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UTILIZATION AND RECOVERY ANALYSIS OF OAK LOGS IN A MODERN WOOD PROCESSING PLANT

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Abstract: This paper analyzes the quantitative and qualitative recovery of pedunculate oak (Quercus robur) logs processed in the modern sawmilling facility of "Drvoprodex" d.o.o. in Srbac, Bosnia and Herzegovina. The research was conducted through a combination of direct measurements during two operational shifts, encompassing 185 logs and company-maintained production records. Logs were classified into three quality grades, with detailed analysis of dimensions and produced assortments, including lamellae (grades A–C), rustic-grade elements (R class), and friezes. The overall recovery from debarked log volume reached approximately 30%, aligning with the lower end of typical industry expectations for oak flooring production. Friezes dominated in quantity (2,376 pcs), particularly in 70 mm width, while lamellae and R-class elements showed optimal yields at 135 mm and 215 mm widths. Regression analysis confirmed a statistically significant positive influence of log diameter on both recovery rate and daily processing volume. While advanced equipment such as a band saw head rig, CNC optimizer, and multi-blade rip saws are employed, several older machines occasionally limit throughput, underscoring the need for further modernization. Importantly, about 70% of the log volume remains as sawmill residue, including slabs, edgings, sawdust, and bark. Recommendations are made for systematic valorization of these co-products: coarse residues can be chipped for biomass energy or panel manufacturing, while sawdust and bark can serve for pellet production or biochemical extraction (e.g. tannins). Enhancing residue utilization would increase material efficiency and economic sustainability, aligning the mill with circular economy principles and near-zero-waste production goals.

Keywords: oak sawmilling, log recovery, wood processing.

1. INTRODUCTION

Wood processing industry in the Republic of Srpska is one of the most important industrial sectors, contributing approximately 10% to the total industrial production and around 17% to the manufacturing industry. The estimated number of active companies in this is around 600, engaged in wood processing, wood product manufacturing, and furniture production.

Oak wood is hard, durable, tough, and easy to work with, making it one of the most widely used species in Bosnia and Herzegovina. It is commonly processed for interior and exterior applications such as parquet, flooring, stairs, panel furniture, windows, and doors. High-quality oak is also used for veneer and panel production. Its aesthetic appeal and strong mechanical properties make it the preferred choice for solid and multi-layered flooring. European oak species, primarily pedunculate oak (Quercus robur) and sessile oak (Quercus petraea), are among the most valuable hardwoods in temperate forests. Their dense, ring-porous wood is ideal for structural timber, furniture, and flooring. Efficient sawmilling is key to maximizing the yield and value of these logs, and numerous studies have focused on sawing technologies, recovery rates and residue utilization.

Oak logs have historically been sawn using frame saws (sash gangsaws), circular saws, or band saws. Each technology has distinct kerf (cut width) and productivity characteristics that affect lumber yield. Frame saws use multiple straight blades in a reciprocating frame; they offer precise dimensional control but relatively wide kerf (typically 2.5–4.2 mm) [1]. Circular saws have the widest kerf (often 3–5.5 mm) and high cutting speed but can waste more wood to sawdust. Band saws, especially modern thin-kerf bands, have the narrowest kerf (around 1.5–2 mm), enabling higher lumber yield due to less material lost as sawdust. Band sawmills also allow flexible log orientation and can handle large diameters, making them ideal for high-quality oak lumber production [1]. Modern sawmills increasingly favor band saw lines to combine accuracy with yield efficiency. Traditional frame saws remain in use for small/medium mills due to their simplicity and lower skill requirement. In practice, sawmills often integrate multiple technologies: a primary breakdown saw (band or circular head-rig, sometimes with chipper-canters to remove slabs as chips) and secondary resaws (band re-saws or gang saws) to balance speed and yield. Recent decades have seen automation and scanning technologies enhance all saw types – e.g. 3D laser or X-ray scanners for log positioning and optimal cutting plans [2]. These systems can adapt cutting to log shape (taper, curvature) and internal defects, further improving yield and value recovery.

Apart from machinery, the sawing pattern significantly influences yield (recovery rate) and lumber quality. Common methods include live sawing, cant sawing, and quarter sawing. Live sawing (slicing the entire log in parallel cuts) is simple and often maximizes volume yield, but it produces a mix of flat-sawn boards prone to distortion. Quarter sawing (radial splits and then tangential cuts) yields a higher proportion of vertical-grain boards with superior stability and figure, desirable for oak, though at the cost of volume yield and increased labor. Studies confirm these trade-offs: Riesco Muñoz et al. (2013) [3] noted that radial/quarter sawing patterns in Q. robur logs yielded less volume than plain-sawing, but produced higher-grade boards. In that study, primarily quarter-sawn oak had a total sawmill recovery of approx. 47.6% by volume, but the authors remark this sacrifice in volume can be justified by the added value of quarter-sawn timber for structural use [3]. Live-sawing, by contrast, tends to maximize the quantity of lumber. Smajić et al. (2021) [4] performed live sawing of pedunculate oak using a modern vertical band saw line and reported a lumber yield of about 57.3% of log volume, significantly higher in volume recovery than the quarter-sawing case. However, live-sawn boards include a range of grain orientations; thus, while volume yield (“quantity yield”) was approx. 57%, the quality yield (portion meeting quality grades) was approx. 88% and the value yield (yield in terms of lumber value) only approx. 50%, indicating that some of the volume was in lower-grade boards. This highlights that sawmillers choose sawing methods based not only on volume recovery but on the target product and value optimization [4].

The results of the study Vilkovský et al. [5] confirm that the choice of sawing pattern significantly affects both the quantitative and qualitative yields in the processing of beech logs. The highest quantitative yield (84%) was achieved with cant sawing, while the highest qualitative yield (up to 62.7% of radial wood) was obtained with quarter sawing. The findings suggest that quarter sawing is recommended when the goal is to obtain dimensionally stable and high-quality radial lumber, while cant sawing enables a higher overall volume of production [5].

According to Ištvanić et al. [6], who investigated the live sawing of oak logs, a quantitative yield of cca 57 % was achieved, while the qualitative yield reached a high 87 %. This indicates that live sawing can result in a significant proportion of high-quality timber, even though the total volume is lower compared to other methods. Popadić et al. [7], analyzing the sawing of beech logs with red heartwood, found that both quarter and cant sawing provided better quantitative results (around 60.5%) compared to through-and-through sawing, which achieved approximately 56.8% yield. Li et al. [8], studying various sawing patterns for coniferous species, demonstrated that “hexagon sawing” could achieve up to 82.7% volumetric yield, significantly higher than traditional live sawing (53.3%), triangular (56.7%), or trapezoidal patterns (63.2%). Similarly, Pang [9] showed that the choice of sawing method greatly affects wood behavior during drying, and that quarter-sawn timber shows substantially lower tendencies toward cracking and deformation. The quantitative yield of pedunculate oak logs varies significantly depending on the applied sawing technology and the log quality class [10].

European oak sawmills often use hybrid sawing methods to balance yield and quality. The "Slavonian method," a modified quarter-sawing technique from Croatia, aims to maximize radially sawn boards. In a study by Smajić et al. [11], this method was compared to live sawing for lower-grade oak logs. While live sawing achieved higher raw volume, the Slavonian method provided better results in terms of quality and value recovery. Sawmills adjust sawing patterns based on log quality and product goals. Lower-grade or small-diameter oak logs are often live-sawn to maximize volume [12], while high-quality, large logs are typically quartersawn to enhance value, despite lower yield. Modern sawmills also apply adaptive sawing, using log scanning to optimize cut placement and grade mix [2], which is especially beneficial for oak due to common heartwood defects.

One of the central metrics for sawmilling efficiency is the lumber recovery rate – the percentage of the log's volume that is converted into sawn lumber. Hardwood sawmilling typically yields lower recovery than softwoods, due to hardwood logs' form and the need for removing defects. For oak, a relatively high-density hardwood, recovery rates reported in the literature generally range from about 40% up to 60% of the log volume, depending on log quality, sawing pattern, and technology. A recent comprehensive review by Pramreiter et al. [2] found that across studies, the total green lumber yield in sawmilling varies widely (from as low as 9% in extreme cases to 60% at best), with an average around 46% when considering dried and planed lumber. This average aligns with industry expectations that roughly half of the log ends up as finished lumber, with the rest in slabs, edgings, sawdust, and shrinkage losses. Indeed, a common rule of thumb is that about 50±10% of a hardwood log's volume is converted to sawn timber [2].

Riesco Muñoz et al. [3] reported a 47.6% yield from Galician oak logs using quarter-sawing, which dropped to just 8.4% when only structural-grade lumber was considered, highlighting the impact of grading standards on recovery. These results align with earlier findings that about 50% of hardwood log volume is typically converted to lumber [2, 13]. Live-sawing generally provides higher volume recovery, while selective patterns and post-processing can reduce net yield. Log characteristics also influence outcomes—larger logs offer higher recovery, while small or defective logs lead to more waste [12]. Interestingly, Riesco Muñoz et al. [3] found that visual log grade did not significantly affect yield when live-sawing was used, suggesting that modern processing and strategic cutting can offset some quality-related losses [2]. "Quality yield" refers to the proportion of lumber volume meeting a specified quality grade; "Value yield" accounts for the proportion of the log's potential value realized as lumber. In well-optimized sawmills processing high-quality, large oak logs with thin-kerf saws, yields of 55–60% have been reported. However, when targeting only high-grade or specialized products, such as structurally certified or quartersawn lumber, the usable yield can decrease significantly. It is important to distinguish between green (as-sawn) and dry yield, as oak lumber shrinks and may be planed, resulting in further volume loss. Pramreiter et al. [2] report average drying losses of 6% and planing losses of around 13%, meaning a 50% green yield may drop to about 40% as a final product. Thomas & Buehlmann [14] showed that reducing sawing variation and kerf can increase lumber recovery, though further gains are increasingly achieved through value optimization rather than volume. In premium oak processing, value-based cutting—often guided by internal scanning—may reduce volume yield but increase profitability.

Converting only 50% of oak logs into lumber means the remaining 50% emerges as residues: slabs (the rounded sides trimmed off), edgings (trim cuts from boards), sawdust and shavings (from the kerf and planing), and bark. Efficient use of these co-products is essential for economic and environmental reasons. Rather than "waste," sawmill residues are widely seen as valuable biomass resources [15]. Dudziec et al. [13] emphasize that sawmill residues account for a large share of solid biofuel used in combined heat and power generation. Coarse residues like slabs and edgings are often chipped on-site and used as fuel in biomass boilers or cogeneration plants, or sold to bioenergy facilities. Fine residues (sawdust, shavings) can be used directly for heat or pressed into fuel pellets and briquettes. In Europe and North America, the wood pellet industry relies heavily on sawmill sawdust and shavings as feedstock. Oak sawdust, being dense and high in calorific value, makes excellent fuel pellets, though sometimes it is blended with softer woods to improve pelletizing flow and binding (oak's high extractives can act as natural binders) [16, 17]. Studies on oak wood pellets have shown they have high energy density and low ash content, though oak's mineral content can lead to slagging in burners if not managed [18]. Bark, which constitutes a significant portion of oak log residues (oak bark can be thick, 10–15% of log volume), is also used for energy. However, bark typically has higher ash and may contain dirt, so it is often segregated. Energy valorization of oak sawmill residues is well-established: slabs and offcuts → wood chips for fuel, sawdust/shavings → pellets or briquettes, and bark → fuel or mulch. This not only provides revenue or savings for sawmills but also offsets fossil fuel use, contributing to renewable energy goals. The properties of these residues (moisture, particle size, etc.) can vary depending on log source and processing, and optimizing their use (e.g., drying or mixing residues) can improve combustion efficiency [13, 19].

Oak residues have diverse industrial applications beyond energy. Wood-based panels are a major outlet, with oak chips and sawdust used in particleboard and fiberboard production. Oak's density contributes to board strength, though its tannins can interfere with adhesives. In pulp and paper production, oak is less favored due to its hardness, but still used in regions lacking softwoods. In the bioeconomy context, oak residues are explored for extraction of polyphenols—tannins and flavonoids—valuable for specialty chemicals, adhesives, and nutraceuticals. Dedrie et al. [20] demonstrated the extraction of catechin and gallic acid from Quercus robur/petraea bark. Historically important in leather tanning, oak bark is now recognized for antioxidant and antimicrobial properties [21, 22]. Biorefinery pilots in Europe aim to recover tannins, lignin, and fermentable sugars from sawdust and bark. Additionally, oak's high density makes it suitable for charcoal and activated carbon. Efficient residue use is crucial for sawmill profitability. When lumber markets decline, residues such as chips, pellets, or pulpwood provide economic resilience [2]. Modern oak sawmills often operate under zero-waste principles, converting nearly 100% of log biomass into marketable outputs. Dudziec et al. [13] highlighted that sawdust and bark properties vary with forest site and tree growth, requiring tailored approaches to maximize energy efficiency. Ultimately, valorization of residues enhances resource efficiency and contributes to the sector's sustainability goals.

2. MATHERIAL AND METHOD

The subject of this research is the analysis of quantitative and qualitative utilization of oak logs (Quercus robur) processed at the modern wood-processing sawmill "Drvoprodex" d.o.o. Srbac. "Drvoprodex" is a family-owned company founded in 1992, initially oriented towards sawn timber production. Over the years, the enterprise expanded its production capacity to include parquet flooring, solid wood flooring, and multi-layered wood panels. The company today exports more than 95% of its total production to the European Union, with key markets including Italy, Germany, France, Austria, and the Netherlands.

The focus of this research is placed on evaluating the recovery rate of oak logs processed through the plant's modern sawing and sorting lines. Data collection was conducted directly within the production site of "Drvoprodex" during two full operational shifts. For each log, detailed measurements were performed including length and mid-diameter, along with an initial quality grade assignment based on visible characteristics and labelling. In addition to direct measurements and observations, the research will utilize a portion of the internal production monitoring data regularly collected and maintained by the company. These internal records will serve as a supplementary data source to validate measured values and enhance the reliability of the analysis concerning the efficiency of oak log processing.

The method employed includes both quantitative analysis, calculating the yield in terms of volume (m^3), and qualitative categorization of produced elements. This encompasses elements for parquet layers (classified into A-C classes), elements for rustic flooring (R class), and wooden stripes (friezes). The final output was statistically processed and visualized using Microsoft Excel and Microsoft Word and Statistica 12 software. Furthermore, the study will discuss the potential for utilizing wood processing residues as a renewable energy resource. The analysis will include an assessment of the quantity of residues generated during sawing and further processing, with particular attention to the current handling practices at the facility.

3. RESULTS AND DISCUSSION

The sawmill at "Drvoprodex" d.o.o. in Srbac operates with a largely modernized set of machinery, incorporating both advanced and some older equipment. The core processing line includes a Dinaco GK-800-2 bark peeler, Dinaco VEL-970 carriage band saw, and a Dinaco band headrig used for longitudinal cutting of logs. Complementing these are a cross-cutting circular saw, a multi-blade rip saw "Most" R320X 2M for width dimensioning, and a CNC optimizer MPCNC 400 FAST "Most", which uses sensors to optimize length cuts and detect defects. Additionally, a small auxiliary trimmer and a joinery-grade band saw are used in the final stages to define the dimensions of narrow frieze elements. Although most equipment is modern, the presence of several older machines occasionally results in short production delays, especially when incoming log volumes are high. The sawing method employed is a combination of live sawing and downstream optimization, beginning with longitudinal cuts on the band saw and progressing through width trimming and CNC-controlled sorting.

The analyzed sample comprises of 185 logs, that are assigned to one of three qualitative classes (I, II, or III), presumably based on visual or dimensional grading standards typically used in the hardwood timber industry. The log lengths range from a minimum of 200 cm to a maximum of 450 cm, with an average length of approximately 296.4 cm. The standard deviation of log lengths is about 65.85 cm, indicating moderate variability. In terms of diameter, logs exhibit a mid-diameter range from 22 cm to 71 cm, with a mean diameter of 38.2 cm. The standard deviation for diameter is 10.35 cm (Table 1).

Regarding volume, the logs display a range from 0.091 m^3 to 1.177 m^3. The average volume per log is 0.363 m^3. This sample thus represents a typical structure of roundwood assortments derived from final felling or selective thinning in mixed or deciduous stands.

Table 1. *Descriptive statistics of sample*

	Log length l (cm)	Log diameter d (cm)	Log volume V (m^3)
N	185	185	185
Mean	296.378	38.2	0.363
Std	65.85	10.347	0.218
Min	200	22	0.091
Max	450	71	1.266

The classification of the logs shows that Class I dominates in both volume and quality, accounting for 43% of the total volume, with the largest average diameter of 47.02 cm. Class II logs, although more numerous (76 logs), contribute 39% of the total volume, while Class III, representing lower-grade logs, make up 18%. The average length of logs is fairly uniform across classes, with a slightly higher value in Class II (3.02 m) (Table 2). The total volume of all logs, including bark, is 67.18 m^3, while the debarked volume is 58.103 m^3. The bark accounts for approximately 13.51% of the total log volume.

Table 2. Distribution of sample by classes

Log Class	No. of Logs	V (m^3)	Share %	d_{aver} (cm)	l_{aver} (cm)
I	53	28.44	43	47.02	292
II	76	26.23	39	37.38	302
III	56	12.51	18	30.79	292
Total (with bark)	185	67.18			
Total (without bark)	185	58.10			

Proper raw-material classification and log selection are crucial for optimizing yield and product value [10]. From the analyzed log sample, the following products were manufactured: lamella elements of A–C grade, R grade elements, and friezes (wooden strips). The production structure of sawn elements shows clear differentiation by width and product category. Friezes are dominantly produced in smaller widths—especially 70 mm (2156 pcs), indicating this format's suitability for narrow frieze elements, possibly due to lower-grade or side-cut material. In contrast, lamella elements classified as A–C grades are concentrated in mid-range widths, notably 135 mm (664 pcs), 100 mm (488 pcs), and 150 mm (347 pcs), suggesting these widths are optimal for flooring lamella manufacturing. The R grade (rustic) elements follow a similar pattern, with the highest outputs also found at 135 mm (186 pcs) and 150 mm (183 pcs), confirming the significance of these widths in processing lower-grade yet usable timber. The data indicates a clear optimization strategy based on width-specific suitability for each product type and grade. The total number of all produced elements is 5,027 (Table 3).

Table 3. *Structure of produced assortments*

Element Width (mm)	Lamella Elements A–C		R Grade		Friezes	
	(pcs)	m^3	(pcs)	m^3	(pcs)	m^3
50	–		–		220	0.086
70	–		–		2156	1.489
100	488	1.029	27	0.032	–	
135	664	2.702	186	0.931	–	
150	347	2.013	183	1.027	–	
180	156	1.326	140	1.086	–	
215	202	2.25	154	1.572	–	
240	13	0.2	–		–	
270	60	1.034	–		–	
340	31	0.661	–		–	
Total	1961	11.215	690	4.648	2376	1575

The majority of the volume from A–C grade lamella elements was obtained from widths of 135 mm and 215 mm, indicating these dimensions as optimal for producing high-grade components. R grade (rustic) elements also showed their highest volume yields at 215 mm and 150 mm, reflecting similar dimensional preferences despite lower visual standards. Wooden strips (friezes) were predominantly manufactured from narrower widths, particularly 70 mm, confirming their role in utilizing side cuts or lower-grade material. The total produced volume reached 17.438 m^3, consisting of 11.215 m^3 of A–C grade lamellae, 4.648 m^3 of R grade elements, and 1.575 m^3 of friezes. This output structure highlights a well-balanced utilization of oak logs, ensuring efficient recovery through targeted dimensional and quality-based sorting. The volume of manufactured products accounts for 25.96% of the total log volume with bark, and 30.01% without bark. These figures align well with typical yield rates for oak logs processed into flooring components, which commonly range between 30% and 45%. The results suggest that the recovery in this case was on the lower end of the expected range, likely influenced by log quality, the proportion of lower-grade assortments, or technical limitations in the cutting and classification process. Nonetheless, achieving a 30% yield without bark indicates a reasonably efficient conversion, particularly considering the inclusion of various product types such as lamellae, rustic-grade elements, and friezes.

To enhance the dataset with additional context and operational depth, the following section presents data derived from the company's internal records, offering a detailed overview of daily production volumes, log characteristics, yield rates, and labor inputs collected over an extended period of monitoring. The dataset captures daily operational data from a sawmill over a period of 49 recorded workdays. During this period, the volume of processed logs ranged from approximately 29.5 to 40.1 m^3/day, reflecting a relatively stable inflow of raw material. The average diameter of the logs varied between 33.99 and 41.68 cm, while their average length ranged from 278.96 to 306.33 cm. The number of logs processed daily fluctuated between 71 and 125 pieces, suggesting the use of both smaller and medium-sized assortments. Material recovery rates showed notable differences, ranging from 34.54% to 42.83%, with the highest yield indicating particularly favorable conditions for efficient processing. Each workday consisted predominantly of 450 minutes of operation, with a consistent workforce of 13 employees, providing a uniform basis for comparing labor productivity and processing outcomes across days.

Some other researches on oak sawmilling indicates that roughly 40–60% of the log volume is converted into sawn lumber under typical conditions [2, 13]. Thus, our overall product recovery of cca 30% (based on debarked log volume in this study) is on the lower end of expectations, but comparable cases are documented in the literature. Horvat et al. [10] showed that sawing lower-quality (Class C) pedunculate oak logs with traditional technology resulted in only about 35% lumber yield, whereas using specialized sawing techniques on higher-grade, larger-diameter logs raised recovery to over 45% [10]. This finding demonstrates the strong influence of log quality class on sawmill outcomes and the importance of matching processing methods to the log grade.

To investigate the impact of selected factors on material recovery and productivity, regression analysis was conducted using the recorded daily operational data. The results demonstrate that mean log diameter has a statistically significant effect on both recovery rate and volume of logs processed. As shown in Figure 1, the correlation between mean diameter and recovery rate is moderate and statistically significant, with a correlation coefficient of R = 0.40, p = 0.004, and $R^2 = 0.16$, indicating that 16% of the variance in recovery rate can be explained by changes in mean log diameter. Figure 2 further confirms a stronger influence of mean diameter on daily processing volume, with a higher correlation coefficient of R = 0.68, p = 0.000, and $R^2 = 0.46$, implying that nearly half of the variability in processed volume is associated with changes in log diameter. In contrast, no statistically significant relationship was found between average log length and either of the observed variables, and thus it was excluded from further regression modelling (Figure 1 and 2). These findings highlight the critical role of input log dimensions, particularly diameter, in determining both yield efficiency and operational output in sawmill processing.

The positive influence of log diameter on recovery rate observed in this study is consistent with other researches. Larger-diameter logs generally yield a higher fraction of lumber because proportionally less wood is lost in slabs and kerf, whereas small-diameter logs suffer disproportionately higher waste losses [12, 2]. Wiedenbeck et al. [12] quantitatively demonstrated this effect: red oak logs under 25 cm in diameter produced significantly lower lumber output than did larger "mill-size" logs, due to the greater relative volume consumed by saw kerf and irregular form in small logs [12]. While modern sawing optimizations (e.g. improved log scanning and edging decisions) can mitigate some waste in crooked or defective logs, fundamentally a bigger, straighter log allows more boards to be sawn and hence achieves higher recovery efficiency [2].

Based on the simulated annual processing capacity of 10,000 m^3 of oak logs at the sawmill, and applying the recovery coefficients obtained through the study (30% final product yield and 70% residue), it is estimated that approximately 7,000 m^3 of wood residues are generated annually. These residues can be categorized as follows: slabs and edgings (35%, or ~2,450 m^3), trimmings and offcuts (20%, ~1,400 m^3), sawdust and planer shavings (30%, ~2,100 m^3), and bark (15%, ~1,050 m^3). Given the existing pelletizing facility, the finest residues – particularly sawdust and shavings – are ideal for pellet production. To improve overall material efficiency and economic sustainability, it is recommended that these residues be valorized through integrated energy and material recovery strategies. Given the existing pelletizing facility, the finest residues – particularly sawdust and shavings – are ideal for pellet production. Oak sawdust is known for its high density and calorific value, averaging between 18.5 and 19.5 MJ/kg, which makes it a desirable feedstock for premium biomass fuel. Coarser residues such as slabs and edgings can

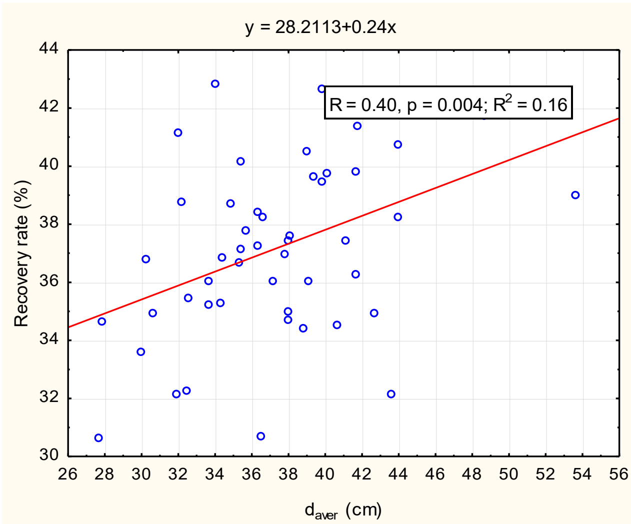

Figure 1. *Influence of mean diameter on recovery rate*

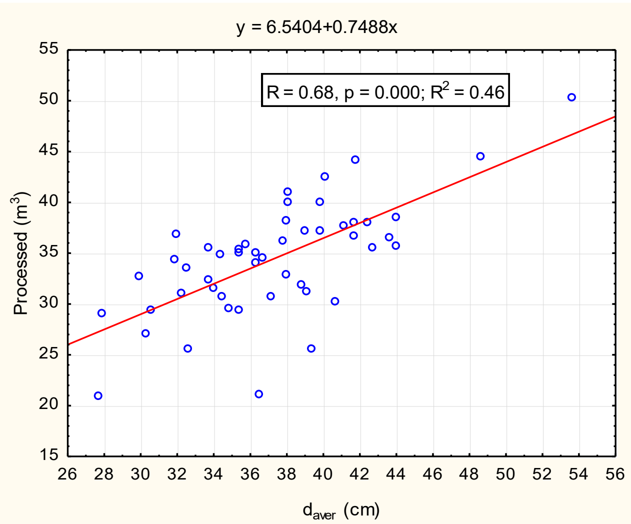

Figure 2. *Influence of mean diameter on processed amount*

be chipped and utilized as fuel in biomass heating systems or sold to wood-based panel manufacturers, while finer residues like sawdust and shavings are suitable for pellet or briquette production. Bark, though higher in ash content, may be combusted in on-site boilers or utilized as mulch or raw material for tannin extraction, given its significant polyphenol content. Valorization of these residues not only contributes to the economic sustainability of the sawmill but also supports circular economy goals and near-zero-waste production boosting profitability, supporting circular economy goals, and reducing its environmental footprint. It is recommended that a systematic residue separation, drying, and storage strategy be implemented to maximize efficiency in pellet production and enable year-round energy utilization.

4. CONCLUSIONS

The study confirms that efficient utilization of oak logs in modern sawmill operations depends on a combination of adequate raw material classification, the application of appropriate sawing technologies, and optimized production organization. The integration of advanced equipment, such as CNC optimizers and multi-blade saws, contributes to better material recovery and product quality, although occasional limitations due to outdated machinery still affect production continuity. The analysis highlights the importance of aligning sawing methods with log quality and end-product requirements in order to balance volume yield with value recovery. Additionally, the research points to the need for a strategic approach to the management of sawmill residues, which represent a significant share of the total processed biomass. By implementing systems for energy recovery and material reuse, sawmills can improve overall efficiency and move toward sustainable, near-zero-waste production models. Future improvements should focus on upgrading remaining equipment, refining quality control procedures, and expanding the utilization of by-products through bioenergy and biorefinery initiatives. Such measures would strengthen the economic performance of sawmill operations while contributing to broader environmental and resource-efficiency goals.

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ИСКОРИШЋЕЊЕ И АНАЛИЗА ПОВРАТА ХРАСТОВИХ ТРУПАЦА У САВРЕМЕНОМ ПОГОНУ ЗА ПРЕРАДУ ДРВЕТА

Сажетак: У овом раду анализира се квантитативни и квалитативни поврат трупаца храста лужњака (Quercus robur) прерађених у савременом пиланском постројењу „Drvoprodex" д.о.о. у Српцу, Босна и Херцеговина. Истраживање је спроведено комбинацијом директних мјерења током двије радне смјене, обухватајући 185 трупаца, као и анализом производних евиденција предузећа. Трупци су класификовани у три квалитетне класе, уз детаљну анализу димензија и добијених сортимената, укључујући ламеле (класе A–C), елементе рустик класе (R) и фризове. Укупни степен искоришћења, рачунат на основу запремине окорених трупаца, износио је приближно 30%, што је у складу са доњом границом уобичајених индустријских очекивања за производњу храстовог паркета. Фризови су доминирали по количини (2.376 комада), посебно у ширини од 70 mm, док су ламеле и елементи R-класе показали оптималне приносе при ширинама од 135 mm и 215 mm. Регресиона анализа потврдила је статистички значајан позитиван утицај пречника трупца на степен искоришћења и дневни обим прераде. Иако се користи савремена опрема, као што су трачна тестера главног реза, CNC оптимизатор и вишелисне тестере за уздужно резање, поједине старије машине повремено ограничавају продуктивност, што указује на потребу за даљом модернизацијом. Значајно је да око 70% запремине трупаца остаје у облику пиланског отпада, укључујући окорке, обреске, пиљевину и кору. Дају се препоруке за систематску валоризацију ових нуспроизвода: крупни остаци могу се уситњавати за производњу енергије из биомасе или плочастих материјала, док се пиљевина и кора могу користити за производњу пелета или за биохемијску екстракцију (нпр. танина). Унапређење искоришћења остатака допринијело би већој материјалној ефикасности и економској одрживости, усклађујући производњу са принципима циркуларне економије и циљевима производње са минималним отпадом.

Кључне ријечи: пиланска прерада храста, искоришћење трупаца, прерада дрвета.

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