COMPARATIVE STUDY OF DANXIA AND CLAAS COMBINES AT TWO DIFFERENT LOCATIONS IN HARVESTING LD-365 RICE VARIETY

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INTRODUCTION

Harvesting is a crucial operation in rice cultivation. Manual harvesting of rice is a troublesome, time consuming and costly operation since it needs about 100-150 man-hours of labour to harvest one hectare of paddy field. In these conditions, contracting combine harvesters would be an effective solution to reduce production cost and enhance labor productivity. Recently, the use of combine harvesters has been increased enormously in paddy harvesting and numerous brands of combine harvesters are available in the market.

But, there is a concern among the farmers that the performance of combine harvesters differ based on their type and brand. However many studies have reported that the performance of the combines depends on the operating conditions of the combine harvesters as well as the field and crop conditions. Therefore, an attempt was made to study the performance of different types of combine harvesters in different fields while harvesting which will be helpful to understand their operations with respect to real field conditions. Therefore, this study aimed to investigate some technical and field aspects of real field harvesting conditions and to compare them in view of their header losses and performances in two different field conditions.

METHODOLOGY

The study was carried out in Batticaloa during *Yala*, 2012. In order to perform the comparative tests, farmers' paddy fields located at Chenkalady and Pankudavely areas were selected where Danxia 2200 (tine bar reel with the header width of 2 m) and Claas-crop tiger 30 combine harvesters (tine bar reel with a width of 2.1 m) were in operation, respectively. The two combine harvesters were compared in harvesting LD-365 paddy variety at different grain moisture contents and different forward speeds in these two field conditions. The observed crop characteristics of LD-365 variety and the field conditions at the two sites have been given in Table 1.

Table 1. Agronomic traits of LD-365 variety and the field conditions at harvest

Location	Combine used	Grain moisture content (wb)	Plant density Nos /m^2	Soil cone index (kg/cm^2)
Chenkalady	Danxia	22.85±2.47	113±9.08	1.28±0.13
Pankudavely	Claas	19.16±1.92	230±5.12	2.11±0.17

The operators were allowed to adjust the combine harvesters based on the field conditions. To get real data, the operators of combine harvesters were not aware about the experiment. Some important operating parameters in terms of header losses were measured while the combine harvesters were harvesting the paddy. Selected machine parameters were determined using the methods given in Table 2. In each location, performance parameters of combine harvesters were measured in three plots which included travel speed, lost time and total required time. Almost three similar size plots were selected in each field to determine the header losses and field performances of the combines. Theoretical field capacity, effective field capacity and field efficiency of the tested combine harvesters were obtained from the formulae reported by Hunt, 1995. Theoretical field capacity is the rate, in ha/h, at which a machine is working when no time is lost due to turns, unused width, stopping, plugging, breakdowns etc. The area covered is divided by the total time (effective harvesting time plus non productive time). Field efficiency is the ratio of the actual field capacity of a machine to its theoretical capacity. The tine bar velocity of each combine was determined as reported by Oduori *et al*., 2008.

At steady-state speed of the combine harvesters, they were suddenly stopped and a steel frame of $0.5m^2$ was placed in front of them. The header losses were determined by picking the fallen grains and the panicles inside the area confined by the steel frame at random locations of each plot in the two selected paddy fields. Three sample areas of $0.5m^2$ size each were randomly selected from the experimental fields and the average yield of rice was calculated as reported by Qamar-uz-Zaman *et al*., 1991. Then, weight percentages of header loss were computed by the formula reported by Pradhan *et al*., 1998. Two sample *t* test was used to analyze the header losses from the machines using MINITAB.

Table 2. Measurement of crop and machine parameters

Parameters	Method of analysis
Grain moisture content	‘Satake’ grain moisture meter
Reel rotational velocity	Stop watch and counter
Cutter bar pulley speed	Tachometer (HIOKI 3404)
Speed of combine harvester	Stop watch and measuring tape
Height of cutter bar and reel diameter	Measuring tape (steel)
Height of the reel axis above the ground	Measuring tape (steel)

RESULTS AND DISCUSSION

The results from the machine losses indicate that there is a difference between the combine harvesters with respect to header losses as the working age of machine, operator’s skills, field condition, grain moisture content etc. were different. A comparison of the header losses demonstrated that the mean header losses from Danxia was 11.4 kg/ha (0.22% of total grain yield of 5152.1 kg/ha) whereas it was found to be 16 kg/ha (0.28% of total grain yield of 5608.1 kg/ha) for the class combine harvester under the tested field conditions (Figure 1). The variation in header losses from these two combine harvesters could be explained in five categories such as the forward speed, the tine bar velocity, cutter bar speed, the grain moisture content and plant density.

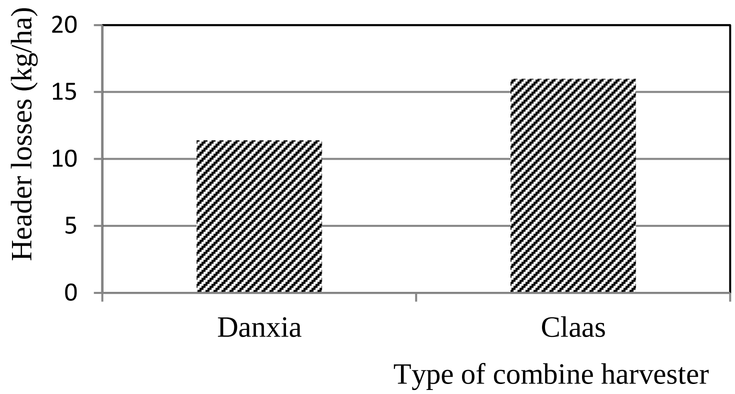

Figure 1 Comparison of the header losses from two types of combine harvesters.

The major observed operational conditions of combine harvesters that the operators selected during harvesting LD-365 paddy variety are given in Table 3. The minimum header losses noticed for Danxia could be due to its lower forward speed of 1.116 km/h compared to Class which was operated at 3.096 km/h. A relatively lower forward speed of Danxia offered gentle handling of the panicles in cutting and conveying processes which resulted in decreased header losses. Generally, the increase in speed was found to increase the header losses, which is in line with the findings of Fouad *et al*. 1990 and Schueller and Bac 1984.

Table 3. Operational parameters of the tested combines in harvesting LD-365 paddy

Parameter	Danxia 2200 30	Claas – Crop tiger
Width of cutter bar (m)	2.0	2.1
Cutter bar speed (m/s)	0.14	0.56
Forward speed (km/h)	1.116	3.09
Height of cutter bar (cm)	10.1	23.5
Tine bar velocity (m/s)	1.1	2.35

The variation in header loss could also be attributed to the variation in magnitude of impact velocity of tine bar. The impact velocity caused by the header unit of Danxia was 1.1 m/s whereas it was 2.35 m/s in Claas combine harvester relative to their forward speeds under the two different field conditions. This has been approved by an investigation by Oduori *et al* (2008) that the shattering or header losses are mainly due to the impact velocity of the tine bar. In general, loss could be attributed to harvest time, type of variety and its physical properties, crop condition in terms of maturity, lodging and soil condition. The differences between the combine harvesters with respect to header losses can also be due to the working age of machine, operator skills and field topography etc.

It has also been reported that the cutter bar speed affects the header loss. The header loss increases with increasing cutter bar speed (Chaiyan Junsiri and Winit Chinsuwan. 2009). The cutter bar speed of 0.56 m/s in Claas combine harvester at Pankudavely might have caused a violent vibration at the header which had a severe impact on the stems and caused grain loss. But in contrast the cutter bar speed of 0.14 m/s the losses were found to be minimal from Danxia.

Having the mean grain moisture contents of 22.85% at Chenkalady and 19.16% at Pankudavely accounted for the observed lower losses at Chenkalady with Danxia than that of at Pankudavely with Claas. This observation indicated that the effect of grain moisture content was considered to have higher header losses as it is inversely related to grain moisture. This conforms to the study of Chinsuwan *et al.* (1997) that high-moisture content or fresh paddy tends to cling to the head firmly and their rate of falling was less than low-moisture or dry grains. As the grain moisture decreased, the losses increased, because the stalks at lesser grain moisture were more frequently broken causing the grains to shatter before being elevated to the threshing drum. This finding also relates to Quick (1972) and Clark and De Pauw (1983).

Further, the plant density at Pankudalvely was found to be higher than that at Chenkalady which might have facilitated for the shattering of more grains per unit area. This is in conformity with the findings of Lien *et al*., (1976) that the header losses were found to be a function of forward speed, plant population and lodged stalks.

The result from the *t* test shows that the losses from Class combine harvester operated at the field conditions of Pankudavely is significantly higher than the losses from Danxia combine harvester operated at the field conditions of Chenkalady (P = 0.02). However, this significant difference in losses is due to the combination of machine operational and crop conditions. Therefore, further studies are needed to find out the effect of individual operational parameters of the combine harvesters.

Table 4. Field performance of Danxia and Claas combine harvesters

Parameters	Danxia	Claas
*Area of plot harvested (ha)	0.0284	0.0296
*Total harvested time (min)	16.33	11.18
*Actual harvested time (min)	7.71	7.21
Effective field capacity (ha/h)	0.104	0.159
Theoretical field capacity (ha/h)	0.27	0.65
Field efficiency (%)	47.2	64.5

*Mean of three replicates

Comparison between field performances of harvesting machines is shown in Table 4. These two combine harvesters cannot be compared in terms of field capacity since they differ in the width of cut (Fouad *et al*. 1990). Therefore, they are compared in terms of their filed efficiency which is mainly affected by the loss of times while harvesting. Field efficiencies were found to be varied from 64.5% for Claas combine harvester to 47.2% for Danxia. The higher field efficiency of Claas was due to its smooth operation without clogging at the forward speed of 3.09 km/h but Danxia combine underwent minor repairs during harvesting so that the total time required for harvesting was found to be greater. This caused lower field efficiency at the forward speed of 1.116 km/h. This implies the failure to utilize the theoretical operating width of the combine harvester due to greater idle time in harvesting.

CONCLUSION

In addition to the machine operational parameters, the header losses were also influenced by the crop conditions as well. The header losses were significantly higher from Claas combine harvester when compared to Danxia combine harvester under these two different field conditions. Even though the header losses were greater from Claas, its performance in terms of field efficiency (64.5%) was acceptable. However the percentage of header losses of total grain yield from both combine harvesters were less than 0.3% which can be considered as minimum. The direct comparison of these two combine harvesters is precluded as their operational conditions including the field conditions, operator's capability, crop density, grain moisture content were different.

RECOMMENDATION

The operational parameters of the combine harvesters should be selected in consideration of the crop conditions to reduce the header losses.

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