Problems Encountered in Log Depots and Measures to Combat Them: A Review

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The aim of this review is to examine the problems encountered with logs kept in depots and the measures recommended to correct them. Biotic, abiotic, and other factors can affect the quality and quantitative properties of stored logs. Biotic factors include fungi (decay/rot fungi, stain fungi, and mold), insects (wood, bark, and ambrosia beetles), and bacteria. The climatic conditions of ultraviolet (UV) light, wind, and temperature at the storage site can be considered as abiotic factors. In addition, storage problems may be caused by business management, inadequate training and qualifications of depot personnel, and the type of depot floor/ground. Measures to counteract these factors were examined in detail, as a result of field observations and literature studies. The solutions presented included: shortening the storage period and expanding winter production rather than maintaining year-round storage, bringing production planning in line with the needs of the sector and providing sufficient training to workers and technical personnel, as well as increasing the sale of standing trees, separating earlier- and later-felled products in depot areas, installing pheromone traps, and ensuring proper drainage and maintenance of depot grounds. Additional measures to be taken in factory warehouses included water sprinkling and holding logs in water (ponding).

Keywords: Abiotic factor; Biotic factor; Log depot; Proposed solutions; Storage problems

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INTRODUCTION

The wood production process is conducted in three main stages: felling, removal, and transportation (Acar 2016). Logs cut from the forest can be stored at many points during the process of transformation into the final product. In addition to planned cuts, such as for regeneration work and thinning, industrial and firewood production is carried out in the forests or special production areas according to customer demands. In this process, many storage sites are needed in the period from production to final consumer. Consequently, forest areas, log depots, factory outdoor (sheltered or unsheltered), and in-plant storage areas have been evaluated. Storage at factory sites is often inescapable due to irregular supply of raw material and unevenness of customer demand (Olsson 2005). Logs in all these areas can be affected by many abiotic and biotic factors, resulting in technical and economic losses. Factors affecting the quality and economic gains of stored logs start with the damage occurring during harvesting and include the storage site conditions (soil, climatic characteristics, *etc*.), stacking methods, holding time, and protective measures (Komut *et al*. 2013).

FACTORS IMPACTING THE QUALITY OF LOGS IN LOG DEPOTS

Biotic Factors

Log depots are the areas where logs are kept from the time of harvesting to processing. These sites may hold a single tree type or multiple tree species together. Similarly, logs with different holding times are stored together. In some log depots, confiscated illegally harvested logs were kept together with the others. During these storage times, many biotic factors are present in the forest (standing/felled trees) or storage areas. These include bark and wood damaging insects, stain and decay/rot fungi, and bacteria. Due to these factors, the quality of the logs can be reduced by the effects of insect pests, decay, and discoloration.

Abiotic Factors

During storage, the climatic conditions and the location of the depots are the most important features determining the effectiveness of abiotic factors. Abiotic factors, such as direct sunlight, direction and intensity of prevailing wind, and temperature changes, reduce the quality of logs and consequently decrease their economic value (Kantay and Köse 2009; Komut *et al.* 2013; Bakır and İmamoğlu 2014).

Other Factors

Other factors may directly or indirectly affect the quality characteristics of logs in the depots. These include management, legal procedures, log stacking methods, and the number and capability of the personnel.

Storage Types

Dry storage

This type of storage can be chosen for storing logs if the temperature is below 0 °C. However, if the temperature is above freezing, checking, ambrosia beetle attack, sapwood discoloration, and decay problems may occur in logs in this type of storage. If high-quality logs are to be stored, a protective chemical impregnation agent should first be applied against discoloration. Afterwards, a coating material (paraffin, oil paint, lime slurry, and dispersion paints) can be applied with a brush to provide effective protection against checking of log-ends or other exposed (debarked) areas. If the cut logs will be sawed into lumber within a short period of time, they should be transferred and stored together with their bark intact. In this case, drying of the debarked surfaces and consequent checking can be omitted (Simpson and Ward 1991). The drying rate of wood in dry storage depends on many factors such as temperature, relative humidity, wind speed, rainfall, tree species, and log size (Petterson and Nordfjell 2007).

Wet storage

If the logs are to be stored for a long period at temperatures above 0 °C (especially between March and October, when temperatures are above freezing.), wet storage is the ideal storage method. This method can provide protection for logs against checking, insects, and fungal attacks. The two most common methods of wet storage are sprinkling and ponding of land-stored logs. The sprinkling method is suitable for storage areas where a pool system is not available and where there is a sufficient supply of groundwater. The

water for sprinkling can be provided by either continuous fresh water from a local watercourse or water re-circulated in a closed system (Jonsson 2004). If the sprinkling is to be effective, the log ends and debarked wood surfaces must be kept continuously wet during the entire period of storage (Simpson and Ward 1991). To achieve this, the amount of water sprinkled on logs should be of a sufficient amount. The spraying intensity should be adjusted depending on the size of the stack. For example, for a five-meter log pile the recommended dispensing rate is 50 mm/24 h to maintain the required 100 to 120% moisture ratio (Nylinder 1953; Simpson and Ward 1991).

Although the method of holding logs in storage ponds has been used from past to present, there can be a few notable problems, namely, the effects of above-water abiotic and biotic factors. To avoid these effects, the logs are held in a bundle using an iron band and kept under the water. Another problem is that some bacteria cause color change in logs kept in the pool for a long time. In addition, honeycomb, collapse, bark, and tannin (phenolic compound) discoloration defects develop in logs that have been submerged for over a year (Simpson and Ward 1991; Liukko 1997). During wet storage, the compounds that leach from the logs (especially common components of softwoods such as phenols and diterpene resin acids) are potentially toxic to the aquatic ecosystem and can cause environmental problems (Borgaa 1994).

PROBLEMS ENCOUNTERED IN LOG DEPOTS AND SOLUTIONS

Problems Caused by Biotic Factors Solutions

Storage holding period

The main control option for minimizing biological degradation in log depots is to reduce log storage times (Yang and Beauregard 2001; Uzunovic *et al.* 2008). To reduce the waiting times of logs, tree harvesting should be completed within a certain schedule and according to customer demands (Ünver and Acar 2005). In this case, the effect of biological activities will not be an issue due to the sales time and shortening of the period between felling and end use. Studies have reported that many important decay fungi can cause serious damage to wood kept in open areas for a waiting period of three years or more. However, especially in storage areas where humidity is high, stain fungi and mold, as well as some fungal species (*Schizophyllum* commune), bark beetles, and ambrosia beetles (*Coleoptera*, *Curculionidae*, *Scolytinae*, and *Platypodinae*) have a much shorter operational period and they can affect the quality properties of wood in 1 to 2 months (Yalçın *et al.* 2019a, 2019b). The rate of decomposition in logs varies depending on the harvest season. In spring and autumn, these periods are quite short, and damage (especially discoloration and moldiness) can begin in 2 to 4 weeks. Therefore, in warm weather, logs should be sawed immediately. In addition, the log storage inventory should be controlled daily and the "first in-first out" rule should be implemented (Uzunovic *et al.* 2008). However, in terms of economics, it is appropriate that priority should be given to the processing of high-quality class logs.

Prolonged storage of logs

In the log depots, illegally cut logs kept on hold for legal reasons can be found along with newly harvested logs. Generally, a separate section of the depot is designated for long-

term stored wood, in which bark intact/debarked logs of many wood species are stored together. Consequently, the products that are stored in the log depots for a long time are likely exposed to a number of biotic factors such as insects, fungi, and bacteria. Some studies have found that wood materials had been stored in log depots for more than 15 years without any commercial reasons. Because these logs had little economic value, they were just stacked with no measures taken to protect the stacks (stacking pads, *etc*.) (Yalçın *et al*. 2019b), and there was serious deterioration and devaluation of the wood. However, more importantly, the insects and fungi that attack and develop in the areas where logs are stored long-term can pose a risk to high-value logs in the same storage area. One of the most effective solutions to this problem is that logs to be stored long-term should be kept in a suitable place outside the industrial log storage areas. This wood should be stored away from settlements, where the prevailing winds are active and the ground is dry.

Dote and tylose formation

In storage areas, the destruction *via* biological factors varies according to tree species. Dote is one of the most important and rapid-growing fungal infections found in logs that are kept in depots. Dote typically occurs mainly in deciduous species with high commercial value such as beech, maple, and hornbeam. Dote can arise in as short as 3 to 4 months, particularly in summer fellings and in logs held in storage areas. Dote is caused by dense tyloses formation (Seeling 1998) and various white rot fungi (Necesany 1969). Dote starts when freshly cut trees become dried to a 30 to 60% moisture content. The first phase involves color change and obstruction of the vessels by tylose formation, with the fibers from the parenchymal cells found around the tracheids extending into the tracheids. The contents of the parenchyma cells are oxidized when oxygen enters the wood in place of the moisture leaving it during drying (Chovanec *et al*. 1993). This event is physiological and causes color change in the wood. The color changes associated with tylose formation can noticeably reduce the commercial value of wood (Baral *et al*. 2013). The next stage is when the exposed portions of the logs (debarked logs, log-ends, *etc*.) become infected by various white rot fungi that bleach the color of the wood. The strength properties are affected at this stage. The fungi that cause dote include *Trametes versicolor*, *Trametes hirsuta*, *Schizophyllum commune*, *Hypoxylon howeanum*, *Stereum hirsutum*, and *Chondrostereum purpureum*. Climatic conditions, felling time, waiting time, and stacking conditions also can be listed as tylose formation factors (Kantay 2002; Anonymous 2019). The most important measures that can be taken against the problem of tylose formation are conducting winter felling and the marketing of standing trees, or by shortening the time frame from when the timber is cut until it is merchandised according to customer demand. Additional measures should be taken if the storage period is long. To prevent rapid drying and checking, which is the cause of tylose formation, it must be ensured that all sides of the logs should remain moist by submerging in ponds or by water sprinkling because there is an important relationship between checking and decay. This relationship can be explained by the fact that the moisture level in the resulting cracks creates a favorable environment for the germination of fungal spores (Olsson 2005). However, although wet storage is suitable for factory warehouses, for outdoor depots it may not be possible in terms of cost and availability. Logs, especially beech logs, which have high economic value, should be stacked and stored in more humid places and not left exposed to direct sunlight to prevent rapid drying and checking (Bozkurt 1971). In addition, cut log-ends can

be treated with a protective impregnation solution (Immutol-B, Basiment ASR®) (Kantay 2002).

Storage sites and ground conditions

Moist wood is the most important climatic condition required for wood-destroying insects and fungi. The moisture of wood in the depots can originate from three different sources: periodic rains, high relative humidity, and the depot ground. Although among these sources rain and relative humidity are natural phenomena that are difficult to control, it is possible to eliminate the effect of depot floors by taking necessary precautions. The first thing to do when selecting a storage location is to avoid places with a high groundwater level. Instead, dry, bare soil without year-round puddling water should be selected. Depot floors of gravel, crushed stone, slag, asphalt, or concrete can be recommended, especially for factory depot sites. Studies conducted in Turkey's Western Black Sea Region observed some depots with earthen floors where puddles from rainwater had formed, and thus, over time they had become muddy. This situation was found to cause difficulties in terms of the depot working conditions and the damage to the logs in contact with the ground (Yalcin *et al.* 2019a). In this respect, it is preferable to have depot floors that are completely flat or lightly sloping so as not to collect the rainwater like a bowl. In the depots, it is very important to prevent direct contact of the logs with the ground. For this, wooden or concrete stacking supports are used on the floor of log depots. However, although it was more suitable in the past, today, in many depots some of the logs in the pile used as stacking supports are being evaluated and offered for sale. This practice is wrong and it would be more suitable to use specially prepared stacking supports for continuous use in the depots. If stacking supports are used, there should be a minimum distance of 30 cm between the floor and the logs to ensure adequate air flow (Ünver and Acar 2005). If the stacking supports to be used are wooden, it is recommended that they be treated with suitable impregnating agents that are resistant to moisture to ensure their durability for many years of use. In addition, periodic maintenance of depot floors is necessary to prevent insect propagation and fungal formation. In this context, the ground should be kept clear, especially of sawdust, chips, and wood pieces.

Distance of depot sites to the forest

Another point to be considered when choosing the location of log depots outside the forest is the distance to be established to the forest. Forest sites are at risk from all sorts of biological pests, such as insects and fungi that develop on both standing and cut trees. Depots can be more exposed to the effects of biotic factors if they are located close to forest areas. Therefore, it is important to build depot sites as far away from forest areas as possible to reduce pest infestation. The field studies of Yalcin *et al.* (2019a, 2019b) confirmed this situation and reported that the species number and density in the depots close to the forest were higher than that of the depots distant from the forest.

Proliferation and spread of insects

During the cutting, transportation, and storage in the depots, many bark and wood-damaging insect species appear. These species proliferate over time and spread within and outside the depots. One alternative method to prevent this is to use the pheromone trap system (Baker 2011). Pheromones should be selected by taking into account the tree

species and insect populations in the area. For example, the depots holding coniferous tree species may use the alpha pinene pheromone, which has a general appeal. In addition, the trapping process can be made more effective by support from additional sex and alarm pheromones according to the local insect species. In general, installation of funnel traps of the Scandinavian type can yield effective results (Yalçın *et al.* 2016; Akçay 2017). Pheromone traps should be installed around the depot at regular intervals (40 to 50 m) and the pheromone should be refreshed on a regular schedule (every 30 to 40 days). With the pheromone trap system, both the proliferation and the spread of insect species in the depots can be kept under control. The prominence of the pheromone trap system is increasing, especially in log depots near settlements. However, it should be noted that the installation of pheromone traps, especially for the depots that are in proximity to forests, can pose the risk of attracting insects from the forest to the depot.

Rapidly developing and spreading of fungal species

Some fungal species develop and spread rapidly in depots storing deciduous wood, including *Trametes versicolor*, *Stereum hirsutum*, and *Trametes hirsuta*, *Pleurotus* sp., and *Schizophyllum* commune. Fungal species that also can be found extensively in large numbers in depots where coniferous wood is stored, when climatic conditions are suitable, include *Gloeophyllum* sp., *Schizophyllum* commune, *Trichaptum* sp., and *Fomitopsis* sp. (Yalçın *et al.* 2019a). In this respect, the depots, especially those holding goods over long periods, should be regularly inspected and the sporophores of these fungi collected and burned. In addition, all infected logs or woody materials should be removed from the depots. Because these fungal species can become active under a certain degree of moisture, the wood surfaces in contact with the soil should be isolated from the ground.

Wood discoloration and prevention

One of the most important factors known to affect the quality of some wood species and decrease their economic value is the change in their natural color. Discoloration can result from fungi, bacteria, or non-biological causes (Uzunovic *et al*. 2008). Non-biological discoloration can be due to chemical, photochemical, and biochemical reactions (enzymatic and non-enzymatic) usually occurring in the core wood (Kreber 1995). However, in addition, discolorations resulting from mechanical effects (saw-blade friction, *etc*.) may be included (Hulme and Thomas 1975). Biological discoloration is caused by blue stain fungi, mold, decay fungi, and bacteria, and usually occurs in the sapwood parts. The fungal species do not have an important effect on the mechanical strength properties of wood (Fleet *et al*. 2001). However, the staining they cause creates visual defects in the wood. Moreover, because bacteria increase the permeability of wood, they can have negative effects on the surface treatment of the lumber product (Olsson 2005). Defects caused by stain and decay fungi can occur when freshly cut damp wood is held at temperatures above freezing (Scheffer 1973). Generally, the stain fungi and mold that cause discoloration on logs or lumber include *Trichoderma*, *Penicillium*, *Aspergillus*, *Fusarium*, *Alternaria*, *Aureobasidium*, *Graphium*, *Ceratocystis*, *Ophiostoma*, *Grosmannia*, *Leptographium*, and *Sphaeropsis* species (Schultz *et al*. 2008; Uzunovic *et al*. 2008). The best growth conditions for these fungi on wood include a temperature range of 20 to 28 °C and wood moisture of 20% or more. Stain and decay fungi are spread by insects (especially bark beetles), mechanical equipment (Uzunovic *et al*. 2004), and surface

water films (Dowding 1969). Some vector insects play a role in the transport and propagation of some stain and decay fungi. Insects can carry fungal spores on their bodies and in their intestines. In this case, the fungus is transmitted *via* insect-infested standing or felled trees (Batra 1963). The formation of decay fungi may result from the mechanical damage during the transport and logs/lumber processing. In particular, damage to the log bark that exposes the cambium layer is one element that triggers the formation of stain fungi (Lee and Gibbs 1996). In general, measures that can be taken against discoloration are prompt processing, chemical control, freezing or storage under snow, log drying, oxygen-free storage (storage under high carbon dioxide (CO_2) atmosphere or in holding ponds), reduction of mechanical damage, control of insect rate, and biological protection. In addition, the use of pheromone traps to prevent various stain fungi *via* their vector insects, such as the ambrosia beetle (*Platypus* spp., *Xyleborus* spp.) or bark beetle (*Ips* spp., *Tomicus* spp., *etc*.), Coleoptera (Curculionidae, Scolytinae, and Platypodinae) (Allison *et al*. 2004), and treating log surfaces with various surface preservatives, are also considered effective methods for preventing discoloration (Richmond 1986). Currently, the use of chemical methods is out of favor for the protection of logs against discoloration and mold. Instead, discoloration can be nearly eliminated by promptly and systematically converting timber products into lumber. However, to prevent discoloration of semi-finished lumber products, drying kilns can be used, and the surface or deep chemical impregnation (triazoles, quaternary, ammonium salts, or carbamates) can also be applied (Uzunovic *et al*. 2008).

Counter Solutions to Abiotic Factors

Holding time of logs

Abiotic factors that have impacts in depots can be listed as rainfall, temperature, wind, and other mechanical influences. The negative effects of some of these factors arise with the prolonged storage period of logs. Because logs cannot be fully protected against these effects, even if the feasible measures are taken in the depots, shortening the waiting times could eliminate the occurrence of problems that might affect the most desirable characteristics of the logs.

Superficial and deep checking of logs

Checking of logs is mainly caused by the effect of temperature and stresses resulting in the sudden loss of moisture from the outer surface or ends of the logs. In addition, the swelling/contraction of the wood in different directions (radial and tangential) and in different proportions is another cause of checking (Yang and Normand 2012). In this respect, the exposure of logs to direct sunlight or constant wind is a factor that accelerates the formation of checks. In particular, sudden moisture loss is greater from the surface of debarked logs compared to other parts. Therefore, care must be taken in the storage of high-quality industrial logs. To avoid this situation, after felling, logs should be promptly processed into lumber and subjected to programmed drying in drying kilns. However, this may not always be possible, and it may be necessary to keep logs waiting. Particularly in the case of furniture and veneer production when checking is undesirable, logs for this type of industrial use can be kept in timber ponds or depots with water sprinkling to avoid checking. However, for storage in open areas or in areas where no water supply is available, logs may be left with the bark intact. As the bark retains the moisture

of the outer part of the log, this can prevent exterior surface checking (from the outer surface to the core). However, in this case, the formation of internal checks (from the core to the outside) can occur (Johansson 2005). This kind of checking is said to be caused by the collapse of the cells brought on by sudden drying especially in tropical areas (Booker 1994). One approach to prevent cracking is to conduct the log harvest in the winter months (Yang and Beauregard 2001). Check formation arises mainly in the end sections of the logs or in the parts where the bark has fallen off. Therefore, the cut-ends of logs should be coated with various sealants (paraffin, wax, latex paint, *etc*.) within seven days to prevent sudden moisture loss from the log-ends (Linares-Hernandez and Wengert 1997). Precaution should be taken, especially against stain fungi in sapwood, when log-end coating is performed because covering the ends with sealants obstructs the elimination of water from the timber. In this case, the formation of fast-growing stain fungi in the damp wood can create problems. Consequently, it is recommended that a preservative impregnating agent against stain fungi be applied to the sapwood before the ends are coated (Simpson and Ward 1991). If the logs are not to be kept for long periods of time, storage in cool forest areas shaded from direct sunlight is an alternative method for prevention of checking (Yang and Normand 2008).

Log harvesting and transportation

The technical and economic value of logs is initially affected by inappropriate log harvesting. Studies have reported that the degradation of wood raw material during harvesting (logging, transportation, checking, *etc*.) alone contributes to 40% of its value reduction (Murphy and Twaddle 1985). Cutting timber lengths without considering customer (cut-to-order) demands also has a considerable impact on the material value of the logs. To reduce losses during harvesting, workers must have an adequate level of training in their field. Various damage can also occur during the harvesting of logs from the forest and transporting them to the depots. This damage may pave the way for both physical and mechanical effects on the logs and the biological degradation that may occur afterwards. To reduce such damage to the wood during transportation, appropriate use of log caps is indicated. These are made of fiberglass material and when attached to the base parts they prevent the product from being damaged (Ünver and Acar 2005).

Tree girdling (*ring-barking*)

Girdling is the traditional method of killing trees. When the phloem layer is completely cut, the tree can no longer transport carbohydrates produced in the needles or leaves to the roots. As a result, the movement of photosynthesis to the roots is interrupted and the tree dries in a short time. In order to increase the effect of this technique, herbicide is applied to the opened part (frilling) (Noel 1970; Kilroy and Windell 1999). The most important change in the tree along with the girdling kills is the sapwood to heartwood transformation. With this change, storage compounds (starch, sugar, lipids) of tree are absent. In addition, the moisture content of the tree decreases. For these reasons, many properties of wood (such as resistance to decay) can be affected (Taylor and Cooper 2007). A longer girdling period decreases the degree of deformation during drying and also increases wood density (Basri *et al.* 2015).

Other Factors

Customer demands in timber production

Losses in the value and economic return of logs may result from the cases where customer demand for the produced logs is not taken into consideration. Before the production of timber in the forests or its storage and grading in the depots, customer demands should be considered. In order to take the appropriate action before beginning log production, careful examination should be made of the sales demands and marketing units of the regional or national forest-products trade enterprises. In addition, meeting tender dates (*i.e.*, the agreed time to supply the logs to the purchasers) and marketing activities should be planned in an integrated manner. In particular, data, such as the log quantity requested and the required sizes (length and diameter), should be collected and a report submitted to the units responsible for production. For example, in an enterprise that provides production jobs for local rural people, the employees should be fully instructed on the standards expected in order to prevent the occurrence of any laxity or shortcuts taken during the processing of this valuable timber. Otherwise, if the demands of the sector are ignored, the logs produced may not be sold at their value.

Log sales policies

Losses in the value of logs occur during the time between the forest enterprise production and the sale to the forest products sector, which can be quite unpredictable during this period. One method that can be applied to combat this situation is the Turkish State policy on sales of standing trees. In this method, standing trees sold in the tender procedure are removed from the forest by the sector as soon as they are felled and promptly transferred to the factory warehouses. Enterprises can store logs in a more controlled way (*e.g.*, by holding in ponds or water sprinkling) or process them quickly to produce lumber or finished products. Thus, because the logs are less exposed to biotic or abiotic agents, their quality characteristics can be maintained from cutting through processing. Although some drawbacks have also been reported in terms of the forestry aspect, the use of this method has increased globally in recent years, especially in the USA, Germany, the UK, and Russia.

Legal procedures

One of the biggest problems for timber depots occurs when legal procedures keep goods waiting in the depots for a long time (Akçay 2017; Yalçın *et al*. 2019a,b). These waiting goods that have been held include different types of wood and logs, and depending on the waiting period, problems can develop with the quality of the goods as well as from the formation and spread of biotic factors. It is important to make the necessary arrangements to accelerate the legal processing of such forest enterprise cases to prevent these potential difficulties.

CONCLUSIONS

Log depots are areas where logs cut for different purposes are held until they are processed. They can be located in open forest areas, outside forests, or at factory sites. Each of these sites may contain factors that have negative effects on the technical and economic

value of the logs. These can be grouped as biotic, abiotic, or other factors. Biotic factors can be listed as decay/rot fungi, stain fungi and mold, wood beetles, bark beetles, and ambrosia beetles. Abiotic factors include daylight, wind, temperature, the depot floor, and the form and method of stacking at the depot site. In addition, other factors, such as business management, and the training and qualification of depot personnel, may cause storage problems. The impact of all these factors increases if the storage methods used are incorrect or the procedures are inadequate, which may result in negative effects on the logs. Therefore, a number of solutions are proposed to reduce or eliminate the impact of these factors.

- The most important consideration is to keep the storage time as short as possible.
- The timber production business must be planned in detail, and the conditions demanded by the sector must be taken into consideration.
- Logging should be performed by personnel who have received the necessary training in the field of harvesting and transport.
- Storage must be completed in accordance with the "first in-first out" rule.
- Previously confiscated illegally felled logs in the depots consisting of different wood species with and without bark may remain in the depots for a long time. Consequently, long-held confiscated timber and newly produced logs should not be stored in the same areas.
- When selecting depot sites, care must be taken to ensure that they are on suitable ground and that the transportation factor is considered. In particular, areas that are drier and covered with materials, such as sand or gravel, should be selected instead of marshy areas of dense vegetation where water drainage is difficult.
- Depots should be installed as far away as possible from forest areas and settlements.
- To prevent the spread of insects and their damage, coniferous species in particular should be debarked in the forest before being brought to the depots. Illegally harvested confiscated logs or firewood for which these conditions have been disregarded can transport bark or ambrosia beetles.
- Log stacks should be checked periodically to make sure that fungal sporophores are collected and destroyed. Thus, by preventing the spread of spores, fungal infections can be avoided.
- Rapid processing is the most suitable method to prevent discoloration and mold in the log products. However, in cases where this is difficult to accomplish, winter-fellings should be made, the logs should be debarked, and various protective impregnating agents and sealants should be applied to the cut-ends of the logs. Effective and inexpensive new substances need to be researched and developed for this purpose.
- The most important point to be considered in depots with beech logs is tylose formation/dote. For this purpose, winter harvesting of logs and keeping them in cool forest areas in the summer, transporting them promptly to factory sites, and sprinkling with water or holding them in water (ponding) may be the solution.
- Measures that can be taken against checking include winter-felling of logs, keeping the bark intact to prevent surface checks in the summer months, preventing rapid moisture loss of cut log-ends with waterproofing sealants such as paraffin wax and not exposing the stacks to direct sunlight, *etc*.

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