

**ENGINEERING STUDIES ON UTILIZATION
OF A PRICKLY PEAR CACTUS FOR
PRODUCING ANIMAL FEEDS**

BY

KAMAL MAMDOUH ABD EL- HAMID ABD ALLAH

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ABSTRACT

All experiments of prickly pear cactus chopping machine were carried out and tested at the workshop of Agriculture Engineering Research Institute (AEnRI), Agriculture Research Center (ARC), Dokki, Giza, Egypt through years of 2020 and 2021 to study some parameters affecting on the machine.

The objectives of the present investigation are to

- 1- Develop a simple machine for removing thorns and cutting a prickly pear cactus.
- 2- Investigate the performance of the developed machine.
- 3- Evaluate the developed machine from the economic point of view.

Two experimental groups were carried out. The first experiment was run under four different feeding drum speeds of 140, 170, 190 and 215 rpm (0.73, 0.89, 0.99 and 1.13 m/s), two different thorn removal brushes states (stationary and moving) and three different clearances between thorn removal brushes of C1, C2, and C3 (1, 1.5 and 2 cm). The second experiment was run under four different cutting drum speeds of 700, 825, 1000 and 1200 rpm (14.7, 17.3, 20.9 and 25.1 m/s) and three different methods of knives rows arrangements (Ka, Kb and Kc), under the optimum feeding rate of 1.94 Mg/h which obtained from the first experiment.

Evaluation of the prickly pear cactus chopping machine was carried out taking into consideration feeding rate, thorns removal efficiency, machine productivity, average of cutting length,

coefficient of variation, required power, energy requirement and operational cost.

It is recommended to operate the prickly pear cactus chopping machine under the following conditions:

- 1- Feeding drums at revolving speeds 170 rpm.
- 2- Using brushes state of moving brushes.
- 3- Clearance between the brushes 1.5 cm.
- 4- Drum cutting speed 825 rpm.
- 5- Using methods of (Kc) knives rows arrangements.

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1. INTRODUCTION

Egypt is suffering a problem of animal fodders shortage, therefor a pressing need to importing fodders and high price of fodders, the concentrated ones in particular. Since the fodders present a staple food for farm animal, it has become necessary to use substitutes for the traditional fodders such as using the waste of agricultural crops as new fodder sources such as prickly pear cactus. Fodder shortage is considered an impediment to develop animal production. Many studies show that fodder balance in Egypt has 6 million Mg annual shortage and that equal 3.5 million Mg of digested food (TDN) **Abd El- Fattah et al. (2016)**.

Livestock production remains the main source of income for rural populations living in dry lands. However, the sector faces many challenges including feeding constraints and climate change. Rangelands in semi-arid regions play an important role in livestock production systems, although their contribution to animal feeding is decreasing. Rangeland productivity is usually low (< 5 Mg/ha.year) dry matter (DM) with low yields of consumable biomass (< 1 Mg/ha.year) DM, leading to low carrying capacity 12-15 ha to sustain an adult cow **Dubeux et al. (2015)**.

The lack of feed resources is one of the main obstacles to the development of animal production in Egypt, which suffers from a lack of animal feed materials. In Egypt the total areas planted with 13 types of tropical and Mediterranean fruits reached 14,956 feddan, including 3,116 feddan of prickly pear cactus. **Almasry Alyoum (2015)**. According to statistics

prepared by the Economic Affairs Sector of the Egyptian Ministry of Agriculture, the cultivated area of prickly pears in Egypt amounted to 5,647 feddan in 2021. **Economic Affairs Sector (2021)**

The availability of fodder is a necessity and the best way to achieve that is planning for developing fodder sources. It can be used to cover the shortage of the fodder balance to feed the animals after treating them with mechanical, natural, chemical, and biological processes to raise their nutritional value. **Taha et al. (2020).**

Prickly pear cactus includes mainly water (80-90%), and the dried cladodes have a high portion of wood up to 33%, a ratio of raw protein, phosphorus, sodium, manganese, copper, zinc. Magnesium, calcium, and iron within the limits acceptable for ruminant animal feed, which may explain why cactus is palatable when served as animal feed **FAO (2000).**

The prickly pear has a special place internationally in sustainable food production systems in dry areas, including animal production systems, due to the climate changes and land degradation that many countries of the world suffer from. Its uses, its high flexibility in adapting to the effects of climate changes, its high water-use efficiency, and its ability to grow in poor and degraded soils where other cladodes fail to grow make it an excellent candidate for forage or fodder supplementation or replacement in these regions.

Prickly pear cactus provides good opportunities to improve the availability of fodder produced from it in these areas, especially in dry periods or in periods of lack of traditional fodder, since the productivity of prickly pear cactus is fast and

begins a few months after planting. The annual production of one acre of prickly pear cactus under intensive agriculture reaches 80 Mg, which is divided into about 8 Mg of dry matter in addition to 72 Mg of good and fresh water stored in cladodes, which is sufficient to provide the necessary fodder for raising 4 - 5 cows annually. Since these cladodes are rich in water by up to 90%, which also makes them an important source of water provision for animals in dry areas. In addition, It contains 10% of the dry matter, divided into a high percentage of carbohydrates (60%), vitamins (A and C) and protein (3 - 5%).

There is a problem facing the prickly pear cladodes before being presented to animals, which is the thorns on the surfaces of the cladodes, which are removed so far manually or by exposing the surfaces of the cladodes to flame, that requires great time and effort, resulting in an increase in labor and costs.

Therefore, it was necessary to provide a mechanical machine that removes the thorns and cuts the cladodes into sizes commensurate with feeding the animals without prejudice to the percentage of water in the cladodes as much as possible and saving time, effort and labor costs.

The main objective of the present study was to carry out engineering studies on utilization of prickly pear cactus for producing animal feeds. To achieve the ultimate goal, the following criteria were taken into consideration

- 1- Develop a simple machine for removing thorns and cutting a prickly pear cactus.
- 2- Investigate the performance of the developed machine.
- 3- Evaluate the developed machine from the economic point of view.