CHAPTER I

INTRODUCTION

A knowledge of physical and rheological properties of rice is essential for the proper design of processing equipments and storage structures which are so important in ensuring better outturn and higher yield of head rice. The designer has still recourse to the trial and error method while designing some of the important rice processing equipments such as thresher, cleaner, dryer, sheller, separator, polisher, grader, mechanical handling and conveying equipment used in the rice processing plant and various types of storage structures for rice. Due to lack of information on physical and rheological properties of rice, the designer has to make his judgement on the basis of his previous experience rather than on scientific method based on material properties.

Rice grains pass through various types of stresses and strains during different processing and handling operations before being converted into a finished product. During threshing operation, the paddy grains undergo compressive, shear and frictional forces. During shelling operation, they have to pass through a narrow clearance between rubber rolls in case of a rubber roll sheller, through interfaces between two discs in case of an under-run-disc sheller or are subjected to impact in case of an impact type sheller. In each of these cases the rice grain is being subjected to dynamic compressive force.

During polishing or whitening operation, it is subjected to frictional and abrasive forces. The magnitude of these forces depends on normal pressure acting on the grain and the coefficient of friction between the grain and the rubbing or abrasive surface. It is likely to crack if the magnitude of normal pressure exceeds a certain limiting value of compressive stress. During mechanical handling or conveying, the grains may be subjected to compressive stresses involving dynamic and quasi-static loading. The granular nature of rice grain lends itself to bulk storage in deep bins. Considering the grain alone, the depth of such bins is limited only by the pressure that the grains at or near the bottom of each bin can withstand without cracking or loss of viability. Although consideration of rice grains in bulk rather than individual grain has, in the past, been directed towards the calculation of wall and floor pressures in storage bins, none has investigated the effect of these pressures on the rice grains themselves. A knowledge of ultimate compressive strength of rice grain may be required to design a grinding mill for making rice flour from broken or whole rice grains.

Several researchers have investigated physical and rheological properties of different biological materials treating them as engineering materials. Rice grain is composed of cells with macromolecules and molecules. Therefore, its mechanism of response may be studied at any one of the three levels, molecular, structural, and phenomenological. To make a beginning of this type of study, it has been decided to use the phenomenological level where the material is assumed to be homogeneous

and isotropic.

The rice grain which contains moisture in and around the cellular structures is a viscoelastic material. The main problem in any experimental study of viscoelastic behaviour is to obtain the relationship among stress, strain, and time for a particular type of stress history. For rice grain, this reduces to determining the time dependence of its modulus or compliance corresponding to the type of deformation chosen. The fundamental deformation characteristics of viscoelastic material are shear, volumetric compression (or dilatation), uniaxial compression and tension. In the present study, uniaxial compression and volumetric compression are the two types of deformations studied for rice grain because of the ease with which they could be obtained in the laboratory.

The behaviour of rice grain in compression depends on the variety, moisture content, temperature and time of loading, and therefore, any study of its compressive behaviour must include these variables.

No systematic research work has been carried out so far with rice grain for determining its rheological behaviour over a wide range of time scale spectrum and its variation with moisture content and temperature. Therefore, the following specific objectives have been envisaged.

1) To study the behaviour of rice grain in compression under dynamic, quasi-static and static loading at different moisture levels and temperatures.

2) To evaluate various rheological parameters for rice grain from observed data.

3) To develop rheological models and prediction equations for rice grain to represent its behaviour for different loading conditions and moisture levels.

It is contended that the basic data presented in this thesis would help to evaluate intelligently the existing and new methods of processing, handling and storage of rice grains. With knowledge of the relationship between rheological properties of rice and environmental conditions, researchers may possibly devise an improved method of overcoming the rice breakage problem as it exists today. Apart from being directly helpful to the designer, the rheological properties of rice grain will also benefit those interested in the field of rice breeding.