

***Opuntia*-based Ruminant Feeding Systems in Mexico**

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INTRODUCTION

Opuntia cactus (prickly pear or nopal) is a group comprising plants belonging to different species of the genera *Opuntia* and *Nopalea*, both of the Cactaceae family. Its origin is the American Continent and can be found from Canada (lat. 59°N) to Argentina (lat. 52°S), and from sea level to an altitude as high as 5100 m in Peru (Bravo and Sheinvar, 1995).

The Cactaceae family includes approximately 130 genera and 1500 species. Of these, the *Opuntia* and *Nopalea* genera are the most important due to their usefulness to man. In America, there are two centers of diversification of the Cactaceae family, one in the northern part of the continent and the other in the south. Most of its genera are in one of the two centers; an exception is the *Opuntia* genus, which is found on both sites. There are 258 recognized species of *Opuntia*, and 100 are found in Mexico, while the genus *Nopalea* has only 10 reported species (Bravo, 1978).

Cactaceas are plants resistant to arid and semiarid conditions. These conditions in Mexico are characterized by scarce and erratic precipitation, high diurnal thermic oscilation, high annual thermic oscilation, and rainfall only in the summer (Flores and Aguirre, 1992).

The arid and semiarid regions of Mexico cover more than 95 million ha, where annual precipitation ranges from 150 to 600 mm, and the average annual temperature is 15°C to 25°C, with more than seven dry months. Vegetation is composed of grasslands and scrublands; plant cover is less than 70% (Jaramillo, 1994).

HISTORY AND PRESENT-DAY IMPORTANCE OF NOPAL IN MEXICO

Three main nopal production systems have been identified: wild cactus communities, family orchards, and intensive commercial plantations. Although intensive commercial plantations are recent, initiated only 50 years ago, they produce the greatest amount of fruit and vegetable nopal that supplies the domestic and international markets (Flores, 1993). Period in use, products, and the total area cultivated per system at present are shown in Table 1.

Table 1. Period in Use, Products, and Total Area Cultivated under Each Nopal Production System at Present in Mexico

Production System	Period in Use	Products	Area (ha)
Wild communities	20,000 B.C. to present	Forage Fruit Vegetable	3,000,000
Family orchards	3,000 B.C. to present	Fruit Vegetable Forage	Unknown
Intensive commercial plantations	1945 to present	Vegetable Fruit Forage Grana	10,400 56,856 150,000 100

Source: Flores, 1993

The use of nopal in Mexico goes back to its first inhabitants. At present, nopal is used in many ways. To name a few: it is eaten as a vegetable and fruit; it is used for forage, fuel, and fences, as well as in medicines, cosmetics, and ceremonies; it produces grana, a natural dye; and it helps to control erosion. The use of the nopal as forage for livestock began with the colonization of northern Mexico by the Spaniards in the 16th century.

NOPAL-BASED RUMINANT FEEDING SYSTEMS IN MEXICO

Extensive (Grazing) Animal Production Systems

Nopal is found naturally on 3 million ha of rangelands in northern Mexico, which have, even now, a good plant population density. Another 150,000 ha of nopal were planted by ranchers and small producers with government support.

Livestock fed with nopal are mainly cattle, goats and sheep. Fighting bulls and oxen are also fed with nopal. The two main products of cattle production are calves for exportation and meat. Goats are used to produce meat and milk, and the sheep to produce meat and wool.

The cattle have certain amount of blood from breeds such as Hereford, Charolais, Aberdeen Angus, and Beef Master. When the quality of the rangelands is lower, crosses are made with Brahman, Indobrasil, etc.

In goats there has been a more limited degree of cross-breeding with breeds such as Nubia, Granadina, Murciana, Alpino Francesa, and Sannen. While in sheep, the situation has been similar with limited cross-breeding with Rambouillet, Suffolk and Corridale.

Feeding cattle is based on grazing on rangeland grasses such as *Bouteloua*, *Eragrostis*, *Buchloe*, *Hilaria*, and the introduced Pennisetum. All of these are reduced markedly during the dry years. There are also shrubs on which cattle forage, such as *Prosopis*, *Acacia*, *Celtis*, *Flourenacia*, etc., and a great variety of cactus (nopal) (Table 2).

Table 2. Main Opuntia Species Used as Forage on the Rangelands of Northern Mexico

Scientific name	Common name
<i>O. streptacantha</i>	Cardón
<i>O. leucotricha</i>	Duraznillo
<i>O. robusta</i>	Tapón
<i>O. cantabrigiensis</i>	Cuijo
<i>O. rastrera</i>	Rastrero
<i>O. microdasys</i>	Cegador
<i>O. lindheimeri</i>	Cacanapo
<i>O. engelmannis</i>	Rastrero
<i>O. azurea</i>	Coyotillo
<i>O. stenopetala</i>	Serrano
<i>O. imbricata</i>	Cardencha
<i>O. fulgida</i>	Choya
<i>O. choya</i>	Choya
<i>O. macrocentra</i>	Chivero
<i>O. chrysacantha</i>	Espina amarilla
<i>O. lucens</i>	Penca redonda
<i>O. duranguensis</i>	
<i>O. tenuispina</i>	

Nopal is fed to livestock using the following methods:

- Direct consumption, even though thorns and glochids are present in all these varieties.
- The edge of the nopal, where the concentration of thorns is greatest, is cut off.
- The whole nopal plant is burned by piling dry brush at the base and burning it in order to eliminate the thorns. However, this method has the disadvantage of causing severe damage to the plant and its recovery is difficult.
- Utilizing a gas or kerosene burner to burn off the thorns of selected nopal pads without damaging the whole plant.
- The best method is cutting off the nopal pads, placing them on the ground, and then burning the thorns off.

The livestock in this kind of rangeland should be given supplements of at least calcium and phosphorus, which can be supplied through the addition of bone meal or blocks with phosphorous and limestone, among others. Also, it is common to use a mineral premix with salt. In some rangelands during dry seasons, a supplement with proteinic concentrates (e.g., cotton-seed meal, oil-seed meals, etc.) is commonly administered to livestock. On good rangelands (with leguminous forage plants) the supplements are sources of energy (e.g., maize, sorghum, sugar cane molasses, etc.).

In general, nopal is used during the dry season of the year. However, because there has been a continuous drought in the northern Mexico during the last four years, it has been used throughout the year, resulting in deterioration of the nopal communities and a depletion of the resource (Flores and Aranda, 1996).

The drought, however, did serve to underline the benefits of using nopal as feed for livestock on the rangelands. In the last three years, 650,000 head of cattle died in northern Mexico as consequence of the drought. The ranchers with nopal, in general, did not suffer great losses compared with those who did not have or ran out of nopal. Moreover, reproduction rates and levels of production of cattle, sheep and goats are superior when the ranchers supplement the normal diet of the livestock with nopal during the dry season.

Confined Livestock

For this system, the nopal is obtained from the rangelands of northern Mexico (3 million ha), from the plantations of forage nopal (150,000 ha), from the plantations of nopal for fruit (cladodes from pruning) in the central region (50,000 ha), and from the plantations of nopal for vegetable (cladodes from pruning) also in the central region (10,500 ha).

Holstein and Holstein crosses with criollo cattle are the most common breed for milk production on small farms of the central and northern regions. Furthermore, small feedlots use nopal to grow and fatten cattle. In this case, the breeds used are the same as those mentioned for rangelands.

The feed of the confined dairy cattle consists of nopal supplemented with commercial concentrates and other forages like oats, alfalfa, maize silage, and sorghum straw, with additions of premix and common salt.

The species of nopal utilized in these conditions are the same as those used under rangeland conditions. Additionally, *O. lindheimerii*, *O. engelmannii* and *O. rastrera* are used on forage plantations. *O. robusta* and *O. streptacantha* are used in family orchards, and *O. amyclaea*, *O. ficus-indica*, and *Nopalea cochinifera* in plantations for fruit or vegetable (nopalito).

Farmers prepare nopal for livestock in a five-step process:

- Cutting the nopal. This is done using a knife attached to a bar or tube with a pair of hooks on the opposite end. The hooks are used to lift the cut cladodes and place them on a truck. The main problem here is the level where the nopal is cut, because most of the time the nopal is cut from the root, limiting the possibility of the plant's recovery.
- Transporting the nopal. The cut cladodes are transported in large or small trucks or on carts pulled by animals, when the distances are not so great. Unfortunately, with wild species, the sites where nopal can be found and cut become increasingly farther away (100-150 km) from the point of consumption.
- Burning the nopal. When the nopal arrives from the field it is piled up in the yard. As it is needed, it is first spread out and then burned in order to remove the thorns (on both sides of the pad). This can be done with a gas (propane) or kerosene burner. The main problem here is the time that the nopal can be kept in piles (no more than 10 days). On the other

hand, the use of burners is expensive, and in the case of kerosene, drops of fuel are left on the nopal, so the cattle refuse to eat it.

- Chopping the nopal. Once the nopal is free of thorns, it is chopped and then given to the cattle. The process can be done manually or by cutting machines (usually on farms with more than 50 head). In some cases, the nopal is chopped without burning off the spines, and causing some animals to have problems in their digestive tract.
- Feeding the cattle. The nopal is carried on wheelbarrows to the feeder stall and usually is supplied twice a day. The amount used to feed cattle is around 30 to 40 kg of fresh nopal per day; and 6 to 8 kg per day to feed sheep and goats. It has been found that different amounts of nopal are used in different parts of the country. For example, in Saltillo, Coah., 200 tons per day are used, while in Monterrey, N.L., the amount is around 600 tons. There are no data available for other regions.

The results obtained when cattle are fed nopal have been shown to reduce the total milk or meat production per animal. However, the production cost per unit of production is less. Thus, nopal offers a good alternative for feeding cattle during the dry seasons and for lowering milk production costs.

CONCLUSIONS

In Mexico, the arid and semiarid regions occupy around 50% of the total area. One of the plant resources with a wide range of distribution and uses by man and animals is nopal (*Opuntia*).

The use of the nopal as forage in Mexico depends mostly on the utilization of wild nopal communities and less on the cultivated forage, fruit, or vegetable plantations.

The *Opuntia* species utilized are numerous, and they are used to feed cattle (milk and meat), goats (meat and milk), sheep (meat and wool), horses (transportation and draft), and wildlife. The volumes fed to cattle are around 30 to 40 kg per day and to goats and sheep around 6 to 8 kg.

Nopal is used by large, medium, and small rangeland ranches, and in medium and small stables.

In general, the technical-scientific knowledge on the use of the nopal in livestock feed is good. However, knowledge for sustainable utilization of the wild nopal communities and cultivated forage nopal plantations is limited and incipient.

Planting nopal on the rangelands of the central and northern regions may be the easiest way to improve the vegetation, conserve soil, stop the desertification process, increase the stock rate, and improve productivity and incomes, thus improving the living conditions of the producers in these regions.

The utilization of nopal has been compared with that of fresh or hay alfalfa, and/or maize silage, among others. Although lower levels of production have been found using nopal, the costs per unit of production (milk and/or meat) are lower. Therefore, the nopal has been, is, and will be an important source of forage for livestock in the central and northern regions of Mexico.

In recent extension work, nopal for forage has been planted in the Mixteca region (Puebla), and in northeastern Mexico (Coahuila, Nuevo Leon, and Tamaulipas), as a first stage in a program that includes: fencing and exclusion, sowing forage shrubs (*Prosopis*, *Acacia*, *Atriplex*, *Agave*, etc.), sowing grasses (*Bouteloua*, *Pennisetum*, etc.), and probably eliminating undesirable species (*Larrea*, etc.).

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