J. Agric. Sci. Mansoura Univ., 30 (3): 1481 - 1487, 2005

DEVELOPMENT OF A COMBINED CUTTING UNIT WITH RICE HARVESTING COMBINE MACHINE FOR UTILIZATION IN FIELD WASTE

Abo-Habaga, M.M.[1] and M.O. Khader [2]
1 - Agric. Eng. Dept., Fac. of Agric. Mansoura Univ., Egypt.
2 - Agric. Eng. Res. Inst., El-Dokki, Giza, Egypt.

ABSTRACT

Developed a cutting unit connected with rice harvesting combine machine, received the straw, cutoff and regularity distributed on soil surface to profit it as a source of organic manure direct in soil is the aim of this study.

It is concluded that increasing the cutting speed and decreasing the rice straw moisture content recorded the shortest straw cutting length and suitable cutting straw distribution on the harvesting area. Furthermore, the cutting unit operation increased the fuel consumption not more about 4% than the fuel consumption of rice harvesting combine machine.

INTRODUCTION

Crop residues are one of the most critical problems in Egypt. The Egyptian farmer burn yearly about 4 million tons of rice straw for vacating the field to prepare the seedbed for next crop (El-Berry et al., 2001). Recycling of crop residues and profit it in many different field such as forage production, organic manure (composite) and raw material for nontraditional energy production is required transport the residues crop from field to production place. According to the small economical value of rice straw moreover high cost of assembling and transport especially after mechanically harvesting, the farmer choose the easy, inexpensive and rapid method through the uncontrolled burning for disposition it and save enough time to prepare the seedbed for the next crops, regardless of environmental pollution resulting from straw burning. Therefore, the chopping of rice straw is an important process to increase use of field wastes efficiently either as fodder, buried or fertilizes the soil. Abdel-Maksoud et al. (1998) reported that the successful chopping reduces the length of straw avoiding long pieces of material fouling on cultivation and sowing implement. Arif (1999) reported that the cut length of residual depends on the feeding drum, speed, moisture content and knives clearance. Abdel Maksoud et al. (1994) carried out experiments on cassava milling machine using clearances between the movable and fixed knives of 1, 1.5, and 2.5 mm. They found that the minimum energy required to produce a unit weight was at 1 mm. Badr (1997) observed that increasing the clearance between the fixed knife and movable knives the cutting length values of all chopped materials increased. He reported that the optimum clearance helps in obtaining the recommended cutting length was 1mm in case of using rice straw. El-Iraqi and El-Khawaga (2002) designed and tested a cutting machine for some field crop residues. They reported that the maximum percentages in cutting rice straw length of less than 5 cm of 87.8% were obtained at cutting speed 10.09 m/s, feeding rate 0.771 ton/h and knife clearance 1.5 mm. Khider (2004) reported that the suitable cutting speed for rice straw was 12.65 m/s at different straw moisture content.

The main objective of this study is to develop and test a manufacture cutting unit, which may be connected with rice harvesting combine machine, received the straw, cutoff and regularity distributed on soil surface to profit it as a source of organic manure direct in soil.

MATERIALS AND METHODS

Cutting unit:

The design of Abo-Habaga (2002) was considered in this work. Where the fixed knifes were added to work along with the rotary knifes. After modification the new designed unit as shown in fig. 1. Rotary motion transmitted from combine machine to main shaft in cutting unit by V-belt and pulleys. The motion transported from the main shaft to second shaft by two equal spur gears.

Rice harvesting combine machine:

The cutting unit was mounted at a Kubota combine machine (Model R2 481 UE, Reaping width 145 cm, Engine diesel 48 HP) for using in this experiment.

Experimental site:

The experiment was carried out in two successive seasons (summer 2002 and summer 2003) on private farm at Koom Elderby village- Mansoura-Dakahlia Governorate. The experimental area (about one feddan) was divided into two plots according to straw moisture content. Each plot was divided into three subplots, in accordance with the cutting speed as shown in fig. 2. Cutting unit was examined at two harvesting times of 21 and 25 days after last irrigation, whereas the straw moisture content was M1 (49%) and M2 (42%) respectively.

Cutting speed:

The experiment carried out with a fixed combine motor speed (2700 r.p.m.), whereas, the cutting unit used three different speed (S1 "12.65 m/s - 1612 r.p.m.", S2 "11.43 m/s – 1456 r.p.m." and S3 "9.15 m/s- 1165 r.p.m."). The rotary speed of the main cutting shaft was measured by using a smith tachometer. This tachometer is suitable to measure rotary speeds up to 50000 r.p.m. with 2, 20 and 200 r.p.m. accuracy for 0:500, 0:5000 and 0:50000 r.p.m. speed ranges respectively.

The length of cutting straw:

The length of cutting straw was measured with meter. The cutting straw sample was accumulated in sack during harvesting. The samples were taken randomly from three different places in each treatment. Four working divisions were taken (< 5, 5 -10, 10 -15, > 15 cm). Weight of each division was found and percent of each of them was calculated to the total weight of sample

Distribution of the cutting straw:

Distribution of cutting straw was determined by using a frame, its inside dimension was 130 × 45 cm. It was divided into five parts. The frame was sited randomly of the cutting straw after harvesting in the perpendicularly direction of harvesting. Straw collected in each part and weighted. Distribution of cutting straw was expressed as a percentage of total straw weight of sample. The average of three repetitions was taken for each treatment as the percentage of the straw distribution.

Fuel consumption

Fuel consumption was determined for each cutting speed as follows: The fuel tank filled completely and the time in hours required for each subplot was measured. After this, the fuel tank was refilled using a graduated glass.
The rate of fuel consumption (RFC) was calculated using the following formula:

$$RFC = \frac{\text{Volume of measured fuel, } \mathbf{L}}{\text{Operating time, } \mathbf{h}} \quad \mathbf{(L/\ h)}$$

RESULTS AND DISCUSSION

Length of cutting straw

The length of cutting straw affected by cutting speed (S) and straw moisture content (M). The results in fig. 3 showed the effect of cutting speed on the length of cutting straw. At straw moisture content M1, recorded cutting speed S1 about 27% from straw length < 5 cm, while straw length between 5–15 cm was about 54% and straw length >15 cm was about 19%, mostly this parts were the upper end of plant. And the main straw cutting length was 8.18 cm. Whereas, S2 and S3 recorded straw cutting length about 24, 51, 25 and 22, 49, 29%, with main straw cutting length about 10.98 and 11.78 cm respectivily. But decreasing the straw moisture content into M2 recorded increasing on percentage of small cutting straw. Using S1 recorded 45, 41, 14% of straw length < 5, between 5–15 and >15 cm with 8.18 cm main straw cutting length respectivily. Whereas, S2 and S3 recorded straw cutting length about 41, 41, 18 and 37, 41, 22%, with main straw cutting length about 9.14 and 10.66 cm respectivily.

From the above results, it may be noted that the cutting speed {S1"12.65 m/s -1612 r.p.m."} considered the suitable cutting speed at different straw moisture content to obtained the highest percentage of shortest cutting straw < 15 cm. length.

Cutting straw distribution

The obtained results (fig. 4) indicated that the cutting straw distribution on the soil surface dependent on the straw moisture content and the place of the cutting feed.

At M1 straw moisture content, the obtained results showed that more than 72% from the total cutting straw was found at parts number 3 and 4, whereas the straw percentage at part 2 was 21% and the rest of cutting straw was accumulated in part number 5, while part number 1 was empty from the cutting straw. While, the experimental data at M2 straw moisture content recorded more than 65% from the total cutting straw was found at parts number 3 and 4, whereas the amount of cutting straw at part number 2 was 16% only. The rest of cutting straw divided between parts 1 and 5, with remark that the straw at part number 5 had about 70% more than the straw at part 1.

The above results indicated that the cutting straw distributed irregular at the total harvested width. The reason is to be found in the center of feeding distance is existed at 10 cm right lateral from the cutting machine middle.

Fuel consumption

The feul consumption of rice harvesting combine machine was measured with constant Motor speed 2700 (r.p.m.), cutting speed S1, S2, S3, machine forward speed about 0.9 and 0.75 m/s at straw moisture content M1 and M2 respectevelly.

Results in fig. 5 recorded that the combine machine need about 2.5 L/h to operation without loading (no harvesting). Whereas, the fuel consumption of combine machine during harvesting was about 4.8 L/h. This resulted was obtained during harvesting at different straw moisture contents.
Using the straw cutting unit recorded very small increasing of fuel consumption. The experimental results recorded that the fuel consumption of combine machine and straw cutting unit was about 5 L/h at operation with different straw moisture content and also different cutting speed.

The results indicated that the using of cutting straw unit had very low effect of the feul consumpition at different cutting speed and straw moisture content. Increasing of straw miosture content increased the actual time for harvesting of unit area. Therefore, The experimental data at M1 recorded increasing of feul consumption about 33% more than the feul consumption at M2 under different cutting speed.

REFFERENCES

Abdel Maksoud ,S .E., El-Shal, M. S. and U. A. Khalil, 1994: "Astudy on developing the machine of cassava tubers preparation". Misr J. Ag. Eng, 11 (1): 89-102.

Abdel Maksoud. S. E. ; Moussa A. L. and A. A. Ibrahim, 1998: "Energy requirement for a locally manufactured combine straw chopper". 1st Conf. on Rationalization of Energy in Agriculture. Agric. Mech. Dept., Faculty of Agric., Mansoura Univ.: 256-266.

Abo-Habaga, M., 2002:"Development of mechanical system for cutting rice straw and utilized it as organic manure in soil". Symposium "role of Agric. Eng. in the profit of Agric. residue and preservational Environment", Agric. Eng. Dept., Fac. of Agric., Mansoura Univ.: 11-14.

Arif, E. M., 1999: "Development and performance of a shredder machine for composting" Ph. D. Thesis, Agric. Mech. Dept., Fac. of Agric. Ain Shams Univ. : 45-79.

Badr, S., 1997: "Development of simple chopping system using the field wastes in small farms". Ph. D. thesis, Zagazig university. P (5-20) and p (56 – 76) .

El-Berry A. M.; Baiomy A.; Radwan H.A. and E. M. Arif, 2001: "Evaluation of (Hematol) machine in rice straw chopping". 9th conference of Misr Society of Agr. Eng., 9-11 September 2001. : 65-76.

El-Iraqi, M. and S. El Khawaga, 2002: "Design and test performance of cutting machine for some crop residues". Symposium "role of Agric. Eng. in the profit of Agric, Residue and preservational Environment", Agric. Eng. Dept., Fac. of Agric., Mansoura Univ.: 108-121.

Khider, M. O., 2004: "Development and performance of a shredder machine for composting" M. Sc. Thesis, Agric. Eng. Dept., Fac. of Agric., Mansoura Univ.: 45-79.

تطوير وحدة ملحقة بماكينة حصاد الأرز المركبة للاستفادة من بقايا المحصول

مصطفى محمد أبوحباجة[1] – محمد عمر خضر[2]
١ - قسم الهندسة الزراعية - كلية الزراعة - جامعة المنصورة – ج.م.ع.
٢ - معهد بحوث الهندسة الزراعية - وزارة الزراعة - الجيزة - ج.م.ع.

يعتبر محصول الأرز من المحاصيل الهامة في مصر، وتبلغ كمية المخلفات الناتجة عنه حوالي أربعة ملايين طن سنويا **(البري وآخرون- ٢٠٠١)**، حيث يتراكم هذا الكم من المخلفات داخل الحقل، مما يمثل أكبر المشاكل التي يعاني منها المزارع عند إخلاءه للحقل بغرض إعداده وتجهيزه للمحصول التالي. وتعتبر عملية حرق مخلفات محصول الأرز من أبسط واسهل الطرق المتبعة لدى المزارعين في التخلص من قش الأرز.

يمكن استخدام قش الأرز في العديد من المجالات المختلفة مثل إنتاج الأعلاف، تصنيع الأسمدة العضوية "كومبوست"، صناعة الورق بالإضافة إلى استخدامه كمادة خام في إنتاج الطاقة الغير تقليدية. ويراعى إنه في جميع هذه المجالات تتطلب تجميعه ونقله إلى مكان محدد لإمكانية استخدامها في المجالات المختلفة السابقة، وهذا يمثل المشكلة الكبرى التي يعاني منها المزارع حيث أن تكلفة تجميعه تفوق بكثير قيمة العائد منه. لذا فإن عملية الحرق تعتبر الأيسر والأبسط التي يختارها المزارع للتخلص من مخلفات محصول الأرز وإخلاء الحقل لإعداده وتجهيزه للمحصول التالي.

وللاستفادة من قش الأرز كسماد عضوي في الحقل مباشرة وبدون تكلفة لنقله وعدم تبوير جزء من الأرض كما في طريقة (الكومبوست) واستغلال المساحة كلها في الزراعة وبأقل تكاليف ممكنة، يلزم إضافة وحدة لتقطيع القش تثبت في نهاية الكومباين، حيث تستقبل القش الناتج من الحصاد وتقوم بتقطيعه وتوزيعه على المساحة المحصودة بالكامل حتى يسهل خلطه بالتربة عن طريق استخدام آلات إعداد مرقد البذرة للزراعة والتي تقوم بخلط قش الأرز بالتربة خلال عملية تجهيزها للزراعة.

تم تطوير وحدة لتقطيع القش وتجربتها في موسمين زراعيين متتاليين لمحصول الأرز (الموسم الصيفي ٢٠٠٢والموسم الصيفي ٢٠٠٣) في مزرعة خاصة بقرية كوم الدربي–المنصورة – محافظة الدقهلية. وتم دراسة عدة عوامل مؤثرة في عملية التقطيع منها ثلاث سرعات مختلفة لسكينة القطع (S3, S2, S1)، ودرجتين لرطوبة قش الأرز (M1, M2) وتأثير ذلك على طول القطع ودرجة توزيعه على مساحة الحصاد بالإضافة إلى معدل الزيادة في استهلاك الوقود الناجم عن إضافة وحدة القطع لماكينة الحصاد.

وقد تم التوصل لعدة نتائج يمكن تلخيصها كما يلـي:

١- زيادة سرعة سكينة القطع مع نقص متوسط المحتوى الرطوبى لقش الأرز تؤدي إلى نقص أطوال أجزاء القش الناتج عن عملية القطع. سجلت النتائج أن متوسط طول القش الناتج عن القطع عند درجة رطوبة M2 كانت ٨,١٨، ٩,١٤، ١٠,٦٦ سم، بينما بلغ طول القش الناتج عن القطع عند درجة رطوبة M1 كانت ٩,٨٤، ١٠,٩٨، ١١,٧٨ سم عند سرعات القطع (S3, S2, S1) على التوالي.

٢- توزيع القش الناتج عن التقطيع غير متساوي على جميع أجزاء منطقة الحصاد، حيث بلغ ما يزيد عن ٨١% من القش الناتج في ٦٠% فقط من عرض الحصاد الكلي والباقي تم توزيعه على الجزء المتبقي بصورة غير منتظمة أيضاً وذلك عند رطوبة M2، مع ملاحظة أن النسبة الأعلى في الاتجاه الأيمن من الآلة ويرجع السبب في ذلك إلى أن نقطة استقبال القش في وحدة القطع تنحرف عن منتصف الآلة قليلا بمسافة تقدر بحوالي ١٠ سم في الاتجاه الأيمن. أما في حالة الرطوبة M1 ازدادت نسبة القش الموزع في ٦٠% من عرض الحصاد، حيث بلغت ٩٣% والباقي تواجد في الـ ٢٠% الممثلة في الطرف الأيمن من الآلة، في حين الطرف الأيسر لا يوجد به أي أجزاء من القش المقطع.

٣- استخدام وحدة التقطيع المطورة والملحقة بماكينة حصاد الأرز المركبة، يترتب عليها زيادة قليلة جدا في كمية الوقود المستهلك لتشغيل الكومباين بمفردة أثناء عملية الحصاد عند جميع سرعات القطع المستخدمة، حيث زادت كمية الوقود بعد تشغيل وحدة القطع بمقدار ٤,٢% فقط عن كمية الوقود المستهلكة في عملية الحصاد فقط.

٤- زيادة نسبة متوسط المحتوى الرطوبى لقش الأرز لا يترتب عنها زيادة في كمية الوقود المستهلك، بينما ترتب عنها زيادة الزمن اللازم للحصاد وبالتالي فإن زيادة رطوبة قش الأرز يترتب عليها زيادة في معدل استهلاك الوقود بالنسبة لوحدة المساحة فقط.

جميع النتائج المتحصل عليها تؤكد أن وحدة قطع القش الملحقة بماكينة حصاد الأرز المركبة مناسبة جدا للتخلص من قش الأرز وتجهيزه للاستفادة منه كسماد عضوي مباشرة في الأرض بدون أي تكاليف إضافية، علاوة على منع التلوث البيئي الناجم عن حرق قش الأرز والمحافظة على بيئة خالية من التلوث.