Available online at www.sciencedirect.com

ScienceDirect

Procedia Food Science 6 (2016) 242 – 245

Procedia Food Science

International Conference of Sabaragamuwa University of Sri Lanka 2015 (ICSUSL 2015)

Effects of combine harvesting on head rice yield and chaff content of long and short grain paddy harvest in Sri Lanka

U.G. Chandrajith[a]*, D.M.C.C. Gunathilake[a], B.D.M.P. Bandara[a], D.P.C. Swarnasiri[a]

[a]*Institute of Post Harvest Technology, Jayanthi Mawatha, Anuradhapura, 50000, Sri Lanka*

Abstract

Paddy harvesting is the process of collecting the mature rice crop from the field which consists of activities such as cutting, handling, threshing and cleaning. Cutting, threshing and cleaning plays an important role to reduce postharvest losses. Lower performance of traditional harvesting process, labour shortage, reduced turn-around time and use of high yielding varieties have inevitably forced farmers to shift into mechanical grain harvesting in Sri Lanka. Rice milling is carried out to produce an edible polished or white rice product from harvested rough rice. Head rice yield is considered for marketing purposes because broken rice has low price in the market. Field survey was conducted in Polonnaruwa, Ampara and Hambanthota districts to identify most popular types of combine harvesters operating in the above districts. Paddy samples were collected from harvest of two most popular models of combine harvester in triplicate. Paddy sample of $1m^2$ area from every paddy field were harvested separately by manual harvesting followed by manual threshing and cleaning in laboratory as control sample of relevant paddy field. Moisture content of the paddy grains were measured in the paddy field using digital moisture meter before harvesting. Paddy samples were subjected to sun drying until the moisture content come down to 14±1% before the quality analysis in the laboratory. Each paddy sample was analyzed for moisture content, chaff percentage and head rice yield percentage (HRY). Paddy was milled using laboratory scale rubber roll sheller and abrasive polisher. Chaff content percentage was measured by adding 100 ml of paddy to water and volume of chaff was measured using graduated cylinder. HRY was calculated dividing the weight of grain partials, which are larger than the $^3/_4$ of the grain, by weight of paddy sample. HRY between the two combine harvesting machine models evaluated were not significantly different at $p<0.05$ and also it was not significantly dependent on the harvesting methods such as combine harvesting and manual harvesting. The chaff content was significantly higher in model-2 in comparison to control sample for long grain paddy while model-1 was not significantly different with control sample for short grain paddy.

© 2016 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of International Conference of Sabaragamuwa University of Sri Lanka 2015 (ICSUSL 2015).

* Corresponding author. Tel.: +94-25-2222344; fax: +94-25-2223983.
E-mail address:chandrajithug@yahoo.com

2211-601X © 2016 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of International Conference of Sabaragamuwa University of Sri Lanka 2015 (ICSUSL 2015).
doi:10.1016/j.profoo.2016.02.029

Keywords: Combine Harvester; Paddy; Haed Rice Yield; Chaff

1. Introduction

Harvest is the operation of gathering the useful part or parts of the plant and carried out at the time when all the nutrients have been developed and when the edible parts have reached the degree of maturity appropriate to the treatments to follow[1]. Paddy harvesting is the process of collecting the mature rice crop from the field which consists of activities such as cutting, handling, threshing and cleaning. Harvesting and threshing play an important role to reduce postharvest losses of fully matured rice crop and quality of milled rice as well. Paddy is harvested by manual labour using sickle in traditional method. But crop harvesting is delayed due to labour scarcity in traditional method resulting in loss of grain owing to over maturity. Lower performance of traditional threshing methods, labour shortage, reduced turn-around time and use of high yielding varieties have inevitably forced farmers to shift into mechanical grain threshing in Sri Lanka[2].

Paddy combine harvesters combine all traditional activities from cutting to hauling into one machine by cutting the crop and feeding into threshing mechanism. Threshed grains are cleaned and discharged into a bulk wagon or directly into bags while straw is usually discharged behind the combine in a windrow[3]. The average paddy production cost can be reduced by 36% using combine harvesters compared to traditional manual harvesting[4]. It is beneficial to use combine harvesters by farmers as they can minimize their production cost significantly[4]. Rice milling is carried out to produce an edible polished or white rice product from harvested and dried rough rice. Head rice yield is considered for marketing purposes because broken rice has low price in the market[3]. Harvesting method can affect the head rice yield due to mechanical damages occur during harvesting. This research was conducted to find out whether there is an effect of use of combine harvesters on head rice yield of milled rice and to find the remaining chaff percentage in paddy samples.

2. Material and Methods

2.1. Field survey

Field survey was conducted in Polonnaruwa, Ampara and Hambanthota districts in Sri Lanka to identify the most popular types of combine harvesters operating in the field. Randomly selected farmers in above districts were given the questioner that contained questions including farm practices and use of combine harvesters. Most popular type of combine harvesters was selected according to the results of field survey to evaluate for HRY and remaining chaff percentage.

2.2. Paddy harvesting and milling

According to the results of the field survey, there were two types of machines identified as most popular combine harvesters such as model-1 (Engine capacity: 60 hp/2400 rpm, length of cutting edge: 2000 mm, machine weight: 2400 kg) and model-2 (Engine capacity: 60 hp/2800 rpm, length of cutting edge: 2100 mm, machine weight: 4270 kg). Model-1 harvester was used for short grain harvesting in Polonnaruwa and Ampara while model-2 for long grain harvesting in Hambantota.

Paddy samples were collected from harvest of two models of combine harvesters in triplicate & three machines were evaluated for each model. Paddy samples of $1m^2$, from same paddy field of the machine operated, were harvested separately by manual harvesting followed by manual threshing and cleaning in laboratory as control sample of the relevant machine. Moisture content of the paddy seeds were measured in the paddy field using digital moisture meter (Gwon - GMK 303RS) before harvesting.

Paddy samples were subjected to sun drying until moisture content came to 14±1% before the quality analysis in the laboratory. Each paddy sample was analyzed for moisture content, chaff percentage and head rice yield. Paddy moisture content was measured using same moisture meter before milling and 300 g of paddy seeds was milled and polished by using laboratory scale rubber roll Sheller (Satake - THU 35A) and abrasive polisher. Chaff content was measured using equation 02 by adding 100 ml of paddy to water and volume of chaff separated was measured using graduated cylinder. Stuff of chaff was contained light weighted unfilled seeds, straw and other foreign matters. For

calculation of head rice yield percentage (HRY), representative working sample of milled rice of 100g was obtained by using precision electrical sample divider. Grain partials, which are smaller than the $^3/_4$ of the grain, were considered as broken grains and they were separated by hand picking and HRY was calculated using equation 01.

$$\text{HRY \%} = \frac{\text{Weight of polished head rice}}{\text{Weight of paddy sample}} \text{ X } 100 \longrightarrow \text{Equation: 01}$$

$$\text{Chaff volume \%} = \frac{\text{volume of chaff floated}}{\text{volume of paddy sample}} \text{ X } 100 \longrightarrow \text{Equation: 02}$$

2.3. Statistical Analysis

Analysis of Variance (ANOVA) on Complete Randomized Design (CRD) by General Liner Model (GLM) procedure was performed and treatment means were separated by the Duncan's Multiple Range Test (DMTR) at α = 0.05 level of significance using SAS for windows version 9.0.

3. Results and discussion

According to the results of the field survey, model-1 machine was the most popular type in Amapara and Polonnaruwa districts and model-2 had been accepted in Hambantota district in Sri Lanka. Model-1 and model-2 had cutting widths 2000 mm and 2100 mm, respectively. Both types are full feeding type combines and had rubber track for moving on muddy paddy fields. Above two models were selected for experimentation since these two types were representative harvesters as most farmers are using in above three districts. All the samples were sundried before laboratory quality analysis, until the moisture content was reduced to 14±1% because 14-16% moisture content is the best grain moisture content to obtain highest HRY[5].

Figure 1 shows variation of the HRY and chaff percentage with different combine harvester (Model 1 & 2) and control samples. It was clear from the figure that HRY had not been shown much variation with harvesting methods, i.e. machine or manual. However chaff percentage was shown higher variation with harvesting methods. Samples obtained from model-2 combine harvester showed comparatively higher chaff percentage than control and model-1 samples. Model two combine harvester was relatively old in use therefore chaff content would be increased due to use of worn out mechanical parts in the machines for long run without replacing.

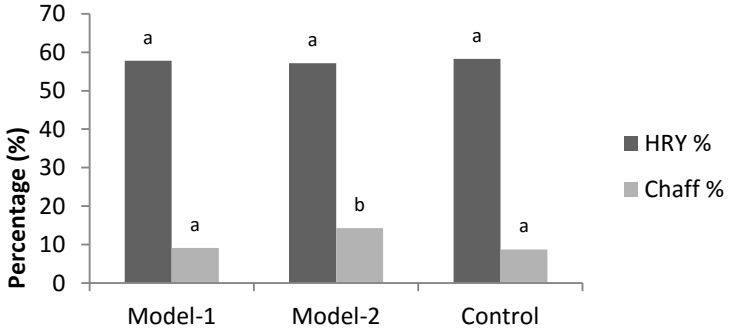

Figure 1: variation of the head rice yield percentage and chaff percentage with different combine harvesters (Model 1 & 2) and control samples

Table 1 shows the results of DMRT multiple mean comparison of HRY and chaff percentage of samples with different harvesting method adopted in this study.

Table 1: Result of DMRT multiple mean comparisons of responses by treatments

Treatment (Different harvesting method)	HRY percentage	Chaff percentage
Model 1	57.80[a]	9.14[a]

Model 2	57.16[a]	14.25[b]
Control	58.31[a]	8.72[a]

Columns having same letter are not significantly difference at $\alpha = 0.05$ by DMRT

It is clear from the table 1 that HRY of samples harvested by different combine harvesters were not shown significant difference in comparison to control samples. However, chaff percentage of samples harvest by model-2 combine harvester was significantly higher than model-1 harvested samples and control samples. The model-2 combine harvester was relatively old therefore cleaning of harvest was not performing well therefore chaff percentage has been increased in model-2. HRY in both machines were not significant and not dependent on the harvesting methods such as combine harvesting and manuals harvesting.

4. Conclusion

The results revealed that harvesting of paddy by different combine harvesters was not effected significantly for head rice yield percentage. Chaff percentage was significantly different with different combine harvesters. Cleaning of harvest can be varies with different combine harvesters because, machine wear and tear is important for better cleaning of paddy harvest.

5. References

1. http://www.fao.org/docrep/006/Y4751E/y4751e0o.htm [Accessed: 12-02-2015]
2. Weerasuriya GVTV, Bandara MHMA, Rambanda M. Performance evaluation of four wheel tractor driven high capacity combine paddy thresher. *Tropical agricultural research* 2011; Vol. 22 (3): 273-281.
3. http://www.knowledgebank.irri.org/step-by-step-production/postharvest [Accessed 19-07-2014]
4. Amarasinghe MN, Samaraweera GC. Economics impacts of using combine harvesters in paddy cultivation in Hambantota district. Proceedings of the 8th academic sessions, University of Ruhuna 2010. Vol.08.p202.
5. Wayne EM, Wadsworth JI. Rice science and technology. Marcell and Dekker.USA.pp139-141.