CHAPTER - I

INTRODUCTION

Energy is an important issue for to national development programme and to provide major vital services that improve human condition – fuel for cooking, light for living, motive power for transport and electricity for modern communication. In agriculture sector, energy is used in every form of inputs- seeds fertilizer, agro-chemicals for plant protection, machinery for various operations, housing, transport and processing. Traditional agriculture was mostly dependent on non-commercial energy sources. Singh (1996) estimated that total energy input in Indian agriculture increased by 5.4 times during 1951 to 1995 while the production during the same time increased by 3.6 times.

In modern agriculture, commercial energy sources contribute bulk of the energy supplies to the production system. The share of tractor and other stationery engines in Rajasthan had gone to 57.99 per cent and 27.54 per cent in 2001-02 from 9.36 per cent and 8.50 per cent in 1971-72, respectively. The share of animal energy had declined from 69.42 per cent in 1971-72 to 9.20 per cent in 2001-02 (Singh *et al.,* 2006).

Inspite of large scale application of tractors and electrical power in agriculture, still animal power plays an important role in India for small and marginal farmers. The value produced by draught animals in India would be over Rs. 1000 billion whereas; mechanical sources of agricultural power depend on fossil fuel that has only limited life. Moreover, fossil fuel sources are fast depleting.

Modernisation and upgrading of draught animal power technology involving 400 million draught animals should be a high priority in developing countries. An increase of only 5 per cent in draught animal power output can be estimated to increase the power available to small farmers worldwide by more than 5000 MW. Efforts to make sustainable improvements in DAP technology have also been recommended by Goe (1983), Brumby (1986), Bodet (1987) and Smith (1981).

Draught animals are major source of motive power for majority of farmers in India. Bullocks, buffaloes, camels, horses, mules and donkeys are common draught animals. These animals perform different field operations and are also used for rural transportation. Total livestock population has increased from 485.0 million to 529.7 million during inter-censual period from 2003 to 2007 indicates a growth rate of 9.2%. But camel population has decreased from 632,000 to 515,000 with a total declination rate of 18.2% during this period (Anonymous, 2010). There are many advantages of using draught animals. They depend on locally available vegetation and grasses thus avoid the risks inherent in the cost of commercial fuels. They have zero replacement cost as they multiply by reproducing and thus do not

require large capital outlays if an appropriate stock of animals is maintained. The by-product like dung, milk, meat and leather are provided which have commercial value. As compared to tractors and power tillers, they are available in small unit size such that even small farmers can afford to own it. They largely involve non-monetized energy sources and use non-monetized labour, which is available especially in the off-season.

Draught animals cultivate about 60 to 65 per cent of total cultivated area in India. The present market value of the draught animals, animal drawn implements and animal carts is Rs. 365,000, 182,500 and 114,400 millions, respectively. In addition, the dung and other by products are valued at Rs. 61500 millions (Anonymous, 2000). In our country, 68 per cent of population depends on agriculture and related activities for their livelihood. Use of animals as source of energy is very dominant in the country and will continue to be so for many more years (Srivastava, 2000). The total power available on Indian farms has increased from 0.31 kW/ha in 1961 to 1.08 kW/ha in 1995, while the contribution of animate power to total power availability decreased from 94.9 per cent in 1961 to 25.9 per cent in 1995 but the absolute contribution from animate power source is nearly same during this period (it varied from 0.279 kW/ha to 0.317 kW/ha) (Anonymous, 2000).

Draught animals will continue to be used in Indian agriculture, which is a time tested renewable source of energy for sustained agriculture in the face of dwindling reserves of the non-renewable source of energy (Yadav, 2001). It is estimated that agro processing sector uses about 10 per cent of the total energy available in the country as compared to 7 per cent in 1980-81, this additional demand has to be met through electrical/mechanical /animal power. It is estimated that liquid fuel and natural gas would exhaust by 2050 and coal by 2250 at the present rate of use. These prediction and their consequences are applicable to India as well (Sukhatme, 1997).

Rajasthan is the largest state of India covering an area of 0.35 million sq. km, which is about 11 per cent of the total land area of the country. A major part of this area is rain fed which is governed by vagaries of monsoon making crop farming unstable enterprise. It is animal that gives stability to agriculture by subsidizing the income of the farmers. Rajasthan has about 3.01 million bullocks, 0.7 million camels and 1.3 million donkeys, which are widely used as draught animals (Singh and Maliwal, 2003). About 50-60 per cent of cultivation work is done through draught animals. It has 12 per cent livestock population of the country, which provides 19 per cent of the total income of the state.

A large part of Rajasthan comes under the Thar Desert. Camel is large and sturdy animal with long legs and neck and prominent hump on the back. It can adopt itself in the arid region and subsists on coarse kind of feed which is generally unsuitable for herbivorous animals. In India one hump camel, the Arabian form is found. Through the camel is found in Gujarat, Punjab, Western Uttar Pradesh, Haryana

but Rajasthan has maximum number of camels. Camel is the major source of power for goods and passenger transport in Rajasthan. Camels are used for very limited period for farm operations. During the idle period they are extensively used for transportation purpose.

Camel can tolerate dehydration to the extent of 30 per cent of its body weight of water. Most other mammals succumb to circulatory failure after a loss of about 12 per cent. Camel is highly suitable for arid zone devoid of vegetation because of its unique qualities of withstanding drought condition and can live for days without water. It can live in shortage of food, which generally are unsuitable for other animals.

The output power of camel depends upon physiological and environmental factors; breed, age, feeding, health, training, mood of the animal as well as rhythm in which labour and efficiency is required. Many studies have been conducted to find out the optimal level of draught so that work efficiencies of the bullock may be maximized. A lot of work has been done to study the physiological behaviour of camels under different levels of draught and environmental variations. Yadav and Srivastava (1993) suggested draught level of 8-14 per cent of its body weight as safe on linear mode of operation in summer and 8-16 per cent in winter.

The use of draught animal power is confined to field operations such as tillage, sowing, interculture, threshing and rural transport. These operations being seasonal, limit the use of animals to about 100 days per year on an average. The average annual use of animal varies from 450 to 1500 hours i.e. draught animals are not being utilized properly for the remaining period. It is necessary to use this available resource in a more meaningful and judicious manner. They can be easily used for 2400 to 2700 hours per year. It can be achieved through employing animal in the rotary mode of power to operate different agro processing machines (Srivastava and Yadav, 1987).

By using animals in rotary mode of operation, the surplus/idle animal power available after tillage, sowing and other field operation can be utilized efficiently for different agro processing operations including generation of electricity. This will reduce the dependency of farmers on the electricity and fossil fuels. It will also enable the farmers to generate extra income when they are not engaged in agriculture operation.

Draught animal power can be harnessed in two ways as discussed by Kumar (1991), first by tractive effort and second by weight of the animal. The tractive effort on a circular path to drive geared system was found most convenient and was already used in past like; Persian wheel, sugarcane juice expeller and oil ghani, which are low speed high torque machines.

However, information on utilization of animal power in rotary mode is not abundantly available. The losses occur in the sweep power due to circular path of draught animals. These losses might account for up to 50 per cent of output that could be reached with traction on straight path which results in slowing of speed and the loss of tractive power. Number of attempts have been made to utilise animal power in rotary mode like for electricity generation (Kohli, 1985), animal drawn drilling rig (Tiwari and Mishra, 1984), wheat threshing (Anonymous, 1987), chaff cutting (Hallikery *et al*., 1995) and winnowing fan (Halikery, 2002). The animal power in rotary mode seems to be an untapped source of power need attention. This rotary mode can serve as a prime mower. This may be beneficial to animal owners of remote rural area, when it can be used to enhance the utility of animals, thereby, reducing maintenance cost. The savings in the use of commercial sources of power in present era of escalating fuel prices. Pollution free energy is the added advantage of the system.

Using the animal power for operating small capacity agro processing machines in rotary mode is the solution without use of electric motor or IC engines in remote villages in hills or plain areas where either the electric supply is not regular or erratic. Electricity generation and battery charging in rural region is a great challenge. For this purpose electricity generation setup for battery charging was developed, which worked successfully with the rotary mode. Maize is a widely cultivated crop in the Mewar region of Rajasthan. A maize dehusker sheller was identified and modified for rotary mode of operation. Similarly a groundnut decorticator and a small air compressor were identified and further modified for rotary transmission system.

Selection of different matching machines and gadgets powered by rotary mode of operation is very difficult. Generally hit and trial method is used for selection of gadgets for rotary mode of operation. But for the proper selection, efficient use, standardization of different parameter and proper testing a technical laboratory simulation procedure is needed. By this simulation set up of rotary mode we can easily evaluate the performance of different matching gadgets at the laboratory condition. Through this laboratory performance matching gadgets is to be selected and the whole process can be standardized technically.

Keeping above points in view, a study was under taken with the following objectives:

1. Identification of matching gadgets for animal drawn rotary power transmission.
2. Development and performance evaluation of suitable matching gadgets through laboratory simulation.
3. To evaluate performance of selected matching gadgets with camel powered rotary transmission system.