Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2497

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (2):** 604-611 (2017)

International Journal of Pure & Applied Bioscience

Research Article

OPEN ACCESS

Performance Evaluation of Harvesting and Threshing Methods for Wheat Crop

Ashok Kumar[1*], Avdash Kumar [2], Kalay Khan[3] and Devesh Kumar[4]

[1,3,4]Ph.D. Scholar, Farm Machinery and Power Engineering, VSEAT, Sam Higginbottom Institute of Agriculture, Technology and Sciences, (Deemed-to-be University), Allahabad-211 007, UP, India

[2]Assistant Profesor , Dept of FMPE, VSAET Sam Higginbottom Institute of Agriculture, Technology and Sciences, (Deemed-to-be University), Allahabad-211 007, UP, India)

*Corresponding Author E-mail: ak02071987@gmail.com

Received: 24.01.2017 | Revised: 5.02.2017 | Accepted: 6.02.2017

ABSTRACT

During harvesting season, often rain and storms occurs causing considerable damage to standing crops. Rapid harvest facilitates extra days for land preparation and earlier planting of the next crop. The use of machines can help to harvest at proper stage of crop maturity, reduce drudgery and operation time. Crops are harvested after normal maturity with the objective to take out grain, straw, tubers etc. without much loss. There are several methods of harvesting and threshing for wheat crop i.e. manual and mechanical method. Under this comparative study, the effective field capacity at 16 % moisture content was 0.30 ha/hr at speed of 3 km/hr. The field efficiency of self propelled binder was 74, 76.79 %, and 77.90 % at moisture content 20, 18, 16 % respectively. The shattering losses of self propelled reaper binder was 51 kg/ha at 3 km/hr forward speed with 20 % moisture content and observed that increase forward speed shattering losses was increase. The grain breakage percentage during experiment of combine harvester at 3.25 km/hr speed with 20 % moisture content was 0.06 % and observed that grain breakage percentage was increase with forward speed and moisture content. The unthreshed grain percentage was 0.66 % at 3.25 km/hr at 20 % level moisture content. The total grain loss was 1.7 % at 4.05 km/hr forward speed at 20 % moisture content.

Key words: *Thresher, multi crop, threshing capacity, threshing efficiency, breakage*

INTRODUCTION

India is one of the vast countries in the world today. The population growth rate is much faster than the growth rate in food grain production in the country. In order to feed so much population, improved agricultural implements will have to be used to increase the output of farming operation in the country. India is a vast country, covering about 329 million hectare geographical area of the total geographical area. About 166 million hectare is cultivated land and net area sown is about 142 million hectare. In U.P. about 70% of total geographical area is under cultivation and scope of land increase under cultivation is not possible whereas, day per day population is increasing.

Cite this article: Kumar, A., Kumar, A., Khan, K. and Kumar, D., Performance Evaluation of Harvesting and Threshing Methods for Wheat Crop, *Int. J. Pure App. Biosci.* **5(2):** 604-611 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2497

To meet the requirement of food grain, scientific farming is necessary which includes introducing of high yielding varieties, development of irrigation facilities, efficient use of chemicals, fertilizers, insecticides etc. coupled with agricultural mechanization. Agricultural mechanization has resulted timeliness of operation, increased productivities of land apart from removal of drudgery of labour and also increase the economic return to farmer. Major components of agriculture mechanization, besides lift irrigation are tractor and associated farm equipment like tillers, disc harrows, seed drills, harvesting, threshers, and increased usage of combine harvester particularly in Northern region of the country.

Developed a stripping machine consisting of a box on wheel pulled ahead by an ox. The grains were dropped in to the box after being pulled off by teeth along the front edge of the box. The box was assisted developed a stripping machine consisting of a box on wheel pulled ahead by an ox. The grains were dropped in to the box after being pulled off by teeth along the front edge of the box. The box was assisted by a rake was operated by an attendant[9].

Developed and tested a whole crop harvested. The first prototype was a single drum machine. Testing showed that multiple drum machines were superior to the single drum machines[4].

Studied the grain losses during conventional harvesting of the wheat crop. They found that, the harvesting losses with manual harvesting depend upon the harvesting time, availability of irrigation and variety of crop. The harvesting losses increased with delay harvesting and losses were also found less in irrigated field and also in high yield varieties[11].

Designed and developed a power operated paddy thresher with a view to increase efficiency and to reduce the cost of threshing operation in comparison to the conventional pedal thresher. It was observed that the higher output and maximum threshing efficiency could be achieved by threshing the paddy crop at 16.5 moisture content at peripheral speed of 622 m/min. It was also found that the net unit threshing cost per quintal of paddy was Rs. 2.11 when threshed by that thresher as compared to Rs. 3.96 per quintal by a pedal thresher[2].

Developed a dual mode thresher in Egypt under the USOD supported National Agricultural Research Project (NARP) which could be operated both as beater or axial flow type machine. This machine could thresh all popular cereals crops that are growing in the developing countries and can also make bhusa. The dual mode machine had generated much interest among farmers and the manufactures had started commercial production Egypt[5].

Tested the tractor mounted vertical conveyor reaper on wheat and mustard to compare the losses and economics with respect to the field. It was found that the grain losses increase with the increase in the speed. On comparison with manual harvesting it was found that grain loss was reduced of 15.89% for paddy and 10.13% for wheat with the use of reaper[10].

Conducted a study to estimate the field loss of Swaraj 8100 combine harvester on wheat crop. The combine harvester gave the threshing efficiency of 94%. This indicated that some improvement was needed in the threshing unit as well as in the cleaning unit. Rack loss and shoe loss were with a limit less than 2%[3].

Conducted experiments using centrifugal force as a mean of obtaining all the three functions of threshing, separating and cleaning. He concluded that threshing and separating processes could be integrated, eliminating the need of spiral raw separating equipment when using centrifugal principle. Tests were conducted to study the effect of cone speed grain- straw ratio, feed rate and breakage on efficiency of centrifugal threshing[6].

Reported that in Punjab state farmers found combining of rice and wheat cheaper and less risky. He stated that several

manufactures in Small Scale Sector took to general purpose standard grain harvesting combines by manufacturing tractor mounted, self-propelled and tractor driven versions. Combining, however, created problem of rice and wheat straw gathering, transforming and handling as Bhusa. Straw disposal through incineration in to the soil was leading to nitrogen stealing. Invention and introduction of straw combines did provide a solution to reclaiming wheat Bhusa but still about 50-60% of the rice and wheat straw is being disposed by burning. It may not be entirely due to combines; the other causes is that the demand for wheat bhusa has also declined. Its transport to feed deficit areas in loose farm expensive and uneconomical in some areas. Complete feed block buffer stocking to fight feed famines is a possibility[1].

Found that, the cost of reaping alone by tractor mounted reaper and self-propelled reaper was 50% and 30% of the manual reaping, respectively. The total cost of harvesting by tractor mounted and self-propelled reaper was 63% and 51% of that manual harvesting, respectively. The total manpower requirement for harvesting by tractor mounted and self-propelled reaper was 25% and 26% of manual harvesting, respectively. Harvesting loss by mechanical reaping was limited to 0.4%. Initially, the farmers' response was positive, since it requires less manpower and reduced harvesting cost drastically. However, any brake down gives a set back to the harvesting operation. Lack of after sales service and unavailability of spare parts does not lure the farmers to go for mechanical harvesting. Fragmentation of farm holdings and lack of roads to the harvestable plots stand in the way of adoption of mechanical reaping[8].

Based on the field demonstration conducted during Kharif 2002, 2003, 2004 and Rabi/ Summer 2004-05 reported that the labour requirement in mechanical harvesting with manual collecting and making bundles of the crop was 10 man days per hectare as compared to 20 man days per hectare in case of manual harvesting, collecting and building of the crop. Thus, there was a saving of 10 man days of labour per hectare. Cost of mechanical harvesting was worked out for different areas of usage during a year, as the cost per hectare varies with the number of hectare of usage of the machine in the year[7].

MATERIALS AND METHODS

Combination of different harvesting and threshing machineries:

Combination of different harvesting and threshing in comparative performance evaluation of different combination of harvesting and threshing methods on wheat crop as well as different performance and economic parameters.

- T1: Manual harvesting + Power threshing
- T2: Self-propelled reaper binder harvester + Power threshing
- T3: Self-propelled combine harvester (harvesting and threshing)

Description of harvesting machineries

Serrated sickle is a simple harvesting tool. It is used for harvesting crops and other vegetation. It consists of metallic blade and wooden handle.

Self-propelled reaper binder: The reaper binder was tested for different losses i.e. post-harvest loss, height of cut, fuel consumption and labour requirement were observed. The cutting unit of this type of reapers may be disc type or cutter bar type. After cutting, the crop is conveyed vertically to the binding mechanism and released to the ground in the form of bundles.

Self-propelled combine harvester It is a machine having its own engine which supplies power to all its moving parts, at the same time pulls the dead load of combine. The combine could be used as stationary thresher, by cutting of the power to drive wheels.

Threshing machinery: The AAI-Wheat thresher basically consisted of following sub unit:

a) Frame and transportation unit
b) Feeding unit
c) Threshing unit
d) Separation and cleaning unit
e) Power transmission unit
f) Outlets

Performance evaluation of harvesting methods:

Harvesting of wheat crop in eastern UP is mainly done manually by hand sickle. Reaper which is better than manual harvesting comes in b/w sickle and combine harvester is rarely used for harvesting by farmers. Combine harvester under study is a reaper, thresher, winnower and a compact machine. It is used in large farms and requires less labour and time. Combines are being accepted by the farmers.

Manual method: The harvesting of crops is traditionally done by manual methods. Harvesting of wheat crop is done by using sickle whereas tuber crops are harvested by country plough or spade. All these traditional methods involve drudgery and consume long time.

Performance evaluation of reaper binder: The reaper binder was tested for different losses i.e. post-harvest loss, height of cut, fuel consumption and labour requirement were observed. The cutting unit of this type of reapers may be disc type or cutter bar type. After cutting, the crop is conveyed vertically to the binding mechanism and released to the ground in the form of bundles.

Crop conditions: The variety of wheat crop was HUW-234, HUW-468 and HD-2967. HUW-234 and HD-2967 are nucleus variety and HUW-468 is weeder variety. To know the conditions of crop, plant height and moisture content of grain and straw were measured.

Crop density: A one square meter frame was placed at three places chosen randomly in the plot to evaluate the density of crop.

Performance variable under consideration:

Independent variable:

Crop moisture content: The crop moisture content of food grains and other agriculture products plays an important role in maintaining the desirable quality of the product. The moisture content on wet basis was evaluated as follow:

$$MC = \frac{W1-W2}{W1} X\ 100 \quad \text{.....eq. (1)}$$

where,

MC = moisture content wet basis, %

W1 = Initial weight of sample, g

W2 = final weight of sample after drying, g

Forward travelling speed:

Foreword speed of travel of the harvesting machine i.e. reaper binder and combine harvester was measured after operating the machine for some time when the speed has stabilized. The foreword speed was calculated as given below:

$$\text{Forward speed (S)} = \frac{\text{Distance(D)}}{\text{Time(T)}} \quad \text{.....eq. (2)}$$

Where,

S = Forward speed, m/sec;

D = Distance, m and

T = Time, sec.

Dependent variables:

Crop moisture content:

The crop moisture content of food grains and other agriculture products plays an important role in maintaining the desirable quality of the product. Changes in moisture content of agricultural material occur during their harvesting. The crop moisture content of food grains (w b) was 20 %, 18 % and 16 %.

Effective or actual field capacity: The effective or actual field capacity of a farm machine or implement is defined as the actual area covered by the machine or implement per hour when the machine or implement is actual working in the field which is given as follows:

Field capacity: The field capacity of a farm machine or implement is the rate at which it performs its primary function i.e., the no. of hectares that can be disked per hour. The field capacity of a farm machine or implement has been divided into two categories which are as follows:

Field efficiency: The field efficiency is defined as the ration of effective or actual field

capacity to the theoretical field capacity. It takes into account the time losses encountered in the field due to various reasons. The field efficiency was calculated as below:

Shattering losses: It is defined as the amount of the grains and ear heads falling on the ground due to the shattering action of the cutter bar and conveyor of the reaper. This gave the shattering losses ($_{W1}$) in g/^{m2} and after three replications the data was converted to hectare basis.

Windrowing losses: It is defined as the amount of grains and ear heads fallen during windrowing, collection and bundling of the crop. The total harvesting losses were calculated as described below**:**

$$W_T = W_1 + W_2 - W_0 \quad \text{.....eq.(3)}$$

Where,

W_T= Total harvesting losses, kg/ha;

W_0 = Pre-harvest losses, kg/ha;

W_1 = Shattering losses, kg/ha, and

W_2 = Windrowing losses, kg/ha.

RESULTS AND DISCUSSIONS

Comparative performance evaluation of different combination of harvesting and threshing methods on wheat crop, was conducted was SHIATS farm and all the data for T1, T2 and T3 were taken.

Speed of operation: was taken as an independent variable to see its effect of various performance parameters like height of cut, grain losses, field capacity and fuel consumption etc. of the reaper binder. The speed of operation was 3.75km/hr, 4.00 km/hr and 4.25 km/hr.

Crop moisture content: for both, reaper binder as well as for manual harvesting of wheat crop. The crop moisture content with the reaper binder and manual method varied from 20 %, 18 % and 16 % and height of cut of the manual method was 3.9, 4.1 and 3.7 cm.

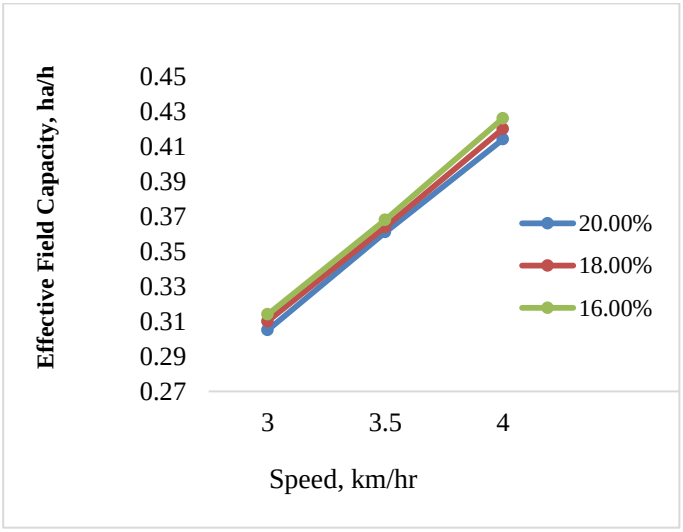

Fig: 3.1. Effect of speed and moisture content on effective/actual field Capacity of self-propelled reaper binder

Field capacity: The results of effect on speed of operation and moisture content on effective field capacity of self-propelled reaper binder for wheat crop has been shown fig: 3.1.

Field efficiency: The various field efficiency obtained for the different moisture content are shown in figures 3.2. It is evident from the figure shown below that maximum field efficiency of 74, 76.79 %, and 77.90 %. At moisture

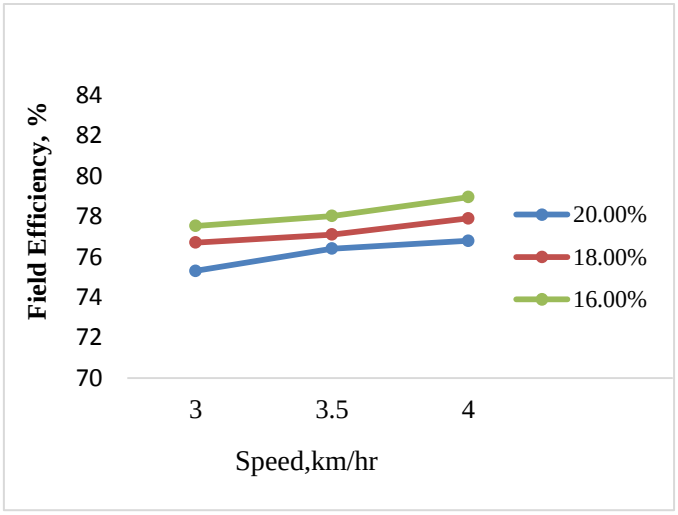

Fig: 3.2. Effect of speed and moisture content on field efficiency of self-propelled reaper binder.

Shattering losses: The shattering losses were dependent upon the forward travelling speed, as shown in fig: 3.3.

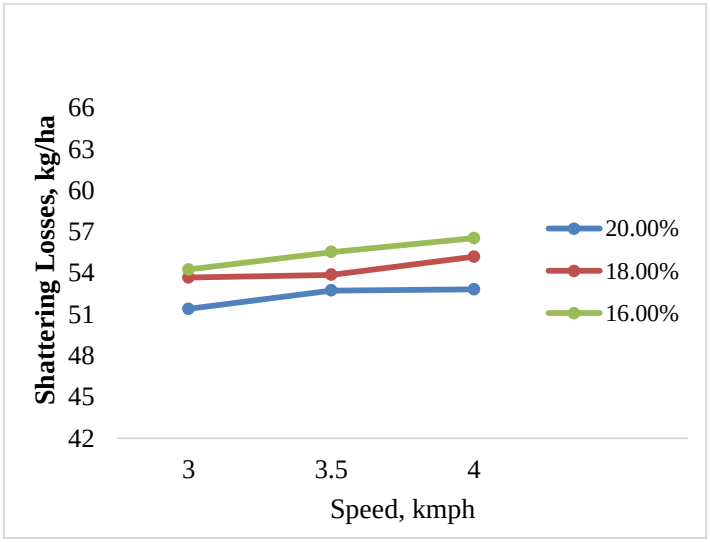

Fig: 3.3 Effect of speeds and moisture content on shattering losses of self-propelled reaper binder

Windrowing losses: The effect of speed on windrowing losses for wheat crop has been shown in fig.3.4

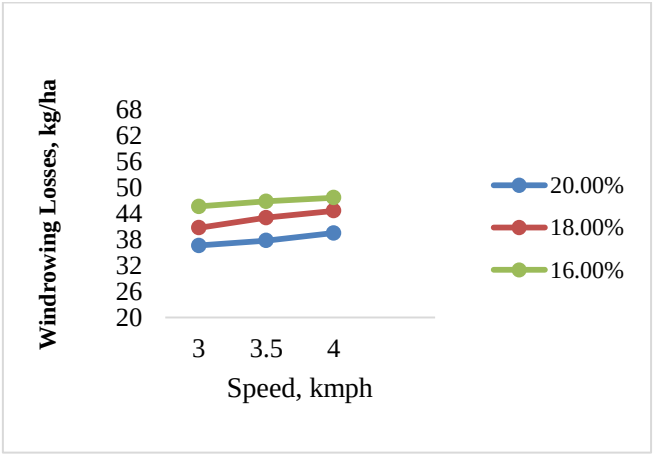

Fig: 3.4 Effect of speed and moisture content on windrowing losses of self-propelled reaper binder

Grain breakage: The amount damaged grain is significantly affected by moisture content and speed of cylinder. Increasing cylinder speed from 600 to 1000 rpm, the grain damage increases twofold. Also grain damage decreased with an increase in crop moisture content.

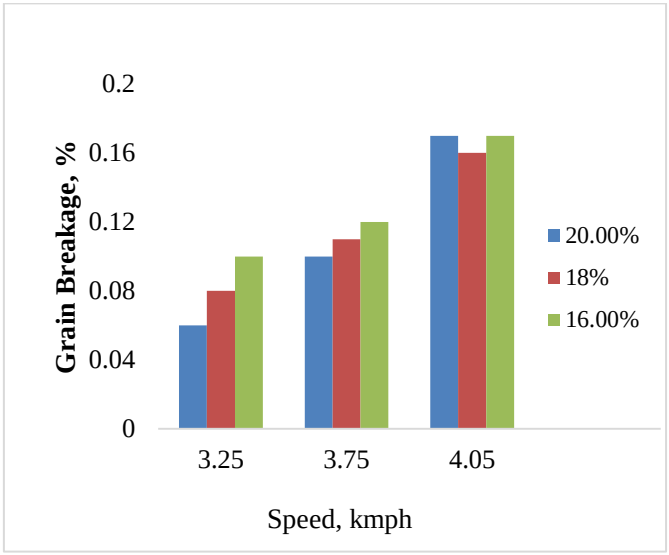

Fig: 3.5 Effect of speed and moisture content on grain breakage of combine harvester

Un-threshed grain: the plants can be calculated in grain loss. All the straw and bhusa is then put through a threshing device, and the grain which is threshed out is weighed to obtain cylinder loss. Un-threshed grains are significantly affected by the threshing method (fig. 3.6).

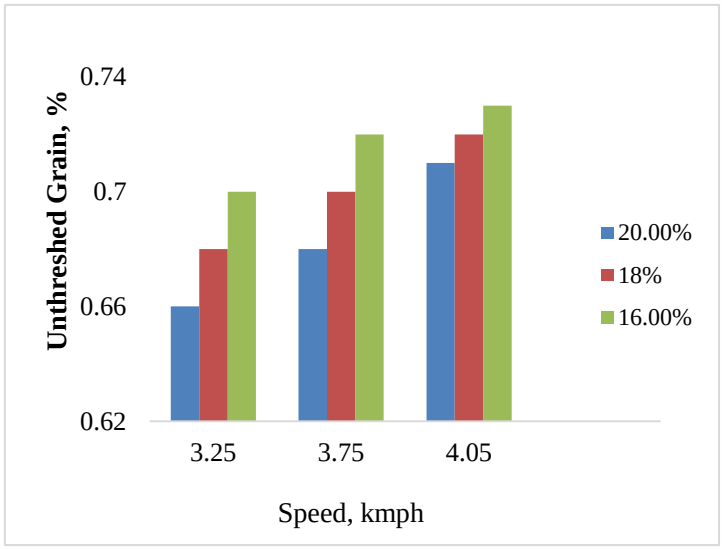

Fig: 3.6 Effect of speed and moisture content on un-threshed grain of combine harvester

Harvesting losses: The total harvesting loss refers to the summation of gathering (cutter bar) loss, threshing/cylinder loss, sieve loss and rack losses. The average values of total harvesting losses are given below. Respectively at different crop moisture content.

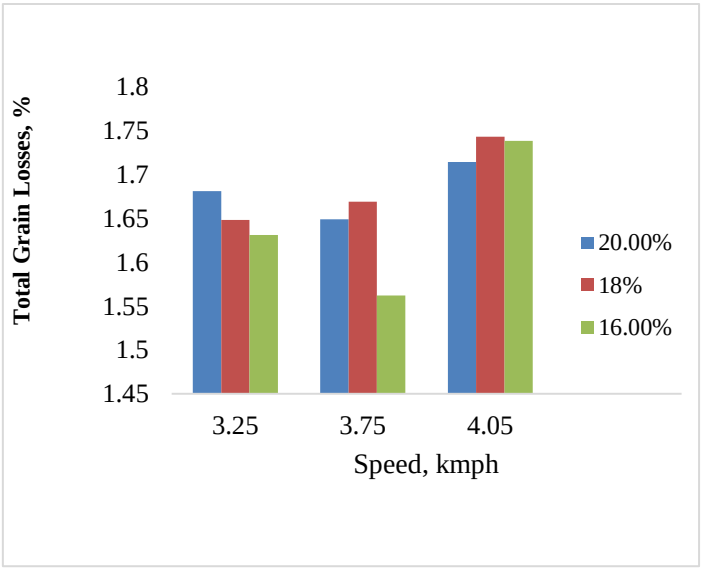

Fig: 3.7 Effect of speed and moisture content on total losses of combine harvester

CONCLUSION

By evaluating the above performance parameters was selected for wheat threshing. It observed that to increase moisture content with increase cylinder loss. Forward speed of the combine harvester also affects and losses of grain were more. Percentage of grain damage increased with high moisture content due to less space between cylinder and concave clearance and with increasing the drum speed. This is because increasing the speed increased frequency of impact between the crop and the threshing members and hence, rubbing of the pods were more severe.

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