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SHISHELOV M.[1]

INNOVATIVE DEVELOPMENT OF THE FOREST COMPLEX OF THE REPUBLIC OF KOMI: STATUS AND PROSPECTS

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Formulation of the problem. Global manufacturers of timber products and specialized research institutes are actively developing innovative materials and improving production processes. The fastest growing groups include innovative packaging materials, innovative building materials, biodegradable polymers and biofuels. *The aim of the article* is to form a theoretical and methodological basis for the innovative development of the forestry complex of the Komi Republic. *The subject of the research* is theoretical and methodological aspects of innovative development of the forestry complex. *Methods used in the study:* historical method, methods of verification of theoretical positions (morphological analysis of the content and relationship of categories, principles and laws, assessment of the correspondence of historical facts to theoretical hypotheses), methods of analysis and synthesis, induction and deduction, logical method (hypothetical and axiomatic approaches), comparison method. *Research hypothesis*. The innovative development of the forestry complex in Russia is associated with forest chemistry. In particular, tall oil rosin and tall oil fatty acids in the markets of Russia and Asia are considered the most priority segments for Russian manufacturers. *Presentation of the main material*. Analysis of the current state of the forestry complex of the Komi Republic revealed an extremely low level of innovation activity. Over the years after the collapse of the Soviet Union, development proceeded along the extensive path of increasing the production and export of forest products of primary and secondary levels of redistribution, and the share of innovative products in the commodity and industry structure was measured at the level of statistical error. *Originality and practical value of the research*. The production of innovative products of the second generation is a promising direction for the development of the timber processing industry in the Komi Republic. The main ones are: bioconversion of cellulose-containing raw materials; biomass torrefaction technology based on plant waste; production of sulphate turpentine; highly active preparations for agriculture from pine needles. *Conclusions of the study*. It is planned to implement these directions by increasing the output of products with high added value, organizing new production of innovative products, commissioning medium and small innovative enterprises for the production of wood flour, biosorbents and other products, and developing regional wooden housing construction.

Key words:
forestry complex, innovations, efficiency, development prospects.

ІННОВАЦІЙНИЙ РОЗВИТОК ЛІСОВОГО КОМПЛЕКСУ РЕСПУБЛІКИ КОМИ: СТАН І ПЕРСПЕКТИВИ

Постановка проблеми. Світові виробники лісопромислової продукції і профільні НДІ активно займаються розробкою інноваційних матеріалів і поліпшенням виробничих процесів. До найбільш динамічно розвиваються груп можна віднести інноваційні пакувальні матеріали, інноваційні будівельні матеріали, біорозкладні полімери і біопаливо. *Метою статті* є формування теоретико-методологічного базису інноваційного розвитку лісового комплексу Республіки Комі. *Предмет дослідження* – теоретичні та методологічні аспекти інноваційного озвиток лісового комплексу. *Методи, використані в дослідженні*: історичний метод, методи верифікації теоретичних по-

[1] **Шишелов Максим Олександрович,** канд. екон. наук, старший науковий співробітник Федеральної державної бюджетної установи Інститут соціально-економічних та енергетичних проблем Півночі Комі Уральського відділу Російської академії наук, м. Сиктивкар, Республіка Комі, Росія.

Shishelov Maksim, Ph.D. in Economic, Senior Research Fellow Federal government budget institutions Sciences Institute socio-economic and the energy problems North Komi Scientific Center, Ural-division of the Russian Academy of Sciences, Syktyvkar, Komi, Russia.
ORCID ID: 0000-0002-9849-8112
e-mail: shishelov.maksim@gmail.com

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ложень (морфологічний аналіз змісту та взаємозв'язку категорій, принципів і законів, оцінка відповідності історичних фактів теоретичним гіпотезам), методи аналізу і синтезу, індукції і дедукції, логічний метод (гіпотетичний і аксіоматичний підходи) , метод порівняння. *Гіпотеза дослідження.* Інноваційний розвиток лісового комплексу Росії пов'язано з лісохімія. Зокрема, талловим каніфоль і жирні кислоти талової олії на ринках Росії та країн Азії розглядаються як найбільш пріоритетні сегменти для російських виробників. *Виклад основного матеріалу*. Аналіз сучасного стану лісового комплексу Республіки Комі виявив вкрай низький рівень інноваційної активності. За роки, після розпаду Радянського союзу розвиток йшло екстенсивним шляхом збільшення обсягів виробництва та експорту лісових товарів первинних і середніх рівнів переділу, а частка інноваційних продуктів в товарно-галузевій структурі вимірювалася на рівні статистичної похибки. *Оригінальність і практичне значення дослідження*. Виробництво інноваційних продуктів другого покоління є перспективним напрямком розвитку лісопереробної промисловості Республіки Комі. Основні з них: биоконверсия целюлозовмістні сировини; технологія торрефікації біомаси на основі відходів рослинної сировини; виробництво сульфатного скипидару; високоактивні препарати для сільського господарства з хвої. *Висновки дослідження*. Реалізувати дані напрямок передбачається за рахунок збільшення обсягів випуску продукції з високою доданою вартістю, організації нових виробництв інноваційних продуктів, введення середніх і малих інноваційних підприємств з випуску деревної муки, біосорбентів та інших продуктів, розвитку регіонального дерев'яного домобудівництва.

Ключові слова:
лісовий комплекс, інновації, ефективність, перспективи розвитку.

ИННОВАЦИОННОЕ РАЗВИТИЕ ЛЕСНОГО КОМПЛЕКСА РЕСПУБЛИКИ КОМИ: СОСТОЯНИЕ И ПЕРСПЕКТИВЫ

Постановка проблемы. Мировые производители лесопромышленной продукции и профильные НИИ активно занимаются разработкой инновационных материалов и улучшением производственных процессов. К наиболее динамично развивающимся группам можно отнести инновационные упаковочные материалы, инновационные строительные материалы, биоразлагаемые полимеры и биотопливо. *Целью статьи* является формирование теоретико-методологического базиса инновационного развития лесного комплекса Республики Коми. *Предмет исследования* – теоретические и методологические аспекты инновационного азвития лесного комплекса. *Методы, используемые в исследовании:* исторический метод, методы верификации теоретических положений (морфологический анализ содержания и взаимосвязи категорий, принципов и законов, оценка соответствия исторических фактов теоретическим гипотезам), методы анализа и синтеза, индукции и дедукции, логический метод (гипотетический и аксиоматический подходы), метод сравнения. *Гипотеза исследования.* Инновационное развитие лесного комплекса России связано с лесохимией. В частности, талловая канифоль и жирные кислоты таллового масла на рынках России и стран Азии рассматриваются как наиболее приоритетные сегменты для российских производителей. *Изложение основного материала.* Анализ современного состояния лесного комплекса Республики Коми выявил крайне низкий уровень инновационной активности. За годы, после распада Советского союза развитие шло по экстенсивному пути увеличения объёмов производства и экспорта лесных товаров первичных и средних уровней передела, а доля инновационных продуктов в товарно-отраслевой структуре измерялась на уровне статистической погрешности. *Оригинальность и практическое значение исследования.* Производство инновационных продуктов второго поколения является перспективным направлением развития лесоперерабатывающей промышленности Республики Коми. Основные из них: биоконверсия целлюлозосодержащего сырья; технология торрефикации биомассы на основе отходов растительного сырья; производство сульфатного скипидара; высокоактивные препараты для сельского хозяйства из хвои. *Выводы исследования.* Реализовать данные направление предполагается за счет увеличения объемов выпуска продукции с высокой добавленной стоимостью, организации новых производств инновационных продуктов, ввода средних и малых инновационных предприятий по выпуску древесной муки, биосорбентов и других продуктов, развития регионального деревянного домостроения.

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Ключевые слова:
лесной комплекс, инновации, эффективность, перспективы развития.

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Formulation of the problem. According to the federal law "On Science and State Scientific and Technical Policy" No. 254 of July 21, 2011 [1], innovation means a new or significantly improved product (product, service) or process, a new sales method or a new organizational method introduced into use. in business practice, workplace organization or in external relations. Innovative development is characterized as “a continuous process of qualitative changes in the structure of production or the social sphere as a result of the creation, application and dissemination of new knowledge, machines, technologies, materials, types of energy, forms and methods of organization and management, raising the level of education, etc.

Innovative products can be conditionally divided into those obtained by mechanical and chemical processing of wood:

- the obtained mechanically include wood flour used in many industries and processed from logging and sawmilling waste, toys, interior items, furniture made of plywood by processing it on laser machines with software control, etc.

- the products of chemical processing of wood are: thermally modified wood, practically invulnerable to the influence of negative environmental factors, widely used in construction for external finishing; torrefied wood pellets and briquettes with better consumer properties in comparison with standard wood fuel; wood composites used in construction and decoration; bioethanol; food additives and medicines, etc.

Analysis of recent research and publications. Global manufacturers of timber products and specialized research institutes are actively developing innovative materials and improving production processes. The fastest growing groups include innovative packaging materials, innovative building materials, biodegradable polymers and biofuels. Such positions were revealed during a survey of key global players in the forest industry. According to the survey, the greatest impact on the market of innovative products from wood raw materials in the foreseeable future will have: innovative packaging materials - answered 72% of respondents; innovative construction and biodegradable polymers - 44% of respondents; biodiesel - 28%; food additives - 11% of respondents answered [2].

Leading countries in the production and export of wood and paper products (Canada, USA, Finland, etc.), taking into account global trends, to maintain and strengthen their positions, invest heavily in research and creation of innovative wood processing products with high added value (biofuels, composite construction materials, plastics, drugs, chemicals, smart paper, etc.).

The Canadian example shows that transformations in the forestry complex begin with investments in traditional forestry sub-sectors in order to increase their economic competitiveness and environmental sustainability through the use of new technologies for harvesting, processing and transporting wood to the final consumer. The implementation of the Forest Innovation Program, which has been in effect since 2012, is designed to ensure the introduction of new technologies in the forest complex of Canada.Its purpose is to support research, development and technology transfer to enterprises in the forest complex of the country, which are carried out by research institutes and non-profit business support centers. The main areas of research:

- new building materials, biofuels to replace fossil fuels;

- biochemical products that can be used for the production of the biopharmaceutical industry, biodegradable plastics;

- personal hygiene products and industrial chemicals [3].

The purpose of the article is is to form a theoretical and methodological basis for the innovative development of the forestry complex of the Komi Republic.

Presentation of the main research material. The Scandinavian countries are following a similar path. Finland, historically focused on the production and export of pulp and paper products, is actively investing in research and development of new bio-products. The country's forestry complex is set to create a sustainable and resource efficient bioeconomy that ensures the cyclic use of products to preserve the value of wood and maximize the added value of products.

In 2017, the Metsä Group launched a new plant for the production of traditional and new

bioproducts of the next generation. Pulp, cardboard, sanitary products, wrapping paper, as well as lumber, plywood and building materials are traditional products. New biological products include: textiles based on wood fibers, electronic components, agricultural fertilizers, paints, car tires, perfumes, household chemicals, fuel - bioethanol [4].

Innovative vectors of development of the forestry complex in Russia

Taking into account the global trends of growth in demand for wrapping paper and sanitary products, a multiple increase in the share of the use of construction materials in residential and non-residential construction, the dynamic development of bioeconomy, the domestic market of forest products and neighboring countries is also changing.

The target vision for the development of the forestry industry in Strategy 2030 [5] provides for: production of pulp, focused more on export, production of containerboard and sanitary and hygienic products to meet demand in the domestic market, oriented equally towards the domestic market and export production of sawn timber , plywood-board products, as well as products of wooden housing construction.

The most promising niches with a capacious domestic market are the production of paper and cardboard products to replace plastic counterparts at the expense of substitute types of paper and cardboard: molded paper fiber (packaging and disposable tableware) and moisture-resistant paper.

A 4% annual growth in sawnwood production will support domestic consumption and sawnwood exports at about the same annual rate. The domestic market and exports of plywood and panel products will grow at a slightly slower pace (3-3.6%).

The innovative development of the forestry complex in Russia is associated with forest chemistry. In particular, tall oil rosin and tall oil fatty acids in the markets of Russia and Asia are considered the most priority segments for Russian manufacturers.

New technologies are appearing on the world market of wooden housing construction, the most promising of which are cross-glued panels and panel-timber technology. For Russian manufacturers, these segments will be the most attractive both on the foreign market, due to the high profitability of Russian house kits made using the technology of cross-glued panels, and on the domestic market, with proper support from the state, will lead the segment of wooden housing construction.

An example of a regional innovation initiative is the Arkhangelsk region. Where on the platform of the Scientific and Educational Center "Russian Arctic" enterprises of the forestry complex, included in the regional forest cluster ("Pomorinnovales"), scientific and educational organizations are united. Key initiatives and areas of its activity: deep processing of organic wood components and obtaining new environmentally friendly materials for packaging, medical use, composites, wood flour, technologies for processing and preserving forest biological resources of the Arctic, reforestation.

Considering all of the above, the authors understand by the innovative development of the timber processing industry at the regional level the introduction of innovations in technological, logistics and other processes at existing and new enterprises, as well as an increase in the share of innovative products in the commodity structure.

The state of innovative development of the forestry complex of the Komi Republic

In 2018, timber industry activities in the republic were carried out by more than 600 enterprises, which employed about 12.8 thousand people from the total number of people employed in the republic's economy [6].

In 2018, the share of the forestry complex in the republic's industry was: 18.7% of employed personnel, 16% of shipped products, 63.5% of exports, 6.2% of investments in fixed assets, 4% of tax revenues. The total production volume exceeded 100 billion rubles. The structure of shipped products was dominated by pulp and paper production (PPI) - 63%, the share of the woodworking industry and logging accounted for 28% and 9%, respectively [7].

According to the data of the Territorial Body of the Federal State Statistics Service for the Komi Republic (TOFSGS for the Komi Republic), in 2018 the enterprises of the complex produced 6170 thousand m3 of raw timber, 1101 thousand m3 of sawn timber, 402 thousand m3 of plywood, 347 thousand of particle boards. m3, cellulose - 820 thousand tons, paper - 793 thousand tons and cardboard - 320 thousand tons (Table 1).

The increase in the output of the main types of timber products, with the exception of particle boards, the consumption of which is decreasing throughout the world due to substitution by other types of materials, was

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ensured by the implementation of priority investment projects in the field of forest development in the Komi Republic, the modernization of existing enterprises and an increase in demand in the Russian and international markets. The most significant projects:

• modernization of the pulp and paper production of Mondi SLPK, within the framework of the Step and Horizon projects;

• modernization of plywood and board production at the Syktyvkar Plywood Plant, Zheshart LPK, Knyazhpogostky Fiberboard Plant;

• modernization of Sevlespil, Luzales and Norwood SM, the largest logging and sawmills in the region;

Table 1: Dynamics of production of the main types of timber products in the Komi Republic in 2008–2018

Name	2008	2012	2014	2016	2018	2018 to 2008, %
Industrial timber, million m3	5896	5418	5383	5347	6170	104
Lumber, million m3	783	640	730	800	1101	140
Plywood, thousand m3	282	319	330	370	402	143
Particleboard, thousand m3	390	326	331	337	347	89
Market cellulose thous.t	546	655	760	800	820	151
Paper thousand tons	636	747	752	782	793	125
Cardboard thousand tons	207	234	270	300	320	155

Source: developed by the author

• implementation of investment projects for the creation of integrated timber processing enterprises (Pechoraenergoresurs, Azimut, Sawmill № 1, Promtech-invest, etc.).

The commodity and sectoral structure of the republic's forestry complex, despite the modernization of existing enterprises and the creation of new ones, continues to remain conservative with a predominance of wood and paper products of low (sawn timber) and medium (plywood, plates, paper, cardboard) levels of redistribution. The share of innovative products with high added value in the overall structure of production remains insufficient and amounts to less than 2%.

The author understands innovative products of the regional forestry complex as products of the first generation (various molded products, furniture panels, glued, profiled beams, massive panels and structures for wooden housing construction, essential oils, fuel briquettes and pellets), which are already presented in the commodity structure or announced to production in investment projects implemented in recent years.

Innovative products of the second generation (tall oil, turpentine, bioethanol, preparations for plants "Verva", thorified briquettes and pellets, wood flour, composite materials from wood, wooden construction, interior items, furniture and toys made of plywood) are completely new products, previously not produced by forestry enterprises in the region.

The analysis of the commodity-sectoral structure determined the significant disproportions in the output of the woodworking and pulp-and-paper industry of the republic in comparison with the Scandinavian countries. In Komi, pulp, paper, plywood and board industries make the largest contribution to shipped products, while in Finland and Norway, sawmilling and planing of wood and the production of innovative first-generation products.

The underdevelopment of the production of innovative products with high added value is due to the historically established specialization of the region's forestry complex in the production and export of pulp and paper, board products and sawn timber, supported by a favorable market situation in the markets of the CIS countries and far abroad. As well as entry barriers to international markets for timber and paper products of high levels of redistribution: high competition, limited access to technology, high cost of borrowed funds in the financial sector of Russia.

Scientific and innovative developments in the use of wood raw materials

The production of innovative products of the second generation is a promising direction for the development of the timber processing industry in the Komi Republic. The research

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teams of the Federal Research Center of the Komi Scientific Center of the Ural Branch of the Russian Academy of Sciences have proposed similar developments.

Bioethanol. Bioconversion of cellulose-containing raw materials. Enzymatic production of glucose and "cellulose" ethanol. Final products: Protein-carbohydrate feed for animals. Glucose is a carbohydrate for food and feed purposes. An enzyme preparation capable of breaking down cellulose - a biocatalyst for enzymatic hydrolysis of cellulose into glucose. "Cellulosic" ethanol is a second generation biofuel [9].

For the production of bioethanol, naturally renewable non-food cellulose-containing raw materials are used, namely, pulpwood, non-commercial wood, sawmill waste. The plant will require up to 450 thousand cubic meters to operate. m of pulpwood per year. The estimated capacity of the enterprise is 100,000 tons of motor biofuel - bioethanol - per year.

A potential location for such a production may be the Troitsko-Pechora region, where there are corresponding reserves of wood (more than 120 million cubic meters of mature and overmature forests) and a railway line for shipment of products to end users in the village. Troitsko-Pechorsk. However, a significant limitation of the creation of a bioethanol plant in this municipality is the low transport accessibility of wood.

Despite the significant volume of the allowable cut in the Troitsko-Pechora region, more than 3.0 million cubic meters. m, forests are developed extremely unevenly. The most transport-accessible Troitsko-Pechora forestry has an allowable cut of about 0.6 million cubic meters. m, therefore, its resources are insufficient for the construction of a bioethanol plant, even if the allowable cut is used by 100%. The solution may be the development of the Pechora-Ilych forestry, where the share of coniferous wood is about 80%, and possibly a low reserve per hectare of 83.5 cubic meters. m with a predominance of coniferous pulpwood will not be an obstacle to the creation of such a production. A significant limitation is the lack of infrastructure for its development, including the construction of large bridges and roads, which may not recoup the investment.

From a resource point of view, the Komsomolskoye forestry is more promising, where harvesting is concentrated in its western part and there is an opportunity to increase harvesting volumes by 200-250 thousand cubic meters. m up to 400-450 thousand cubic meters m, which also does not cover the raw material requirement of the bioethanol plant. The use of the eastern part of the Komsomolskoye lesnichestvo also requires huge investment costs for the construction of roads and infrastructure, while here the foothills in front of the Ural Mountains begin with their own specifics for logging.

Another possible location may be industrial sites of large operating enterprises in the city of Syktyvkar and the Ust-Vymsky region in the event of agreements with the owners of the production facilities, the availability of appropriate infrastructure or opportunities for its creation, as well as the supply of raw materials for production, due to the supply of wood from forest-supplied areas republics.

Torreficates. Biomass torrefaction technology based on plant waste. In the process of torrefaction, biomass is exposed to temperature with limited air access, which leads to the loss of the least caloric part of volatile substances by the feedstock. As a result, the calorie content of the product increases. And after pressing in the form of pellets or briquettes, the bulk density of such biomass turns out to be the same or higher than the bulk density of traditional wood fuel pellets or briquettes [10].

Torrefied pellets and briquettes have an energy consumption of 5.6 MW * h / ton, which is 25% higher than conventional pellets. The global demand for torrefied biomass in the form of industrial fuel briquettes and pellets tends to increase in the last 5-10 years.

Organization of stations ionic or mobile high-tech complexes for biomass torrefaction are advisable in the immediate vicinity of logging and wood processing enterprises or in conjunction with them.

Turpentine. The new technology is aimed at processing a by-product of pulp and paper production - sulfate scpidar for the purpose of recycling waste from pulp and paper production and obtaining practically important products used in medicine, perfumery, agriculture, industry [11].

Despite the existing production capacities of the leading domestic wood chemical and pulp and paper enterprises and the availability of raw materials for the production of turpentine, as well as a significant amount of research and applied work devoted to its processing, in the

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Russian Federation, turpentine is considered mainly as a solvent for paints and varnishes, and industrial production there are practically no products based on it.

At the same time, the assortment of the transnational company GLIDCO Chemical comprises more than 150 types of products obtained by deep processing of turpentine. The creation and practical implementation of such a concept through the development of scientific and applied foundations of technological processes for the complex processing of sulfate turpentine and their introduction into production, as well as promising directions for the use of turpentine products, will make it possible to offer competitive products based on environmentally friendly plant raw materials to the domestic and foreign markets.

Conclusions and prospects for further research. Analysis of the current state of the forestry complex of the Komi Republic revealed an extremely low level of innovation activity. Over the years after the collapse of the Soviet Union, development proceeded along the extensive path of increasing the production and export of forest products of primary and secondary levels of redistribution (round timber, lumber, plywood, board products, cellulose, cheap types of paper), and the share of innovative products in the structure was measured at the level of statistical error.

In many ways, this situation was a consequence of the favorable situation in the international forest products markets, supported by the constant depreciation of the ruble against other currencies, which made the production and export of products with low added value (round timber, sawn timber) more and more attractive.

The inclusion of enterprises in the list of priority investment projects in the field of forest development in the Komi Republic and obtaining a long-term lease with a 50% discount even more "relaxed" the owners and consolidated the existing export-oriented model of forest products with low added value.

Prospects for the innovative development of the forestry complex in Russia are associated with forest chemistry, new types of structures for wooden housing construction, paper and cardboard products.

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