Classification of technological processes of logging

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Abstract: The efficiency of a timber harvesting company depends primarily on the proper selection of technologies and systems of machines that would satisfy as much as possible the natural - production requirements and the conditions in which the company operates. In the timber harvesting regions of Russia operating machinery conditions are quite different from each other. They differ in taxation indices of wood, soil, rainfall, terrain, temperature regimes. In this research the article classifies machine systems and processes to identify similar groups, which allow providing advice on their use in the various natural - production conditions, both individually and in various combinations. Machines are classified by the condition of their use depending on the terrain, soil conditions, the average volume of tree-length material and its maximum diameter. Technology processes are classified by types of finished products (wood, tree-length, assortment, chips, etc.), by place of processing of the object of labor, etc. Classification allows you to specify a limited number of the most appropriate to the specific natural - production conditions of technologies and machine systems.
Keywords: timber harvesting work, the classification of technological process, timber harvesting technologies, the formation of machine system, natural - production factors, logging waste, processing of brush wood.

Technology of timber harvesting has a significant impact on the cost of the produced goods, so the most important task of timber industry complex is the selection of technologies and machine systems, the most acceptable to the diverse conditions of Russian timber harvesting areas. Now most manufacturing processes of timber harvesting are based on the machine system, classification of which is performed by a diverse variety of features.

Technology and machine systems are mainly formed in accordance with the natural and production conditions of logging sites [1]. Accordingly, the purpose of classification is to identify groups of similar machines systems and technologies, which allow providing advice on their use in the various natural and production conditions, both individually and in various combinations.

Natural - production factors significantly affect the conditions of movement of forest machines in the cutting area and the conditions of the performance of operations related to the felling of trees, skidding, limbing, tree-length bucking [2].

The quantities of natural - production factors can vary greatly, even within a single logging company. Let's consider a few natural - production factors at greater length:

- climatic (ambient temperature, the amount and timing of rainfall, the prevailing direction and strength of wind, the height of the snow cover in winter, etc.);

- soil and subterranean (the type and properties of soils, their moisture content, density, mechanical composition, macro-, meso- and micro- relief, bearing capacity of soil);

- silvicultural (average volume of trees in plantation, species composition, average height, average diameter at breast height of trees, stock up on 1 hectare, the presence of viable undergrowth in the cutting area, the degree of clutter in the cutting area, the nature of the allocation of the trees in the area);

- technological (skidding distance, composition and combination of operations performed by machines, total cutting area;

- production (planned amount of work, shift system, the degree of mechanization of processes, types and methods of harvesting, period of execution of work, operating characteristics of machines, operators' skills).

The analysis of the natural - production factors which have a major impact on the formation of systems of harvesting machines, allows to distinguish among them the following (in order of importance): the volume of harvesting by enterprise; the average volume of the tree-length material; liquid reserve of trees per 1 ha; lay of land; the soil and groundwater conditions; the species composition of trees.

Small private businesses cannot afford to buy expensive high-performance and multiple-function logging machines, often operate with the simple set of equipment for felling trees and removing branches by gasoline-powered saws, skidding by choker-tractors.

The average volume of the tree-length material has a major impact on the efficiency of harvesting machinery, liquid reserve of trees per 1 hectare affects the amount of preparatory work, labor productivity in felling and skidding.

The terrain is one of the most important factors also determining the principles of organization and technology of logging work. The most favorable for harvesting is smooth or slightly hilly terrain, in the timber industry with steep slopes of more than 22^0 specialized equipment or cable systems are used. The bearing capacity of the soil influences the permeability of logging trucks, and hence their productivity.

Species composition of plants has the most significant effects on the complexity of delimbing and bucking of tree-length material, and therefore the final cost of product. Hardwood species, as a rule, have a crown with thick branches, which the delimbing machineheads cannot handle with.

The depth and level of wood processing introduce some additional machines into the technological chain.

Traditionally the three groups of technological processes of logging are considered [3]: skidding of trees, skidding of tree-length material, skidding of logs. Accordingly, for each group of technological processes there are their own groups of harvesting machines. The place of delimbing and bucking operations depends on the type of object skidded. Let us analyze the data of groups in accordance with the objectives of classification.

Both trees and tree-lengths are skidded in unloaded or semi loaded positions. The weight of the load or part thereof, dragging along the ground, is distributed on the soil which reduces the pressure on the undercarriage of the tractor and an adverse effect on the soil. Consequently, on low load-bearing soils the technological process with skidding of trees or tree-length is more commonly used. Also in this type of skidding the center of gravity is reduced and shifted toward

trailing wood, which makes it more attractive to increase the stability of the machinery in the harvesting areas with hilly terrain [4, 5].

Technology with skidding of trees in terms of the collection and processing of logging residues is the most effective and perspective. Most of the waste is concentrated in the areas of processing trees by delimbers. These areas names area loading point and an industrial site. The density of waste reaches a relatively high concentration, which can be increased in the future and due to the fact that there is collected illiquid and low-quality wood. Contamination with mineral impurities is large only in the season of bad roads. In wintertime, pollution of logging waste is minimum, in the summer, it is more, but this is offset by its lower losses during felling and skidding.

Tree-lengths skidding or transportation of logs involves cutting branches in the cutting area; the cutting of the crown in this case is used by a gasoline-powered saw or harvester. Logging waste is located outside the loading point on the portages and a part of the cutting area. Their local density is low; the contamination with mineral impurities is practically absent. During the processing of brush wood into the technological chips the following operations should be included - their collection, and in some cases sorting [6].

The quality of cutting waste while harvesting logs in the cutting area depends on the technological process used and system of machines [7]. Logging waste is arranged evenly over the part of the cutting area, with a tendency to approach the portages, when the technology with a feller and forwarder is used. The technological process of logging activities are classified according to the following features [8]:

1 - type of products produced (trees with a crown, trees with roots, tree-length material, assortments, wood chips, recoverable resources)

2 - method and organization of felling work:

2.1 - method of felling (felling with roots, felling by sawing and separating from the stump, felling through the consistent separation of wood pieces, felling through the consistent separation of wood assortments);

2.2 - principle of felling trees (continuous felling, felling by the piece, group felling, by grinding a growing tree);

2.3 - the type of equipment used for felling (gasoline-powered saw, felling machine, feller buncher, felling-delimbing machine, felling-delimbing-bucking machine);

2.4 - kind of products received in the cutting area (trees with roots, tree-lengths, assortments, trees with a crown, pieces of trees with a crown, wood chips);

3 - method and organization of delimbing:

3.1 - kind of processed products (trees with the roots, trees with a crown, pieces of trees with a crown);

3.2 - processing method (group, the piece);

3.3 - place of work (a part of the cutting area, loading point, the lower lumberyard, processing plant);

3.4 - kind of production (tree-lengths, assortments);

3.5 - operations when combined with the separation of branches (felling, skidding, felling-bucking, felling-bucking-debarking, felling-grinding, grinding);

4 - method and organization of debarking:

4.1 - kind of raw material debarked (tree-lengths, assortments, trees with a crown, pieces of trees with a crown);

4.2 - method of debarking (group processing, processing of the piece);

4.3 - place of debarking (cutting area, upper or lower lumberyard, wood and timber processing companies);

4.4 - operations when combined with the separation of branches (felling, skidding, felling-bucking, felling-bucking-debarking, felling-grinding, grinding).

The article [8] also proposes a classification of technological processes of harvesting, which has a hierarchical structure, the first level of which determines the type of received production, the second - the purpose of products, the third - the place of receipt of the final product, and the fourth - kind of the processed raw materials, the fifth - the kind of cutting, the sixth - a way of removal, seventh - basic operations (or used equipment).

Carrying capacity of the soil has a direct impact on the choice of propulsion, movement speed, and hence on the performance and efficiency of the machine in general. Grounds and soil in the timber industry are considered as a single unit and are assessed in relation to passability by machinery and workers. Soil and ground conditions for their performance indicators for the purposes of logging operations are distributed in four categories [9]. In accordance with the above categories systems of machines can be classified by passability: very high (tractors with special propulsion with a small ground pressure), high (tractors with caterpillar tracks), middle (wheel tractors with special caterpillars) and low permeability (wheeled tractors with a large ground pressure).

Forest machines and technological equipment are usually divided into four classes depending on engine capacity, weight of machines, characteristics of labor object (volume of tree-lengths, the maximum diameter of the tree at the point of treatment). The power of engines of forest machines (harvesters and forwarders) for selective cutting is recommended in the range of 80-110 kW, for clear cutting in middle-sized and large-sized plantations - 140-180 kW. Accordingly, mass of forest machines for selective cutting is 7-14 tons, for clear cutting - 17-19 tons. On these basic machines chassis the technological equipment of wide application is mounted, for example, when installed on the manipulator of the machine instead of the harvester head of the bucket, the machine performs a function of an excavator [10].

Relief conditions divide machines into three categories depending on the governing slope: machines with extreme slopes up to 15^0, with a limit slope from 15^0 to 22^0, machines which can operate on slopes greater than 22^0.

Taking into account the type of technology process, the type of logging, timber volumes all systems of logging machines (SLM) can be classified into four types:

- SLM, which has in its composition gasoline-powered saws and tractors with the cable equipment, i.e. such SLM which, on the one hand, are using manual labor, and on the other - have no restrictions on their technical capabilities;
- SLM, composed of machines that exclude manual labor in cutting area, but has restrictions on its technical capabilities;
- combined version of SLM, composed of machines, excluding the manual labor, and also gasoline-powered saws and tractors with a cable equipment for extra harvesting timber that can't be harvested by the mechanized complex due to restrictions on its technical capabilities;
- combined version of SLM, composed of machines, excluding the manual labor, having different technical possibilities for timber harvesting under different conditions.

Systems of logging machines are divided into groups by the degree of processing of wood and the kind of manufactured products:

- technological products in the form of round wood (trees, tree-lengths, industrial assortments);
- technological products in the form of short-length timber (fragments of stems, twigs, branches, woods culls);
- technological products in the form of bulk timber (technological wood chips, pine needles, bark);
- obtaining of the energy products in the form of roundwood (trees, tree-lengths, wood assortments);

- obtaining of the energy products in the form of short-length timber (fragments of stems, twigs, branches, woods culls, briquetted forest residues);

- obtaining of the energy products in the form of bulk timber (fuel wood chips, wood pellets).

When included in an order book of the technology chips or fuel wood chips, the operation of grinding woods by chippers is included into the technological process [11, 12]. The position of this operation in the technological process determines the further logistics of storage and transportation of production, as well as the mutual dependence of technological machines. The technological chain called "hot" when dependence of machines on each other is significant. In such a chain, when logistics is wrong, prolonged downtimes of technique, long-term storage of goods in warehouses and increasing the cost of production can be possible [13]. The technological chain called "cold" when dependence of machines on each other is not significant.

For the production of technological or fuel wood chips the technologies and systems of machines can be selected by the following features [14].

By places of execution the grinding operation can be classified:

• in the cutting area (stump harvesting machines). The process of grinding wood into chips takes place directly in the cutting area. In this case mobile chippers with the container or combined harvester machines equipped with a chipping module are used;

• in the upper lumberyard (in the loading point by the road). Wood is delivered to the point of loading to the place which sides with a forest road, where it is crushed into chips. This technology uses mobile chippers mounted with tractors, or chippers mounted on truck chassis. In the case of large transport movement between places of logging during wood chip production a combined chip trucks equipped with chipping modules are also used;

• in terminal (in the lower lumberyard). The wood is transported to the lower lumberyard, where it is crushed into chips with using mobile chippers [15];

• at a consumer's (mini-thermal power-station, boiler). Grinding biomass takes place on the premises of the consumer using the powerful stationary or mobile chippers.

Also the systems of machines can be classified by type of delivered wood to the loading bay:

• harvesting of assortments, delimbing and bucking trees into assortments takes place on a piece of woodland at the stump. Today it is widespread in many parts of the Siberian region of Russia;

• tree harvesting. There is felling and skidding trees (with a crown) to the logging roads, then delimbing and bucking tree-lengths to assortments;

• tree-lengths harvesting. After felling occurs delimbing, then bucking and skidding at the loading point;

• wood chips harvesting. This technology involves grinding trees into chips immediately after the felling on a piece of woodland to further transport the chips to the consumer.

Today it is impossible to offer a single universal system of machines and technology that satisfy a whole complex of requirements: maximum productivity, low cost, high reliability, efficiency on hard and soft ground, social and environmental sustainability.

Conclusions.

1. When choosing the technology of harvesting along with typical schemes, advanced achievements of science and practice best suited to the natural and production conditions of this company and ensured high production efficiency should be used.

2. Ensuring profitability, labor productivity growth, safety of work in the timber industry, the most complete and efficient use of harvested wood are

possible only on the basis of a comprehensive mechanization of technological operations through the use of modern systems of machines, providing the full range of works when harvesting, transporting and primary processing wood without using manual labor.

3. The main groups of technological processes and systems of machines are given. They allow further provide advice on their use in various natural-industrial conditions, both individually and in various combinations.

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