Stakeholders' Perspectives on Utilization of Logging Residues for Bioenergy in Turkey

Hasan Alkan, Mehmet Korkmaz, Mehmet Eker

Abstract

Although using logging residues for bioenergy is not a new issue for countries such as Sweden, Finland, Austria, Germany, etc. that are developed in terms of forestry, it is a new issue that requires studying for countries such as Turkey. This study investigates the views of forest engineers working in forest enterprises, researchers working in forestry research institutes and academicians working at universities concerning the use of logging residues for bioenergy that are not currently used in energy production. Within the framework of the study, a questionnaire was sent out to 181 forest engineers, 77 academic staff members and 29 research institute employees, a total of 287 respondents. According to the results of the study, logging residues that are either left in the forest floor or collected by forest villagers for the purpose of fire wood have a favorable potential for energy and forestry if they are used in bioenergy production. Thus, the issue is substantial and of primary importance for Turkey. On the other hand, there are barriers in developing bioenergy sector and using logging residues for this purpose. In order to remove these barriers, first of all, forestry administration should clarify its strategies and policies related to the issue.

Keywords: Bioenergy, logging residues, stakeholder's perspectives, Turkey

1. Introduction

In parallel with population growth, requirements for energy increase every single day while energy sources are rapidly decreasing. The speed of energy consumption in the world is 300 thousand times higher than the speed of fossil fuels formation. In other words, fossil fuel formed in a thousand years is consumed only in one day (Yılmaz et al. 2003). For this reason, the fact that fossil fuel reserves such as petrol, coal and natural gas, will come to an end at most between the years 2030 and 2050 should be taken into consideration (Akyüz 2010). On the other hand, consumption of world energy chiefly from fossil fuels can cause environmental problems such as air, water and soil pollution to a dangerous extent (Ertürk et al. 2006). Another matter related to the issue is the possibility of employment that can emerge based on using new energy resources and types of production (Gökcöl et al. 2009, Halder et al. 2012).

Thus bioenergy has become one of the most dynamic and rapidly changing sectors of the global energy market. In general, three main categories of bioenergy resources are used globally: forest biomass, agricultural biomass and waste biomass (Resch et al. 2008, Halder et al. 2012). Forest biomass has the potential to be one of the most convenient energy sources in the future as it was in the past (Ladanai and Vinterbäck 2009). In USA, one of the major sources of woody biomass comes from conventional forests, particularly logging residues (Gan and Smith 2006). 90% of biomass on earth consists of the animals and microorganisms together with stems, branches, needles and leafs and debris (Saraçoğlu 2006a). Logs that are left in the forest and not evaluated due to low additional value, their main stems, roots, stumps, stem end, top of stem together with timber, cone, bark, needles and leafs of small diameter trees that are damaged in felling or transport can be called as logging residues (Röser et al. 2008, Eker et al. 2009). Although logging residues

have the potential to be used directly or indirectly like other forest biomass, which is used as clean and renewable energy source, it is known that it not used as much as possible (Ateş et al. 2007, Aruga et al. 2011, Saraçoğlu 2010, Eker 2011). Due to rising costs based on factors such as: topographic structure of Turkey, actual timber harvesting system, work force, lack of technology, etc., logging residues can be left in the forest without undergoing a process (Acar et al. 2001, Saraçoğlu 2006b). As a result of not evaluating the logging residues and leaving them in the forest, fuel material density and risk of fire in the forest base increase and the problem of bark beetle damage and rejuvenation obstacles can emerge. Not collecting the logging residues and leaving them in the harvesting area can cause the loss of a potentially energy supplying material for the local population and loss of possible employment opportunities. On the other hand, the literature on forest biomass also addresses various environmental, ecological, economical, and logistical issues associated with harvesting and transporting logging residues (Dirkswager et al. 2011, Kühmaier and Stampfer 2012). For example in low site indexed areas, removing logging residues together with nutrients will impoverish the growing environment (Sterba 2003, Hacker 2005). In this respect, in Finland it is regulated by law that 30% of logging residues must be left in the area (Hakkila 2006).

Turkey has an important potential in terms of renewable energy resources. The forest is the most important of these resources. The government owns approximately 99.9% of Turkish forest areas. Thus, 21.7 million hectares of forests are controlled, protected and managed through The General Directorate of Forestry (GDF), which has a large rural organization expanding along the whole country, founded by the state (Öztürk et al. 2010). The ratio of these forest areas are approximately 27.8% of the total area of the country. Tree volume in our forests is about 1.5 billion m^3 every year, and regular and legal production of 14–16 million m^3 of wood raw material is carried out. Forest villagers are commonly employed in the production activities (GDF 2012).

It is impossible to say that necessary attention is paid and required investment is made to provide renewable energy resources in Turkey. Based on this, 80% of energy requirements is still supplied by importing and the environment is polluted rapidly by intense fossil fuel use. Besides, researches related to renewable energy are not adequate. Thus, the perception and attitude of stakeholders to the issue are different, and consistent strategies and policies for making use of forests to produce bioenergy cannot be carried out. To remove these handicaps and start using harvest residues as raw material for energy sector is closely related with the approach, attitude and behavior of related organizations and institutions and other stakeholders.

2. Aim of the study

The aim of this study is to determine the views of forest administration employees, forest research institute employees and academicians who are considered the most important stakeholders of the issue and the ones that have the role in forming the regulation to use biomass, bioenergy and harvest residues in bioenergy. Based on stakeholders' views it has been found out that the biomass and its components are not well determined and such issues are brought into conformity with the now current literature.

3. Materials and methods

The study was designed as a two-step process. In the first phase, the researches related to the issue in Turkey and globally were supplied by general survey and they were evaluated. In the second phase, researchers (research and development – R&D) and executers that are the stakeholders in the issue were determined. Research and development group was composed of academic staff working in various forestry faculties in Turkey that have or might have the potential to carry out theoretical or practical researches in the field and researchers working in forestry research institutes. Strategies and policies determined about forestry were applied by forest engineers who work within the framework of forestry general directorate. For this reason, the group of executers in the study is composed of engineers working in the General Directorate of Forestry.

3.1 Data collection

Primary data were collected in the course of the field survey by using a questionnaire. Existing literature and secondary data such as reports, plans, etc. were also investigated in this study, as well as other material.

In order to determine the views of group members about bioenergy, an electronic questionnaire form was produced. The questions included in the forms were prepared according to criteria of questionnaire forming. In the questionnaire, based on the specifications of the subject; open ended, multiple choice questions with questions including two or more answers were used. In order to try the questions and eliminate the shortcomings, ideas of academicians and executers

were consulted and pre-tests were carried out. As a result, some of the questions were excluded from the questionnaire, while some other questions that were considered important were added. The final form was filled in by each member of R&D and execution group.

In Turkey, there are 217 Forestry Operation Directorates under 27 Regional Forestry Directorates and there are 1,308 Forest Sub-District Directorates empoying 4,799 forest engineers.

In order to determine the view of the group of executers with 10% sampling error, the sampling size was calculated by the formula below (Karasar 2005):

$$n = \frac{Z^2 \quad N \quad p \quad q}{N \quad D^2 + Z^2 \quad p \quad q} \qquad (1)$$

Where:

- n sampling size;
- Z safety coefficient (for 95% safety level Z=1.96);
- N population size (4,799);
- p, q probability of availability of the mass to be measured in the main mass;
- D sampling error accepted (10%).

Based on the above formula, it was calculated that it was necessary to provide 94 questionnaires. However, in this study, 181 questionnaire forms were filled and analyzed to increase the reliability of the study. Actually, 205 forest engineers participated in the questionnaire activity on behalf of the group of executers. Since there were significant deficiencies in the questionnaire received and in transferring the data into MS Excel data base, 24 questionnaires were excluded from the study.

In the study conducted about R&D group, the sample size was calculated. Academicians working in different 9 forest faculties and researches working in 8 research institutes was selected as a target R&D group, to fill the questionnaire from in electronic media. In this respect, the number of participants who were thought to be related to the subject and asked to participate in the study was approximately 150. 29 researchers from research institute and 77 academic staff members from universities participated in the questionnaire activity by R&D group.

The questionnaire studies conducted on-line showed various feedback levels, namely between 6% and 73%. In general, feedback level between 20% and 40% is considered acceptable (Tekin and Zerenler 2005, Derinalp 2007). In this study, the feedback level was 70.6%.

Additionally, in order to carry out situation analyses related to the issue, interviews were made with forest villagers, cooperative administrators, raw material suppliers, forestry operation directorates, investors and other stakeholders and significant data were obtained.

3.2 Analysis of data

For the statistical analyses of the questionnaire, SPSS 15.0 package program was used. In the analyses, data about questions were installed at first, and frequencies and percentages were used according to the specification of the questions. Statistical relationship between answers given by executers and R&D group members were analyzed by using Mann-Whitney *U* test (Kalaycı 2010, Özdamar 1999, Nachar 2008).

In order to analyze the overall-case and summarize it effectively, SWOT analysis was used. SWOT is an abbreviation for strength, weakness, opportunity and threat. SWOT analysis aims at identifying the strengths, weaknesses, opportunities and threats in the environment. Having identified these factors, strategies are developed. These strategies may develop the strengths; they can eliminate the weaknesses, exploit the opportunities or counter the threats. While the strengths and weaknesses are identified by an internal evaluation, the opportunities and threats are identified by an external evaluation (Dyson 2004).

4. Result and discussion

4.1 Profile of stakeholders

Upon investigating the profile of stakeholders, it was found out that the majority of the practitioners (83.3%) were in middle age group (26 to 45). The other age groups were: 9.94% for 18 to 25 age group and 6.63% for 46 to 65 age group. This case bears importance in terms of obtaining the expected data in the study. Besides, 57.46% of the participants had 6 or more years of vocational experience.

When R&D group was investigated, it was understood that: 69.73% of the academicians were working in Forest Engineering, 25% were working in Forest Industry Engineering and 5.27% were working in other departments. The academicians with the highest rate of participation were Assistant Professors (41.56%). It was followed by Associate Professors (19.48%) and Professors (18.18%). The units with the highest amount of participation in R&D group were: forest economics (15.38%), silviculture and afforestation (11.54%), forestry harvesting and transportation (11.54%) and forest product chemistry (9.62%) departments.

4.2 Definition and components of logging residues

There is not yet an adequate term for identifying residual materials such as thin branches, bark, needles

Table 1 Forest biomass components to be used for the purpose of energy production*

Components	R&D group		Execution group	
	Frequency	%	Frequency	%
Branch woods	77	72.64	92	50.83
Cutting residues	85	80.19	149	82.32
Energy forest	46	43.40	26	14.36
Small-diameter trees	57	53.77	36	19.89
Industrial residues	42	39.62	60	33.15
Shrubs	62	58.49	70	38.67
Needles, leaves	36	33.96	48	26.52
Cones	50	47.17	74	40.88
Bark	60	56.60	106	58.56
Other	13	12.26	9	4.97

*Respondents had the chance to choose more than one option

and leaves, logs, etc., materials that emerge upon harvesting and not evaluated because they are unmerchantable in our country. They are identified as harvesting residue in GDF (2009), felling residue in Ateş et al. (2007), and logging residue in Eker et al. (2009) and Saraçoğlu (2010). Views of the stakeholders related to the issue are given in Fig. 1.

As seen in Fig. 1, harvesting residue, logging residue and cutting residue are the three most commonly offered terms for both stakeholder groups. When evaluations by Eker et al. (2013), international literature, production process, quality of the outcome, and other issues are taken into consideration, it can be said that logging residue is more suitable than other terms. Thus, in order to identify this substance, the term logging residue was used.

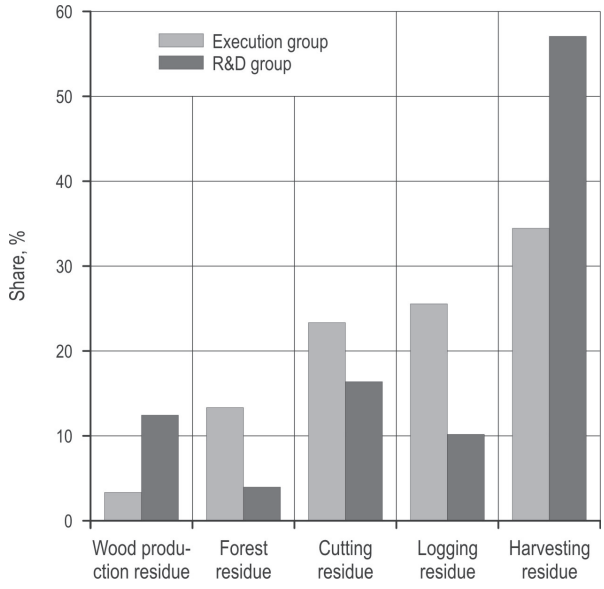

Fig. 1 The term offered to define the woody residual material

There are differences as to which components of forest biomass to use for the purpose of producing bioenergy and which components to use as logging residues (Table 1).

It can be seen that according to stakeholders, felling residues and branches and wood are considered to be the most important components to form logging residues. Besides, with species whose bark can be removed, the bark is also considered as an important component.

4.3 Current use of logging residues in Turkey

The fact that renewable natural resources are consumed rapidly according to the current literature, glob-

Table 2 Current evaluation method of logging residues

Evaluation method	Frequency	%
It is left in stand	96	53.04
It is stored in stand for mulching and protection of seedling	64	35.36
It is collected by forest villagers with reasonable unit prices	130	71.82
It is collected by supplies because of standing tree selling	40	22.10
It is burnt in stand	17	9.39
Other	8	4.42

Table 3 Views about adequacy of the current activities

Current activities are necessary and adequate in terms of constituting and developing wood based bioenergy sector in our country						
Stakeholders	I agree		I am Neutral		I disagree	
	Number	%	Number	%	Number	%
R&D group	6	5.66	17	16.04	83	78.30
Execution group	13	7.19	42	23.20	126	69.61

al climate change scenarios, approaches to reduce the dependence on fossil fuels and petroleum products by the reasons of carbon cycle and sustainable development made bioenergy production and use of logging residues for this purpose important (Ertürk et al. 2006, Halder et al. 2012, Resch et al. 2008, Ladanai and Vinterback 2009, Yılmaz et al. 2003). However, using logging residues in producing bioenergy is still not a common issue (Aruga et al. 2011, Ateş et al. 2007, Eker et al. 2009, Eker 2011, Röser et al. 2008, Saraçoğlu 2010). In countries where logging residues are used as a source of bioenergy, the logging residues after the production of wood raw material is chipped and made ready for various purposes (Spinelli and Hartsough 2001, Yoshioka et al. 2002, Röser et al. 2008, Laitila et al. 2013). For example, 20% of production in Finland (Malinen et al. 2001), 18% in Sweden and 14% in Austria are supplied from bioenergy made of wood and plant wastes (Saraçoğlu 2008). In USA, the total amount of recoverable logging residues reaches 36.2 million dry tonne (Gan and Smith 2006). It is stated by Demirbaş (2001) that the potential of forest residues as bioenergy source is 18 million ton and their energy value is 5.5 Mtep (million ton petrol equivalent). It is stated by Saraçoğlu (2008) that the annual biomass potential of Turkey is 17.2 Mtep. Still, the use of logging residues in bioenergy utilization is not yet applicable and the activities mentioned are not used in Turkey. According to the data obtained by the group of executers, the most common use of logging residues by forest villagers is for cooking and/or heating. These logging residues are collected by forest villages by a moderate price paid as a subvention. In times when supply costs are high, and heating and cooking needs are supplied by replacement products, forest villagers are not very interested in this method of use. In such conditions, the residues stay in their places without undergoing a process and they are left to rot. In places where logging residues are considered as an obstacle in reforestation activities, forestry organizations move these residues to a certain place and burn them. By the help of standing tree selling which is commonly used in the recent years, the utilization of logging residues has also started (Table 2).

4.4 Need for using logging residues for bioenergy

The necessity of using logging residues for bioenergy is becoming obvious. Furthermore, the answer to the question »Do you think the issue of logging residues-bioenergy is one deserving attention, research and focus on?« was Yes by 94.34% of R&D group members and 93.37% of execution group members. When comparing the answers to the question, no statistical difference between groups was established (p>0.05). On the other hand, there was a significant difference between views of academic staff members and researchers working in forestry research institutes that form R&D group (U=991.500, p=0.027) according to Mann-Whitney U Test (Table 8[1] – Test number 1). Academic staff members believe that it is necessary to increase the use of logging residues for bioenergy.

Necessary scientific, R&D quality or applied researches about logging residues have not been carried out so far. Views of the stakeholders concerning the premise »Current activities are necessary and adequate in terms of constituting and developing wood based bioenergy sector in our country« are shown in Table 3. According to the findings of Mann Whitney-U test (Table 8 – Test number 2), there is no statistically significant difference between the views of the two groups (U=8,775.000, p=0.121). The most important reason for the stakeholders view that the current studies are inadequate and that more researches should be carried out is that they believe that in Turkey bioenergy should be produced by logging residues in times when there is enough raw material and its supply does not cause any disagreement in terms of economic, social and ecologic concerns (Table 4).

One of the reasons of the stakeholders view that current studies are inadequate and that more research

[1] Within the framework of the study, in order to compare the groups, all Mann-Whitney U tests conducted are given in Table 8 as Test number 1, 2, 3, 4 and 5 respectively.

Table 4 Views concerning the necessity of using forest biomass (logging residues) to produce energy*

Stakeholders	Premises	I agree		I am neutral		I disagree	
		Number	%	Number	%	Number	%
R&D	It is chiefly necessary for Turkey to produce energy (heat, power and fuel) from wood biomass under current conditions	77	72.64	13	12.26	16	15.09
	It is a luxury for Turkey to produce heat and power from wood biomass under current conditions. However, it has a potential to form a market by the support of energy forestry and other activities	64	60.38	19	17.92	23	21.70
	In times when there is enough raw material and its supply does not cause any disagreement in terms of economic, social and ecologic concerns, it is necessary to use wood biomass in bioenergy production	91	85.85	6	5.66	9	8.49
Executers	It is chiefly necessary for Turkey to produce energy (heat, power and fuel) from wood biomass under current conditions	130	71.83	37	20.44	14	7.73
	It is a luxury for Turkey to produce heat and power from wood biomass under current conditions. However, it has a potential to form a market by the support of energy forestry and other activities	23	12.71	36	19.89	122	67.40
	In times when there is enough raw material and its supply does not cause any disagreement in terms of economic, social and ecologic concerns, it is necessary to use wood biomass in bioenergy production	150	82.87	20	11.05	11	6.08

*The respondents had the chance to choose more than one option

Table 5 State of acknowledgement of the importance of logging residues in bioenergy sector

Level of knowledge	R&D group		Execution group	
	Number	%	Number	%
I have no information	6	5.66	11	6.07
I have some information	47	44.34	112	61.88
I have a stock of knowledge which I obtained from different sources	40	37.74	51	28.18
I have made theoretical and practical researches. I have full knowledge of the issue	12	11.32	7	3.87
Other	1	0.94	-	-
Total	106	100.00	181	100.00

should be carried out is that parties concerned have no enough information. Table 5 shows the stakeholders' state of acknowledgement in using logging residues for bioenergy production.

As shown in Table 5, in Turkey there is still no adequate stock of knowledge concerning using forest biomass for the purpose of producing bioenergy. According to the results of Mann-Whitney *U* test (Table 8 – Test number 3), there is a statistically significant (U=7,753.000, p=0.002) difference between the views of researchers (R&D group) and executer groups. These are two separate groups whose views are consulted within the framework of knowledge level related to the subject. R&D group members state that they have more information than the employees concerning the issue. The most important reason for this is that they study global literature more than the employees of the General Directorate of Forestry.

4.5 Potential gains by using logging residues for the purpose of energy production

Stakeholders' views related to potential gains by using logging residues for the purpose of energy production are shown in Table 6. As shown in Table 6, 98.0%

Table 6 Views related to potential gains by using logging residues for the purpose of energy production *

Potential gains	R&D group		Execution group	
	Number	%	Number	%
Supports local energy production	77	72.64	132	72.93
Supports rural development	75	70.75	116	64.09
It helps these activities to be carried out regularly by obtaining material from tending and thinning	45	42.45	55	30.39
Helps to reduce fuel material deposited in forest and decrease fires	72	67.92	142	78.45
Create employment opportunities in energy industry	66	62.26	109	60.22
Within the framework of optimization of sustainability of forest utilization, it can produce new vocational opportunities to forest engineers, private forestry companies and technical staff	57	53.77	102	56.35
It can contribute to improve wild life habitats	9	8.49	17	9.39
It can supply additional source of income for forestry management	56	52.83	107	59.12
It will not have any gain	2	1.89	2	1.10
Other	6	5.66	7	3.87

*The respondents had the chance to choose more than one option

of R&D group and approximately 99.0% of executer group believe that using logging residues for the purpose of energy production could possibly have a gain. In the new sector to be formed by using logging residues for the purpose of energy production, there will be potential opportunities such as supporting local energy production, providing new working opportunities in terms of energy sector, supporting rural development, bringing professional and attractive gains for forest engineers, supplying forestry managements with new sources of income, giving positive effects to forest ecosystem when conducted appropriately, etc.

The group with the highest level of gain was R&D with supporting local energy production, while the gain for the executer group was the reduction of fuel material deposition in forest and risk of fires.

Furthermore, especially executer group members believe that after final cutting removing logging residues from forest will give positive effects in terms of the health and reforestation of the area. There is statistically significant difference between groups (U=8,329.000, p=0.030). The views of R&D group are more pessimistic (Table 8 – Test number 4).

4.6 Obstacles in using logging residues for the purpose of energy production

Views of stakeholders about the establishment of the bioenergy sector and obstacles in using logging residues for the purpose of energy production are shown in Table 7.

As shown in Table 7, more than 50% of the obstacles considered by R&D group are: lack of necessary efforts by competent authorities, difficulty in sustainable supply of logging residues, high supply costs (production, transportation) of logging residues and ecologic damages caused while removing logging residues from the forest area.

More than 50% of the obstacles considered by execution group are: difficulty in providing adequate number and quality of working force, high supply costs (production, transportation) of logging residues, lack of necessary efforts by competent authorities.

The first condition for considering bioenergy as an alternative or additional source of energy and using logging residues as a raw material or product for energy sector is that stakeholders (Stidham and Simon-Brown 2011) and competent authorities make the necessary efforts by developing their strategies and policies, and do sample applications and divert the parties in this field. The stakeholders who participated in the study conducted by Dwivedi and Alavalapati in USA in the year 2009 also addressed this issue. In Turkey, the highest authority for this issue is the Ministry of Energy and Natural Resources. The ministry has made some important steps related to the issue. For example, in order to generalize the use of renewable

Table 7 Views about the factors to prevent establishment and development of energy sector*

Factors	R&D group		Execution group	
	Number	%	Number	%
Lack of necessary efforts by competent authorities (lack of policies and even strategies)	70	66.04	96	53.04
Difficulty in providing adequate number and quality of working force	32	30.19	123	67.96
High supply costs (production, transportation) of logging residues	55	51.89	109	60.22
Raw material (for example fiber-chip sector) competition in forest products industry	38	35.85	55	30.39
High distribution costs of energy obtained from logging residues	30	28.30	42	23.20
Difficulty in sustainable supply of logging residues	63	59.43	74	40.88
Lack of methods and techniques necessary for the supply of logging residues (difficulty in supplying and operating chopping equipment in forest operations)	52	49.06	62	34.25
Ecologic damages caused while removing logging residues from the forest area	54	50.94	54	29.83
Potential negative effects of the use of logging residues on wild life and habitat	39	36.79	43	23.76
Other	2	1.89	9	4.97

*The respondents had the chance to choose more than one option

energy resources, they have issued the law No. 5,346 concerning »Using Renewable Resources to Produce Electricity« in 2005. With this low, biomass sources were included in the renewable energy resources. Also by the change in the law (Dec. 29, 2010), energy purchase price, which was 5.5 Euro cent/kWh, was changed to USD and this purchase price was determined as 13.3 USD – the highest for companies that carry out production based on biomass with the guarantee that their production would be purchased. Besides, on condition that local machinery and equipment is used in the facilities, there is an incentive between 0.4–2 USD cent/kWh. However, the General Directorate of Forestry that is the institution with the highest authority on the issue has not determined a strategy or policy about the issue, yet. In the recent days, The General Directorate of Forestry started a study to promote foreign investments on the South West of Turkey (for example Muğla Region), but considering the fact that there might be difficulty in the supply of raw material by the investment in some sectors, such as chip wood sector, and the pressures directed upon the institution, the General Directorate of Forestry interrupted the study. Due to the attitude of the General Directorate of Forestry, investors think that there will be problems in the sustainable supply of logging residues as raw material. Stidham and Simon-Brown (2011) state that distrust between investors, suppliers of raw material and other parties, is a significant obstacle in the development of the sector. In Turkey, an adequate amount of trust has not yet been formed between the parties. Not taking steps in this issue, which is important for a sustainable implementation of the investment, is a serious obstacle and threat in the development of the sector. On the other hand, the General Directorate of Forestry does not make the necessary researches nor provides necessary support to the activities carried out.

When the residual material left in the forest is taken into account in calculating the result of producing wood raw material, it seems to be light in weight and value. Another obstacle in terms of sustainable supply of logging residues is the costs (Hacker 2005, Guo et al. 2007, Röser et al. 2008, Aguilar and Garrett 2009, Stidham and Simon-Brown 2011). Allen et al. (1998) and FAO (2009) states that supply costs have a high ratio in total costs of biomass use. One of the most important reasons for this lies in high logistic costs during supply. Eriksson and Björheden (1989) state that optimization of logging residues depends on minimization of transport costs. In developed countries, where logging residues are used as a source of bioenergy and industrial raw material, for the minimization of costs, especially of transport costs, the current production methods and technologies are changed and the mechanization level used in wood production system is improved (Karha et al. 2009). For example, logging residues are generally chipped in the area (Spinelli and Hartsough 2001). It is stated that the supply

Table 8 Man-Whitney *U* test results

Test Number	Groups	*n*	Mean ranks	Sum of ranks	M-Whitney *U*	*Z*	*p*
1	Academic staff	77	51.88	3,994.50	991.500	–1.187	0.027
	Researchers	29	57.81	1,676.50			
	Total	106					
2	R&D group	106	151.72	16,082.00			
	Execution group	181	139.48	25,246.00	8,775.000	–1.550	0.121
	Total	287					
3	R&D group	106	161.36	17,104.00	7,753.000	–3.036	0.002
	Execution group	181	133.83	24,224.00			
	Total	287					
4	R&D Group	106	155.92	16,528.00	8,329.000	–2.165	0.030
	Execution group	181	137.02	24,800.00			
	Total	287					
5	R&D group	106	118.68	12,580.00	6,909.000	–4.246	0.000
	Execution group	181	158.83	28,748.00			
	Total	287					

of 70% of woody biomass in Finland is obtained by this method (Junginger et al. 2005). The current production–transportation system in Turkey is an activity which is expected to be costly. Thus, alternative methods and techniques, like chipping in the forest after collecting and then transporting can be necessary. However, the lack of equipment of forest villagers and cooperatives that will be involved mandatorily in all related actions based on the low, and their inability to solve this lack of technology with their financial resources, etc. are considered to be the obstacles that can prevent the change.

Whether extracting logging residues from the forest might have positive or negative effects on the forest ecosystem in terms of ecology is an issue commonly addressed in the current literature. Especially in places where growing environment is not fertile, if the organic material and food materials are removed from the forest in high amounts, the growing environment can grow poor (Sterba 2003, Hacker 2005). Stakeholders' views as to whether extracting logging residues from the forest might have positive or negative effects on the forest ecosystem in terms of ecology was analyzed by Mann-Whitney *U* test (Table 8 – Test number 5) and statistically significant differences were found between the views of the groups (U=6,909.000, p=0.000). Members of R&D group are more negative concerning the effects on the forest ecosystem in terms of ecology. Respondents have emphasized the impact on site nutrient budgets. A similar situation is described in international literature. According to Hacker (2005), a majority of research on removal of logging residues is focused on this problem. In this reason, ecological researches should be focused on nutrient budget, before removal of logging residues from the stand.

Although some job opportunities might emerge by the use of logging residues for the purpose of bioenergy production (Dirkswager et al. 2011), it can also cause problems concerning employment and work power (Cantor and Rizy 1991). In Turkey, another problem related to this issue is the difficulty of finding the right number of skilful workers. The reason the forest villagers think that they will be paid less for these activities discourages their involvement. If these

Table 9 SWOT matrix

Strengths	Weaknesses
⇒ Adequacy of forest assets and resources organized for the purpose of wood raw material in Turkey. ⇒ Promotes energy security: Legitimizing the use of wood biomass in energy production by the law No. 5346 concerning »Use of Renewable Energy Resources in Energy Production«. ⇒ Level of knowledge and willingness of stakeholders related to the necessity of producing energy from logging residues. ⇒ Logging residues have a potential of forming a market supported by energy, forestry and other applications.	⇒ Authorized forest institutions not making necessary efforts. ⇒ Unavailability of policy or strategy by Forestry General Directorate about using logging residues in energy production. ⇒ Lack of R&D activities related to using the energy obtained from logging residues. ⇒ Lack of current activities concerning the establishment and development of wood based bioenergy sector in our country. ⇒ Lack of development of methods and techniques necessary for supply of logging residues (difficulty of supply and chopping systems for forest operations). ⇒ Lack of finance and technology in forest village cooperatives. ⇒ Lack of acknowledgement about the issue in related groups. ⇒ Presence of topographic problems due to distribution of forest resources in mountainous regions of our country.
Opportunities	**Threats**
⇒ Proliferation of using biomass in bioenergy production in the world. ⇒ Having potential of supporting local energy production. ⇒ Having potential of supporting rural development. ⇒ Help to decrease the deposition of fuel material in fire risk zones and number of fires. ⇒ Supplying new vocational opportunities in terms of energy industry. ⇒ Supplying new vocational opportunities to private forestry companies and their technical staff together with optimization of using forest resources. ⇒ Supplying forest managements with new sources of income. ⇒ Removing the doubts of forest villagers about production phase, and based on their contentment, positive views that logging residues can be collected.	⇒ Competes with conventional forest products industry: Increase in raw material requirement of chip board sector and raw material competition of forest products (for example flake board sector) with industrial ones. ⇒ Forest villagers using a great amount of logging residues as source of heating wood. ⇒ Difficulty of finding adequate number of qualified workers caused by reluctance of villagers to collect these resources. ⇒ Possible damages to forest ecology: Negative views about the collection of logging residues that can have negative effects on forest ecosystems in terms of ecology. Beside, using logging residues can have potential negative effects on wild life habitats. ⇒ Difficulty of sustainable supply of logging residues. ⇒ Reduction in prices of fossil based energy resources. ⇒ Energy imports from other countries.

doubts are not clarified, forest villagers will object logging residues to be used for the purpose of producing energy and a potential source of workers will be lost.

It is clear that logging residues to be used for the purpose of producing energy brings extra loads for forest management in terms of planning, applying and controlling. Forest managements that are not able to carry out their own activities due to the lack of personnel may have additional difficulties. Views of the respondents support this issue. Furthermore, if the necessary precautions are taken, it can be said that this issue will not constitute a problem in terms of forming and developing the bioenergy sector.

Taking the above issues into consideration, SWOT matrix is shown in Table 9. As seen in SWOT matrix, Turkey has the strength to use logging residues for the purpose of bioenergy production. Weaknesses, on the other hand, can be removed if the necessary attention is paid to them by related institutions and organizations, and comprehensive research related to the subject is carried out.

5. Conclusions

Based on the current researches and views of the stakeholders, it can be said that forest assets of Turkey and required forest resources for the production in terms of raw material supply are adequate. Turkey should use biomass for the purpose of bioenergy production and purchase these resources in places where there is no disagreement in terms of financial, ecological and social requirements.

A sector to be formed by widespread production – consumption of bioenergy and use of logging residues for bioenergy can: contribute and support local energy production, provide new employment opportunities, have positive effects on rural development, provide work and challenging opportunities for forest engineers, provide an extra source of income for forestry managements, and if the right techniques are applied, it can also prevent forest fires and have positive effects on forest ecosystem and reduce environmental pollution.

To do so, the competent institutions led by the General Directorate of Forestry should focus their attention on this issue and start developing strategies and policies concerning the evaluation of logging residues as soon as possible.

According to the stakeholders, the production of bioenergy and use of logging residues for this purpose is a subject that should be taken into consideration in Turkey. The importance of carrying out theoretical and practical researches about the issue is getting more and more importance and, however, it becomes obvious that the necessary level of knowledge is not even present at universities and research institutions and that there is no terminological understanding about the issue.

The current forestry and wood production system does not let logging residues be procured economically and this prevents the development of an ideal supply chain system in Turkey. In order to solve this problem as done in developed countries, harvesting methods and production technologies can be changed and mechanization level might be improved. In this respect, forest villagers who are one of the most important links of the supply chain will be supported technically and financially.

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6. References

Acar, H. H., Kalaycıoğlu, H., Topalak, O., 2001: Harvesting of Rhododendron Wood by Chippers. Third Balkan Scientific Conference, October 2–6, 2001, Sofia, Bulgaria, Proceedings, Volume IV: 248–256.

Aguilar, F., Garrett, H. E., 2009: Perspectives of woody biomass for energy: Survey of state foresters, state energy biomass contacts, and National Council of Forestry executives. Journal of Forestrty 107: 297–306.

Akyüz, K., 2010: Avrupa Birliği'nde yenilenebilir enerji politikaları ve orman biyokütlesi. Ankara Üniversitesi Avrupa Toplulukları Araştırma ve Uygulama Merkezi, 46. Dönem AB Temel Eğitim Kursu, p.46.

Allen, J., Browne, M., Hunter, A., Boyd, J., Palmer, H., 1998: Logistics management and costs of biomass fuel supply. International Journal of Physical Distribution and Logistics Management 28: 1–10.

Aruga, K., Mrakami, A., Nakahata, C., Yamaguchi, R., Yoshioka, T., 2011: Discussion on economic and energy balances of forest biomass utilization for small-scale power generation in kanuma, togichi prefecture, Japan. Croatian Journal of Forest Engineering 32: 571–586.

Ateş, S., Akyıldız, H. M., Vurdu, H., Akgül, M., 2007: Türkiye'de orman kesim artıkları ve değerlendirilmesi. KÜ Orman Fakültesi Dergisi 7(1): 94–103.

Cantor, R. A., Rizy, C. G., 1991: Biomass energy: Exploring the risks of commercialization in the United States of America. Bioresource Technology 35: 1–13.

Demirbaş, A., 2001: Energy balance, energy sources, energy policy future developments and energy investments in Turkey. Energy Conversion and Management 42: 1239–1258.

Derinalp, S., 2007: Dünya'da ve Türkiye'de lojistik hizmetlerde dış kaynak kullanımı: Türkiye'de faaliyet gösteren endüstriyel işletmelerde bir uygulama. Yüksek lisans tezi, Çukurova Üniversitesi, Sosyal Bilimler Enstitüsü, Adana, p 85.

Dirkswager, A. L., Kilgore, M. A., Becker, D. R., Blinn, C., Ek, A., 2011: Logging business practices and perspectives on harvesting forest residues for energy: a Minnesota case study. Northern Journal of Applied Forestry 28(1): 41–46.

Dwivedy, P., Alavalapati, J. R. R., 2009: Stakeholders' perceptions on forest biomass-based bioenergy development in the southern US. Energy Policy 37: 1999–2007.

Dyson, R. G., 2004: Strategic development and SWOT analysis at the University of Warwick. European Journal of Operational Research 152: 631–640.

Eker, M., 2011: Assessment of procurement systems for unutilized logging residues for Brutian pine forest of Turkey. African Journal of Biotechnology 10(13): 2455–2468.

Eker, M., Acar, H., Ozcelik, R., Alkan, H., Gurlevik, N., Coban, H. O., Korkmaz, M., Yılmaztürk, A., 2013: Ormancılıkta hasat artıklarının tedarik edilebilirliğinin araştırılması. TUBITAK, Proje (110O435) Raporu, Turkey 2013.

Eker, M., Coban, H. O., Acar, H. H., 2009: The Procurement Problem of Logging Residues in Turkish Forestry. Proceedings of FORMEC ´09, Prague, Czech Republic 2009, p. 115–124.

Eriksson, O., Björheden, R., 1989: Optimal Storing, Transporting and processing for a forest fuel supplier. European Journal of Operational Research 43: 26–33.

Ertürk, F., Akkoyunlu, A., Varınca, B. K., 2006: Enerji üretimi ve çevresel etkileri, Türkasya Stratejik Araştırmalar Merkezi, Stratejik Rapor No:14, 88 p.

FAO, 2009: State of the World's Forests-2009. FAO, İtaly, 152 p.

Gan, J., Smith, C. T., 2006: Availability of logging residues and potential for electricity production and carbon displacement in the USA. Biomass and Bioenergy 30: 1011–1020.

GDF, 2009: Yenilenebilir enerjide orman biyokütlesinin durumu. Biyoenerji çalışma grubu raporu, Orman Genel Müdürlüğü, Turkey, 134 p.

GDF, 2012: Türkiye orman varlığı, GDF Publication. Yayın No. 85, Turkey, 23 p.

Gökcöl, C., Dursun, B., Alboyaci, B., Sunan, E., 2009: Importance of biomass energy as alternative to other sources in Turkey. Energy Policy 37(2): 424–431.

Guo, Z., Sun, C., Grebner, D. L., 2007: Utilization of forest derived biomass for energy production in the USA: Status, challenges, and public policies. International Forestry Review 9(3):748–758.

Hacker, J. J., 2005: Effects of logging residue removal on forest sites a literature review. West Central Wisconsin Regional Planning Commission, USA, p. 19–25.

Hakkila, P., 2006: Factors driving the development of forest energy in Finland. Biomass and Bioenergy 30: 281–288.

Halder, P., Prokop, P., Chang, C. Y., Usak, M., Pietarinen, J., Nuutinen, S. H., Pelkonen, P., Çakır, M., 2012: International survey on bioenergy knowledge, perceptions, and attitudes among young citizens. Bioenergy Research 5: 247–261.

Junginger, M., Faaija, A., Bjorhaden, R., Turkenburg W. C., 2005: Technological learning and cost reductions in wood fuel supply chains in Sweden. Biomass and Bioenergy 29: 399–418.

Karha, K., Jylhä, P., Laitila, J., 2009: The Fixteri – A Novel Machine Concept for Integrated Pulpwood and Energy Wood Harvesting in Early Thinnings. Proceedings of FORMEC´09, Kostelec/Prague, Czech Republic, 2009, p. 220–228.

Kalaycı, S., 2010: SPSS uygulamalı çok değişkenli istatistik teknikleri. Asil Yayın Dağıtım, Turkey, 426 p.

Karasar, N., 2005: Bilimsel araştırma yöntemi. Nobel Yayın Dağıtım, Turkey, 292 p.

Kühmaier, M., Stampfer, K., 2012: Development of a multicriteria decision support tool for energy wood supply management. Croatian Journal of Forest Engineering 33(2): 181–198.

Ladanai, S., Vinterbäck, J. 2009: Global potential of sustainable biomass for energy report 013. Swedish University of Agricultural Sciences, Department of Energy and Technology, Sweden, 30 p.

Laitila, J., Kilponen, M., Nuutinen Y., 2013: Productivity and cost-efficiency of bundling logging residues at roadside landing. Croatian Journal of Forest Engineering 34: 175–187.

Malinen, J., Pesonen, M., Maatta, T., Kajanus, M., 2001: Potential harvest for wood fuels (energy wood) from logging residues and first thinnings in Southern Finland. Biomass and Bioenergy 20: 189–196.

Nachar, N., 2008: The Mann – Whitney *U*: A test for assessing whether two independent samples come from the same distribution. Tutorials in Quantitative Methods for Psychology 4: 13–20.

Özdamar, K., 1999: Paket programlar ile istatistik veri analizi. Kaan Kitabevi, 1. Cilt (2. Baskı), 335 p.

Öztürk, A., Saglam, B., Barlı, Ö., 2010: Attitudes and perceptions of rural people towards forest protection within the scope of participatory, forest management: a case study from Artvin, Turkey. African Journal of Agricultural Research 5(12): 1399–1411.

Resch, G., Held, A., Faber, T., Panzer, C., Toro, F., 2008: Potentials and prospects for renewable energies at global scale, Energy Policy 36(11): 4048–4056.

Röser, D., Asikainen, A., Rasmussen, K. R., Stupak, I., 2008: Sustainable use of forest biomass for energy: A synthesis with focus on the Baltic and Nordic Countries. Managing Forest Ecosystems, 12 p.

Saraçoğlu, N., 2006a: Enerji Ormancılığının Kırsal Kalkınmaya Katkısı. Ormancılıkta Sosyo-Ekonomik Sorunlar Kongresi, Çankırı, Turkey, p. 7–12.

Saraçoğlu, N., 2006b: Modern enerji ormancılığının Türkiye ormancılığı, kırsal kalkınma ve ülke ekonomisine katkısı. Orman ve Av 83(1): 33–38.

Saraçoğlu, N., 2008: Modern Enerji Ormanciliği–Ormanlardan Biyokütle Enerjisi Üretimi ve Çözümlemeler. Orman Genel Müdürlüğü, Turkey, 26 p.

Saraçoğlu, N., 2010: Küresel İklim Değişikliği, Biyoenerji ve Enerji Ormancılığı. Efil Yayınevi, Turkey, 300 p.

Spinelli, R., Hartsough, B., 2001: A survey of Italian chipping operations. Biomass and Bioenergy 21:433–444.

Sterba, H., 2003: Growth After Biomass Removal During Precommercial Thinning. In: Limbeck-Lilineau, B., Steinmüller, Th., Stampfer, K. (Hrsg.), Austro2003: High Tech Forest Operations for Mountainous Terrain, Institute of Forest Engineering, p. 1–9.

Stidham, M., Simon-Brown, V., 2011: Stakeholder perspectives on converting forest biomass to energy in Oregon, USA. Biomass and Bioenergy 35: 203–213.

Tekin, M., Zerenler, M., 2005: Konya otomotiv yan sanayinin rekabet gücü hakkında bir araştırma. V. Ulusal Üretim Araştırmaları Sempozyumu, İstanbul, Turkey, p. 75–81.

Yılmaz, I., Ilbas, M., Su, S., 2003: Türkiye Rüzgar Enerjisi Potansiyelinin Değerlendirilmesi. In: Yeni ve Yenilenebilir Enerji Kaynakları Sempozyumu, Kayseri, Turkey, p. 399–401.

Yoshioka, T., Aruga, K., Sakai, H., Kobayashi, H., Nitami, T., 2002: Cost, energy and carbon dioxide effectiveness of a harvesting and transporting system for residual forest biomass, Journal of Forestry Research 7: 157–163.

Authors' address:

Assoc. Prof. Hasan Alkan, PhD.*
e-mail: hasanalkan@sdu.edu.tr;
hasanalkan07@gmail.com
Assoc. Prof. Mehmet Korkmaz, PhD.
e-mail: mehmetkorkmaz@sdu.edu.tr
Assoc. Prof. Mehmet Eker, PhD.
E-mail: mehmeteker@sdu.edu.tr
Suleyman Demirel University
Faculty of Forestry
Department of Forest Engineering
32260 Isparta
TURKEY

* Corresponding author

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