FOREST INDUSTRY COMPLEX. TRANSPORTATION AND TECHNOLOGICAL PROBLEMS

UDC 630*6

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INNOVATION PRODUCTION OF PULPCHIPS AT LOGGING SITE

Evaluation of "Vitebskdrev" enterprise forest fund is completed. The efficiency of harvesting wood chips in a gray alder plantations is considered. The foundations of technologies and options for machine systems harvesting of the whole or parts of trees in a logging site are provided.

Introduction. Implantation of market relations in the forest complex of Belarus has resulted in competition between loggers for a share of profit from state forest reserves without taking into account the form of ownership and subordination. It leads to fixation of market prices for round timber. In order to guarantee the supply of wood raw material in such a situation every reworker solves a problem of decreasing market ambiguity in raw material supplies both in price and in volume.

Despite the expected growth of logging yield by 2015 (all kinds of cutting more than 170,000 cubic meters) [1] because of construction and introduction into exploitation a number of huge woodworking enterprises manufacturing timber-based materials (woodchip boards, fibreboards) in PC "Ivatsevichidrev", PC "Vitebskdrev", PC "FanDOK", PC "Rechitsadrev", PC "Gomeldrev", PC "Mostovdrev" (total woodworking capacity of 1,030 cubic meters) [2], the task of guaranteed supply of modern woodworking enterprises with raw materials becomes even more actual. Positive solution of the problem can be ensured by means of implementation of two strategies. Strategy 1: to sustain certainly higher purchase prices than competitors. Capability of this strategy is limited by profitableness of production. Strategy 2: to create the upright-integrated structure comprising both processing enterprises logging ones providing raw materials for a long term (for example, by means of forest leasing), or forestry enterprises, providing raw materials being out of competitive field.

However the presence of floristries in a structure of huge processing plants involves the their having additional expenses on reforestation, forest preservation and protection e .d. on forest management. All these things result in the net cost of final output and from the economical point of view forms a unified production process from forest planting to final output. In our country PC "Vitebskdrev" – became the first enterprise of such a type comprising Gorodoksky and Beshenkovichsky forestry having prescribed cut of 360,000 cubic meters.

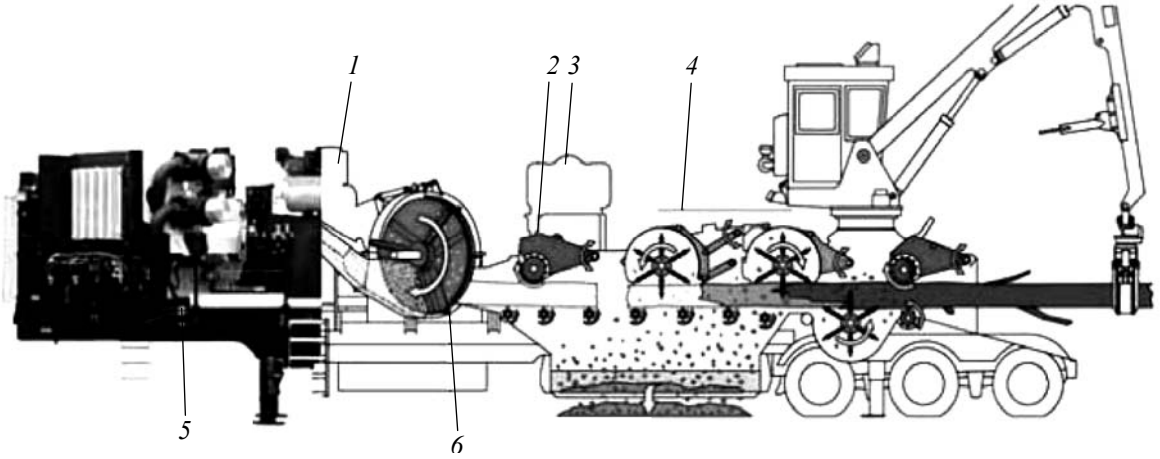
Taking into account that existing enterprises producing woodchip boards and fibre boards within of PC "Vitebskdrev" and, especially, a building fiberboard mill using German equipment (power consumption 140 cubic meters) require larger investments, it is common to consider pulpchips value as one of significant source of saving, rise of competitive strength of finish products according to price factor and growths of expert potential.

1. Pulpchips production systems. To reduce expenditures on final output we will analyze an interdependent process from logging to pulpchips manufacturing.

Now in European countries the technique of pulpchips production comprising 14 stages is the most popular. They are: 1) logging of assortment by harvesters; 2) transfer of assortments to a loading platform; 3) piling logs on forest transport; 4) removal of felling residues; 5) utilization (burning) of felling residues; 6) delivery of logs to consumer's enterprises; 7) collection of the fallen round timber; 8) discharging of timber; 9) stacking of logs; 10) transfer of logs along the storage to a workshop; 11) single-piece distribution of logs for processing; 12) a barking of workable timber; 13) grinding of logs into pulpchips; 14) a sorting of chips.

Large and known manufacturers of paper and slabs in the USA, Canada, Australia apply a production technique of high-quality debarked pulpchips directly at cutting area from whole trees [3].

Pulpchips production consists of four stages and in practice looks as following: the first and second stages comprise logging and full-tree skidding to buffer store by means of feller-brunches and skidders. At the third stage, in a buffer store, there is a machine (produced by "Perterson Corp.") for delimbing, debarking and grinding the logs into chips and loading them to chip truck.



Principal diagramme of operation of delimbing-chipping-bark peeler:
1 – air compressor; 2 – feed close regulation; 3 – water tank and pump; 4 – chain driving system;
5 – motor; 6 – chipping machine disk

At the fourth stage transporting of chipwood by chip trucks to consumers takes place. Not less than 95% from total amount of manufacture chipwood in winter season contains bark to 1%, in summer season – to 0.8%. The "American" system of production and deliveries of chipwood from loggers to reworkers reduces a number of stages of engineering process, including a great variety of machinery and people, and allows to use the following advantages:

– producing chipwood from short balances the last machine cuts make impossible to obtain chipwood of necessary length, and it turns to waste which can be reduced when grinding the whole stems;

– expenses on producing chipwood reduce due to work mix, decrease of displacement operations, the absence of hard work for production of assortments;

– the absence of capital expenditure on workshops construction for preproduction of raw material and grinding it into chipwood;

– green wood is easier to debark, there is no problem bark utilization;

– recycling of crowns o and trees of small diameter which (were not processed earlier) results in output increase by 15–20%, there is no need in slash removal and no risk of fire when utilizing them;

– ecological situation being improved and expenses on chipwood production being saved to 10%.

When organizing machine system work in two changeovers (12 h, or 24 h per day), it is possible to produce nearby 900 cubic meters of fine pulpchips [3].

2. Forest exploitation characteristics of the cutting reserves of PC "Vitebskdrev". We will analyze a feasibility of a "North American" technique of chipwood production in our country on the example of PC "Vitebskdrev". The prescribed cut is defined by a high share of broadleaved species – 78.2%. Cutting reserves of Gorodoksky forestry is characterized by unfavorable species structure where standing timbers of a birch, aspens, black and grey alder comprise 85% of the prescribed cut reserve . Thus almost half of operation stock of broadleaved species goes to nondurable standing timbers of aspen and alderwood brimstone. The average square of plots for clear felling both conifers (2.1 hectares), and hardwoods (3.3 hectares) is rather small in comparison with analogous parameters for country forests (3.9 and 5.7 hectares correspomdently). The average haul distance to PC "Vitebskdrev" lower landing comprises about 35 km.

At an machine felling and delimbing the diameter of stem is of great importance being limiting for chain blade, size of debranching cutters opening etc. It has been determined that average diameter for all species, except spruce, has not exceeded 26.3 cm, for black alder – 23.5 cm and white elder – 20.5 cm. Quantity of stems of all species in percentage with a diameter 8–20 cm for black and grey elder comprised 42.6 and 61.2 cm correspondently, with a diameter 24–32 cm by analogy 51.6 and 36.2 cm. In noncarr of the 1–2nd growth class their average height can be approximately accepted equal to average diameter.

According to developed forest exploitation classification [4] allocation of corporation cutting reserves is resulted in Table 1.

As shown in the table, the cutting reserves differs in a high share (32.6%) of the fourth type of locality which represents water-logged mineral and peat-boggy soils, the most unfavorable for forest exploitation – as having low bearing capability of soils and a high level groundwater occurrence. We will mark, that white elder stands grow predominantly on such soils.

Table 1

Cutting reserves allocation of PC "Vitebskdrev" according to types of locality

Object	Area by type of area, %				
	I	II	III	IV.1	IV.2
Beshenkovichsky forestry	29.0	36.2	5.7	19.0	10.0
Gorodoksky forestry	17.0	42.7	6.8	25.2	8.3
PC "Vitebskdrev"	19.9	41.1	6.5	23.8	8.8
Vetebsky region	18.4	41.8	10.5	15.0	7.2

Thereupon, selecting machinery for development of white and black elder stands considering forest exploitation evaluation of natural-industrial conditions of "Vitebskdrev" the priority should be given to machinery:

– eliminating and minimizing manual work;

– with multiaxis wheeled propulsor allowing if necessary to set removable caterpillar chains for increasing passability;

– ensuring, whenever possible, logging limber and utilization of fuel raw material;

– having a shear head and storagefor simultaneous deduction of several hungry woods.

3. Engineering process and machine system for chips production. Logs, pulpchips and fuel chips can be a main product gained at developing white elder stands. Considering the exit of commercial logs being insignificant, the technology of logging and processing of alder stands into pulpchips is of great interest for the enterprise. Developed and applied in countries of North America a production technique of debarked pulpchips directly at cutting area from the whole whips, despite visible advantages, with reference to PC "Vitebckdrev" conditions is cannot be realized. Principal causes: impossibility of application in the fourth type of locality of heavy feller-bunching caterpillar vehicles of digger type and heavy duty skidders; small sizes of falling sites and operation stocks of raw materials on them, that will lead owing to high efficiency of given type of machinery to their numerous moves; at falling sites there are no places for delimbing-chipping-barker peelers; the full-tree skidding from a place of logging to a grinding place by skidders in a semiloaded condition results in additional contamination of crown and parts of stems with mineral impurities and aggravates quality of pulpchips.

As in PC "Vitebskdrev" swamp falling sites are interchanged with parts of cutting reserves having good bearing capability of soils and allowing to create a reliable transportation network, buffer stores should become a place of work delimbing-chipping-barker peelers. Raw material (preferably in completely loaded state) should be supplied from several falling sites. It will allow to create reserves of pure raw material and to ensure work front for delimbing-chipping-barker peeler, and safe delivery of pulp chips by chip trucks to the head plant. Domestic chip train MAZ-5516 + MAZ-8561 or MAZ-6501A5 + MAZ-857102 with capacity of baskets 70 m^3 can be used as transport means as well as cars with mechanism of containers changeover with a capacity of 35 m^3 MAZ-6501A3 [5].

Analysis of modern structures of forest machinery and their operation conditions [5–7] has shown that for logging of grey older, delivery of raw materials in the form of trees (parts of trees), its grinding into pulp chips we can apply the following machine systems.

I. Broad cut feller skidder with a cutting device of the knife operation with the storage + delimbing-chipping-barker peeler.

II. Broad cut feller skidder with a chain cutting device and a trailed truck + delimbing-chipping-barker peeler.

III. Broad cut feller skidder with a cutting device of the knife operation with the storage and skidder + a petrole-powered chain saw + delimbing-chipping-barker peeler.

IV. Feller-buncher with an accumulative shear head + skidder + delimbing-chipping-barker peeler.

V. Feller-delimber-bucher-skidder (harvarder) with changeable geometry of a service platform + delimbing-chipping-barker peeler.

Considering low bearing capability of soils and felling residues being used not always for solidifying skidding trails the basis for the given machines should be driver with wheel formula 8K8 allowing to improve passability per each pair of wheels should be equipped with caterpillar belt. In order to increase the distance between yarding corridor crane radius should be not less than 9 m. The use of the 3d machine system is rational for logging sites with yarding corridors having large labour effort. Possibility of skidding trees felled by a petrol-powered saw to the zone of crane radius will allow to increase additional distance between apiary runs to 60–75 m. Alternative to the suggested machine system can be skidded cable installations. However because of a large share of manual work we at did not consider them in operation.

Their application in machine systems with the wheeled driver allows to increase effective distance of raw materials transfer to buffer stores from several logging sites to 1.5 km. Using skidders (IV machine system) the distance can be larger. Transportation of stored lumber in completely loaded state (except for the IVth machine system) does not pollute it with mineral impurities and allows to obtain clear chipwood.

For the logging of grey elder stands we recommend felling heads equipped with the storage. They help cut and pack several trees and their parts

simultaneously, stack formed bunch in wood bunk, load, unload and pile the raw material. They can be unitized with specialized (harvesters, harvarders, feller-buncher) or common machinery. As a rule, heads are fixed on a handle of basic machine manipulator and equipped with knifes of cutting power. 3–7 levers work as catch-storage. In a position of felling a tree the head possesses stability, that ensures holding of tree bunch in a vertical position. Such a structure allows to fell elder stands in two steps depending on the height. Logging of tree parts makes possible their transfer in completely suspended state. The short engineering characteristics of new shear heads with the storage is resulted in Table 2.

Table 2

Cutter heads with the storage

Model	Basic parameters		
	The maximum diameter of a cut-off, mm	The possibility of lifting packs of trees from the ground	Operating weight, kg
Ponsse EH25	25	yes	400
Moipu 400 E	30	yes	540
Kesla 1500-40E	32	yes	560
Silvatec 235 MD 35	45	no	615
Log Max 4000	50	no	620
AFM-45 Corona	50	no	850

The basic machines satisfying meeting the requirements of operating conditions and having high level of operational reliability, can be: harvesters produced by "Ponsse", "Entracon", "Silvatec", having wheel formula 8K8 and crane radius 9–11 m; forwarders "Ponsse" – Wisent, Elk. Buffalo 10 W (wheel formula10K8), having possibility to variate geometry of a service platform and to ensure transfer of tree parts, and also machinery produced by other enterprises: "Entracon", "John Deer", "Valmet", "Amkodor", "Rottne", "Logset", etc. All of them should be equipped with shear heads with storage and to have wheel formula 8K8.

As a rule, development of grey elder by machines should be done in winter season or in dry summer. At the recirculation scheme of logging site development (III type of locality) its width (B) and at ring circuit (IV.1 type of locality) the distance between runs should be equal to multiple number of distances that are necessary for a panel of one bunch:

$$B = B_1 = l + B_b = n\frac{10\,000Q_p}{bq} + B_b,$$

where l – distance traveled by machine paneling the bunch, m; B_b – width of safety zone, m; n – quantity of bunches formed on one band; Q_p – a volume of bunch being skidded, cubic meters; b – width band being developed, m; q – average forest stock per 1 hectares, cubic meters.

The leader in machine systems I-V is delimbing-chipping-barker-peeler which fulfills delimbing, barking, grinding and chipwood loading in chip trucks buffer store. The design of such machine produced by the company "Peterson Pacific" model DDC5000-G is displayed at the picture. The machine having a length of 15.8 m, is made on the two-section frame in the form of the three-axial towed vehicle. The frame also supports on four hydraulic bearing parts that allows it to have resistant operation position. The operator (sitting in a cub with a heating system and conditioning) executes feeding of raw materials to limbing-barking chamber for processing by means of manipulator.

The whip (by means of the double feed rollers executing delimbing functions and coarse barking, and also 6 rollers of lower feed) at first is moved to zone with three rotating drum heads where its barking takes place by deposition of multiple strokes on a surface of whip by the chains fixed on drum heads. Further the whip is moved to chipping compartment. Obtaining of a qualitative chipwood is attained due to rotating spring feed roller and the disk for certain speed and an angle of rotation of knifes in order to provide a required chip dust depending on the dimensions of raw material being ground. A tuning and monitoring are implement by means of computer. The chipping disk with diameter of 1.67 m is made of strong steel. The obtained pulpchips cleared by a dividing box from pollutants, fines and chips are rejected in a chip truck basket. Fixed power of machine engine is 735 kw, fuel tank capacity – 1,048.6 l, capacity of a hydraulic filling chest – 1,818 l. Delimbing-chipping-barker-peeler structurally can consist of two self-supporting units (delimbing-debarking and chipping), made on its own frame-trailer, and having smaller powers and efficiency.

Conclusion. Commissioning of chemistry engineering enterprises in Belarus results in sharp demand for wood raw material in the form of pulpchips. One of the sources of its obtaining is white elder stands (possible logging can be 400,000 cubic meters per year). The suggested machine systems and production techniques of pulpchips in the conditions of logging site in PC "Vitebskdrev" from white elder stands are innovative and can be realized in other localities of country. Selection machine system modes for pulpchips production in concrete natural-industrial conditions should be based on appropriate engineering calculations.

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