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SENSITIVE AND DIFFERENTIAL ANALYSIS COSTS OF ENERGY USAGE OF STRAW COMPILED BY ROLLED BALES SYSTEM

SENZITIVNA I DIFERENCIJALNA ANALIZA TROŠKOVA ENERGETSKOG KORIŠĆENJA SLAME SPREMLJENE SISTEMOM VALJKASTIH BALA

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SUMMARY

Basic parameter which largely determines cost-effectiveness of exploitation of harvest residuals for energy purposes used system rolled bales is the ratio between the price of energy thus generated and the price of energy from alternative sources, or coal in this casa. Since classical cost analysis yields only static picture, quality assessment is possible through sensitive and differential cost analysis. Sensitive analysis indicates that, economically, the present harvesting system is relatively resistant to price fluctuations for crucial inputs. On the other hand, there is a relatively high sensitivity to changes in efficiency of drive and attachment units. Differential calculation yields the sum of differential costs which is 43% lower than the total costs. According to that, there are visible economic advantages to using straw as energy resource.

Key words: *rolled bales, energy, costs, sensitive analysis, differential analysis.*

REZIME

Osnovni parametar koji određuje ekonomičnost energetskog korišćenja žetvenih ostataka spremljenih sistemom valjkastih bala je odnos cene energije koja se na ovaj način dobija i cene energije iz alternativnog izvora, odnosno uglja. Budući sa klasična analiza troškova predstavlja statičku sliku procesa do ocene kvaliteta posmatranog rešenja moguće je doći kroz senzitivnu i diferencijalnu analizu troškova. Senzitivna analiza ukazuje da je posmatrani sistem ubiranja sa ekonomske strane relativno rezistentan na promene cena najvažnijih inputa. Sa druge strane postoji relativno visoka osetljivost na promene učinaka pogonskih i priključnih mašina. Izrada diferencijalne kalkulacije daje sumu diferencijalnih troškova za 43% nižu od ukupnih troškova. Na osnovu toga očito je postojanje ekonomskih prednosti pri korišćenju slame kao izvora energije.

Ključne reči: *valjkaste bale, energija, troškovi, senzitivna, diferencijalna analiza.*

INTRODUCTION

Calculation of expenses made only through the calculation of the overall cost, basically has static character. Accordingly, the real effects of certain solution cannot be assessed in such a way. The testing of the possibility of usage of particular technical-technological solution is thus made through the sensitive and differential cost analysis. Sensitive analysis should provide an answer about the change of costs in conditions of changing significant value or technical-technological parameters of the production process. Sensitive analysis is valuable support of the operational planning since the obtained data enable efficient predictions and follow up of costs and their changes, and influence the improvement of the overall business in such a way. Apart from that, these analyses should help in making conclusions about the safety of the solutions defined by the calculations and plans. In the interpretation of the results of the sensitive analysis it is very important to be familiar with the probability of the change of certain tested factors, and interpret the results accordingly. Introduction of a new technologic process, on the other side, does not impact all the costs of the business, but mainly influence the increase in the variable expenses (in case there is no change of capacity or provision of new means during the introduction of the process). An adequate analysis of the changes that will occur can only be made through the development of the differential calculation with accountancy of only new costs.

METHOD OF WORK AND DATA SOURCES

The application of the sensitive analysis of the costs in the first step requires defining of parameters significant for economic effects of the exploitation. After that, the analysis of the intensity of change of total cost depending on the defined parameters is conducted. In the specific case, defining of the influential factors is made based on the cost structure obtained in the calculation of total costs. Sensitive analysis is made for the cases of change (increase or decrease): in prices of fuel and motor oils, interest rates, salaries of full-time employees, wages for seasonal i.e. occasional workers and achieved performances. Testing of the obtained results with sensitive analysis is conducted with the assumption that the values of the stated elements increase or decrease by 30%.

The assumption in making differential calculation is that the observed households have all required operating and binding machines, their differential expenses are calculated after the division to fixed costs. Amortisation costs, interest, insurance costs, accommodation costs, tax and charges are not included into calculation; maintenance expenses are calculated as 60% of the planned costs, costs of operational fuel, motor oil, differential and lubricating oil and tyres are calculate in total. Costs of full time labouring power are not calculated; while the costs of seasonal manpower are calculate in total. Costs of combustion for instalments using coal are not calculated, only the correction is made for the losses in combustion. For the instalments com-

busting straw, cost calculation is made according to the total costs, whereby the costs of salaries are omitted.

REASEARCH RESULTS WITH THE DISCUSSION

The impact of the change in prices for the operational fuel and motor oil has been analysed with the assumption of the 30% increase in price. The price of fuel increases from 105 to 137 RDS per litre, and the price of oil from 180 to 234 RDS per litre. The observed costs increase by 13,77% and make 1.914,04 RDS per ton of pressured straw. Thus, the costs of obtaining 10.000 kJ of energy increase by 11,68% and make 2.283,02 RDS (Table 1). It is obvious that the transportation costs actualise the biggest increase, while the costs of materials do not increase.

Table 1. Costs increase of preparing and energetic usage of straw compiled by rolled bales system

Tabela 1. Povećanje troškova spremanja i energetskog iskorišćavanja slame spremljene sistemom valjkastih bala

Cost categorization	Unite of measure/ Jedinica	Basic solution costs/ Troškovi baznog rešenja (RSD)	Tested solution costs/ Troškovi testiranog rešenja (RSD)	Increase of costs/ Rast troškova (%)
Pressure/ Baliranje	RSD /ton	485,42	546,65	12,61
Material/Materijal	RSD /ton	57,00	57,00	0,00
Lading/Utovar	RSD /ton	593,01	683,39	15,24
Transport/Transport	RSD /ton	110,98	129,81	16,97
Kaying/Manipulacija	RSD /ton	155,59	178,18	14,52
Storage/Skladištenje	RSD /ton	280,40	319,01	13,77
Total pressured straw/ Ukupno balirana slama	RSD /ton	1.682,40	1.914,04	13,77
Costs of producing 10.000 kJ of energy/Troškovi dobijanja 10.000 kJ energije	RSD	2.044,31	2.283,02	11,68

With such increase of costs, the energy obtained by the combustion of the rolled bales is by 25,83% cheaper than the energy obtained from the stone coal. In the observed case, only the costs of the material do not show any growth. The total growth is higher than the growth of costs when small square bales system is used, but the obtained results are still more favourable (Zekić and Jovanović, 2008).

The impact of the interest rate change has also been analysed, with the assumed growth by 30%. With this growth, the interest rate increases from 6 to 7,80 RSD, causing the increase of compiling of the pressured straw by 2,11%. Accordingly, the costs now make 1.717,97 RSD per ton of pressured straw. In that, the costs of obtaining 10.000 kJ of energy increase by 2,43% and make 2.093,97 RSD (Table 2).

With this increase of costs, the energy obtained by combusting rolled bales is still by 32,18% cheaper than the energy obtained from stone coal, although it is obvious that this technology is more sensitive to the changes in interest rate, due to the engaged technical equipment. The biggest growth is also realised in pressuring expenses, since machines of highest value are engaged during this operation

The following analysis refers to the increase of full time employees and wages of seasonal or occasional workers. The foreseen growth of wages is 30% , and the change of costs in case of rolled bales system is given in the Table 3.

Table 2. Costs increase of preparing and energetic usage of straw compiled by rolled bales system

Tabela 2. Povećanje troškova spremanja i energetskog iskorišćavanja slame spremljene sistemom valjkastih bala

Cost categorization/Kategorija troškova	Unite of measure/ Jedinica	Basic solution costs/ Troškovi baznog rešenja (RSD)	Tested solution costs/ Troškovi testiranog rešenja (RSD)	Increase of costs/ Rast troškova (%)
Pressure/ Baliranje	RSD /ton	485,42	498,57	2,71
Material/Materijal	RSD /ton	57,00	57,00	0,00
Lading/Utovar	RSD /ton	593,01	604,41	1,92
Transport/Transport	RSD /ton	110,98	112,64	1,49
Kaying/Manipulacija	RSD /ton	155,59	159,02	2,21
Storage/Skladištenje	RSD /ton	280,40	286,33	2,11
Total pressured straw/ Ukupno balirana slama	RSD /ton	1.682,40	1.717,97	2,11
Costs of producing 10.000 kJ of energy/Troškovi dobijanja 10.000 kJ energije	RSD	2.044,31	2.093,97	2,43

Table 3. Costs increase of preparing and energetic usage of straw compiled by rolled bales system

Tabela 3. Povećanje troškova spremanja i energetskog iskorišćavanja slame spremljene sistemom valjkastih bala

Cost categorization/Kategorija troškova	Unite of measure/ Jedinica	Basic solution costs/ Troškovi baznog rešenja (RSD)	Tested solution costs/ Troškovi testiranog rešenja (RSD)	Increase of costs/ Rast troškova (%)
Pressure/ Baliranje	RSD /ton	485,42	494,26	1,82
Material/Materijal	RSD /ton	57,00	57,00	0,00
Lading/Utovar	RSD /ton	593,01	617,11	4,06
Transport/Transport	RSD /ton	110,98	116,00	4,52
Kaying/Manipulacija	RSD /ton	155,59	161,61	3,87
Storage/Skladištenje	RSD /ton	280,40	289,20	3,14
Total pressured straw/ Ukupno balirana slama	RSD /ton	1.682,40	1.735,17	3,14
Costs of producing 10.000 kJ of energy/Troškovi dobijanja 10.000 kJ energije	RSD	2.044,31	2.136,28	4,50

The energy obtained by combusting rolled bales in this case is by 31,43% cheaper then the energy obtained from the stone coal. It is apparent that the rolled bales system is, from the economic point of view, not sensitive to the change of the day wage due to the low work involvement.

Sensitive analysis can also be used for testing technological features of the observed processes, i.e. for the analysis of the change of economic indicators depending on the change of the technological process output. According to the previously presented model, decrease of the outputs by 30% has been pro-

jected. The decrease of the normative has been deduced for the total technological process, except the combustion process. In the case of rolled bales system, straw compiling costs increase by 41,11% and make 2.374,12 RSD per ton. Thereby, the costs of obtaining 10.000 kJ of energy increase by 34,87% and come to 2.757,15 RSD (Table 4).

Table 4. Costs increase of preparing and energetic usage of straw compiled by rolled bales system

Tabela 4. Povećanje troškova spremanja i energetskog iskorišćavanja slame spremljene sistemom valjkastih bala

Cost categorization/Kategorija troškova	Unite of measure/ Jedinica	Basic solution costs/ Troškovi baznog rešenja (RSD)	Tested solution costs/ Troškovi testiranog rešenja (RSD)	Increase of costs/ Rast troškova (%)
Pressure/ Baliranje	RSD /ton	485,42	693,46	42,86
Material/Materijal	RSD /ton	57,00	57,00	0,00
Lading/Utovar	RSD /ton	593,01	847,16	42,86
Transport/Transport	RSD /ton	110,98	158,54	42,86
Kaying/Manipulacija	RSD /ton	155,59	222,27	42,86
Storage/Skladištenje	RSD /ton	280,40	395,69	41,11
Total pressured straw/ Ukupno balirana slama	RSD /ton	1.682,40	2.374,12	41,11
Costs of producing 10.000 kJ of energy/Troškovi dobijanja 10.000 kJ energije	RSD	2.044,31	2.757,15	34,87

With such output changes, the energy obtained by the combustion of rolled bales is still by 10,43% cheaper than the energy obtained from the stone coal. Further testing has shown that only the decrease in the output of operational and binding machines of over 40% can jeopardise the economy of this process.

Economic aspects of certain changes in the agriculture can most comprehensively and in best quality be analysed by differential calculations. In order to come to accurate consequences of such a change to an enterprise, it is necessary to perform the analysis of costs, i.e. of their change in case of introducing energy exploitation of the straw. Differential analysis of costs, performed after the described methodology in case of compiling of the straw by the rolled baled system is given in the Table 5.

Table 5. Total and differential cost of energetic usage straw compiled by rolled bales system

Tabela 5. Ukupni i diferencijalni troškovi energetske upotrebe slame spremljene u obliku valjkastih bala

Cost categorization according to operations	Total costs/Ukupni troškovi		Differential costs/Diferencijalni trošk	
	Costs/Troškovi (RSD /ton)	Structure/Struktura (%)	Costs/Troškovi (RSD /ton)	Structure/Struktura (%)
Pressure/ Baliranje	485,42	28,85	251,99	26,30
Material/Materijal	57,00	3,39	57,00	5,95
Lading/Utovar	593,01	35,25	336,96	35,17
Transport/Transport	110,98	6,60	68,61	7,16
Kaying/Manipulacija	155,59	9,25	83,84	8,75
Storage/Skladištenje	280,40	16,67	159,68	16,67
Total/Ukupno	1.682,40	100,00	958,07	100,00

Differential costs of the obtained energy, gained by the usage of the rolled bales system, calculated in this way are lower than the previously given results and comprise 1.172,60 RSD per 10.000 kJ of the gained energy (Table 6).

Table 6. Total and differential price of energy produced by combusting rolled bales

Tabela 6. Ukupna i diferencijalna cena energije proizvedene sagorevanjem valjkastih bala

Description/Opis	Unite of measure/Jedinica mere	Total value/Ukupna vrednost (RSD)	Differential value/Diferencijalna vrednost (RSD)
Costs price of straw/Cena koštanja slame	d/ton	1.682,40	958,07
Costs of combustion (corrected)/Troškovi sagorevanja (korigovani)	d/ton	995,65	578,03
Total costs of producing energy/Ukupni troškovi dobijanja energije	d/ton	2.678,05	1.536,10
Energetic value of flue/Energetska vrednost goriva	kJ/ton	13.100,00	13.100,00
Costs of producing 10.000 kJ of energy/Troškovi dobijanja 10.000 kJ energije	RSD	**2.044,31**	**1.172,60**

It is important to emphasise that in this case, it is not about the overall costs, but only about the increase of costs compared to the basic solution. According to the calculation that has been made, differential costs are approximately 43% lower than the total costs.

CONCLUSION

As the final conclusion of the deduced sensitive analyses it is possible to say that the system of ingathering by the rolled bales, from the economic point of view, relatively resistant to changes in prices of the most important inputs. On the other side, there is high sensitivity to the changes in the operational and binding machines outputs. Accordingly, the observed deviations are significant enough and the process of introducing the technique of energy exploitation of the straw must not be based solely on the implementation of the analytical calculation and clarification of total costs. On the other hand, great connection of certain production lines, high level of fixed costs and significant latent reserves dictate the application of the differential calculation. Calculation presented in the previous text is quite an optimistic assumption, whereby the sum of differential costs is by 43% lower than total costs, and the saving compared to the energy obtained from the coal is almost 60%. On the other side, the presented calculation refers to the households that are highly equipped with operational and binding machines and certain capacity reserves. Accordingly, the result confirmed by the application of the differential analysis is largely the consequence of the exploitation of the enterprise's reserves and neutralisation of hidden losses. Apart from that, it is important to know that the positioning of the differential calculation, i.e. determination of differential costs does not have universal character, since during the development of the differential calculation the analysis of the changes that solely depend on the features of the household and the type of changes is conducted. Regardless of that, the conducted analysis indicates that there are significant economic advantages in the usage of the straw as the source of energy.

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