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Wheat Harvesting Losses in Some Saudi Arabian Farms

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Abstract. A survey was carried out to estimate wheat harvesting losses resulting from the different functional components of combine harvesters. The evaluation was based upon the actual speed set by the operator replicated three times for each combine harvester. The results show that there are considerable variations in machine component losses between the different makes of combines. These variations are partly due to operators' skills, operating speed, stubble height, farm size, farm yield and the way the farms are managed.

Introduction

Wheat crop is one of the main strategic commodities in Saudi Arabia. The Saudi Government gives special attention to this crop and sets up an agricultural policy to help the farmers expand their cultivated area and increase crop productivity. The major part of this policy is subsidizing the agricultural machinery including combine harvesters. The subsidy is paid to the rate of 45% of the official price list of the machinery issued by the Ministry of Agriculture, while the rest of the price is considered as a loan to be paid back by the farmers in a period of ten years. Due to this encouragement and facilities given to the agricultural sector, the production of wheat has been improved to the extent that the country is now self sufficient and exports large quantities of extra wheat yield. The Kingdom's total crop yield increased from 39,000 tn. in 1972 to 2,544,000 tn. in 1986 [1].

The importance of wheat crop and the large investment on imported combine to harvest the vast areas now grown with wheat made it vital to the farmers to look after

their machines and care about them. This will improve efficiency of grain harvesting activities and cut down combine wheat losses to the minimum.

Combine harvesting losses occur at four distinct areas of the combine after which they were named [2–4]. Those losses are cutter-bar, cylinder, straw walker and shoe losses. They are affected by nature, condition and volume of material passing through the combine together with the design characteristics of the combine and the adjustment of the three main combine harvester controls i.e., steering, cutter-bar height and forward speed [5]. According to Hunt [6], cutter-bar losses were greater than other losses for correctly adjusted, direct cut combines. He also stated that combine losses as a per cent of gross yield in Midwestern United States were 3.4 for cutter-bar, 0.1 for cylinder and 0.6 for separation (straw walker and shoe) giving a total loss of 4.1%. While McCuen and Silver [2], Nyborg [7], Nyborg *et al.* [4] and Reed *et al.* [8] reported that excessive losses occur over the straw walkers.

Losses can be determined by different methods; Silver and Sitterly [9] used a canvas trailed behind the combine to collect the effluent from the rear of the machines. McCuen and Silver [2] used two canvases one over the other, the top canvas to collect the straw from straw walkers and the lower one to collect chaff from the sieves. Wrubleski and Nyborg [10] used a batch processor capable of separating both the free grain and the unthreshed grain in either a shoe or straw walker collection. Also some of the combines were fitted with grain loss monitors [5,11] to detect different harvest losses. These are sensors installed behind the straw walkers and sieves to record the sound of grains falling on them and then convert the results to a quantitative meter reading on a dial in front of the operator where he can make the appropriate adjustments to match a pre-selected meter reading.

The lack of research concerning wheat harvest losses in Saudi Arabia necessitates a lot of work to be done in this field. Such work to estimate the amount of combine wheat losses and hence get to know the remedies necessary to reduce these losses and then pass the results to the combine operators for proper combine adjustments and operation.

The primary objective of this study is to survey randomly selected wheat farms in Al-Kharj and Riyadh regions to estimate wheat harvesting losses for 1987 harvesting season. Also the different combine components losses together with the combine settings used by farmers and any other unusual operating practices will be investigated.

Materials and Methods

Ten farms in Al-Kharj and Riyadh regions were selected randomly when harvesting wheat crop of 1987 season. John Deere, New Holland, Arbos and Allis Chalmers were the makes of combine harvesters operating on these farms. For each farm, three runs were conducted for the evaluation of combine harvesting losses. In every run a plot with seven meters long and a width equal to the width of cut of the machine were selected at the center of the farm. The seven meter length of the plot were marked by two range poles at a distance of one meter away from the standing crop.

The combine harvester was operated approximately fifty meters back from the first pole to give all functional parts of the combine ample time to be fully loaded. As soon as a marked point on the combine comes in line with the first of the two poles, a signal was given and the test started. Immediately two canvases 4.0 by 6.0 meters were pulled under the rear of the combine; one to collect the discharge from the straw walkers and the other to catch the efflux from the sieves. A record of the elapsed time was kept using a stop watch for speed determination.

The average width of cut was determined by measuring the distance between the standing crop and the two poles then deducting the one meter distance measured earlier between the previously standing crop and the marking poles. The straw and chaff were bagged, labelled, weighed and then taken to the laboratory for further rethreshing and cleaning. The weight of loose grain collected from the top canvas constitutes the straw walker losses, while that from the lower canvas resembles shoe losses. Cylinder losses were obtained from the weight of unthreshed grains collected from both canvases.

Samples for field and preharvest losses were determined from one square meter plots. The standing crop within this area was harvested carefully by hand to determine the yield. The weight of grain left on the ground in that area represents preharvest losses.

The cutter-bar losses were computed from the weight of grain gleaned from a one meter by two meters frames placed randomly in the harvested test area where the throughput of the combine was previously collected on the canvases. This represents both cutter-bar and preharvest losses.

Results and Discussion

Harvest losses were evaluated and shown in Table 1. The amount of total machine losses obtained were reasonable and fall between 0.71% and 4.82% of harvest yield. This means that all combines were operating with grain loss levels less than 5%. But, in term of kg/ha, the losses ranged between 29.51 kg/ha and 199.94 kg/ha which were believed to be high (Fig. 1). Sixty per cent of the combines tested recorded total machine losses higher than or equal to the seed application rate of wheat crop which is supposed to be between 115 kg/ha and 150 kg/ha. Having total machine losses equal to or greater than the seed application rate, means regrowth of wheat crop of last year whenever irrigated; this henceforth will require additional field operations to be done by the farmers to eradicate this parasitic wheat crop.

Table 1. Farm harvesting data of 1987 season

Farm No.	Speed km/hr	Area (ha)	Combine make	T.M.Loss % of H.Y.	T.M.Loss kg/ha	H.Yield kg/ha	T.M.Loss tons
1	2.59	200	JD 1075	1.83	73.46	4018	14.692
2	5.86	800	NH 8080	2.42	130.43	5379	104.344
3	3.63	1120	NH 8060	1.96	42.11	2150	47.163
4	2.23	1120	NH TR70	2.83	66.51	2350	74.491
5	2.14	120	JDT 882	1.61	112.26	6990	13.471
6	5.46	0.5	AR MT14	4.48	192.47	4297	0.096
7	2.21	200	JD 975	3.77	153.28	4068	30.656
8	2.13	200	JD 975	4.82	199.94	4150	39.988
9	2.31	1440	AC GN6	3.06	127.91	4180	184.190
10	2.25	1440	JD 1085	0.71	29.51	4180	42.494

The results showed considerable variations in machine total losses between the different makes of combines. These variations were partly due to operator skills, operating speed, stubble height, field size and field yield.

The operating speed of the combines ranged between 2.13 km/hr giving total losses of 199.94 kg/ha and 5.86 km/hr with 130.43 kg/ha total losses. Seventy per cent of the farms were harvested with combine forward speed below 2.6 km/hr which is very low compared to the recommended speed of 3.0 km/hr to 6.0 km/hr. One of the main reasons of this low speed is the high average yield of 4.18 t/ha obtained from the farms surveyed. This high yield as compared to world average yield of 1.79 t/ha [12] will lead to machine overloading by having large quantities of material entering the

threshing mechanism and hence decreases machine efficiency and increases total machine losses.

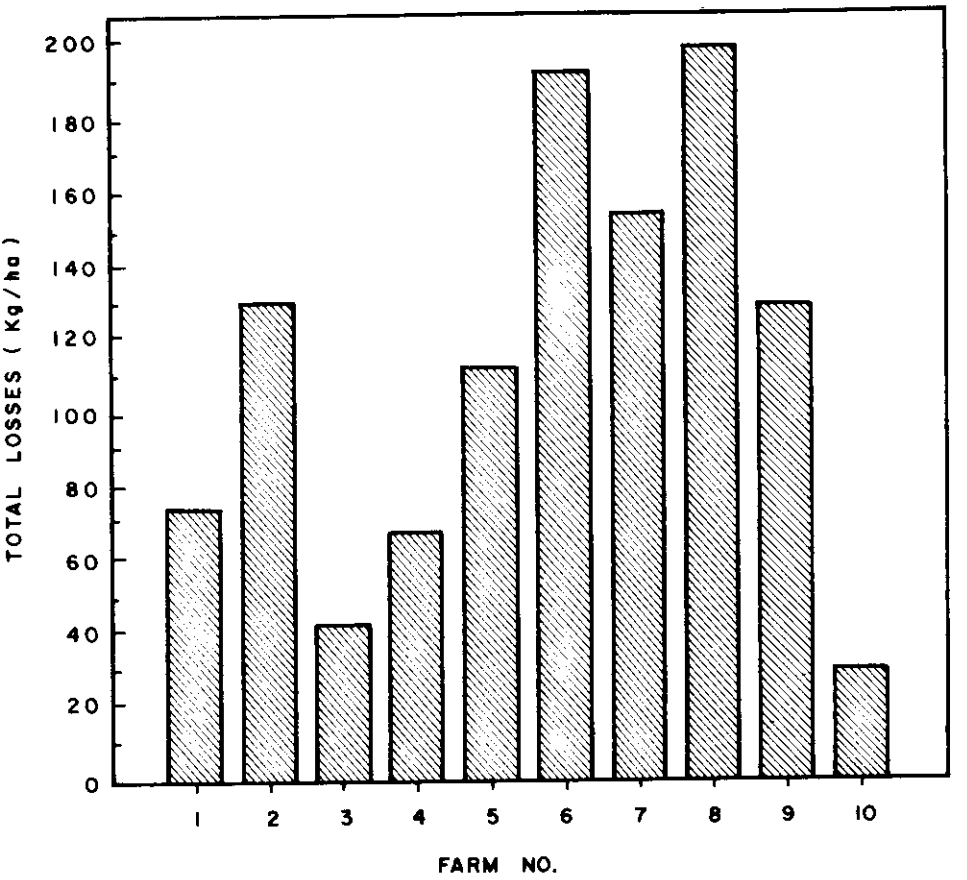

Fig. 1. Farms total harvest losses

In large farms of area more than 1000 ha., machine total losses were found to be 29.51, 42.11, 66.51 and 127.91 kg/ha for farms number 10, 3, 4 and 9; respectively. Smaller losses in large farms were mainly due to the good management practiced on those farms plus the presence of skilled operators controlling their machines to the best advantage. The loss levels of the total area of farms checked in the survey ranged between 0.1 t. for small farms to 184.2 t. for large ones.

The different combine harvesting losses were grouped under gathering and pre-harvest losses, processing losses (cylinder + straw walker + shoe) and total losses.

The Grain Grower [13] indicated that losses should not exceed 34 kg/ha (0.044 m^3/ha), 54 kg/ha (0.07 m^3/ha) and 85 kg/ha (0.11 m^3/ha) for processing, gathering and preharvest and total losses; respectively. Loss evaluation showed that seventy per cent of all combines exceeded the loss level of 34 kg/ha for processing losses, while forty per cent exceeded the loss level of 54 kg/ha for gathering and preharvest losses (Table 2). For total losses, sixty per cent of the combines exceeded the acceptable loss level of 84 kg/ha (Fig. 1).

Table 2. Different combine harvesting losses

Farm No.	Pre. H. losses kg/ha	Preharvest and gathering loss kg/ha	Preharvest and gathering loss m^3/ha	Processing loss (CY.±SW.±SH) kg/ha	Processing loss (CY.±SW.±SH) m^3	Total losses kg/ha	Total losses m^3/ha
1	1.500	4.43	0.066	69.03	0.090	73.46	0.095
2	0.500	84.10	0.109	46.33	0.060	130.43	0.169
3	0.000	17.66	0.023	24.45	0.032	42.11	0.055
4	0.000	4.16	0.005	62.35	0.081	66.51	0.086
5	0.000	105.96	0.138	6.30	0.008	112.26	0.146
6	23.100	36.55	0.480	155.90	0.203	192.47	0.250
7	0.910	81.24	0.106	72.04	0.094	153.28	0.199
8	0.000	101.67	0.132	98.27	0.128	199.94	0.260
9	0.000	42.13	0.055	85.78	0.111	127.91	0.166
10	0.000	28.92	0.38	0.59	0.001	29.51	0.038

Recommendations

High combine efficiency is normally achieved when the machine is properly adjusted and operated by a skilled and efficient driver. This was seen clearly in farm number Ten where total machine losses were reduced to 29.51 kg/ha as a result of good farm management and proper adjustments and operation of the combines. The cylinder losses which are usually the lowest machine losses showed some variation than expected. The cylinder losses were the highest of all combine component losses in twenty per cent of all farms (Fig. 2).

The effect of plant density is quite noticeable; greater losses in terms of kg/ha occurred in farms of high yield as the case of farms number (2) and (7). Ten commercial combines of different makes and ages were included in the survey. Nine of the combines were of the conventional type while the tenth one is an axial flow observed in farm number (9).

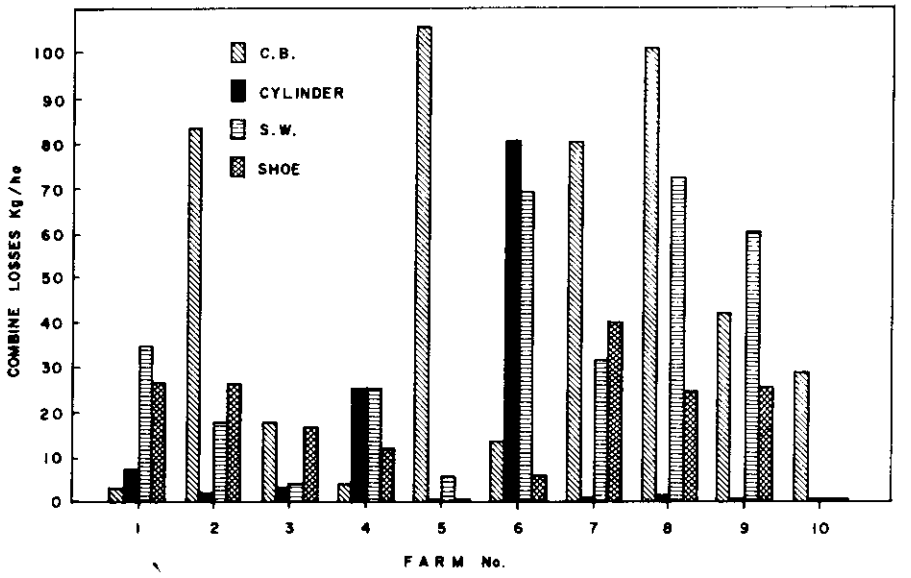

Fig. 2. Combine component losses

Further research is recommended in the same field of combine harvesting losses. Specific studies for further investigations of each of the factors affecting combine harvesting losses such as feed rate, harvesting speed, height of cut, operator skills and machine capacity will be of concern. A collection cart to catch the discharge from the rear of the harvesting machines is recommended to replace the blanket method for quick and easy sample collection and to enable the survey of more farms during the short harvesting season.

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فواقد حصاد القمح في بعض مزارع المملكة العربية السعودية

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ملخص البحث. الغرض من هذه الدراسة هو إجراء حصر ميداني لبعض مزارع القمح في المملكة العربية السعودية لمعرفة الفواقد في محصول القمح والناتجة عن استخدام آلات الحصاد الكومباين. لقد تم البحث في موسم ١٩٨٧م على عشرة مزارع اختيرت عشوائيًا بمنطقتي الرياض والخرج. وبينت النتائج أن نسبة الفقد الكلي بين ٧١ر٠٪ و ٨٢ر٤٪ من الإنتاجية، وهذا يعني أن كل آلات الحصاد والدراس تعمل بكفاءة عالية وبمستوى فقد أقل من ٥٪. غير أن كمية الفقد بالكيلوجرام/هكتار تبدو عالية (٥١ر٢٩ كجم/هكتار إلى ٩٤ر١٩٩ كجم/هكتار) خاصة وأن ٦٠٪ من الآلات بلغت كمية الفقد فيها أعلى من معدل البذر المطلوب للزراعة (١١٥-١٥٠ كجم/هكتار).

كما أوضحت النتائج أن ٧٠٪ من الآلات فاق الفقد فيها من أجهزة الدراس والفصل والتنظيف معدل الفقد المقبول (٣٤ كجم/هكتار)، بينما ٤٠٪ من الآلات تعدت المعدل المقبول (٥٤كجم/هكتار) بالنسبة لفقد جهاز القطع والتجميع وفقد ماقبل الحصاد. أما بالنسبة للفقد الكلي فإن ٦٠٪ من الآلات تعدت المعدل المقبول (٨٥ كجم/هكتار).