

World Distribution and Utilization of Mulberry, Potential for Animal Feeding

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Introduction

The scientific name of Mulberry is *Morus spp.*, a genus belonging to the Moraceae Family of the Urticales Subclass, and it is usually associated with sericulture, the production of silk with the silkworm (*Bombyx mori*). The domestication of mulberry must have started several thousands of years ago as a requirement for silkworm rearing (FAO, 1990).

Considering that the silk trade has been going on for a long time throughout the Old World, and that this plant is also cultivated for its fruit and for landscaping, mulberry germplasm has been taken to a lot of countries, and it now has a very wide distribution range in Asia-Europe (from Korea to Spain, including China, India, Central Asia and Near East); in Africa (North and East Africa) and in America (from the U.S.A. to Argentina, including Mexico, Central America, Colombia and Brazil). The origins of most cultivated mulberry varieties are believed to be in the area of China-Japan and in the Himalaya foothills.

Silk production was important in Europe during the 19th and early 20th Centuries, as it was in Japan and Korea up to the middle of the 20th Century. Silk production nowadays is dominated by China and India.

Although in some countries of Asia mulberry leaves have been traditionally fed to farm animals, interest in the intensive production of mulberry and its utilisation for animal production

started in several countries in the late 1980s and early 1990s. The attractive biomass yields, the palatability and the exceptionally high nutritive value for ruminant and monogastric animals, have been the reasons behind the great interest in mulberry for animal feeding in recent years.

This introductory paper gives a general framework of mulberry in the world without going into specific details, which will be covered and discussed during the conference.

Species and Varieties of Mulberry

There are about 68 species in the genus *Morus*, and the majority of them occur in Asia (Datta, 2000). In China, there are over a thousand varieties under cultivation. They originated from four main species, the White mulberry (*Morus alba*), the Lu mulberry (*M. multicaulis*), the Mountain mulberry (*M. bombycis*) and the Guangdong Mulberry (*M. atropurpurea*) (Yongkang, 2000).

In India the main species are *M. indica*, *M. alba*, *M. serrata* and *M. laevigata*, which grow naturally in the north of the country (Ravindran *et al.*, 1997). Most of the cultivated varieties belong to either *M. indica* or *M. alba*. In Mysore (India) The Central Sericulture Research and Training Institute keeps 223 mulberry cultivars: 78 indigenous; 44 exotic; 21 unknown and 101 elite hybrids (Sastry, 1984).

In the Republics of the ex-USSR, the most common species are *M. multicaulis*, *M. tartarica* and *M. nigra* (Datta, 2000). In Indonesia (West Java) there are seven species: *M. alba* (varieties *tartarica* and *macrophylla*), *M. nigra*, *M. multicaulis*; *M. australis*; *M. cathyana* and *M. miorovra* (Katsumata, 1972). In Vietnam they have over 100 varieties, mainly *M. alba*, *M. nigra* and *M. laevigata* (Katsumata, 1973). According to Janaki Ammal (1960) only *M. rubra* is native to America.

The most popular species in the world are believed to be *M. alba* and *M. indica*. These have been the subject of intensive selection from open pollination, controlled hybridization and selection and mutation breeding in several countries, resulting in over a thousand varieties including many polyploids. In Brazil there are about 90 varieties, all *M. alba* (de Almeida and Fonseca, 2000).

A key to the taxonomy of mulberry, as proposed by Chinese scientists will be included in a paper on mulberry in China in this conference (Yongkang, 2000)

Current Uses of Mulberry

Sericulture. The most important use of mulberry globally is for the production of the silkworm, that feeds exclusively on its leaves. The country with the largest area of mulberry is China with approximately 626,000 ha, then India with nearly 280,000 ha. Several other countries (e.g. Thailand and Brazil (35,000ha)) still have some mulberry production but on a much smaller scale.

Silk projects have and are being started in various developing countries, particularly in Africa and Latin America. Regardless of how successful or sustainable they have been, these projects have been responsible for the introduction and dissemination of mulberry varieties to different soil and climatic conditions.

Fruit. All throughout Asia, but in particular in Central Asia and in the Near East, mulberry is highly appreciated for its delicious fruit, which is consumed fresh, or in the form of juice or preserves. A few mulberry orchards also exist in Latin America.

Wood. Especially in the Indian subcontinent, mulberry wood is used for handicrafts, cabinetwork and for sporting woods (e.g. Grass-hockey sticks and tennis rackets). Its thin branches are woven into baskets.

Landscaping. In Asia, Southern Europe and in Southern U.S.A. (Tipton, 1994), mulberry trees are utilized for landscaping. Their resistance to pruning and their low water requirements, make them very suitable plants for urban conditions, house gardens, street shade and city embellishment.

Medicine. A variety of medicinal properties have been attributed to the different parts of the mulberry plant (Datta, 2000). Leaves are also dried and used in infusions in Asia (e.g. China, Thailand)

Forage. Silk producers have traditionally fed mulberry refusals, leftovers from silkworm feeding, to farm animals and to herbivorous carp in polyculture fish ponds (Gongfu *et al.*, 1997). In this sense, farm animals are well integrated into silk production. There have even been economic studies of the combined benefits from silk and dairy production in India (Mehla *et al.*, 1987). A review on the mulberry for animal feeding will be published in the next issue of World Animal Review (Sánchez, 2000).

In the countries south of the Himalayas, where mulberry trees occur in nature, their foliage has been part of the traditional mixed diet of domestic ruminants. In India, there have been numerous research reports on the use of mulberry residues and leaves for various domestic animals, from cows to poultry. In general terms, Indian scientists have considered mulberry foliage as medium quality forage.

Some small farmers in East Africa, mainly in Tanzania and in Kenya, harvest foliage from mulberry trees and include it as part of the diet offered to ruminants in confinement. Although its nutritive value is recognized in these countries, there has not been much planting of mulberry for this purpose.

Since the late 1980s and mainly in the late 1990s, the cultivation of mulberry as forage has expanded considerably in

Latin America (LA), in Central America and in the Caribbean in particular, but it is still mainly associated with research institutions. This has been mainly the result of the initial studies done by the Tropical Agricultural Research and Higher Education Center (CATIE) in Costa Rica and in other Central American countries (Benavides, 1994) and the expansion by a number of research and development projects. There have been, however, in other countries in LA, independent initiatives to feed mulberry leaves to various species of farm animals (e.g. Brazil, Colombia).

Mulberry Research

Extensive research on the various components of the cultivation of mulberry has been carried out in several countries, always depending on the viability of local silk production. Much work was conducted in several European countries beginning in the 19th Century, for example France, Italy, Bulgaria, and Poland. By the middle of the 20th Century, silk production in Europe had practically disappeared. There was also significant production and studies in Japan and Korea in the middle of the 20th Century.

Currently, most of the mulberry research for sericulture takes place in China and India, with several institutions actively involved in both countries. For fruit and for silk production, studies are carried out in the Central Asian Republics of the ex-Soviet Union, for example in Uzbekistan, Turkmenistan, Tadjikstan and Kyrgystan.

Studies on mulberry as animal feed are or have been conducted in Japan, India, Tanzania, Kenya, Costa Rica, Colombia, Mexico, San Salvador, Guatemala, Brazil and Cuba. The most active research on mulberry for animal feeding is currently taking place in Cuba. Research includes agronomic aspects, harvesting modalities, forage preservation and animal trials.

Potential of Mulberry for Animal Production

It is not by chance that mulberry germplasm is causing so much interest as an alternative high quality feed for farm animals. Over several hundred, and perhaps thousands, of years, mulberry species and varieties have been selected and improved to feed the silkworm, which is nutritionally very demanding. The aim has been to produce greater quantities of leaves of higher quality under a wide range of conditions (in the tropical, subtropical and temperate regions).

Although, in general terms, the principles of mulberry cultivation for sericulture purposes should apply to its cultivation as forage for feeding farm animals, there are certain important differences. Frequency of harvesting and in particular planting density, can be intensified if the goal is to feed ruminants, since the quality is already high enough and the main purpose would be to increase overall biomass yields. The issue of maintenance of soil fertility and plant persistence become important is huge quantities of nutrients are extracted from the soil in the biomass under cut-and-carry systems.

Individual leaf picking, as is commonly practiced for silkworm feeding, could be only justified for small scale or family units of mini-livestock, e.g. snails, guinea pigs or rabbits. Mechanical harvest might be more appropriate for ruminant feeding in larger operations.

Feeding ruminants. The urgent need for a high quality feed for ruminants in the tropics, in particular for small ruminants, and the excellent characteristics of mulberry, are the justifications for the great enthusiasm for its intensive cultivation and use as a supplement for cattle, and as the main feed for goats.

The nutritional quality of locally produced mulberry leaves is equivalent to that of grain-based concentrates. Thus, they are an ideal supplement in most forage diets.

Table 1. Summary of mulberry utilization and research in the world.

Country	Area with mulberry (1000ha)	Utilization				Research		
		Seri-culture	Fruit	Forage	Other*	Agronomy	Breeding selection	Animal nutrition
Africa								
Egypt	n.a. **	✓	✓			✓		
Ethiopia	n.a.	✓				✓		
Kenya	n.a.	✓		✓		✓		✓
Madagascar	n.a.	✓				✓		
Tanzania	n.a.			✓				✓
Tunissia	n.a.	✓	✓			✓		
America								
Argentina	n.a.				✓ 1			
Bolivia	n.a.				✓ 1			
Brazil	38	✓		✓		✓	✓	✓
Colombia	n.a.	✓		✓		✓		
Costa Rica	n.a.			✓		✓		✓
Cuba	<1			✓		✓		✓
Dominican R.	<1			✓				
El Salvador	<1			✓				✓
Guatemala	n.a.			✓				✓
Honduras	<1			✓				
Mexico	<1	✓	✓	✓	✓ 1	✓		✓
Panama	<1			✓				
Perú	n.a.				✓ 1			
Saint Vincent	<1			✓				
U.S.A.	n.a.				✓ 1			✓

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Country	Area with mulberry (1000ha)	Utilization				Research		
		Seri-culture	Fruit	Forage	Other*	Agronomy	Breeding selection	Animal nutrition
Asia								
Afganistan	n.a.			✓				
China	626	✓			✓ 2	✓	✓	
India	280	✓		✓	✓ 3	✓	✓	✓
Indonesia	n.a.	✓						
Japan	n.a.	✓	✓	✓	✓ 2	✓	✓	✓
Korea	n.a.	✓		✓		✓	✓	
Kyrgystan	n.a.	✓	✓			✓		
Malaysia	n.a.	✓				✓		
Pakistan	n.a.	✓		✓		✓		
Philippines	n.a.	✓				✓		
Syria	n.a.		✓					
Tadjikistan	n.a.	✓				✓		
Turkey	n.a.		✓					
Turkmenistan	n.a.	✓	✓			✓		
Vietnam	n.a.	✓		✓		✓	✓	
Uzbekistan	n.a.	✓				✓		
Europe								
Bulgaria	n.a.					✓		
France	n.a.			✓	✓ 1	✓		✓
Greece	n.a.				✓ 1			
Italy	n.a.				✓ 1	✓		✓
Poland	n.a.					✓		
Spain	n.a.				✓ 2			

* Other uses of mulberry:

1 = Landscaping & gardening;

2 = Medicinal & infusion;

3 = handicrafts & cabinetwork

** n.a. = data not available

The greatest impact of mulberry on livestock productivity is to be expected in dairy cattle sector in the tropical regions.

Feeding mini-livestock. The nutritive value of mulberry leaves becomes greater in inverse proportion to animal size, since metabolic rate and hence nutrient requirements decrease with size (to the power of 0.75). Mulberry leaves should be the preferred feed for guinea pigs, rabbits and perhaps snails. The performance of dairy goats fed mulberry-based diets in Costa Rica has been impressive (Oviedo *et al.*, 1994). Many more excellent results are to be expected when mulberry is offered to other herbivores, small species in particular.

Mulberry for browsing. Several studies have looked at the possibility of placing mulberry for direct browsing by cattle in Italy (Talamucci and Pardini, 1993) in France (Armand and Meuret, 1995) and in Japan (Kitahara, 1999). Although the results have been promising, much work will need to be done before mulberry is incorporated into grazing systems on a large scale.

Table 1 summarizes the utilization of and research on mulberry in different parts of the world.

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