

Power Requirement and Performance Factors of a Sunflower Thresher

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Abstract

A prototype sunflower thresher was designed, fabricated and tested. The performance of the machine by a PTO tractor at five levels of drum speeds; 650, 700, 750, 800 and 850 rpm and three feed rates; 2,000, 2,500 and 3,000 kg(head)/h, were used. The results showed that the no load power requirement of the sunflower thresher at a drum speed of 750 rpm (10.99 m/s) was 1.8 kW. At feed rate of 3,000 kg(head)/h and drum speed of 750 rpm; the thresher capacity was 1,098 kg(grain)/h with a threshing efficiency of 99%, grain damage was less than 1%, cleaning efficiency of 99%, grain loss of 0.82 to 1.07% and specific energy consumption of 3.86 to 4.38 kW-h/ton.

Introduction

As in other countries, sunflower is one of the important oil seed crops of Thailand. The area planted with sunflower in Thailand has increased rapidly from 11,984 to 96,000 ha in 1993 to 2000 (OAE, 2000) and is expected to increase further. Currently, no thresher to thresh local sunflower is available in Thailand. Farmers in some areas of Thailand thresh sunflower using a rice or soybean thresher or corn sheller. However, the results obtained indicate that these threshers are not appropriate for threshing sunflower. A mechanical thresher for sunflower threshing was designed and developed. The objectives of this study were to evaluate the performance of the sunflower thresher and to recommend the best combination of operating parameters for the developed sunflower thresher.

Materials and Methods

The sunflower thresher operates on the principle of axial flow movement of material (Figure 1). The machine consisted of threshing unit, separating and cleaning unit, feeding unit and power drive unit. The rasp-bar drum was of 92 cm length and 28 cm diameter with 4 rasp-bars arranged in the opposite position on the threshing drum surface. The concave was made of steel plate with elliptical holes 11x60 mm. The concave clearance was 35 mm. The Hysun-33 sunflower variety was used. The average moisture contents of seeds and straw were 6.52 and 16.59% (w.b.), respectively. The average ratio of seed to straw was 1.33. In this experiment, five levels of drum speeds, 650 rpm (9.53 m/s), 700 rpm (10.26 m/s), 750 rpm (10.99 m/s), 800 rpm (11.73 m/s) and 850 rpm (12.46 m/s) were used during the tests. Three levels of the feed rates used were 2,000, 2,500 and 3,000 kg(head)/h. Power consumption tests of the sunflower thresher at no load condition with drum speeds of 650, 700, 750, 800 and 850 rpm were conducted. For measuring the power requirement during load, the crop material was fed to the threshing unit through a feeding devices at a particular combination of drum speed and feed rate. The performance of the sunflower thresher (RNAME Test code, 1995) was analyzed by using a RCBD 3x5 factorial experimental design with three replications in each treatment. Comparison between treatment means was done by LSD at 5% significance level and considering the relationships between dependent and independent variables by a simple linear regression and/or a simple non-linear regression (Sudajan, 1998).

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Figure 1 Sunflower thresher during operation.

Results and Discussion

The power requirement increased almost linearly with the drum speed (Figure 2). The total power requirement increased from 1.019 to 1.918 kW as drum speed was increased from 650 to 850 rpm. The no-load power requirement of the sunflower thresher at a drum speed of 750 rpm (10.99 m/s) was 1.8 kW. At this drum speed, the power requirements of the rasp-bar drum, shaking sieve, blower and belt conveyor were 62.71, 6.68, 26.21 and 4.40% of total power requirement respectively.

The capacity at 3,000 kg(head)/h feed rate rapidly increased with increase of drum speed from 650 to 700 rpm, varying from 698 to 1058 kg/h and slightly increased with further increase in drum speed. When the speed was increased up to 850 rpm (12.46 m/s), the capacity gradually decreased from 1054 to 965 kg/h. However, the capacities at 2,500 and 3,000 kg(head)/h feed rates were 1093 and 1098 kg/h respectively at the drum speed of 750 rpm. The highest capacity was obtained at about 750 rpm drum speed for all feed rates (Figure 3).

Grain damage was in the range of 0.28 to 0.65%. The results are in conformity with those reported by Sudajan (1996) who used a corn sheller for sunflower threshing and Bhutta *et al.* (1997) who threshed the sunflower using John Deere combine harvester. The threshing efficiency varied from 99.27 to 99.99%. The cleaning efficiency was between 99.21 to 99.33% when the drum speed was increased from 750 to 850 rpm. The cleaning efficiency in this study was found higher than that observed values by other researchers (Sudajan, 1996 and Bhutta *et al.*, 1997). The percentage of grain loss was between 0.91 to 1.20% when drum speed varied from 650 to 750 rpm. The grain losses rapidly increased with increase in drum speed from 800 to 850 rpm (Figure 4). The average power requirements at 2,500 and 3,000 kg(head)/h feed rates were between 3.83 to 4.57 kW and 3.87 to 4.71 kW respectively, when drum speed was increased from 650 to 800 rpm (Figure 5). The minimum specific energy consumption was 3.86 kW-h/ton. The specific energy consumption of the sunflower thresher in this study was found lower than that observed by Sharmar and Devnani(1978).

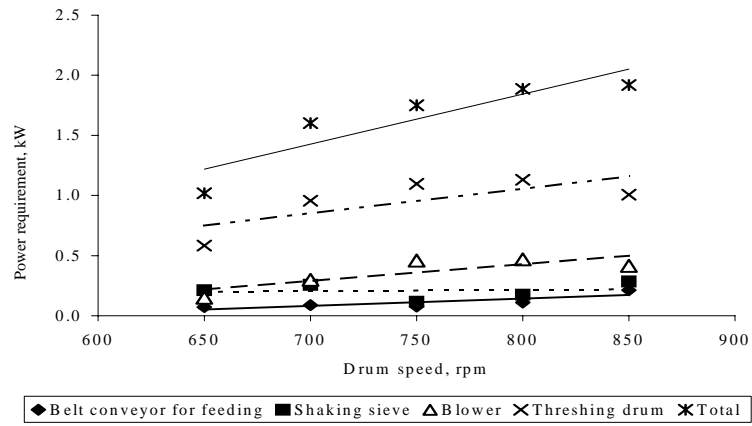


Figure 2 Effect of drum speed on power requirement of different components under no load condition.

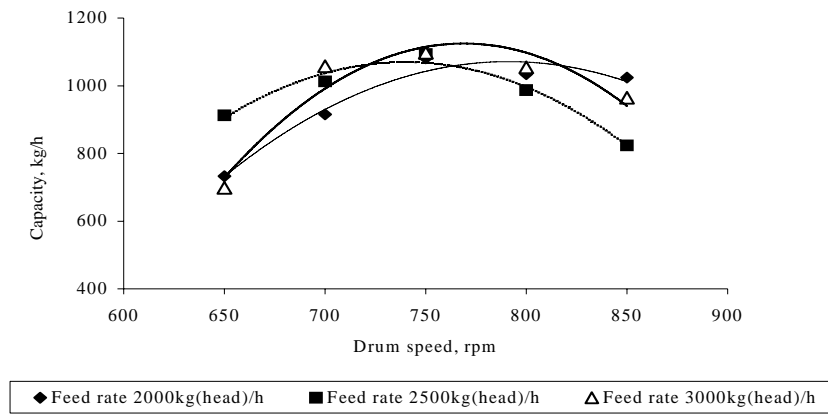


Figure 3 Effect of drum speed on capacity at different feed rates.

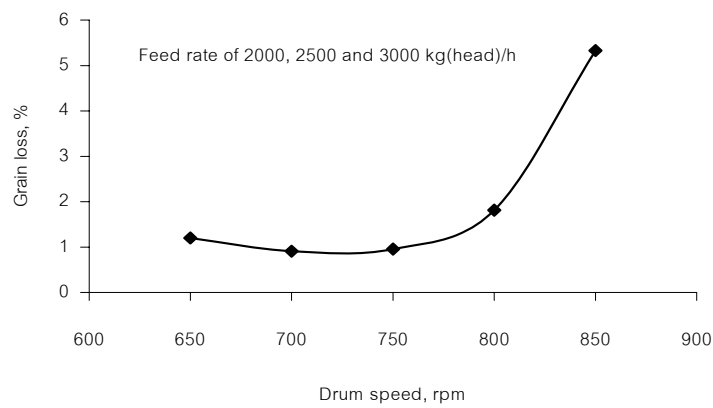


Figure 4 Effect of drum speed on grain losses.

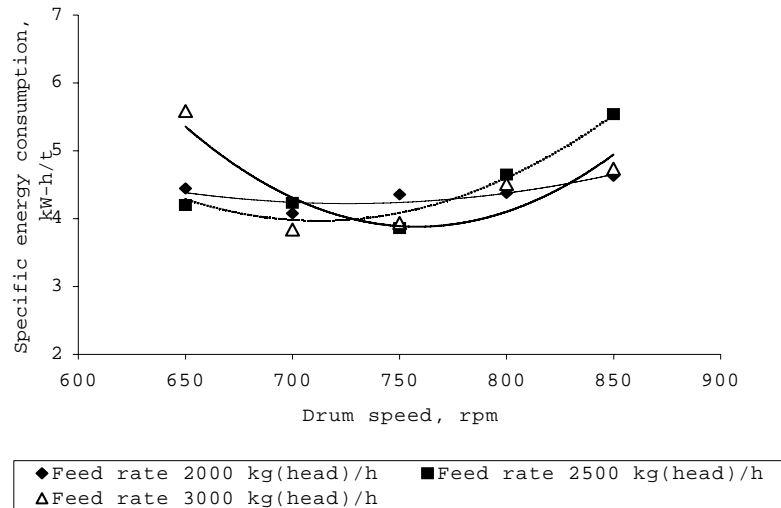


Figure 5 Specific energy consumption of a sunflower thresher at different drum speeds and feed rates.

Conclusions

The optimum combination of drum speed and feed rate of a rasp-bar sunflower thresher in order to obtain the higher output capacity, threshing efficiency, lower grain damage, grain losses, specific energy consumption at 2000 to 3000 kg(head)/h feed rates was a combination of 700 to 800 rpm (10.99 to 11.73 m/s) drum speed, 35 mm concave clearance and 11x60 mm concave hole sizes.

Acknowledgement

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