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ASSESSMENT OF HARVEST AND POST HARVEST GRAIN YIELD LOSSES OF RICE

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Abstract

The present study was carried out in 1999 rice growing season at the six growing Governorates i.e. Kafr El-Sheikh, El-Dakahliya, El-Beheira, El-Gharbiya and Damietta. The main objective of this study was determination of yield losses during harvest and post-harvest processing methods. The yield losses were determined during harvesting, transporting the crop from the field to the threshing yard, threshing and milling.

The results indicated that yield losses ranged between 10.33 % to 28.05 of % according to the harvesting and post harvest processing methods used. Moreover, losses during mechanical harvesting were higher than manual harvesting. Manual harvesting caused the highest losses during transporting the crop from the field to the threshing yard comparing with camel or bull-cart methods. The highest losses during threshing were determined for tractor treading method. In addition, the traditional one-pass milling machine (Engelberg type) resulted in the maximum losses during milling.

Losses were maximized when all traditional harvest and post- harvest processing methods (manual harvesting plus transporting the crop from the field to the threshing yard by labor + tractor treading (Korsa) plus one-pass traditional mill) were used, while the lowest losses occurred when rice was mechanically harvested and threshed and milled by modern one-pass milling machine.

INTRODUCTION

There is a popular perception " a large amount of post-harvest food losses occurs in developing countries and that, post harvest processing technology has to be improved in order to reduce it", Packhop (1980). According to this view, by adopting improved post-harvest technology, food supply can be increased more easily and economically that expanding field production which requires either expansion of cultivated area or increased productivity per unit land area.

Rice is an increasingly popular food stuff in Egypt for several reasons. First, increases in rice production have expanded outside the traditional production zones in

the Delta, where a lot of households consume a good part of what they produce. Second, locally milled rice is ready and convenient to cook. Third, rice is reported to be a main stable food in some zones of the Delta that are under-supplied with subsidized baladi bread. The annual production of rice in Egypt ranged between 55.5 to 6.0 million ton. It is reported that an estimated amount of 15% of this production is paddy losses every season due to post-harvest processes including harvesting methods, threshing, transportation and milling. The national annual production is converted to milled rice, using a national average conversion factor of 0.65. Milling yield is reported to be the higher for Public Sector Mills and the best of the Private Sector commercial mills, generally in the 65-70% range. However, a large portion milled by small village mills (Engelberg type), whose milled rice yield is generally closer to 55-60 %.

In Egypt, rice is harvested when more than 85 % of the grains on the panicle are yellow firm and clear in appearance with approximately 18% moisture content. Harvesting is done by two main methods, manually by sickle, or mechanically by a combine harvester. Manual harvesting is the dominant method. The matured plants are cut 10-15 cm above the ground and left on the field to dry for a few days in heaps before threshing. After drying, the crop is transferred to threshing yard "Gorn" by camel, bull-cart or manual labors. Threshing is then practiced by locally made threshers or by tractor treading "Korsa". This method utilizes ribbing or shear action for separating the grain from the panicle. A standard 4-wheeled tractor is runs-over the harvested rice crop which is spread on the threshing floor. The several passes to expose the panicles underneath for threshing. the threshed crop is then winnowed with the aid of wind. After winnowing the crop is bagged and stored.

El-Nawasani (1975) reported that the total post-harvest losses of the rice crop in Egypt was as large as 24.09% and these losses could be decreased by improving the different post harvest processing methods. Abd-El-Bary et al (1981) reported losses of harvesting, transportation, and threshing in Egypt from 14,35 in Garbiya Governorate and 33.08% in Alexandria Governorate with average national losses of 25.3 %.

Azza (1987) in a study to determine the post-harvest losses for rice found that losses due to manual harvesting and crop transfer by camel and threshing by tractor threading ranged between 0.23 - 0.632 ton/fed. These losses decreased to 0.26-0.55

ton/fed. when mechanical thresher was used. On the other hand, the lowest losses (0.18 ton/fed) were detected when mechanically harvester was used.

There is no complete information of the effect of different harvest and post-harvest processing methods on grain yield losses. Accordingly, the present investigation was designed to determine these type of losses in six rice growing governorates in Egypt.

MATERIALS AND METHODS

The present investigation was carried out during 1999 rice growing season in the six rice growing governorates, i.e. Kafr El-Sheikh, El-Dakhaliya, El-Beheira, El-Sharkiya, El-Gharbiya and Damietta. Three fields grown with the same variety in three different districts of each governorate were studied. The study was concerned with determination of harvest and post-harvest grain yield losses according to Harries and Lindbled (1976) through the following steps:

a. Yield losses due to harvesting method:

Two harvesting methods i.e. manual harvesting using sickle, and mechanical harvesting (combine harvester) were used. Three plots of 10 m2 each in three replications were randomly sampled for each method in three locations at the six governorates. Weight of shattered grains and grain of the unharvested panicles were determined for each plot as losses due to harvesting methods.

b. Yield losses due to means of transporting the crop:

After harvesting, the crop is usually left for drying in the field for few days and then transferred to the threshing yard (Gorn) by using any of three means; camel, bull-cart or manual labor. For manually harvested plots, 10 m2 each, in three replications were used for determination of this type of losses. Plastic or canvas sheets were placed under rice bundles right after harvest to ensure that grains shattered from the stalk are collected on the sheet and not mixed with harvesting losses.

One out of these four plots was threshed in the field directly, after harvesting as a control, while the crop of the others was left for drying in the field and then transferred to the threshing yard by the different means and then threshed. Pedal driven thresher was used in all cases and the differences in grain weight between the control and treatments were computed after adjusting the moisture content at 14% for all samples.

c. Yield losses due to different threshing methods:

Losses of three threshing methods were determined. These methods were: mechanical harvester, local-made thresher and tractor treading (Korsa). The crops of 4 plots, 100 m2 each, in three replicates were used. These plots were manually harvested and one of these plots was threshed directly in the field using pedal driven thresher as a control, while the others were threshed by stopped mechanical harvester (to avoid the harvesting losses), the local-made thresher and by tractor treading method. Threshing was done directly in the field to avoid the losses due to other factors, and differences between the different threshing methods and the control were computed.

d. Yield losses due to different milling machines:

Four types of milling machines i.e. one-pass traditional milling machine (Engelberg) and three modern small-scale milling machines manufactured in China, Indonesia and Japan were used. Three random paddy samples, 100 kg each, in three replicates were milled by each milling machine. Yield losses were estimated by comparing the total milled rice of each machine by the total milled rice of three other samples milled by the experimental milling machine at the Rice Research & Training Center, Sakha, Kafr El-Sheikh as a control.

Statistical Analysis

The collected data were statistically analyzed as split plot design according to Gomez and Gomez (1983). The main plots were governorates, while the methods were located in the sub-plots.

RESULTS AND DISCUSSION

1. Yield losses due to different harvesting methods:

It is clear from table (1) that yield losses were affected significantly by the harvesting methods. Manual harvesting caused higher losses than mechanical harvesting. The manual harvesting losses were ranged between 0.38 % to 64% while the mechanical harvesting losses ranged from 0.8 % to 1.56 %.

On the other hand, significant differences between governorates were also computed. The highest losses (%) were determined for Damietta and Sharkiya governorates, while the lowest losses (%) were found in Garbiya and Dakahliya governorates.

These finding could be attributed to the fact that during manual harvesting, all stems are collected during cutting. However, in mechanical harvesting some stems are left unharvested especially those in field corners and those that are fully lodged. Abd El-Motaleb (1982) reported that the losses in mechanical harvesting ranged between 0.8 % and 5.1 %. Moreover, when hard sickles were used, total losses differed from 1.6 to 7.8% depending on harvesting time. However, Ramos (1982) reported that no significant loss during the cutting process was noticed. This low loss during cutting was attributed to the inherent varietal characteristics. In Korea , Chang (1986) estimated the grain losses during harvesting operation as 3-5 % for Indica X Japonica varieties.

II. Yield losses due to means of transporting the crop:

Grain on panicles are subject to at least two kinds of forces impact and shear, which incur shattering losses during transportation of paddy from one place to another (Sabbah et al, 1979). Table (2) clarifies that yield losses during transporting the crop from the field to the threshing yard by different methods ranged between 1.83 % to 3.95% . The highest losses were recorded from transferring the crop by the laborers, while the lowest was found in case of using the camel. The mean losses different significantly between governorates and were highest in Sharkiya governorate (3.42%) and lowest in Gharbiya Governorate (2.37%). Meantime, the interaction between means of transportation and governorate was significant.

It was observed that higher losses occurred when hand labor was used to lift and move the bundles from the field to the threshing yard. Shattering took place when the grains and panicle rubbed against each other. Severe shattering occurred when labor dropped the bundles to the ground. This explains why the manual method incurred more losses. On the other hand, with the camel method, the rubbing action was minimized as result of tying the load with a rope. The whole load acted as one solid bundle and gentle shaking caused by the movement of the animal did not result in much shattering of grains.

Backhop (1980) indicated that losses in transportation of the paddy crop with a moisture content of 17% ranged from 0.8 % to 2.3%. Ramos (1982) reported that the camel as a means of transport the paddy incurred lower loss when compared with the cart method. At 14.2 % grain moisture, transport by camel incurred only 0.9 % losses compared to 4.35% with cart at moisture of 15.4%.

III. Yield losses due to different threshing methods:

Threshing losses include unrecovered grains from the panicles, grain lost during winnowing and losses during packing. Table (3) shows the percentage of yield losses incurred by different threshing methods. It was found that higher losses (%) occurred when the tractor treading was used. In this case the losses ranged between 2.3 % in Kafr-EL-Sheikh to 2.63 % in Gharbiya. On the other hand, the lowest losses occurred with the mechanical harvester and differed from 0.99 % to 1.79 % in Damietta and Beheira Governorates, respectively. In addition, the mechanical harvester and local made thresher resulted in a very high degree of purity, comparing with grain from tractor treading which had mudballs that reduce quality of milled rice. In general threshing losses include unrecovered grains from the panicles, grain lost during winnowing and losses during packing.

Furthermore, the differences between governorates, as well as the interaction between methods and governorates were significant. In Egypt the experimental data obtained by Sabbah et al (1979), on losses associated with threshing by tractor treading, showed that losses represented 22% of the total post-harvest losses.

IV. Yield losses as affected by different milling machines:

It is clear from table (4) that yield losses were differed significantly for the different milling machines. The traditional milling machine (Engelberg type) caused the highest yield losses. The average losses due to this type was 21.12% regardless of variety. Meanwhile, losses were significantly reduced by using the other modern one-pass milling machines. Their losses differed from 4.54 % to 9.23 % for the Japanese and Indonesian milling machines, respectively. Furthermore, it was observed that a high percentage of broken grains was present in rice milled by the traditional milling machine.

On the other hand, table (4) indicated that yield losses during milling differed among varieties. The lowest losses were detected for Giza 177 variety while the highest losses were found in case of the rice variety Giza 178. These differences could be attributed to differences in grain shape of the different varieties. However, the interaction between varieties and machines was insignificant.

CONCLUSION

Table (5) presents yield losses (%) as the affected by harvest and post-harvest processing methods. In general, the yield losses ranged between 10.33% and 28.05%. The lowest losses were estimated when the mechanical harvester, mechanical thresher and the modern one-pass milling machine were used. However, the maximum losses were determined when all traditional processing methods including manual harvesting, manual transfer of the crop by labor, tractor treading, threshing method and Engelberg milling machine were used.

Accordingly, it is concluded that significant losses occur during the harvest and post-harvest steps. Reducing or preventing these losses by improved technology should increase total production of rice to the extent that a 10 % reduction in losses would provide about 500.000 metric ton of milled rice equivalent to the normal quantity of annual rice exportation in Egypt and valued at about $ 1.5 million per year.

Table 1. Rice grain yield losses (%) as effected by different harvesting methods at different Governorates

Harvesting Methods	Kafr El Sheikh	Dakahliya	Behira	Sharkiya	Gharbiya	Damietta	Mean
Manual	0.41	0.44	0.38	0.52	0.46	0.64	0.84
Mechanical	1.02	0.97	1.32	1.65	0.85	1.56	1.23
Mean	0.72	0.69	0.85	1.09	0.66	1.10	
L.S.D 0.05 (Methods)	0.23						
L.S.D. 0.05 (Governorates)	0.19						
L.S.D. 0.05 Interaction	N.S.						

Table 2. Rice grain yield losses (%) as effected by different means of transporting the crop from field to threshing yard in different Governorates

Harvesting Methods	Kafr el Sheikh	Dakahliya	Behira	Sharkiya	Gharbiya	Damietta	Mean
Camel	1.75	2.10	2.23	1.64	1.17	1.99	1.83
Cart	3.38	3.15	2.80	3.28	2.81	3.27	3.11
Labor	3.28	3.29	3.97	5.32	3.15	350	3.95
Mean	3.24	2.84	3.03	3.42	2.37	2.92	2.97
L.S.D 0.05 (Methods)	0.79						
L.S.D. 0.05 (Governorates)	0.53						
L.S.D. 0.05 Interaction	N.S.						

Table 3. Rice grain yield losses (%) as effected by different threshing methods in different governorates

Methods	Kafr el Sheikh	Dakahliya	Behira	Sharkiya	Gharbiya	Damietta	Mean
Tractor treading	2.31	2.57	2.47	2.4	2.63	2.56	2.49
Local made thresher	1.65	2.24	2.08	1.88	2.23	2.07	2.03
Mechanical harvester	1.38	1.43	1.79	1.05	1.49	0.99	1.35
Mean	1.78	2.08	2.11		2.12	1.87	
L.S.D 0.05 (Methods)	0.56						
L.S.D. 0.05 (Governorates)	N.S.						
L.S.D. 0.05 Interaction	N.S.						

Table 4. Losses (%) of milled rice as affected by different types of milling machines for different rice varieties

Methods	Giza 171	Giza 172	Giza 176	Giza 177	Giza 178	Mean
a- Engelberg	20.16	21.75	22.03	19.02	22.69	21.12
b- Chinese	9.67	8.39	9.51	8.82	9.74	9.23
c- Indonesian	9.17	9.22	9.59	9.53	10.11	9.47
d- Japanese	4.06	5.45	4.59	3.01	5.64	4.54
Mean	10.77	11.20	11.37	10.09	12.04	
L.S.D 0.05 (Machines)	4.49					
L.S.D. 0.05 (Varieties)	1.06					
L.S.D. 0.05 Interaction	N.S.					

Note: 1- Mean Losses (%) of newly developed machines (b,c and d) = 775 %

2- General mean of losses % of one-pass milling machines = 11.09 %.

Table 5. Losses (%) of rice grain as affected by harvest and post-harvest processing methods

Processing Method	LOSSES %
Manual harvesting + camel +tractor treading +Engelberg Mill machine (E.M.M.)	25.92
Manual harvesting + camel + tractor treading + Modern milling machine (M.M.M.)	12.55
Manual harvesting + camel +local made thresher + (E.M.M.)	25.46
Manual harvesting + camel +local made thresher + (M.M.M.)	12.07
Manual harvesting + cart + tractor treading + (E.M.M.)	27.20
Manual harvesting + cart + tractor treading + (M.M.M.)	13.83
Manual harvesting + cart + local made thresher + (E.M.M.)	26.74
Manual harvesting + cart + local made thresher + (M.D.M.M.)	13.37
Manual harvesting + labor + tractor threshing + (E.M.M.)	28.05
Manual harvesting + labor + tractor threshing + (M.M.M.)	14.67
Manual harvesting + labor + local made thresher + (E.M.M.)	27.58
Manual harvesting + labor + local made thresher + (M.M.M.)	14.21
Mechanical harvester + Mechanical thresher + (E.M.M.)	23.70
Mechanical harvester + Mechanical thresher + (M.M.M.)	23.70

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تقدير فاقد الحبوب خلال معاملات الحصاد وما بعد الحصاد لمحصول الأرز

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أجرى هذا البحث فى الموسم الزراعى ١٩٩٩ لمحصول الأرز وذلك فى محافظات كفر الشيخ - الدقهلية - البحيرة - الشرقية - الغربية ودمياط لتقدير فاقد الحبوب فى محصول الأرز نتيجة معاملات الحصاد وما بعد الحصاد الذى قدر خلال عمليات الحصاد (يدوى - ميكانيكى) ونقل المحصول من الحقل إلى الجرن (بالأفراد - بالجمل - بالعربة والدراس (بإستخدام الجرار " القرص " - ماكينة الدراس المصنعة محليا " السراتة " - ماكينة الحصاد المكيانيكى) وماكينات التبييض (الفراكة التقليدية " الموانى ") الفراكات الحديثة " اليابانية - الصينية - الأندونسية ")

وقد أوضحت النتائج أن نسبة الفاقد فى المحصول بصفة عامة تراوحت ما بين ١٠,٣٣ ٪ إلى ٢٨,٠٥٪ كما أوضحت النتائج أن نسبة الفقد فى الحصاد الميكانيكى كانت أعلى من الحصاد اليدوى - كما تسبب إستخدام الأفراد فى نقل المحصول من الحقل إلى الجرن إلى أعلى نسب الفقد بالمقارنة بطرق النقل الأخرى.

كما أظهرت النتائج أن إستخدام الجرار فى الدراس (القرصة) حقق أعلى نسب فقد - أما أثناء التبييض قد قدرت أعلى درجات الفقد عند إستخدام الفراكات البلدية وذلك بالمقارنة بأنواع الفراكات الحديثة.

وعلى ذلك فإن أعلى نسب للفقد قدرت عند إستخدام جميع الطرق التقليدية فى الحصاد وما بعد الحصاد (حصاد يدوى + استخدام الأفراد فى نقل المحصول + الدراس بإستخدام الجرار (القرصة) + التبييض بإستخدام الفراكات البلدية " الموانى " بينما كانت أقل نسبة للفاقد عند إستخدام الحصاد الميكانيكى وإستخدام الفراكات الحديثة فى التبييض.