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WEAR OF THRESHER KNIVES ON LOSSES IN PRIMARY PROCESSING OF TOBACCO

Vlatko Marušić
Strojarski fakultet,Trg. I.B.M. 18
55 Slavonski Brod, Croatia

Sanja Marušić
Industrijsko-obrtnička škola, Kumičićeva
Slavonski Brod, Croatia

Dražan Kozak
Strojarski fakultet,Trg. I.B.M. 18
Slavonski Brod, Croatia

ABSTRACT
Testing of quality of Burley tobacco (separation of fine part of leaves from stems) was carried out, depending upon wear of thresher knives. It was established that work with worn knives reflects itself in the most negative way on mixtures of tobacco leaves and fractions having the greatest market value. It has been assessed that timely change of worn knives leads to reduction of losses even up to 6% with the top quality mixture of leaves, and to somewhat less than circa 4% with less quality leaves.
Keywords: tobacco, threshering knives, thresher, wear, losses

1. INTRODUCTION
After air curing of tobacco leaves to portion of 15 to 17% of moisture content in space protected from direct sunshine rays and influence of weather, tobacco is graded into different categories. Leaves in the middle of the stem are of the best quality, then leaves from top and lower part of the plant are of lesser degree of excellence. Leaves de-dusted from soil particles and sand, graded by size of leaves, are cured with water, steam and hot air at temperature at circa 75° C) and transported on the stripping line. On 4 stage threshers these leaves are stripped (broken). Such partially stripped tobacco leaves are led into classification machines where sorting out into 7 categories by size of loose leaves is being carried out. Part residues after each sorting out are returned to repeated process of threshering. System of ø5 mm sieves separates tiny particle prior to de-dusting. Separated tiny particles are mixed up with previously separated and additionally dried leaves. In this enumerated tobacco processing stages, thresher knives are exposed to wear more than any other machine members, during execution of the main processing stage – breaking of tobacco leaves. The aim of this paper is to ascertain how condition of blade surfaces influences the quality of this processing stage. It should help the manufacturers through assessment of potential savings not only to define criteria in selection of procedures for blade protection, but also in evaluation of the allowed dimensional wear prior to change of the blades.

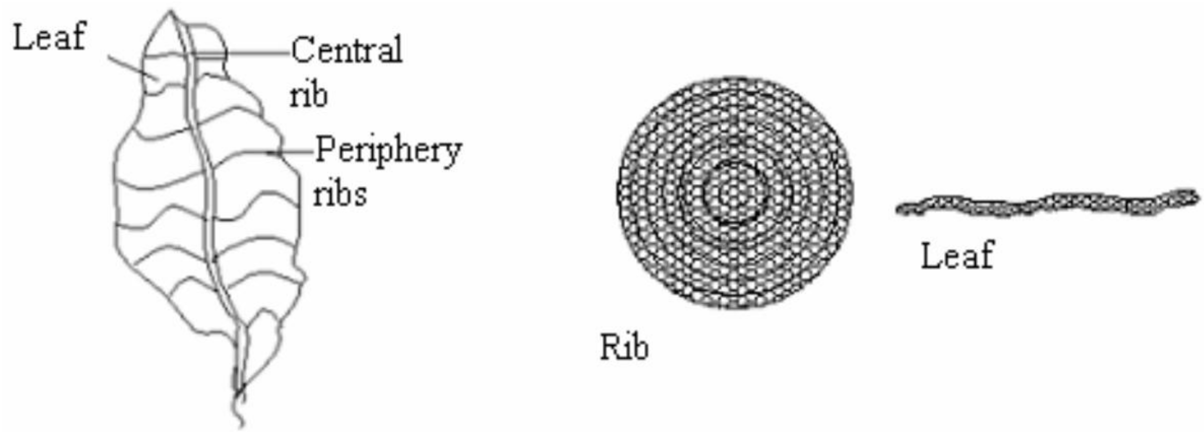
2. TRIBOSYSTEM OF THRESHER
Thresher is shown in Fig. 1. Tobacco enters from the upper part of thresher, is being caught by rotating knives, which tear it over fixed knives. On the exit there are separated leaves and those which remained joined with the rib. This part will be sent, after grading, into the next thresher stage – to the next processing phase. Inside thresher (Figure 1.) there are two kinds of knives: fixed ones and rotating knives. Fixed knives don't change their position; they are fixed on both sides of the thresher stator and on side door. They are positioned perpendicularly towards to the axis of the rotating drum, under an angle of 180 degrees. On each side, in the row, there are17 fixed knives. Rotating knives are fixed on the fringe of the drum in 6 rows. Each row contains 16 knives, rows being slanted at an angle of 60 ^{0}, so that thresher

drum contains altogether 96 rotating knives. Inspection of condition showed that knives are made with protective coating obtained by injection [1]. The appearance of knives worn in exploitation is shown in Figure 2.

a) *b)*
Figure 1. Thresher: a) schematic display; b) position of knives in open thresher

a) *b)*
Figure 2. Worn thresher knives with injected protective coating; a) fixed; b) rotating

One fixed and one rotating knife with injected protective coating was selected for the purpose of testing of structure and hardness. Metallographic examination of material structure and hardness measurements (HV 0, 3) were performed on the base material and on protective coating, on transversal cross-section of knives.
Measurement on cross section established up to 1 mm thickness of injected coating. Hardness value ranged from 700 to 1230 HV 0, 3. Hardness around180 HV 0, 3 was measured on the base material of the class C45 [2].
Tobacco is a plant containing certain amount of minerals, which may come in the form of oxides, carbides or mineral salts. The elements entering into composition of minerals have been established by analysis of ashes obtained after burning of tobacco, as follows: K= 19-29%; Ca= 27-50%; Mg =7-15%: Si =5-18% i Cl =0,5-9%[3,4].
The appearance of Burley tobacco leaf is shown in Figure 3.a. Along central part of the leaf there is central rib, with branches of periphery ribs (enervators). The upper leaf surface is covered with dense hair extracting rubber and juice (tar). This tar sticks to hands and machinery during harvest in the form of black rubber like clusters.
The main and periphery rib contain due to their role of armature, stronger joining texture, which after drying and loss of moister turns woody. During thresher filling tobacco leaves fall with their entire surface between fixed and rotating knives, yielding maximal resistance to tear of leaves. The cross section of the leaf surface and the rib (Figure 3. b) shows that this ratio ranges even to 1:10 in favor of size of the cross section of the rib. The outcome is that ribs exert greater wear on blades then the leaf surface itself.



a) *b)*

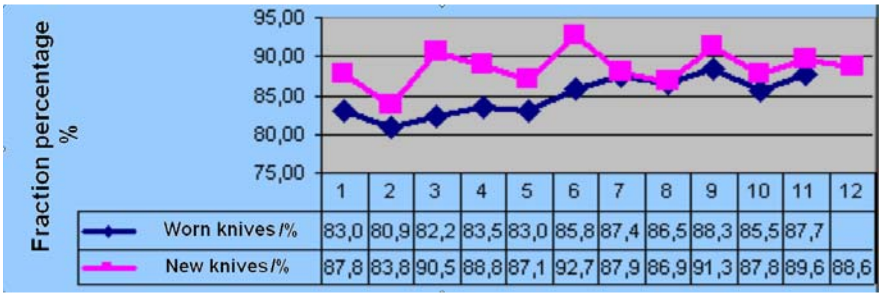
Figure 3. Schematic representation of tobacco leaf – Burley tobacco (a);and b) cross section.

3. INTERDEPENDANCE OF QUALITY OF TOBACCO STRIPPING AND KNIVES WEAR

To reach conclusions how wear of thresher knives effects quality of tobacco stripping, participation of tobacco fractions obtained with the new knives was examined. Control of stripping was carried out in factory laboratory with the standard method on the relevant equipment. Three different leaf sizes (fractions) are separated over vibrating sieves: the first one: 1" x 1";- the second: 1/2" x1/2";- the third: 1/4"x1/4". Thereby the big size fractions are of the best quality, achieving highest market prices. Fraction participation is followed for each of the three possible mixtures (leaf position on the stalk), because it significantly influences the price. Fraction participation of each sampling is added and average percentage of fraction participation in the control sample is being calculated.

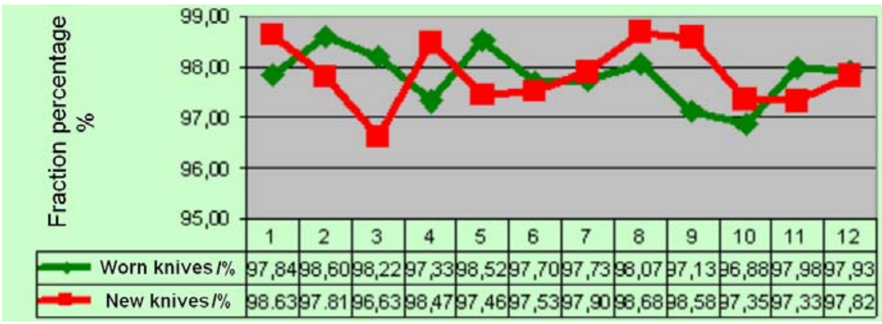
Diagrams show results of single fraction participation for each mixture:

I – While knives were new and undamaged; II – While knives have been already damaged.



	1	2	3	4	5	6	7	8	9	10	11	12
Worn knives /%	83,0	80,9	82,2	83,5	83,0	85,8	87,4	86,5	88,3	85,5	87,7	
New knives /%	87,8	83,8	90,5	88,8	87,1	92,7	87,9	86,9	91,3	87,8	89,6	88,6

Figure 4. Fraction participation for leaf surface 1/2"+1" when stripping tobacco mixture with new and worn knives.



	1	2	3	4	5	6	7	8	9	10	11	12
Worn knives /%	97,84	98,60	98,22	97,33	98,52	97,70	97,73	98,07	97,13	96,88	97,98	97,93
New knives /%	98.63	97.81	96,63	98,47	97,46	97,53	97,90	98,68	98,58	97,35	97,33	97,82

Figure 5. Fraction participation for leaf surface 1/2"+1" + 1/4" when stripping tobacco fraction of upper and centrally positioned leaves, depending on knife wear.

Diagram in Figure 4. shows percentage amount for each single fraction, leaf surface size 1/2" +1» in the control mass of 12 samples during one harvesting campaign. It can be observed that differences in fraction participation during processing with new knives in relation to operation with worn knives range between 0 to 4,5%, Similarly is the case with tobacco rib. Simultaneously it has been established that wear intensity does not effect significantly to differences in participation of single fractions 1/2" +1/4"+1".
Diagram in Figure 5. gives graphic representation fraction percentage (%) after stripping of mixture of upper and centrally positioned leaves. It can be observed that almost equal results have been achieved by stripping with the new and the worn knives. The same applies equally for fraction participation 1/2"+1" and 1/2" +1/4"+1", and for tobacco rib.
Diagram in Figure 6. shows graphically percentage (%) of fraction after stripping of mixture of the centrally positioned and lower leaves. It can be observed that bigger fraction participation 1/2"+1", even up to 6% has been achieved by stripping with the new then with the worn knives. With fractions 1/2" +1/4"+1", and for tobacco rib, these differences achieve at most up to 1, 5%.

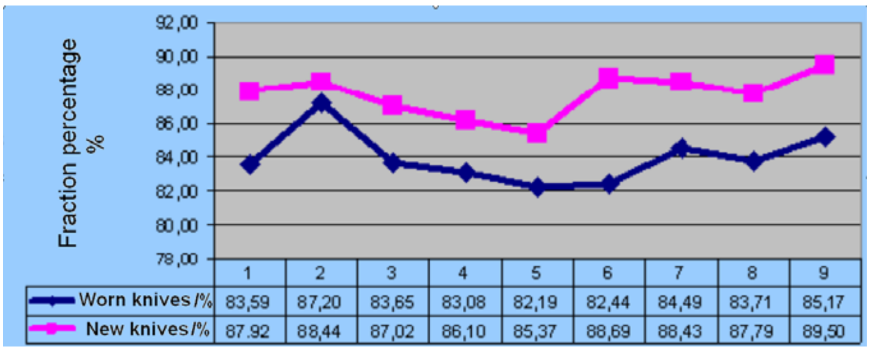


Figure 6. Fraction participation for leaf surfaces 1/2"+1, when stripping of middle positioned and lower placed leaves, using new and worn knives.

4. ANALYSIS OF TEST RESULTS AND CONCLUSION

The available data [5, 6] show that tobacco production in Croatia ranges between 8000 and 11 000 tons per year. This number gives us picture how large processing losses may be due to fraction differences in the controlled mass. Specific position of tobacco industry, being in the middle of aggressive anti smoking campaign, represents a limitation for publication of information on potential savings which might be achieved: I by right choice of wear protection of thresher knives and II – right definition of criteria of dimensional wear after expire of their operational lifetime.
Test results of fraction participation of high quality fraction (1/2"+1") and lower quality fraction (1/2"+1" + 1/4") for three basic tobacco leave mixtures indicate to the following:
- fraction participation (1/2"+1") during processing with new knives in relation to operation with worn knives ranges up to 4,5%,
- fraction participation of upper and centrally positioned leaves does not show effects of operation with worn knives,
- fraction participation for middle and lower leaves differences in participation of quality fractions, when operating with new knives range up to 6,25% in relation to work with worn knives.

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