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RENEWABLE ENERGY SOURCES AS A PATH TO SUSTAINABILITY: BIOMASS ENERGY POTENTIAL IN AGRICULTURE

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Abstract: *The main purpose of this paper is to identify and discuss challenges and opportunities of using biomass in agriculture. The importance of biomass supply chain is thus emphasized. The main objective is to identify all the challenges of assessing the potential of biomass as well as the challenges in collection and storage of biomass residuals in agriculture on the example of Croatia. Methodology framework for determining potential locations for collection and logistics centers and establishment of the value chain is proposed and is based on the Herfindahl-Hirschman Index (HHI) and concentration rates by counties. The scientific contribution of the paper is seen in filling the research gap on biomass potential and organization of the biomass supply chain. Research results and policy recommendations can be informative for government decision making as well as for designing and implementing national bioeconomy strategy, but they can also be useful for analyzing the biomass supply chain and designing new business models with the purpose of efficiently using biomass potential.*

Keywords: *sustainable development, biomass potential, Croatia, renewable energy sources, Herfindahl-Hirschman Index*

JEL classification: *F6, F1.*

INTRODUCTION

Renewable energy sources are becoming an integral part of energy sustainability. Global and regional energy requirements put emphasis on decreasing greenhouse emissions and replacing traditional non-renewable sources with renewable ones. Trend of increased use of bioenergy has been recorded in recent years, especially in developing countries with limited access to affordable, accessible, and reliable energy sources

(Ilić et al., 2018). The peculiarities of biomass as an energy source in relation to other forms include the possibility of its use beyond the place of origin, the possibility of storage, allowing a continuous process of energy production, and satisfying sustainability criteria.

The main objective of this paper is to identify potential milestones in biomass use and to discuss all the challenges of assessing the potential of biomass in the Republic of Croatia. Furthermore, organization of the supply chain is analyzed, specifically collection and storage of biomass remaining after the production and processing of agricultural products is considered. The analysis of the biomass potential was based on data from the national Register of Agricultural Holdings. Estimation of potential locations for collection and logistics centers was done using the Herfindahl-Hirschman Index (HHI) by counties. The scientific contribution of the paper is seen in filling the research gap on biomass potential and organization of the biomass supply chain.

The paper consists of five parts. After the introduction follows the literature review in which recent studies on biomass potential, supply chains and plant locations were included. The third part of the paper is the methodology and in the fourth part results and discussion are provided. The fifth part is the conclusion.

LITERATURE REVIEW

The EU's Common Agricultural Policy (CAP) shapes international supply chains through production and consumption effects (Rudolf and Wieck, 2020). Agricultural supply chains affect various sustainability dimensions, mostly those focusing on food security and availability. Complex supply chains with many parties involved have been prevailing so far. In recent years, sustainable development goals have emphasized the need for shorter supply chains that can complement traditional long chains and modify them in a way they become important drivers of sustainable and equal development (Hoang, 2021).

At the European Union (EU), the New Industrial Strategy for Europe was launched in 2020 with the main aim of ensuring climate neutrality and digital leadership. To make the EU more competitive, greener, and more circular, it is necessary to ensure a secure supply of clean and affordable energy and raw materials. Renewable energy sources are therefore the key factor in ensuring the EU's energy independence. All European countries have decided to incorporate into their energy development strategies and plans to significantly increase the use of renewable energy sources and to implement the necessary legislative framework for implementation of those plans. Having in mind different renewable energy projects, the following three main incentive measures can be distinguished in the EU: guaranteed tariffs, mandatory quotas in combination with green certificates and the system of public tenders/contracts, and in addition to the above measures there are various complementary mechanisms such as investment subsidies and fiscal measures (Raguzin, 2011).

Government policies and incentives affect the biomass supply chains in the long-term. However, there are other operational uncertainties that affect supply chains and require immediate adjustments, such as biomass quality and price, biofuel demand or production costs (Saman Pishvaee, 2021). International trade and long-distance transportation also have an important role in many biomass supply chains, supporting countries without sufficiently developed national or regional markets for biomass

(WBA, 2018). According to (Kumar Gosh, 2016), some of the most common obstacles in the biomass supply chain involve transport costs, lack of government support, price determination mechanism and lack of demand side network. The author proposes introducing implantable government policies, subsidies, tax and tariff structure. In many countries there are no clear rules for using biomass resources in a comprehensive manner nor penalties for its misuse. Biomass energy industry is not managed and there are no mechanisms that ensure the implementation of national standards (Raychaudhuri and Kumar Gosh, 2016). Modern agrarian economies are circumventing the manufacturing sector to directly develop their service sector as a consequence of greater participation in agricultural global value chains (Lim and Bellamare, 2021).

Recently, COVID-19 pandemic has disrupted supply chains in almost all sectors, including bioenergy. The pandemic intensified the risk of long-term supply chain functioning and sustaining the bioeconomy (Andiappan, 2021). On the other hand, (Kulišić et al., 2021) investigate how biomass supply chains could help in post-COVID-19 recovery. Authors conclude that investments in supply chains can boost economic development and contribute to cleaner and resilient energy systems. Digitalization and new technologies offer solutions for managing supply chains in the most efficient manner. For example, blockchain technology can provide greater transparency, traceability and sharing of real-time information among stakeholders in the biomass supply chain (Silva, 2018). It can ensure information on the quality and origin of the biomass from suppliers and supply availability, making the functioning of the supply chain more efficient.

Research into the potential of biomass as an energy source has gained much attention in the past few years. Different methods are proposed for determining biomass plant and collection center locations as a significant part of the supply chain.

When designing a plant, the necessary precondition is to understand fundamental bulk characteristics of current and future sources of fuel. The foundation for the design of an efficient plant that has the capability to operate at its intended output over its life cycle is based on a specific fuel form (Ilić et al., 2018).

(Akgul et al., 2022) employed designing optimum biomass to the bioenergy supply chain for agricultural activities using Geographic Information System and Simulated Annealing algorithm to overcome a real-world problem in Turkey. Authors researched the cost of transportation, transmission, and optimum location for a plant. Research results showed that the installation of one power plant is the optimum. (Sutcu et al., 2020) also determined appropriate places for biomass power plant in Turkey by using facility location problem and then Mixed Integer Programming Model which maximizes the potential value of facilities. Their results revealed the best options would be to select 3, 5 or 7 cities in Turkey, and listed them as well as the investment needed.

(Nosratinia et al., 2021) used the fuzzy-analytical hierarchy process method to weigh the locating criteria in the geographical information system. The results indicated certain zones in southern parts of the Tehran province in which the industrial livestock farms become frequently widespread and the suburb areas of smaller cities on the eastern part of the Tehran province are the most proper areas for biomass plant location.

Using a macro screening approach (Van Deal et al., 2021) determined the most interesting locations for the Limburg province in the Netherlands within a minimal time span. However, the downside of this method is that it cannot select the best location among the alternatives.

By employing a combination of Multi-criteria Analysis (MCA) and Geographical Information Systems (GIS) (Woo et al., 2018) identified optimal locations for prospective biomass power plants. Based on the results of different scenarios it was determined that three biomass plants within a radius of 80 km is the best option for Tasmania's future biomass energy plant.

METHODOLOGY

The purpose of this paper is to give an estimation of biomass potential in Croatia and to define the locations of collection and logistics centers. Accordingly, the following methodological steps were conducted:

1. Collection and analysis of relevant literature on biomass potential, supply chains and plant locations
2. Case study analysis
   a. Analysis of biomass potential in Croatia by presenting data from the National Register of Agricultural Holdings
   b. Estimation of potential locations for collection and logistics centers using the Herfindahl-Hirschman Index (HHI) and concentration rates by counties in Croatia
   c. Determination of current biomass energy use status and challenges of future development in Croatia
3. Identification of policy implications and recommendations in order to use biomass potential and establish efficient supply chains in agriculture.

The first step of the research was the analysis of scientific and professional literature on biomass potential and supply chains which enables understanding of a wider context of biomass usage potential. Secondly, collection, processing, and analysis of data from the Register of Agricultural Holdings was conducted on a county level for the period 2016-2020. The average values for the period 2016-2020 were used and also for 2020 separately, in order to get a better insight into the current situation. The main aim was to determine the potential locations of collection and logistics centers of agricultural biomass. Two criteria were used to determine the collection and logistics centers' location: (1) the criteria of the total area of selected plant species by counties are imposed, (2) the criterion of the concentration of certain plant species by counties. Based on the conducted research, certain limitations and gaps in the functioning are recognized and policy recommendations are provided.

RESULTS AND DISCUSSION

The following part contains the results of the analysis of plant biomass potential in Croatia. Methodology framework for determining potential locations for collection and logistics centers and establishment of the value chain is presented.

Data on the areas of selected plant species by counties for the period 2016-2020 are presented in Table 1. The average annual area of tobacco in the period 2016-2020 amounted to 3,777.34 hectares, and the largest part fell on Virovitica-Podravina County (almost 80%). The average annual area of fodder plants was 88,097.99 hectares, and the most fodder plants fell on Osijek-Baranja County (16.2%) and Zagreb, Brod-Posavina, Sisak-Moslavina and Bjelovar-Bilogora counties (all over 8%). The average annual area of karst pastures was 74,340.47 hectares at the national level, with Lika-Senj County (27.3%), Zadar County (23.4%) and Šibenik-Knin County (16.3%). The Split-Dalmatia and Primorje-Gorski Kotar counties are also significant with a share of over 10% in the area of karst pastures. In the same period, there were on average 100.63 hectares of short patrol culture in Croatia, of which 45% in Međimurje County, 30% in Virovitica-Podravina County and 10% in Osijek-Baranja County. As for meadows, in the period 2016-2020 there were 91,665.73 hectares in Croatia, of which over 13% in Bjelovar-Bilogora and Lika-Senj counties and about 10% in Zagreb and Sisak-Moslavina counties. The average annual area of medicinal plants in the same period was 7,403.74 hectares, of which over 55% is in Virovitica-Podravina County, followed by Osijek-Baranja County with 22% of the total area of medicinal plants. Olive was represented by an area of 14,316 hectares in Croatia, of which 26% in Split-Dalmatia County, 20% in Istria County, 17% in Zadar County and about 15% in Šibenik-Knin and Dubrovnik-Neretva County. Other industrial plants were represented by 1,746.24 hectares in Croatia, of which 32% were in Virovitica-Podravina County and then 26% in Sisak-Moslavina County. In the same period, there were 4,603.48 hectares of pastures per year in Croatia, of which 41% were in Sisak-Moslavina County, 14% in Osijek-Baranja County and 11% in Bjelovar-Bilogora County. Noble vines were represented by 17,095.40 hectares in Croatia, of which the highest was in Istria (15%), Osijek-Baranja County (13%) and Dubrovnik-Neretva County (10%). Vegetables were represented by 19,429.13 hectares in Croatia, and the most in Međimurje County with almost 16%. There were an average of 324.59 hectares of nurseries per year in Croatia, most of them in Osijek-Baranja County (32%) and Međimurje County and the City of Zagreb (13% each). As for soybeans, there was an average of 78,869.73 hectares per year in Croatia, most of them in Vukovar-Srijem County (31%), Osijek-Baranja County (22%) and Virovitica-Podravina County (14%). Regarding sugar beet, out of a total of 14,046.86 hectares, 50% is located in Osijek-Baranja County and 39% in Vukovar-Srijem County. Thus, the share of these two counties in the area of sugar beet is 89%. The situation is similar with oilseeds. Out of the total annual 89,263.59 hectares in Croatia, the most represented are Osijek-Baranja County with 41% and Vukovar-Srijem County with 22%. These two counties account for a total of 63% of the area of oilseeds. Along with them, Virovitica-Podravina County stands out with a share of 10% in the total area of oilseeds. Out of a total of 33,227.05 hectares of fruit species in Croatia per year in the observed period, the highest, about 15% of the area is in Osijek-Baranja County. Finally, with regard to cereals in the observed period, the average annual area was 507,309.24 hectares at the national level. Most of them are in Osijek-Baranja County (23%), Vukovar-Srijem County (14%) and Bjelovar-Bilogora County (10%).

Observing the total area of observed species at the country level, 48.52% falls on cereals, followed by meadows (8.77%), oilseeds (8.54%), fodder plants (8.43%), soybeans (7.54%) and pastures (7.11%). Of the other species, fruit species stand out with over 3% (Figure 1).

Table 1 Area of selected species by counties, ha, average 2016-2020

	Tobacco	Fodder crops	Karst pasture	Culture of short patrols	Meadows	Medicinal herbs	Olive	Other industrial herbs
Zagreb County	0,58	7.206,47	411,55	1,16	9.336,21	78,11	9,82	87,37
Virovitica-Podravina	3.017,57	4.581,85	0,60	30,37	1.785,47	4.099,10	1,34	558,51
Požega-Slavonia	625,60	3.615,99	0,70	0,98	2.372,47	60,77	2,43	17,94
Brod-Posavina	0,99	7.356,74	0,17	0,96	1.719,75	15,33	2,10	18,37
Zadar	0,00	1.452,60	17.361,74	0,00	4.337,89	279,80	2.488,36	4,65
Osijek-Baranja	44,26	14.303,74	39,78	10,27	1.262,26	1.597,94	5,38	172,87
Šibenik-Knin	0,00	561,70	12.150,51	0,00	2.961,58	199,69	2.085,67	0,50
Vukovar-Srijem	15,19	4.140,09	3,71	4,18	279,16	67,99	0,62	119,06
Split-Dalmatia	0,00	609,06	8.619,89	0,00	1.140,24	180,80	3,762,60	3,39
Istria	0,00	5.298,70	2.047,86	0,04	2.516,51	87,90	2.899,71	17,07
Dubrovnik-Neretva	0,20	45,48	980,16	0,00	128,21	34,56	2.132,97	0,00
Krapina-Zagroje	0,00	1.431,82	2,71	0,13	6.329,51	8,21	4,82	8,61
Međimurje	0,00	1.025,38	0,41	45,04	1.353,00	95,15	0,97	26,50
City of Zagreb	3,02	1.650,95	2.053,20	0,95	2.759,26	51,94	197,83	89,18
Sisak-Moslavina	0,00	7.422,82	0,00	3,19	8.958,55	245,52	4,45	450,60
Karlovac	0,00	5.375,99	2.462,76	0,00	7.421,49	19,53	1,32	18,04
Varaždin	0,00	995,04	0,00	1,91	3.159,41	10,38	4,55	25,40
Koprivnica-Križevci	44,05	6.480,35	68,00	0,08	7.254,68	99,46	2,44	36,08
Bjelovar-Bilogora	25,81	7.751,68	0,00	0,61	12.238,09	141,14	0,69	91,92
Primorje-Gorski Kotar	0,08	451,86	7.856,62	0,74	2.355,32	25,53	572,36	0,22
Lika-Senj	0,00	6.339,69	20.280,08	0,00	11.996,67	4,89	135,55	0,00
Total	**3.777,34**	**88.097,99**	**74.340,47**	**100,63**	**91.665,73**	**7.403,74**	**14.316,00**	**1.746,24**

	Pastures[a]	Noble vine	Vegetables	Nursery	Soya	Sugar beet	Oil seed	Fruit sorts	Cereals	Total
Zagreb County	253,36	606,21	999,06	6,81	2.805,83	0,12	1.303,82	1.657,13	29.888,47	54.652,11
Virovitica-Podravina	288,88	399,10	1.444,45	14,69	11.166,48	545,09	9.035,39	2.289,19	41.305,85	80.563,94
Požega-Slavonia	234,21	1.397,37	602,01	1,42	4.023,25	310,96	2.924,51	1.827,80	23.257,91	41.276,34
Brod-Posavina	340,49	198,85	521,69	14,74	6.931,81	452,37	6.099,81	2.475,69	34.231,41	60.381,28
Zadar	0,16	1.142,00	1.270,96	11,38	2,03	0,00	5,89	1.633,29	1.225,56	31.216,30
Osijek-Baranja	638,27	2.201,23	1.230,09	104,32	17.081,48	6.994,25	36.652,52	4.935,32	118.510,41	205.784,38
Šibenik-Knin	1,31	776,24	133,45	0,00	0,38	0,00	1,64	267,37	388,40	19.528,45
Vukovar-Srijem	140,31	1.568,50	1.399,35	16,19	24.261,07	5.420,59	19.313,50	1.988,21	69.685,11	128.422,82
Split-Dalmatia	0,29	1.379,07	471,47	0,76	7,95	0,00	2,88	656,31	1.126,95	17.961,67
Istria	0,02	2.609,73	1.381,48	0,17	22,86	0,03	42,17	461,37	2.776,33	20.161,96
Dubrovnik-Neretva	0,00	1.759,61	375,90	22,84	0,00	0,00	0,00	2.079,17	25,88	7.584,98
Krapina-Zagroje	55,26	617,27	452,52	0,09	47,92	0,00	223,72	1.011,67	7.916,14	18.110,39
Međimurje	19,67	434,14	3.063,43	41,78	936,66	148,35	2.492,11	1.005,66	17.842,51	28.530,75
City of Zagreb	69,87	628,47	429,14	40,56	670,27	39,83	463,81	2.337,74	5.204,66	16.690,69
Sisak-Moslavina	1.872,07	184,69	432,58	17,28	4.445,43	0,00	1.837,56	1.783,49	23.439,06	51.097,30
Karlovac	70,15	85,16	680,97	0,59	76,65	0,00	101,72	1.555,91	7.956,25	25.826,51
Varaždin	37,23	365,36	1.884,80	16,60	466,38	27,69	1.944,74	821,23	18.106,08	27.866,80
Koprivnica-Križevci	70,39	369,34	830,96	2,29	998,57	98,38	4.581,27	1.206,63	47.747,45	69.890,42
Bjelovar-Bilogora	498,79	113,47	1.154,75	12,06	4.832,78	8,85	2.069,63	2.244,79	52.906,58	84.091,64
Primorje-Gorski Kotar	12,76	248,43	106,63	0,00	76,75	0,33	166,13	315,11	777,18	12.966,05
Lika-Senj	0,00	11,15	563,43	0,02	15,18	0,00	0,77	673,96	2.991,06	43.012,43
Total	**4.603,48**	**17.095,40**	**19.429,13**	**324,59**	**78.869,73**	**14.046,86**	**89.263,59**	**33.227,05**	**507.309,24**	**1.045.617,21**

[a]Data for pastures available only for 2016.

Source: Agency for Payments in Agriculture, Fisheries and Rural Development, Register of Agricultural Holdings (2021).

Determining potential locations of collection and logistics centers is possible by applying different criteria. Based on the available data, the criterion of the total area of selected plant species by counties is imposed, as well as the criterion of the concentration of certain plant species by counties. Of course, a combination of different criteria is also possible. Figure 1 shows the possibilities of using the first criterion - the total area of selected plant species by counties.

Figure 1. Area of selected areas by counties, annual average 2016-2020 (ha)

Source: authors' calculation; Agency for Payments in Agriculture, Fisheries and Rural Development; Register of Agricultural Holdings.

In order to calculate the concentration of the observed species by counties, the Herfindahl-Hirschman Index (HHI) was calculated for the above types of plant production. This index is an absolute measure of spatial concentration and one of the most commonly used concentration measures. The lowest value of the index depends on the number of regions (counties), i.e., 1/n (in this case 1/21, i.e. 0.048). The Herfindahl-Hirschman index would take a value of 0.048 if all counties participated with equal shares in the total area of crop production. The opposite would be the case if the total area of crop production was concentrated in only one county. The index would then be 1, which is theoretically the highest possible value of this index. In other words, counties with higher HHI have a higher concentration of certain plant species, while counties with lower HHI have a higher representation of more plant species in the total area.

Table 2 shows the order of counties by size HHI for the average annual crop production period 2016-2020. and 2020. Minor differences are noticeable. Higher HHI indicates a higher concentration on individual plant groups.

Table 2 Herfindahl – Hirschman index by counties, average 2016-2020 and 2020

Average 2016-2020		**2020**	
County	**HHI**	**County**	**HHI**
Koprivnica-Križevci	0,491	Koprivnica-Križevci	0,5063
Varaždin	0,447	Varaždin	0,4452
Bjelovar-Bilogora	0,430	Bjelovar-Bilogora	0,4440
Šibenik-Knin	0,425	Šibenik-Knin	0,4272
Međimurje	0,416	Međimurje	0,4250
Primorje	0,408	Primorje	0,4021
Osijek-Baranja	0,377	Osijek-Baranja	0,3990
Brod-Posavina	0,362	Brod-Posavina	0,3869
Vukovar-Srijem	0,356	Vukovar-Srijem	0,3718
Zagreb County	0,350	Zagreb County	0,3711
Požega-Slavonija	0,347	Požega-Slavonija	0,3502
Zadar	0,345	Zadar	0,3477
Lika-Senj	0,327	Lika-Senj	0,3460
Krapina-Zagorje	0,325	Krapina-Zagorje	0,3354
Virovitica-Podravina	0,304	Virovitica-Podravina	0,3181
Split-Dalmacija	0,291	Split-Dalmacija	0,2890
Sisak-Moslavina	0,274	Sisak-Moslavina	0,2708
Karlovac	0,234	Karlovac	0,2324
Dubrovnik-Neretva	0,228	Dubrovnik-Neretva	0,2250
City of Zagreb	0,174	City of Zagreb	0,1977
Istria	0,157	Istria	0,1556

Source: authors' calculation; Agency for Payments in Agriculture, Fisheries and Rural Development; Register of Agricultural Holdings.

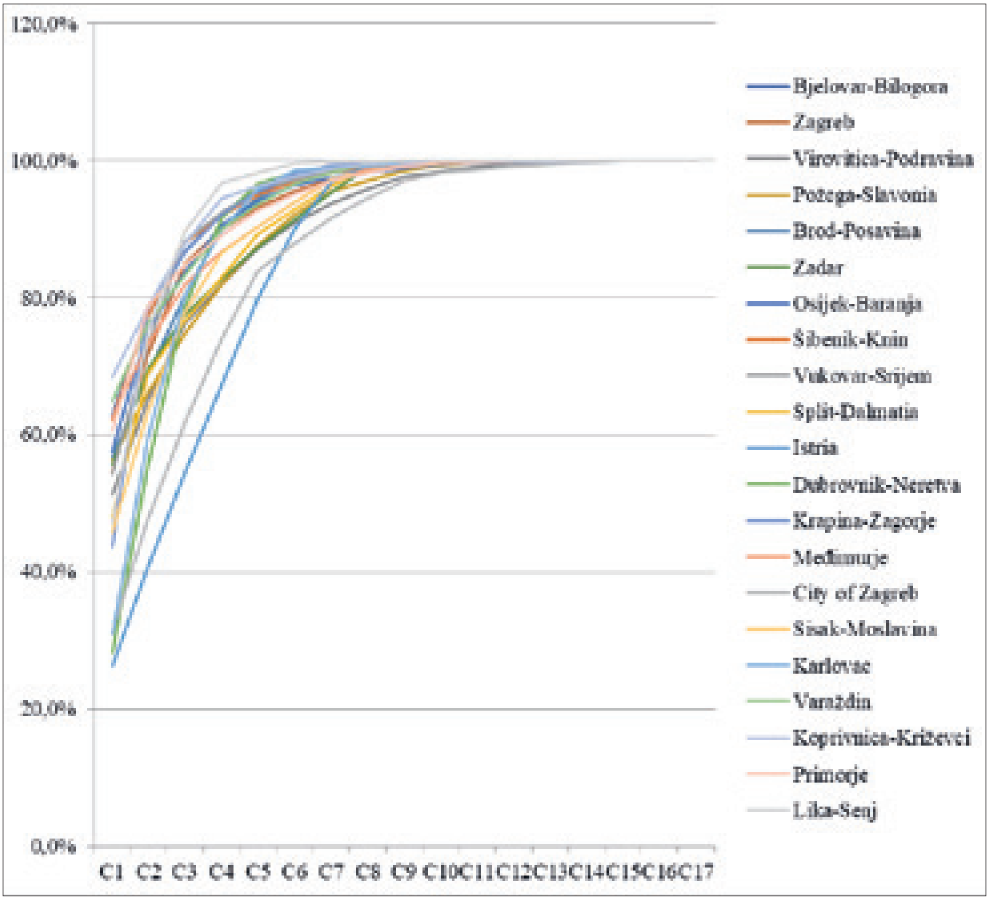
Figure 2. HHI by counties, average 2016-2020

Source: authors' calculation; Agency for Payments in Agriculture, Fisheries and Rural Development; Register of Agricultural Holdings.

Finally, concentration rates were calculated and the summary is shown by Figure 3. Concentration rates show the percentages of areas of individual plant species by county. For example, C1 shows the percentage of the most common types of crop production, C2 the percentage of the two most common types of crop production, C3 the percentage of the three most common types of crop production and so on. These concentration rates allow the application of the principles of efficiency and proportionality to determine the potential locations of collection and logistics centers for the collection of biomass of plant origin.

The energy potential of biomass depends primarily on the amount of biomass available for energy purposes, i.e., surplus biomass from activities such as agriculture (both plant and animal origin), forestry, fisheries and the share of biodegradable industrial and municipal waste (Tomšić et al., 2020). The biggest disadvantage of using

Figure 3. Plant production concentrate rates by counties, 2016-2020



Source: authors

biomass is considered to be its transport (Tomšić et al., 2020). Biomass potential in Croatia was researched by (Ćosić et al., 2011) and they provided potential methodology framework. Authors concluded that Eastern Croatia has the highest energy potential and minimal potential have counties in the South Croatia. (Čikić et al., 2021) advocate for a more rational approach to further increase in energy capacities powered by renewable biomass. By designing different scenarios, they determine available biomass for conversion in secondary energy. Croatia is moving towards low-carbon economy but the use of biomass as an energy source is far from planned (Biljuš and Sertić Basarac, 2021). However, newer data are missing. This is most likely the result of no comprehensive statistical database that includes all agricultural areas, so the current potential cannot be defined. Additionally, Croatia does not have a strategic document that would determine and guide the use of biomass as an alternative energy source.

In order to develop and efficiently use the potential of biomass as a renewable energy source it is necessary to map all the actors involved in the value chain and to design a strategy and action plan with clear responsibilities. Monitoring the implementation of the action plan and evaluating its outcomes is also a necessary requirement.

CONCLUSION

Renewable energy sources are considered to be the imperative for future development and are determined in numerous strategic objectives. Global environment and the war in Ukraine have additionally revealed the relevance not only of renewable energy sources but of self-sufficiency in the supply of renewable energy sources and of energy security as well. From a wide specter of renewable sources, biomass has great potential which has been proven by the latest trends and studies. The analysis conducted in this paper revealed the necessary steps and guidelines for proper use of national biomass in agriculture in the Republic of Croatia. The criteria used in this research can be used for determining the potential locations for logistics centers but there are various other steps needed. Based on the research, the following policy recommendations are put forth. It is necessary to create a statistical database with national data about biomass in agriculture covering all areas. It is also necessary to analyze and map the existing infrastructure to determine its use potential. Value chains need to be identified and analyzed so new business models can be designed that would increase the efficiency of the vale chain. Strategic framework is missing along with the action plan with clearly defined actors and responsibilities, which is a necessary element of efficient use of biomass as a renewable energy source. Thus, national strategy and action plan for biomass use should be designed. Implementation and monitoring is crucial for all of the activities to be carried out as planned. Specific challenge is determining the potential of biomass from livestock and fisheries, so full potential form biomass in agriculture can be determined.

Limitation of the research is the fact that only biomass from plants is considered. In further research it would be necessary to include fishery and livestock to reveal the full potential. The methodology framework used in this research can be used for determining the locations for collection and logistics centers, but it is necessary to consider the already existing infrastructure. The idea is not to build something new but to use the existing resources. In order to do this effectively it is necessary to analyze value chains and gaps in it. Based on the analysis it can be concluded that a change of paradigm is necessary, followed by the change in business models so value chain can function efficiently.

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