

The Current Status of Forest Residues and Disposal Machinery in Turkiye

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Abstract

The term "cutting residue" is a widely used term in Turkey, which refers to the leftover pieces of logs in the forest after cutting, except for the logs. As of yet, there is no specific expression and explanation for the term "slash" in Turkish forestry. Turkey carries out intensive forestry activities based on industrial wood production, primarily in mature stands and damaged after disasters such as fire or storm fall. Products that do not carry industrial woodiness in the stand, such as branches, roots, and tips that are not suitable for industrial production, are considered firewood and used for energy production or left in the stand. As a result, it is observed that the collected cutting residues from the fields that are sufficient in terms of benefit and cost is burned to generate electricity in electricity generation stations. Due to the demand for forest-based wood raw materials in recent years, some domestic companies have begun converting thick branches into industrial products such as paper and chipboard production. Additionally, some studies have been conducted to reduce transportation costs in bringing cutting residues to the economy, focusing on the storage and processing of forest cutting residues on the landing sites. In this regard, small-scale chipping machines have been produced by the domestic industry. Therefore, slash disposal and mechanization have a very limited place in Turkish forestry. Decision makers need to prepare action plans in this regard and provide support to joint research projects with academic units.

Keywords: Energy, Forest biomass, Logging residue, Production, Feasibility, Turkiye

1. Introduction

The annual average volume of trees cut from the forests is 28 million m³ in Turkiye and approximately 25% of the harvested trees (7 million m³) consists of branches, trunk bark and end pieces left after cutting, as felling residues, remain in the forest (Karayılmazlar et al., 2011). A large proportion of this residuals is left to rot in the forest because it is not economically feasible to extract them from forests (Saraçoğlu, 2006). In recent years, forest biomass related studies have increased regarding within the measures to reduce carbon emissions within the scope of combating climate change. In Turkiye, there have been developments related to energy production from forest biomass. Within the scope of these developments, support was given for the establishment and development of biomass energy production facilities. These facilities cover not only the use of forest biomass but also the use of other biomass resources (Kaygusuz and Türker, 2002; IRENE, 2020; Balcioglu et al., 2023; Gülci et al., 2023).

Forest bioenergy potentials can be converted into alternative biofuels. This process involves physical processes, thermochemical processes, chemical

processes and biological processes. However, biophotolysis processes have gradually become widespread among conversion methods in recent years. Physical presses include grinding, drying, pelletizing and briquetting. The main thermochemical processes are combustion, pyrolysis (torrefaction, slow pyrolysis and fast pyrolysis), gasification and hydrothermal processes. Pyrolysis, gasification, fermentation and anaerobic digestion methods, which are among the biomass-to-energy conversion technologies, are used to convert forest-derived biomass into energy (Sarıkoç, 2020; Jha et al., 2022).

Forestry residues, such as branches, twigs, leaves, and stumps, are generated as derivations of forestry activities, such as logging and thinning (Moskalik and Gendek, 2019). These residues can be used for various purposes such as bioenergy production, soil improvement, and animal feed. However, if not managed properly, forestry residues can cause environmental problems including soil degradation, erosion, and greenhouse gas emissions. Therefore, effective and sustainable operation of forestry residues is crucial for both environmental and economic reasons (Janeiro et al.,

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2015; Pergola et al., 2022). In Türkiye, particularly, the demand for effective and sustainable timber residue operation is crucial due to increasing demand for renewable energy, the need for soil improvement, and public awareness of environmental issues (Eker, 2011; Kutlu and Koçar, 2017; Turk and Yildiz, 2019; Demir et al., 2020).

In Türkiye, the forest industry generates significant amounts of forest residues, such as branches, stumps, and tree tops during logging and timber processing operations (Eker, 2011; 2014; Çoban and Eker, 2014; Saracoglu, 2015). The management and disposal of forest residues is a critical issue for sustainable forest management, as these residues can cause soil degradation, forest fire hazards, and hinder natural regeneration (Marchi et al., 2018). However, the current status of timber residue and disposal machinery in Turkish forestry is not sufficient to meet this demand (Bilgen et al., 2015; Demirci et al., 2018).

The machinery, including chippers, grinders, slashers, and balers, have been used to collect, shred, and bale the agriculture and forest residues for easier transportation and utilization. However, the machines used for forestry activities, such as logging and thinning, is not suitable for the efficient and sustainable management of forestry residues. Due to the lack of clear regulations and incentives for the production and use of bioenergy from forest residues, it is difficult for the industry to attract investment and develop sustainable business models (Toksoy et al., 2020). Therefore, there is a need for increased investment in research and development of new and efficient forest waste/residue management and disposal machinery, as well as standardization and certification programs to ensure the safety and quality disposal machinery.

2. Recent Literature Related to Forest Residue Recovery in Türkiye

“Potential of forest biomass in Türkiye” conducted by Sarikoç (2020) analyzed the potentials of forest biomass for energy production in Türkiye, considering forest residues and slash. The study identified the amount and quality of forest biomass in different regions of Türkiye and evaluated the feasibility of using forest biomass for energy production. In another study, “Energy production from forest residues in Türkiye”, Saraçoğlu (2015) evaluated the utilization of forest residues for bioenergy production in Türkiye. Other similar studies analyzed the characteristics of forest residues, including slash, and evaluated the technical and economic feasibility of using forest residues for bioenergy production in Türkiye (Ateş et al. 2007; Eker, 2011; Eker et al., 2017).

The researchers also assessed the availability of logging residues, including slash, to meet the demand of industry for producing bioenergy in Türkiye (Alkan et al. 2014; Kurt, 2020). These studies evaluated the amount

and characteristics of logging residues in different regions of Türkiye and analyzed the technical, political and economic feasibility of using logging residues for bioenergy production. Thus, logging residues and energy recovery potential in Turkish forestry sector was investigated by researchers regarding with the alternative use of logging residues in the Turkish forestry sector.

The main concept of logging residues in Türkiye is still subject to many challenges, thus, it is essential to analyze the current status and opportunities related to the sustainable management of logging residues, including slash, in Türkiye. The future may also evaluate the existing policies and regulations related to logging residues and analyze the potential of using logging residues for erosion and material production. For example, in previous studies conducted by Akay et al. (2007), Turk (2018) and Turk and Yildiz (2019), the effectiveness of wood chip and slash treatments in reducing soil compaction was evaluated during forest harvesting operations.

3. Forest Machinery in Türkiye

Forest harvesting by tractors is considered to be an effective method in Türkiye, especially in small-scale operations. Akay, (2005) conducted a study on the use of tractors in small-scale timber harvesting operations in Türkiye and reported that the use of tractors can significantly reduce the logging costs and improve the efficiency of the harvesting process. Similarly, Öztürk et al. (2019) and Çağlar, (2020) evaluated the productivity and costs of a tractor-based logging system in a Turkish forestry and found that it was cost-effective and could compete with other traditional logging methods.

In recent decades, the use of forest machinery has been increasing to improve the efficiency of forestry operations in Türkiye (Demir and Bilici, 2010). According to a study by Bilici and Akay (2021), the use of modern forest machinery has increased in recent years, and this has led to significant improvements in forest management practices. Hence, mechanized logging and transportation operations have been shown to reduce labor costs and increase productivity in Turkish forestry. In industrial forest stands, modern forestry machinery such as harvester, feller-buncher, and skidder have been used for activities such as tree felling, extraction, and skidding in Türkiye (Acar et al., 2018).

In particular, chippers and grinders have been used to convert slash into smaller, more manageable pieces that can be used for various purposes such as energy production, composting, and soil improvement. An example of a portable wood chipper operation from chipping of forest residues in Türkiye is given in Figure 1. However, it should be noted that the use of disposal machines is still relatively limited in forest operations in Türkiye due to factors such as high costs, limited availability, and lack of awareness among practitioners.



Figure 1. Landing site of a forest residue disposal operation (Erdoğan, 2021)

In general, tree-based cutting residues obtained from parks and gardens are grinded by some municipalities in Türkiye. Grinded cutting residues have been used for fertilizer purposes in parks and gardens (Figure 2). Thus,

these small-scale operations also prevent environmental pollution and contribute to the ecological balance in urban areas.



Figure 2. Studies on the grinding of wood cutting residues with a gasoline-powered grinder (Karabaglar, 2021).

4. Recommendations and Conclusion

Considering literature review, there have been several studies conducted on the potential of forest waste/residue, slash, and disposal machinery in Türkiye. The studies show that there is a significant potential for using forest residue and slash for energy and material production in Türkiye. However, the current status of disposal machinery is not sufficient to meet the demand for efficient and sustainable forest residue management (Eksi and Karaosmanoglu, 2017; Kurt, 2020). The studies highlight the need for policy support and investment in research and development of disposal machinery. Thus, further efforts are required in Türkiye to enhance the utilization and conversion of forest biomass into energy.

Various biomass conversion technologies can be generated through the utilization of different comminution machines, particularly when segregating stem wood from forest residues piles during logging or thinning activities (Waste to Wisdom, 2018). The utilization of forest biomass requires the testing of various methods in production and calculations. However, ensuring the inclusion of relevant variables, such as small, medium, and large wood pieces, in the calculations will enhance the effectiveness of the sampling method and overall success of the study (Kizha and Han, 2015).

Furthermore, it is important to enhance the ecosystem services derived from forests. By considering the economic, social and ecological aspects, a long-term sustainable utilization of forest biomass can be achieved while maintaining a balance of benefits (Nicholls et al., 2022). Harvesting woody biomass for different purposes, such as biochar production, can contribute to the overall health and sustainability of forests by reducing stress and vulnerability to insects, pathogens, and wildfires. Briefly, utilization of forest residues aims to maximize the ecological value of forest residues by transforming them into goods that promote sustainability and contribute to environmental conservation. For instance, biochar serves as both a valuable energy source derived from wood and a product that enhances soil fertility, resembling the effects of wildfire regimes (Scott and Page-Dumroese, 2016).

Due to several factors, the current state of equipment for managing forest residues in Türkiye is inadequate to meet the demand for effective and long-term forest residue management. Firstly, the existing technology is largely incapable of handling the volume and diversity of residue generated by modern forestry practices. The machinery in use is not equipped to efficiently process and utilize the wide range of residue materials. Secondly, limited financial resources and a lack of official support have resulted in a shortage of investments in modern and innovative machinery. The forestry sector faces challenges in acquiring advanced equipment that can enhance residue management practices.

Moreover, the scarcity of skilled workers in the forestry industry contributes to the underutilization and suboptimal operation of available machinery. The lack of qualified personnel proficient in operating and maintaining specialized equipment hinders the effective utilization of forest residue management strategies.

Lastly, the absence of a comprehensive and coordinated national policy for forest residue management decelerates the situation. The lack of a comprehensive strategy and guidelines on managing forest residues at the national level further impedes progress in this area.

Until significant improvements are made and scientific approaches are implemented in these key areas, Türkiye may continue to face challenges in effectively managing forest residues. It is crucial to address the limitations in equipment, increase investments, develop skilled workforce, marketing and establish a comprehensive policy framework to enhance forest residue management practices.

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References

- Acar, H., Eker, M., Eroglu, H. 2003. A review on the wood harvesting and transportation technologies in Turkish Forestry. In World Forestry Congress, Proceedings A, Voluntary papers (No. 0462-B4).
- Akay, A.E. 2005. Using Farm Tractors in Small-Scale Forest Harvesting Operations, *Journal of Applied Sciences Research*, 1(2): 196-199.
- Akay, A.E., Yuksel, A., Reis, M., Tutus, A. 2007. The impacts of ground-based logging equipment on forest soil. *Polish Journal of Environmental Studies*, 16(3):371-376.
- Alkan, H., Korkmaz, M., Eker, M. 2014. Stakeholders' perspectives on utilization of logging residues for bioenergy in Turkey. *Croatian Journal of Forest Engineering*, 5(2):153-165.

- Ateş, S., Akyıldız, M.H., Vurdu, H., Akgül, M. 2007. The Utilization of Slash in Türkiye. *Kastamonu University Journal of Forestry Faculty*, 7(1): 93-103.
- Balcioglu, G., Jeswani, H.K., Azapagic, A. 2023. Energy from forest residues in Türkiye: An environmental and economic life cycle assessment of different technologies. *Science of The Total Environment*, 874:162316.
- Bilgen, S., Keleş, S., Sarıkaya, İ., Kaygusuz, K. 2015. A perspective for potential and technology of bioenergy in Turkey: present case and future view. *Renewable and Sustainable Energy Reviews*, 48: 228-239.
- Bilici E., Akay, A.E. 2021. Forestry and forest operations in Türkiye: challenges and developments. *Revista Pădurilor*, 136(1):37–52.
- Çaglar, S. 2020. Productivity analysis of tree-length harvesting using farm tractor in a Nordmann fir stand in Turkey. *European Journal of Forest Engineering*, 6(2): 78-86.
- Çoban, H. O., Eker, M. 2014. A hierarchical approach to estimate spatially available potential of primary forest residues for bioenergy. *BioResources*, 9(3):4076-4093.
- Demir, M., Bilici, E. 2010. Assessment of timber harvesting mechanization level in Turkey. In Proceedings of FORMEC 2010 conference: forest engineering: meeting the needs of the society and the environment, Padova, Italy (Vol. 1114).
- Eker, M. 2011. Assessment of procurement systems for unutilized logging residues for brutian pine forest of Türkiye. *African Journal of Biotechnology*, 10:2455–2468.
- Eker, M. 2014. Trends in woody biomass utilization in Turkish forestry. *Croatian Journal of Forest Engineering: Journal for Theory and Application of Forestry Engineering*, 35(2): 255-270.
- Eker, M., Spinelli, R., Gürlevik, N. 2017. Recovering energy biomass from sustainable forestry using local labor resources. *Journal of Cleaner Production*, 157:57-64.
- Eksi, G., Karaosmanoglu, F. 2017. Combined bioheat and biopower: A technology review and an assessment for Turkey. *Renewable and Sustainable Energy Reviews*, 73: 1313-1332.
- Erdoğan, A. 2021. Continue to work with the Sumitomo 210 Jenz Chip and Chips Machine by Erdoğan A., <https://youtu.be/LRtrVA2ZWKs> (Accessed 01.03.2023)
- Gülci, N., Gülci, S., Akay, A. E., Sessions, J. 2023. A Comparison of two felling techniques considering stump-height-related timber value loss. *Croatian Journal of Forest Engineering*, 44(1):103-110.
- Han, H.-S., Jacobson, A. Bilek, E.M., Sessions, J. 2018. Waste to Wisdom: Utilizing forest residues for the production of bioenergy and biobased products. Final Report. 78p.
- IRENE, 2020. Renewable energy statistics 2020. The International Renewable Energy Agency, Abu Dhabi. <https://www.irena.org/publications/2020/Jul/Renewable-energy-statistics-2020> (Accessed 06.10.2022)
- Janeiro, L., Patel, M.K. 2015. Choosing sustainable technologies. implications of the underlying sustainability paradigm in the decision-making process. *Journal of Cleaner Production*, 105:438–446.
- Jha, S., Nanda, S., Acharya, B., Dalai, A.K. 2022. A review of thermochemical conversion of waste biomass to biofuels. *Energies*, 15(17):6352.
- Karabağlar, B. 2021. “Branch shredder machine was also brought to Karabağlar”. <https://www.karabaglar.bel.tr/haber/karabaglara-dal-ogutme-makinesi-de-kazandirildi> (Accessed 08.03.2023)
- Karayilmazlar, S., Saraçoğlu, N., Çabuk, Y., Kurt, R. 2011. Utilizations of biomass as an energy source in Türkiye. *Bartın Faculty of Forestry Journal*, 13(19):63-75.
- Kaygusuz, K., Türker, M.F. 2002 Biomass energy potential in Türkiye. *Renewable Energy*, 26(4): 661-678.
- Kizha, A.R., Han, H.S. 2015. Forest residues recovered from whole-tree timber harvesting operations. *European Journal of Forest Engineering*, 1(2):46-55.
- Kurt, R. 2020. Determining the priorities in utilization of forest residues as biomass: an A'wot analysis. *Biofuels, Bioproducts and Biorefining*, 14(2): 315-325.
- Kutlu, O., Kocar, G. 2017. Biochar from residual biomass in Türkiye, and possibility of return to the soil: an estimation of the supply and demand. *Polish Journal of Agronomy*, 30:10-24.
- Marchi, E., Chung, W., Visser, R., Abbas, D., Nordfjell, T., Mederski, P.S., McEwan, A., Brink, M. and Laschi, A. 2018. Sustainable Forest Operations (SFO): A new paradigm in a changing world and climate. *Science of the Total Environment*, 634:1385-1397.
- Moskalik, T., Gendek, A. 2019. Production of Chips from logging residues and their quality for energy: a review of European literature. *Forests*, 10: 262.
- Nicholls, D., Vaughan, D., Mitchell, D., Han H-S, Smidt, M., Sessions, J. 2022. Forest bio-hubs to enhance forest health while supporting the emerging bioeconomy—a comparison between three U.S. regions. *Energies*, 15(3):931.
- Onwona-Agyeman, S., Nakamura, S., Kawabata, Y., Yamada, M., Sabi, E. B., Tanahashi, M. 2012. Utilization of forestry residue in erosion control and soil moisture conservation. *Journal of Arid Land Studies*, 22(1): 279-282.
- Öztürk, T., Varsak, M., Bilici, E. 2019. Evaluating productivity and cycle time of skidding method with farm tractors in Bigadic Forest Enterprise Directorate in Turkey. *European Journal of Forest Engineering*, 5(2):77-82.

- Pergola, M.T., Saulino, L., Castellaneta, M., Rita, A., Pecora, G., Cozzi, M., Moretti, N., Pericolo, O., Pierangeli, D., Romano, S., Viccaro, M. 2022. Towards sustainable management of forest residues in the southern Apennine Mediterranean mountain forests: a scenario-based approach. *Annals of Forest Science*, 79(1):1-13.
- Saracoglu, N. 2015. Energy production from forest residues in Turkiye. In 3rd International Symposium and Innovative Technologies in Engineering and Science, Valencia, Spain. ISITES pp. 9-16.
- Saraçoğlu, N. 2006. Enerji ormancılığının kırsal kalkınmaya katkısı / The contribution of energy forestry to rural development. Ormancılıkta Sosyo-Ekonomik Sorunlar Kongresi, Çankırı, Turkey, p. 7–12.
- Sarıkoç, S. 2020. Bioenergy potential of Turkiye's forest sources, biomass energy conversion methods, products, and applications. In *Renewable Energy-Technologies and Applications*. IntechOpen: London p. 1-22.
- Scott, D.A., Page-Dumroese, D.S. 2016. Wood bioenergy and soil productivity research. *BioEnergy Research*, 9:507–517.
- Toksoy, D., Çolak, S., Bayramoğlu, M.M. 2020. A study on the biomass energy potential of Turkiye: example of wood pellets. *Journal of Anatolian Environmental and Animal Sciences*, 5(5):867-871.
- Turk, Y. 2018. The effects of using wood chips and slash in reducing sheet erosion on forest road slopes. *Forests*, 9(11): 712.
- Turk, Y., Yıldız, M. 2019. The effects of wood chips and slash usage on skid trail sheet erosion caused by log skidding using a farm tractor. *ŞumarskiLlist*, 143(5-6):241-248.