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

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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.

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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