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Evaluation of the potential amount of dendromass left in beech stands of the Little Carpathians after intentional felling and its economic assessment

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Abstract: The paper deals with the determination of the amount of logging residues including merchantable timber volume (brush) left in the beech stands for further use. Logging residues were recorded in all types of intentional felling starting with intentional improvement felling up to 50 years and ending with intentional regeneration felling. The potential amount of biomass left was divided into the share of brush and the share of small wood. The parameter was monitored for 3 years and all measured values were then statistically evaluated and related to 1 m^3 of intentional felling in beech stands. A partial goal of this publication is characterization of economic impacts of the proposal for processing the recorded volume of logging residues left in the beech stands on the forest branch in Smolenice. The economic impacts are characterized in two proposed and mutually compared scenarios. The first scenario considers framework contractors for logging works with their own machines, i.e. by assignments, as a mediation of service invoiced for the assumed amount (m^3) forwarded to the roadside landing, with the ownership of the forwarded dendromass belonging to Lesy SR (Forests of the Slovak Republic). Then, the dendromass is sold from the roadside landing to customers who are going to transport and process it at their own expense. The second scenario considers sales of assumed amounts of left dendromass including brush to customers who will provide for its transport and processing on the identified roadside landing within a set deadline under obligation to return the site to its original condition if there is possible damage. In this case, Lesy SR would be only a control body supervising labour quality and set-up technological procedures.

Keywords: European beech; logging residues; economic analysis; analysis of use; wood chips

Greening of energy operations is only one of the important elements for reducing environmental pollution in advanced countries (Badal 2012). It follows more or less from the viewpoint of the European Environment Agency and its scientific committee that in order to meet the assumption of carbon neutrality of using biomass for energy, which would contribute to reduce the concentration of CO_2 (Wantulok 2011), the overall growth of plants would have to increase to have sufficient amounts of crops for energy purposes while covering all other human needs (Yoshida et al. 2016). Exactly this part of biomass is represented in real conditions by logging residues which are difficult to utilize and process in the standard model of economy. In normal forest management, such residues are usually left to natural decay (Klvač, Delvin 2011). The relation of the processing of logging residues for energy purposes to ecosystem functions of the forest has been studied by a number of authors who monitored negative impacts of using logging residues for energy purposes and on biodiversity (Ranius et al. 2018).

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This commodity is interesting for energy purposes because of the reliability and safety of resources (Yoshida, Sakai 2017). Taking into account felling volumes of brush in the forests, the potential amount of this biomass for energy purposes and its availability are relatively balanced while the latter is not essentially affected by external factors (Teobaldelli et al. 2009). A more complicated situation occurs in the solution of logistics for supplying the forest biomass to power plants. Current practice mainly consists in using wood chips for combustion most frequently in large operations, most frequently modernized power plants (Kotas 2011). Requirements for the capacity of these operations are very high and the sufficient supply and conversion of chips would likely be impossible without government support. Optimal transport distance and storage of forest biomass are subjected to the following rules: truck transport up to the distance of 120 km and railway transport up to the distance of 190 km (Kotas, Vlkanova 2011). Wood chips are stored with the intention to reduce their moisture content and thus to improve their properties for combustion Klvač (2012).

Machines for wood mass transport can currently haul large amounts of both brush and small wood with the transportation of small wood being more difficult with respect to the load size. Forest practice is different and the proportion of small wood is affected in real conditions by economic and technical availability of the dendromass as such (Yavorov et al. 2015). A certain part of wood mass often remains on the "stump" site as economically and technically unusable brush (Neruda et al. 2013). Very important is the effect of the felling site size where the today's trend of lower logging intensity on small areas results in economic disinterest in the production of both energy and fuel wood Šafařík (2012).

The paper deals with the evaluation of the potential amount of dendromass left behind in the beech stands of the Little Carpathians after intentional felling. The potential amount of logging residues left after felling in the forest was divided into the proportion of brush and small wood. The potential amount of left logging residues was related to 1 m^3 of timber mass felled by the traditional stem-only logging method and to the amount of felling already done in the beech stands. Economic impacts on the organizational unit of branch establishment in Smolenice were quantified.

MATERIAL AND METHODS

Units used in the conversion of wood for energy. Forest practice usually works with units of volume and weight; however, a unit essential in power engineering is actual energy yield from the supplied fuel (Stupak et al. 2007). Therefore, suppliers have to understand units considered by their business partners. A unit acceptable for both parties can prevent conflicts between suppliers and customers is atro (dry) ton, i.e. ton of absolute dry matter (Neruda et al. 2013).

Units used in timber sales in forestry practice are as follows: (Suchomel, Gejdoš 2009; Dvořák, Behjou 2011; Fischer 2014):

(1) m^3 – cubic meter of compact wood, or solid (cubic) meter;
(2) prm – stacked cubic meter (stere) – stacked bolts including gaps;
(3) sprms – bulk cubic meter, used for billets, chips, shavings and sawdust;
(4) $prms_s$ – bulk cubic meter of wood, shaken (settled) down by vehicle driving to the customer or to the deck;
(5) Lutro ton – weight of fresh timber;
(6) Atro ton – weight of absolutely dry timber;
(7) Heating value in MJ – heating value of a certain amount (1 m^3, 1 prm etc.) of supplied material during its combustion.

Economic aspects of choosing the type of chipping technology. Labour consumption of chipping of whole trees from juvenile thinning and thinning on the forest road is low because grabbing a bunch of trees by a grapple and its insertion into the chipper is faster than the loading of trees onto the forwarder (Neruda et al. 2013).

The most suitable method for chipping in regeneration fellings using whole trees is chipping on the roadside landing after extraction of logging residues from the felling site by a forwarder (Neruda et al. 2013).

Chipping in the whole-tree fellings does not require the extraction of logging residues by forwarders and is carried out directly on the site of the roadside landing (Klvač 2012). Chipping of stems can be done directly on the felling site if allowed by access for mechanization. If the access of machines is not possible, the stems have to be transported to the roadside landing by forwarders and chipped there (Klvač, Kleibl 2012).

Dumping the produced chips on a deposit and their secondary loading onto hauling vehicles is in-

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appropriate because it increases labour consumption as well as consumption of fuels (Snäll et al. 2017) not mentioning their loss and contamination. A crucial problem is to establish a relatively fair price for energy wood. In Slovakia, the market has been unstable so far and selling prices need not reflect the manufacturer's costs. In order to compare the selling prices, it is possible to use data from neighbouring Austria as the two markets are close and interconnected (Dvořák 2005; Neruda et al. 2013).

The merchandised volume of waste biomass does not correspond to the volume in forest stands. Nevertheless, numerous studies tackling the issue were published (Braekke 1986; Korsmo 1995; Ter-Mikaelian, Korzukhin 1997).

Input data for assessing the accuracy of prescribed logging volume calculation. The initial point in this study was the division of logging planned in beech stands into improvement felling, i.e. thinning up to 50 years and over 50 years, and regeneration felling (Poljanec, Kadunc 2013). Incidental felling is not tackled in detail in this paper because it results in high amounts of logging residues due to frequent depreciation of assortments, even breakage of whole stems by lengthwise splits in windthrows. This is why it would not be representative to determine the amount of logging residues left behind as incidental felling follows the action of various harmful agents, most frequently wind, and has specific features. Considerable differences would arise in the volumes of logging residues because an essential role played in incidental felling caused by wind would include terrain characteristics and subsoil of the terrain for the processing of incidental felling amounts and the amount of logging residues. Improvement felling and regeneration felling were divided according to individual units of the forest spatial division, and units of the forest spatial division were selected not only those of nearly monocultural character of European beech.

Methodology. The volume of left dendromass including the shares of brush and small wood was determined according to the method for cubing felled timber using the calculation according to Huber's formula. Pieces left behind were divided into individual sections of meter lengths using a tape measure. At all times, the measurement was done in the middle of the given section using a calliper and the measured values were rounded to whole numbers to follow the procedure typical of the calculation of wood mass volume by means of Huber's formula. Tools used for the measurement included forestry measuring stick, calliper, tape measure and forestry marking chalk. A procedure for determination of the volume of left dendromass is illustrated in Figure 1.

The equation for the calculation of the volume of left dendromass – Huber's formula (Equation (1) – basic equation, Equation (2) – simplified equation). The volume of wood mass in bark equals the basal area at mid-length in square meters multiplied by the section length in meters.

$$V = g_{1/2} \times l \quad (1)$$

$$V = 0.25 \times \pi \times (d_{1/2})^2 \times l \quad (2)$$

where:

V – volume of wood mass in bark (m^3);

$g_{1/2}$ – basal area at mid-length (m^2);

l – length (m);

$d_{1/2}$ – mid-diameter (m).

For further processing and subsequent analysis of measured values, a field diary was established in electronic form of Microsoft Excel file. The field diary in a shortened form is presented in Figure 2.

Determination of real volumes of felled timber and left logging residues. After the allocation of logging residues to the respective units of the spatial division of the forest, the real volume of felled wood mass was determined in the Microsoft Excel document in which all volumes of left logging residues were recorded, register of logging residues, volumes of prescribed logging and volume of im-

Figure 1. Procedure for determining the volume of left dendromass (photo: Daniš 2018)

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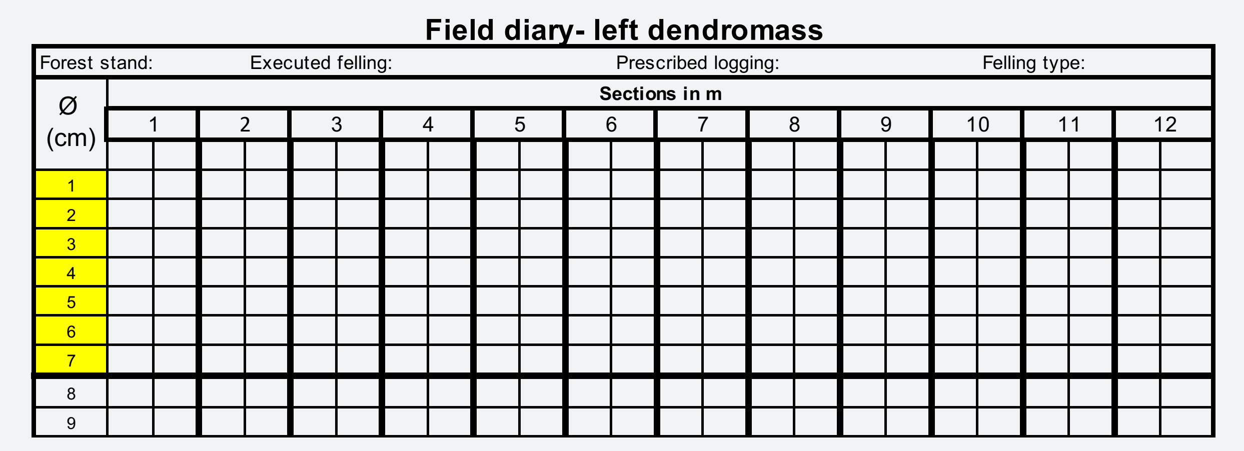

Figure 2. Model of field diary for left dendromass

plemented felling. The total volume of felled wood mass was determined using a simple function for the calculation of felled wood mass and volume of left logging residues (volume of brush logging residues and small wood logging residues calculated and presented in the Microsoft Excel programme (Ver. 2010, 2010) as a common value).

This volume of left logging residues was calculated from the value of median by the ratio of the total sum of left logging residues of brush including small wood and the volume of implemented logging. Then the amount of the left logging residues was calculated, redistributed according to the percentage shares of measured brush and measured small wood.

Proposal for the processing of left logging residues and subsequent calculation of possible revenues according to felling types. A possibility for the processing of logging residues was proposed after implementation of field works and subsequent elaboration of the groundwork document for determination of the amount of left logging residues. The processing procedure is to be based on the volume of logging residues left on the site. In the case of a low volume of up to 20 m^3 (Suchomel, Gejdoš 2009), processing by own capacities is to be preferred. With the adverse terrain configuration and poor or no accessibility for mechanization, logging residues are to be left on the site for spontaneous decomposition and favourable humification in the forest stand. If the volume value is over 20 m^3, processing of logging residues by chipping is to be proposed. The price of one forwarder with the load of 24 t of fresh chips was 1 296 EUR (WebLes 2 2020) at the time of elaboration. With the bulk fresh weight of European beech, the average value of 1 m^3 equals 950–1 000 kg. Hence, we can assume that the expected volume of 20 m^3 (Suchomel, Gejdoš 2009) is represented by one semi-trailer of 24 t in weight. The volumes of logging residues left on the sites of the respective felling systems are to be used for the calculation or average expected volume of left logging residues in m^3. The value is to be a decisive factor in the future determination of the processing method of logging residues.

Outlook and future economic impacts on the branch establishment in Smolenice after the application of research results.

Scenario 1: Basic parameters were data taken from results showing the total amount of felled wood mass. Then the volume of the logging residues of brush and small wood was calculated and the total volume of dendromass for further conversion into chips. The price of the preparation of chips was taken from the forestry information system for calculations, planning, budget and controlling (KRPK program) and was averaged for the objective assessment of costs of dendromass preparation, i.e. at a level of 11.21 $EUR \cdot m^{-3}$ of dendromass prepared on the roadside landing. The calculated volume of prepared dendromass was multiplied by the selling price, i.e. 22.04 $EUR \cdot m^{-3}$, and the costs of the preparation were deducted. The result was the calculated potential profit from dendromass sales.

Scenario 2: Basic parameters were data taken from results showing the total amount of felled wood mass. Then the volume of the logging residues of brush and small wood was calculated and the total volume of dendromass for further conversion into chips. The price of the preparation of chips was zero in this case

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because the sold amount of left dendromass was in m³ in this scenario. The price of dendromass was around 8.4 EUR·m⁻³. The volume of left biomass was multiplied by the price. The result was the calculated potential profit from dendromass sales.

Based on the above items, expected returns could be determined from the logging residues because logging residues have so far been left on the site for spontaneous decay and support to humification in 70% of all units of the forest spatial division. In this way, a new amount of financial resources available for the Smolenice branch establishment in the future can be identified. It is also possible to plan extended processing of logging residues into chips, possibly by own capacity derived from the price per ton of chips because the price of own production of chips stabilized at 10 EUR·m⁻³ in previous years (WebLes 2 2020) and the price of chips has been fluctuating recently. Another possibility can be conveying the logging residues to suppliers who would buy the logging residues to process and sell them on their own. With this philosophy, it is necessary to set the amount of logging residues (Karlsson, Tamminen 2013) generated in the respective felling systems to prevent conveying an uncertain volume of logging residues determined by estimation. Also, the price in EUR for 1 m³ of logging residues should be established for this model. This price should be theoretically lower than the price of own production, which would make it to start below 10 EUR·m⁻³ of logging residues.

RESULTS

The results were obtained for 2017, 2018 and 2019 with the procedures following the methodology for dendromass determination. The individual units of the spatial forest division managed in the systems of intentional regeneration felling, intentional improvement felling and incidental felling were subjected to random investigation. There were altogether 17 units with intentional regeneration felling, 1 unit with incidental felling and 12 units with intentional improvement felling. Already in the initial measurement and also in the subsequent comparison of the measurements with the other units of the spatial division of the forest, the volumes of dendromass (Rahman et al. 2017) including brush left on the sites managed under the system of intentional regeneration felling were often higher than on the sites managed under the other systems, i.e. intentional improvement felling and incidental felling.

Field works for determination of left dendromass were carried out in 2019 for selected units of the spatial division of the forest managed mainly under the systems of intentional regeneration felling and intentional improvement felling. Measurements were taken in 7 units of the spatial division of the forest.

Table 1 shows that the medians of measured brush and small wood in 2019 were 47.13 m³ and 55.93 m³, respectively. Taking into account the volume of felled wood mass, we can derive the theoretical amount of left logging residues suitable for processing into energy wood and chips. In this case, the proportion of energy wood in each 1 m³ of wood mass processed either by using the cut-to-length or by stem only or full-tree method would be 0.11 m³ with the brush/small wood ratio being 45 : 55, i.e. 0.0495 m³/0.0605 m³.

The field works to determine the volume of left dendromass were carried out for the selected units

Table 1. Descriptive statistics from the investigation of all units of the forest spatial division in 2019

	Volume of prescribed harvest	Volume of implemented felling	Brush (measured)	Small wood (measured)
	(m³)			
Mean value	1 010.14	1 074.51	53.04	73.64
Mean value error	269.16	285.50	11.49	16.04
Median	827	906.87	47.13	55.93
Standard deviation	712.14	755.37	30.41	42.44
Range max-min	1 853	2 005.04	84.11	117.56
Minimum	25	25	5.01	10.11
Maximum	1 878	2 030.04	89.12	127.67
Sum	7 071	7 521.55	371.28	515.51

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of the forest spatial division in 2018. In this year, intentional regeneration felling and intentional improvement felling were done; incidental felling was also included. The incidental felling was not mentioned in the research because different masses of wood are generated which would belong to the left dendromass. The wood cannot be processed, because it is broken into pieces of different lengths. Every case of the incidental felling is different. The left dendromass is different in comparison with the prescribed felling. There were altogether 11 units of the forest spatial division surveyed.

Table 2 shows that in 2018 the medians of measured brush and small wood were 6.66 m^3 and 14.95 m^3, resp. Taking into account the volume of felled wood mass, we can derive the theoretical amount of left logging residues suitable for processing as energy wood, i.e. chips. In this case, the share of energy wood in each 1 m^3 of wood mass processed either using the cut-to-length method, stem only, or full-tree method would be 0.07 m^3 with the brush/small wood ratio being 30 : 70, i.e. 0.021 m^3/0.049 m^3.

The field works to determine the volume of left dendromass were carried out for the selected units of the forest spatial division in 2017. In this year, intentional regeneration felling and intentional improvement felling were done. There were altogether 9 units of the forest spatial division surveyed.

Table 3 shows that in 2017 the medians of measured brush and small wood were 21.74 m^3 and 71.54 m^3, resp. Taking into account the volume of felled wood mass, we can derive the theoretical amount of left logging residues suitable for processing as energy wood, i.e. chips. In this case, the share of energy wood in each 1 m^3 of wood mass processed by the assortment method or whole-stem method would be 0.13 m^3 with the brush/small wood ratio being 23 : 77, i.e. 0.0299 m^3/1.001 m^3.

Recapitulation of the survey of left dendromass. The above table shows that the investigation of dendromass left on fellings sites in the selected

Table 2. Descriptive statistics from the investigation of all units of the forest spatial division in 2018

	Volume of prescribed harvest	Volume of implemented felling	Brush (measured)	Small wood (measured)
	(m^3)			
Mean value	528.36	558.97	10.56	34.53
Mean value error	214.66	221.89	3.16	10.88
Median	300	302.35	6.66	14.95
Standard deviation	711.93	735.93	10.50	36.10
Range max-min	2 350	2 432.53	33.36	91.83
Minimum	0	12.54	3.01	10.19
Maximum	2 350	2 445.07	36.37	102.02
Sum	5 812	6 148.7	116.12	379.84

Table 3. Descriptive statistics from the investigation of all units of the forest spatial division in 2017

	Volume of prescribed harvest	Volume of implemented felling	Brush (measured)	Small wood (measured)
	(m^3)			
Mean value	856.22	932.98	34.41	74.02
Mean value error	217.67	235.89	9.27	14.04
Median	679	695.76	21.74	71.54
Standard deviation	653.01	707.66	27.82	42.12
Range max-min	1 845	1 886.77	77.14	121.46
Minimum	175	201.24	10.18	10.9
Maximum	2 020	2 088.01	87.32	132.36
Sum	7 706	8 396.82	309.68	666.14

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units of the forest stand revealed the amount of processable logging residues on average at 0.031 m^3 of brush and 0.069 m^3 of small wood, falling on 1 m^3 of wood mass felled by the cut-to-length method or the stem-only method. The value is the average of three years of research (2017, 2018 and 2019) and was calculated as the arithmetic mean of values presented in Table 4 for the brush volume of left logging residues, the small wood volume of left logging residues and total sum of left logging residues.

The average value is generally applicable to determine the assumed amount of left logging residues in all types of intentional felling even after taking into consideration the above facts. It can be generalized and used in the future as a guideline in determining the amount of left logging residues including brush for other units of the forest spatial division in which intentional improvement felling up to 50 years, intentional improvement felling above 50 years of age and intentional regeneration felling will be carried out. The potential amount of left logging residues falls to the volume of 1 m^3 of wood mass extracted using the assortment method or the method of whole stems. The assumed volume of left logging residues not being a standard value (because it is based on actual measured data), the standard deviation should be max. ± 10% from the total amount of left logging residues including brush and small wood occurring on the felling site.

Possibilities for the conversion of left dendromass and economic impacts. In this last part of the results, a scheme is proposed for the processing of left dendromass including brush and economic consideration for the sales of this commodity in different scenarios. There are two scenarios proposed for the processing of left dendromass including brush:

Scenario 1 is based on the assistance of framework suppliers of logging works with their own machines, i.e. by way of assignments or mediated service billed for an assumed hauled volume in m^3 on the roadside landing with the hauled dendromass falling in the ownership of Lesy SR. Then the dendromass is sold from the landing to the customer who will convert the dendromass and transport it at their own expense.

Scenario 2 is based on the sales of an assumed amount of left dendromass including brush to the customer who will provide for the transport and conversion of dendromass on a determined roadside landing at their own expense and will be obliged subsequently to return the landing into the original condition if this had suffered damage. In this case, the corporation Lesy SR would be only a body supervising the compliance to labour quality and set-up technological procedures.

Table 4. Left dendromass per 1 m^3 of wood mass felled by the assortment method or the whole-stem method

Year	Brush	Small wood	Total
		(m^3)	
2019	0.0495	0.0605	0.11
2018	0.021	0.049	0.07
2017	0.0299	0.1001	0.13
Average	0.0334	0.0691	0.10

For the following calculation, the values of the amount of left dendromass (see Recapitulation of the survey of left dendromass) established in the previous research were needed. The selling prices were taken from the price list of "Energy wood and wooden chips for the branch establishment in Smolenice", i.e. 1 m^3 of logging residues and the price of 1 ton of chips (energy wood). The prices of chips were converted to EUR·m^{-3}, because chips are sold by tons and the remaining dendromass data are in m^3.

The volumes of brush and small wood in the table are taken from the performed survey, i.e. from Table 4 "Left dendromass falling to 1 m^3 of wood mass felled using the assortment method or the method of whole stems". The selling price for 1 m^3 of logging residues already prepared on the roadside landing (energy wood) was calculated by a simple mathematical method for the calculation of direct or indirect sequence of two quantities and one constant, i.e. by the rule of three. Input quantities include the volume weight of chips converted from 1 m^3 of dendromass of European beech, which is claimed (Neruda et al. 2013) to be 408 kg and the price for 1 ton of chips = 54 EUR, taken over from the price list of energy wood for the branch establishment in Smolenice.

Analysis of scenarios for dendromass processing and economic impact. The graph of potentially converted dendromass and economic impacts is related to the surveyed area and all felling operations implemented in that area. Implemented felling includes the total volume of implemented intentional felling in the surveyed area and represents the basic parameter for the calculation of small wood logging residues and brush logging residues. These volumes were calculated by multiplying the average value of small wood and brush from Table 4, and the total vol-

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ume of logging residues was included in the parameter of convertible logging residues. Costs for dendromass were calculated by multiplying the average value for dendromass preparation according to the respective scenarios and the total volume of logging residues. The price of dendromass was calculated for both scenarios by multiplying the selling price for 1 m^3 of logging residues and the price for 1 m^3 of energy wood presented in Table 5 by the total volume of logging residues. Total profit of the respective scenarios was calculated as a difference between total costs and total selling price of dendromass. The values are expressed in m^3 for the parameters of implemented felling, logging residues of brush, logging residues of small wood and convertible logging residues. The parameters of costs for dendromass, price of dendromass and profit are expressed in EUR. The graph shows that the potential profit is in general higher in Scenario 1 than in Scenario 2. However, Scenario 1 includes also the billing of costs for dendromass preparation, which are higher than the potential profit. In Scenario 2, the costs are zero but the potential profit is lower than in Scenario 1. In summary, the logging residues represent about 10.3% in the total volume of implemented felling, more precisely expressed by the ratio of small wood to brush 70:30. These results also follow from Table 4.

Potential profit converted to 1 m^3 of the volume felled using assortment or whole-stem methods was calculated as the ratio of the total profit presented in Figure 3 and the total volume of implemented felling presented in Figure 3. It follows from the Figure 4 that the potential profit related to intentional felling of 1 m^3 of wood mass felled using the whole-stem method or the assortment method ranged at a level of 1.12 EUR·m^{-3} in Scenario 1. The potential profit in Scenario 2 is lower (0.87 EUR·m^{-3}). In terms of costs, Scenario 2 reaches the zero value while Scenario 1 reaches the value of 11.21 EUR·m^{-3}. The costs include the preparation of left dendromass for further conversion, i.e. loading of the left dendromass including its possible chainsaw cross-cutting for easier transport and the following dendromass transportation to the roadside landing and stacking.

Table 5. Price of energy wood/logging residues – branch establishment Smolenice

Commodity	EUR	Weight (kg)
1 m^3 of logging residues	8.4	–
1 t of chips (energy wood)	54	1 000
1 m^3 of logging residues (fire wood)	22.04	408

DISCUSSION AND CONCLUSION

The logging residues composed of brush and small wood are processed into wood chips. Processing has the advantage that the area remains clean after harvesting and is ready for either subsequent harvesting or afforestation, and the utilization of the mass of brush and small wood is maximized (Han, Murphy 2011).

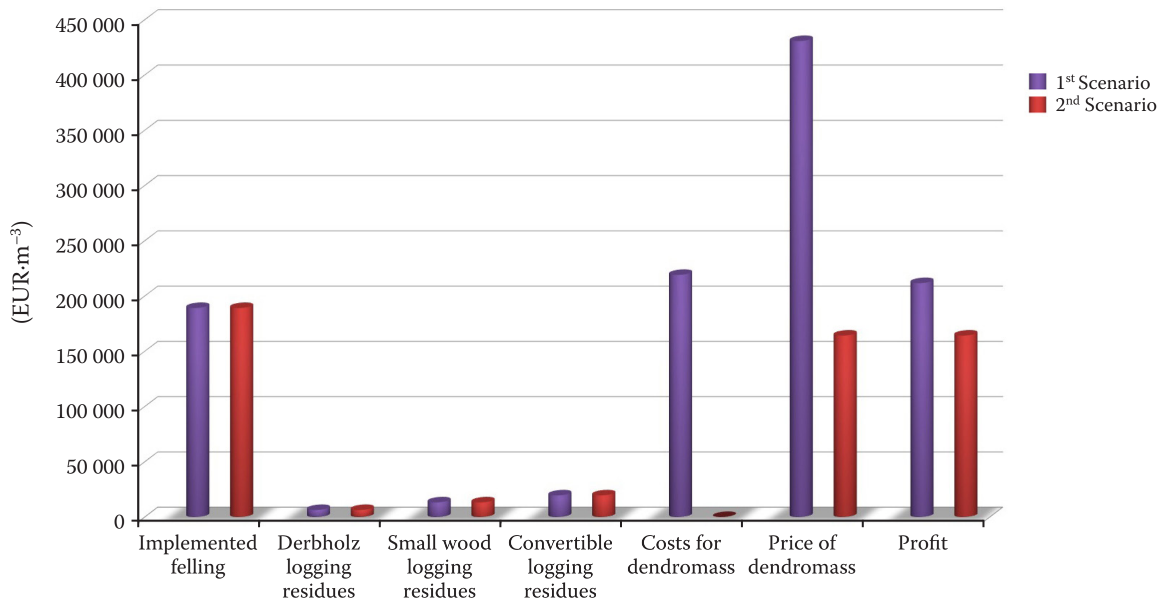

Figure 3. Graph of potential dendromass and potential economic impacts in the surveyed area

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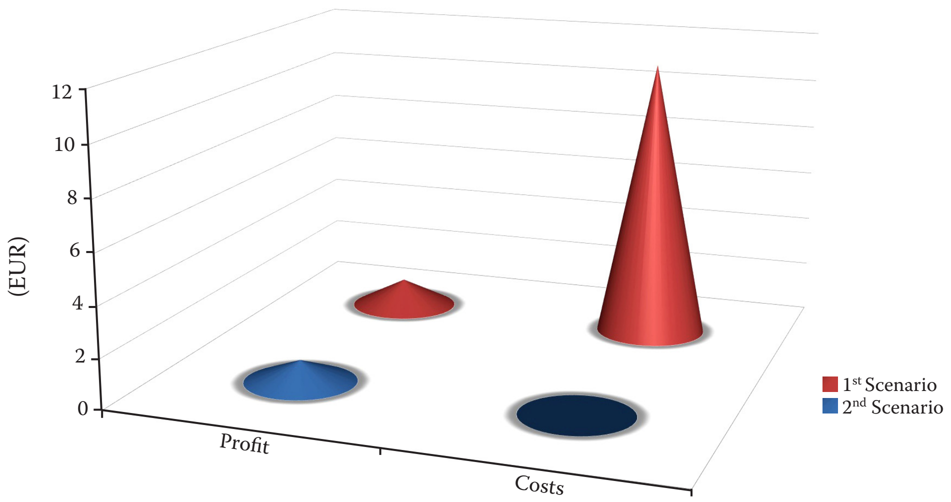

Figure 4. Graph of potential profit and costs of dendromass expressed in EUR for implemented intentional felling in the amount of 1 m^3

The combination of both proposed scenarios would be an appropriate way. As the net profit from logging residues is around 1 EUR·m^{-3} of wood chips, this amount for processed logging residues is interesting after adding to the already harvested wood using the assortment method or the whole stem method, where the average profit is at 10 EUR·m^{-3}.

The current situation suits the contractors, as there is always a larger volume of wood than the prescribed logging and they are not forced to thoroughly process the brush mass. This is also confirmed by the investigation of the left logging residues, which resulted in an average value of 0.03 m^3 in the logging residues for 3 years of investigation. This value is at the level of 3%, but it is only average and may vary from one type of logging to another (Johansson et al. 2006). This is not an exact Figure, but it is based on the actual measured data and therefore the deviation should be a maximum of ± 10% of the value of the total volume of left logging residues including brush and small wood. In a certified methodology for determining the amount of residual dendromass for a specific workplace developed by Foresta SG, a.s. Vsetín it is stated that the necessary outputs and potential possible values are necessary, but real values are lower, mainly for work planning reasons (Štorek et al. 2017). It is further stated (Štorek et al. 2017) that the volume entered in this way is very indeterminate and very complicated to quantify with respect to the production capacity of production technologies, because the reality differs from the relation of 1 m^3 of brush = 1 prms of chips by up to ± 50%. Problems could arise when converting the value of prms to the value in m^3 during the normal forestry operation, as the quantity in m^3 would be sold and the taking-over protocol is in units of prms.

When proposing the use of logging residues as forest chips, an economic impact on the Smolenice branch was developed. On initial inspection, the value of the net profit from processable dendromass may appear to be small as it is around EUR 1, but the value of the net profit from the sale of high-quality beech logs is 10 EUR·m^{-3}. When these two values are compared, the value of the net profit from the sale of the remaining logging residues is not as low as it seems to be at first. When multiplied by the amount of harvested timber, the values of the net profit are based on sold logging residues in hundreds of thousands of euros. In comparison with the already developed methodology for determining the amount of residual dendromass, it is stated Štorek et al. (2017), the average selling price at the level of 20 CZK·m^{-3}, which is 0.8 EUR·m^{-3}. The value of 8.4 EUR·m^{-3} was determined in agreement with the management of Smolenice and was based on the selling price for 1 m^3 of self-production, but was halved by two, in order to get the perfect cleaning of the area, which is impossible during self-production. This amount fell on processing under the second scenario, i.e., direct sale of all dendromass left in the logging area. In this second proposed scenario, there may be doubts about thorough processing and in practice it may result in a lower share of the processing of brush from

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harvested trees and the consequent possible loading of the edge trees which are not intended for felling. In the first proposed scenario, where the collection is mediated through suppliers of work in logging activities, compared to the second scenario, there are also costs of the preparation of dendromass. Despite these costs, the advantage is again that the possible lower yield of brush is minimized and this process is easier to control. When comparing the two scenarios, the first scenario appears to be more profitable, but there may be a risk of so-called "drowning of profits" in the dendromass supply and possible slowdown with possible profit reduction, as dendromass degrades over time and natural volume decomposes. A similar conclusion was drawn by Rahman et al. (2017), who stated that dendromass can only be prepared temporarily, as a cost item without any profit. In the second scenario, the money would be paid out directly without further need for costs, but at the expense of a lower profit from the sale of this commodity.

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