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ASSESSMENT OF THE VOLUME OF CROP BY THE WINDROW'S MEASUREMENT

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Abstract: *The construction's solution of the preservatives' applicator used during the biomass' harvesting is presented in this work. There have also been described own studies, the purpose of which is drawing up of an operation's algorithm of applicators' controller making it possible to change the dope of a preserving preparation in the function of collected mass' volumes. As a result of the conducted experiments it has been determined, that the analysed data is consistent with the gamma distribution. Identification of the probability distribution shall make it possible to accept certain assumptions concerning the construction of the costs' optimization model and drawing up of the applicator's steering algorithms.*

Keywords: Steering with applicators, Green fodder's harvesting, Biomass ensiling.

1. Introduction

In the agrarian practice, conducting of field works with the use of the best available methods is an important element making it possible to achieve high crops. It is also very important in case of harvests (Bochat and Zastempowski 2013, Zastempowski and Bochat 2014). Mistakes made at that time may result in getting increased losses, getting a low quality product, increase of problems related to storage and later post-harvesting treatment. In case of harvested green fodders designed for silages to be used as fodder or a biogas plant's substrate, incorrect harvesting may drive even to the harvested material's damaging. Energy losses occurring as a result of natural processes occurring in a pile are another crucial element in case of harvesting fodders preserved by ensiling.

Lactic fermentation is a common method of preservation of plant material designed for fodder's production and substrate's acquisition for a biogas plant. (Kalač 2011; Köfinger et al. 2012; Pakarinen et al. 2011; Weissbach 2009). The technology of preparing silages to be used as batch – coenzyme for biogas production at agrarian biogas plants is similar, like in case of ensilaging of fodders for ruminants. That is why, bad quality ensilages are also not fit for biogas production due to the volume of obtained gas and biomethane comprised in it (Węglarzyk and Podkówka 2010). Due to the required volume of actic acid and acetic acid, preferred is the use of additives comprising heterofermentative lactic bacteria, in particular of *Lactobacillus buchneri*, which shall not result in excessive acidification with actic acid but with acetic acid (Kalač 2011; Oude Elferink et al. 1999). However, the heterofermentative process leads to fermentation losses (Banemann et al. 2008, 2009; Nussbaum 2012; Ruser et al. 2009).

Getting good ensilage depends on many variable factors such as the quality of harvested plant material, adding of an appropriate preservative in an appropriate volume. The volume of the dope (volume) should depend on temporary machine's efficiency. At present on the market there are available many systems supporting the work of agrarian machines, which are characterized by high reading precision of the harvested material in real time. However, not so many solutions are designed for adjustment of temporary

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capacity of applicators assembled on harvesting materials. It is in particular noticeable in case of trailers and harvesting presses.

That is why, the analysis of commercial solutions existing on the market of systems for automatic adjustment of applied additives' volumes in the function of temporary efficiency of a harvesting machine and presentation of own studies the effect of which is drawing up of an algorithm of a applicators' controller operation making it possible to change the dope of preservative in the function of harvested mass of plant material to be ensilaged, constitutes the purpose of the study.

Well known world concerns specializing in production of machines for harvesting green fodders, have in their offer many solutions easing work with their machines. These systems, often based on the GPS technology, make it possible to obtain information which may be used for adjustment of temporary applicators' efficiency.

2. Material and methods

The following machines constituted the test bed: a tractor, a rotating mowing machine, a carrousel tedder, a carrousel rake. Lucerne (*Medicago media*) from the second swath in the beginning of blooming phase was the plant material used in the tests.

Following cutting, the plant material was redried in the field up to the humidity of 45 %. Then, from the material redried like that, rollers were formed. All the activities were conducted pursuant to the rules of good agrarian practice.

Having formed the rollers, the intermediate measurements of a roller's height were made with the use of a controller's model developed at the Faculty of Mechanical Engineering, UTP in Bydgoszcz. In the tests there was used the information from the ultrasonic sensor making it possible to measure the distance within the range 0 - 1500 mm. The applicator is made of a central unit equipped with a touch display unit making it possible to change the setpoints. Applicators' steering is possible thanks to the applied proportional valve or the PWM signal for solid materials' applicators. The input information comes from the sensors (ultrasonic sensor 1) and an impulse generator located on a collecting machine's land wheel. The block diagram of the applicator's controller used for the tests is presented in Fig. 1.

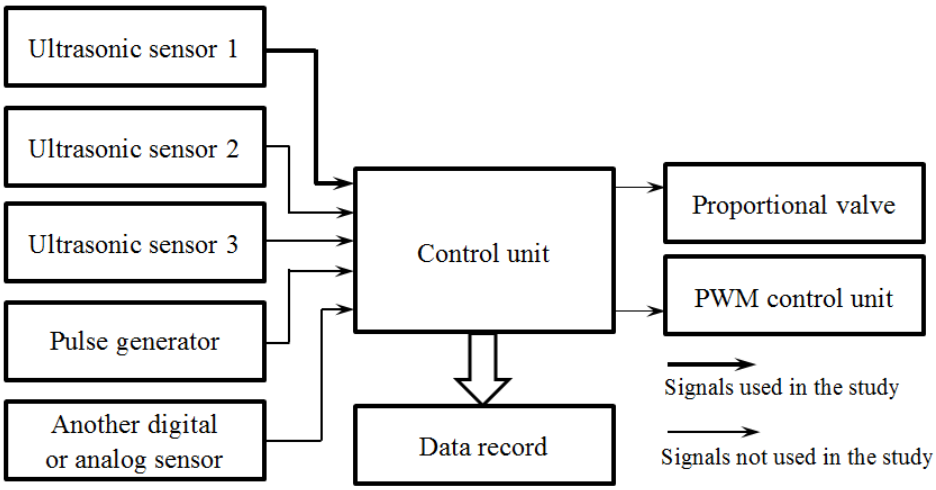

Fig. 1: Block diagram of the applicator's controller.

3. Conducted tests

N = 4120 of measurement data obtained in the course of measurements have been subject to statistical analysis. As a result of the conducted analysis, the following has been obtained:

- Mean value = 525.98 mm
- Standard deviation σ = 73.57 mm
- Variation coefficient V = 0.14

- xmin = 395 mm
- xmax = 773 mm

The basic purpose of that stage of statistical analysis was to find the probability distribution of the analysed real data (Bobrowski and Łybacka, 1995). The preliminary analysis of data showed, that in the analysed case the examples with „a shift" should be considered. The minimum measurement value obtained is equal to Min = 395 mm, that is why from each value the value of 390 mm has been deducted. For the data prepared like that, the attempt was made to match the gamma distribution of the probability density function of the form:

$$f(x) = \frac{1}{\beta^{\alpha}\Gamma(\alpha)} x^{\alpha-1} e^{-x\beta} \tag{1}$$

for x>0, α>0, β>0.

Γ(α) means the gamma function determined with the formula:

$$\Gamma(\alpha) = \int_0^{\infty} x^{\alpha-1} e^{-x} dx \tag{2}$$

Values of invariable parameters were estimated with the maximum likelihood method and the following has been calculated:

$$\alpha = 3.16$$

$$\beta = 43.24$$

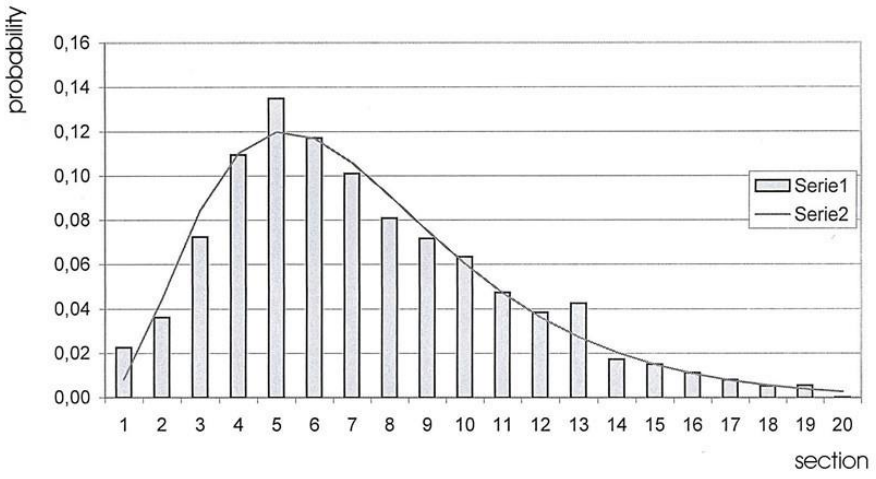

Fig. 2: The histogram of distribution: series1 – of empirical data, series 2 - theoretical data.

The consistency of the empirical distribution with the gamma distribution has been tested with the use of the Kolmogorov compliance test (for big statistical samples). Empirical and theoretical density is presented in Fig. 2. The calculated value of statistics λ = 0.91. The value of the significance level p–value = 0.66, points at the absence of grounds to reject the hypothesis that the analysed data are consistent with gamma distribution. The diagram of density presented in Fig. 1 shows, that gamma distribution is a good model for the examined empirical distribution.

4. Conclusions

As it results from the analysis of the selected literature sources, the preserved biomass designed for power purposes, stored in the form of silage, requires adding of silage additives. Appropriately selected formulations allow to decrease the losses of energy at the time of storage and allow to increase the biogas' yield. However, the use of additives at present takes place in most of the cases, without automatic change of dose during harvesting. Only few harvesting chaff cutters are equipped with appropriate systems controlling the work of applicators.

The conducted preliminary tests showed the usability of ultrasonic sensors for the windrow's height measurement. Obtaining of that type of results makes it possible to take up works on a controller, which may control the applicator's capacity in a simple manner. As it results from the conducted analysis of constructional solutions, on the market there are no constructions designed for use in trailers and collecting presses.

Identification of the probability distribution shall make it possible to assume appropriate assumptions for construction of the costs optimization model and the algorithm of applicators' steering.

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