ORIGINAL ARTICLE

Indicators of Operation for the Forage Chopper RSA/30

Indicadores de explotación de la picadora de forraje RSA/30

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ABSTRACT: The present work is one of the investigations carried out by the Center of Agricultural Mechanization (CEMA) of the Agrarian University of Havana (UNAH), on the evaluation of agricultural groups for the production of food animal, as part of the project "Development of the Technological-Scientific-Educational-Productive Scenario of Cuban Agriculture in the University Farm Guayabal". Its objective was to determine the indicators of operation of the forage chopper RSA/30 during the crumbling of King Grass. A coefficient of use of the time and productivity, in productive time of 0,66 and 18,70 kg/h, respectively, was obtained.

Keywords: Technological Evaluation, Forage, Chopper.

RESUMEN: Como parte del proyecto Desarrollo del escenario tecnológico-científico-docente-productivo de la agricultura cubana en la Granja Universitaria Guayabal, el Centro de Mecanización Agropecuaria (CEMA) de la Universidad Agraria de La Habana (UNAH), se realizan investigaciones sobre la evaluación de conjuntos agrícolas para la producción de alimento animal, siendo el objetivo del presente trabajo, determinar los indicadores de explotación de la picadora de forraje RSA/30 durante el desmenuzado de King Grass. Donde se obtuvo un coeficiente de utilización del tiempo y productividad en tiempo productivo de 0,66 y 18,70 kg/h respectivamente.

Palabras clave: Evaluación tecnológica, picadora, forraje.

INTRODUCTION

In cattle production in Cuba, during the application of new technologies for animal feeding, it is oriented to create fodder areas basically of sugarcane and King Grass, which generated a high demand for mechanized technologies to process these new food sources in dairy farms (Valdés *et al.*, 2016).

For the processing of these plants in the country's livestock entities, forage chopper equipment adapted to the specific operation conditions are required. These machines perform the plant physical breakdown during their shredding which is necessary due to their high-fibre content, so facilitating faster digestion, greater contribution of nutrients and higher energy consumption by the ruminant (Elias *et al.*, 1990; Delgado, 2006, cited by Valdés *et al.* 2016), aspect to take into account for the acquisition of these machines (Paneque *et al.*, 2018).

The creation of the National Food Self-Sufficiency Program in the base productive units, demands the production of food required by the cattle mass in their own dairy areas, consequently increasing the native base of food resources and relaying more on the available resources and efficient use of energy (Valdés *et al.*, 2012; de las Cuevas *et al.*, 2015). The strategy of this program is based on supplying the cattle with shredded fresh forage by using forage choppers from grasses such as sugarcane and King Grass, which when processed by these machines have their fibber content physically broken, facilitating rapid digestion, and greater contribution of nutrients to livestock. That increases animal consumption and productivity and reduces forage waste compared to non-shredded (Ramos *et al.*, 2017).

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Several authors have carried out research on forage mincing machines (Valdés *et al.* (2010, 2012, 2015, 2016, 2017, 2019). They highlighted the influence of the constant feeding angle and the moment of inertia on the calibre of the shredded particles by the drum-type forage mincers with manual feeding. In addition, they evaluated the technological and operation indicators of the modified IIMA model EM-01 forage mincer, and determined the energy cost. De las Cuevas *et al.* (2010), de las Cuevas *et al.* (2011, 2015) evaluated the technological and operation indicators of the JF-50 forage chopper added to the Belarus 510 tractor using the automated program "Exploitative Technological Evaluation" TECEXP (De las Cuevas *et al.*, 2008).

In this sense, López *et al.* (2003) (cited by Valdés *et al.* 2016), carried out a nutritional evaluation of eight varieties of sugarcane with forage potential for animal feed with excellent results.

With the sowing of sugarcane and King Grass in the areas of the dairy farms, there is a demand for forage choppers that are adapted to the specific operation conditions of each production unit. For that reason, the investigations related to the evaluation and determination of operation parameters of the different types and models of forage harvesters allow the authors to propose the most suitable ones for the particular conditions of each unit, which will result in an increase in the organizational efficiency of the technological process of the activities related to them.

In recent years in Cuba, several authors have carried out studies on forage mincing machines such as those carried out by Valdés *et al.* (2010, 2012, 2015, 2016), where the influence of the constant feeding angle and the moment of inertia on the calibre of the shredded particles by drum-type forage mincers with manual feeding is highlighted. In addition, they evaluated the technology and operation indicators of the modified IIMA model EM-01 fodder mincer and determined the energy cost. De las Cuevas *et al.* (2009, 2011, 2015), evaluated the technological and operational indicators of the JF-50 forage chopper added to the Belarus 510 tractor using the automated program "Exploitative Technological Evaluation" TECEXP (De las Cuevas *et al.*, 2008).

The evaluation of the operation indicators of agricultural machines is very important when evaluating or characterizing a technological process. From which it is possible to trace technical and technological improvements that improve the productivity and quality of the final product.

This study is part of the Research Project ""Development of the Technological-Scientific-Educational-Productive Scenario of Cuban Agriculture in the University Farm Guayabal", where the Center for Agricultural Mechanization (CEMA) of the King Grass Agrarian University develops research on the evaluation of agricultural sets to produce animal feed. The objective of this work was to determine the indicators of operation of the forage chopper RSA/30 during the crumbling of King Grass. The balance of time (clean, operational and productive), hourly productivity, technological and technical safety coefficient and coefficient of use of productive time are evaluated.

FIGURE 1. RSA/30 forage chopper.

MATERIALS AND METHODS

The investigations took place at Guayabal University Farm, belonging to the Agrarian University of Havana (UNAH), in Mayabeque Province, where RSA/30 forage chopper was evaluated (Figure 1). It is a stationary type machine, with electric drive and a three-phase motor of 220 V, 3440 min-1 and 3 kW of power. Its design corresponds to the production of animal feed, both for daily feeding and for storage in the form of silage. The machine has forced feed and electrical operation.

For the elaboration of the shredded fresh forage, King Grass was used. The experimental data were collected during the month of March 2022, under the following average weather conditions: relative humidity 71.47%, temperature 27.2°C, rainfall rate 15.56 mm, atmospheric pressure 1020 hPa and wind speed 4.2 m/s.

Standard PG-CA-043 (2013) was used to determine the operational technological indicators. The timing and classification of the times of each operation was carried out according to the established model. For the evaluation and determination of the different times, productivity and operation coefficients, the automated system "Exploitative Technological Evaluation" TECEXP by De las Cuevas *et al.* (2008) was used, with the use of the following expressions:

Productivity per hour of clean time, W1

$$W_1 = \frac{Q}{T_1},\ t/h \quad (1)$$

where:

Q- amount of grass mass processed during the work of the machine, t;

T1- clean work time, h.

Productivity per hour of operating time, W02

$$W_{02} = \frac{Q}{T_{02}}, t/h \quad (2)$$

where:
T02- operating time, h;

$$T_{02} = T_1 + T_2, h \quad (3)$$

where:
T2- auxiliary time, h.

Productivity per hour of productive time, W04

$$W_{04} = \frac{Q}{T_{04}}, t/h \quad (4)$$

where:
T04-productive time, h;

$$T_{04} = T_1 + T_2 + T_3 + T_4, \text{h} \quad (5)$$

where:
T3- time of technical maintenance of the machine, h;
T4- time for fixing failures, h.

To determine the productivity in clean time W1, the chopper is put into operation and after stabilizing the movement of the work organ, the King Grass is introduced through the feeding hopper. Operation times are measured with a 1s precision digital stopwatch.

The different values of the operation coefficients are determined by:

Technological safety coefficient, K41

$$T_{41} = \frac{T_1}{T_1} + T_{41} \quad (6)$$

where:
T41- Time for elimination of technological failures, h;

Technical safety coefficient, K42.

$$K_{42} = \frac{T_1}{T_1} + T_{42} \quad (7)$$

where:
T42- Time to eliminate technical failures, h;

Coefficient of use of productive time, K04

$$K_{04} = \frac{T_1}{(T_1 + T_{04})} \quad (8)$$

RESULTS AND DISCUSSION

Analysis of the operation indicators behavior of the RSA/3 forage chopper, for King Grass shredding.

Table 1 shows the results of the operation indicators, obtained from the automated system (TECEXP).

Labor: Shredded King Grass.

Place of evaluation: Guayabal University Farm.

The evaluation was carried out in an observation time of 2:08:20 h. It was found that clean work time represented 65.58% of total work time. The technical and technological safety coefficients took values between one and 0.96, respectively, considered adequate, since the loss of time for these concepts is in the range of 0 and 4%, respectively.

The coefficient of utilization of productive time is 66%. The use of this chopper is advantageous, compared to that achieved in the stationary chopper MF IIMA model EM-01 (Valdés *et al.*, 2015), which presents a (K04) of 59%. RSA/30 chopper presents a 7% greater use of time compared to the MF IIMA. The technological stops presented during the test correspond to the manual bags filling with the product.

The productivity per hour of clean time was 28.52 kg/h, with operational and productive time values of 19.30 and 18.70 kg/h, respectively. Although these indicators are lower than those obtained by Valdés (2015) when evaluating the MF IIMA model EM-01 stationary chopper, are adequate according to the dimensions of the machine under study.

CONCLUSIONS

- The coefficient of use of time and productivity in productive time of the RSA/30 forage chopper are 0.66 and 18.70 kg/h, respectively.
- In the technological process there were no losses of time due to breakdowns, with a technical safety coefficient of 1.
- Technological safety was affected 4% of the time, due to jams in the feeding process of the RSA/ 30 chopper.

TABLE 1. Operation indices of the RSA/30 forage chopper in the shredding of King Grass

Indicators Unit Values	Unit	Values Values
Clean time	h	1.40
Operating time	h	2,07
Productive time	h	2.14
Productivity per hour:		
of clean time	kg/h	28.52
of operating time	kg/h	19.30
of productive time	kg/h	18.70
Technological safety coefficient	-	0,96
Technical safety factor	-	1,00
Productive Time Utilization Ratio	-	0.66

REFERENCES

DE LAS CUEVAS, M.H.R.; DÍAZ, A.M.; PANEQUE, R.P.: "Software para el cálculo de indicadores energéticos, de explotación y económicos del sistema de distribución de humus de lombriz", *Revista Ciencias Técnicas Agropecuarias*, 19(2): 65-70, 2010, ISSN: 1010-2760, e-ISSN: 2071-0054.

DE LAS CUEVAS, M.H.R.; HERNÁNDEZ, R.T.; PANEQUE, R.P.; HERRERA, P.M.I.: "Software para la determinación de los costos energéticos y de explotación de las máquinas agrícolas", *Revista Ciencias Técnicas Agropecuarias*, 18(2): 78-84, 2009, ISSN: 1010-2760, e-ISSN: 2071-0054.

DE LAS CUEVAS, M.H.R.; RODRÍGUEZ, H.T.; HERRERA, P.M.I.; PANEQUE, R.P.: "Software para la evaluación tecnológica de las máquinas agrícolas", *Revista Ciencias Técnicas Agropecuarias*, 17(2): 24-28, 2008, ISSN: 1010-2760, e-ISSN: 2071-0054.

DE LAS CUEVAS, M.H.R.; RODRÍGUEZ, H.T.; PANEQUE, R.P.; DÍAZ, A.M.: "Costo energético del rodillo de cuchillas CEMA 1400 para cobertura vegetal", *Revista Ciencias Técnicas Agropecuarias*, 20(3): 53-56, 2011, ISSN: 1010-2760, e-ISSN: 2071-0054.

DE LAS CUEVAS, M.H.R.; VALDÉS, H.P.; RODRÍGUEZ, A.D.; DELGADO, L.R.; RODRÍGUEZ, R.R.; VÁZQUEZ, Q.J.L.: "Índices de explotación del tractor BELARUS 510 y la picadora de forraje JF 50", *Revista Ingeniería Agrícola*, 5(2): 44-48, 2015, ISSN: 2306-1545, e-ISSN: 2227-8761.

NC 34-37:03: *Máquinas Agrícolas y Forestales, Metodología para la Evaluación Tecnológica Explotativa*, Inst. Oficina Nacional de Normalización, norma cubana, La Habana, Cuba, 2003.

PANEQUE, R.P.; LÓPEZ, C.G.; MAYANS, C.P.; MUÑOZ, G.F.; GAYTÁN, R.J.G.; ROMANTCHIK, K.E.: *Fundamentos Teóricos y Análisis de Máquinas Agrícolas*, Ed. Universidad Autónoma Chapingo, vol. 1, Chapingo, Texcoco, México, 456 p., 2018, ISBN: 978-607-12-0532-2.

RAMOS, G.R.; CUN, G.R.; CORDOVÍ, A.Y.; YERO, M.J.C.; ALMAGUER, R.J.Á.: "Indicadores de explotación de la picadora de forraje PN-Plus-2000", *Revista Ingeniería Agrícola*, 7(3): 23-29, 2017, ISSN: 2306-1545, e-ISSN: 2227-8761.

VALDÉS, H.P.; DE LAS CUEVAS, M.H.; RODRÍGUEZ, A.D.; SUÁREZ, L.R.; GÓMEZ, A.M.V.; DELGADO, R.R.: "Determinación de los indicadores tecnológicos y de explotación de la máquina picadora de forraje MF IIMA modelo EM-01 modificada", *Revista Ciencias Técnicas Agropecuarias*, 24(3): 28-34, 2015, ISSN: 1010-2760, e-ISSN: 2071-0054.

VALDÉS, H.P.A.; CHUAIREY, C.M.; GÓMEZ, A.M.V.; DE LAS CUEVAS, M.H.; VÁZQUEZ, Q.J.L.; FERNÁNDEZ, G.T.: "Costos energéticos del tractor Belarus 510 y picadora de forraje JF-50", *Revista Ciencias Técnicas Agropecuarias*, 28(3): 5-12, 2019, ISSN: 1010-2760, e-ISSN: 2071-0054.

VALDÉS, H.P.A.; DE LAS CUEVAS, M.H.; GÓMEZ, A.M.V.; RODRÍGUEZ, A.D.; VÁZQUEZ, Q.L.; SUÁREZ, L.R.: "Determinación del costo energético de la picadora de forraje MF IIMA modelo EM-01 perfeccionada", *Revista Ciencias Técnicas Agropecuarias*, 25(2): 17-21, 2016, ISSN: 2071-0054.

VALDÉS, H.P.A.; DE LAS CUEVAS, M.H.; RODRÍGUEZ, A.D.; GÓMEZ, A.M.V.; DELGADO, R.R.: "Análisis comparativo de los costos de explotación de dos máquinas picadoras de forraje", *Revista Ciencias Técnicas Agropecuarias*, 26(2): 4-11, 2017, ISSN: 1010-2760, e-ISSN: 2071-0054.

VALDÉS, H.P.A.; MARTÍNEZ, R.A.; PÉREZ, P.J.: "Análisis de la caña de azúcar como alimento para el ganado", *Revista Pre-Til de la Universidad Piloto de Colombia*, 10(26): 59-74, 2012.

VALDÉS, H.P.A.; MARTÍNEZ, R.A.; VALENCIA, O.Y.; BRITO, D.E.: "Influencia del momento de inercia del tambor y de diferentes ángulos de alimentación constantes sobre el calibre de las partículas de forraje procesado con picadores del tipo de tambor con alimentación manual. Parte I", *Revista Ciencias Técnicas Agropecuarias*, 19(3): 53-56, 2010, ISSN: 1010-2760, e-ISSN: 2071-0054.

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