CHAPTER I

INTRODUCTION

1.1 General

India is predominantly an agricultural country. It is estimated that about seventy per cent of Indian population live in villages and 4 out of every 5 persons living in rural areas depend on agriculture for their livelihood. Although the farm yield has increased over the years there is scope for further increase. The increase in agricultural production, however, can be brought about by increasing yields of various crops, and the outputs of animal and aquaculture. Consequently, agriculture needs to be modernised by using production inputs, and efficient machinery.

The average horsepower available per hectare in Indian farms was estimated to be 0.302 (Stout and Drowning, 1974). In order to produce moderately good yields it is necessary to have 0.52 - 2.7 hp/ha (Jain, 1978). This level can be achieved through proper use and judicious management of different farm power sources viz. man, animal and machines within the framework of the present socio-economic status of the Indian farmers and their land holdings. According to Singh and Kaul (1972) out of the 70 million holdings in India about 70 per cent of the holdings are below

2 ha, 26 per cent are in the range of 2.02-10 ha and 7 per cent are above 10 ha. Over and above, the fragmentation of these land holdings limits the use of medium and big machines for the simple reason that they cannot be transported to the fields for want of sufficiently wide farm roads. The lack of initial capital required for these machines as well as their maintenance and technical know-how, imposes another problem for the poor Indian farmers. Under the circumstances, the use of improved indigenous tools and implements drawn by man and animal appears to be imminent.

One of the aspects of the use of small tools and implements is in weeding operation. Weeding is one of the most important farm operations involved in the crop production system. Weeding is the act of removal of 'weeds' from the field crops, 'weeds' are the unwanted plants growing among the cultivated plants, such as rice, wheat, potato etc. and competing with them for light, nutrients, space and water. In India, this operation, by and large, is performed manually with a traditional hand tool - khurpi or a spade. These require more time and labour. It is estimated that a single hand weeding for upland paddy requires about 300 - 1200 man-hours per hectare (De Datta et al. 1974).

Of the total man-hours involved in agricultural work during the cultivating season as much as 15 per cent of the labour is used in cutting weeds from lowland and upland (Nag and Dutt, 1979).

The weed infestation is a major factor accounted for the low yield of upland paddy and most of the rabi crops. At national level, as such, no statistical data are available for yield loss due to weeds, however plot study gives 20 to 30 per cent yield loss (Biswas, 1983). According to another study by Mani et al. (1968) weeds cause a loss of 31.5 per cent in yields of food grain crops, 22.7 per cent in the rabi and 36.5 per cent in the kharif seasons. But as the farmers adopt some kind of weeding on their fields, a conservative estimate of 10 per cent loss in the crop yields may be taken as more realistic. When calculated in terms of losses in Rupees (Rs.) it amounts to 4,200 million annually (Joshi, 1973).

There are different methods of weed control, these include among others - manual, mechanical and chemical. During the peak seasons of the year it becomes rather impossible to find labourers for hand weeding in the crops,. Among the mechanical methods, the use of power weeders is yet to be introduced in India. However, the use of animal drawn indigeneous and improved implements like 'Bukhar' 3-Tine cultivator, spike tooth harrow etc., are very much in vogue in nearly all parts of the country. The limitations of chemical methods are their high cost and non-availability, over and above the cost of the equipment required for their application. There is an urgent need to develop a chemical weeder suitable to Indian conditions which will reduce the quantity of herbicide required per hectare and at the same time require less power for operation and with simpler

technical know-how. Attempts were made to develop such a weeder. The results of this work are described in the thesis. Considering the scarcity of labour for weeding during peak seasons it becomes essential to maximize their working capacity using improved tools and implements. It appears therefore, that along with the animal drawn implements, there is a great need for manually drawn small, improved dual purpose weeders for mechanical and chemical control of weeds. The present authors' study (Tewari, et al. 1983) indicates that the use of an improved wheel hoe-type of weeder reduces the labour demand for weeding, in comparison to hand weeding, upto about 30 per cent.

1.2 Ergonomic Considerations for Weeder

Much of the human engineering study done to-date has been directed towards solving existing or anticipated problems related to industrial operations and to air and spacecraft, whereas hardly any intensive work has been done towards application of this science in design and development of small tools and implements for use in agricultural operations. Many of these operations require postures that may not be comfortable for normal working with the existing limitations of human being. The result is that operators suffer from numerous ailments which arise while working with ill designed tools and implments involving unusual postures like bending and stooping, over and above, the stress due to environmental factors, as a result the working capacity of labourers is reduced. All these situations

can be avoided considerably, if the design of implements is well matched with workers capabilities and limitations, these being determined through physiological measurements. The efficiency and power of his muscles, heart, lungs, fatigability, and the speed of recovery during rest are essential, however, sufficient informations about them are not available.

Therefore, physiological cost of agricultural task is an essential basis for evaluation of the use of human being as a source of farm power.

Although different types of small tools and aids are available for weeding or interculture operations in the country, no systematic investigation has been done to study and design them from ergonomic considerations.

In the case of operation of the weeder for mechanical control of weeds, the person has to apply pushing and pulling force against the resistance of the weeds while in a standing posture. Therefore, before introducing such a type of weeding implement, it becomes necessary to investigate the physiological cost of its operation as well as to develop it to suit the human limitation, and for maximizing his muscle power output.

On the basis of the above, it may be necessary to re-design the implement or the operation so that it may be operated with much reduced effort satisfactorily. This aspect has been given due emphasis in this investigation for increasing the working capacity of farm workers.

Keeping these facts in view, a study was undertaken in the Agricultural Engineering Department, I.I.T., Kharagpur with the following objectives

1. Evaluation of performance of human operated weeding devices, namely, Khurpi, Spade, 3-tined hoe from ergonomic and engineering considerations.
2. Design and development of a mechanical recorder for measuring the forces exerted in operation of a weeder.
3. To develop a dual-purpose weeder for mechanical and chemical control of weeds and evaluation of its performance in laboratory and field.
4. Laboratory simulation of pushing and pulling operations of the dual-purpose weeder and the study of muscle power involved in its operations.
5. Design and Development of different types of weeding blades with optimum width of cut and the evaluation of their performance from engineering and ergonomic considerations.
6. Study of work-rest pause on human performance during operation of the dual-purpose weeder in field.
7. Study of the static grip strength of agricultural workers from age, body weight, body height, grip diameter and normal heart rate, with regard to development of weeders.