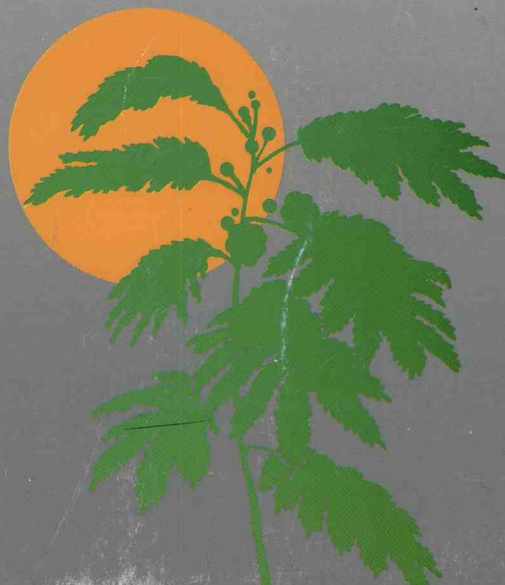


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# **SHRUBS AND TREE FODDERS OR FARM ANIMALS**

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



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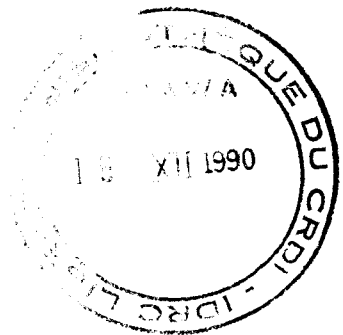
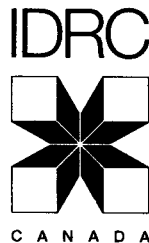
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# Shrubs and tree fodders for farm animals

Proceedings of a workshop in Denpasar, Indonesia,  
24-29 July 1989

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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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# Availability and use of shrubs and tree fodders in Bangladesh

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**Abstract** — This paper highlights the importance of shrubs and tree fodders and their availability and patterns of use as animal feeds in Bangladesh. Shrubs and trees are regarded as good fodder sources in the country. Using shrubs, tree leaves, tender shoots, stems, and twigs as feed for ruminants is a village tradition. The characteristics, types, and uses of common shrubs and fodder trees in the homestead, forest, and common lands are discussed. Institutional support to compile a complete inventory of forage shrubs and trees is necessary as is the need for regulated lopping and grazing in the forest, homestead, and common lands. Indiscriminate lopping often results in the death of desirable shrubs and trees. Special attention should also be directed to determine the nutritive value of various feeds and the nature and extent of various toxic elements.

**Résumé** — L'auteur souligne l'importance des arbres et des arbustes fourragers et précise leur disponibilité et leur utilisation comme fourrage au Bangladesh. Dans ce pays, les arbustes et arbres sont considérés comme de bonnes sources de fourrage. Donner à manger aux ruminants des feuilles d'arbustes et d'arbres, des jeunes pousses, des tiges et des brindilles est une tradition dans les villages. L'auteur aborde les caractéristiques, les types et les emplois des arbustes et des arbres fourragers communs de la ferme, de la forêt et des terres communales. Il affirme qu'il faut une aide institutionnelle pour établir un répertoire complet des arbustes et des arbres fourragers et qu'il s'impose aussi d'en assujettir à des règles l'émondage et le pâturage dans les forêts, dans les exploitations agricoles et sur les terres communales. L'émondage sans discernement aboutit souvent à la mort de bons arbustes et arbres. Il faut aussi s'attarder à déterminer la valeur nutritive des divers fourrages et la nature et l'importance des divers éléments toxiques qu'ils contiennent.

**Resumen** — Este estudio destaca la importancia de forrajes de arbustos y árboles y sus disponibilidades y pautas de utilización como alimento de animales en Bangladesh. Los arbustos y árboles son considerados como buena fuente de forrajes en el país. La población acostumbra a utilizar las hojas de árboles, arbustos, vástagos, tallos y ramitas como alimentación de rumiantes. Se tratan las características, tipos y usos de arbustos y árboles forrajeros comunes en la heredad, bosques y tierras comunales. Es tan necesario que se apoye institucionalmente la confección de un inventario completo de árboles y arbustos forrajeros, como también que la poda y pastoreo en los bosques, la heredad y tierras comunales se efectúe en forma reglamentada. La poda indiscriminada da por resultado, frecuentemente, la pérdida de árboles y arbustos útiles. También debe prestarse especial atención a la determinación



## **Introduction**

Livestock has been an essential component of the farming systems of Bangladesh for centuries. About 98% of draught power for preparing land for cereal crops, a substantial amount of power for transporting goods, meat and milk for human consumption, hides and skins, bones and horns as raw material for industry and export, manure for crop fields, and fuel for domestic use are all derived from the country's livestock. Although this sector's share of gross domestic product was only 6.2% in 1981/82, the indirect contribution through draught or fuel was large (BBS 1983). Gross output has been estimated at  $25 \times 10^9$  BDT annually at current prices, growing at about 6%/year over the past few years (World Bank 1983) (in July 1989, 32 Bangladesh taka [BDT] = 1 United States dollar [USD]). Livestock products are the third largest foreign exchange earner in Bangladesh;  $1.3 \times 10^9$  BDT worth of hides and skin were exported in 1979/80.

Cattle are the most important farm animals. There is about 21.2 million head in Bangladesh; cattle account for about 90% of the country's animal units (BBS 1986). About 0.46 million buffaloes are kept on the new diluvial (char) land of southern and northeastern Bangladesh. The total number of goats was estimated at 8.7 million, of which 40% are male and the remaining 60%, female. Most of the goat population is in the rural area (98%); only 2% is in the urban area. Goats are kept mostly by marginal and landless people to convert small amounts of roughage and browse into meat for sale. Most of the 0.5 million sheep are owned in large flocks by families who have or try to establish special land-use rights in the char areas. The contribution of sheep to the income of average rural families is negligible. Therefore, attention must be focused on goats. The poultry population is estimated at 78.4 million. They are widely distributed among rural households and are generally kept as scavenging birds.

## **Feed resources**

### **Feeds from arable land**

The major feed for livestock in Bangladesh is straw. About 2 kg of straw is available per head per day and supplementation is limited to about 1 kg of green fodder plus marginal quantities of cereal and oilseed by-products. Leguminous cash crops and pulses are mostly grown for grain, but their straw is also fed to livestock. Bangladesh produces a variety of different oilseeds. The most important of these are mustard and rape, with a total production of 116 000/year in 1980 (BBS 1983). These nonleguminous crops provide most of the oil cakes used as livestock feed. The balance is produced with sesame and groundnuts, with a combined production of about 50 000 t/year.

## Feeds from nonarable land

Nonarable land contributes most of the green fodder for ruminants in the country. With the extreme pressure on land, it must be considered as an important future source of feed. Nonarable land at the farm level is found around pond embankments, on bunds, and around homesteads. Outside the farms, it is usually public wasteland found along canals, rivers, roadsides, and railways. The Bangladesh Department of Forestry has planted arhar (pigeon pea, *Cajanus cajan*) along roadsides in different districts. The legume ipil-ipil (*Leucaena leucocephala*) has also been introduced. Trials have been made to grow traditional grasses like para grass (*Brachiana mutica*), napier grass (*Pennisetum purpureum*), guinea grass (*Panicum maximum*), and pangola grass (*Digitaria decumbens*) in some areas by the Directorate of Livestock Services. Results have been unsatisfactory.

## Importance of shrubs and tree fodders

The permanent use of arable land for fodder production is not part of traditional land use. Arable land is used for food and cash crops and there is no scope for fodder production in the near future. Forage species that are late maturing have no place in smallholder agriculture. However, many farmers cultivate leguminous forage species as cash crops at the end of kharif, using residual soil moisture and soil crops that can be planted with little or no tillage. Khesari (*Lathyrus sativa*) and matikalie (*Phasecolum aconitifus*) are the species most commonly used.

Although Bangladesh has no arable land for fodder production, there are numerous unconventional sources of feedstuffs for livestock. Among these, shrubs and tree fodders are important. Using shrubs and tree leaves, tender shoots, and twigs as fodder for ruminants is traditional in the villages of Bangladesh. Cultivation of these shrubs requires no extra arable land or labour. The use of shrubs and tree fodder as livestock feed has recently been increasingly recognized. In fact, more animals are now fed on shrubs and tree fodders than on traditional grasses. The growing importance of shrubs and leaf fodders in the livestock economy of the country has necessitated the planing of trees in bunds, riversides, waysides, and homesteads.

Information on the feeding pattern and use of shrubs and tree fodder for animals in Bangladesh is lacking. About one-third of Bangladesh is inundated during the monsoon season. House-cum-pond is typical in most flooded areas and, obviously, water plants are abundant throughout the year. Water hyacinth (*Eichornia crassipes*), which is plentiful everywhere, is unsuitable for cattle and buffaloes as a single feed; however, it can be fed to cattle and buffaloes mixed with rice straw. Dhaincha (*Sesbania aculeata*), a large shrubby herb 300–400 cm long with small leaves, is a useful fodder for goats and sheep. It is cultivated before the monsoon season.

Banana leaves and stems are another promising source of green roughage. Large quantities can be produced under rain-fed conditions on nonarable land. Banana is a cash crop producing the fruit for human consumption and the leaves and stems as fodder for ruminants. When fed to animals, the leaves and stems are chopped and mixed with straw. This mixture is an important green roughage for ruminants during floods and drought.

Table 1. Chemical composition (g/100 g dry matter) of traditional grass species, common shrubs, and tree fodders for livestock in Bangladesh.

Species	Dry matter (%)	Crude protein	Crude fibre	Ether extract	N-free extract	Total ash	Source
Traditional grasses							
Para grass (fresh)	24.3	3.2	25.9	1.1	59.8	10.1	Saadullah (1988)
German grass (fresh)	18.6	9.8	35.6	2.2	36.9	11.0	Saadullah (1988)
Pangola grass (fresh)	36.3	9.8	36.2	2.6	45.9	5.8	Saadullah (1988)
Shrubs and tree fodders							
Benian leaves	34.2 (88.9) <sup>a</sup>	12.2	23.1	2.1	41.6	5.1	Ali (1981)
Ipil-ipil leaves	88.5	25.0	16.0	4.6	46.8	7.2	Saadullah (1981)
Banana leaf meal <sup>b</sup>	90.8	15.5	25.5	9.5	30.0	19.8	
Water hyacinth leaves (sun dried)	92.0	26.0	13.2	2.5	51.6	6.8	Saadullah (1981)
Pakar leaves (sun dried)	87.4	14.3	29.1	3.3	36.2	4.9	Ali (1981)
Karie leaves (sun dried)	95.6	16.6	26.6	2.7	42.3	6.3	Ali (1981)
Sisoo leaves (fresh)	37.1	20.2	21.8	4.9	45.0	8.0	Khan (1965)
Mango leaves (fresh)	44.0	8.1	28.1	2.7	50.6	10.0	Khan (1965)
Jam leaves (fresh)	38.9	7.9	20.7	2.6	61.7	7.0	Khan (1965)

<sup>a</sup> Dry matter content of sun-dried leaves.

<sup>b</sup> Source: D. Hossain and S.M. Bul Bul (personal communication).

**Table 2. Live weight at slaughter and other physical characteristics of Black Bengal goats fed different ratios of dhaincha (*Sesbania aculeata*) and roadside grasses.**

Characteristic	Dhaincha:grass		
	100:0	50:50	0:100
Live weight at slaughter (kg)	16	13	11
Dressing %	62	57	45
Body length (cm)	58	56	55
Leg length (cm)	47	47	43
Width through shoulders (cm)	12	10	9
Width through hips (cm)	14	13	13
Width through legs (cm)	18	16	15
Body depth (cm)	25	25	24
Leg circumference (cm)	23	23	22

Source: Alam et al. (1978).

Leaves from various trees like jackfruit (*Artocarpus heterophyllus*), babla (*Acacia arabica*), mander (*Erythrina oralifolia*), karaie (*Albizia licida*), shewara (*Streblus asper*), and bamboo (*Bambusa tulda*) are fed to goats and sheep all over Bangladesh. Forest areas are almost all reserved and beyond the reach of most livestock. In spite of this, forests are important local sources of fodder and grazing, resulting in perpetual problems in forest management. Cattle and buffaloes graze in the forest when there is no other grazing land or when the forests provide better grazing than available grazing land. Goats are often excluded from reserved forests, but are permitted to browse in controlled forests. Lopping is common in most forests.

Information on the potential value of various shrubs and tree fodders as feeds for livestock in Bangladesh is lacking. Sporadic research has been conducted at the Bangladesh Agricultural University and the Animal Husbandry Institute in Dhaka. There is a variety of forage supplements throughout the country. They are traditionally used by farmers in the feeding systems of ruminants because of their easy accessibility, their wide variety, and because they reduce the requirement for expensive concentrates. Comparing the feeding values of grasses with those of shrubs and leaf fodders, relative nutritive values of the latter are not lower than the traditional grasses (Table 1). In fact, with trees and shrubs, nutritive values fluctuate less.

Dhaincha is a very palatable feed for goats. Studies have been done to determine its palatability and digestibility with Black Bengal goats (Alam et al. 1978; Alam and Wahed 1980). The dry matter intake and digestibility were 1.6 kg/100 g live weight and 66%, respectively. Black Bengal goats fed only dhaincha also showed a higher dressing percentage (Table 2).

Some research on the value of water plants as a supplement has also recently been performed (Khan et al. 1981; Hamid et al. 1983; Haque and Saadullah 1983; Saadullah 1984). It appears that supplementation of about 6 kg water hyacinth (7% dry matter) with rice straw could improve daily feed intake, live weight gain, and dressed carcass weight (Table 3). It also appears that water hyacinth as green supplement results in a better growth rate than traditional napier grass (Table 4).

Shrubs and tree leaves are believed to be important sources of protein for ruminants. In view of this, Huar and Saadullah (1988) studied the ruminal

**Table 3. Various characteristics of calves fed rice straw (RS) with and without water hyacinth (WH) (*Eichornia crassipes*).**

Characteristic <sup>a</sup>	Untreated RS		Urea-treated RS	
	+ WH <sup>b</sup>	- WH <sup>c</sup>	+ WH <sup>b</sup>	- WH <sup>c</sup>
Straw DMI (kg/day)	2.6	5.4	2.6	5.2
Fresh WH intake (kg/day)	6.5	—	6.3	—
LW gain (g/day)	114	132	227	227
Dressing %	35	32	36	36
Rumen/reticulum contents (% LW)	22	26	21	22

Source: Haque and Saadullah (1983).

<sup>a</sup> DMI, dry matter intake; LW, live weight.

<sup>b</sup> 250 g oil cake/day per calf.

<sup>c</sup> 500 g oil cake/day per calf.

**Table 4. Characteristics of calves fed rice straw (RS) with water hyacinth (WH) (*Eichornia crassipes*) or napier grass (NG) (*Pennisetum purpureum*).**

Characteristic <sup>a</sup>	Urea-treated RS		Untreated RS
	NG	WH	NG
DMI (kg/day)	2.5	2.5	2.3
Feed conversion (kg DM/kg LWG)	11.0	8.5	21.0
LWG (kg/day)	226	295	107

Source: Hamid et al. (1983).

<sup>a</sup> DMI, dry matter intake; DM, dry matter; LWG, live weight gain.

**Table 5. Nylon bag degradability (%) of crude protein of leaves commonly used as livestock feed in Bangladesh.**

Species	Incubation time (h)						
	3	6	9	12	24	48	72
Jackfruit	34	37	44	81	83	89	90
Ipil-ipil	40	44	58	68	80	85	86
Napier grass	33	35	37	58	69	77	78
Mango	31	33	37	46	63	68	71
Mander	33	43	44	55	57	60	61
Banana	47	49	53	54	55	57	60
Bamboo	35	37	39	39	41	45	51

Source: Huar and Saadullah (1988).

degradability of dry matter of various tree leaves traditionally fed to the ruminants in Bangladesh. The low degradability of bamboo leaves, followed by banana and mander leaves, indicates the possible availability of higher amounts of undegraded protein in the abomasum (Table 5). Saadullah et al. (1983) reported that the degradability of oil cakes was found to be extensive compared with fish meal, dhaincha, matikalie, and ipil-ipil (*Leucaena leucocephala*) (Fig. 1).

## Ownership and growing patterns

Trees, bushes, vegetables, and spices are grown mostly on homestead area. The species available in the homestead have some ecospecificity that determines their

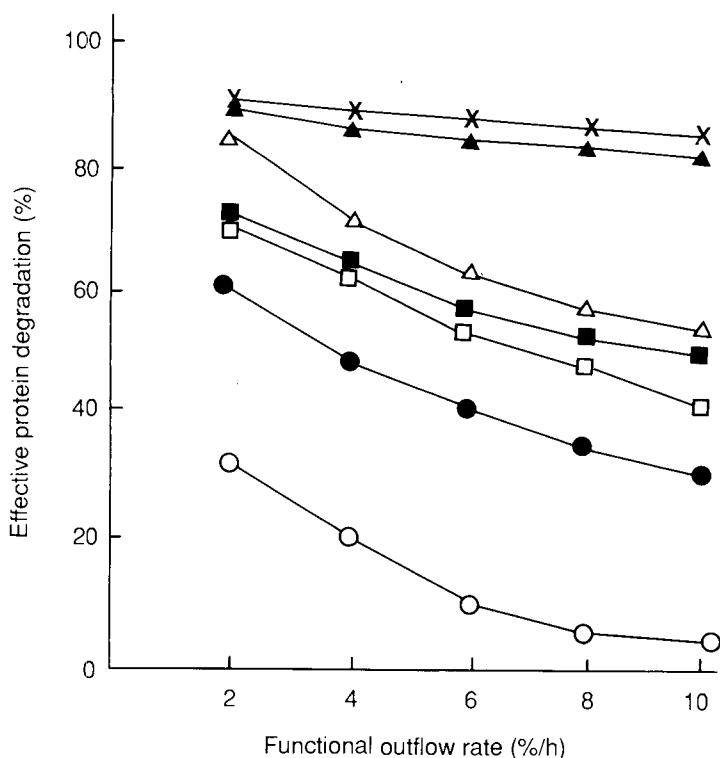


Fig. 1. Effective protein degradation in the rumen as a function of outflow rate: x, mustard oil cake; ▲, sesame oil cake; △, soybean meal; ■, dhaincha; □, matikalie; ●, ipil-ipil; ○, fish meal (source: Saadullah et al. 1983).

coexistence with livestock, poultry, humans, and the environment. Such plants have diverse uses. The growing pattern is generally spontaneous, that is, without purpose or care for propagation.

Khan et al. (1988) reported the existing agroforestry practices, ownership of trees in relation to landholding, and growing pattern in the homestead of different villages at the Farming Systems Research Site in the Jamalpur district of Bangladesh (Table 6). The results indicated that, for landless farmers, 47% of the total available land was occupied by the homestead; for large farmers, this was only 7%. The ownership pattern of the homestead greatly influenced the plantation. The tendency to plant was better (70%) with single-owner farms than with large farms. On the basis of availability and intensity of the plant species in the homestead, trees with diverse uses (fuel, animal feed, fuel, and fruit) are dominant. The number of trees per household or family was 7.5, 4.0, 12.4, 1.6, 1.7 and 1.0 for jackfruit, mango (*Mangifera indica*), banana, bamboo, jekka (*Lannea grandis*), and mander, respectively (see Table 1). It is important to note that the leaves or stems from these trees are useful fodders for cattle, goats, and buffaloes. Khan et al. (1988) reported also that the growing pattern of 56% of the trees was spontaneous; the rest of the trees (44%) were planted purposely. For plants species, the initial establishment needs care, but, once established, lateral propagation is spontaneous, for example, banana and bamboo.

Table 6. Shrub and tree fodder species available in the homestead in relation to land area.

Common name	Botanical name	Plants per family <sup>a</sup>			Total (all families)	Growing pattern	
		Landless	Marginal	Small	Large	Wild	Cultivated
Aswath tree	<i>Ficus religiosa</i>	0.0	0.0	0.1	0.1	100	0
Babla	<i>Acacia arabica</i>	0.3	0.2	0.4	0.3	100	0
Bamboo	<i>Bambusa tulda</i>	1.5	2.0	3.5	3.0	— <sup>b</sup>	— <sup>b</sup>
Banana	<i>Musa sapientum</i>	20.0	27.0	74.0	47.0	— <sup>b</sup>	— <sup>b</sup>
Banyan tree	<i>Ficus bengalensis</i>	0.0	0.0	0.1	0.1	100	0
Black berry	<i>Engenia jambolanum</i>	0.2	0.5	1.0	1.5	60	40
Cane	<i>Chrysalidocarpus roxburghii</i>	0.2	0.3	1.0	0.5	100	0
Coral tree	<i>Erythrina indica</i>	0.4	0.6	2.2	1.0	0	100
Demur	<i>Ficus glomerata</i>	0.0	0.2	0.3	0.2	100	0
Ipil-ipil	<i>Leucaena leucocephala</i>	0.2	0.1	0.9	1.0	0	100
Jackfruit	<i>Artocarpus heterophyllus</i>	6.2	6.4	16.6	8.8	10	50
Jekka	<i>Lannea grandis</i>	1.0	1.2	4.5	4.5	0	100
Jujuba	<i>Zizyphus jujuba</i>	0.4	0.8	3.3	2.2	60	40
Mandar	<i>Erythrina oralifolia</i>	0.6	0.8	1.4	3.4	0	100
Mango	<i>Mangifera indica</i>	3.0	4.6	9.2	5.4	50	50
Neem	<i>Azadirachta indica</i>	0.2	0.4	0.9	0.3	80	20
Rain tree	<i>Enterolobium saman</i>	0.3	0.1	1.0	0.0	90	10
Shilkari	<i>Albizia liciida</i>	0.2	0.4	1.2	0.6	40	60
Shoera	<i>Streblus asper</i>	0.5	0.3	0.8	0.6	100	0
Simul	<i>Bombax malabaricum</i>	0.2	0.2	0.4	0.2	80	20
Sisoo	<i>Dalbergia sisoo</i>	0.1	0.1	0.7	0.6	0	100
Tamarind	<i>Tamarindus indica</i>	0.4	0.2	0.9	0.9	85	15

Source: Modified from Khan et al. (1988).

<sup>a</sup> Landless, 0.01–0.49 acres; marginal, 0.50–0.99 acres; small, 1.00–7.49 acres; large, >7.50 acres (1 acre = 0.405 ha).

<sup>b</sup> Initially cultivated, then grown wild.

## Potential sources of shrubs and tree fodders

There is considerable potential for increasing fodder production. On arable land, this could be done using straw or additional cash crops intercropped with food or other cash crops. On nonarable land, permanent vegetation must be emphasized, yielding large amounts of biomass and maintaining the available shrubs and tree fodders for lopping and browsing by livestock. The description of shrubs and fodder trees presented here is based on Khan (1965). These shrubs and trees provide not only fodder for livestock but also fuel, fruits, and timber. Most are flood tolerant and provide fodder during dry periods, when leaves and twigs are the only alternative feeds. Trees are lopped whenever and wherever they are found. Although the demand for shrubs and tree fodders is likely to decrease by improving pasture management and fodder storage, trees and shrubs should be included as a stable constituent of rangeland. Lopping may be regulated where it is unavoidable, but it is essential that fodder trees be grown along with other species in plantations to create fodder reserves against periods of scarcity.

### Shrubs

Several fodder shrubs are found in Bangladesh:

- *Asaria (Capparis horrida)*: A climbing shrub with shoots and leaves covered with pubescence; leaves, oblong, elliptic, 5–10 cm long; found throughout; leaves and twigs eaten by goats and cattle.
- *Aswagandha (Withania somnifera)*: An evergreen undershrub 2–12 cm high; leaves thin, ovate; found throughout; fodder for goats.
- *Bamboo (Bambusa spp.)*: Bamboos are eagerly browsed by cattle and goats.
- *Begoon (Solanum indicum)*: An erect, 30–150 cm high shrub; prickles on the petioles and leaves; leaves ovate and truncate, base cordate or unequal sided; found throughout; leaves are fodder for goats.
- *Bhai-birung (Embelia robusta)*: A large, rambling shrub with sprawling branches; leaves, 6–15 cm by 4–8 cm, entire, elliptic, or ovate, thick pale beneath; found in Mymensingh district and Chittagong; medium quality fodder.
- *Chhagul buti (Daemia extensa)*: An extensive, slender, twinning shrub; leaves, opposite, 2–7 cm long, broadly ovate or suborbicular, base deeply cordate; found throughout; fodder for goats.
- *Delup (Saurauja roxburghii)*: A small evergreen, branches with white lenticels; leaves, 20–40 cm long with strong parallel veins diverging from the midrib; found in Chittagong forests and sometimes cultivated in villages for fodder; good fodder for goats.
- *Dhaincha (Sesbania aculeata)*: A large, shrubby herb 300–400 cm long with small weak prickles on branches and leaf rachis; leaves, 2–3 cm long, leaflets 20–40 pairs linear; cultivated throughout Bangladesh as green manure and sticks for fuel; leaves are useful fodder and liked by goats and cattle.
- *Guya-babul (Acacia farnesiana)*: An erect, thorny shrub, evergreen with light



brown rough bark; cultivated in different areas; leaves and green pods are excellent feed for sheep and goats.

- Juva (*Hibiscus rosasinensis*): A native of China, it was introduced as an ornamental; a large, evergreen shrub; leaves, 7–10 cm long, ovate, coarsely toothed; cultivated in gardens as hedge or ornamental; browsed by goats and cattle.
- Kabra (*Capparis decidua*): A prostrate and trailing species; leaves, broad orbicular; found throughout; medium quality fodder for goats.
- Kak dumur (*Ficus hispida*): A shrub or small tree; throws up abundant root suckers, branches stout, often hollow, marked by the scars of petioles and stipules; found throughout; a good fodder species.
- Kala, banana (*Musa sapientum*): A shrub-like herb, 150–350 cm high; thick stems, composed of convolute leaf sheaths; leaves very large, many-flowered petals shorter than calyx; wild and cultivated throughout Bangladesh; cattle feed during drought and flood.
- Lal-jhau (*Tamarix dioica*): A gregarious shrub, bark reticulately cracked, grows along open stream; twigs not articulate; leaves sheathing with a broad white margin; found in the hilly region; medium quality fodder.
- Madhubilata (*Hiptage madablota*): A large, evergreen, woody, climbing shrub; branchlets, young leaves, and inflorescence hoary or with a depressed tomentum, mature one is glabrous; found in Chittagong forest area, also cultivated in other parts of Bangladesh; medium quality fodder.
- Mankanta (*Randia dumetorum*): A large, deciduous, thorny shrub or a small tree; leaves, 3–7 cm by 1–5 cm, stipulate ovate acuminate; found in Sal forest, Mymensingh district; medium value for goats.
- Mathara (*Callicarpa macrophylla*): An erect, evergreen, 200–250 cm high shrub; twigs, petiole, peduncle, and leaves beneath densely wooly tomentose; found throughout; good fodder species.
- Nishinda (*Vitex negundo*): A large shrub; bark thin grey, branches whitish with fine tomentum; leaves opposite, digitately 3–5 foliate; found in Sunderbans and Chittagong; medium quality fodder in times of scarcity.
- Pola (*Kydia calycina*): A deciduous, soft-wooded, large shrub; young shoots, inflorescence and lower side of the leaves grey or tawny tomentose; leaves palmately 5–7 nerved, having a large gland on 1–3 of the nerves beneath; found throughout; medium to poor fodder, flowers commonly eaten by buffaloes.
- Shoera (*Streblus asper*): A rigid shrub; bark light grey or greenish with faint ridges, rough when old; juicy, milky; twigs, hairy and scabrid; good fodder, fed to cattle, goat, and buffaloes.
- Sun hemp (*Crotalaria juncea*): A large shrubby herb about 250–350 cm long with small weak prickles on branches and leaf; leaves, 4–6 cm long; cultivated in Tangail, Chittagong, Chittagong Hill Tracts, and Comilla district; leaves are valuable feeds for goat, cattle, and buffaloes.
- Tita-konga (*Dregea volubilis*): A stout, large, twinning shrub; branches rough

with raised lenticels; leaves, opposite, 6–15 cm by 4–10 cm; found in hilly areas; browsed by goats and sheep.

- Water hyacinth (*Eichornia crassipes*): An aquatic plant found throughout Bangladesh; grows rapidly and tends to clog streams and ponds in the areas where there is much surface water; valuable feed during drought and flood; fed to cattle and buffaloes.

## Fodder trees

The following trees of Bangladesh are useful for fodders:

- Am, mango (*Mangifera indica*): A cultivated, large to medium-sized tree; leaves are dark green, coriaceous; fruit, fleshy drupe; leaves are medium quality fodder for goats and cattle.
- Babla (*Acacia arabica*): An erect, medium-sized evergreen with rough, dark brown bark; wild and planted on riversides or highways; a very good fodder for goats and sheep; pods are fed to cattle.
- Badam (*Sterculia alata*): A tall, large tree with smooth leaves, entire, simple, glabrous; leaves used as cattle feed.
- Bel (*Aegle marmelos*): A small to medium-size tree, young shoots, hairy armed with sharp spines; leaves, alternate, trifoliate; a good fodder species in some areas.
- Bot, banyan (*Ficus bengalensis*): A large tree with rooting branches; branches spreading, sending down numerous aerial roots, which become trunks; wild and planted; lopped for fodder.
- Demur (*Ficus glomerata*): A large or medium-sized tree with figs on leafless branches; mature leaves glabrous; found in the plains; good fodder.
- Jum (*Garuga pinnata*): A large deciduous tree; found throughout; good fodder.
- Kanthal, jackfruit (*Artocarpus heterophyllus*): A large evergreen, 100–150 cm high; leaves, 10–20 cm long, entire, dark green; wild and cultivated throughout Bangladesh, especially in Mymensingh and Dinajpur districts; leaves eaten by goat and cattle; good fodder.
- Kaori (*Albizia procera*): A large, fast-growing timber tree; found throughout; lopped for fodder.
- Kool, barie (*Zizyphus mauritiana*): A large shrub or medium-size tree; branches often drooping, armed with stipular spines; leaves, velvety, tomentose beneath; lopped for fodder for goats and cattle.
- Moala (*Sterculia colorata*): Medium-size tree; branches have large leaf scars; leaves crowded at the ends of branches, broader than long, 3–5 cm lobed; found in the Chittagong and Chittagong districts; twigs and leaves are used as cattle fodder; good fodder species.
- Neem (*Azadirachta indica*): A large evergreen tree; found throughout; leaves are eaten by goats and sheep; good fodder.

- Rain tree (*Enterolobium saman*): A large evergreen that grows exceedingly fast; wild and cultivated; a fairly good fodder for cattle.
- Safed-babul (*Acacia leucophloea*): A medium-size deciduous tree; fed to goats and sheep; pods are fed to cattle in some regions.
- Sajna (*Moringa pterygosperma*): A medium-size to large tree that can be propagated by cuttings; young parts tomentose; leaves usually tripinnate; young pods are used for pickling and cereal; a good fodder species; branches are lopped for fodder; goats are especially fond of sajna.
- Sal (*Shorea robusta*): A large gregarious, deciduous tree, but seldom leafless; leaves glabrous and shining when mature, 10–25 cm long, base rounded or cordate; found in the forest area of Mymensingh, Chittagong, Khulna, and Dhaka districts; medium quality fodder at times of scarcity.
- Sisoo (*Dalbergia sisoo*): A medium-size to large tree; leaves are imparipinnate; wild and has been planted in the north east; frequently lopped for fodder.
- Tetul, tamarind (*Tamarindus indica*): A very large, unarmed evergreen with dark grey bark; leaves, even, pinnate, opposite, 10–20 pairs, 1–2 cm long; found throughout; good fodder.
- Tiktashk (*Crataeva religiosa*): Medium-size deciduous tree with large white lentils on the branches; leaves clustered at the ends of branchlets, trifoliate; found throughout; cultivated for its handsome flowers and fruits; leaves are lopped for fodder.
- Tut (*Morus indica*): A deciduous tree; leaves truncate or rounded, the base of some is slightly cordate and narrows into an acuminate apex; cultivated and wild in Rajshahi and Dinajpur districts; good fodder.

## Availability of by-products

Using information on land area and total yield of fruit trees (BBS 1983), the availabilities of individual tree and crop by-products have been calculated (Table 7). In some parts of Bangladesh, by-products are fed to livestock when feed is scarce. The extraction rates suggested by Devendra (1988) and Tareque and Saadullah (1988) have been used. Recycling of these wastes as animal wastes would be possible only after valid assessments of benefits, costs, risks, and toxicity have shown that benefits substantially outweigh costs and risks.

## Toxicity

In Bangladesh, little is known about the toxicity of various shrubs, tree fodder, and wastes. The presence of tannins, HCN, or prussic acid may kill an animal. Devendra (1988) summarized the various toxic principles found in common nonconventional feeds in Asia. Sobhan et al. (1970) reported that young shoots of bamboo (*Bambusa bambos*) contain a cyanogenic glycoside (0.0346 mg/100 g) and are poisonous. They also found that some plants in the Mymensingh district contained nitrate. Intoxication and death of animals after ingesting green fodder

Table 7. Availability and yield of by-products from fruit trees and field crops in Bangladesh.

Crop	Area (ha $\times 10^3$ )	Production (t $\times 10^3$ )	Extraction rate (%)	Yield (t $\times 10^3$ )
Banana	42	673		
Fruits (skin)			15	101
Stems			80	539
Leaves			30	202
Mango	45	181		
Kernel skin			50	90
Pineapple	15	153		
Waste			25	38
Jackfruit	21	204		
Seeds and skin			50	102
Sweet potato	66	580		
Vines and leaves			30	204
Sugarcane	0.2	7 023		
Bagasse			14	933
Green tops			12	843
Molasses			4	281

Source: BBS (1983).

containing nitrate has been observed in many studies (e.g., Sen and Rahman 1984; Sobhan 1984).

## Government policy

A more global view of livestock-sector constraints, development objectives, and support requirements was established in the development plan of 1981–1985. Feed shortages and deficiencies in the health and care of farm animals were identified as major constraints. There is currently no program to improve the fodder production of nonarable land (roadsides, embankments, field bunds, homestead plots) (World Bank 1983). Most nonarable lands are covered with natural grasses and shrubs. The Bangladesh Forestry Department, responsible for most public nonarable land, has begun roadside planting of pigeon pea in some districts. This generates some ruminant feed. The Department also plans roadside planting of fast-growing fuel and timber trees, which might help to increase the availability of tree fodder for livestock feeding. The Directorate of Livestock Services has been promoting the planting of tropical, traditional grasses on nonarable lands; however, lack of management, conservation, and overgrazing have rendered this effort largely unproductive. Of greater significance, the Directorate is planting different fodder trees like ipil-ipil on roadsides and embankments.

## Development and future strategies

The high demand for food has forced Bangladesh farmers to use their available land at high cropping intensities. Of a total area of  $14.2 \times 10^6$  ha, some  $9.3 \times 10^6$  ha are cultivable land (World Bank 1983). The unavailability of cultivable wasteland leaves little scope for expanding the current cropped area for traditional fodder production for livestock in the country. Consequently, emphasis must be placed on

the development, conservation, control, and use of shrub and tree fodder resources for increased livestock production.

The use of trees as an integral part of pasture requires that factors such as suitability of species, use (fuel, timber, fruit, or fodder), and soil type be determined. The comparative value (fuel, timber, fruit, and fodder) of forage shrubs and trees has to be considered while cultivating these shrubs and trees on homestead or common lands (roadsides, riversides, or embankments). In the hilly region and rain-fed areas of Bangladesh, where fodder cultivation is insufficient, the fodder requirements from shrubs and trees assume greater importance.

People resort to lopping trees and shrubs in the common lands, homestead, and forests. This is due to the large livestock population, the absence of a proper management system, and faulty methods of collecting fodder for animal feeding. Together, these factors may result in the disappearance of fodder trees and shrubs from such areas. Indiscriminate lopping and browsing often result in death of desirable trees and shrubs. Mostly, the trees in private and common lands are ruthlessly lopped. The *Upazilla Parishad* (local government) could minimize this vandalism by encouraging people to plant trees and shrubs on their own land and to cooperate in the use of common lands. Grazing or lopping may be reduced in the early spring to enable the shrubs and trees to become established. This would make it possible to implement rotational grazing.

In reserved forests, lopping and grazing is often forbidden. However, grazing and lopping may also be regulated: some trees may be protected, others may be lopped either on a rotation or special basis. Although foresters have long believed that the intensity of grazing should depend on the carrying capacity of forests, there is little information, based on properly controlled experiments, that could be used to determine optimal grazing incidence. Of course, a moderate amount of grazing in certain circumstances does not harm forests and may aid fire prevention. However, heavily grazed areas frequently become scrub or thorn forest, and are highly susceptible to damage. Therefore, grazing or lopping should be properly regulated if it is to improve the quality and quantity of resources. This may be done by monthly grazing in a particular area or block. Grazing could be limited by executive order or by imposing a nominal fee.

There is an urgent need for a complete inventory of forage shrubs and trees grown in the homestead, common lands, and forests. Such an inventory should cover nutritive value, characteristics, mode of collection, and use. Standard methods of analysis and experimentation are also needed so that the results achieved in different laboratory and countries can be reliably compared. Special attention should also be directed to the nature and extent of toxic substances such as HCN and tannins in shrubs and tree fodders. Studies on effective, low-cost methods of eliminating these toxic elements and their effects are also needed. Institutional support is essential for the intensive production and use of shrubs and tree fodder by small farms in Bangladesh.

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