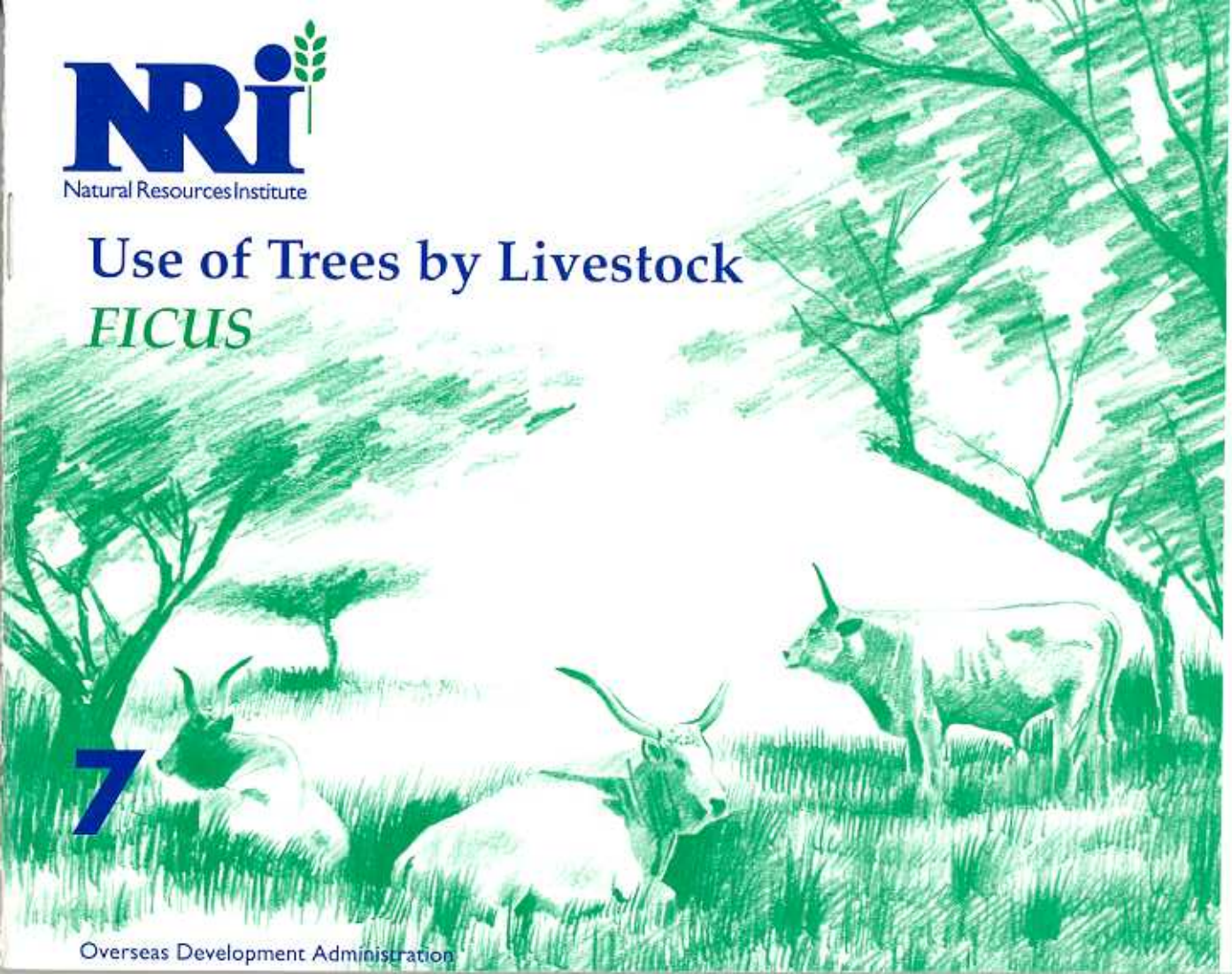

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Contents

Foreword

The importance of trees and shrubs in the feeding of animals in the tropics and sub-tropics has long been recognized by livestock owners. In arid areas where the growth of herbaceous plants is limited by lack of moisture, leaves and edible twigs of trees and shrubs can constitute well over 50% of the biomass production of rangeland. At high altitudes, tree foliage may provide over 50% of the feed available to ruminants in the dry season, branches being harvested and carried to the animals. Even in regions of higher rainfall where grass supplies the major proportion of the dry matter eaten by ruminants, tree leaves and fruits can form an important constituent of the diet, particularly for small ruminants.

In the last two decades interest in the planting of trees as a source of feed for livestock has been encouraged by workers in research and development, but in contrast to the hundreds of indigenous species which are used as fodder, attention has focussed on a limited number of introduced species. Thus there are many publications reporting the chemical composition of *Leucaena leucocephala* leaves and suggesting management strategies for utilization of the tree for fodder, but it is more difficult to find information on alternative genera which might be equally, or more, appropriate.

The aim of this series of publications is to bring together published information on selected genera of trees which have the potential to increase the supply of fodder for ruminants. Each booklet summarizes published information on the fodder characteristics and nutritive value of one genus, with recommendations on management strategies, where available. Further, since the leaves of woody species frequently contain secondary compounds which may have an anti-nutritional, or toxic, effect, a separate booklet summarizes the effects of a number of these compounds. It is hoped that the booklets will provide useful resource material for students, research and extension workers, interested in promoting the use of trees as a source of fodder for ruminants

Further copies of this booklet or others in the series can be obtained by writing to Publishing and Publicity Services at the Natural Resources Institute.

Margaret Gill
Livestock Production Programme

Genus *Ficus*

Family MORACEAE

Principal species

Ficus auriculata (syn. *F. roxburghii*)
Ficus benghalensis (syn. *F. indica*)
Ficus capensis
Ficus carica
Ficus cunia
Ficus elastica
Ficus elasticoides
Ficus exersperata
Ficus glaberrima
Ficus glomerata
Ficus glumosa
Ficus gnaphalocarpa
Ficus hispida
Ficus hookerii
Ficus iteophylla
Ficus lacor (syn. *F. infectoria*)
Ficus ligens
Ficus nemoralis
Ficus neriifolia
Ficus pseudosycomorus
Ficus religiosa
Ficus salicifolia
Ficus semicordata
Ficus sycomorus
Ficus teleukat
Ficus thonningii
Ficus tsiela

Common names

Fig
Earth fig
Banyan
Peepul

Summary

Ficus is a large genus which is distributed widely throughout the warmer parts of Asia, Africa, America and Australia. It was introduced into the Mediterranean region thousands of years ago for the production of figs, which are consumed fresh, dried or preserved and used in cooking and for the production of wines and spirits. Apart from food for humans, members of the genus are used for many purposes. These include the production of fodder, latex, bird lime and wax, medicines for both humans and animals, fibres for ropes and cloth, wood for internal construction, packing, small tools and fuel, and shade for crops and settlements. Some species have religious significance in Africa and the Indian sub-continent. Many wild animals, ranging from insects to bats and monkeys, feed avidly on the fruits of a large number of species of figs, and so are responsible for the natural dissemination of the seed.

From the point of view of livestock production, many species are important for the provision of browse and fodder for cattle and buffaloes, small ruminants and camelids. In general terms, the foliage contains high levels of total digestible nutrients and is rich in calcium, reasonably high levels of crude protein and moderate amounts of crude fibre. The major nutritional problems lie in the low concentrations of phosphorus and the relative indigestibility of the protein fraction. While the fruits and foliage of most species are well accepted by livestock, *F. elastica* and *F. tsiela* are known to be toxic, particularly to cattle and buffaloes, where ingestion of large amounts of foliage can lead to animal mortality. The toxic principles have not been specifically determined, but proteolytic enzymes, coumarins, furo-coumarins and alkaloids are all known to occur in the genus. Some fig species are deciduous, but others retain their leaves all year round.

Seeds of *Ficus* spp. show low levels of germination, but vegetative propagation, either by stakes, including apicormic cuttings, or by tissue culture, is both rapid and efficient. Many species are attracting attention, particularly in India and Nepal, as multi-purpose trees in reafforestation projects.

Description and distribution

Ficus is a large and varied genus and comprises some 800 species. The following general information is taken mainly from Uphof (1968); Willis (1973) and Mabberley (1987).

While most commonly cultivated for fruit production in warm temperate and Mediterranean regions, *Ficus* is frequently found in areas with tropical and subtropical climates. Members of the genus range in growth habit from shrubs to large, spreading trees, although many species are root-climbers, twiners and epiphytes. Adventitious and buttress roots are common and even the epiphytic members usually maintain contact with the soil through long aerial roots. Species such as *F. benjamina* climb up other trees, producing clasping roots which form a network that can eventually smother and kill the supporting tree. The banyan tree of India and Pakistan (*F. benghalensis*) is a crown-spreading species which starts life as an epiphyte. Aerial roots reach the ground and become accessory trunks. In this way, a single individual may occupy an area of several hectares.

In southern Africa, Coates-Palgrave (1983) recognized three groups of figs as follows:

- strangler figs, the seeds of which will germinate in the forks of branches. The aerial roots overwhelm and eventually smother and kill the support tree;
- rock-splitting figs, which tend to grow on rocky outcrops. The roots squeeze into crevices and cracks, splitting apart even great boulders; and
- free-standing trees and shrubs. Strangler and rock-splitting species can often grow as normal trees if the seeds germinate in open land.

Some members of the genus adopt a deciduous life-style. Thus, they are able to avoid unfavourable growing conditions by shedding their leaves and entering into a period of dormancy. While this has little influence on fruit yield, it can present special management problems when reliance is placed on the plants for animal feed. In addition to the direct loss of fodder, protein and digestible energy contents decrease and the fibre content increases in the period prior to the shedding of the leaves (Gohl, 1981).

The inflorescence of *Ficus* is hollow, consisting of a number of flowers (from 2 or 3, up to several thousand in the largest figs) inside a globular, or pear-shaped common recepticle, the narrow apical orifice of which is closed by small, overlapping bracts. Three types of flowers are produced: males, females, and sterile females known as gall-flowers. The sub-genera *Urostigma*, *Sycomorus* and *Pharmacosycea* are monoecious, all three types of flowers being produced on the same plant. In the dioecious sub-genus *Ficus*, male and gall-flowers are produced on one plant (gall-plant) and female flowers on another (seed-plant). In this case, both gall and seed plants must occur in the same locality for the formation of mature fruits. Pollination is carried out by insects which enter inside the fig to reproduce. For each species of *Ficus*, there would appear to be an individual gall-insect. These are often wasps belonging to one of several different genera of the Hymenopterous family Agaonidae (Chalcidoidea). Many fig species bear their flowers in stalked bunches growing from old parts of the stem, although others fruit on underground stolons growing from the base of the trunk. These may be up to 10 m long, the figs being buried up to 10 cm deep in the soil. The seeds, carried within the fig, take the form of very small nuts which are naturally disseminated by the animals and birds which avidly eat the figs.

Many species of *Ficus* produce a milky latex which is sometimes tapped as a source of bird lime, or rubber.

Ficus may have originated in western Asia, the figs of commerce probably being introduced into the Mediterranean region thousands of years ago. While chiefly found in Indo-Malaysia and Polynesia, the genus is well represented in the warmer parts of Asia, western and southern Africa, Australia and the Americas from Mexico, Central America and the Caribbean into Peru and Brazil.

Fodder characteristics

In an early report from West Africa, Dalziel (1937) saw little economic merit in the genus *Ficus*, and of 35 species which he described, only *F. iteophylla* in N. Nigeria was considered to be of value as a fodder tree. More recently however, in Oyo State, Nigeria (humid forest and derived savannah zone), Carew *et*

al. (1980) found *F. exersperata* compared very well with other indigenous browse species in terms of acceptibility. In northern Africa, in a Mediterranean climatic zone where browse is a more important component of rangeland than in the more tropical parts of the continent, Le Houerou (1980a) noted that *F. carica, F. ligens, F. pseudosycomorus, F. salicifolia* and *F. teleukat* were palatable to sheep, goats and camels. In more eastern areas of Africa, leaves and fruits of *F. thonningii, F. capensis* and, to a lesser extent, *F. glumosa*, are rated as highly palatable to domestic animals (Audru, 1980; Le Houerou and Corra, 1980). Bark, leaves and twigs of *F. sycomorus* are consumed by elephants (Lamprey *et al.*, 1980). In the Sudanian and Guinean zones, leaves of *F. gnaphalocarpa* are eaten by domestic livestock (Le Houerou, 1980b).

In Nigeria, *F. elasticoides* is a browse species which is available at all times of the year. It can be fed fresh but the leaves have good milling characteristics and could be included in prepared rations if necessary (Asiegbu and Anugwa, 1988). Anugwa and Okori (1987) estimated the nutritive value of the foliage of the tree species *F. elasticoides, Elaeis guineensis* (oil palm) and *Anacardium occidentale* (cashew). They found that the fresh *Ficus* leaves and petioles were well accepted by West African dwarf lambs and led to higher levels of apparent digestibility than the other tree species, ranging from 70.1% for crude fibre (CF) and ether extract (EE) to 81.8% for nitrogen-free extract (NFE). Although the crude protein (CP) levels were modest, the apparent digestibility was high at 73.9%. It was suggested that feeding fig fodder to lambs should be actively encouraged in Nigeria.

Reference is frequently made to the use of *Ficus* in Asia as a dry season forage where branches are lopped and the leaves fed to both large and small ruminants (Gatenby *et al.*, 1989a; Amatya, 1992; Upadhyay, 1992). In this region, several species of *Ficus* are highly rated as cattle feed. Gohl (1981) listed *F. benghalensis, F. carica, F. glomerata, F. lacor* and *F. religiosa* as being trees which are often lopped for fodder. In an area of Nepal where the average mature fodder tree can be expected to produce 50-90 kg of fresh fodder per year (Panday, 1982), *F. lacor* is capable of yielding some 150 kg of leaves and edible twigs. In a preliminary study with immature (4-5 year old) trees of *F. glaberrima* and *F. semicordata*, Amatya (1992) measured dry season yields of green matter of some 14 and 30 kg/tree respectively for the two species, of which 70% (November) to 80%

(March) was leaf and the rest twigs.

In the hills of Nepal, numerous *Ficus* spp. show potential for bridging the gap between the amount of feed needed by existing livestock populations and the availability from present feed resources (Gatenby *et al.*, 1989a). In a listing of the flowering plants to be found in the country, Hara *et al.* (1982) noted the presence of 35 individual species of *Ficus*. Research work is being conducted on a number of these, including: *F. semicordata, F. nemoralis, F. lacor* (syn. *F. infectoria*), *F. cunia, F. auriculata* (syn. *F. roxburgii*), *F. glaberrima* and others (Oli, 1987; Purohit, 1989; Dixit 1990). At the level of accepted usage, Gatenby *et al.* (1989b) listed *F. roxburghii* (syn. *F. auriculata*), *F. lacor, F. nemoralis* and *F. semicordata* as important feed resources for buffaloes in the Koshi Hills.

It is interesting to note that in the Salija area of Nepal at an altitude of 1800-2300 m, where tree fodders are of great importance in the feeding of livestock, 86% of the women, but only 27% of the men interviewed in a study (Gold and Rusten, 1993) listed *F. nemoralis* as their first choice for tree fodder for animal feed. This species is frequently found on privately owned lands where it grows close to the houses and is thus readily accessible. It is a small, easily lopped tree without protective thorns. The favourite tree of the men in the area was *Quercus semecarpifolia*, a large, thorned species commonly found in the uncultivated areas further from the houses at higher altitudes. Although more dangerous and difficult to harvest, it is likely that a given quantity of fodder may be lopped more rapidly from the larger trees.

In a wider ranging survey of the Dhading and Bara districts of Nepal (Upadhyay, 1991; Kapali, 1992), *F. neriifolia* was ranked second behind *Castanopsis tribuloides* as the most valued tree for animal production. No preferences relating to the gender of the livestock owners were recorded in this study.

A number of reports refer to the nutritive value of *Ficus* spp. (Mia *et al.*, 1960; Gohl, 1981; Chanda and Bhaid, 1987) and representative data are shown in Table 1. There is considerable variation both between and within species but this is due, at least in part, to the effect of season and to the deciduous growth pattern of many species within the genus. Further variation may be explained by differences in genetic potential, bioclimatic conditions and cropping systems. There would also appear to be differences

Table 1 Proximate and fibre analyses of *Ficus* spp.

	Dry matter	Crude protein	Crude fibre	Ash	Ether extract	NFE	*In vitro* DMD	ADF	Source
F. auriculata FRESH LEAVES AND TWIGS	35.0	13.5						36.0	
F. benghalensis FRESH LEAVES		9.7	22.6	14.4	2.9	50.4			2
F. carica FRESH LEAVES	34.2	14.2	17.1	16.7	5.9	46.1			2
F. exersperata LEAVES AND TWIGS	54.0	14.5	25.0	12.0	10.0	38.6	45.5	20.0	3
F. elasticoides LEAVES AND TWIGS (Wet Season)	52.6	14.9	21.5	12.5	4.7	46.4			4
LEAVES AND PETIOLES (Dry Season)	75.0	10.8	25.2	7.5	4.0	52.5	75.5 (*in vivo*)		5
F. glomerata FRESH LEAVES	48.0	10.1	15.0	13.4	12.5	49.0			2
F. gnaphalocarpa LEAVES	33.9	8.9	14.9	16.0					6
F. hookerii LEAVES	26.7	10.9	15.7	17.9	3.6	51.9			7
F. lacor MATURE LEAVES		12.5	20.0	13.1	3.5	50.9			2
SHED LEAVES		7.3	25.5	14.2	2.7	50.3			2
F. religiosa LEAVES		14.0	22.4		2.7	46.0			8
FRESH LEAVES AND TWIGS	50.5	11.7	26.1	15.3	2.9	44.0			2
F. sycomorus BARK, TWIGS AND LEAVES		8.4	24.6	10.4	1.9	50.1			9
F. tsiela DRY LEAVES (Hay)	90.3	8.1		18.1	4.0	52.9		40.6	10

Notes: NFE – Nitrogen free extract, DMD – dry matter digestibility, ADF – Acid detergent fibre.
Sources: 1 Pearson, 1990; 2 Gohl, 1981; 3 Carew *et al.*, 1980; 4 Mecha and Adegbola, 1980; 5 Anugwa and Okori, 1987; 6 Rose-Innes, 1967; 7 Gupta and Balaraman, 1989; 8 Mia *et al.*, 1960; 9 Lamprey *et al.*, 1980; 10 Chanda and Bhaid, 1987

between species of domestic livestock in the way in which they can utilize fig foliage. Goats utilized the nitrogen content of *F. religiosa* more efficiently than cattle (Mia *et al.*, 1960) and they were able to survive on a diet of *F. tsiela*, a species which is reportedly toxic to cattle and buffaloes (Divakaran Nair *et al.*, 1985). In common with many tree fodders, those species of *Ficus* which do not shed their leaves tend to maintain their quality well into the dry season, making them valuable feed resources when herbaceous vegetation is in short supply (Nehra *et al.*, 1987; Gatenby *et al.*, 1989a,b).

Goats appear to consume fresh fodder of *Ficus* spp. in relatively larger quantities than do cattle. To compare intake between animals of widely differing sizes, the amount of feed consumed may be expressed on the basis of daily voluntary intake of fodder dry matter per 100 kg of animal liveweight. Using this measure, goats were reported to consume 3.2 kg of *F. hookerii* (Gupta and Balaraman, 1989), while in a single, short-term experiment with *F. religiosa*, goats ate 5.2 kg, compared with 2.0 kg by cattle (Mia *et al.*, 1960). It is, however, uncommon for animals to be offered tree fodder alone unless no other feed sources are available. In the arid Haryana region of India, recommended daily feeding levels of fresh *F. religiosa* leaves and edible twigs are 1-2 kg/head for goats, 1-1.5 kg for sheep, and 3-4 kg for camels. The order of decreasing acceptance of tree fodders in general is considered to be goats, sheep and camels, with cattle showing least preference for browse (Nehra *et al.*, 1987).

Rusten and Gold (1991), reviewing indigenous knowledge regarding tree fodder in Nepal, noted a number of species, including *F. nemoralis*, which could increase both milk production and butterfat content when fed to lactating cattle. Other species such as *F. hispida*, *F. auriculata* and *F. lacor* are considered by many authors to be useful dietary components for both large and small ruminants. There are, however, few data available concerning the long-term effects of feeding fodder of *Ficus* spp. to livestock. Most of the work reported in the literature has been short-term, aimed at the study of metabolic balances over a feeding period of one or two weeks. The growth rates measured in such work do not necessarily bear a close relationship to animal productivity over a full season.

In an experiment with mature draught oxen in the Koshi Hills region of Nepal, animals with free access

to rice straw and 4 kg/day of freshly harvested leaves of *F. auriculata*, consumed more feed and regained more weight in the three weeks following a two-week period of work, than animals fed on rice straw alone. The tree fodder did not prevent the loss of some 8 kg/head during the work period but it allowed the oxen to recover the lost body condition in the following two to three weeks. Although both rice straw and tree foliage were considered to be deficient in nitrogen available to the rumen microbes, the author (Pearson, 1990) speculated that the tree fodder could be an acceptable alternative to expensive concentrates for working oxen kept on a diet based on poor quality roughage.

Murugan and Kathaperumal (1987) compared different supplements to sheep fed on a standard, low quality basal diet. Those animals with access to *F. religiosa* leaves gained 4.07 kg in weight over a post-weaning period of 84 days (48 g/day) while those supplemented with *Azadirachta indica* and *Enterolobium saman* leaves lost 0.53 kg and 0.23 kg respectively in the same period.

In the Nigerian work of Anugwa and Okori (1987) mentioned above, West African dwarf lambs gained 71 g/day over a 14-day period when fed a sole diet of *F. elasticoides* foliage. In a more recent study using the same fodder species and breed of sheep (Anugwa, 1990), the high nutritive value shown by the levels of digestible energy (12.26 MJ/kg DM), total digestible nutrients (68.8%) and digestible protein (11.5%), indicated the potential of the fodder for dry season ruminant production.

In the Mhow area of India, where it is common practice to feed goats on the leaves of trees gathered in the forest, an experiment was conducted with uncastrated male goats aged about 14 months and weighing some 25 kg. A diet of dried leaves of *F. tsiela* was fed together with 0.3 kg/day of wheat bran and 5 g of common salt. The animals consumed the tree fodder dry matter at an acceptable daily rate of 2.52 kg/100 kg body weight, and gained a modest average of 42 g/day liveweight. The leaves were relatively high in calcium (3.43%) but low in phosphorus (0.09%). The digestibility of the dry matter was estimated at 50.1% but the crude protein was almost totally indigestible and the feed was classified as inferior quality roughage (Chanda and Bhaid, 1987).

In a further study in the same area, *F. tsiela* was shown to be less economical for the feeding of goats

than other tree species such as *Hardwickia binata*, which could be fed without wheat bran supplements. Bundles of tree fodder offered for sale in the Patti Bazar included *Ficus* samples which consisted of 55% leaf and 45% twig and *H. binata* samples which consist ed of 75% leaf and only 25% twig. Since the price of the bundle did not vary with the fodder species, the daily feeding cost using *Ficus* and wheat bran was calculated at 163% higher than with the *H. binata* alone (Mehta and Bhaid, 1990).

In the Sikkim area of India, where trees commonly grown for fodder include a number of *Ficus* spp. (Bennet, 1985), dry matter of *F. hookerii* was consumed by local goats (average weight 25.6 kg) at a level of 3.2 kg/100 kg liveweight. The digestibility of the dry matter and crude protein were estimated at 54.3 and 35.7% respectively. The high level of calcium (3.38%) and the lower level of phosphorus (0.21%) were not dissimilar to those noted above for *F. tsiela* and animals showed positive balances for nitrogen and calcium, and a marginal negative balance for phosphorus when fed on a sole diet of the fig leaves. It was noted that *F. hookerii*, when supplemented with bone meal or minerals, could provide a maintenance diet for goats, although in view of the presence of anti-nutritive factors (possibly tannins), long-term feeding trials should be conducted to study potentially adverse effects (Gupta and Balaraman, 1989).

Although conclusive, long-term data are scarce, the evidence suggests that while the digestibility of the protein component, and the level of phosphorus in *Ficus* spp. may both be relatively low, the protein and calcium contents are high enough, at least in those species which are commonly utilized by livestock, to make them valuable as dry season forage.

Anti-nutritive factors

Although Panday (1982) has implicated *F. auriculata* in decreases in milk production, dysphagia and urinal disorders in bovines, only *F. tsiela* and *F. elastica* are commonly reported as causing specific toxic effects in domestic livestock.

Gohl (1981) noted that while several species of *Ficus* were commonly lopped for animal feed, particularly in India and Pakistan, the young leaves of *F. elastica* were poisonous to most animals, causing

profuse sweating, paralysis and eventual death.

Mortality in cattle and buffaloes due to consumption of the leaves of *F. tsiela* has been reported from a number of areas of India (Rajan *et al.*, 1986), although as noted above, goats are able to grow, at least for a limited period, on a diet of foliage from this species when it is supplemented with 0.3 kg/day of wheat bran (Chanda and Bhaid, 1987). The foliage, which is sometimes stored on farms for use as a manure for paddy fields (Divakaran Nair *et al.*, 1985), is readily eaten by livestock and toxicity has been provoked in young calves (2-3 months of age) by the consumption of a total of 2.5 kg of mature, tender leaves and soft stems over a period of three days, or by 3-4 kg spread over some 12 days. Physical symptoms, which occur within 4-12 days after ingestion of the fodder, include excessive salivation, frequent bellowing, laboured breathing and intermittent tonic convulsions. The symptoms are predominantly nervous in nature and associated with significant histological changes, including cerebral oedema and demyelination, together with renal and hepatic degeneration and necrosis (Divakaran Nair *et al.*, 1985; Rajan *et al.*, 1986). Pathological studies suggest that the leaves contain substances which predominantly affect the capillaries of the central nervous system.

Several potentially toxic substances have been isolated from *Ficus* spp. The proteolytic enzyme ficin is found in the latex of several members of the genus, including *F. carica*, the common fig. This compound is more toxic when administered intravenously than when ingested, and the toxicity depends primarily on the amount given, rather than on the concentration of the dose. Sub-lethal doses provoke vomiting, sanguineous diarrhoea and general prostration.

A furo-coumarin, ficusin (also known as psoralene), has been isolated from the leaves of *F. carica*, and a dialysable, alkaloid-like compound has been found in the latex. This species is known to cause percutaneous photosensitization in man, probably due to the presence of coumarins and furo-coumarins, including ficusin (Watt and Breyer-Brandwijk, 1962).

The leaves of *F. septica*, which are used in Papua New Guinea to cure fevers, fungal and bacterial diseases, contain a range of alkaloids, including tylophorine, septicine and autofine. A recent isolate is the new indolizidine alkaloid, ficuseptine.

Methanolic extracts of the leaves displayed intense antibacterial and antifungal activities (Baumgartner *et al.*, 1990). While many alkaloids are beneficial to both humans and livestock due to their medicinal properties, others are known to be toxic, the effect varying with the species of animal (Kingsbury, 1964; Southon and Buckingham, 1989).

Although precise identification of the toxic principles has yet to be made, it is likely that one or more of the chemical groups noted above could be involved in the reported animal mortality resulting from ingestion of *F. elastica* and *F. tsiela*.

It has been noted above that the protein content of the foliage of *Ficus* spp. is often poorly digested by livestock. Some fig species, such as *F. glumosa*, have been used for the tanning leather (Uphof, 1968), and it is well known that tannin, the active fraction in the process, is capable of interfering with the digestion of proteins (Mangan, 1988). Although published confirmation is lacking, it would seem likely that tannins are responsible for the occasional poor utilization of fig fodder.

The leaves of *F. exersperata* contain a high proportion of calcium silicate (Watt and Breyer-Brandwijk, 1962), an abrasive which may be capable of causing intestinal inflamation and associated health problems in both cattle and humans.

Management

In common with many plants that produce tiny seeds, the germination of *Ficus* spp. is often poor and *F. lacor*, an important fodder tree in Nepal at altitudes between 800 and 2000 m, has a germination rate of only 15% (Jackson, 1987). While this is adequate for natural regeneration, it presents problems for reafforestation activities. In such a programme in the central Himalayas of India, eight species of *Ficus* have been chosen for distribution to villagers as multi-purpose trees, by virtue of their resistance to drought and frost, high photosynthetic rates and efficiency of water usage. Fortunately, vegetative propagation is easy and both seedlings and stem cuttings are produced by the project for planting on small farms for use as shade, fodder, fuel wood and edible figs for jams and curries (Purohit, 1989).

Several techniques of vegetative propagation have been successfully utilized, particularly in the Indian sub-continent. In the middle hills region of Nepal, where *F. nemoralis* is highly palatable to grazing

animals, stem cuttings of about 1 m length are planted within the canopy of *Neolitsea umbrosa*, a small bushy tree that is totally unattractive to livestock and therefore ignored by them. The fig is protected from browsing as it grows up through the crown of the nurse tree (Gold and Rusten, 1993). Although no data are presented, farmers claim that the fig grows more quickly when associated with *N. umbrosa*, a species which is used locally for fuel wood, tools and utensils, and whose fruit is reputed to have medicinal properties.

In Senegal and Madagascar, a number of *Ficus* spp. including *F. thonningii* have been successfully propagated using apicormic shoots. These are large shoots which grow vertically upward from lateral branches and which exhibit many of the growth characteristics of mature seedlings. When cut at an age of about three years, they have a basal diameter of some 15 cm and are then trimmed to a length of 2.5 m. After cutting, they are laid horizontally in the shade for one week and then stood vertically for a further three weeks to harden before being planted to a depth of about 50 cm. These large cuttings establish rapidly and require little protection from browsing. The technique is well suited to the planting of trees as living fence posts, or in existing pastures (Jolin and Torquebiau, 1992).

An *in vitro* micropropagation technique was developed in Nepal for *F. lacor*, permitting multiplication by a factor of 20-30 every 8-12 weeks over a period of at least two years (Amatya and Rajbhandary, 1991). Shoot tip explants from standing trees were treated with benzyl aminopurine, kinetin and casein hydrolysate to promote shoot proliferation. Microshoots were rooted in sand at high humidity under a polythene cover. When rooted plants 5-6 cm high were transferred to soil for hardening prior to planting out in the field, no losses were suffered. Micropropagation offers the potential for cheap, rapid multiplication of disease-free planting stock from elite, individually selected parent trees.

In much of the area where *Ficus* spp. are important for the feeding of livestock, individual holdings are small and are not capable of supporting all of the nutritional needs of the animals kept on them. In India and Nepal, it is common practice to care for trees planted along the boundaries, or within the confines of the family property, but trees growing on common land and in communal forests are also

harvested, either by the owners of the livestock or by others, in order to sell fodder to stockmen (Mehta and Bhaid, 1990). The newly opened leaves of *F. nemoralis*, one of the most popular fodder species in the Salija area of Nepal, are nutritious, but are known to produce watery dung. Mature leaves, on the other hand, lead to more solid manure which is easier to collect and handle. Mature foliage is therefore harvested selectively where the manure from livestock is valued as an important resource for use within the cropping activities of the farm (Rusten and Gold, 1991).

In the Haryana region of India, with light soils and an annual rainfall of 250-500 mm most of which falls in about three months, naturally occurring *F. religiosa* is an important fodder tree. Trees on private land are usually protected but those growing along roadsides and on common grazing lands are often subject to over-use. Stockmen harvest foliage from all trees which are known to be palatable to livestock. The cut material may be fed to herded animals *in situ*, or carried back to stock kept in confinement. In times of plenty, surplus feed is cut for feeding later in the year. Under these arid conditions, lopping once per year of a single tree of *F. religiosa* will yield 150-300 kg of fresh, edible fodder, compared with 15-50 kg/tree for other local fodder species, including members of the genera *Acacia*, *Prosopis* and *Zizyphus* (Nehra *et al.*, 1987).

Optimum management practices and the resultant productivity of a particular tree will depend upon those variables which govern speed of plant growth such as soil fertility, rainfall, temperature, competition and biotic factors. In the arid Haryana region, however, where cutting should be minimized in areas prone to soil erosion, the following lopping recommendations have been made to ensure both the survival and the sustainable productivity of the existing tree fodder resource (Nehra *et al.*, 1987):

- only trees over 2 m tall, and branches over 7.5 cm in diameter should be lopped;
- only the lower two-thirds of the foliage should be removed;
- only mature foliage should be cut in a rotational lopping system, such that each branch is only cut once per year.

Alternative uses

As multi-purpose trees, members of the genus *Ficus* are used in a variety of ways in both subsistence and commercial agriculture (Watt and Breyer-Brandwijk, 1962; Uphof, 1968; Willis, 1973; Mabberly, 1987).

Perhaps the most important use is in the production of fruits which may be eaten raw, dried or preserved, used in cooking or for the preparation of wines and spirits. *F. carica*, the best known commercial fig, is probably native to southwest Asia but it has been cultivated in the Mediterranean region for some 6000 years. Many named varieties have been developed in a number of countries, and have been classified either according to the colour of the fruit, which may be deep purple or greenish yellow, or with the principal end use, such as fresh, dried, or preserved fruit. In Africa, America and Asia, many species other than *F. carica* produce fruits which are gathered for human consumption. These include *F. auriculata, F. capensis, F. cunia, F. padifolia, F. palmata, F. pumila* and *F. sycomorus*. At high altitudes in India, fruit yields of 112 kg/tree/year were reported from *F. recemosa* (Purohit, 1989).

Although the importance of latex production has decreased in recent decades due to the cultivation of the South American species *Hevea brasiliensis* and the development of synthetic compounds, a number of *Ficus* spp. have been tapped for rubber production. These include *F. elastica* (Assam, or India rubber), *F. vogelii* (Dahomey rubber), *F. nekbuda* (in the Congo) and *F. annulata* (in Australia and Malacca). Allied to the production of sticky latex, a number of species such as *F. anamani, F. benghalensis* and *F. glumosa* yield bird lime, which is used to trap small birds.

The bark of many species such as *F. artocarpoides, F. glumosa, F. lingua, F. luteola, F. michelsonii* and *F. vogelii* is used to make cloth, while the bark and twigs of *F. baroni* and *F. tinctoria* produce fibres used for ropes and fishing nets.

In Java, wax is extracted from *F. ceriflua* and *F. toxicaria*. This is used in batik work and also for the making of candles. In southeast Polynesia, a red dye is extracted from the fruit of *F. tinctoria*.

In several parts of the world, *Ficus* spp. are used in traditional medicines. The latex and bark of *F. anthelmintica* are used to treat fevers in Peru, while the same plant parts of *F. cotinifolia* are used to treat wounds and bruises in Mexico and Central America. The latex of *F. benghalensis* is used for bruises,

rheumatism and lumbago in Burma and Malaysia. A decoction of leaves of *F. crassinervia* finds a use in the treatment of liver diseases in Cuba. *F. septica* acts as an antidote to poisoning resulting from eating or touching some toxic species of fish and crabs in Malaysia. *F. involuta* and *F. lacor* are used in a range of medicines in Mexico and China respectively, while in India *F. hispida* is used in the treatment of jaundice, leprosy and anaemia (Acharya and Kumer, 1984). The latex of a number of species, including *F. carica*, shows anthelmintic properties associated with the presence of the proteolytic enzyme ficin.

The rough leaves of *F. exersperata* can be employed as a sandpaper to polish wood, while the bark of *F. glumosa* is used in the tanning of leather in parts of Africa.

The wood of *Ficus* spp. is often whitish grey in colour. It is light and fairly hard, and not usually durable, although timber from some species withstands prolonged immersion in water. It is of limited commercial value, used principally for cheap furniture, interior construction, tea chests, yokes and carvings. Species such as *F. benghalensis, F. glomerata, F. laevigata* and *F. mucoso* are employed in this way. Planks are cut from the buttress roots of *F. sycomorus*. Wood from lopped branches is often valued as a source of fuel.

Silkworms are fed on the leaves of *Ficus* spp. In India, *Theophila religiosae* is raised on leaves of *F. religiosa* and *F. benghalensis*, while in the northwest Himalayas, *Ocinara signifera* is grown on leaves of *F. tsjaleka*. Lac insects, kept for the production of shellac, are grown on *F. religiosa*.

Both *F. religiosa* (peepul) and *F. benghalensis* (banyan) have religious significance for Hindus and Buddhists, while in East Africa, *F. capensis* is revered by the Kikuyu people as sacred shrines or places of sacrifice to ancestral spirits.

Several species such as *F. macrophylla* (Moreton Bay fig) and *F. thonningii* are large, attractive, spreading trees which are often planted for shade in avenues and gardens in Australia and tropical Africa respectively. Other species are used to provide shade for crops and domestic animals and mark the boundaries of plots in the Indian sub-continent and Southeast Asia (Audru, 1980).

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