

MAPIRANJE POTENCIJALA POLJOPRIVREDNE I ŠUMSKE BIOMASE U HRVATSKOJ

MAPPING OF AGRICULTURAL AND WOOD BIOMASS POTENTIAL IN CROATIA

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Sadržaj: Cilj ove studije je izračun tehnički potencijala poljoprivredne i šumske biomase u Hrvatskoj. Potencijal poljoprivredne biomase računa se za pšeničnu slamu i kukuruzovinu. Za izračun količine slame i kukuruzovine koristi se omjer slame prema zrnu, a za slamu se koristi vrijednost od 1,6 dok je taj omjer za kukuruz 0,8. Tehnički potencijal slame dobivamo tako što od ukupne količine slame koju dobijemo množenjem količine zrna sa omjerom 1,6 oduzmemo potrebnu količinu slame za zaštitu tla od erozije i za stočarsku proizvodnju dok se kod izračuna tehničkog potencijala kukuruzovine pretpostavlja da 50% od ukupne količine slame potrebno ostaviti na poljima za zaštitu tla i gnojenje i da je tehnički potencijal kukuruzovine 30%. Kod izračuna količine šumskih ostataka koristi se pretpostavka da 12% od ukupne mase posječenog drveta predstavlja korisni šumski ostatak koji se uz naknadnu obradu može koristiti u energetske svrhe.

Abstract

In the time of increasing price of fossil fuels more and more countries are turning to the renewable resources of energy, especially to biomass, for production of heat and electricity. Biomass fuels used in the production of heat and electricity are wheat, oat, and barley straw corn stover and wood chips from forest residual and wood industry. The focus of this study was to estimate sustainably removable residue from wheat straw, corn stover and forest in Croatian counties and how much energy can be produced in counties. The methodology used for estimating wheat straw residual is based on minimum straw cover required for soil protection from wind and water erosion and minimum requirements for animal feeding and bedding. For estimating residual from corn technical potential of 30% is used and requirements for soil protection from wind and water erosion was estimated at 50% from all biomass of corn stover. Methodology used for estimating forest residual is based on the assumption that 12% of the total mass of trees cut is forest residual which can be used for production of wood chip. Results of this study indicate an annual average production of over 1.2 million tons of wheat straw and 1.6 million tons of corn stover in Croatia. Technical potential of corn stover is 0.4 million tons and potential of wheat straw is 0.75 million tons. Mass of cut down wood in Croatia is over 5 million cubic meters and technical potential of forest residual is 0.7 million cubic meters.

Key words:

Corn stover, wheat straw, forest residual, biomass, technical potential, wood chip

1. INTRODUCTION

This paper analyses potential biomass in Croatian counties. Croatian counties collectively produce more than 2.8 Mt of wheat and maize grain annual and cut over 4.5 million cubic meters state owned forest. The grain production of wheat and maize were converted to equivalent straw and stover production by using straw to grain mass ratio. For wheat straw this ratio was 1.6 and for maize stover were 0.8. Production of cereals straws in this paper was derived using data from Croatian Statistics yearbook of cultivated area, yield and total grain production in period of 4 year (2002-2006). Total quantity wheat straw which can be produced in Croatian field was reduced for amount needed for soil protection from wind and water erosion and amount needed for livestock demand. The amount straw needed for wind and water erosion were 1.5 t/ha and amount needed for livestock demand was 0.75 t/cattle. Requirements for corn stover soil protection from wind and water erosion were estimated at 50% from all biomass of corn stover and technical potential for corn of 30% is used. The total available wheat straw was calculated to be about 748 kt with annual variation from maximum 1.1 Mt to minimum of 575 kt. The total available corn stover was calculated to be about 400kt with annual variation from maximum 480kt to minimum of 300kt. In the period of 2006-2015 in Croatian forest planned to be cut around 5.8 million cubic meters of tree yearly and using assumption that 12% of the total mass of trees cut is forest residual we get over 690.000 cubic meters of forest residual which can be used for industrial purposes.

2. AGRICULTURAL BIOMASS IN CROATIA

2.1 Agricultural residues

Crop residues in this paper include straw from wheat and corn residue. Table 1. list the cultivated area, yield and total production of wheat and maize grain in Croatia. The data are averaged over 4 years from 2002 to 2007. Statistical data for 2004 are not available and that is reason why is 4 year periods used in this paper for calculating average, maximal and minimal production of wheat and maize grain.

Table 1. Cultivated area, production and yield of wheat and maize grains in the Croatia for 4 years (2002-2006) [1].

		Wheat production			Maize production		
		Area, ha	Production, t	Yield, t/ha	Area, ha	Production, t	Yield, t/ha
Croatia	Avg	190.382	750.946	3,97	357.278	2.053.043	5,86
	Max	233.611	988.175	4,58	407.455	2.501.774	6,92
	Min	146.411	601.748	2,96	296.521	1.569.150	3,86

Straw production was estimated from straw to cereal grain ratio. For wheat is used 1.6 [2] straw to wheat grain ratio and for maize is used 0.8 [3] stover to maize grain ratio. The quantities of straw for wheat and stover for maize were calculated by multiplying the grain production of wheat and maize listed in Table 1 by straw to grain ratio for wheat 1.6 and for maize 0.8. Table 2 list calculated amount of straw for corn and maize.

Table 2. Estimation of wheat straw and maize stover production in Croatia for years 2002-2006 based on straw to grain mass ratio and grain production from Table 1.

		Wheat straw	Maize stover
		Total, t	Total, t
Croatia	Avg.	1.201.513	1.642.434
	Max.	1.581.080	2.001.419
	Min.	962.797	1.255.320

2.2 Technical potential of agricultural biomass

Table 2 list total straw production but not all of the straw produced on the field can be removed. One part must be left on the field for the wind and water erosion control and one part of straw is using for bedding and feeding of livestock. In this paper assumption for wind and water erosion for wheat straw was 1.5 t/ha [2] and with that amount of straw left on the field ground cover is 60 % [4]. Also is used amount of 0.75t/cow [2] for animal bedding and feeding, mostly for raising beef and dairy cattle. Average number cattle in Croatia are 224.000 [5]. Data in Table 3 show the amount of wheat straw which must left on the field for soil protection from wind and water erosion and amount of straw for livestock support in Croatia.

Table 3. Total straw needed for soil protection from wind and water erosion and for livestock support in Croatia

		Wheat straw needed for soil protection	Wheat straw needed for livestock support
		Total, t	Total, t
Croatia	Avg.	285.573	167.836
	Max.	350.417	
	Min.	219.617	

Technical potential shown in Table 4 was calculated after deductions amount of straw needed for soil protection and for livestock use from total straw production shown in Table 2.

Table 4. Total production of wheat straw on Croatian field and total technical potential of wheat straw after deductions for soil conservation and livestock.

		Wheat straw	
		Total straw, t	Technical potential, t
Croatia	Avg.	1.201.513	748.104
	Max.	1.581.080	1.062.828
	Min.	962.797	575.345

Assumption of 50% [4] was used for calculating amount of corn stover which must be left on the field for the protection from wind and water erosion and 80% [6] corn stover can be harvested. For calculating technical potential in this paper was used assumption of 30% [7]. Data in Table 5 show total production of corn stover and technical potential of stover in Croatia.

Table 5. Total production of corn stover on Croatian field and total technical potential of stover after deductions for soil conservation and harvesting

		Corn stover	
		Total maize stover, t	Technical potential, t
Croatia	Avg.	1.642.434	394.184
	Max.	2.001.419	480.341
	Min.	1.255.320	301.277

3. FOREST BIOMASS IN CROATIA

3.1 Forest residues

Potential supplies of forest residue from Croatian forest are based on current national felling. In this paper forest residual are only calculated for state owned forests and residual for private forests are not calculated. Table 6 lists forest area and forest land, wood stock, yearly growth and yearly felling in selected Croatian counties for state owned forests which are managed by "Hrvatske Šume" d.o.o. Data listed in Table 6 are for 10 years period from 2006 to 2015.

Table 6. forest area and forest land, wood stock, yearly growth and yearly felling in selected Croatian counties for state owned forests which are managed by "Hrvatske Šume" d.o.o. [8].

Counties	Forest area and forest land	Wood stock	Yearly growth	Yearly felling
	1.000 ha	1.000 m ³	1.000 m ³	1.000 m ³
Zagreb	62	15.000	400	272
Sisak-Moslavina	151	36.700	1.100	686
Karlovac	111	23.800	566	470
Koprivnica-Križevci	42	11.650	305	265
Bjelovar-Bilogora	86	24.200	635	500
Primorje-Gorski Kotar	170	35.450	682	605
Lika-Senj	306	44.920	1.050	680
Virovitica-Podravina	64	18.140	520	400
Požega-Slavonija	78	16.660	450	290
Brod-Posavina	53	13.680	380	300
Osijek-Baranja	114	23.000	770	620
Vukovar-Syrmia	69	20.240	545	450
Total "Hrvatske Šume" d.o.o.	2.020	302.420	7.960	5.800

Assumption for calculating forest residue was that 12% [8] of the total mass of trees cut is forest residual which can be used for industry purpose. Table 7 shown total quantity of forest residual which is result of multiplying yearly felling and assumption that 12% of total mass of trees cut is forest residue.

Table 7. Total quantities of forest residual in Croatian stat owned forests which are managed by “Hrvatske Šume” d.o.o.

Counties	Forest residual
	1.000 m ³
Zagreb	33
Sisak-Moslavina	83
Karlovac	55
Koprivnica-Križevci	30
Bjelovar-Bilogora	60
Primorje-Gorski Kotar	70
Lika-Senj	80
Virovitica-Podravina	45
Požega-Slavonija	36
Brod-Posavina	37
Osijek-Baranja	75
Vukovar-Syrmia	50
Total “Hrvatske Šume” d.o.o.	690

4. CONCLUSION

Results of this study indicate that a significant quantity of removable wheat straw and corn stover exist in Croatian counties, also there are significant quantity of forest residual. Average quantities of removable wheat straw are 740 kt, corn stover 400 kt and removable quantities of forest residual calculated in this study are 690.000 cubic meters. This residual from agriculture and forests could contribute to the total production of heat and electricity. This residual should be regarded as interesting fuel in production of heat and electricity in Croatia in nearly future.

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