

Mechanized Harvesting Systems in Permanent Stands and Technology

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ABSTRACT - The application of different modern logging systems depends on the silvicultural aims and methodologies. Depending upon these specifications the appropriate technique must be selected. This is the basic condition, which leads to a specific logging system in Central European and especially in German forestry. In the following an overview is to be given upon the different applications of full-mechanized harvesting systems in permanently managed forests in Germany. First of all the principles of sustainable silviculture are explained. Afterwards the advantages of modern Harvesters and Forwarders and their limitations under given conditions are discussed. Further an idea of the ecological effects for stock and soil, caused by the use of heavy logging machines, is to be given.

SILVICULTURAL BASICS

The principles of silviculture in Germany and especially in the southwest of Baden-Wuerttemberg are shaped through the natural essentials and small scale forestry. These are the main reasons for the fact that the forests are managed as continuous forests. In more recent time the realization is added, that forests cannot only serve pure wood production, but have also an ecological meaning and have to serve as a recreation region too. Due to high population density in Germany it is not possible to separate these different requirements, the same forest area has to fulfill all requirements at the same time. Outgoing from this starting situation it becomes obvious that an clear cut on large surface (> 1 hectare) forbids itself. From traditional forest forms of management and the requirements of the society to the forest, the silvicultural target finally results as continuous forest.

The management of a continuous forest is shaped by the fact that trees of different ages and heights are present at the same time. Harvesting is done in all ages, heights and diameters. This type of silviculture causes permanent use of harvesting techniques, which can be quite problematic as described in the following.

MACHINE USAGE IN THE CONTINUOUS FOREST

The continuous forest management saves some problems for the forest technique. Despite the permanent crossing by logging machines it must remain ensured that the productivity of the soil and the stock is not impaired substantially. The largest influences on the stock are damages by cutting and skidding and compression of the soil body by crossing with heavy machines. In both cases substantial growth losses at the remaining stock can result from inappropriate application of harvesting techniques. This can go so far that stocks are destabilized and become susceptibly to various calamities (e.g.: Storm or bark beetles). The application of full-mechanized harvesting procedures in continuous forests is shaped additionally by the structures and especially the increased strong wood proportions.

Contrary to age-class-forests in the continuous forest a broader tree species composition and different ages are to be found. These structures have to be sustained, while by clear cutting all individuals are harvested simultaneously. This causes a harvesting technology, which gives consideration to the regenerating tree collective. To avoid damages in the regeneration the machine operator needs a good overview of his working area. Therefore features like ergonomically formed, height adjustable operator cabins are developed, which allow a circumspectly handling with suppressed and intermediate trees. Simultaneously a substantial increase in power rate is necessary to handle the big dimension trees, which are found in higher proportion in the continuous forests. The increase in power is associated with safer handling of big dimension logs, but means also increased vehicle mass and dimensions. The requirements of harvesting big dimension logs led to a stronger machine generation.

The new machine generation has an intensified influence on the compression of the soil. In addition to the machine mass further impacts on the soil are the mass of the big dimension logs and dynamic processes while harvesting. Problems are strengthened by the shorter temporal intervals between the logging operations. In the following the solutions of the forest utilization and techniques in Germany are shown.

CHANGES IN HARVESTING TECHNIQUES IN THE CONTINUOUS FOREST

Technical Modifications

The mechanical engineering reacts to the different request of the forest people with various technical solutions. By the implementation of certain chassis principles e.g. track assemblies, pendulum arm suspension system or a "Tilt" the use in rough terrain is improved. Modern chassis constructions and improved transmissions and drive trains lead thereby further to the reduction of soil damage and at the same time to higher energy-saving potentials. The increase of machine performance offers possibilities to harvest surely and efficiently stronger wood assortments. By high-quality material usage the reliability or life span of the machines is preserved despite of a higher load. Modern materials in conjunction with higher performance offer also an increase of range and lead thus to a lower crossing intensity.



Figure. 1: Königtiger, by M. Bacher

As example for the new machine generation the Track harvester Impex 1650T "Königtiger" is manufactured in Germany. It is equipped with an efficient power unit, its chassis offers high stability and it is capable of climbing steep terrain. With 15 m the range is very high and the

height adjustable operators cab offers a good overlook in strongly structured stands. All these components lead to a substantial increase in productive efficiency of the whole system. Same developments are made by other machine manufacturers also.

CONSEQUENCES OF THE INCREASE OF PRODUCTIVE EFFICIENCY

The soil as abutment is most strongly affected by the increase. Figure 2 shows which forces occur during logging. The data are from a test series where effects of logging machines to the soil body were examined. Objective of the field test was to get data under conditions as realistic as possible. Therefore pressure measurements in the soil and at the same time procedure observations by video studies were executed. The black line in figure 2 shows excellent how operational sequences affect the dynamic pressure development in the soil. In this case the pressure was so high that soil damage occurred. As result of several tests the assumption is verified, that forest soils are damaged by dynamic actions of modern harvesting machines. Since however the machine employment is necessary and required, harvesting procedures must be found which guarantee a careful handling with the resource soil. In Baden-Wuerttemberg therefore two developments, the "Kombinierte Verfahren" and the "Permanente intelligente Feinerschließung" have been made.

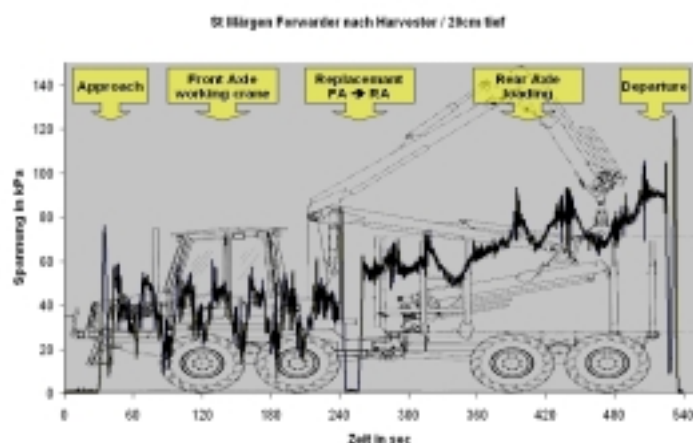


Figure 2: Soil pressure diagram by crossing with forwarder. (y-axis = pressure in kPA / x-axis = time in seconds)

THE “KOMBINIERTE VERFAHREN”

Though the use of Harvesters and Forwarders offers a more careful logging, the crossing intensity is increased at the same time. The range of a conventional harvester is approximately 10 m. This means a skid trail system with distances from 20 m in between, whereas logging without harvesters allow distances between skidding lines from 40 to 60 m.

The basic idea of the “Kombinierte Verfahren” is that the two different logging systems should not exclude each other. Rather the systems should merge in order to use both their advantages. This leads to an optimisation of efficiency and simultaneously a decrease in crossing intensity. Especially in the continuous forest you can solve the problems with big dimensions logs and soil. The “Kombinierte Verfahren” contain a cut to length system done by the harvester which operates on skidding trails with a distance of 40 m. The Trees in the intermediate area which cannot be reached by the crane are felled conventionally by forest workers and either skidded

by cable or can be reached by the harvester. Advantages are economical processing by the Harvester, lower skidding costs by concentrating, lesser hauling damages by cut to length assortments and a reduction of crossing intensity.

THE “PERMANENTE INTELLIGENTE FEINERSCHLIEßUNG“

The soils occurring in South West Germany are ecologically impaired after crossing. To minimize the ecologically impairments crossing should be restricted on certain areas of the stand. If a net of trails in 30 m intervals and 4 m in width is planned, already 12% of the stand are covered. Another important aspect is, that the net of trails is used permanently over a long period of time and a crossing outside of the tracks is not allowed. Contrary to these requirements in earlier times skidding trails were oriented by the single logging operation. A change in logging system forced frequently to a new installation or modification of the skidding trails. In the long term thus a high crossing intensity could not be avoided.

“Permanente Feinerschliessung” means that the skidding trails are permanently marked in the stands and also documented by GPS/GIS and maps.

“Intelligente Feinerschliessung” means that the skidding net is independent from logging system but tries to take into consideration changing requirements during the different growth phases.

SUMMARY

An effective and economic logging in the continuous forest is possible by the use of high tech harvesters and forwarders. But this technique implicates disadvantages which have to be reduced. In Baden-Wuerttemberg we try to find a compromise between use of machinery and soil protection by different demands:

- Use of combined harvesting systems (Kombinierte Verfahren)
- Installation of permanent intelligent skidding trail systems (Permanente intelligente Feinerschliessung)
- Use permanent stands by modern and effective high end logging technique (low-pressure tires, boogie tracks, pendulum arm suspension system, tracked chassis, etc.)