Comparison of Conventional and Mechanical Harvesting Systems: Machine Trafficking Effects on Site Impacts.

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The trend in timber harvesting systems has been away from the conventional handfall and processing with line skidder system to a fully mechanized feller-buncher/grapple skidder mechanical process system. The mechanical system has significantly greater productivity than the conventional system, with a potential increase in site impacts.

The objectives of this study were:
1) to compare the impact of the conventional and mechanical systems on compaction related soil physical properties.
2) to determine the loading applied to the soil by off-road equipment during harvest operations.
3) to relate machine traction to site impacts.

A study site in the mixedwood forest of Saskatchewan was divided into two sections. A conventional harvest was conducted in one section, and a mechanized harvest was conducted on the other section. The post harvest impact data collected included causes, types and degree of dispersed and non-dispersed surface disturbances, and slash distribution. Soil measurements included bulk density, penetration strength, texture and water content. Machinery dynamic axil-load data were measured and used to estimate pressures applied to the ground. Measured soil properties were used along with the machinery load data to test a model of the soil compaction process. Model predictions were compared to measured values of rut depth and bulk density.

Results:
In both conventional and mechanical harvesting systems, machine traffic disturbed approximately 51% of the respective harvest areas. Disturbed bulk densities were significantly higher in the mechanical treatment than in the conventional treatment at depths from 200-300 mm; however, increases in bulk density under both treatments appeared to be non-detrimental over 85% of the treatment areas. Average compaction from 0-300 mm depth appeared to be within published tolerances for root growth. The remaining areas sustained moderate to high soil compaction and forest floor displacement.

Excessive compaction was due to operation of machinery on slopes and in wetter areas of the site. The severe compaction was attributed to excessive weight transfer (poor load distribution) of machinery when operating on slopes, and to high slippage in wetter areas where soil is easier to deform. Compaction by the grapple skidder used in the mechanical treatment was magnified by unfavourable dynamic load distribution. Multiple passes of machinery increased rut depth and caused significant compaction to greater depths.

The soil compaction model correctly predicted relative trends of compaction by various machinery on both the mechanical and conventional sites. The model tended to slightly over-estimate rut depths and the increase in bulk density in the top 100 mm of soil. Average bulk density predictions from 0-300 mm depth were very good.

Variations in site characteristics are an important influence on the spatial distribution of impacts due to forestry traffic. Knowledge of spatial distribution of site characteristics along with estimates of soil property functions and soil compaction models could be used to predict relative distributions and intensities of soil

compaction. Linking a soil property database with GIS and with models of machine-soil interaction will make is possible to estimate site impacts due to machine traffic.