

DEVELOPMENT AND EVALUATION OF A CHOPPING MACHINE FOR ANIMAL FEED

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ABSTRACT

A manually operated chopping machine was designed, developed and tested for chopping animal feeds. The capacity of the machine was determined for chopping straw, German grass and Napier grass and was compared with traditional chopping (chopping with sickle) method. The machine could chop straw at a capacity of 32.21 kg/hr to 55.36 kg/hr. The average capacity for German grass and Napier grass were 123.48 kg/hr and 171.546 kg/hr, respectively. This machine was capable of chopping 2 to 3 times higher than that of chopping by sickle. Also it was capable to control the length of chopped straw according to requirement. The performance tests indicate that the facility could be used in the farm level with high satisfaction.

INTRODUCTION

Livestock in Bangladesh is an essential component of agricultural system, supplying the major part of the draft power required for land cultivation and transport. The livestock sector contributes about 6.5% of total GDP. It has 21 million heads of cattle and Buffalos (BBS, 1990). The availability of livestock feed in Bangladesh is far below the requirements. The serious scarcity of feed ingredient in Bangladesh limits livestock production. It has been estimated that overall livestock feed deficit in the country in terms of dry matter, digestible nutrients and crude protein are 50.50 and 80 percent, respectively. Available feeds are sometimes fed without consideration of their quality or the requirements of the animal. Such diets adversely affect the growth rate, age of maturity, milk production, meat production of animal and also the draft power output for land preparation.

Rice straw is the basal feed for ruminants feed with or without supplementation. In Bangladesh out of the total 29.1 million tons of roughages available for ruminants rice straw contributes around 23.57 million tons (81 %) and green grass only 1.6 million tons (Tareque and Saadullah, 1988). As such the rice straw alone contributes almost 85.5 percent of the total available dry matter.

Chopping of animal feed is considered as a labour intensive processing operation in animal production system. Traditionally, animal feed, specially rice straw is chopped manually by a sickle in the farms of Bangladesh. It is a labour intensive, less efficient and time consuming operation. Traditional technology for chopping of animal feed is even more inefficient and slow as well as old in case of medium and large farms.

Very limited research works have been conducted on chopping machine so far. Most of the work done are seemed to be suitable for developed countries. A simple device for cutting straw was developed in Shanzai Province of China which was known as "Chinese Straw Cutter". A long knife, one end of which is hinged to a slotted wooden beam on curved iron frame and the other with a handle, cut against a fixed edge. A chopping machine is also available in the dairy farm of Bangladesh Agricultural University, Mymensingh which is suitable for hard roughages such as maize, napier and german grass. But it is not suitable for straw.

An attempt has been made to design and develop a manually operated low cost animal feed chopping machine with a view to increase the chopping efficiency and decrease cost. The specific objectives of the study were as follows :

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1. To design and develop a manually operated low cost animal feed chopping machine, and
2. To manufacture and test the device.

MATERIALS AND METHODS

Chopping is a process of size reduction of materials and there are different types of size reduction methods. They are cutting, crushing and shearing (Henderson and Perry, 1980). Shearing method was selected because of simplicity of fabrication and operation. Also shearing is usually used for reducing materials of a tough fibrous nature such as straw. The machine was equipped with two sharp blades one was fixed with the frame other was fixed with a fly wheel.

The machine (Fig. 1) was fabricated and tested in the workshop of the Department of Farm Power and Machinery, Bangladesh Agricultural University, Myensingh. It has the following major components.

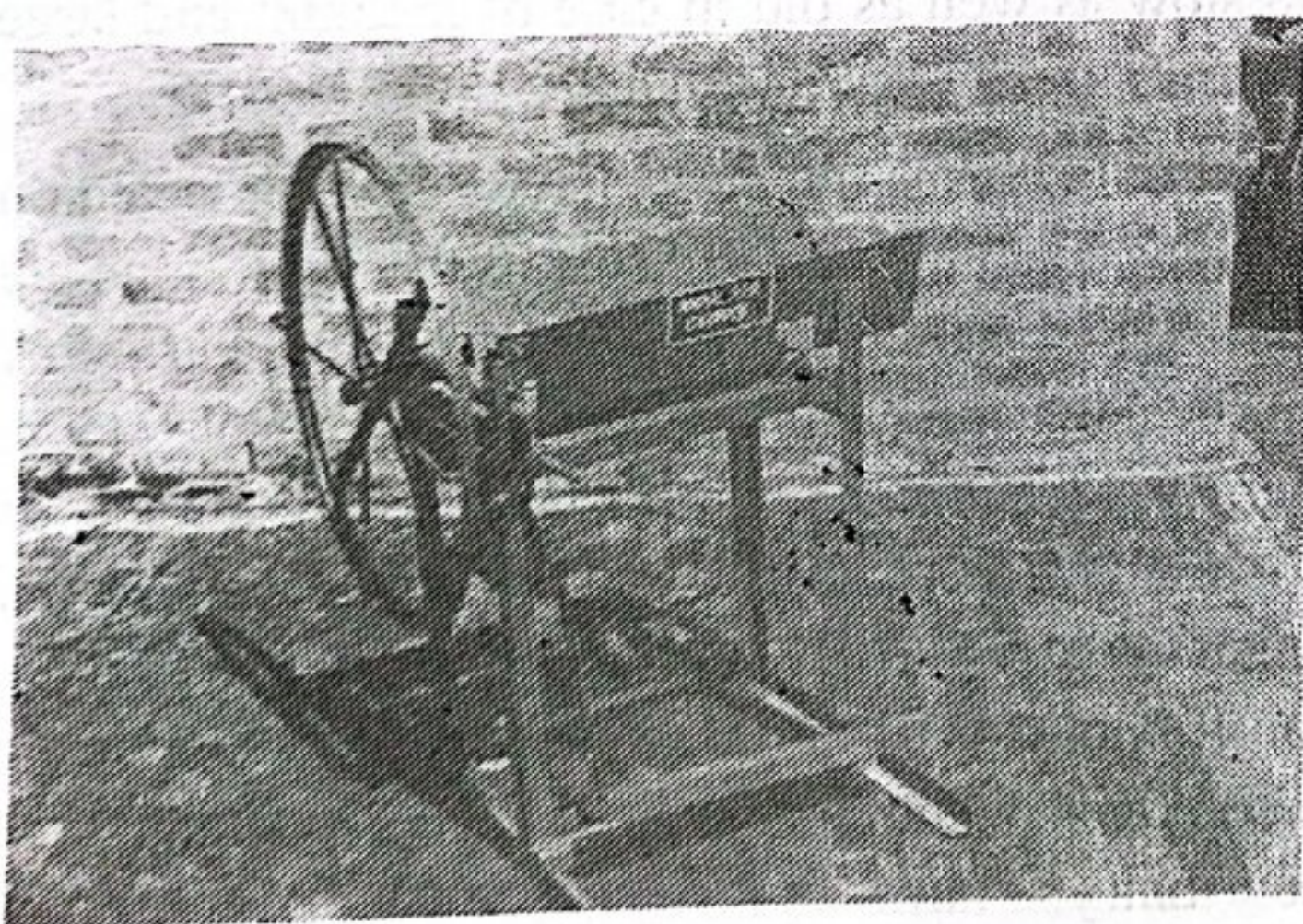


Fig.1 A pictorial view the animal feed chopper

The Conveyor Belt : A conveyor belt, an important component of the machine carried feeds to the cutting blades (Fig. 2). The conveyor belt, placed horizontally, was made of a piece of cloth which was driven by two wooden rollers. The wooden rollers were powered by a foot pedal through a pair of bevel gear. There was also a provision to adjust belt tension to facilitate better convey of material with minimum slippage.

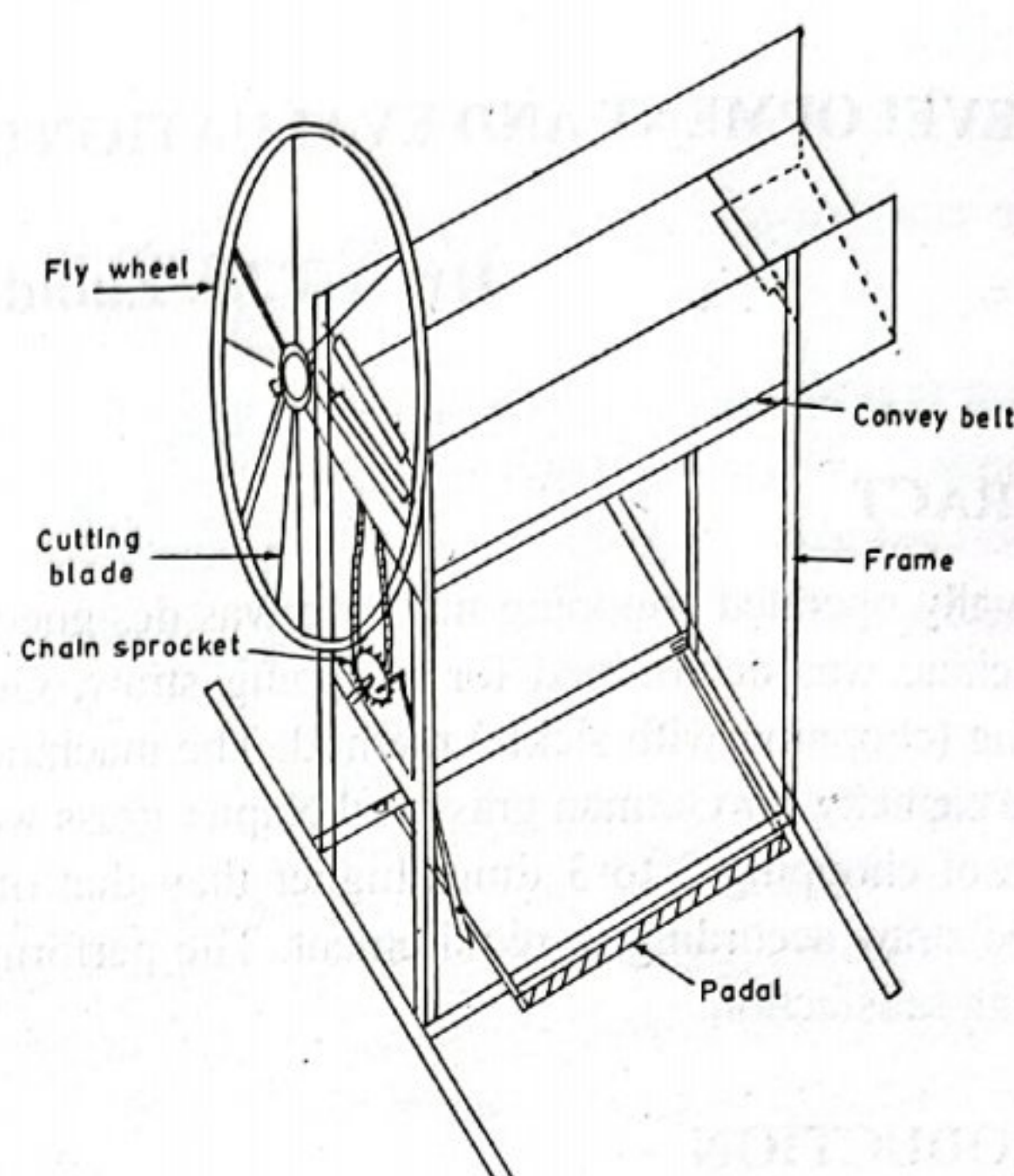


Fig. 2 A complete view of a chopping machine for animal feed.

The flywheel with Cutting Blade : Made of mild steel flat bars, the fly wheel acted as a heart of the machine which actually did the chopping function by its sharp knives fixed with it. It receives power from a pedal through a shaft and rotates in a vertical plane. Sharp knives fixed along the radius of the fly wheel cuts the feeds as conveyed by the conveyor belt. The cutting action was analogous to a scissors with one blade kept stationary and the other moving. The conveyor belt brings the feed at the end of the platform where another knife is fixed. The rotating knives cut the feed against the fixed knife in to pieces. (Fig. 2). There is a provision to attach more knife along the radius of the fly wheel.

Main Shaft and Power Transmission System : The main shaft, made of mild steel rod, transmits power to various components of the machine. It rotates with the help of a chain-sprocket system and powers the flywheel. Power is also transmitted to the rollers of the conveyor through the main shaft. The main shaft is horizontally fixed with the frame with bush bearing support at the two ends. The large sprocket of the chain-sprocket system was fixed with a pedal system and the small sprocket was fixed to the main shaft. The system of power transmission is shown in Fig. 2.

The Frame : The main shaft, the fly wheel, the conveyor belt and the pedal were assembled and fixed to a suitable frame, made of mild steel angle bar and flat bar.(Fig. 2). The overall dimension of the machine is 335 X 700 X 810 mm.

RESULTS

Four experimental replications were performed for determination of chopping capacity of different materials with different number of blades on flywheel and with different roller diameter. Table 1 represents various operation and their impact on the chopping capacity and length of chopped feed. The table also indicates a relationship between the roller diameter and chopping capacity and relationship between number of blades and length of chopped material. The table indicates that chopping capacity increased with the increase of roller diameter and the length of chopped straw decreased with the increase of number of blades when the roller diameter was constant. But the length of chopped straw increased with increase of roller diameter. Table 1 also indicates that the capacity was changed with the type of feed used. The machine capacity for green German grass and green Napier grass were 123.48 kg/hr and 171.55 kg/hr, respectively.

Table 1 Average chopping capacity of the machine for different feeds

Name of feeds	Roller diameter (mm)	No. of blades	Length of chopped feed (mm)	Average chopping rate (kg/hr)
Straw (dry)	40	1	138	41.65
	40	2	75	37.91
	40	4	40	32.21
	60	4	71	43.36
	75	4	81	55.36
German grass green	40	2	70	123.48
Napier grass (green)	40	2	80	171.48

Figure 3 represents the graphical relationship between length of chopped straw and number of blades when the roller diameter was 40 mm. The figure indicates that the length of chopped straw decreased from 138 mm to 40 mm, when number of blades increased from 1 to 4 (Table 1). A linear relationship between length of chopped straw and number of blades was developed as;

$$Y = 155.5 - 30.5 X \quad (R^2 = 0.88)$$

where,

Y = Length of chopped straw, mm

X = No. of blades

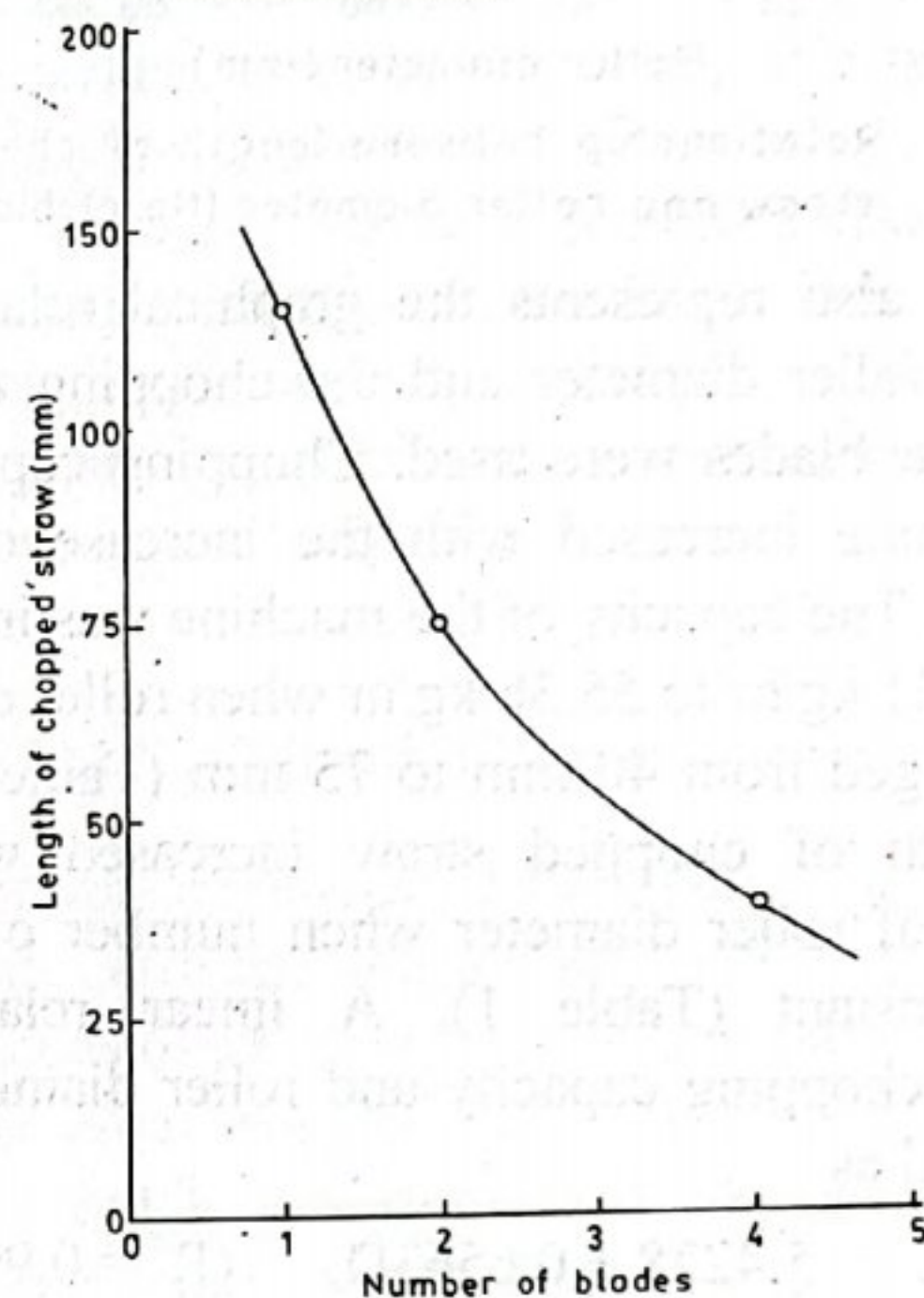


Fig. 3 Relationship between chopped straw and number of blades (Roller dia. 40mm)

The graphical representation of the relationship between length of chopped straw and roller diameter when number of blades were four is shown Fig. 4. Length of chopped straw increased from 40 mm to 81 mm with the increase of roller diameter from 40 mm to 75 mm (Table 1). The length of chopped straw can be calculated from the model developed as.

$$Y = -5.527 + 1.19189D \quad (R^2 = 0.921)$$

where,

Y = length of chopped straw, mm

D = Roller diameter, mm

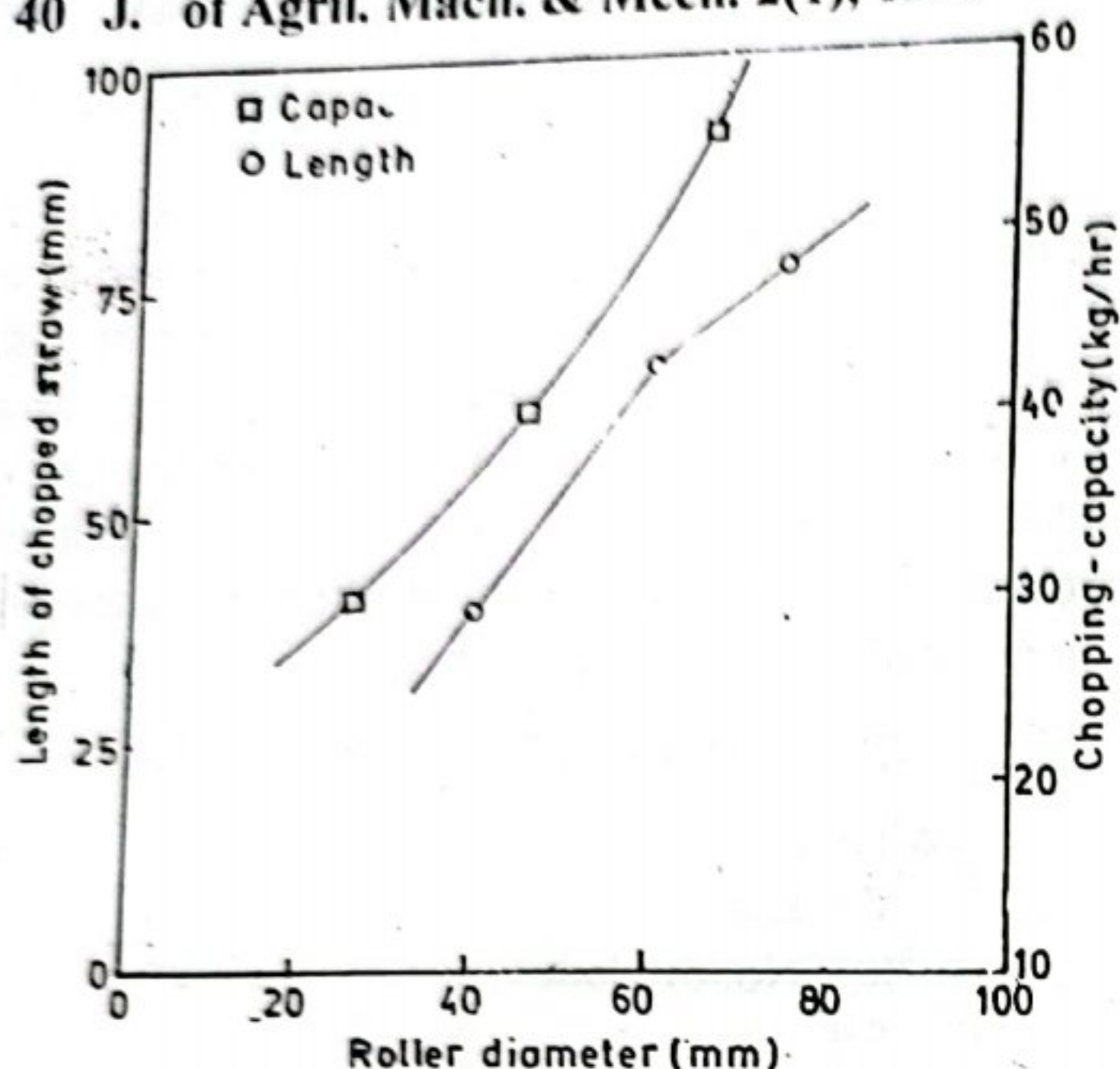


Fig. 4 Relationship between length of chopped straw and roller diameter (No. of blade 4)

Figure 4 also represents the graphical relationship between roller diameter and the chopping capacity when four blades were used. Chopping capacity of the machine increased with the increase of roller diameter. The capacity of the machine was increased from 32.21 kg/hr to 55.36 kg/hr when roller diameter was changed from 40 mm to 75 mm (Table 1). But the length of chopped straw increased with the increase of roller diameter when number of blades were constant (Table 1). A linear relationship between chopping capacity and roller diameter was developed as

$$C = 5.4228 + 0.6563D \quad (R^2 = 0.9912)$$

where,

C = Chopping capacity, kg/hr

D = Roller diameter, mm

DISCUSSIONS

The chopping machine was very simple in construction and operation. A single person can operate it easily. It could be used for chopping rice straw, wheat straw and different type of long grasses. The machine is quite capable to control the length of chopped material according to requirement. However, some minor modification may improve the performance and operation of the machine. It was capable to process feeds 3 to 4 times faster than that chopped by a sickle. Thus the machine is recommended for use at farm level.

ACKNOWLEDGEMENTS

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