DESIGN DEVELOPMENT OF A PNEUMATIC CONVEYOR FOR HANDLING OF PADDY IN FARM OPERATIONS

A.R. Ariyaratne

Department of Agricultural Engineering, Faculty of Agriculture
University of Peradeniya

Introduction

Qualitative and quantitative losses of paddy, related to the post harvest operations practiced by farmers, are a well-known fact in Sri Lanka. With the introduction of the high capacity thresher in the major paddy growing areas, further deterioration in quality has been observed during the last five cropping seasons. The thresher, introduced as a solution to the severe labour shortage in harvesting season, has contributed to some changes in the field practices. As a result, the time taken from reaping to packing in bags is reduced from about five days to about one day. Therefore, in the present scenario, the moisture content of paddy at the time of bagging is 18-20% (wb). Farmers keep the paddy with the high moisture in their storage places without adopting suitable methods for grain conditioning. Lack of awareness among farmers, unavailability or high costs of labour and unexpected rainy weather during these seasons are the reasons for the failure to dry grain to storable condition. In some instances, due to deterioration in storage, the farmers were compelled to sell their paddy for animal feed, resulting in heavy financial losses. Measures are needed to prohibit this worsening situation in the Sri Lankan paddy sector since it has many implications including health risks.

As a solution, appropriate mechanized grain-handling methods, that facilitate movement of grain for operations such as open air-drying by the farmer himself, need to be developed. The technology should be suitable for small-scale operations at field level. Although high capacity equipment that are intended for field operations are available, simple techniques for small-scale applications are not yet developed. Therefore, development of appropriate paddy grain handling equipment to suit Sri Lankan farming environments is needed to support farmers and safeguard consumers. The objective of the study is to develop a small-scale pneumatic conveyor for handling paddy at farms or farm houses.

Methodology

A portable size pneumatic conveyor that operates on suction was designed. From among the different types of pneumatic conveying mechanisms, such as suction type, pressure type and suction and pressure combined type (George *et al.*, 1997), the suction mode of operation was selected to collect and convey grains without mechanical damage. A centrifugal blower, run by the tractor power or an electric motor, exerts a negative pressure sufficient to lift and convey paddy

grain. The suction velocities resulting from the Venturi effect was studied for the parameters required for pneumatic conveying. A blower powered by a three-phase motor (1 hp) and a motor speed controller was used to obtain air flow at different velocities. Air velocity measurements were made with a probe type digital anemometer.

Results and Discussion

A test model consisting of air blower with variable speed, a junction of two tubes with a restriction to create the Venturi effect and suction, and a delivery line was constructed at the Department of Agricultural Engineering. The apparatus had the facility to change the angle between pipes at the junction which resembles a "Y" shape joint of pipes. The main duct which carries air from the blower was a straight PVC pipe of 60 mm and it could be coupled with the blower unit and the delivery pipe. Inside this pipe, just ahead of the joint, a restriction was installed to obtain the Venturi effect. The suction pipe which gives suction effect was connected to the main duct from a side with a flexible link so that the angle between pipes could be adjusted. The suction pipe made of 32 mm diameter PVC was connected to a flexible duct of the same diameter, which normally comes with vacuum cleaners.

In order to select the best angle between pipes, a series of tests was conducted and air velocities in the pipe connected to the blower, the suction tube and the delivery pipe were observed. Results indicate that the highest air velocities of 9.0 and 11 m s^{-1} in the suction and delivery pipes respectively were produced at the angle of 60^{O} between pipes in the joint. These velocities are well within those required for lifting and conveying velocities for paddy grains and are comparable with operational conditions of general pneumatic conveying (David *et al.*, 2004). At these conditions, blower speed was 3600 rpm which could be achievable with a two-wheeled tractor coupled belt-type power transmission unit. Conveying capacities, obtained at various speeds indicated that improvements were needed to match the requirements of grain handling at farm level. It suggests that the apparatus have to be made with larger diameter pipes while having increased capacity of blower unit.

Conclusions

The study shows that the suction created by the Venturi effect could be used to lift and convey paddy in vertical and horizontal directions. The capacity of conveyance obtainable from the design is below the requirements to suit paddy farm sizes. Further improvements of the design are required to enhance the conveyance capacities.

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References

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