

CHAPTER I
INTRODUCTION

1. General

Winnowing is the process of removing chaff, straw, dust, and shrivelled grains from the threshed crop by natural wind or artificially created air-blast. It is usually the final operation after harvesting for most of the cereals and pulses, and some of the oil seed crops. The separation of the chaff and other impurities from the grains takes place, as these have a less value of M/A --that is, the ratio of mass to projected area--and fall beyond the spot where the grains drop.

2. Common Methods of Winnowing in India

From times immemorial winnowing in natural wind is the most commonly used method. For an efficient job a steady, unidirectional wind is required. Use of air-moving devices, such as winnowing fans, is comparatively a recent development. Due to unpredictable nature of natural wind, and under unfavourable weather conditions use of a winnowing fan becomes a necessity. In addition, the fan can create desired blast which may result in more effective winnowing operation. Stationary threshers and combines are used to a very limited extent as these are beyond the reach of large number of farmers.

While exploiting the bounties of nature, the operation is carried out either standing on the ground or on a especially constructed platform three to five feet high. In the former case minimum one person is required, while two men are needed for the latter. In either case the threshed material is dropped against the direction of wind in a thin controlled sheet using a "supda"--a shallow, square basket like structure with one side open--by raising it above the shoulders (Fig. 1-1). The clean grains drop on a tarpaulin or canvas spread on the floor while the chaff is blown away. If some of the chaff falls on the grains due to fluctuations in the wind it is removed by vigorously fanning the grain-heap with the "supda". Such a treatment is feasible, as during the threshing operation itself big pieces of straw, chaff, and empty ears are removed by hand. Some time two such operations are required.

Winnowing fans are becoming increasingly popular among the farmers and at present are being manufactured by more than a dozen firms. Due to economic considerations alone, a simple, horizontally mounted, manually operated or power driven axial-flow fan with blades of sheet steel, is used for this purpose. Sieves or straw racks are not incorporated. Few of the firms are also manufacturing radial-flow fans with straight impellers. Its construction

is such that the air and grain streams meet at an angle of 30 to 60° in the first quadrant of a circle. Here, too, for the manually operated fan two men are required, while for the power driven minimum one man is needed. The rest of the operation remains basically the same. Figs. 1-1 and 1-2 depict winnowing operations under typical conditions.

3. Objective

The design and construction of a less expensive but efficient winnower requires thorough study of the principles of winnowing. Due to lack of data on functional requirements its design is arbitrary and lacks scientific approach. The objective of this study was to establish winnowing principles and to collect experimental data which might help in proper designing of a winnowing fan. It was also desired to investigate whether simple treatments like initial velocity of grains and chaff (which could be conveniently changed by varying the height of dropping), and the angle between the air and grain streams have any appreciable effect on winnowing.

Emphasis was laid on the following three factors:

- (1) The optimum velocity range to separate two given particles--for example, grain and chaff--that will fix the velocity requirement of a winnowing fan.

(ii) The duration for which the particles should remain in the air-stream; that will fix the size (diameter) of the fan.

(iii) Sizes of the particles that cannot be separated by this method; that will fix the ultimate limits of this operation.

The investigation was carried out in three phases.

3-1. Study of winnowing indices

In order to find a logical winnowing index for the comparison of winnowing operations under different sets of conditions, a comparative study of various winnowing indices was taken up.

3-2. Experimental

Stress was laid on experimental results as far as possible. This part covered the behaviour of a grain-chaff mixture in an air-stream. For preparation of these mixtures, paddy (rice) grains and two varieties of chaff, (i) paddy chaff and (ii) linseed chaff, cut to different lengths, were used. Results for various treatment-combinations involving air-velocity, height of free fall above air-stream, and angle of feed of grains and chaff with the vertical were obtained and compared.

These experiments were repeated for grains alone and chaff alone, in order to determine interaction between the two.

3-3. Theoretical

The experimental findings were generalised by determining theoretically the movement of a single particle and its behaviour in an air-stream. This covered the following factors:

- (i) Effect of fan diameter, and upward inclination of air-stream.
- (ii) Effect of free fall, before and after the action of air-stream.
- (iii) Sizes of particles, which could only be effectively separated by pneumatic separation.