# Chapter 1

# Introduction

## 1.1 Background of the study

The increase of weight and volumes of farm machines used in modern mechanized agriculture have been reported as a major factor in aggravating the incidence of field soil compaction.

As confirmed by many research works, the reduction of yield is mainly due to soil compaction. Moreover, it is not only the agricultural aspect but also the environmental issue that has been influenced by undesired soil compaction. Serious, widespread and long-term implications for the quality of the environment have been widely recognized. Among hazardous phenomena recognized recently, the greenhouse effect is of major concern. Changes of soil properties due to soil compaction lead to the emission of greenhouse gases into the atmosphere.

There have been many efforts made to reduce the effect of soil compaction on crop production and environmental quality. These include the prevention of soil compaction occurrence, of which the reduction of traffic in field is a method to be attempted. The well-known methods adopted to meet this propose are, for example, the conservative tillage and no-tillage systems. Also, the development of the tractor in reducing its weight by using new materials that are high in strength but light in weight helps to alleviate this problem.

However, to achieve the goal of reducing soil compaction in the field, the most important process that has to be performed initially is to investigate the process of soil compaction and its behavior being influenced by the traffic-induced force system. Even though there have been many research works concerned this issue recently, further

researches are still needed because of the complications of the soil and machinery traffic system.

In the field, traffic-induced load transmitted to the soil element is a complex phenomenon. It changes not only in its magnitude but also in its direction, which causes the soil element to come under a dynamic loading system. Laboratory experiments corresponding to this phenomenon have not been widely conducted even though their necessity is recognized.

In order to contribute to the understanding of traffic-induced soil compaction, attempts were made to clarify the behavior of field soil compaction caused by the driving devices of a tractor. However, this study focused only on quick torsional shearing phenomena that normally occur in soil beneath a wheel during the turning operation of a tractor at headland. Similar torsional shearing phenomena may also be encountered even in the straight running of a tractor on irregular profile surface due to the manual correction of the direction of front wheels that are skewed so as to maintain straight driving.

The force generated by tractor wheels under these phenomena tends to follow the pattern of cyclic torsional shear. The method of cyclic torsional shear loading test, which is widely employed in the field of civil engineering to solve the problems of earthquake and traffic on railway and highway, appears to be capable of identifying the loading pattern that is likely analogous to traffic loading under the above phenomena. This is the principal reason for the adaptation of this method in this study.

### 1.2 Objectives

In this research study, indoor experiments have been carried out to investigate the behavior of soil compaction related to the traffic-induced loading system by adopting the

cyclic torsional shear loading test method. This method was applied in order to simulate the loading system that is generated by passages of tractor wheels during operations in the field, particularly on their turning action at headland. To achieve this goal, the research work was carried out with the following objectives:

1. To clarify parasitic interrelationships among various parameters involved in the behavior of soil compaction. These include cyclic torsional shear stress, confining stress, torsional shear strain, loading frequency, bulk density and number of cyclic loading.

2. To investigate the failure characteristics, dynamic shear strength and critical state of soil compaction under this loading system.

3. To observe the influence caused by the loading and loading-free processes of cyclic torsional shear load on soil compaction characteristics.