance to acid soils and good for fuel and other wood uses.
Bauhinia menandra	• Being tested at FSSRI, UPLB.
Cajanus cajan	• Being tested at IRRI. • Multipurpose perennial shrub.
Cassia spectabilis	• Grows well along roadsides in Mindanao, is being tried successfully as ipil-ipil replacement in Cagayan de Oro.
Desmanthus virgatus	• Being tested at IAS, UPLB, and IRRI. • Research elsewhere indicates drought but not acid tolerant; aggressive; coppicing and reseeding well.
Erythrina sp.	• Being tested at FSSRI and IAS. • Good hedgerow and shade species. • Established by stem cuttings.
Gliricidia sepium	• In Cagayan de Oro, showing excellent promise as a green manure crop in alley cropping. • Widely used as shade for coffee and cacao; wood used for fencing, orchid growing. • Considered by farmers as unpalatable to livestock. • Although best propagated by seeds, stem cuttings are possible.
Hibiscus tileaceus	• Being tested at IAS. • For alley cropping (elsewhere).
Moringa oleifera	• Being tested at IAS and FSSRI. • Farmers planting as replacement for ipil-ipil; used as vegetable. • Findings indicate drought tolerance, low biomass production, and poor coppicing; grown from seeds and stem cuttings.
Pithecellobium dulce	• Being tested at IAS and FSSRI. • Findings indicate wide uses and adaptability.
Samanea saman	• Widely grown throughout the country and used as shade and craftwood/timber. • Susceptible to *H. sesbania* attack.

(continued)

Table 6. Concluded.

Species	Comments[a]
Sesbania grandiflora	• Used as vegetable and wood for fuel and fencing. • Findings show good intercrop with cassava, maize, peanuts, and soybeans; slow foliage regeneration.
Sesbania rostrata	• Being tested at DTRI and IRRI. • Very fast-growing and excellent N-fixer, but photosensitive.
Tamarindus indicus	• Being tested at FSSRI.
Trema orientalis	• Used as shade for commercial crops in agrosilviculture. • Being tested at IAS.

[a] FSSRI, Farming Systems and Soil Resources Institute; UPLB, University of the Philippines at Los Baños; IRRI, International Rice Research Institute; IAS, Institute of Animal Science; DTRI, Dairy Training and Research Institute.

Table 7. Nutritive value of fodders of some shrubs and trees (% dry matter basis).

Species	DMD	CP	CF	Ca	P
Albizia falcalaria	—	21.2	37.0	—	—
Cajanus cajan	—	17.3	28.1	—	—
Leaf	53	15.8	29.2	—	0.22
Small stem	42	10.5	48.7	—	0.25
Meal	—	14.8	28.9	—	—
Desmanthus virgatus					
Leaf	53	14.6	19.5	—	0.19
Stem	32	7.0	50.5	—	0.17
Gliricidia sepium					
Leaf	55–68	16–28	21	—	0.13
Leucaena leucocephala	51–71	22	14	2.7	0.17
Leaf	69	16	18.3	—	0.17
Stem	26	4.4	57.7	—	0.22
Samanea saman	—	24	48	—	—
Sesbania grandiflora	—	30–35	5–7	2.3	0.33
Tamarindus indicus	—	14–23	6–19	—	—

Note: DMD, dry matter digestibility; CP, crude protein, CF, crude fibre.
Source: Brewbaker (1985).

season. New shoots would grow and succulent feeds would be produced during the dry season. Easily propagated by seeds and cuttings, gliricidia replaces ipil-ipil very well in alley cropping, as a shade tree, and for green manure, fodder, and fuelwood. It coppices vigorously and tolerates regular lopping. In addition, zero cutting for 4 to 6 months also allows regrowth of branches large enough to be used as fuelwood in addition to the leaves.

Based on a 60-day cutting interval, Calub (1988) estimated that 200 trees in a hedgerow or a living fence of gliricidia planted 1 m apart could provide 25% of the daily feed required by a 300 kg cattle on a year-round basis. This is based on an annual dry matter yield per tree of 0.47 kg/cutting in the Bali accession. Calub (1988) cited an experiment from Sri Lanka suggesting that gliricidia planted 0.45 m apart yielded 4 kg edible fresh leaves per tree per year; hence, 400 m fenceline

Table 8. Edible herbage dry matter yield of fodder trees at Los Baños, Philippines.

Species	1985		1987				1988
			Dry season (Jan–May)		1 year		
	g/cutting per tree	g/tree per year	g/cutting per tree	g/tree	g/cutting per tree	g/tree per year	One harvest
Leucaena leucocephala[a]	361	722 (2)	274	274 (1)	274	547 (2)	—
Trema orientalis	143	143 (1)	921	1 842 (2)	504	2 016 (4)	99
Pithecellobium dulce	258	258 (1)	434	867 (2)	224	1 342 (6)	51
Moringa oleifera	259	259 (1)	238	475 (2)	128	765 (6)	167
Gliricidia sepium							
Local	196	196 (1)	717	1 434 (2)	330	1 980 (6)	68
Bali[b]	—	—	898	1 796 (2)	364	2 181 (6)	93
Desmanthus virgatus[b]	—	—	272	815 (3)	160	960 (6)	43
Hibiscus tileaceus[c]	—	—	441	441 (1)	187	747 (4)	64
Erythrina sp.[b]	—	—	867	867 (1)	243	1 213 (5)	66
Sesbania grandiflora[b]	—	—	883	1 765 (2)	434	1 971 (6)	42
Albizia lebeckoides[c]	—	—	192	192 (1)	185	371 (2)	—

Note: No cutting was done in 1986. Values in parentheses indicate the number of harvests.
Source: Calub (1988).
[a] *Heteropsylla* infestation allowed two harvests in 1985 and two harvests in 1987.
[b] Included in the 1986 test, but harvesting was done in 1987.
[c] Included in the 1987 test.

would support 25% of the feed requirement of a milking cow. For gliricidia plantations, Brewbaker and Glover (1988) reported dry leaf production of 12–36 t/year from 10 000 trees/ha with cutting intervals of 1–3 months. An ongoing fodder tree project indicates good potentials of gliricidia, catuiray (*S. grandiflora*), and *Trema orientalis* among others as possible substitutes for ipil-ipil as sources of green fodders, particularly during the dry season (Table 8).

Few feeding trials are being conducted with shrubs and tree fodders. At the Dairy Training and Research Institute, supplementary quantities for gliricidia, *Sesbania*, and *Boehmeria nivea* (ramie) to rice straw and grass are being determined using goats and cattle. As supplements, these feeds do not pose any palatability problem.

Fodder trees are being incorporated into goat production at the Mindanao Baptist Rural Life Centre (MBRLC) (Watson 1988). The dairy system uses 0.25 ha to support six does and their kids plus one buck. The plot is divided as follows: one-half planted to energy feeds such as sweet potato and cassava; one-quarter planted to protein supplements such as *Sesbania sesban* and *Calliandra callothyrsus*; one-eighth planted to napier grass; and the remaining one-eighth is contour lines of high-quality legumes like *Desmodium gyroides*, *Desmodium ransonie*, *Flemingia congesta*, and *Leucaena diversifolia*. Boundaries are planted with gliricidia. This system has been operating now for 2 years and is nearly sufficient in feed requirements. The MBRLC trial is an excellent example of how intensive livestock production can work in a self-reliant system that makes full use of land resources, with fodder trees playing an important role. Better or more suitable systems could be designed not only for Mindanao but also for other parts of the country.

The Government is giving a high priority to livestock development, and it is envisaged that the current ruminant population can be doubled or more. Considering the pressure on land use to support the ever-expanding human population, intensive livestock production appears to be the only solution. Maximum use of locally available feed resources is therefore essential. This would mean full use of crop residues and forages from marginal land and strategic supplementation with mainly high-quality leguminous fodders from shrubs and trees that can be conveniently planted on marginal lands, along fences, and along sidewalks. Shrubs and tree fodders would therefore be considered as a catalyst for increased ruminant production. Without this important feed ingredient, the full use of poor-quality feedstuffs, which are being neglected at the moment, is unlikely to be realized.

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