ABSTRACT

In India, the farmers of marginal and small categories perform cutting and threshing of paddy crop separately because of unaffordable cost of existing mini combine harvester. Consequently, their tradition of performing operations separately continues which leads to dependency on labors and machine owners. Labor demand increases in peak season which causes labor shortage and hence the delay in harvesting. As a result, the grain loss increases due to shattering during harvesting. The manual crop harvesting consumes large number of labor and time which results in increased input cost and disturbance in timeliness of operation. These problems could be minimized by improving the mechanization level of small farms. Considering these facts, a low-cost small scale machine was developed. Dissimilar to the existing manual or mechanical methods, the sequence of operations like cutting and then threshing was not adopted in the proposed machine. It was designed to thresh only the grain bearing portion of the standing plant and can cover single row at a time. In the existing machines, the crop cutting unit, feeding unit and the threshing of whole crop consumes more energy. With developed harvester, direct threshing of grain bearing portion of standing plants was carried out *in-situ* which permits faster threshing than the whole crop feed thresher. The panicles appear in the plant above 60 cm height for the crop variety IR-36 and therefore, the axis height of threshing cylinder was fixed at 60 from the ground. Some mechanical properties of the paddy plant such as straw breaking force and plant uprooting force were also determined. Using these values, a laboratory model harvester was developed. It comprised of a threshing cylinder fitted with wire-loop threshing elements, concave, collecting tray, crop guiding plates, motor and power transmission. The thresher was kept stationary and plants were moved for feeding them into thresher. Torque sensor, rotary encoder and proximity sensor were equipped for measuring threshing torque, cylinder speed and crop feeding speed. Experimental layout was designed using central composite design and accordingly laboratory experiment was conducted. Numerical optimization was carried out and it was found that the threshing efficiency, specific energy consumption and total grain loss were 98.99%, 1.59 kWh/ton of grain and 4.84%, respectively, at optimized cylinder speed and crop feeding speed of 18.94 m/s and 0.8 km/h, respectively.

Based on the optimized values, a field model of single-row harvester was developed. It was supported on wheels. A gasoline engine was used to power both the threshing cylinder and the ground wheels. The field model was also equipped with torque sensor and rotary encoder and then tested in the field. For the field model, specific energy consumption was found to be 3.42 kWh/ton of grain at a grain throughput rate of 82 kg/h. Later, the transducers were removed and a prototype single row harvester (PSRH) was made and tested again in the field. The PSRH had a threshing efficiency, total grain loss, field capacity, fuel consumption and operational cost 98.23%, 4.75%, 0.014 ha/h, 0.27 l/h and 7022 ₹/ha, respectively.

Labor requirement, operational cost and grain loss in different existing methods were compared with those of PSRH. These parameters were, respectively, 2.5, 1.3 and 2.4 times lower in PSRH compared to manual harvesting. Comparing the combination of manual cutting and pedal-operated thresher together with developed PSRH, the labor requirement and cost of operation of 55.75 and 32%, respectively, could be saved using PSRH. While comparing the manual crop cutting and power threshing together, the labor requirement, operational cost and grain loss of 74 to 94 man-h/ha, ₹2,084 to 2,709 /ha and 1.31 to 7.98%, respectively, could be saved using PSRH.

It was concluded that the low-cost prototype harvester can be used by small and marginal farmers having less than 2 ha land due to its lower labor requirement, cost of operation and grain loss over conventional methods of crop cutting and threshing. It can be used for harvesting paddy crop in less time, which could save the crop against adverse weather conditions of sudden rain.

Keywords: harvester, direct threshing of panicle, peripheral speed of threshing cylinder, threshing efficiency, grain loss, specific energy consumption.