International Journal of
Science and Engineering Investigations vol. 7, issue 75, April 2018
ISSN: 2251-8843

Evaluation of Losses in Mechanical Corn Harvest under Three Speeds

Taize Calvacante Santana[1], Silvestre Rodrigues[2], Adilson Machado Enes[3], Carlos Fernandes Mariano Nogueira[4], Welington Gonzaga do Vale[5]
[1]Undergraduate Student, Department of Agricultural Engineering, Federal University of Sergipe, S. Cristovão, SE, Brazil
[2,3,5]Assistant Professor, Department of Agricultural Engineering, Federal University of Sergipe, S. Cristovão, SE, Brazil
[4]Undergraduate Student, Department of Mechanical Engineering, Federal University of Sergipe, S. Cristovão, SE, Brazil
([1]taizehaes@gmail.com, [2]silvestrerod@yahoo.com.br, [3]adilsonenes@gmail.com, [4]engmec.mariano@gmail.com, [5]valewg@gmail.com)

Abstract- This work aimed to evaluate the losses in mechanical corn harvesting under three working speeds: 4 km/h, 6 km/h and 8 km/h. To reach this goal, it was used a harvesting machine JUMIL-350 to do tests in an area of 1000 m^2 located in the Rural Campus of the Federal University of Sergipe. Some quality parameters of the harvested grains, such as impurities, moisture and mechanical damages were analyzed. To the mechanical damage analysis, the Biospeckle technique was used in seed analysis. The data obtained in this process showed that the grain most damaging speed was 8km/h. By the other hand, the grain less damaging speed was 6 km/h. The Biospeckle technique presented a viable and effective map in the analysis of biological content in living tissues.

Keywords- *Grain Losses, Mechanical Damage, Mechanical Harvesting*

I. INTRODUCTION

Corn is a cereal of great economic importance and cultivated throughout the world, apart from stands out for its diversity of uses and applications. Above all, corn represents many using ways, from animal feed, to the high technological industry. Maize accounts for about 70% of animal feed in the world.

Some of the foods produced in the world are often lost because of the neglect with which they are treated, occurring throughout all the production chain, from the implantation of the crop to the final consumption [8]. A significant part of the losses occurs during the mechanized harvest, reducing the productivity and profitability of the operation, resulting in losses to the producer, once that this is the final operation in the production process, at which point grain has the highest added value [15].

Harvesting is one of the most important step in any production process of any crop, once that it is a high-cost operation with high energy demanded. The use of machines in maize harvesting has become an advantageous practice, financially viable and profitable practice. Notably, the time spent on the operation was reduced and the quality of the harvested product was improved.

Harvest losses are influenced by factors inherent to the crop and to the harvester [4].

In the mechanized harvest, the working speed of the harvester influences quantity of losses. The ideal working speed is between 5.5 and 6.0 km · h-1. Higher speeds suggest higher corn grain losses.

The direct mechanical harvesting presents significant losses in the collection of material (platform) and the feed rate of the machine and crop conditions at harvest time strongly influences damages in the internal mechanisms of the harvester [16]. It also presents qualitative losses such as: impurities in the harvested grains, mechanical losses and germination failures, important points when it comes to grain harvesting. There is a considerable need to generate parameters to develop machines that minimize the production losses in camp and maximize the economic return of the investors.

This work aimed to evaluate the losses in mechanical corn harvesting under three working speeds: 4 km/h, 6 km/h and 8 km/h. It was executed at the Rural Campus of the Federal University of Sergipe.

II. MATERIAL AND METHODS

The planting was done in an area of 1000 m^2 in soil under no - tillage system. The corn cultivated was a triple hybrid - AG 7088, of early cycle, adapted to several regions of Brazil with the following characteristics according to its supplier: type and color of the medium/orange grain. A Jumil-2670 precision line seeder (Figure 1) was used.

Figure 1. Planting/Personal collection.

Maize was harvested with the Jumil model JM 350 (Figure 2), a single line, known as "little rocket". In order to evaluate losses in the mechanized harvest of maize, after five months of planting the corn grains were harvested by machines under the influence of three working speeds A = 4 km · h-1, B = 6 km · h-1 and C = 8 km · h-1. The determinations for each treatment were made in three steps, with three replications.

The tests were carried out in the 2015/2016 harvest, determining the following evaluations: losses of loose grains and corncob grain losses, being that the sum of both losses will be considered as total losses. Grain quality parameters (moisture content, grain purity and mechanical damages) were evaluated.

Figure 2. Grain harvester Jumil- model JM 350/Personal collection.

To evaluate the losses of loose grains on the ground, we used rectangular frames constructed of wood and twine, both arranged in a transversal direction to the planting of the lines, with a width of crop spacing and length equal to 1m, being positioned behind the harvester The harvester cutting platform will be adjusted to a spacing of 0.80 m between rows. The losses in the operation will be measured by collecting all the grains on the soil inside the frame, soon after the passage of the maize harvested.

Corncob grain losses were determined by collecting all the cobs dropped on the soil by manual harvesting (Figure 3). The results were obtained by weighing the samples. For each speed, samples of five linear meters were collected in three replicates, totaling samples of fifteen linear meters for each speed.

The sum of the losses of loose grains plus corncob grain losses will determine the total losses.

Figure 3. Manual corn grain harvesting /Personal collection.

For the grain quality parameters (grain impurities, grain moisture content and mechanical damage), a sample of the grains harvested by the harvester from each one of the pre-selected speeds was performed and then subdivided for each evaluation.

The evaluation of the impurities in the grains was carried out according to [3]. 900g of the working sample of each treatment was withdrawn, after homogenization.

The relation between the weight of the impurities (g) and the initial weight of the seeds (g) determined the percentage of impurities (Eq. 1). The calculations were based on the following mathematical model:

$$D_1 = \frac{IM}{PI} \times 100 \qquad (1)$$

In which:

D1 = percentage of undue impurities (%)

PI = initial seed weight (g)

IM = weight of impurities (g)

The evaluation of the moisture content of the grains was done in the Department of Agronomic Engineering - UFS in a greenhouse at 105 °C, for 24 hours according to [3].

The mechanical damage analysis was done using the Biospeckle analysis technique, and the image processing was performed in MATLAB and ImageJ software.

III. RESULTS AND DISCUSSIONS

After the harvest, the grain moisture test was performed. The degree of moisture of a sample is represented by the loss of weight through the greenhouse method at 105 °. It is expressed as a percentage of the original sample weight. The test was done according to [3]. The samples collected were separated from the losses and according to the speeds established - 4 km / h, 6 km / h and 8 km / h -, three repetitions were made for each speed. The percentage of moisture was calculated with Eq. 2:

$$\%\text{ of Moisture }\left(\mathrm{U}\right)=\frac{100(P-p)}{P-t} \qquad (2)$$

In which:

P = initial weight, container weight and its lid plus wet seed weight;

p = final weight, container weight and its lid plus dry seed weight;

t = tare weight of the container with its lid.

The average moisture of the replicates of harvested maize is 12.2% and the mean moisture of the replicates of the losses is 11.75%.

The evaluation of impurities was carried out according to [3]. 900g of the sample was removed and then homogenized. The percentage of impurities was determined by (Eq.2).

$$D_1=\frac{54}{846}\times 100=6.38\%$$

The sum of the losses of the loose grains plus corncob grain losses, separated by the speeds tested, determined the total losses.

TABLE I. SOIL AND EAR LOSSES

Grain Losses on Ground (Kg/Ha)	
4 Km/h	1280,5
6 Km/h	2525,0
8 Km/h	2758,0
CORNCOB GRAIN LOSSES (g)	
4 Km/h	9614,4
6 Km/h	12818,6
8 Km/h	19388,1

TABLE II. TOTAL LOSSES

Total Losses = Grain Losses on Ground + Corncob Grain Losses (Kg/Ha)	
4 Km/h	10894,9
6 Km/h	15343,6
8 Km/h	22146,1

According to the results, it was clear that at all working speeds there were grain losses, but the most significant losses occurred when the harvester worked at 8 km / h. Working speed is one of the main factors that cause losses during grain harvest, however it is necessary to emphasize that other factors also influences this account, such as the unequipment of planted area, setting of the harvester, speed of the fan among others. For the experiment, the fan speed was kept constant so as not to influence the results, thus preventing the operator from altering it in order to avoid greater losses.

Regarding mechanical damages after image processing in the MATLAB and ImageJ software, we obtained the following bioactivity maps of maize grains harvested at the three speeds tested, Figure 4 a) 4 Km/h; b) 6 Km/h e 8 Km/h .

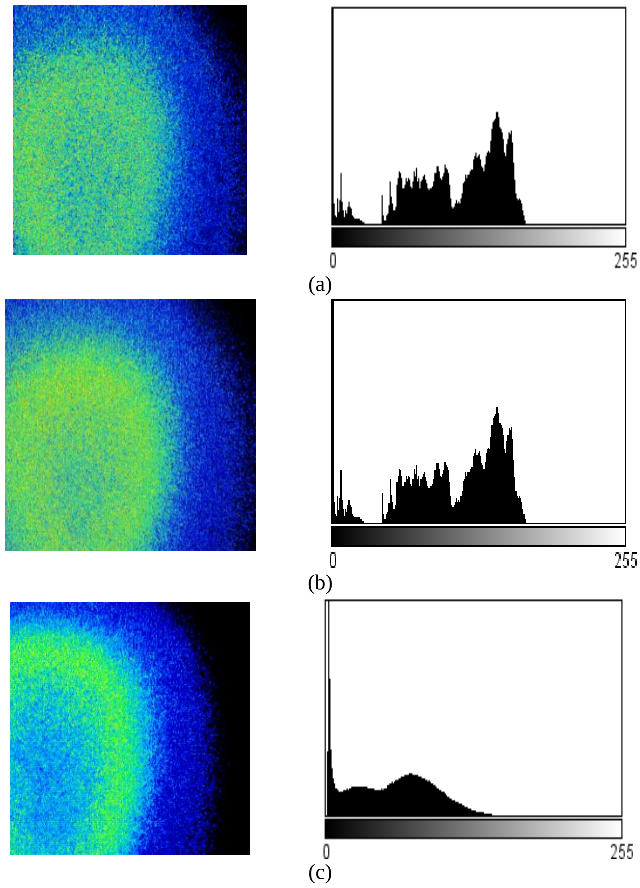

Figure 4. a) Bioactivity map and histogram of corn grains harvested at 4 km/h, b) Bioactivity map and histogram of corn grains harvested at 6 km/h, c) Bioactivity map and histogram of corn grains harvested at 8 km/h.

The analysis is done through the intensity of the pixels that compose the maps, where the regions with darker colorations (blue) represent low pixel intensity and a lower intensity of biological activity whereas the regions with lighter colorations (green) represent higher pixel intensity and in turn greater intensity of biological activity. Taking a look to the histograms number 4 a), b) and c), it can be observed that for the three speeds different peaks of concentration of pixels occurred which can be related to the presence of mechanical damages in the grains. Comparing them to each other, it was observed that the speed 6 km/h presented the highest peak of pixelar concentration, which represents a higher intensity of biological activity in the grains and is related to a lower intensity of damage in relation to the others. This result differs from the results obtained in the field, which suggests a deeper study on the subject.

IV. CONCLUSIONS

There were losses at all speeds tested during the harvest, although the one that generated more losses was 8Km/h and the one that generated less losses was 4 km/h. Concerning mechanical damages, the best speed was 6 km/ h, which sugests a deeper study on the subject. The Biospeckle technique proved effective in mapping the biological activity in living tissues.

REFERENCES

[1] ARGENTA, G.; SILVA, P.R.F. da; SANGOI, L. Arranjo de plantas em milho: análise do estado-da-arte. Revista Ciência Rural, Santa Maria, v.31, n.5, 2001.

[2] ASAE (AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS). ASAE E497.6 JUN09: Agricultural machinery management data. In:_.ASAE Standards 2009: standards engineering practices data. St. Joseph, p.350-357. 2009.

[3] BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. Regras para Análise de Sementes (RAS). Brasília: Mapa/ Assessoria de Comunicação Social, 2009.

[4] CAMPOS, M. A. O.; SILVA, R. P.; CARVALHO, A. F.; MESQUITA, H. C. B.; ZABANI, S. Perdas na colheita mecanizada de soja no Estado de Minas Gerais. Engenharia Agrícola, Jaboticabal, v. 25, n. 1, 2005.

[5] CONAB – COMPANHIA NACIONAL DE ABASTECIMENTO. Levantamento de Grãos Safra 2014/2015. CONAB, 2015. (2015, January 9th) Retrieved rom: http://www.conab.gov.br/OlalaCMS/uploads/arquivos/ 15_01_09_09_00_21_boletim_graos_janeiro_2015.pdf>.

[6] EMBRAPA. EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. Centro Nacional de Pesquisa de Soja. Sistemas de produção 9: tecnologias de produção de soja – Região central do Brasil 2006. Londrina, 2005.

[7] FERREIRA, I.C.; SILVA, R.P.; LOPES, A.; FURLANI, C.E.A. Perdas quantitativas na colheita de soja em função da velocidade de deslocamento e regulagens no sistema de trilha. Engenharia na Agricultura, v.15, p.141-150, 2007.

[8] GERMINO, R.; BENEZ, S. H.; SILVA, A. R. B. ; SILVA, P. R. A. ; MAHL, D. . Análise da viabilidade da colheita mecânica da cultura do milho (Zea mays L.) cultivada em diferentes espaçamentos entre linhas. In: CONGRESSO BRASILEIRO DE ENGENHARIA AGRÍCOLA, 32., 2003, Goiânia. Anais. Jaboticabal: SBEA, 2003.

[9] HUNT, D. Farm power and machinery management/Donnell Hunt. Ames: Iowa state, 2001. 368p.

[10] MANTOVANI, E. C. Colheita e pos-colheita. In: CRUZ, J. C.; VERSIANI, R. P.; FERREIRA, M. T. R. (Eds.). Cultivo do milho. Sete Lagoas: Embrapa Milho e Sorgo, 2000.

[11] PORTELLA, J.A. Colheita de grãos mecanizada – implementos, manutenção e regulagem. Viçosa, MG: Aprenda Fácil, 190 p, 2000.

[12] QUEIROZ, D.M.; SOUZA, C.M.A.; PINTO, F.A.C.; MANTOVANI, E.C. Simulação dos processos de trilha e separação em colhedoras de grãos. Revista Engenharia na Agricultura, Viçosa, v.12, n.2, 2004.

[13] SANTOS J.P.; MANTOVANI, E.C. Perdas de grãos na cultura do milho: pré-colheita, transporte e armazenamento. Sete Lagoas: EMBRAPA, CNPMS, 1997. 40 p. (EMBRAPA. CNPMS. Circular Técnica, 24).

[14] SANTOS, J.P. Pragas de grãos armazenados. Embrapa Milho e Sorgo. (2005, March 22). Retrieved from: http://www.cnpms.embrapa.br/publicacoes/milho/colpraga

[15] SGARBI, V. P. Perdas na colheita de milho (Zea mays L.) em função da rotação do cilindro trilhador e umidades dos grãos. 2006. 40f. Monografia (Graduação em Agronomia) – de Ciências Agrárias e Veterinárias, Universidade Estadual Paulista, Jaboticabal, 2006.

[16] SOUZA, C.M.A.; RAFULL, L.Z.L.; REIS, E.F.; SOBRINHO, T.A. Perdas na colheita mecanizada de milho em agricultura familiar da Zona da Mata Mineira. Revista Brasileira de Milho e Sorgo, Sete Lagoas, v.5, n.2, p.280-90, 2006.