

O-01: A Trajectory of Final Harvests in the Pacific Northwest, USA over 50 Years: Loggers, Safety, Technology, and the Future

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ABSTRACT: The author has worked in the woods, been a Professor of Forest Engineering and Timber Harvesting Extension Specialist, and consulting Forest Engineer over a 50 year career in Oregon and the World. There are trajectories of development for the volume and size of timber harvested; safety and health of loggers; industry structures and workforce characteristics; technological developments; and future directions that are evident but not well documented. Revisions to Oregon's Forest Activities Code of safety and health regulations over the past 35 years reflect different approaches to logger safety. The sector's approach to technical efficiency, economic viability and environmental performance show changes over the fifty years. The author comments on "cutting edge" developments over the period and into the future, including tethered felling machines, shovel logging and grapple yarding. The author also provides insights from more than 60 cases of litigation involving logging accidents over 50 years.

O-02: Steep Terrain Forest Operations – Challenges, Technology Development, Current Implementation, and Future Opportunities

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Dzhamal Amishev, Forest Operations, FPInnovations, Canada

ABSTRACT: While modern fully mechanised ground-based systems are a default option for safe and productive harvesting, they have always been limited by terrain factors such as slope, soil strength and or roughness. There is a limit with regard to the physical feasibility of operating machines on steep slopes because both the weight and also the force from the momentum created during traction loss can affect stability. There is a huge interest and recent worldwide effort to improve traction of harvesting machines when operating on steep slopes. One way to improve traction and stability on steep slopes is through assisting harvesting machines by winch and cable to anchor locations such as tree stumps or stationary equipment. Additionally, this technology offers potential for improving the safety, productivity, and efficiency of a harvesting operation, as well as for improving felling-machine mobility and reducing soil disturbance through the reduction of slip.

There have been several cases of cable failures (both single and double-cable systems), shackle or other connection failures, anchor failures, and machine rollovers without any serious injuries. Only in New Zealand on June 2016 a single-cable bulldozer anchor machine was pulled down the hill pinning the operator of the felling machine under the dozer.

The forest industry worldwide has been, and will be, aspiring to completely eliminate incidents during forest operations. With the exponential development of technology, an integrated approach must be developed for conducting productive and injury-free mechanical harvesting operations on steep slopes that draws on the skills and accountabilities of the working team. Beyond a certain physical threshold, the only feasible and achievable solution providing some "intelligent behaviour" to machines and systems would be the role of mechatronics application. One of the most relevant points could be the possibility to introduce the concept of "teleoperation" using unmanned ground vehicles. Combining teleoperation with winch-assist technology would provide a platform for extending the range of ground-based equipment to previously infeasible terrain conditions.

Keywords: Steep slope, Harvesting system, Winch-assist, Remote control, Teleoperation

O-03: Productivity of a Harvesting Operation for a Small Clear Cut Block by Direct Grappling Using a Processor in the Kochi University Forest

Yasushi Suzuki, Haruka Kusaka, Yuki Yamaguchi, Haruka Aoki (Kochi University), Yoshifumi Hayata, and Hirotaka Nagai (Field Science Center, Kochi University)

ABSTRACT: A case study is analyzed on productivity of clear cutting operation conducted by newly introduced logging machines in the Kochi University Forest. A small block of 0.2 ha is clear cut annually to prepare a planting practice site for the Forest Science Course students. Although harvesting operations were performed by a small-scale oriented system using such as a winch-mounted mini-forwarder until 2015, an updated system has instead started to operate since 2016 with a processor equipped on a 0.25m³ class base machine and a forwarder with 3 t capacity. A series of operations was conducted, that is cutting, logging, processing, bucking, and forwarding, by the system in November, 2016. The total productivity was evaluated over 4 m³ person⁻¹ day⁻¹, which was raised from that of the former system, around 2 m³ person⁻¹ day⁻¹. As of extraction operation by the processor, an angle of fell trees toward a strip road was one of critical factors on the productivity.

Key words: Clear cut, Small block, Direct grappling, Processor, Kochi University Forest

O-04: Productivity and Harvesting of Exotic Tree Plantations on Highland in Chiang Mai, Thailand

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ABSTRACT: On the highland of Thailand, the exotic plantations had been promoted in the deforestation areas facing the lack of woods and environment degradation. As forest sustainable management, the productivity and harvesting intensity level and methods with appropriate and environmental friendly was studied in 30-year-old exotic tree plantations with spacing of 2 m x 2.5 m at Ang Khang Royal Agricultural Station, Chiang Mai province. These plantations composed of six exotic tree species and 26 indigenous tree species with 1,450 trees ha⁻¹ and the volume of 282.98 m³ ha⁻¹. The suitable harvesting level was 20% of basal area and the most appropriated logging system with the least impact on plant, wildlife, and water resource was chain saw and log chute extraction. This information can be used for sustainable forest management including forest harvesting impact management.

Keywords: Sustainable Forest Management, Forest Harvesting, Exotic Tree Plantation, Highland

O-05: Forwarding Operation Using a Tractor and a Trailer in Mountainous Forest

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ABSTRACT: Forwarding operations using a tractor and a trailer is popular in Europe, however it is rare in Japan. Because a tractor with a trailer is not suitable for backward driving and requires a U-turn spaces or a circuit road, which are difficult to construct on a steep slope. A Valtra A93 High Tech tractor with a Farmi Vario 101 trailer was tested to clarify its forwarding ability in a mountainous forest. Stop watch time study was carried and loading volume, driving velocity and fuel consumption were measured in relation to road inclination. As results, the relationships between driving velocity and road inclination were clarified. The fuel consumption was proportional to operation time. The effects of introducing another grapple loader on operation cost were discussed.

Keywords: Driving velocity, Fuel consumption, Loading volume, Operation cost, Road inclination

O-06: Ground Pressure Distribution of Forest Machines

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ABSTRACT: Forest roads need to have strength enough to support forest machines. In particular, as Japan's planted forests are reaching maturity, 12 ton excavator-based forest machines which can process larger diameter trees are expected to be widely used. The authors measured ground pressure distribution of 7 ton and 12 ton excavator-based forest machines to clarify the required strength of forest roads.

Keywords: Ground pressure distribution, Excavator based forest machine, Forest road strength

O-07: A New Small Yarding System for Log Transportation

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ABSTRACT: Today, the damages at residual stand and quality/quantity losses on wood of log extraction activities is above acceptable level. Therefore, it is important to develop new methods and techniques to minimize these losses. In Turkey, forest cable yarding systems are the only system that allows transportation on cable of logs without touching the ground. However, these systems have various disadvantages such as imported, very expensive, long installation/disassembly, requiring the opening of transport corridors in the forest and not being rentable when the amount of transported wood is under a certain amount. While the number of forest yardings in Turkey has been over 50 in the 1980's, new ones have not been purchased due to these disadvantages and only a few are left today. This brings the agenda to the development of a new portable system which is affordable by those engaged in forest harvest, and minimizing both environmental damage and economic loss. The aim of this study is to develop a mini yarding system which is enable the logs to be transported up the slope, non-tower, easy to install and use, cheaper and ergonomic than alternative systems. The system consists of an wagon produced in the industry and a forest tractor, and it can carry on the cable logs up to 300m. A portable hand crane or truck-mounted crane can be used in this developed system for power supply.

Keywords: Log, Carriage, Small yarding, Environment-friendly transport techniques

O-08: The Limits and Possibilities of Japanese Swing Yarders in Comparison with European Cable Systems

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ABSTRACT: Japanese swing yarders are typically modified from excavators and equipped with winches for cable logging. According to the latest statistics published by the Forestry Agency Japan, more than 900 swing yarders have been introduced to Japanese forestry. However, their productivities are mostly low compared to European cable systems. That is because Japanese forestry does not introduce appropriate equipment such as remote controlled carriages or standing skylines that are very popular in European forestry. In addition, two-line running skyline systems, very often used for swing yarders in Japan, are almost incapable of lateral yarding for thinning. In this study, we discussed the advantages and disadvantages of Japanese swing yarders in comparison with European cable systems, and proposed the ways to improve their productivities based on the comparative discussion.

Keywords: Japanese Swing Yarder, Excavator, Cable System

O-09: Developing Accessibility Measurement Tool between Forests and Woody Biomass Plants Using Google Maps API

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ABSTRACT: In order to estimate harvesting and collecting costs for woody biomass plants, the accessibility measurement tool consisting Java Script with Google Maps API was developed. The transportation distance and time from artificial forest points to biomass power power plants were measured by JavaScript with Google Maps API. The distribution of artificial forests was obtained from the 6th vegetation survey by Biodiversity Center of Japan. As a result, the transportation distance and time for 30 points could be measured based on the current transportation network. In our system, Euclidean distance in forests could be measured as well as roads. However, depend on the measurement time, some of routes were different. They were up to 31.87km and 0.93h, respectively.

Keywords: Forest road, Harvesting, Transportation distance, Transportation time

O-10: Physiological Inputs in Cable Yarding Operations

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ABSTRACT: Working conditions and the working environment in forestry have particular features that distinguish forestry work from many other industries. Worksites are usually temporary and scattered; facilities are more difficult to arrange than at permanent work premises; climatic, topographical and biological conditions, and the large share of contractual and seasonal workers, have significant impacts on labor issues and on the welfare of labor. Cable yarding operations are a common practice in Central and East Europe since the 1970s when mobile integrated tower yarders were introduced. Nowadays it is well recognized that cable yarding represents a low impact system for extracting wood in steep terrain both on soil as well on residual stand trees. The study report the first results of a survey on the working conditions in the forests of the Mediterranean forests, where the mechanization of the operations is limited, owing to the difficult geomorphological conditions. A group of workers has been followed by a precise criteria selection: determinate the physiological cost of each task by measuring oxygen consumption and the heartbeat rate. The stress of dynamic work has been investigated and the measurements were conducted with a portable gas analyzer with a purpose of sampling metabolic and ventilatory data.

Keywords: Metabolic rate, Energy cost, Heartbeat frequency, VO_2

O-11: Risk Perception and Work Safety Behavior of Indonesian Chainsaw Operators

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ABSTRACT: Operating a chainsaw in forest harvesting operating is well associated with high occupational health disturbances and accidents risk. Adopting psychometric paradigm (Slovic's et al. 1987), this study tried to grab risk perception of the Indonesian chainsaw operators. As much as 24 activities (vary from chainsaw-related operation up to tree harvesting techniques) were questioned to 36 chainsaw operators. The results show that in average, the operators considered the risk of operating chainsaw in tree felling as relatively known to science. They also ever see the impacts/suffer of those exposed, and already know the risk since at least 5 years ago. They also perceived that the risk on operating a chainsaw is not an immediate impact to their health and safety. If there is accident, they noted that the consequences are relatively fatal, more to be an individual than to mass effect, and dislike to accept the impact to their safety and health. However, they didnot think that the impact is dreadful. They also think that they, somehow, could avoid the risk that may occur. However, the perception did not resemble a safe operation in the field. Data taken from interviews and direct observations showed a big gap in the term of safety behaviors, indicated by ea: negligence in wearing full PPE and improper technique of making a felling cut.

Keywords: Occupational health, Risk perception, Tree felling, Psychometric paradigm

O-12: Analysis of Work-Related Injuries of Felling Work Using Chain Saws in Japan

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ABSTRACT: There are the most disasters of the forestry in all industries. Accidents during felling work exceed 60-70% among them. Existing analys of work of work of work-related injuries have been performed by classifying it as model of the accident, work contents and tools due to the accident so far. This study is to intend to consider instruction items which is required in the education of the chain saw works. I investigated the investigated the investigated theinvestigated theinvestigated the investigated the tendency of the tendency of the tendency of the tendency of the tendency of the date, time and day of week that a disaster occurred. I also analyzed the cause of the disasters dividing the factors into two, which is caused by poor felling technique and ability for safety management of its work environment. The study was based on the data which refers to "death disaster database" it managed by Ministry of Health, Laborer and Welfare and "forestry death disaster breaking news" it managed by Forestry and Timber & Health Association.

Keywords: chain saw, work-related injury, felling

O-13: ICT Assistance and Management for Manual Chainsaw Operation

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ABSTRACT: Chainsaw operation by manual work is inevitable for forestry operation. The portable device is connected to the human body movements to maneuver the chainsaw for felling, delimiting, crosscutting and so on. These actions can be interpreted into the productivity and are utilized to grasp how these are processed. The former is essential for operation system management and the latter enables work safety management. ICT-enabled sensors on the chainsaw to see the posture, movements, vibration and the mechanical movements. This provides understanding on the usage condition and the process transition/continuity, they show the operation processes. A chainsaw with these sensors was developed and the process understanding model was developed. Also a set of the utilization and the further utility for regional/national/grovel management and control on the handheld machineries were discussed.

Keywords: Chainsaw, manual work, Safety, Productivity, ICT

O-14: The Physical Effects of Shapes of Hinge in Chainsaw Felling Operation

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ABSTRACT: In Japan, most of felling operations are obliged to rely upon manual working with chainsaw because of steep and difficult terrain. Thus, the average working productivity remains around 5 m³ per man-day, and the working accident has not been decreased effectively. Especially, felling and bucking operations by chainsaw cause about 60% of fatal accidents. One of the main reasons of those fatal accidents is irregular felling direction, and it is mainly due to the uneven shape of the remaining hinge on the felling surface. We performed a pulling experiment by wires to make clear the physical feature of the hinge during manual felling operation. As the results, the uneven shape of the hinge produces a moment toward the thicker side of the hinge, and the moment increases with the increasing area of the hinge. Consequently, it is made clear that the larger uneven hinge changes the felling direction more different from the optimum direction.

Keywords: Shape of hinge, Physical effect, Felling direction, Chainsaw felling, Pulling experiment

P-01: Estimation of Forest Workers Environment under the Climate Change

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ABSTRACT: Climate change is one of the most important issues in the world, which might decline labor productivity. Even now, forest operations have been carried out in the tough working environments. In this study, working environments were estimated using temperature and humidity under the climate change. The temperature - humidity index (THI) in forest areas in Japan were calculated using current (average during 1961-1990, in July) and future (at 2050, CSIRO and MIROC-H, in July) temperature and humidity raster which obtained from CliMond. As a result, THI in forest areas under current climate were from 61 to 83. THI under future climate were from 64 to 86 (MIROC-H) and 64-85 (CSIRO). Although elevated levels of THI showed low, increasing could be found throughout the Japan.

Keywords: Temperature, Humidity, Slope, GIS

P-02: Method for Determining Felling Directions to Prevent Damage to Saplings

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ABSTRACT: In felling operations, chainsaw operators are required to reduce the impact of felling trees on saplings, in order to successfully form the next generation of mature trees. This paper proposes using mathematical programming various formulations that minimize damage to saplings by felling trees, while giving consideration to the spatial arrangement. The main decision variables in their formulations are binary variables on felling directions of each felling tree. Once formulated, problems are solved with a commercial MIP solver and then the solutions are compared with the actual results obtained from logging surveys.

Keywords: Felling damage, Felling directions, Spatial optimization, Mathematical programming

P-03: Study on Prediction of Sapling Damage Area by Felling and Skidding

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ABSTRACT: In order to optimize logging method for shelterwood, it is a prerequisite that the damage area of the understory caused by harvesting has been clarified. In the past method using basement facilities as explanatory factors such as forest road, it is not suitable for evaluation of natural regeneration with random distribution. This study, firstly, survey individual level spatial distribution of damage in *Chamaecyparis obtusa* dominated shelterwood stands, and then construct a prediction model with logistic regression analysis; overstory as explanatory variable. After that, we adapt the model to the dataset of damages observed at the adjacent survey site and compare the damage occurrence range of each forecasted whole-tree or stem-only collection.

Keywords: Shelterwood, Logging damage, Forest operations, Spatial analysis

P-04: Work Load by the Difference in Slant at the Time of the Chain Saw Work and Posture

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ABSTRACT: This study was to measure Muscle load, Heart rate and Body surface temperature quantity from workers. The work posture that we were surveyed work every five seconds and analyze the reproduction image which recorded felling of the chain saw worker appeared of, standing, 30°trunk flexion, 90°trunk flexion and half kneeling. The measurement of the muscle load did it with four places of rectus abdominis muscle (right, left), the erector muscle of spine (right, left). The condition of the slant assumed it flat, 10 degrees, 20 degrees and set 12 conditions in total. The experiment is performed in the room to do temperature, the humidity constantly four schoolboys that a subject is normal. As for the erector muscle of spine, the left had a bigger muscle load than the right. In addition, 30°trunk flexion has a biggest muscle load together the left right, and there are the fewest muscle load; 90°trunk flexion showed a tendency. When an inclination rises, half kneeling a muscle load decreases showed a tendency.

Keywords: Chain saw, Muscle load, Work posture, Movement analysis

P-05: Effects of Final Cutting as a Preventive Measure of Pollinosis and the Tama Timber Certification System on the Local Logging System and Productivity

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ABSTRACT: The Tokyo Metropolitan Government started the ‘preventive measure of pollinosis’ in 2006. This aimed to cut down the amount of pollen of Japanese cedar by 20 percent by clearcutting 1,200 ha of Japanese cedar forest and then planting saplings of low-pollen Japanese cedar cultivars. The harvested logs within this framework were certified as ‘tama timber’. This certification system ensures that the logs were harvested from sustainably-managed forest in the Tama region of Tokyo. The local logging contractors were, by implementing this political measure, expected to be considerably influenced. Thus, in this study, changes of the logging systems of registered certified contractors as well as the timber distribution in the local market were investigated, and the effect of the measure on the local logging system and productivity.

Keywords: Final cutting, Logging system, Productivity

P-06: Analys on Economic Balances of Clear Cutting and Regeneration Operations in the Northern Area of Tochigi Prefecture, Japan

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ABSTRACT: This study analyzed economic balances of clear cutting and regeneration operations with operators’ daily reports and product sales of the Nasu Forest Owners’ Cooperative in the Northern area of Tochigi prefecture, Japan. Nasu has a relatively gentle slope, and so a relatively large forestry machine can be used there. Furthermore, the cooperative extracts smaller diameter logs for a woody biomass power generation. The productivities of clear cutting in 2013 and 2014 were 8.94 and 10.11 m³/person-day whereas those in the conventional and mechanized thinning operations were 3.09 and 5.14 m³/person-day. Total costs including direct and indirect costs of clear cutting operations in 2013 and 2014 were 50.25 and 62.32 USD/m³ whereas those in the conventional and mechanized thinning operations were 106.82 and 75.29 USD/m³. These productivities and total costs were similar to the average values in Japan. The revenues of clear cutting operations in 2013 and 2014 were 85.64 and 104.71 USD/m³ whereas those in the conventional and mechanized thinning operations were 117.32 and 95.35 USD/m³. Therefore, profits of clear cutting operations were 35.39 and 42.49 USD/m³ whereas those in the conventional and mechanized thinning operations were 10.49 and 20.06 USD/m³. Since profits of clear cutting operations in 2013 and 2014 were 15,205.94 and 20,804.40 USD/ha and regeneration costs including site preparation, planting, weeding for 5 years were 17,773.44 and 17,825.62 USD/ha, the economic balance in 2013 was deficit. This is the typical situation of current Japanese forestry. Although regeneration operations were subsidized and economic balances with subsidies in 2013 and 2014 were profitable, 12,324.19 and 21,178.18 USD/ha, clear cutting and regeneration costs should be reduced for future budget cuts of subsidy.

Keywords: Revenue, Labor input, Productivity, Cost, Profit

P-07: Productivity of Final Cutting in *Chamaecyparis obtuse* Dominated Shelterwood Stands -A case of KANAZAWA YAMA National Forest-

Mikiko Matsui, Masashi Saito, Dai Otsuka, Hiroki Matsunaga, Tatsuhito Ueki (Faculty of Agriculture, Shinshu University)

ABSTRACT: Final cutting operation is a lot of cost considered to take in order to felling while protecting the understory unlike clearcutting operation. However, it is unclear that harvest cost of shelterwood cutting in Japan. Therefore, in order to clarify the cost of final cutting, we observed the final cutting at the site different from previous research on the habitat environment and working system. As a result, productivity was about 4.0 m³/person day. It took a lot of time for skidding and bucking. Particularly in the s the skidding, it is considered that efficient skidding was not possible because the direction of felling is limited in order to protect the understory at the time of felling down. This work was supported by JSPS KAKENHI Grant Number JP15H04508,

Keywords: Final cutting, Productivity, Harvesting cost, Shelterwood, *Chamaecyparis obtuse*

P-08: The Tokyo Metropolitan Government final cutting project

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ABSTRACT: In some areas of Japan, final cutting activities have been decreasing because of the high cost of logging and low price of wood. It is possible that local logging enterprises, who are familiar with local conditions such as productivity and the safety of final cutting, will give up logging. Under these conditions, it is important to determine how to increase final cutting activities in mountain forests. This study conducted interviews to evaluate the final cutting project promoted by the Tokyo Metropolitan Government. The project started in 2006. In Tokyo, the project has increased final cutting activities.

Keywords: Final cutting, *Cryptomeria japonica*, Interview, Tokyo, Policy

P-09: Factor of Illegal Logging Through Villagers Perspectives: A Case Study in PRF Ulu Sat, Kelantan, Peninsular Malaysia

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ABSTRACT: Illegal logging is the main issue in Permanent Reserve Forest (PRF) Ulu Sat. The objectives of this study were to identify the factor that caused the illegal logging in PRF from the local community perspectives. This study were conducted in the state of Kelantan, which is one of the states in Peninsular Malaysia with the largest forest reserve and experiencing problems of illegal logging activities. About 400 respondents were randomly selected through sampling method. Data collected were analyzed by using the “Statistical Package for the Social Science” (SPSS version 22.0). The act of illegal logging in PRF can be better understood if the studies be expanded among the other states in Malaysia.

Keywords: Illegal logging, Villagers, Permanent Reserve Forest

P-10: Long-term Wood Supply Planning Using Precise Forest Information

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ABSTRACT: In Japan, trees planted at the period of high economic growth (1954-1973) are enough to be harvested, and the Japanese Government is promoting final cutting and reforestation. However, wood demand and supply are lacking coordination because these plantation stands aimed to produce housing studs in spite that the number of housing starts are decreasing in these decades. In addition, difficulty of precise estimation of harvesting volume complicates adjustment of supply and demand. In this study, we tried to estimate wood supply ability considering practical harvesting methods by using aerial photographs, LiDAR, and the other documents. We also produced annual wood supply plans for 40 years at a certain stand management schedule, and predicted a transition of stand conditions (distribution of age classes, density, volume, DBH, height, and relative yield index) by using a stand growth model.

Keywords: LiDAR, GIS, Logging possibility, Road network, Stand growth

P-11: Productivity of Logging Large-diameter and Long Logs for Final cutting on Moderate Mountain Forest

Masahiko Nakazawa, Chikashi Yoshida, Tatsuya Sasaki, Seishiro Taki, Takumi Uemura, Takayuki Ito, Hirokazu Yamaguchi, Masahiro Mozuna, Kengo Usui, Yuta Inomata, Hidenori Suzuki, Satoshi Yamaguchi, Hiroko Muneoka, Yoshiaki Tanaka and Masaki Jinkawa (Forestry and Forest Products Research Institute), Kotaro Zushi and Hideharu Aiura (Toyama Forestry Research Institute)

ABSTRACT: Today in Japan, a large part of artificial forests has been matured. These trees are becoming larger; it is more difficult to log them with current technics. This study aimed to develop logging system for larger-diameter and longer logs than usual in Japan. We examined the productivity of final cutting on moderate mountain forest in Toyama Prefecture, and were compared the productivities of each log length class (4, 6, 8m) using both current and bigger-machine harvesting system. Moreover, felling technics for large-diameter tree were considered using mechanical wedge popular in central Europe. Consequently, the safety of felling using mechanical wedge and the productivity using bigger-machine system were higher than the current technics and system, on the other hand the productivities of each log length class were differed little.

Keywords: Productivity, Logging, Large-diameter and long logs, Final cutting, Moderate mountain forest

P-12: Improvement of Forestry Strip Roads and Assessment of Possible Introduction of Logging Operation Systems

Shin Yamasaki (Kochi prefectural forestry technology research center), Yasushi Suzuki (Kochi University), Yukihiro Mitani (Kami forestry Association), Masanobu Morimoto (Kami forestry Association)

ABSTRACT: The Kurotaki area of Nankoku city, Kochi Prefecture, Japan, is famous of forestry activities by local residents since early times. As of the area's forestry activities, they have been using a method of making narrow forestry strip road network in steep terrain and extracting logs using small winches. However, in recent years, problems have occurred; that is, reduction of forestry workers due to a lack of successors and that efficient work is coming to be difficult with conventional methods due to the large size of growing trees planted around 1950-70's. Therefore, the forest owners' cooperative of the area, instead of the local forest workers, has started to perform logging operations using newly introduced forestry machines in this area. In this presentation, the authors will report the result of the survey on the operational efficiency both of the conventional logging method and of the newly introduced European tower yarder.

Keywords: Steep slope, Strip road, Logging operation system, Tower yarder

P-13: The Effects of Compaction Operation road at the Constructing

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ABSTRACT: It is required to perform sufficient compaction at the construct operation road, because it is based on the soil structure. However, there are cases that compaction is not sufficiently at the constructing based on the idea that can be compacted the vehicle running. Operation road must be not only save the cost, but also having durability and safety. In this study, we carried out the effects of compaction on strength and road surface condition of operation road. As a result, the CBR value representing the strength of the surface layer was not greatly different whether or not compaction wa performed, but the Nd value indicating the inside bearing capacity was confirmed that there was a tendency lower than 5 which is the weak layer. Without compaction, the amount of settlement of the surface layer of the road increased after running of the vehicle. This work was supported by JSPS KAKENHI Grant Number JP15K19709.

Keywords: Operation road, Compaction, Bearing capacity, CBR value, Nd value

P-14: Effect of Stripping Bamboo for Using in Skidding Road

Satoshi YAMAGUCHI, Hidenori SUZUKI, Hiroko MUNEOKA, Yoshiaki TANAKA and Masaki JINKAWA (FFPRI, Japan)

ABSTRACT: After constructing skidding roads, we dig ditches because we have to drain from the surface of roads. But we feel uncomfortable about ditches when we drive on the ditches because of shock. And ditches leak with cross-point of wheel tracks. Then we tried to use bundles of stripped bamboo as filler to solve the problems. Because of the management shortage and lower demand, moso bamboo increase too fast in Japan. While we can get moso bamboo easily in Japan, and they are usable because of their lightness and strength. As a result of trying, we could use bamboo in a few years. In a use, bundles of stripped bamboo didn't break easily, but rods of bamboo broke easily. Then we examined why bundles of stripped bamboo can withstand wheel load.

Keywords: Bamboo, Skidding road, Ditch, Wheel load, Bundling

P-15: Evolution of Forest Harvesting in Peninsular Malaysia

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ABSTRACT: Since its inception in 1978, Malaysian forest is managed under sustainable forest management by adopting Selective Management System practices that consider reduced impact logging and Malaysian Criteria and Indicator to meet international requirement and forest certification. With regard to sustainable forest management (SFM), evolution can be seen in forest harvest operation whereas conventional logging has been transformed to RIL practices and application of geoinformatic technology. The Forestry Department Peninsular Malaysia (FDPM) has adopted geoinformatics technology for forestry in early 1997 as suggested during Seventh Malaysia Plan. This paper attempts to discuss the evolution phases in forest harvesting, and how evolution will shape the future forest operation in Peninsular Malaysia. This includes forest engineering activities, such as forest resource surveying and harvest planning, and forest road planning.

Keywords: Malaysian forest, Forest harvest operation, Sustainable forest management

P-16: Trends in Charcoal Production in Mangrove Forest Reserve, State of Perak, Malaysia

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ABSTRACT: Kuala Sepetang is a part of the mangrove forest in Taiping and Larut Matang district, State of Perak, Malaysia. The aim of the study was to determine trends in charcoal production in Matang Mangrove Forest. The study describes factors that influence the production of charcoal. Mangrove forest can be harvested as determined by the Mangrove Forest Management Plan, Perak State Forest Department. Each contractor gets a different area by rotation and based on a number of kiln owned by the contractor. The increasing production of charcoal began in 2004. It is based on local market and export demand. Production for export markets is higher, which was 70% annually compared to the local market. Distribution of charcoal in the local market (Perak, Penang, Kuala Lumpur) showed no significant difference in each year (p -value = 0.792). Total royalty of charcoal increases by RM50,668 each year. Total of charcoal cess showed increases followed by the total of charcoal production and royalty.

Keywords: Charcoal production, Mangrove forest, Perak, Malaysia

P-17: Rigging methods of simple logging cable systems for small scale forestry

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ABSTRACT: A majority of forest owners is that of small scaled ones in Japan. They prefer small scale machines for forestry operations because of their low investment although with low productivity. One of such machines is a winch equipped mini forwarder with a loading capacity around 1 t. A kind of simple cable system can be rigged up using the machine. The system consists of the machine, a standing skyline of 10-12mm of a maximum span of around 100 m, a carriage without clamping device, and a main line driven by the winch. There exist a few types of rigging methods of which are mainly different on a mechanism of blocks on the carriage for lifting and/or lateral pulling of a load. This paper at first classify the rigging methods. Secondly a force balance at the carriage is analyzed in order to assess and compare the availability of lateral pulling between the methods. The analysis is oriented to support a possible improvement of the system with low cost.

Key words: Logging cable systems, Rigging methods, Small scale forestry

P-18: Availability of Small-Scale Woody Biomass Gasification -Power Generation from the View of Forest Resources in Tochigi Prefecture-

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ABSTRACT: This study extracted production forests and estimated the annual available amounts of forest biomass resources under profitable forest management in Tochigi prefecture. Production forests were extracted as sub-compartments where expected revenues surpassed all costs—from planting to final harvesting—for a 55-year rotation. Then, annual available amounts of forest biomass resources were estimated on the basis of annual supply potentials from production forests. Annual supply potentials from precommercial, commercial thinning and final felling operations were 64,357 tons, 156,830 tons, and 172,855 tons, respectively. Annual available amounts were estimated at 28,726 tons, 69,398 tons, and 76,681 tons with a destination and 33,446 tons, 81,103 tons, and 89,271 tons with nine destinations, respectively. Since the 2,400-kW Nakagawa woody biomass power generation plant consumed 50,000 tons/year, the largest annual available amounts for small-scale woody biomass gasification power generation was 43,000 tons in Kanuma city.

Keywords: Woody biomass, Estimation of availability, Harvesting cost

P-19: An Optimum Size of Slash Pile for a Grinding Operation -Modeling the Operations of a Grapple Excavator and a Horizontal Grinder-

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ABSTRACT: The previous study by authors investigated processing the woody biomass waste piles for use as fuel instead of burning them. At each landing slash pile location, a 132 kW excavator with grapple was used to transfer the piles into a horizontal grinder (522 kW). Economies of scale could be expected when grinding a larger pile, while the efficiency of a loading operation might be diminished. Therefore, three piles, i.e., ‘Small (Length: 20 m; Width: 15 m; Height: 4 m),’ ‘Medium (L: 30 m; W: 24 m; H: 4 m),’ and ‘Large (L: 35 m; W: 30 m; H: 4 m)’ piles, were ground and the operations were time-studied. As a result, grinding the ‘Medium’ pile was found to be the most productive, 31 BDT/PMH₀, thereby suggesting that there might be an optimum size of slash pile for a grinding operation. This study discussed that by modeling the operations of an excavator and a grinder.

Keywords: fuel reduction, grinding operation, modeling, slash pile, woody biomass

P-20: Effects of the Variation of Canopy Openness after Thinning on the Understory Vegetation

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ABSTRACT: We evaluated the effect of canopy openness on understory vegetation by investigating the understory vegetation and creating the crown projection maps both by taking hemispherical photographs and crown projection maps of the sites after qualitative thinning or line thinning. The test site is a mixed forest of Sugi (*Cryptomeria japonica*) and Hinoki (*Chamaecyparis obtusa*) in Kami City, the Kochi Prefecture. Two levels of cutting treatments (qualitative thinning and line thinning) and three levels of the elapsed years after thinning (immediately, 5 years, and 10 years after the thinning) were set as the factors. There was no significant correlation between the canopy openness by hemispherical photo and the canopy openness by crown projection maps. On the other hand, a significant negative correlation was observed between the canopy openness by crown projection maps and the understory vegetation cover. The authors are planning to continue further investigation on the sites and evaluate the impact from thinning treatments.

Keywords: Canopy openness, Understory vegetation, Hemispherical photo, Crown projection maps, Thinning,

P-21: The Temiar Community in Kelantan, Malaysia - Their Socioeconomic and Culture Values -

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ABSTRACT: Forests in Malaysia have a wide range of roles and functions. It is highly important to the communities to meet their needs in terms of food, shelter, traditional medicine and culture values. The increasing rate of forest degradation and unplanned development is one of the factors that have threatened the life of sub group of orang asli from Temiar community. This study was conducted in Kampong Manok, state of Kelantan, Malaysia. The objectives were to identify the socioeconomic activities conducted by the Temiar community and to determine the monetary value from such activities. A total of 100 respondents were identified. Information was gathered through questionnaires distribution. In-depth interview and site observation were also conducted. The data were analyzed by using IBS SPSS Statistic Version 22.0. The study revealed that majority of Temiar community involved in plantation (46%), forest product gathering (28%), logging sector (14%), traditional handicraft (8%) and other sector (4%) such as trading non-timber forest products. The highest monetary value of the community was from RM401 to RM700 per month and the lowest monetary value ranged between RM50-RM300 per month.

Keywords: Socioeconomic characteristics, Aboriginal people, Temiar community, Kelantan, Peninsular Malaysia

P-22: Managing of Malaysian Tropical Rainforest: Issues and Challenges

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ABSTRACT: Deforestation activities can seriously damaging our environment. It is caused by the growing demand for forest products, conversion of forest to agriculture as the human population continues to expand and unplanned urban development. Malaysia's forests still cover about 59.5% of the total land area. However, deforestation is a major concern and unavoidable as the country is still rapidly developing. Government policies is to increase the coverage of forest protected areas, improve the management of production forests for the supply of sustainable timber, and restore degraded areas especially where there is need to maintain critical forest linkages. Malaysia is committed in implementing Sustainable Forest Management (SFM). Therefore, criteria for the SFM introduced by the government had reflect the national context and the specific ecological and environmental conditions, as well as social, economic, political, cultural and spiritual dimensions. The forest are harvested in a sustainable manner by adopting the method of reduced impact logging practices (RIL) and Selective Management System (SMS) logging practices.

Keywords: Forest management, sustainable, Selective Management System, harvesting,