

# The Base Cutter of Sugarcane Harvesters: Characteristics, Importance, Problems and Conditioning Factors



<https://cu-id.com/2177/v32n1e08>

## El cortador base de las cosechadoras cañeras: características, importancia, problemáticas y condicionantes

✉Leandro Verdecia-Moya<sup>1\*</sup>, ✉Roberto Andrés Estrada-Cingualbares<sup>II</sup>, ✉Héctor Calzadilla-Dubrás<sup>I</sup>,  
✉Juan Rafael Pérez-Pupo<sup>III</sup>, ✉Carlos Manuel Ricardo-Aballes<sup>I</sup>

<sup>1</sup>Centro de Desarrollo de la Maquinaria Agrícola (CEDEMA). Holguín, Cuba.

<sup>II</sup>Universidad de Holguín, Facultad de Mecánica, Centro de estudios CAD/CAM, Holguín, Cuba.

<sup>III</sup>Escuela Superior Politécnica de Chimborazo (ESPOCH), Facultad de Mecánica, Escuela de Ingeniería Industrial, Ecuador.

**ABSTRACT:** A review of specialized literature has been carried out to determine the main characteristics and importance of the base cutter of sugarcane harvesters. This mechanism is of vital importance for the correct cutting of the cane, hence developing an efficient base cutter and finding a reasonable base-cutting mode is key to successful mechanical harvesting. Various kinematic and construction parameters, such as cutting speed, oblique blade angle, cutting disc pitch angle and blade shape, influence the performance of base cutters. As a result of the investigation, the insufficient number of investigations focused on the impact cutting systems receive from dissimilar objects found in the ground was verified. On the other hand, abrasive wear is the main phenomenon that threatens the durability of the cutting segment, as well as the morphological and physiological characteristics of the cane, the correct preparation of the soils, the damages caused by the bad manipulation of the mechanism in the cutting process and the working speed.

**Keywords:** Sugarcane Harvester, Base Cutter, Mechanized Cut.

**RESUMEN:** Se ha realizado la revisión de literatura especializada para determinar cuáles son las principales características e importancia del cortador base de las cosechadoras cañeras. Este mecanismo es de vital importancia para el correcto corte de la caña, de ahí que desarrollar un cortador base eficiente y buscar un modo de corte base razonable es clave para una cosecha mecánica exitosa. Varios parámetros cinemáticos y de construcción, como la velocidad de corte, el ángulo oblicuo de la hoja, el ángulo de inclinación del disco de corte y la forma de la hoja, influyen en el rendimiento de los cortadores base. Como resultado de la investigación se constató el insuficiente número de investigaciones enfocadas al impacto que reciben los sistemas de corte por disímiles objetos encontrados en el terreno; por otra parte, el desgaste abrasivo es el principal fenómeno que atenta contra la durabilidad de los segmentos de corte, así como las características morfológicas y fisiológicas de la caña, la correcta preparación de los suelos, los daños causados por la mala manipulación del mecanismo en el proceso de corte y la velocidad de trabajo.

**Palabras clave:** Cosechadora de caña de azúcar, cortador base, corte mecanizado.

## INTRODUCTION

Sugarcane is native to New Guinea and spread to China, North Africa, Spain, North and South America in the 7th and 8th centuries (Fischer *et al.*, 2008). According to the World Crop and Livestock Statistics

published by the Food and Agriculture Organization (FAO), the global area under sugarcane cultivation increased from 6.3 million hectares in 1950 to 26.5 million hectares in 2020 (FAOSTAT, 2022).

Author for correspondence, Ing. Leandro Verdecia-Moya, e-mail: [verdecia@cedema.co.cu](mailto:verdecia@cedema.co.cu)

Received: 20/07/2022

Accepted: 09/12/2022

Before the advent of mechanized harvesting, sugarcane was harvested manually, this conventional harvesting operation is still maintained on a large scale in developing and underdeveloped countries around the world. However, the technological and industrial impact of sugar processes has been significant for each of the producing countries and that is that current sugarcane harvesters are made up of various mechanisms capable of making all these processes more efficient and economical. Within these processes is the base-cutting system, which is in charge of guaranteeing the quality of the cane cut.

The base-cutting systems of these harvesters (Figure 1) use a rotary double disc cutter, which, in the same action of cutting the base of the cane rushes by impact, helps the process of feeding and sweeping the ground, collecting the fallen reeds and incorporating them into the harvest process. In addition, modern base cutters usually have five blades per disc, although they are also available with six grooves which are preferable for high working speeds (Australia, 2014).

Manufacturers also supply discs with different diameters and blade fixing angles, either to increase or decrease the gap between them. This can help in the rejection of foreign matter from the productive flow.

Although researchers have put a lot of effort into optimizing the cutting process, the ideal arrangement for the base-cutting mechanism is still debated. (Toledo *et al.*, 2013).

## MATERIAL AND METHOD

The information was obtained by reviewing both, printed and digital specialized bibliography, in which the characteristics, importance, problems and conditions of the base-cutting system of sugarcane harvesters were described. Subsequently, the information obtained was compiled which allowed knowing optimal speed and angle values for the cane cut and what these parameters bring to its quality. Factors and conditions to be evaluated in the field for carrying out an efficient cane cut are also described, in addition to the losses caused by the bad operation of this mechanism.

## RESULT AND DISCUSSION

### Base Cutter Dynamics

Although the base cutter is a mechanically simple system, the interactions that occur during the cane cutting process are complex, depending on the cutting speed, the cutting angle, the cutting height, among others (Figure 2).

### Cutting Speed

According to Remus (1999), when the cutting speed is low, the tearing and breaking of the stem occurs;

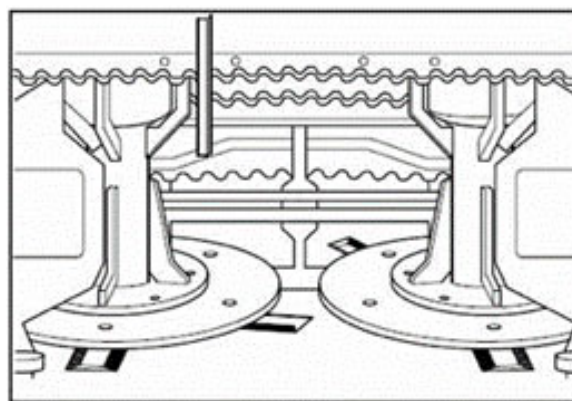


FIGURE 1. Base-cutting box, the most common (CASE IH).

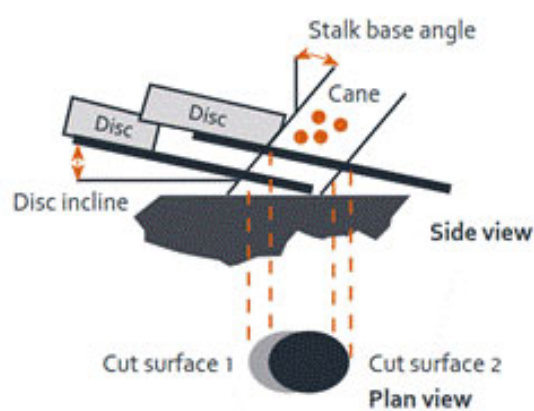


FIGURE 2. Inclination of the disc and angle of the stem base. Taken from Australia (2014).

with the increase in speed, the cut is obtained without tearing and without breaking, thus reducing the forces of resistance to cutting.

In addition, according to Australia (2014) to maintain optimum quality of cut and new growth (the shoot of the new sugarcane plant), the revolutions per minute (rpm) of the base cutter must be variable to match the forward speed of the combine. Base cutters typically have a fixed rotational speed of between 580 and 650 rpm, depending on the year and model of the machine.

Therefore, for a given forward speed and high base-cutter rpm, the blades will repetitively cut the cane stems, thus causing a considerable increase in wear on the segments. Otherwise, when the base-cutter rpm are too low for the forward speed, they produce the reduction of the shoot when tearing the stem and the increase of the soil supply during the harvest (Australia, 2014).

In addition, according to Ke *et al.* (2018), the orthogonal test carried out in their research showed that the optimal cutting depth was 40 mm, the rotation speed of the disc was 600 rpm and the forward speed of the combine was 0.6 m/s.

### Angle of Inclination of the Base-Cutter Disc

Inadequate positions of the cutting angles cause poor quality in the action of cutting the cane and high values of soil added in the process, in addition to the damage that it causes to the crop, therefore, it is advisable to adapt the cutting angle to a position as suitable as possible, even if it implies additional work.

The cutting angles of the base cutter must correspond to the special conditions of the field, since no crop is totally uniform (Rizo, 2018), (Figure 3). In addition, according to Australia (2014), base cutters are angled forward from 11° to 17° for easy end-first feeding. This minimizes the drag of the discs on the cut stubble.

### Cut Quality

The quality of the cut in stems and plants is of vital importance to reduce cane losses (juice) and to avoid the possibility of reducing shoots. Therefore, a good cane cut must produce a cut surface with a minimum of cracks, managing to reduce the cutting force and energy consumption. The researchers conducted a series of studies on how the dynamic and geometric parameters of the system affect cut quality. (Ma et al., 2014).

Gupta and Oduori (1992) studied the effect of the cutting speed of the blade on the quality of the cut through a series of laboratory tests, where they found that the base cutter would uproot the stem of the cane from the root instead of cutting it if the cutting speed is less than 13.8 m/s.

Later, Liu, Ou, Qing and Song (2007) conducted similar cutting tests in the laboratory and also concluded that there is a minimum speed requirement for good cut quality. The estimated threshold value in this investigation was 22.0 m/s compared to 13.8 m/s from Gupta and Oduori (1992). In the study by Gupta and Oduori (1992), it should be noted that the oblique angle and the established angle of inclination were 35° and 27°, respectively, according to the results of the first stage tests, while, in the study from Liu, Ou, Qing and Song (2007), the oblique angle and tilt angle were 0° and 8°, respectively.

There are other parameters of the cutting system that affect the quality of the cut. Liu, Ou, Qing and Wang (2007) carried out a series of tests to analyse the sensitivity of the quality of the stem cut. Sensitivity analysis showed that blade cutting speed has the most significant impact on stubble cut quality.

Liu, Ou, Qing and Shixing (2007) compared the rates of stem damage caused by single-blade and double-blade cutting, concluding that the two-blade cutting process has a lower stubble damage rate than single-blade cutting. The reason is that the maximum cutting force required during single-blade cutting is higher than the maximum cutting force required

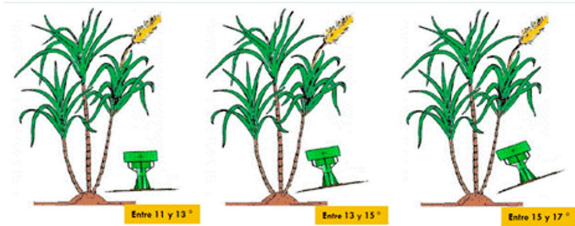


FIGURE 3. Recommended magnitudes of the angles. Taken from (Rizo, 2018)

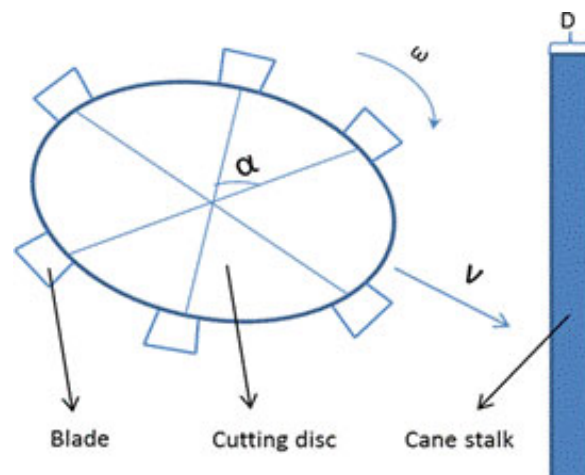


FIGURE 4. Diagram of the cane cutting process:  $\alpha$  = angle between two adjacent blades;  $v$  = forward speed of the machine (m/s);  $\omega$  = cutting disc rotation speed (rad/s);  $D$  = diameter of the cane (m). Taken from Ma et al. (2014).

during two-blade cutting, so single-blade cutting has a higher probability of failure during the stem cutting.

To improve the quality of the stem cut, the study suggested increasing the ratio between the speed of rotation of the cutting disc and the forward speed of the machine. Figure 4 shows the process of cutting the cane stalk using a rotating-cutting disc. Equation 1 is used to determine the ratio ( $R$ ) of the cane stem diameter ( $D$ ) to the distance of two adjacent blade tips in the direction the machine is moving. When  $R < 1$ , the cane stem is cut with only one blade. When  $R > 1$ , the cane stalk is cut by two or more adjacent blades (Liu, Ou, Qing, & Shixing, 2007). Since the diameter of the cane stem ( $D$ ) and the angle ( $\alpha$ ) are constant, the relationship ( $r$ ) between the rotation speed of the cutting disc ( $\omega$ ) and the forward speed of the machine ( $v$ ) determines whether it will be cut with one blade or multiple blades.

$$R = \frac{D}{v\alpha/\omega} = \frac{D\omega}{v\alpha} \quad (1)$$

Like the cutting force, the shape of the segment is also an important factor affecting the quality of the cane cut. Mello and Harris (2000) compared the performance of jagged-edged and smooth-edged cut segments in terms of sugar loss and stem damage.

Although the jagged segments had a better cut quality than the smooth ones, sugar losses were higher due to the roughness of the jagged segment surface. To minimize the negative effect on sugar loss, [Mello and Harris \(2000\)](#) suggested that serrated blades could be made curved to add some level of cut to the impact cutting process of straight jagged blades.

### Factors to Consider in the Evaluation of the Base Cutting

The main factors that must be considered for the evaluation in the base cutting are: soil preparation, cane typologies, damages and impurities occurred during the cut, work speed, automation and control of the base cutting.

### Influence of the Soil Preparation and Planting System

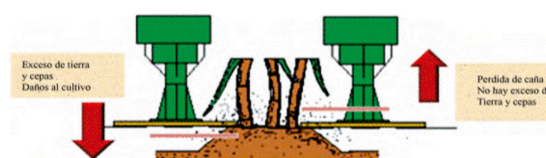
Soil preparation and planting system appears as one of the most important aspects in relation to the base cutting in sugarcane harvesters. As the unevenness, the holes, the presence of obstacles such as stones and stumps in the area increase, the difficulties of operating the harvesters also increase ([Volpato, 2001](#)).

The sugarcane is planted in furrows, at an average depth of 30 cm, which normally makes it difficult to operate the cutting and feeding mechanism of the harvester, due to the irregularities of the soil ([Magalhães & Braunbeck, 1998](#)). When the cane is inside the furrow, there is no chance of the machine cutting to the desired height near shoot level; it causes internode tearing instead of shearing, which would be expected. This situation generates an inhomogeneous cut, leaving a high and fragmented stump, increasing losses in the field and the probability of attack by insects and diseases on the shoot, in addition to incorporating soil into the harvested raw material ([Cannavam & Ripoli, 2002](#)).

Level planting can be a solution, since it leaves the soil surface practically uniform, without undulations. These conditions facilitate the use of the harvester, the machine can develop higher speed and the blades suffer less wear, generating uniformity in the cutting height of the stems and less waste of the base parts richer in sucrose ([Furlani- Neto, 2000](#)). However, one of the main problems of level planting is related to the agronomic aspects involved with water retention in the furrow, which is why its use is not adopted in all producing regions ([Salvi, 2006](#)).

### Influence of Sugarcane Characteristics

The morphological and physiological characteristics of the varieties interfere in the mechanical cutting of sugarcane. In principle, combines work best with upright, vigorous canes with a deep root system. The vertical canes facilitate cutting, from the base and the upper part, which results in a gain in the work capacity



**FIGURE 5.** Influence of the basecutter on the incorporation of soil and the destruction of the crop.

Taken from ([Pérez-Reyes et al., 2022](#))

of the machine, since the harvest is carried out without major interruptions ([Cannavam & Ripoli, 2002](#)). Canes must have a deep root system since mechanical cutting results in the action of rotating blades and requires some support resistance from the stems for adequate shearing to occur. If the cane has a shallow root system and is not vigorous, an imperfect cut or a torn cut can occur, destroying that internode ([Salvi, 2006](#)).

### Losses Due to the Base Cutting

The base cutter is one of the main systems of the sugarcane harvester. The quantity and quality of the cane that goes to the mill depends to a large extent on its efficiency. Anything that is contaminating material (mainly soil and parts of the plant) that enters the system reduces the grinding capacity and increases sucrose losses in the sugar production stages ([Pérez-Reyes et al., 2022](#)).

According to [COOPERSUCAR \(1989\)](#), there are other ways to classify raw material losses, where they can be categorized as visible or invisible. The designation of visible losses is given by the ease of being detected in the field, represented by whole canes, stems, pieces of cane, stumps and crushed canes lost in the field or attached to the harvester. Invisible losses, on the other hand, are represented by shrapnel and stem fragments that break off during the cutting action of the mechanism and are thrown on the ground, so it is difficult to quantify this type of loss in the field.

The deficiency in the control of the cutting height of the harvesters ([Figure 5](#)), brings with it the losses in the stems with soil and vines during the cutting operation below the ideal surface and in the opposite case, losses of the raw material due to high cuts are presented ([Cannavam & Ripoli, 2002](#)).

About that, [Furlani-Neto \(1984\)](#) observed sugarcane losses in the stumps left by the height of the base cutter of 1.48 t/ha. Equally, [Cruz \(1976\)](#) found losses of 8 t/ha due to imperfections caused by the base cutter in the mechanized harvest. Also [Ometto \(1994\)](#) presented losses in the form of stumps left by the base cutter when the cut is lifted, these losses reached 1.17% (1.26 t/ha) in burned cane and 1.44% (1.43 t/ha) in cane unburned, out of a total of approximately 5% of the total visible losses. Equally, [González \(2011\)](#) in his study, reflected total visible losses of 2%.

The use of mechanical cutting has some peculiarities related to the machine-plant interactions during the harvest, caused by the disc of the base cutter. The damages can reduce production in the next harvest, by increasing the exposure of the stump to the attack of pests and diseases (stumps that are too high and/or torn), in addition to the destruction or elimination of new shoots responsible for the following sprouting (Kroes & Harris, 1996).

Also, according to Ridgue (1980), the ways to minimize the problem of the presence of soil in the raw material, is nothing more than to make changes in the existing cultural practices in soil preparation, planting, the width between rows, or through changes in the design of the disc of base cutter.

### Characteristics and Importance of the Base-Cutting Mechanism in Sugarcane Harvesting

The base-cutting mechanisms are designed based on two main systems: bar cutting system and rotating-cutting system (Patil & Patil, 2013). The rotary-cutting mechanism with segments is used more frequently, the advantage of this mechanism is the great inertia and impact forces that are exerted while cutting when the discs have a diameter of up to 90 cm, especially when cutting high-tonnage stems (high density), the advantage of using inertia and impact force becomes more prominent. The bar-cutting mechanism is used more for thick stems that have more resistance to cutting (Pérez-Reyes et al., 2022).

Therefore, the base cutter of sugarcane harvesters that is currently used generally consists of two counter-rotating rotating discs (A) that perform the cut with replaceable segments (B) (blades) on each of their discs (Figure 6 and Figure 7), which act with 60% of their contact area (Ma et al., 2014).

The cutting of the sugarcane stalks carried out by the base cutter takes place in highly difficult situations, since the segments, in addition to cutting the cane stalks, frequently come into contact with various obstacles found in the furrow (stones, tree stumps, metal sections), which affects the proper performance of this operation (Volpato, 2001).

### Handling Base-Cutter Segments

Another aspect of great importance is the handling and assembly of the base-cutter segments (Figure 8). This, combined with the inadequate cutting height and an equally inappropriate angulation of the base cutter, is capable of generating foreign matter incorporations, such as dirt and vines, up to 0.5%, in addition to crushing losses of up to 0.6 tons of cane per hectare, which contributes to the accelerated wear of the segments (Pérez et al., 2022).

The segments require regular adjustments and replacements due to the wear they are subjected to, these are available in 4, 5 and 6mm thickness. Soils

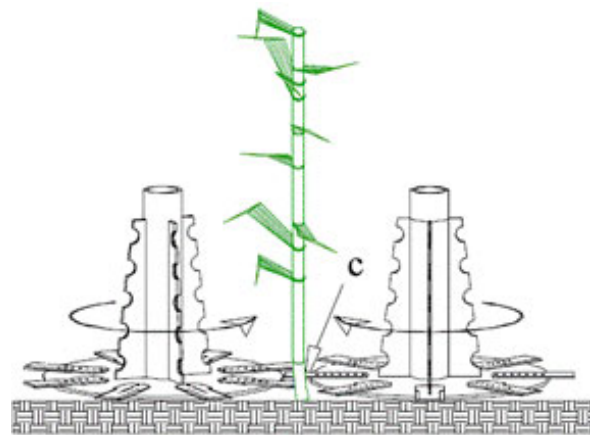


FIGURE 6. Double-disc cutter to make the base cutting and sweeping of the soil in the sugarcane harvest (C-Cutting point). Taken from Braunbeck & Magalhães (2002)



FIGURE 7. John Deere 3522 harvester base cutter. Taken from Ma et al. (2014).



FIGURE 8. Wear on the rounded ends due to improper angulation (do not cut with the tips of the blades). Taken from Rizo (2018)

with medium to high rock levels can bend and/or break segments, increasing operating costs and downtime during harvest season (Australia, 2014).

Several studies have focused on external factors that affect cut quality. [Momin et al. \(2017\)](#) found that the base-cutter blade design ([Figure 9](#)) influenced the quality of sugarcane cutting and provided guidelines for different blade configurations.

According to [Australia \(2014\)](#) in good harvest conditions with an upright crop in a row and dry soil, forward speeds should be limited to 9 km/h, where minimal damage per plant will occur, as long as the cut segments are brand new. To keep plant damage negligible, the combine's ground speed should be reduced to 6 km/h when 25 mm of the blade has been lost. As the segment wears, it not only loses length, but also loses much of its cutting ability and, at some point along the curve of the blade the shank prefers to slip off the edge and tear, instead of being cut ([Figure 10](#)).

### Performance of the Segments in the Cut

[Pérez-Reyes et al. \(2022\)](#), in their research, carried out a simulation with a numerical model for the base cutting of sugarcane from experimental data obtained in five typical cane varieties from Ciego de Ávila Province. They obtained the performance of the BONEM and BUSSOLA base-cutter segments. The validation of the study is carried out from a test of resistance to sugarcane cutting with two types of segments.

The comparison of the power magnitudes obtained at the time of cutting each variety with the results of [Pupo et al. \(2019\)](#), who carried out an evaluation of the loads in the sugarcane harvester under Cuban conditions, determined that the organs with the highest energy consumption are the base-cutter discs with 20.4 kW. The power is determined by the [expression \(2\)](#):

$$Mt = \frac{N}{\omega} \quad (2)$$

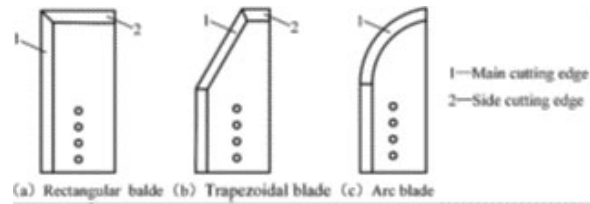
Where:  $Mt$  is the torque transmitted by the base-cutter shaft or shear moment (Nm);  $N$  is the power transmitted by the shaft (W);  $\omega$  is the angular velocity of the shaft (rad/s).

Therefore:

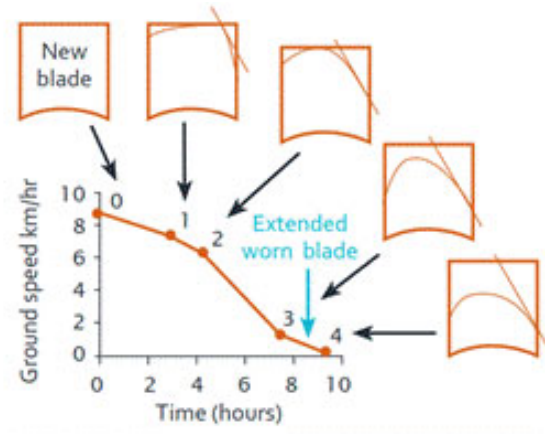
$$N = Mt \times \omega \quad (3)$$

Being the angular velocity of cut ( $\omega$ ) according to [Pupo et al. \(2019\)](#) 65 rad/s for calculation.

[Pérez-Reyes et al. \(2022\)](#), in their research, obtained different power magnitudes that are described in [Table 1](#). There, the behaviour of the BONEM and BUSSOLA segments against the five varieties of sugarcane studied is reflected. It shows that C90-469 variety is the one that presents the greatest magnitudes of effort and reaction force in the stem, which makes that this variety has the greatest influence on the performance of these tools, while varieties C120-78 and C1050-73 present the lowest magnitudes of these parameters and favour the behaviour of the segments.



**FIGURE 9.** Different shapes of segments. Taken from [Qiu et al. \(2021\)](#).



**FIGURE 10.** Base-cutter blade wear and maximum forward speed. Taken from [Australia \(2014\)](#)

### Underground Court

[Zhou et al. \(2015\)](#) found that the depth of cut of the disc has a significant effect on the breakage rate of the stubble. On the other hand, [Qing et al. \(2005\)](#) simplified the sugarcane stem with models of laterally loaded piles, in order to be able to study the behaviour of the internal forces and the deformations of the stems, once the cut is made below ground level. Comparative analysis showed that the internal force and root deformation of the underground base cutting was as much lower than that of the above ground base cutting. Therefore, they concluded that base cutting below ground is an effective way to reduce stubble damage.

According to the study carried out by [Bai et al. \(2020\)](#), the effect of cutting height (distance from the lowest point of the blade to the ground), disc rotation speed and combine ground speed on base-cutter performance is closely related to work parameters of the harvester. Once the base cutting occurs underground, the height of cut becomes negative, so it is called depth of cut in underground mode.

In addition, according to [Bai et al. \(2020\)](#) with fixed disc-rotation speed and fixed combine forward-speed, stubble breakage rate in underground base-cutting mode was reduced by 11.32%→17.38% compared to base-cutting mode above ground, while power consumption increased by 16.24%→23.52%.

**TABLE 1.** Results of the comparison of the power magnitudes obtained from the cutting moment of each variety according to Pérez-Reyes *et al.* (2022)

Variety (sugarcane)	Cutting moment (Nm)	Obtained power (kW)	Difference (%)	Average power (kW)
<b>BONEM</b>				
C86-156	297,52	19,34	5,19	
C90-469	334,734	21,76	6,67	
C93-540	315,731	20,52	0,59	20,4
C120-78	297,154	19,32	5,29	
C1051-73	294,26	19,13	6,23	
<b>BUSSOLA</b>				
C86-156	250,902	16,31	20,05	
C90-469	308,455	20,05	1,72	
C93-540	301,938	19,63	3,77	20,4
C120-78	278,374	18,09	11,32	
C1051-73	277,326	18,03	11,62	

### Automation of the Base-Cutting Control

For Garson (1992), an automation of the base-cutting mechanism of sugarcane harvesters may be a more effective way of reducing the amount of soil present in the supply of cane to the industry. The other advantages of an automated height-control system are lower fuel consumption, greater ease of harvester operation, reduced damage to the base of the cane, as well as lower sucrose losses.

Volpato (2001) developed a linkage support-bar mechanism for a set of base cutters, called the floating base cutter. The mechanism follows the surface of the soil profile based on the interaction force developed at the disc-soil contact point, in order to avoid collecting soil during the harvesting operation.

Ripoli *et al.* (2003) studied the floating base-cutting mechanism of Volpato (2001), comparing it to a regular base cutter, manually controlled at different speeds. According to the results obtained the mechanism, under the conditions carried out by the study, did not present advantages in reducing the presence of soil in the harvested cane.

Also Salvi *et al.* (2005) analysed the use of a semiautomatic base cutter device under the use of operators with different degrees of freedom. The results showed that the skill-experience of the operator influences the cutting height of the cane and the use of the device helped the less experienced operator to obtain an average cutting height within the limit specified by the industry. However, the height of the cut cannot be considered under statistical control and the use of the device did not interfere with the mineral impurity indices, in comparison with the regular, manually controlled base-cutting system.

In addition, at present, there is the presence of different automatic height control systems, such as the so-called AutoTracker used by the CASE Company in all its combine harvester models and the CABI used by John Deere, where they help to reduce losses and damages during harvest.

### CONCLUSIONS

- Current harvesters use a base-cutting mechanism with a rotating disc that performs the cut without support and by impact, where the main factors to consider for the evaluation in the cutting process are correct soil preparation, damage caused by poor handling of the mechanism, the working speed and the application of a basic cutting-control system.
- The influence that the morphological and physiological characteristics of the cane varieties may have interference on the quality of the mechanical cutting of sugarcane. Harvesters work best with upright, vigorous canes.
- Base cutters usually have a fixed rotation speed of between 580 and 650 rpm and are best suited for a forward speed of 7 km/h.
- Abrasive wear is the main phenomenon that threatens the durability of the base cutter segments of sugarcane harvesters.
- The cutting of the sugarcane stalks takes place in highly difficult situations, since the segments, in addition to cutting the cane stalks, frequently come into contact with various obstacles found in the furrow (stones, tree stumps, sections of metal), which greatly affects the proper performance of this operation, as well as the breakage of different elements of the technological system for cutting and transporting the grass in the harvester.

### REFERENCES

- AUSTRALIA, S. R.: Harvesting Best Practice Manual. In *Technical publication MN14001*, 2014 . [www.sugarresearch.com.au](http://www.sugarresearch.com.au)
- BAI, J., MA, S., KE, W., WANG, F., XING, H., MA, J., & GAO, S.: Experimental Research On Sugarcane Under-The-Ground Basecutting. *American Society of Agricultural and Biological Engineers*, 36(3), 331-339, 2020. <https://doi.org/10.13031/aea.13504>

- BRAUNBECK, O. A., & MAGALHÃES, P. S. G.: Seguimento do perfil do solo no corte e/ou levantamento de produtos agrícolas rasteiros. *Revista Brasileira de Engenharia Agrícola e Ambiental*, 6(1), 151-158, 2002.
- CANNAVAM, R. T. C., & RIPOLI, M. L. C.: Biomassa da cana-de-açúcar: colheita, energia e ambiente. 2.ed. Piracicaba, 302, 2002.
- COOPERSUCAR: *Colheita mecanizada de cana picada: avaliação de perdas invisíveis e estilhaços nos sistemas das colhedoras*, 1989.
- CRUZ, E. Z.: Estudio sobre la Cosecha de la Cana de Azúcar. *Distribuidora Venezolana de Azúcares*, 173-181, 1976.
- FAOSTAT: *Sugarcane production in the world: 1950-2020*, 2022 <https://www.fao.org/faostat/es/#data/QCL>
- FISCHER, G., TEIXEIRA, E., HIZSNYIK, E. T., & VELTHUIZEN, H. V.: Chapter 2: Land use dynamics and sugarcane production. In *Sugarcane Ethanol: Contributions to Climate Change Mitigation and the Environment*. Wageningen Academic, 2008. <https://doi.org/10.3920/978-90-8686-652-6>
- FURLANI NETO, V. L.: *Incidência de Matéria Estranha e Perdas no Campo nos processos de corte manual e com Colhedoras Amontoadas em Cana-de Açúcar (Saccharum spp)* [Tesis de Doctorado, Universidade de São Paulo], 1984.
- FURLANI NETO, V. L.: *Sistematização e adequação de áreas e máquinas para colheita mecanizada*, Reunião Agrícola Fermentec, Piracicaba, 2000.
- GARSON, C. A.: Control of harvester base cutter height. *Proceedings of Australian Society of Sugar Cane Technologists*, 1, 156-162, 1992.
- GONZÁLEZ, J. M.: *Evaluación del Corte Basal de la Cosechadora C-4000 con cuchillas de tres filos* [Tesis de Maestría, Universidad de Holguín], 2011.
- GUPTA, C. P., & ODUORI, M. F.: Design of the Revolving Knife-type Sugarcane Basecutter. *Transactions of the ASAE*, 35(6), 1747-1752, 1992. <https://doi.org/10.13031/2013.28793>
- KE, W., MA, S., WANG, F., YANG, G., XING, H., PAN, Y., & GUO, B.: Experimental Research on Sugarcane Under-the-Ground Basecutting. *2018 ASABE Annual International Meeting*, 2018. <https://doi.org/10.13031/aim.201800481>
- KROES, S., & HARRIS, H. D.: Knockdown causes major damage to cane during harvesting. *Proceedings of Australian Society of Sugar Cane Technologists*, 1, 1996.
- LIU, Q., OU, Y., QING, S., & SHIXING, H.: High-speed bphotography analysis on the damage process in cutting sugarcane stalk with smooth-edge blade. *Transactions of the CSAE*, 38(10), 31-35, 2007.
- LIU, Q., OU, Y., QING, S., & SONG, C.: Cutting force test of sugarcane stalk. *Transactions of the CSAE*, 23(7), 90-94, 2007.
- LIU, Q., OU, Y., QING, S., & WANG, W.: Stubble damage of sugarcane stalks in cutting test by smooth-edge blade. *Transactions of the CSAE*, 28(3), 103-107, 2007.
- MA, S., KARKEE, M., SCHARF, P. A., & ZHANG, Q.: Sugarcane Harvester Technology: A Critical Overview. *American Society of Agricultural and Biological Engineers*, 30(5), 727-739, 2014. <https://doi.org/DOI10.13031/aea.30.10696>
- MAGALHÃES, P. S. G., & BRAUNBECK, O. A.: *Ingeniería rural y mecanización agraria en el ámbito latinoamericano*, 1998.
- MELLO, R. D. C., & HARRIS, H.: *Cane damage and mass losses for conventional and serrated basecutter blades* Proceedings of the 2000 Conference of the Australian Society of Sugar Cane Technologists held at Bundaberg, Queensland, Australia, 2000.
- MOMIN, M. A., WEMPE, P. A., GRIFT, T. E., & HANSEN, A. C.: Effects of four base cutter blade designs on sugarcane stem cut quality. *Transactions of the ASABE*, 60(5), 1551-1560, 2017. <https://doi.org/https://doi.org/10.13031/trans.12345>
- OMETTO, M. C.: Desempenho da Colhedora Engeagro. *Revista STAB*, 12(3), 21-24. 1994.
- PATIL, M., & PATIL, P. D.: Optimization of blade angle for cutting system of sugar cane harvester. *International Indexed & Refereed Research Journal*, 42(4), 49-52, 2013.
- PÉREZ-REYES, R. A., DAQUINTA-GRADAILLE, L. A., BONILLA-ROCHA, J. D., RECAREY-MORFA, C. A., SÁNCHEZ-NUMA, A., & GÓMEZ-BRAVO, J. E.: Numerical Model for Sugarcane Base Cutting. *Revista Ciencias Técnicas Agropecuarias*, 31(2), 2022. <https://www.redalyc.org/journal/932/93271464002/93271464002.pdf>
- PÉREZ, R. A. R., DAQUINTA, L. A. G., BONILLA, J. D. R., RECAREY, C. A. M., RODRÍGUEZ, O. H. A., & ÁGUILA, J. G.: Fundamentos, problemática y repercusión del proceso de corte base en la cosecha mecanizada de la caña de azúcar. *Revista Ciencias Técnicas Agropecuarias (Cuba)*, 31(1), 67-78, 2022. <https://www.researchgate.net/publication/359722056>
- PUPO, J. R. P., ALONSO, J. R. S., GUERRERO, J. N. P., & MARIÑO, C. J. S.: Valoración de las Cargas en la Cosechadora de Caña de Azúcar en las Condiciones de Cuba. *European Scientific Journal*, 15(21), 2019. <https://doi.org/10.19044/esj.2019.v15n21p294>



- QING, S., QU, Y., & LIU, Q.: Internal forces and distortions of sugarcane stalks in the condition of soil support. *Journal of Huazhong Agricultural University*, 10, 109-113, 2005.
- QIU, M., MENG, Y., LI, Y., & SHEN, X.: Sugarcane stem cut quality investigated by finite element simulation and experiment. *Biosystems engineering*, 206, 135-149, 2021. <https://doi.org/10.1016/j.biosystemseng.2021.03.013>
- REMUS, J. S.: *Teoría y cálculo de máquinas agrícolas*. Editorial Pueblo y Educación, 1999.
- RIDGUE, D. R.: Minimizing the problem of soil in chopper harvester cane. *Proceedings of International Society of Sugar Cane Technologists*, 2, 315-323, 1980.
- RIPOLI, M. L. C., RIPOLI, T. C. C., & OLIVEIRA, M. A.: Evaluation of two different base cutters in green cane mechanical harvest. ASAE ANNUAL INTERNATIONAL MEETING, Las Vegas, 2003.
- RIZO, L. A. A.: *Optimización de la cosecha mecanizada de caña de azúcar. Apuntes básicos de mejoramiento*. Conferencia Red agrícola, Trujillo, Perú, 2018. <https://www.redagricola.com/pe/assets/uploads/2018/08/1--luis-armando-abadia-optimizacion-de-cosecha-mecanica-de-cana-de-azucar.pdf>
- SALVI, J. V.: *Qualidade do corte de base de colhedoras de cana-de-açúcar* [Tesis de Maestría, Universidade de São Paulo], 2006.
- SALVI, J. V., MILAN, M., SARRIES, G. A., SOUZA, A. B. M., NAGUMO, G. K., & MATOS, M. A.: *Avaliação dos sistemas de corte basal de uma colhedora de cana de açúcar* Congreso Brasileiro de Engenharia Agrícola, Canoas, .
- TOLEDO, A. D., SILVA, R. P. D., & FURLANI, C. E. A.: Quality of cut and basecutter blade configuration for the mechanized harvest of green sugarcane. *Scientia Agricola*, 70, 777-780, 2013. <https://www.scielo.br/j/sa/a/LNNjwPJvDsYnKBvqvWQ9cvS/?format=pdf&lang=en>
- VOLPATO, C. E. S.: *Otimização de um Cortador de Base Flutuante para Seguimento do Perfil de Solo em Colhedoras de Cana-de-Açúcar* [Tesis de doctorado, Universidade Estadual de Campinas]. Campinas, SP, 2001.
- ZHOU, J., ZHU, Y., LI, S., LU, A., HE, Y., XUE, B., & PAN, Y.: Study on the effect of cutting depth of cutter disk on ratoon damage rate. *J. Agric. Mech. Res.*, 2, 186-189, 2015.

Leandro Verdecia Moya. Ing. Mecánico, Especialista, Centro de Desarrollo de la Maquinaria Agrícola (CEDEMA). Holguín, Cuba. e-mail: [lverdecia@cedema.co.cu](mailto:lverdecia@cedema.co.cu).

Roberto Andrés Estrada Cingualbres. Dr.C., Ing. Mecánico, Prof. Titular, Universidad de Holguín (UHo). Facultad de Ingeniería, Centro de Estudios CAD/CAM, Holguín, Cuba, e-mail: [cingualbres2005@gmail.com](mailto:cingualbres2005@gmail.com).

Héctor Calzadilla Dubrás. MSc., Ing. Mecánico, Especialista, Investigador Auxiliar, Centro de Desarrollo de la Maquinaria Agrícola (CEDEMA). Holguín, Cuba, e-mail: [hcal@cedema.co.cu](mailto:hcal@cedema.co.cu).

Juan Rafael Pérez Pupo. Dr.C. Ing. Mecánico, Prof. Titular, Escuela Politécnica Superior del Chimborazo. ESPOCH. Riobamba, Ecuador, e-mail: [perezpupo@gmail.com](mailto:perezpupo@gmail.com).

Carlos Manuel Ricardo Aballes. MSc. Ing. Mecánico, Investigador Agregado, Centro de Desarrollo de la Maquinaria Agrícola (CEDEMA). Holguín, Cuba, e-mail: [cricardo@cedema.co.cu](mailto:cricardo@cedema.co.cu).

The authors of this work declare no conflict of interests.

**AUTHOR CONTRIBUTIONS: Conceptualization:** L. Verdecia., R. A. Estrada, H. Calzadilla, C. M. Ricardo. **Data curation:** L. Verdecia., R. A. Estrada, H. Calzadilla, J. R. Pérez. **Formal analysis:** L. Verdecia., R. A. Estrada, H. Calzadilla, C. M. Ricardo. **Investigation:** L. Verdecia., R. A. Estrada, H. Calzadilla, J. R. Pérez. **Methodology:** L. Verdecia., R. A. Estrada, H. Calzadilla. **Supervision:** C. M. Ricardo. **Validation:** L. Verdecia., R. A. Estrada, H. Calzadilla, J. R. Pérez. **Roles/Writing, original draft:** L. Verdecia., R. A. Estrada, H. Calzadilla, C. M. Ricardo. **Writing, review & editing:** L. Verdecia., R. A. Estrada, H. Calzadilla, J. R. Pérez

This article is under license [Creative Commons Attribution-NonCommercial 4.0 International \(CC BY-NC 4.0\)](https://creativecommons.org/licenses/by-nc/4.0/)

The mention of commercial equipment marks, instruments or specific materials obeys identification purposes, there is not any promotional commitment related to them, neither for the authors nor for the editor.