CHAPTER I

INTRODUCTION

Oils and fats are important commodities in India's economy. Oil seeds constitute the second largest agricultural crop in quantity as well as value. Among oil seeds, groundnut (Arachis hypogaea L.) ranks first in area under cultivation as well as in production. In 1970-71, groundnut production of India accounted for more than half of the world output(51). During 1977-78 the area under groundnut was 7.72 million hectares, and production was 6.06 million tonnes(1).

1. 1 State of Art of Harvesting

Groundnut is grown in both northern and southern parts of the country in light to heavy soils. Both bunch (erect) and spreading type of varieties are cultivated. The former is harvested mostly by hand uprooting, and the latter by either ploughing or harrowing the field using animal power or tractors, and thereafter manually collecting the plants in small heaps. About 120 man-hours are required for harvesting one hectare of crop (58).

The present mode of harvesting is disadvantageous for three reasons. Firstly, dead (diseased) plants become detached from pods which are left in the ground when the plants are uprooted by hand. Secondly, in case of densely weed infested fields, heavy loss of pods occur when harvesting is done by pulling the plants by hand (50). Thirdly, the beneficial effect of nitrogen fixation by the crop is reduced, since some of the

nitrogen bearing nodules are also removed with plant roots from the soil in the harvesting process. In addition to these disadvantages, the present mode of harvesting is tedious and labour intensive. Multiple cropping, which includes relay and mixed cropping, is becoming a characteristic feature of modern Indian agriculture. Timeliness of field operations is a basic requirement for successful multiple cropping, since a series of crops is grown in quick succession on the same piece of land. In northern and southern regions, the harvest of the groundnut occurs during a period of maximum concentration of field operations, which is obviously the period of peak labour and energy demand. This situation, therefore, calls for the development of appropriate groundnut harvesting equipment.

1. 2 Design of Digging Blade

The tractor operated groundnut harvesting equipment in India use single blade rather than the half sweeps commonly used on European and American machines. The former was preferred in Indian conditions as the latter resulted in greater losses in the form of undug plants (58). The draft requirement of the harvesting machine equipped with the half sweeps is known to be considerably high. For instance, it has been reported that a 20 hp groundnut combine used 15 hp for digging operation alone (36). Further, the operation of harvesting equipment, having either single blade or half sweeps, in heavy soils results in the formation of bigger clods as well as excessive adherence of soil to pods and a considerable difficulty in

separation of soil from the pods, leading to substantial loss in the yield of the crop.

Various investigations (11, 13, 22, 24, 32, 41, 48, 55, 59, 65) have shown that vibrating a blade offers several advantages, such as reduced draft and increased soil pulverisation. The latter characteristic has an important bearing on improved separation,and consequently lesser damage and loss of tubers. The use of a vibratory blade allows transfer of a fraction of power application from the tractive phase to PTO phase-a more efficient mode of power transmission. As a consequence, a smaller tractor weight is sufficient for traction, resulting in reduced soil compaction. Application of vibratory blades for harvesting of root crops has reportedly been found quite promising (8, 13, 14, 25, 31, 57, 62).

1. 3 Scope and Objectivesof the Investigation

In view of the inherent advantages of a vibratory blade, its application for groundnut harvesting may prove capable of overcoming the drawbacks of a nonvibratory or passive blade mentioned in Section 1.2.

Although several field and laboratory investigations have been carried out for determining the draft and power requirements of a vibratory blade system, only a few of them have attempted to analyse the problem of dynamic interaction of vibratory blade with soil or soil-plant medium (6, 9, 28, 41, 47, 56, 65).

In order to predict the performance of a groundnut

harvesting equipment, basic laws governing the interaction of vibratory blade-soil-groundnut plant medium (SPM) have to be understood. Therefore, this project aimed at a theoretical as well as experimental investigation of the interaction with SPM of a blade subjected to forced longitudinal vibration. This interaction is inherently complex due to the random spread of the groundnut plant roots and pods in the soil. Obviously the strength of the SPM varies with the maturity of the crop, moisture content and bulk density of soil, and changes in soil structure brought about by roots and pods. Therefore, the actual field conditions were simulated in an indoor soil bin by transplanting the plants excavated (along soil monolith) from the field. A rectangular ridge of uniform cross-section with the transplanted groundnut plant-soil monoliths simulated actual field conditions for a one dimensional cutting process. The set of soil bin experiments facilitated an investigation of the comprehensible behaviour of the blade - SPM interaction under various operating parameters, such as amplitude and frequency of vibration, blade lift angle, and forward velocity. Optimum operating system parameters were determined from these soil bin experiments and a prototype tractor mounted vibratory groundnut digger was designed, constructed and tested under actual field conditions.

The following were the specific objectives of this investigation :

1. To study the main dynamic parameters of soil and SPM.

2. To develop a mathematical model of dynamic blade-soil and blade-SPM interaction based on the analysis of the one dimensional sinusoidal cutting process.

3. To determine the effect of operating blade system parameters, such as lift angle, amplitude and frequency of vibration, and forward velocity, on the draft and power requirements under controlled laboratory conditions.

4. To evaluate the effect of blade lift angle, amplitude and frequency of vibration on soil breakup.

5. To design, develop and construct a prototype tractor mounted vibratory groundnut digger and to test it under actual field conditions.