SHRUBS AND TREE FODDERS FOR FARM ANIMALS

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

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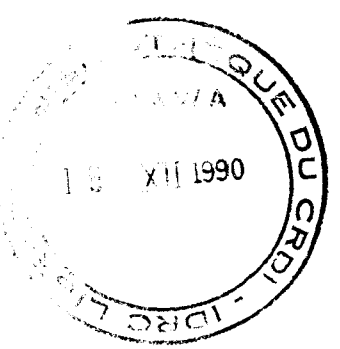

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Abstract

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 China

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Abstract *— This paper reviews information on the availability and use of shrubs and tree fodders in China. It is estimated that there are more than 400 species of shrubs and fodder trees in China, which could produce over 500 $\times 10^6$ t of fodders for animals. Their use is currently underestimated. Data are given on the nutrient contents of some tree leaves and on the use of feeds from* Pinus *spp. for egg production and* Robinia pseudoacacia *by pigs. Up to 10%* Leucaena leucocephala *leaf meal in the diet has been found to be beneficial to pigs. The importance of developing shrubs and trees for fodder to keep pace with an anticipated expansion in animal production is emphasized.*

Résumé *— L'auteur passe en revue l'information sur la disponibilité et l'utilisation, en Chine, des arbustes et des arbres fourragers, dont il y aurait plus de 400 espèces, capables de produire plus de 500 $\times 10^6$ t de fourrage. Leur utilisation est actuellement sous-estimée. Il avance des chiffres sur les nutrients contenus dans certaines feuilles d'arbre et sur l'emploi de* Pinus *spp. dans l'alimentation des volailles pour accroître leur production d'oeufs et de* Robinia pseudoacacia *dans l'alimentation des porcs. Les feuilles de* Leucaena leucocephala, *données sous forme de farine formant un maximum de 10 % de leur ration, seront bénéfiques aux porcs. L'auteur insiste sur l'importance de la mise en valeur des arbustes et des arbres fourragers en prévision de l'expansion prévue de la production animale.*

Resumen *— Este trabajo analiza la información relativa a la disponibilidad y uso de arbustos y rboles forrajeros en China, donde se calcula que hay más de 400 especies de arbustos y árboles forrajeros que podrían producir más de 500 $\times 10^6$ t de forraje para animales. Se desestima su uso en la actualidad. Se brinda información respecto al contenido de sustancias nutritivas de algunas hojas de árboles, al uso de forraje obtenido de* Pinus *spp. para la producción de huevos y a la utilización de* Robinia pseudoacacia *como forraje para porcinos. Se descubrió que hasta un 10% de harina de hoja de* Leucaena leucocephala *en la ración alimenticia de los cerdos resulta provechosa para ellos. Se pone de relieve la importancia de desarrollar arbustos y árboles destinados al forraje para avanzar al ritmo de la expansión prevista en la producción animal.*

Introduction

Shrubs and tree fodders are traditional, important feed resources in China, especially for cattle, sheep, and goats. Species used are very diverse and are found

in various climates. More than 400 species of trees and shrubs are cultivated, widely distributed, used by farm animals (Feng 1985), and of economic importance (Cai 1986). More than 500×10^6 t of tree fodder could be produced annually (Feng 1985; Wang 1985; Liu 1987). If only one-fifth of this is used as animal feed, the amount would be three times the total grain feed that is now used in livestock feeding. This great potential has attracted much attention because of the serious shortage of feed and arable land in China. Unfortunately, research on the availability and use of tree fodder is limited. Nevertheless, this paper reviews the results available in China.

Resources and evaluation

In terms of morphology and origin, tree fodders can be divided into three groups: needle leaves, broad leaves, and shrubs. The first two comprise forests; the third is an important component of the grasslands of China. A lot of research is necessary to get a clear idea about the amount of resources and their nutritional value. Some of the more important tree fodders are discussed here.

Pine needles

Pine needles are one of the main needle leaf fodders in China. They are produced industrially and used widely as animal feed, especially for pigs and poultry. There are more than 30 varieties of pine in China and at least 300×10^3 t of pine needle leaf meal could be produced annually (Huang 1985).

Crude protein varies among different varieties, as does the ether extract (Table 1). Ether extract contents of pine needle leaf are high. Values for total digestible nutrients have not been reported. In pig and poultry diets, pine needle leaf meal is used to supplement vitamins and trace minerals. Limited analysis indicates that pine needle leaf meal contains more than 120 ppm carotene, 522 ppm vitamin C, 3.8 ppm vitamin B, 17.2 ppm vitamin B_2, and 3.6 ppm selenium (Liu 1985; Li 1986). Soil analysis has shown that a large part of China is deficient in selenium. Pine needle leaf meal is rich in selenium and a good source of vitamins.

Zhao and Liu (1985) used pine needle leaf meal (*Pinus massoniana*) to replace 5% of corn in the diets of growing-finishing pigs. The daily weight gain was 572.3 g for the experimental group and 566.7 g for the control group. Li and Yu (1982) fed pine needle leaf meal to laying hens; diets contained 0, 3, 5, and 7% leaf meal. The best egg production rate was observed with the 5% leaf meal diet. In a second experiment, Li and Yu (1982) examined the effects of vitamins in pine

Table 1. Nutritive value of pine needle leaf meal (% dry matter basis).

Species	CP	EE	CF	NFE	Ash	Source
Pinus massoniana	8.5	7.7	29.2	51.3	3.3	Li (1986)
	25.5	5.0	22.5	42.4	4.6	Zhao and Liu (1985)
Pinus densiflora + *P. thunbengii*	9.7	12.0	29.4	45.1	3.7	Liu (1985)
Pinus densata	13.5	6.5	18.0	55.1	6.9	Liu (1985)
Pinus spp.	7.8	11.4	34.4	43.1	3.3	Liu (1987)

Note: CP, crude protein; EE, ether extract; CF, crude fibre; NFE, nitrogen-free extract.

Table 2. Effect of pine needle leaf meal on egg production.

	Treatment		
	I	II	III
Diet			
Base diet (%)	94	94	100
Pine needle leaf meal (%)	6	6	—
Vitamin complex (g/50 kg)	—	2.5	5
Egg production rate (%)			
One month before experiment	42.5	42.9	42.6
End of experiment (66 days)	54.5	63.2	60.7
20 days after experiment	49.8	53.9	51.8

Source: Li and Yu (1982).

needle leaf meal. The pine needle leaf meal could replace 50% of vitamin complex in laying hen diets (Table 2). Some reports also indicated the colour of the egg yolk improves if pine needle leaf meal is included in the diet (e.g., Liu 1987).

Broad-leaf fodders

A lot of broad-leaf tree leaves can be used by farm animals. Important trees include poplar (*Populus*), willow (*Salix*), elm (*Ulmus*), locust (*Robinia pseudoacacia*), and some fruit trees. The leaves are generally 5% of total tree's weight (Liu 1987). Total edible broad leaves useful for animals are estimated at 300 $\times 10^6$ t (Liu 1987; Huang 1985). Broad leaves are all rich in nutrients, especially crude protein and vitamins (Table 3).

Li and Zhou (1987) fed poplar leaf meal (*Populus acladesca*) to 35-week-old broilers. The base diets contained 16.4% crude protein, 11.77 kJ/kg metabolizable energy (ME), and a vitamin complex. The results indicated that increasing levels of leaf meal reduced egg production after 60 days (Table 4). Also, the egg yolk colour in groups I to III was much better than that in group IV, and 40% of the vitamin complex could be saved if the diet contained 7% poplar leaf meal.

The crude protein content of locust tree leaf meal is high, but varies with collecting season. The digestible energy of locust tree leaf meal for pigs was measured at the Sichuan Provincial Research Institute of Animal Husbandry and

Table 3. Nutrient content of tree leaves (% dry matter basis).

Species	CP	EE	CF	NFE	Ash	DE (kJ/kg)
Populus acladesca[a]	13.4	4.5	16.3	55.8	10.0	—
Robinia pseudoacacia[b]						
Spring	27.7	3.6	12.8	38.1	7.8	—
Summer	24.7	3.6	14.8	49.1	7.9	—
Autumn	19.3	5.0	19.4	48.9	5.5	—
Robinia pseudoacacia[c]						
Pinchangn county	20.7					5.7
Bazong county	19.4	5.6	19.2	48.1	7.5	4.5

Note: CP, crude protein; EE, ether extract; CF, crude fibre; NFE, nitrogen-free extract; DE, digestible energy (dry matter basis).

[a] Source: Li and Zhou (1987).

[b] Source: Liu (1987).

[c] Source: Sichuan Provincial Research Institute of Animal Husbandry and Veterinary Science.

Table 4. Effect of poplar leaf meal on egg production.

	Treatment			
	I	II	III	IV
Diet				
Base diet (%)	97	95	93	100
Poplar leaf meal (%)	3	5	7	0
Egg production rate (%)				
30 days before experiment	58.4	58.3	57.6	57.8
60 days experiment	67.4	62.5	64.5	60.5
30 days after experiment	62.6	61.3	60.6	60.2
Egg weight (g)	55.1	54.5	54.6	53.4
Fertility of eggs (%)	95.5	95.6	95.4	94.7
Hatchability of fertilized eggs (%)	89.7	92.2	89.3	89.5

Source: Li and Zhou (1982).

Table 5. Pig-feeding experiment.

	Treatment		
	I	II	III
Concentrate feeds (%)	90	90	90
Wheat bran (%)	10	5	—
Locust leaf meal (%)	—	5	10
Daily live weight gain (g)	532.4	590.2	520.9
Feed conversion rate	4.7	4.6	4.8

Source: Zhao et al. (1975).

Veterinary Science by using the vitro method described by Zhang and Nie (1986). Results indicate that locust tree leaf meal could be used at a 5% level in pig diets, replacing wheat bran, which is a common feed ingredient in China and often in short supply (Table 5).

Shrubs

Shrubs are widely distributed in China. In Guizhou Province, southern China, there are over 1 300 kinds of shrubs (Li 1988). The leaves and tender twigs of shrubs are rich in protein, vitamins, and minerals, but their nutritive value varies with maturity (Table 6).

Table 6. Nutrient content of some shrubs (% dry matter basis).

Species	CP	EE	CF	NFE	Ash
Lespedeza bicolor[a]	22.2	3.1	17.0	48.1	9.6
Caragana stanophylla[b]					
Early spring	10.6	6.2	42.3	37.5	3.4
Vegetative	18.7	5.9	38.1	31.0	6.2
Flower bud	23.8	4.8	34.5	25.3	11.8
Caragana pygmaca[b]					
Dry season	11.6	4.9	46.4	34.6	2.5
Strong budding	22.6	3.5	31.1	37.3	5.5
Late blooming	17.1	5.2	40.4	28.9	4.3

Note: CP, crude protein; EE, ether extract; CF, crude fibre; NFE, nitrogen-free extract.
[a] Source: Linmao (1985a).
[b] Source: Linmao (1985b).

Table 7. Pig-feeding test with leucaena leaf meal.

	Wong (1985)		Lizi (1986)		
	I	II	I	II	III
Diet					
Concentrate (%)	100	95	100	90	80
Leucaena leaf meal (%)	0	5	0	10	20
Daily live weight gain (g)	656.5	659.7	520	578	483

Shrubs are mainly used by grazing animals, especially goats. Recently, some have been processed into leaf meal and fed to pigs and other monogastric animals. In 1988, an animal husbandry station in Hebei Province used *Lespedeza* leaf meal to replace wheat bran in the diets of pigs and laying hens. During a 91-day pig-feeding experiment, the daily weight gain of the test group was 675 g; that of the control group was only 470 g. In a feeding experiment with laying hens, the control diet contained 10% wheat bran and the test diet contained 2% wheat bran and 8% *Lespedeza* leaf meal. The egg production rate of the test group was 3% higher than that of the control group over the 89-day experimental period. The researchers concluded that *Lespedeza* leaf meal was equal in value to wheat bran.

Wang (1985) and Lizi (1986) fed *Leucaena leucocephala* to pigs. Their results were nearly identical. According to Lizi, *Leucaena* can be included in the diet up to a level of 10%. There were no toxic symptoms at even 20% *Leucaena* (Table 7).

Use of shrubs and tree fodders

Grazing

Grazing by ruminants is the traditional way of using shrubs and tree leaves and remains the most common in areas where animal raising is the people's main means of livelihood. Most of these areas are in northern and western China, and in the Qing-Zang and Yun-Gui high plateaus. There are 286.7×10^6 ha of grassland in northern and western China, with about 220×10^6 ha available area and 100 million goats and sheep. The area is large but generally dry and cold. Shrubs and tree leaves are one of the main foods of goats and sheep. *Caragana*, *Calligonum*, and *Hedysarum* are important shrubs that are now planted in these areas.

In southern China, grazing districts are concentrated in the mountainous area. There are 46×10^6 ha of tropical and subtropical grassland, carrying about 26 million goats and 10 million sheep (Li 1988). Because of the wet, warm climate, the shrubs and trees grow very well. The farmers are mainly engaged in agriculture, but also traditionally raise goats and cattle in nearby woodlands and on grassy slopes. Because these grasslands are scattered among crop lands, farmers often have to tether their animals or hire someone to herd them to the mountains for grazing in the morning, returning late in the evening. Here, shrubs such as *Bauhinia championi*, *Coriaria sinica*, *Lespedeza* spp., *Rhododendron simsii*, *Spiraea pubescens*, *Rosa* spp., *Rhus chinensis*, and *Rubus* spp. are still abundant.

Cut-and-carry feeding

In agricultural areas and near large cities, the demand for meat and milk is high. People can earn more money in the dairy market than by planting crops. Therefore, dairy cattle (generally crossbred cows that can also help plow the field) and dairy goats are being developed in some rural areas where there is organized milk collection. Farmers prefer to confine these animals in a shed and cut and collect grasses and shrubs as feed. The extra work involved in finding and cutting forage for these animals brings considerable benefit to the farmers.

Processing into leaf meal

The practice of processing tree fodders into leaf meal and adding them to standard diets is developing rapidly in China. In the case of pine needle processing, the first plant was established in 1980. By June 1984, 8 plants were in production; 20 other plants are being established. To set up a 300 to 500 t capacity processing plant, about 100 000 CNY must be invested (in July 1989, 3.5 Chinese yuan [CNY] = 1 United States dollar [USD]). However, the net profit in 1 year could completely return the capital invested (Zhou 1986).

In the Yaobian Autonomous District of Jiling Province, the feed company only produced 5.35 t of leaf meal in 1981; however, the quantity reached 386 t in 1982 and 436.1 t in 1983 (Yanbian Siliaogongsi 1984). In a suburb of Beijing, since 1975, more than 6.5×10^6 kg of amorpha and locust tree leaves have been collected and added to animal feeds at 5–10% (Beijing Siliaogongsi 1979).

In Bazong County, Sichuan Province, the forage and feed station set up a small processing plant at a township in 1986 and rented it to a farmer. This farmer produced 132 t of locust tree leaf meal in 1988 and sold it to the feed company of Bazong. The income the farmer accumulated from running this business from June to September was substantial. Bazong County is now trying to establish more of these plants; leaf meal production could be increased at least 20-fold.

The importance of tree fodders

The importance of developing livestock is justified by the growing demand from the human population of China, which now stands at about 1.1 billion (10^9). The demand for meat and milk is increasing very quickly. At the same time, the arable land, especially for grain production, is decreasing (Table 8). Lack of feed has already become a limiting factor in animal production. However, if natural grasslands or grassy slopes are converted into arable land, ecological problems, such as soil erosion, will become even more serious.

Developing and using tree fodders is one important way of solving these

Table 8. Cropping area in China from 1975 to 1985 ($\times 10^6$ ha).

	1975	1980	1982	1984	1985
Total cropping area	149.6	146.4	144.8	144.2	143.6
Proportion (%)	80.9	80.1	78.4	78.3	75.8

problems. Tree fodders could be produced on marginal lands, combined with forest, or in areas not useful for grain production. Trees can also help to prevent soil erosion and sustain land use. Fodders could be used both as ruminant feed and as a feed ingredient for monogastric animals. Moreover, many tree fodders have not been fully explored. The Chinese government is now giving more attention to this field. Some grassland-improvement programs and herbivore-development projects are being initiated. A law protecting grasslands has been passed and, in many districts, cropping on a slope over 25° is prohibited. Most natural grassland and grass slopes have been assigned to farm households. Therefore, increased animal production based on shrubs and tree fodders is expected.

Toxic substances

Research on toxic substances is very rare in China, but toxic plants do create some problems for animals. In the mountainous areas of Sichuan and other provinces, for example, many cattle die between April and mid-May. The Provincial Research Institute of Animal Husbandry and Veterinary Science of Sichuan found that this was because the animal ate leaves from *Quercus* spp., which is widely distributed. Some experiments have also been conducted to study the effects of tannic acid. Much more research is required on toxic plants, the toxins involved, and ways to reduce their effects.

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