

# Chapter 1

## Trees—components of farming systems

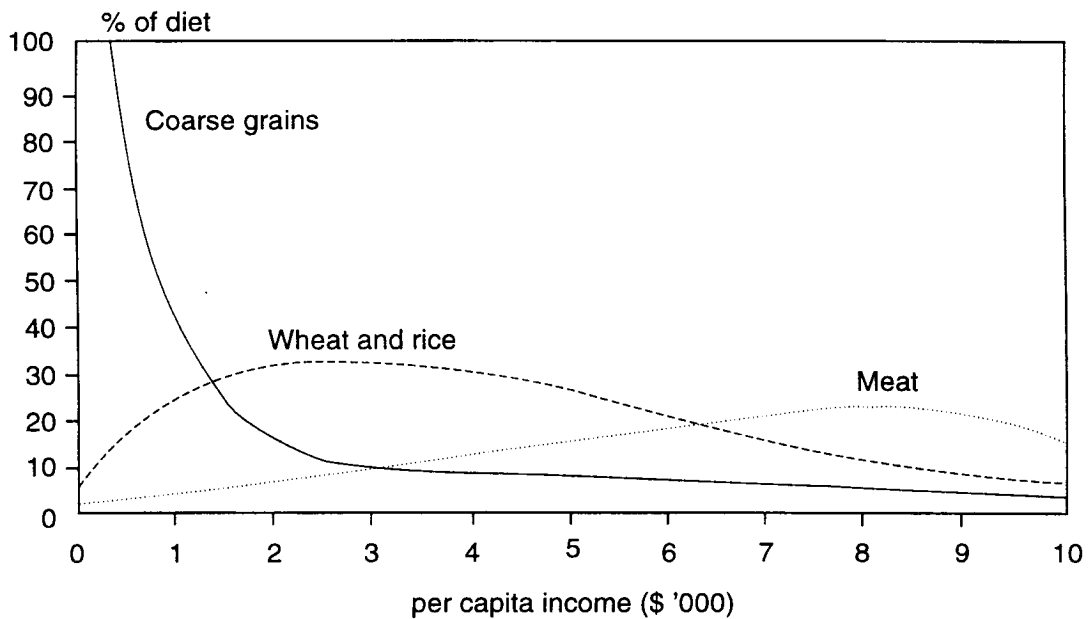
### 1.1 Introduction

Animals have crucial rôles to play in human food production, either directly or indirectly. In developing countries, ruminants are primarily kept as a source of draft power, as an accessible source of funds when sold, for milk production (mostly as a byproduct, but in some cases large dairy herds have been established) and often they are important as an indication of wealth and standing. Generally they are only slaughtered for food when crops and other resources become scarce.

Whilst cattle have remained largely as draft animals in developing countries, more emphasis is now on them as a source of high quality food (protein) particularly for the middle class. People demand more animal protein in their diet as their standard of living increases (see Figure 1.1 on the next page). Over many years, milk and meat availability increased only through expanding numbers of animals and there was little increase in production per animal (Jackson, 1981); this was largely owing to

the secondary importance of meat or milk production to draft power. The main feed resources for large ruminants have remained crop residues, agro-industrial byproducts or pastures from infertile lands, which, in general, support only low levels of production.

Figure 1.1: *The changing demand for meat/milk in developing countries according to per capita income (Marks & Yetley, 1987).*



The push for increased food from animal sources is probably only 30–40 years old, but it is now suggested that the demand for animal products will increase by 3.6% per annum in developing countries as compared with only 2.4% for plant products.

Increasing the efficiency and extent of ruminant production in developing countries will depend on:—

- improving the balance and availability of nutrients from a diet based mainly on agro-industrial byproducts and crop residues
- improving feeding, breeding and disease control
- developing ruminant production as a primary production rather than a byproduct of crop production

- developing animals with the genetic capacity to utilize feed efficiently within the environmental and management practices of a locality
- developing equitable markets for the products.

It is a basic premise in this publication that these changes must be brought about using local rather than imported resources.

## **1.2 Feed resources available for ruminant production in developing countries**

Because large ruminants are mainly found in cropping areas where land for pasture is scarce or non-existent, crop residues (straws and stovers) remain a single major resource used for feeding ruminants in developing countries. Another major resource is grassland that is either too difficult to cultivate or is of low inherent fertility. Pastures hand cut from roadsides, railway embankments, boundaries between crops and any other wastelands are also a major feed resource particularly in Asia. Another source of significant amounts of feeds is agro-industrial byproducts such as bagasse, molasses, sugar cane tops, sisal waste and oilseed cakes or meals.

Cellulose is the greatest single feed resource for ruminants world wide, with some 100 billion tons available worldwide annually. Cellulosic (fibrous) biomass is only usable as a major component of a diet by herbivores and ruminants in particular as it requires microbial fermentative activity for its digestion.

## **1.3 Overview: the potential uses of tree foliages**

Recognition of the potential of tree foliage to produce considerable amounts of high protein biomass has led to the development of animal farming systems that integrate the use of tree foliages with local bulky feed resources. In order to determine the suitability of trees/shrubs as components of ruminant fibrous diets, knowledge is required in many areas, including:—

- the capacity and ability of the tree to regenerate foliage when grazed or harvested
- the feeding behaviour of animals when confronted with tree forages

- the voluntary intake of tree foliage under different environmental conditions
- the adaptation of trees to the local conditions and their potential to become weeds
- the ease of seedling establishment, rate of growth and regeneration
- the growth pattern of trees/shrubs in relation to crops or pasture
- the required soil pH characteristics and nutrient status
- the nutritive value of the foliage and its change with harvesting, grazing or cultivation.

#### 1.4 Tree foliage as ruminant feeds— perspectives and properties

Ligneous plants, which may be large/small trees or shrubs, are an important component of the cellulosic and high protein fodder resources available for use by livestock and wildlife alike.

Foliage has been used as animal feed since Roman times and it appears to be the preferred forage of goats and some breeds of sheep as well as numerous species of deer, particularly on the arid savannahs. In more recent times, trees and shrubs have been introduced into cropping and grazing systems to provide green fodder high in protein to supplement the available low protein forage. These are grown in banks or hedges, between crops (alley farming) or as components of pastures and also as shade trees.

Tree foliage is being increasingly recognized as a potentially high quality feed resource for ruminants, particularly to supply crude protein. This is especially true in harsh and arid conditions where trees often provide more edible biomass than pasture and this biomass remains green and high in protein, even when pastures dry off and senesce. Because of their deep rooted nature, trees are able to tap water and nutrient resources deep in the soil profile. Many trees have micro-organisms associated with their root systems that allow them to mobilize soil bound mineral resources such as phosphorus and to fix  $N_2$  from the atmosphere into organic compounds.

In some mountainous or arid areas, it has been found that grazing ruminants contribute 90% to rangeland production and use 40–50% of the total feed available (see LeHourou, 1980). In the wet tropics of Latin and Central America, the Caribbean Islands, S. E. Asia and Africa, fodder from trees and shrubs, especially from leguminous species, are being used widely as sources of dietary supplement for ruminants.

Table 1.1: *World trade in oilseed cakes (Borgstrom, 1980). Industrialized countries imported the major proportion of oilseed cakes produced in developing countries. Figures are in 10<sup>6</sup> tonnes.*

	Imports	Exports	Net imports	Net exports
Industrialized countries	18.7	9.4	9.3	–
Developing countries	1.7	10.8	–	9.1

In the context of increasing human population numbers in the developing countries, decreasing land availability for forage crop production, increasing dependence of ruminants on “low quality” basal feed resources and competition for the available protein meals (most developing countries export their protein meals to developed or industrialized countries, see trade of protein meals, Table 1.1), tree foliages are increasingly seen as potential protein and energy supplements to increase productivity by ruminants.

Whilst foliage of trees has been a traditional supplement to straw based diets fed to ruminants in many countries, little has been done to develop the use of tree foliages to balance critical nutrient deficiencies. The greatest potential use is by small farmers who gather foliage from hedges, woodlands and waste ground to supplement goats, sheep and cattle fed straw based diets, or by ranchers in extensive grazing systems.

## 1.5 Trees in the agricultural ecosystem

It must be also recognized that apart from their rôle as animal feeds, trees and shrubs are valuable sources of:—

- fuel wood
- timber and fencing materials
- chemicals with pharmacological and other properties (about 50% of all pharmaceuticals arise from plants)
- food for humans (mainly fruits)
- green manure or mulch

- landscape improvement
- shelter and shade
- wild life habitat

and they play important rôles as they:—

- provide employment
- generate income
- protect soil from water and wind erosion
- cycle nutrients through leaf fall
- store carbon, which is important in decreasing atmospheric carbon dioxide accumulation and thus reducing the Greenhouse Effect.

Of these, the most important issues for small farmers in developing countries are food, feed, fuel wood and timber. The order of importance of these depends on the particular country or region. Many of the other uses of trees and their products will influence the adoption of ‘strategies’ for utilizing tree foliages as a component of the diets of ruminants and must be considered in the overview of trees on farms.

## **1.6 Tree foliage as basal feed or as supplements to other foliages**

The purpose of the discussion here is to review the potential of fodder trees as important nutrient sources for ruminants. Whilst it is well recognized that some tree foliages are palatable, digestible and are often high in protein, the detailed rôles of these forages as sources of critical nutrients in forage based diets are largely unknown.

The four potential rôles of tree foliages in ruminant nutrition are as a:—

1. high quality, high digestibility biomass resource
2. supplement to provide nutrients deficient in the diet, an enhancement of microbial growth and digestion of cellulosic biomass in the rumen of cattle, sheep and goats

3. source of protein that escapes rumen degradation to be digested in the intestines and enhance the protein status of the animal
4. source of vitamins and minerals to complement deficiencies in the basal feed resource.

In the following discussion the basic concepts of ruminant nutrition and the mechanisms by which these animals use low quality forages are discussed to enable the reader to appreciate the potential of tree foliages to fit into the above four rôles. The use of tree foliages as the only feed resources is not discussed at length because it is apparent that in most developing countries such a system is probably uneconomic, although it is occasionally encountered. For example, mulberry (*Moracea* sp.) foliage in Costa Rica forms a large proportion (i.e., 3.4% DM liveweight) of the feed intake in goats, supporting high levels of milk production (Rojas & Benavides, 1994).