Feller Productivity in First Thinning Systems

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Introduction

Systematic thinnings, in particular 1-in-3 line thinning, have been applied on a widespread basis in Ireland at first thinning stage. However the risk of windthrow associated with such thinnings has renewed interest in making first thinnings more selective (Gallagher, 1987). In the north west of the country, pure selection thinnings are presently being applied with extraction most commonly by horse or cable-crane (Phillips, 1987). In other areas susceptible to windthrow, rack and selective thinning systems are being used. However, it is expected that the widespread application of these systems will influence feller productivity. This paper describes a study that was carried out to quantify the effects of thinning systems upon feller productivity.

Methods

Time study technique: As part of the project, a time study was carried out on the felling operation. Two people participated in this, one person was responsible for the timing of the operation while the other measured the mid-diameters of the pieces cut from each tree. The aim of this time study was to relate the time taken to fell a tree to the volume of that tree and thus determine feller productivity as follows:

$$\text{Productivity } (m^3/\text{minute}) = \text{Volume}(m^3)/\text{Time}(\text{minutes}).$$

The felling operation was divided into sub-elements. The purpose of this was to identify which sections of the felling operation were influenced by thinning systems. The sub-elements chosen and their definitions were as follows:

1. Walking: – the time taken to walk from a tree that had been processed to the next tree to be felled.

2. Clearing: – any time spent clearing in preparation for tree felling e.g. removing branches from adjacent trees if they obstructed the felling of the tree being studied. It also included the time required to clear brash off piles.

3. Brashing: – the time taken to remove branches from study trees up to a point approximately 1.3 metres from the ground.

4. Felling: – included the time taken for the undercut and felling cut.

5. Downing: – the time taken to push or pull down a tree that became hung up.

6. Limbing: – the time spent removing limbs and branches from a tree and the time taken to crosscut it into the required lengths.

7. Bunching: – the time taken to bunch the pieces cut from a tree.

8. Urea: – the time taken to apply urea to stumps.

9. Productive delay: – the time spent on delays that were a necessary part of the entire operation such as refueling or chain sharpening.

10. Unproductive delay: – the time spent resting or talking.

The Husky Hunter micro-computer, in conjunction with a work study programme (SIWORK) developed by the Danish Institute of Forest Technology, was used to time the operation. Three-metre pulpwood lengths were cut on the sites and the mid-diameters of these pieces were measured with calipers. Once the data were collected they were transferred from the Husky Hunter onto the mainframe computer at University College Dublin, where they were analyzed.

Description of study: A preliminary study was carried out in Ballyfin Forest, Co. Laois. The purpose was to give an indication of how future studies should be carried out and to establish the approximate plot size. From the data collected, it was shown that plots should consist of 50 trees in order to be able to predict productivity with a precision level of 10% and a confidence level of 90%. It also became clear that the plots should be replicated.

Two further studies were carried out in Ring and Mullinavat Forests. Ground conditions on the two sites were relatively similar. Both were located on level ground which had been ploughed with either a single mouldboard (Ring) or a double mouldboard plough (Mullinavat). The crops being thinned were seventeen-year-old Sitka spruce of yield class 24 in Ring and 22 in Mullinavat. Three thinning system were examined on these sites, namely, 1-in-4 line thinning (system 1), racks 1 line in 10 with chevron thinning (system 2), and racks 1 line in 9 with selective thinning (system 3). Selection in the latter system was carried out by the forester. On these sites, extraction racks were cut across plough ribbons. In each forest two fellers operated in the three thinning systems and each plot (feller/system combination) was replicated three times. This gave a total

of 18 plots on each site. In the rack and chevron thinning, the chevrons were cut at a 45 degree angle to the main racks. The timber was extracted across the plough ribbons with a Valmet 872K. The total number of trees studied was 2,029.

During this study no cognisance was taken of safety that the fellers adopted. However it was apparent that they did not vary their approach to safety in the different thinning systems.

Results

The mean volume per tree, mean time per tree, and mean productivity were examined for each thinning system. These means are presented in Table 1.

Table 1: Mean Volume, Mean Time, and Mean Productivity for each Thinning System.

Thinning system	Mean Volume per tree m^3	Mean Time per tree mins	Mean Productivity m^3/hr
Line 1 in 4	0.0702	4.0558	1.0385
Rack + chevron	0.0691	4.2244	0.9814
Rack + selection	0.0554	4.1461	0.8017

An analysis of variance (ANOVA) showed that there were significant differences between the mean productivity data. Further analysis confirmed that feller productivity in systems 2 and 3 was significantly lower than that in system 1 (5% and 23% respectively). Productivity in system 3 was also significantly lower than that in system 2 (18%). Analysis of the volume and time data showed that mean volume per tree differed significantly between systems, i.e. the volume in system 3 was significantly lower than in either system 1 or 2. On the other hand, thinning system did not have a significant effect on the mean time spent per tree.

The means of the sub-element times in the three thinning systems are presented in Table 2. Downing time was the only sub-element time shown to be significantly affected by thinning system. Analysis of the data showed that more time was spent taking down hung up trees in systems 2 and 3 than in system 1.

Three members of the Development Division of Coillte Teoranta timed and rated the fellers as they operated in each thinning system. They produced work values for each system using data collected from 12 plots. The

Table 2: Mean Sub-element Data (in minutes) from Ring and Mullinavat forests.

Sub-element	Thinning System		
	1-in-4	Rack + chevron	Rack + selection
Walking	0.1296	0.1306	0.1407
Cleaning	0.1133	0.0799	0.0851
Brashing	0.4453	0.4475	0.4437
Felling	0.2386	0.2375	0.2050
Downing	0.2187	0.3240	0.3498
Limbing	1.7837	1.7896	1.6083
Bunching	0.5945	0.5440	0.4798
Apply Urea	0.1104	0.1082	0.1129
Prod. delay	0.1892	0.2923	0.2160
Unprod. delay	0.2325	0.2708	0.5048
Time	4.0558	4.2244	4.1461

means of these work values, in standard man hours per m^3 for systems 1, 2 and 3 were 1.27, 1.38 and 1.48 respectively. These data indicate that productivity in system 3 is 17% less than that in system 1 while productivity in system 2 is 9% less than that in system 1. These results compare well with the results that this study produced, i.e. 23% and 5%, respectively (from Table 1).

Discussion

Examination of the time and volume data of each system offers an explanation as to why productivity varies as it did. The mean volume per tree was 21% less in the selective system than in the line thinning system, but there was very little difference in the time spent per tree between these systems. These results seem to contradict the usual trends in time and volume data where cutting time per tree increases as the volume per tree rises (Bol and Gerritsen, 1960). In this study, it appeared that cutting time for smaller trees was similar to that for larger trees. However, working conditions in an area being selectively thinned differ considerably from those in an area being line thinned. During selective thinning, fellers

have to operate in unbrashed rows and fell and take down trees where there are no breaks in the canopy. The results confirmed that downing time was significantly greater in the selective system than in the line thinning system. Thus, although the average volume in selective thinnings may be smaller than in line thinnings, the unfavourable nature of the working environment in such thinnings outweighs any advantages that these smaller trees may offer the feller with regard to cycle time. This explains why productivity in the 1-9 selective system was significantly lower than that in the line thinning system.

The slight difference between productivity in the rack and chevron system and in the line thinning system can be attributed to the problem of taking down hung up trees. Trees tended to get hung up more often in the chevrons because of the limited felling space.

The differences in results between the rated and the unrated data can be explained by the manner in which rest was accounted. In this study the actual time that the feller spent resting, was measured. On the other hand, personnel from Coillte Teo. added a rest allowance of 30% in all thinning systems. As the actual amount of rest time required in each system varied, the results from the two sets of data varied.

Conclusion

In this study feller productivity is shown to be 23% lower in a 1-in-9 rack and selective system than in the line thinning system. Feller income would fall accordingly if fellers were to operate in such systems. The questions of whether fellers should be compensated for doing so, by increasing the piece rate paid to them and who should pay for this compensation, remains unresolved.

It is likely that with training, feller productivity in rack and selective systems will increase. In addition, some of the problems that fellers encounter when operating in these systems would be alleviated if they were allowed to select stems for felling. This would require additional training. Both the cost of training and an increase in piece rate to compensate for reduced productivity, could be offset against the reduction in marking and brashing costs.

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