

# **Exploiting fodder potentials of Cactus (*Opuntia* spp) in Kenya for pastoral livestock feeding under a changing climate**

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## **Abstract**

The cactus plant genus *Opuntia* is found in many parts of arid and semi arid parts of Kenya. The cactus family constitutes some of the most drought tolerant plant species known due to their anatomic and physiological adaptation. Their flat oval stem known as cladodes or paddles remain green and succulent throughout the year and contain about 90% moisture. As a livestock feed, cactus can produce a large quantity of green forage throughout the year if properly managed, also provides the much needed water, energy and vitamins in the dry seasons. There are two main types of *Opuntia*, the spineless types and spiny types, but both have similar nutritional value. The spiny types however, pose certain utilization challenges due to the damage it can inflict on alimentary tract of the animal grazing on it. Therefore, spines must be removed by burning or scrapping them with a machete before feeding them to animals. *Opuntia* has low fiber and protein content and has to be supplemented with rich source of fiber and nitrogen in order to enhance animal performance. Despite its fodder potential, cactus is an underutilized fodder resource in Kenya and other East African countries due to lack of information on its nutritive value and other benefits. Until recently in Baringo and Laikipia West districts, cactus was regarded as a noxious weed. Therefore, information on their fodder potential need to be collated and be disseminated to pastoralists and other stakeholders in order to promote and exploit cactus as livestock feed. We conclude that, utilization of this extremely drought tolerant plant is the best fodder option in the changing climate.

## **Introduction: Biology and distribution**

Cactus belongs to the genus *Opuntia*, order Caryophyllales and family Cactaceae. Cactus are characterized by the presence of stems bearing specialized short-shoots called areoles, which usually develop the spines (modified leaves) that represent the familiar hallmark of most types of Cactus. Some Cacti species have sharp spines of 2-5 cm long and a cluster of troublesome tiny barbed stickers called glochids. There are two types of cactus: those with spine and the spineless. The spiny cactus is dangerous to handle and to eat due to the injury the spines and glochids can inflict on the handler and the alimentary tract of the animals grazing on them. They therefore need to be handled with equipment like tongs when cutting them for the animals. The spines and glochids have to be

removed by scrapping with a machetes or burning with light flame. On other hand, the spineless are easily handled and readily eaten by animals. They therefore, need protection with a fence when putting up a spineless cactus plantation. Globally there are fewer spineless cacti growing in the wild because of overgrazing. The two types are similar in nutritive value, but differ in the number of fruit that are also eaten by people and animals. The spineless have 3-4 fruits while the spiny have 12-15 fruits per paddle (Nefzaoui and Bensalem 2001).

The plant is easily propagated from the oval stem known as cladodes or paddles when they are detached from the main plant and drop on the ground where they develop roots and more pads. These succulent pads rarely fail to establish except when they are disturbed frequently during the rooting. Cactus employ a photosynthetic pathway known as Crassulacean Acid Metabolism (CAM) whereby stomata open primarily at night when temperatures are lower and water loss is lower. Cacti have a thick waxy cuticle on their stem that act as water proofing skin. The stoma also allows the intake of carbon dioxide from the atmosphere at night. Because of this low water loss, cacti are among the most extremely drought tolerant plants and consequently thrive in very arid regions (De Kock 1980). Cacti also survive in saline soils where no many other plants can thrive. Therefore, cactus is found in many parts of arid and semi arid parts of Kenya, growing in the wild or planted as hedge. Else where, Cactus grows in the wild or grown in plantations as forage for livestock and as source fruit and vegetables for human consumption in arid parts of USA, Mexico, South America, South Africa, West Asia /North African (WANA) region, Italy and Ethiopia.

Cacti has a better water use efficiency (WUE) and rain use efficiency (RUE) than any other conventional fodder crops. It is even better than acacia trees. Opuntia uses 267 kg of water per kg dry matter (DM) produced, while pearl millet (one of the prominent drought tolerant cereal crop) uses 400 kg water per kg DM produced (De Kock 2001). The RUE of Opuntia is 40 kg DM/mm/year, while pearl millet is 25 kg DM/mm/yr (De kock 2001). Thus, cactus is an appropriate fodder for declining rainfall and also when using irrigation.

### **Fodder value and utilization.**

Opuntia being a CAM plant has potential for producing a large amount of forage to feed large and small ruminant animals in dry regions. In Tunisia under rain fed condition, spineless Opuntia yields 20t/ha/year of fresh paddles as reported in areas with 150mm/year rainfall and 100t/year in areas with 400mm/year rainfall (Nefzaoui and Ben salem 2001). In USA fertilized Opuntia spaced at 1.2x1.2m produced a total of over 100t/ha /year. A Cow consumption is about 40kg /day, therefore, the stocking rate for cactus would be about 1 cow/ha in semi arid areas. Santana (1992) reported a range of fresh weight from 106.9 to 205 t/ha/year that was approximated at 16 to 31t DM/ha/year in Brazil. Garcia de Cortazar and Nobel (1990) and Riveros et al., (1990) respectively, reported yields of up to 40 t DM/ha/year under irrigation and 8 t DM/ha/yr under rain fed conditions.

The dry matter content of *Opuntia* less than 15%, (table1). It has low protein content about 4% CP, low phosphorus and fiber content about 10.0% of the DM. However, it is rich in energy, calcium and ash. As such, cactus is energy feed source. Since fiber content is low and protein is lower than the maintenance requirement for ruminants (about 7% of the DM), Cacti need supplementation with nitrogen sources and fibrous feed like straws from cereals for optimum animal performance. Since paddles are highly succulent (about 85% water), animals can survive for a long time without water in areas where water is a problem (Nefzaoui and Ben salem 2001). A cow consuming 40 kg of fresh cactus per day will also consume 35 litres of water per day simultaneously (Felkener 2001).

Table 1. Nutrient composition of *Opuntia* spp.

	DM%	IVD MD %DM	DE MJ/kg DM	NFE	TDN %DM	CP% DM	CF %DM	NDF% DM
Fruits Ethiopia <sup>1</sup>		82.92	15.57	65.76	77.78	13.10	10.39	
Paddles Ethiopia <sup>1</sup>	9.17	75.40	13.92	68.89	71.33	11.6	9.28	
Chile <sup>2</sup>	10.00	90.00			77.9	3.8	15.4	19.7
WANA Region <sup>3</sup>	13.48	86.52		58.16		3.84	8.55	35.08
South Africa <sup>4</sup>	11.01	88.99		65.30		4.76	10.91	

Source <sup>1</sup> Tegegne 2001

<sup>2</sup> Azocar 2001

<sup>3</sup> Nefzaoui and Ben salem 2001

<sup>4</sup> De kock 1965

*Opuntia* is highly digestible. On average invitro digestibility was reported to be 75.4% in Ethiopia by Tegegne (2001). While Nefzaoui and Ben salem (2001) using sheep reported 60 to 65% digestibility. Most of it is degraded rapidly within 6-12 hours in the rumen and none is left after 24hours (Benthlija 1987).

### **Why cactus is appropriate fodder for the changing climate**

Cactus is drought tolerant and makes use of little moisture in rainy season to produce large quantities of forage. It has high carrying capacity than any other drought tolerant fodder in arid and semi-arid areas. It remains green and succulent during drought thus supplying the much needed energy, water and vitamins in drought period. It withstands severe defoliation and has good regeneration ability. It is easy and cheap to establish while its maintenance cost is low. Due to their anatomic and physiological makeup, Cactus withstands a wide range of soils types as well as harsh climatic conditions. Therefore, development of good pastoral system should incorporate cactus establishment as it is also suitable in soil conservation and reduction of desertification (Nefzaoui and Ben salem 2001 and De kock 1980). The fact that cacti combine drought tolerance and water use efficiency, it produces large quantity forage that remain green and succulent in

drought period, it is easy and cheap to establish, makes it the best fodder option in the changing climatic situations.

### **Kenya farmers experience with Cactus**

In wet areas of Kenya cactus was introduced as ornamental plants while in the dry areas they were probably introduced as boundary markers. The Masai residents of Laikipia North believe that livestock and wildlife disperse Cactus seeds with their faecal droppings especially elephant and goats after feeding on the cactus fruits. Opuntia was probably introduced by white settlers as markers of ranch boundaries or for some other purposes like beauty or livestock feeding. This plant has gradually spread in large tracts of land in Baringo (around Lake Baringo), Nyeri North, Laikipia North and Laikipia East districts (Mukogodo and Lamuria divisions, respectively). Apart from Lamuria and Nyeri North, the other parts had no use for cactus and it was viewed as an invasive noxious weed. The local communities in Baringo believed that cacti were involved in land degradation and desertification. They have therefore appealed to the government and well-wishers to help in eradicating the plant. They did not see it as a succession stage in an ecosystem because of over-grazing, leaving cacti, which is drought and low fertility tolerant, to take over from preferred forage species in a severely degraded land. Just recently after two years of drought, one bull started feeding on cacti and the rest of the herd joined it. This bull, which was later named mwalimu, was moved from herd to herd by the staff of an NGO called Rehabilitation of Arid Environment (RAE) to encourage other livestock to feed on cactus. As a result cattle were able to survive the drought and cactus population was effectively controlled (Crawley 2001). Droughts are now common than before hence increasing the use of cactus for feeding livestock.

The authors of this paper got interested with cactus when the Nyeri North Ministry of livestock staff enquired from them the nutritive value of Cactus since cows were increasingly eating it as the drought of year 2008 intensified. This novel feed initially caused lesions in the mouth that were similar to Foot and Mouth Disease, except that it was not accompanied by lameness. On examination by the area veterinary officer, the cactus spines and glochids were implicated. In order to continue feeding their animals, farmers resulted to scrapping off the spines with machetes. This worked well for them and they soon finished cactus in their area and turned to collecting some from Laikipia East with Lorries and pick up vehicles. Laikipia East had large tracts of cactus, which had not been exploited. While visiting Laikipia East, the authors interviewed local farmers and found out that a large proportion of the community (mainly the immigrant Kikuyu community) frequently feed their livestock on cactus during the periods of severe drought. This was not happening in Laikipia west because they were herding their animals in rangeland, while in the Nyeri North and Laikipia east they were practicing zero and semi-zero grazing systems. The farmers reported that under zero-grazing system cactus was over exploited in Laikipia East.

In Laikipia North, the Masai pastoralists who were interviewed by the authors believe that cacti were noxious weed and should be removed. They appealed to the government to assist in controlling the alien and invasive plant that was being spread by wildlife

especially elephants that ate the fruit and voided seeds with their faeces. They acknowledged that children ate the fruit but some said it affected their health. It was probably true, but could also have been caused by poor handling of fruits. The scraping of glochids was effected through scraping the fruit on the ground. There being very little water in the area, this fruits are not washed before eating and could result in ingestion of parasites and pathogenic microorganism. On being informed that cacti could save their animals during drought or be used as human food, they desired that they be taught on how to cook it. The chief of the area even suggested that they should buy some two bulls to try feeding them with cactus for some time. The community was ready for a reasonable suggestion and welcomed change if satisfied with the findings. The ministry of agriculture staff in the area has never been for eradication of Cacti as they argued that it controlled the soil erosion and desertification. They even taught farmers the recipes involving cactus fruit (DAO Laikipia North 2009). Children in other parts of Laikipia commonly ate the cacti fruit. Since cactus fruits are eaten during famine, cacti have been stigmatized as a famine food. In the last 2 years of 2008 and 2009, communities in famine stricken area have appeared in local newspapers, as so severely hit by hunger that they were surviving on wild fruits of cactus. This certainly is not a good start for developing and commercializing cactus as human food. However, cactus was well presented by Daily Nation 12 August 2009 as a solution to maintaining livestock during droughts that are now very common in Baringo district. The Nyandarua Laikipia (Nyala) Dairy cooperative plant in Ndaragwa used to receive 44,000 litres per day in December 2008 and by July 2009 it had reduced to 4000 litres of milk per day. It was noted that a few of their members who had, and fed cacti to their dairy cattle, never lost any of their milk animals in the severe drought of 2008-2009. Their animals still produced some milk and were able to come on heat regularly (Kang'ara 2009).

### **Way forward**

Both the spiny and spineless cactus occurs in Kenya therefore an exploratory survey should be conducted to identify and characterize the *Opuntia* species and varieties available in Kenya and a database created. Their agronomic requirement should be determined on station and the effect on animal when fed on these cactus be elucidated. Using this information, promotion of cactus for livestock feeding by pastoralists in marginal production areas, the rangelands arid and semi arid areas should be zealously encouraged. The spineless cactus should be bulked as a source of propagation materials since they are very few in the country. There is also need to conserve *in situ* and *ex situ* the cactus genetic resource for further research and use in future. A combined effort between the three ministries of Livestock, agriculture and Northern Kenya and Arid Lands is needed to develop, promote and commercialize cactus for both livestock and human food.

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