Prediction Equations for Losses of Axial Flow Rice Combine Harvester when Harvesting Khaw Dok Mali 105 Rice Variety

Prapagon sangwijit[1*]
Winit Chinsuwan[2]

Abstract

The objective of this study was to predict losses of combine harvester when harvesting Khaw Dok Mali 105 rice variety. The results of the study indicated that grain moisture content (MC), grain to material other than grain ratio (GM), service life of cutter bar (Y), cutter bar speed (V), reel index (RI), stem length (H), tine clearance over cutter bar (C), tine spacing (R), product of RI and R (RI*R), product of V and C (V*C), V^2, RI^2, louver inclination (LI), feed rate (FR) and product of MC and GM (MC*GM) were the major parameters affecting the harvest losses. The prediction equations had R^2 = 0.91. The average losses given by the estimation equation was 0.31% different from the measurement. The predicted losses errors were 5.47% and 0.54% for average percentage error and standard error respectively.

Keywords: Axial Flow Rice Combine Harvester, Loss, Prediction Equations

Introduction

Khaw Dok Mali 105 is a rice variety that are high in quality and demand in both domestic and international markets (Urairong & Kitkuandee, 1998). In 2007, Thailand exported approximately 3 million tons of Chaw Dok Mali 105 rice variety, which accounts for about 30% of the country's total rice export of 47,000 million baht (Office of Agricultural Economics, 2009). One of the most important process affecting rice quality and volume is harvesting. Most farmers use combine harvesters for harvesting their crops, specifically, about 5,000 of them were used in Thailand nowadays (Chinsuwan et al., 2007). Almost all of them were axial flow rice combine harvester and were made in Thailand (Chinsuwan et al., 1999). The study harvest losses of Khaw Dok Mali 105 the use of combine harvester by Chinsuwan et al. (1999), showed 4.81% losses in 19 combine harvesters monitored, with 2 major parameters affecting the harvest losses: plant conditions and machine conditions. Plant conditions include rice variety (Chinsuwan et al., 2002), grain moisture content (Chinsuwan et al., 1997), incline of the angle

[1] *Graduate Student, Department of Agricultural Engineering, Faculty of Engineering, Khon Kaen University*
[2] *Associate Professor, Department of Agricultural Engineering, Faculty of Engineering, Khon Kaen University*
**Corresponding author, e-mail: mesiyanee@yahoo.com*

of the rice (Chinsuwan et al., 2004), grain to material other than grain ratio (Andrews et al., 1993), and rice plant density (Yore et al., 2002). Meanwhile, there were 2 different issues regarding the conditions of combine harvesters. One concerned the performance of the header unit , the other concerned that of the threshing unit. The performance of the header unit can be affected by cutter bar speed (Hummel and Nave, 1979), reel index (Chinsuwan et al, 2004), tine clearance over cutter bar (Quick, 1999), tine spacing (Mohammed and Abdoun, 1978), service life of cutter bar (Klenin et al., 1986), and stem length (Siebenmorgen et al., 1994). As for the performance of the threshing unit, such factors are feed rate (Chinsuwan et al., 2003a), clearance between concave rod (Chinsuwan et al., 2003b), concave clearance (Andrews et al, 1993), and louver inclination (Gummert et al. 1992).

The study operating parameters affecting header losses of combine harvester for Khaw Dok Mali 105 rice variety by Junsiri & Chinsuwan (2008) showed that significant parameters affecting the losses in the header unit, for Khaw Dok Mali 105 rice variety, were grain moisture content, reel index, cutter bar speed, service life of cutter bar, tine clearance over cutter bar, tine spacing, and stem length.

In addition, the study operating parameters affecting threshing system losses of an axial flow rice combine harvester by Chuan-Udom & Chinsuwan (2007) concluded that rotor tangential speed , louver inclination, grain moisture content, feed rate, and grain to material other than grain ratio, are parameters influencing the losses in the threshing unit.

After indicating all of the parameters mentioned above, it would be of great benefits to develop prediction equations for the total losses of combine harvester for Khaw Dok Mali 105 rice variety. The equations would be another tool for predicting combine harvesters performance under different conditions. Furthermore, they could provide information for decision making in modifying current combine harvester. This study, therefore, aims to develop such equations for predicting losses of combine harvester when harvesting Khaw Dok Mali 105 rice variety.

Equipments & Methodology

The study was divided into 2 phases: developing prediction equations for losses of combine harvesters and evaluating those prediction equations. The details are as follow:

1. Developing prediction equations for losses of combine harvesters

The prediction equations for losses of combine harvesters were developed during harvesting season in the Kula Ronghai Field, in 2007. The total of 22 random combine harvesters were selected to measure losses as well as to identify parameters affecting combine harvesters in 11 different brands. Losses measurements were performed in 2 different machine functions, i.e. in the header unit and in the threshing unit. First, we gathered residues trapped in the meshed grill, then straws were separated from grains and chaff through the action of the threshing unit. In addition, the grain fallen on the ground, excluding losses before reaping, around the axial flow from the threshing system, were also measured and realized as the losses from reaping. According to the loss prediction equations, all the losses mentioned above must be combined to be the total loss and assigned as one of the dependent variable in the equations. Parameters affecting the monitored combine harvesters were used as independent parameters in the equations, according to studies by

Junsiri & Chinsuwan (2008), i.e."operating parameters affecting header losses of combine harvester for Khaw Dok Mali 105 rice variety", and by Chuan-Udom & Chinsuwan (2007), i.e."operating parameters affecting threshing system losses of an axial flow rice combine harvester". There were total of 11 parameters and 19 independent parameters. They were grain moisture content (MC), grain to material other than grain ratio (GM), service life of cutter bar (Y), cutter bar speed (V), reel index (RI), stem length (H), tine clearance over cutter bar (C), tine spacing (R), product of grain moisture content & service life of cutter bar (MC*V), product of reel index & tine spacing (RI*R), product of cutter bar speed & stem length (V*H), product of cutter bar speed & tine clearance over cutter bar (V*C), square of cutter bar speed (V^2), square of reel index (RI^2), cylinder speed (CS), louver inclination (LI), feed rate (FR), and product of grain moisture content & grain to material other than grain ratio (MC*GM).

The regression equations were derived from the collected data, with 95% confidence level. If the equation's confidence level were lower than 95%, then remove independent parameter term with the lowest confidence level, one by one (Chap, 2003). First, start with independent parameter term that is squared or the product of other parameters, or start with any independent parameter with no correlations to other squared or the product of independent parameter term. After removing all those independent parameters, the new regression equation is then again tested until the confidence level is finally higher than 95%.

2. Evaluating Prediction Equations

The prediction equations were randomly tested for their accuracy in predicting losses and other relevant parameters concerning combine harvester's performance. The measurement was done in 11 brands of combine harvesters across the total of 22 machines. Similarly, the data collection was done during harvesting season in Kula Ronghai Field, in 2008. Results from the equations were compared with collected data, determined by error equation (Eq.1), percentage error equation (Eq.2), and standard error equation (Eq.3).

$$E = \left| TL_p - TL_f \right| \quad ...(1)$$

$$E_p = \frac{\left| TL_p - TL_f \right|}{TL_f} \times 100 \quad ...(2)$$

$$SEP = \sqrt{\frac{\sum (TL_f - TL_p)^2 \left\{ \frac{\left[\sum (TL_f - TL_p)\right]^2}{N} \right\}}{N-1}} \quad ...(3)$$

Where:
- E = Error (%)
- E_p = Prediction error (%)
- SEP = Prediction standard error (%))
- TL_p = Predicted losses (%)
- TL_f = Measured losses (%)
- N = Number of records

Results & Comments

Developing Prediction Equations for Losses of Combine Harvesters

In order to build an initial equation, the losses from harvesting Khow Dok Mali 105 rice variety in 11 brands across 22 combine harvesters were measured. The results, shown in Table 1, were as followed: grain moisture content (MC) was 19.74 - 28.92 %wb; grain to material other than grain ratio (GM) were 0.36- 0.87; service life of cutter bar (Y) were 200 - 1,000 rai; cutter bar speed (V) were 0.63 - 0.89 m/s; reel index (RI) were 1.39 - 3.48;

stem length (H) were 44.04 - 73.53 cm; tine clearance over cutter bar (C) were 9.22 - 81.83 mm; tine spacing (R) were 9.39 - 13.67 cm; cylinder speed (CS) were 14.05 - 20.23 m/s; louver inclination (LI) 59.26 - 70.02 degrees; and feed rate (FR) were 4.68 - 14.47 t/h.

The regression equation was derived from the collected data to estimate the losses as shown in Eq.4, with the coefficient of determination (R^2) of 0.91. Independent parameter terms, removed from the initial equation, were cylinder speed (CS), product of grain moisture content & service life of cutter bar (M*Y), product of grain moisture content & cutter bar speed (MC*V), and product of cutter bar speed & stem length (V*H). These terms were removed because they caused the confidence level to be lower than 95%, as well as affected other dependent parameters which caused insignificant losses.

$$\begin{aligned} LOSS = {} & 104.094 - 1.135MC - 48.615GM + 0.001Y - 157.418V - 11.312RI \\ & + 0.079H + 0.760C - 0.793R - 0.974(V * C) + 0.669(RI * R) \\ & + 123.976V^2 + 0.536RI^2 - 0.263LI + 0.309FR + 1.942(MC * GM) \end{aligned} \quad ...(4)$$

Correlations between parameters and losses were illustrated by varying each parameter in the regression equation. As for the unvaried parameters, they were assigned constant values, i.e. 25%wb for grain moisture content, 0.6 for grain to material other than grain ratio, 430 rai for service life of cutter bar, 0.75 m/s for cutter bar speed, 2.4 for reel index, 57 cm for stem length, 29 mm for tine clearance over cutter bar, 12 mm for tine spacing, 68 degrees for louver inclination, and 9 t/h for feed rate.

Results from varying the grain moisture content showed that, as the grain moisture content increased, the total losses tended to increase accordingly, as shown in Figure 1. This is in accordance with the study by Chinsuwan et al. (1997) and Chuan-Udom (2007). The increase in total losses can be explained by the fact that higher grain moisture content created difficulty in the threshing process as well as grain separation process. In this matter, Chinsuwan et al. (1997) suggested that the best time for harvesting Khow Dok Mali 105 rice variety was 25 to 35 days after harvesting, or at grain moisture content of 18.00 - 28.00%wb.

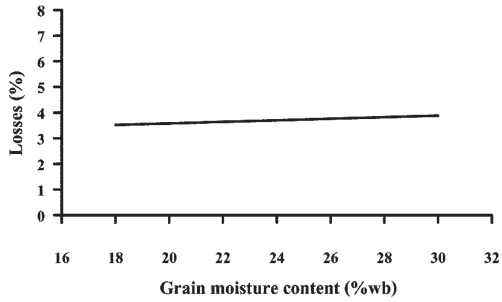

Figure 1. Correlations between grain moisture content and losses

Varying grain to material other than grain ratio from 0.3 to 0.9, as shown in Figure 2, had an insignificant effect to the total losses. The decrease in total losses from 3.75% to 3.70% was caused by small amount of straws in the cylinder, making it easier to separate straws from grains and to process those grains. In fact, the grain to material other than grain ratio is influenced by 2 parameters, i.e. number of grains in the ears of rice and the stem length.

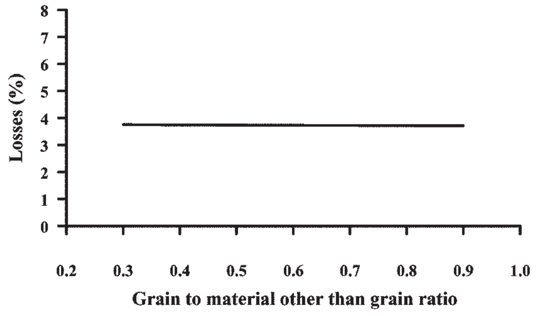

Figure 2. Correlations between grain to material other than grain ratio and losses

The increase in service life of cutter bar caused a decrease in the total losses, shown in Figure 3. The cutter bars gets dull as their service life increased, making it more difficult to cut the rice stem resulting in losses in header unit. Another cause for losses in header unit could be the increase in cutter bar speed, because, since it was dull, the cutter bar's speed needed to be increased in order to cut the rice stems.

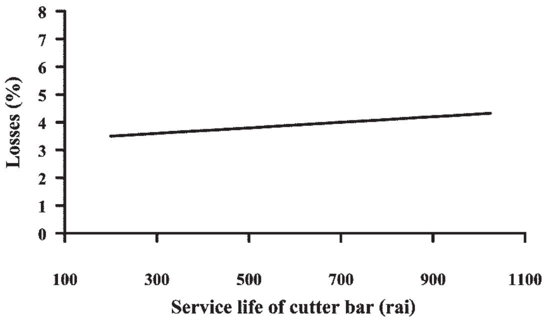

Figure 3. Correlations between service life of cutter bar and losses

Total losses decreased after cutter bar speed was increased from 0.60 to 0.75 m/s. However, if the cutter bar speed was increase up to more than 0.75 m/s, total losses increased drastically, as shown in Figure 4. This is due to the fact that the cutter bar could not cut as many stems as it should have when the cutter bar speed was too low. On the contrary, if the cutter bar speed was high, there would be high impact on the stem causing grains to fall from the ear around the header unit.

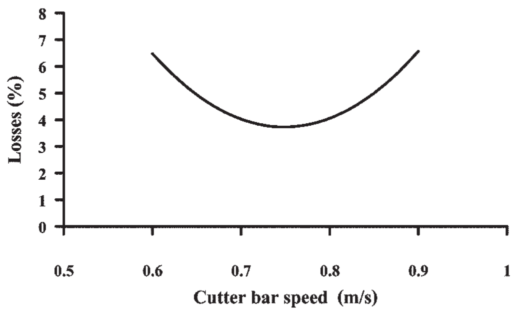

Figure 4. Correlations between cutter bar speed and losses

After varying the reel index value, we have found that the increase in reel index caused the total loss to decrease in the beginning. However, as the reel index exceeded the value of 3, total losses tended to rise (see Figure 5). In fact, when reel index was more than 5, total losses increased rapidly, which is in accordance with the study by Chinsuwan et al. (2004). The reason for the high total losses when reel index was low was because the reel revolves too slow causing the teeth to be unable to feed crops to fall into the auger once it is cut. On the other hand, if the reel revolves too fast, the teeth would hit the crop too hard creating losses.

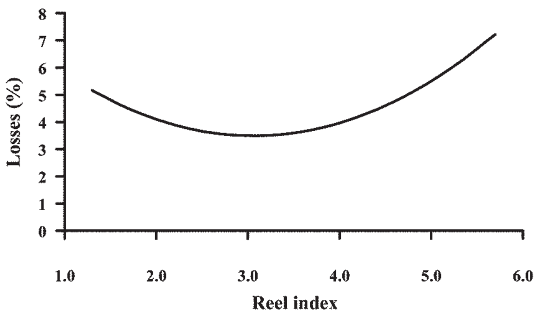

Figure 5. Correlations between reel index and losses

As for the stem length, we have found that as it increased, the total losses tended to increase as well, as shown in Figure 6. When the stems were long, they needed to be cut at their stubs which had high density, making it more difficult to cut. Thus, losses occurred at the header unit where grains fell out. Moreover, the stem length also affected the grain to material other than grain ratio leaving fewer grains entering threshing unit. And because longer rice straws had more moisture content, they were more difficult to separated from grains within the threshing unit (Chuan-Udom & Chinsuwan, 2008), which was another reason for the losses.

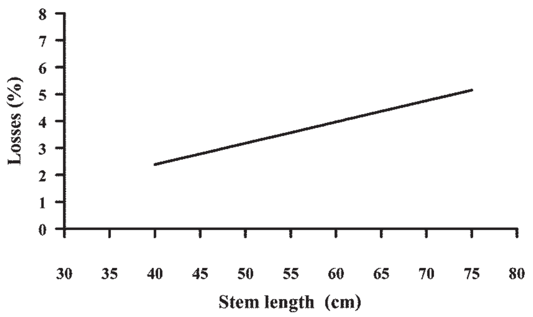

Figure 6. Correlations between stem length and losses

After increasing the tine clearance over cutter bar, we found an increase in total losses, shown in Figure 7. Theses losses occurred because when the clearance was too wide, tines might be unable to sweep all the stems into the header unit.

Figure 7. Correlations between tine clearance over cutter bar and losses

The total losses also increased after the tine spacing had been increased, as shown in Figure 8. When tine spacing was too wide, there might not be enough tines to feed straws into the platform to be cut, causing many grains to fall around the header unit. Most of the combine harvesters have tine spacing of 11 - 12 centimeters.

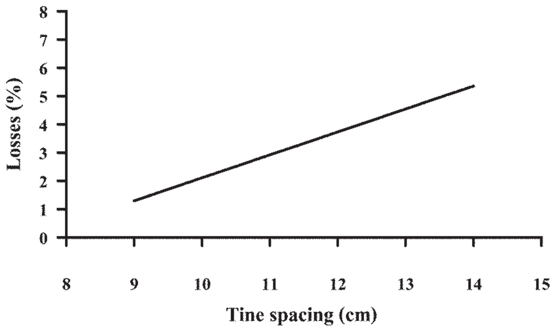

Figure 8. Correlations between tine spacing and losses

Figure 9 showed correlations between louver inclination and losses: an increase in louver inclination increased the total losses. This is because the greater the louver inclination, the more time the crops had in the threshing process (Gummert et al., 1992). Consequently, this allows more time for ears of rice to be threshed by the cylinder. Recommended louver inclination for axial flow rice combine harvester is at least 68 degree along the threshing shaft axle (Chuan-Udom, 2009).

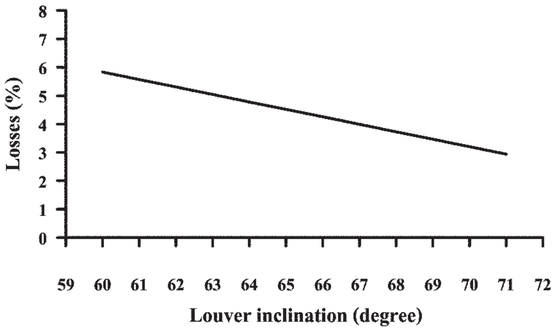

Figure 9. Correlations between louver inclination and losses

Finally, we have found that an increase in feed rate caused an increase in total losses, as shown in Figure 10, because higher feed rate resulted in higher crops density in the threshing mechanism. This created difficulty in the threshing process as well as the grain separating process, which is in accordance with the study by Chinsuwan et al. (2003) and Chuan-Udom (2008). By observing combine harvesters operating process, operators usually controlled the feed rate according to the crops density.

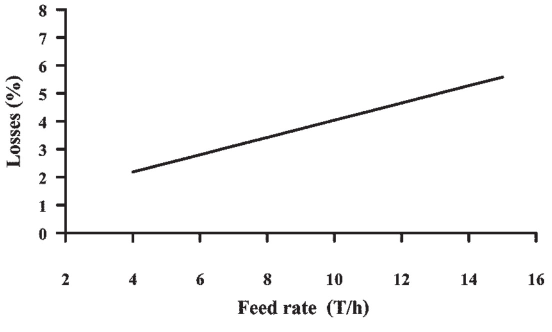

Figure 10. Correlations between feed rate and losses

Evaluating prediction equations

Table 2 shows results from random inspection of combine harvesters' performance and losses in 11 brands across 22 machines. The inspection results were used to evaluate prediction equations which indicated that the equations for losses of combine harvesters were 0.00 to 1.93% different from measurements (0.31% on average). The predicted losses errors were 0.00% to 23.97% (5.47% on average) and 0.54% for standard error, which was rather low. Consequently, the prediction equation for losses of combine harvesters, Eq.4, can be used to predict or estimate the losses of combined harvesters, manufactured in Thailand, for harvesting Khaw Dok Mali 105 rice variety.

Summary

The results from the study for losses of combine harvesters, when harvesting Khaw Dok Mali 105 rice variety, indicated that grain moisture content (MC), grain to material other than grain ratio (GM), service life of cutter bar (Y), cutter bar speed (V), reel index (RI), stem length (H), tine clearance over cutter bar (C), tine spacing (R), product of RI and R (RI*R), product of V and C (V*C), V^2, RI^2, louver inclination (LI), feed rate (FR) and product of MC and GM (MC*GM) were the major parameters affecting the harvest losses. The prediction equations had R^2 = 0.91. The average losses given by the estimation equation was 0.31% different from the measurement. The predicted losses errors were 5.47% and 0.54% for average percentage error and standard error respectively.

Acknowledgement

The authors wish to thank the Postharvest Technology Innovation Center, and the Agricultural Machinery and Postharvest Technology Research Center, Khon Kaen University for providing financial support for this research.

References

Agricltura Economics, Agriculture and Cooperatives. **Export Statistics** [online].[Cite 25 August 2009].Available from:http://www.oae.go.th/oae_report/export_import/export.php. (In Thai)

Andrews, S.B., Siebenmorgen, T.J., Vories, E.D., Loewer, D.H. and Mauromoustakos, A. 1993. Effects of Combine Operating Parameters on Harvest Loss and Quality in Rice. **Transactions of the ASAE** 36(6): 1599-1607.

Chap, T.LE. 2003. **Introductory Biostatistics.** USA: Wiley Interscience.

Chinsuwan, W., N. Pongjan, S. Chuan-udom, and W. Phayom. 2003a. Effects of Feedrate and Threshing Speed on Performance of Axial Flow Rice Thresher. **TSAE Journal.** 10(1):9-14. (In Thai)

Chinsuwan, W., N. Pongjan, S. Chuan-udom, and Phayom, W. 2003b. Effects of Threshing Bar Inclination and Clearance between Concave Rod on Performance of Axial Flow Rice Thresher. **TSAE Journal.** 10(1):15-20. (In Thai)

Chinsuwan, W., Pongjan, N., Chuan-udom, S. and Phayom, W. 2004. Effect of Reel Index on Gathering Loss of Rice Combine Harvester. **TSAE Journal.** 11(1): 7-9. (In Thai)

Chinsuwan, W., Pilawut, S. and Pongjan, N. Changes in Paddy Quality when Stored in a Steel Silo. 2007. **KKU Research Journal.** 12(2): 157-166. (In Thai)

Chinsuwan, W., Chuan-udom, S. and Phayom, W. 2002. Rice Harvest Losses Assessment. **TSAE Journal.** 9(1): 14-19. (In Thai)

Chinsuwan, W., Chuan-udom, S., Udompetaikul, V. , Phayom, W. and Panya, N. 1999. A Study on Harvest Losses of Hommali Rice Due to Manual Harvesting System and the Use of Combine Harvester. **KKU Research Journal.** 4(2): 4-12. (In Thai)

Chinsuwan, W., Mongpraneet, S. and Panya, N. 1997. Optimum Harvest Period for Hommali Rice Using Combine Harvester. **KKU Research Journal.** 2(1): 54-63. (In Thai)

Chuan-udom, S. and Chinsuwan, W. 2007. Operating Parameters Affecting Threshing System Losses of an Axial Flow Rice Combine Harvester. **KKU Research Journal.** 12(4): 442-450. (In Thai)

Chuan-udom, S. 2007.**Prediction of threshing system losses on axial-flow rice combine harvester.** [Doctor of Philosophy Program in Agricultural Machinery Engineering]Khon Kaen: Graduate School Khon Kaen University(In Thai)

Chuan-udom, S. and Chinsuwan, W. 2009. Effects of Louver Inclination on Threshing Unit Losses of an Axial Flow Rice Combine Harester. **KKU Research Journal.** 14(3): 322-330. (In Thai)

Gummert, M., Kutzbach, H.D., Muhlbauer, W., Wacker, P. and Quick, G.R. 1992. Performance Evaluation of An IRRI Axial-flow Paddy Thresher. **AMA.** 23(3): 47-58.

Hummel, J.W. and Nave, W.R.1979. Impact Cutting of Soybean Plants. **Transactions of the ASAE** 22(1):35-39.

Junsiri, C. and Chinsuwan, W., 2008. Operating Parameters Affecting Header Losses of Combine Harvester for Khaw Dok Mali 105 Rice Variety. **KKU Research Journal.** 13(5):613-620. (In Thai)

Klenin, N.I., Popov, I.F. and Sakun, V.A. 1986. **Agricultural Machines: Theory of Operation, Computation of Controlling of Operation.** Russian translations series 31. New Delhi (India): Gidson Printing Works.

Mohammed, I.A. and Abdoun, A.H. 1978. Testing MF-400 Combine Harvest under Condition of the Sudan. **Agricultural Mechanization in Asia, Africa and Latin America** 9(2): 39-42.

Urairong P. and Kitkuandee K.1998 **Harvest and post harvest practices jasmine rice.** Document lecture courses. "Manufacturing technology of high - quality jasmine rice" BKK: ISBN 974-7465-04-3. (In Thai)

Quick, G. 1999. **The Rice Harvester Reference.** RIRDC Rice Research and Development Program. RIRDC Publication No. 99/38.

Siebenmorgen, T.J., Andrews, S.B. and Counce, P.A. 1994. Relationship of the Height Rice is Cut to Harvesting Test Parameters. **Transactions of the ASAE** 37(1):67-69.

Yore, M.W., Jenkins, B.M. and Summers, M.D. 2002. Cutting Properties of Rice Straw. **Presented at the 2002 ASAE** Annual International Meeting, Paper number 026154. ASAE, Chicago, lllinois, USA July 28-July 31.

Table 1. The random measurement performance and a loss of about harvest machine for creating equations predict losses from harvesting khaw Dok Mali 105 rice

Brand	No.	MC (%wb)	GM	Y (rai*)	V (m/s)	RI	H (cm)	C (mm)	R (cm)	LI (degree)	CS (m/s)	FR (T/hr)	Loss (%)
A	1	27.29	0.87	300	0.89	3.00	73.53	11.50	9.89	67.63	18.11	5.91	7.06
	2	26.82	0.52	250	0.70	3.13	65.10	35.33	11.39	70.02	17.16	9.78	3.04
	3	28.23	0.36	500	0.72	2.06	57.84	32.39	13.00	67.83	17.38	8.99	3.63
	4	20.69	0.67	200	0.71	1.91	46.30	34.56	11.17	68.75	18.13	11.71	4.05
B	1	26.31	0.46	400	0.84	2.24	64.84	9.22	11.78	69.49	20.23	11.98	6.30
	2	24.42	0.40	500	0.87	2.22	68.07	29.50	10.33	69.49	17.88	14.47	6.92
	3	28.39	0.67	500	0.76	2.60	60.40	37.50	11.89	69.67	17.56	10.32	4.32
C	1	26.66	0.68	300	0.81	3.48	66.26	43.00	13.11	69.49	18.44	4.68	4.89
	2	21.89	0.58	300	0.66	2.35	56.15	22.89	12.89	68.57	15.73	6.30	2.62
	3	23.10	0.60	500	0.84	2.67	59.65	81.83	13.67	65.19	17.36	8.80	3.95
D	1	27.48	0.49	300	0.69	2.83	61.03	27.17	11.17	64.25	19.72	9.39	3.84
	2	27.08	0.59	300	0.69	1.58	59.45	19.06	11.67	66.04	19.79	9.64	5.26
E	1	27.89	0.77	500	0.80	2.02	51.15	19.67	9.61	68.25	16.67	7.63	3.77
	2	25.94	0.70	200	0.76	1.64	51.81	15.00	11.28	67.51	15.66	10.60	4.25
F	1	28.92	0.80	500	0.74	1.86	48.90	53.44	9.39	68.15	17.14	10.19	5.27
	2	25.80	0.54	200	0.75	2.65	65.36	30.00	12.83	62.67	14.05	7.54	5.54
G	1	27.25	0.47	300	0.66	2.33	46.70	13.58	13.44	63.02	14.64	7.12	3.97
	2	25.59	0.62	300	0.76	1.39	44.04	18.89	11.06	59.26	19.74	9.84	5.41
H	1	24.72	0.61	600	0.63	2.06	45.75	9.67	10.94	64.94	18.25	7.65	1.59
I	1	21.01	0.70	1000	0.63	3.10	47.71	40.61	10.94	67.26	18.68	5.16	3.42
J	1	25.24	0.42	500	0.66	2.05	58.16	23.83	12.39	64.07	16.51	10.14	6.88
K	1	19.74	0.44	1000	0.79	1.84	63.06	26.50	10.89	64.94	17.36	7.66	7.18
Maximum		28.92	0.87	1000	0.89	3.48	73.53	81.83	13.67	70.02	20.23	14.47	7.18
Minimum		19.74	0.36	200	0.63	1.39	44.04	9.22	9.39	59.26	14.05	4.68	1.59
Average		25.48	0.59	430	0.74	2.32	57.33	28.87	11.58	66.66	17.55	8.89	4.69

*6.25 rai = 1 ha

Table 2. The random measurement performance and a loss of about for predict equations assess losses from the khaw Dok Mali 105 rice harvest.

Brand	No.	MC (%w.b.)	GM	Y (rai)	V (m/s)	RI	H (cm)	C (mm)	R (cm)	LI (degree)	FR (T/hr)	Loss(%)		E (%)	E_p (%)
												TL_f	TL_p		
A	1	24.94	0.41	100	0.84	2.93	46.00	23.33	12.56	70.30	4.94	2.53	2.49	0.04	1.58
	2	22.84	0.40	250	0.70	2.01	51.03	37.72	10.72	66.37	10.78	5.52	5.47	0.05	0.91
	3	22.20	0.45	200	0.73	2.32	65.79	12.61	12.56	69.74	8.15	3.36	3.92	0.56	16.67
	4	16.50	0.62	800	0.80	2.39	79.14	77.44	13.89	66.52	5.69	5.36	5.55	0.19	3.54
B	1	25.91	0.49	300	0.88	2.60	54.08	15.94	10.96	64.89	7.93	5.99	5.99	0.00	0.00
	2	23.45	0.45	500	0.84	3.00	61.18	12.86	10.61	64.89	8.02	5.29	5.11	0.18	3.40
	3	18.44	0.29	800	0.72	3.10	69.37	17.11	11.75	68.97	9.41	7.52	7.57	0.05	0.66
C	1	18.21	0.53	600	0.70	1.98	60.29	40.00	11.47	68.20	10.10	6.52	6.43	0.09	1.38
	2	21.47	0.21	300	0.75	2.70	55.26	29.39	11.92	67.56	16.38	8.07	8.21	0.14	1.73
	3	22.49	0.44	800	0.85	2.78	53.75	23.06	11.56	65.15	13.45	7.53	7.69	0.16	2.12
D	1	25.82	0.40	400	0.90	2.66	60.75	17.17	11.50	56.73	13.68	13.63	11.70	1.93	14.16
	2	21.00	0.70	1000	0.92	1.67	53.74	30.00	11.50	66.11	6.77	7.86	7.09	0.77	9.80
E	1	24.86	0.38	150	0.91	2.91	56.58	25.28	10.75	69.12	7.54	4.97	4.77	0.20	4.02
	2	26.38	0.39	500	0.74	3.02	58.64	29.67	12.33	66.25	11.18	4.31	4.76	0.45	10.44
F	1	22.96	0.66	200	0.82	2.30	57.55	12.92	11.22	69.12	11.01	4.45	4.31	0.14	3.15
	2	24.61	0.50	450	0.73	2.29	55.25	55.83	14.14	69.15	7.60	6.07	5.97	0.10	1.65
G	1	23.18	0.68	150	0.70	3.29	67.76	47.78	13.28	66.80	7.20	7.11	7.07	0.04	0.56
H	1	23.45	0.59	250	0.74	2.06	51.39	56.72	13.42	69.78	9.86	4.13	5.12	0.99	23.97
I	1	25.62	0.48	600	0.75	2.03	50.58	57.11	10.61	67.19	7.48	3.13	3.40	0.27	8.63
J	1	19.10	0.43	300	0.81	3.16	56.88	24.94	11.03	68.75	11.42	4.79	4.99	0.20	4.18
K	1	24.31	0.28	400	0.74	2.74	35.45	75.00	11.17	67.33	7.47	2.74	2.90	0.16	5.84
L	1	17.70	0.62	500	0.76	2.25	52.38	35.78	11.78	66.78	7.56	2.98	2.92	0.06	2.01
Maximum		26.38	0.70	1000	0.92	3.29	79.14	77.44	14.14	70.30	16.38	13.63	11.70	1.93	23.97
Minimum		16.50	0.21	100	0.70	1.67	35.45	12.61	10.61	56.73	4.94	2.53	2.49	0.00	0.00
Average		22.52	0.47	434	0.79	2.55	56.95	34.44	11.85	67.08	9.26	5.63	5.61	0.31	5.47

SEP = 0.54 %