Improving the efficiency of forest use in the Russian Federation

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Abstract. The article discusses practical aspects of forest use in the Russian Federation and identifies the most common forest uses. We propose to increase forest use by harvesting and collection of non-timber forest products, including resin, forest foods and medicinal plants. We also describe the main pathways of utilizing waste from logging and wood processing to obtain products that are in great demand in the market and have a high selling price. Finally, we present the results of the analysis of changes in forest productivity depending on the increase in the number of types of forest use.

1. Introduction

Rational use of forests involves not only wood harvesting and mechanical and chemical processing to obtain products with high added value, but also the use of waste generated during the harvesting and processing of timber, as well as the use of other forest resources. Article 25 of the Forest Code of the Russian Federation [1] defines 16 types of forest use; however, in practice forest areas are often used only for timber harvesting. According to the Strategy for the Development of the Forest Complex of the Russian Federation until 2030, out of the total forest fund of the Russian Federation totalling 766.6 million hectares, 232.6 million hectares have been leased for timber harvesting, and 32.5 million hectares, for permanent use; about 7 million hectares of the latter have been used for timber harvesting, and 25 million hectares for recreational activities. Thus, over 90% (or ca 240 million hectares) of the total area of 265 million hectares of leased or permanently used forest have been used exclusively for timber harvesting.

Forest areas are sometimes used for geological exploration and extraction of minerals, construction, reconstruction and operation of linear facilities, construction and operation of reservoirs and other artificial water bodies, for hydraulic structures, sea and river ports, terminals and berths, for scientific research and educational activities, growing planting material of forest plants, etc. A relatively small forest area is used for harvesting forest foods (about 3.5 million hectares), and hardly any area is used for harvesting resin, non-timber forest products and medicinal plants, for growing forest fruit, berry, ornamental and medicinal plants, and for wood processing.

The absence of contracts for the lease of forest plots for the harvesting of resin, non-timber forest products and medicinal plants is primarily due to the lack of clearly prescribed rules for harvesting and collecting these resources, the lack of a methodology for their quantitative and qualitative assessment, economic calculations for costs of their procurement, and the lack of processing industries. In this regard, it became necessary to develop clear rules for the procurement and collection of these resources, methods for their quantitative and qualitative assessment, study of relevant markets, and the
creation of the necessary infrastructure for the procurement, transportation and processing of non-
timber forest resources.

An increase in the volume of harvesting and collection of non-timber forest resources is a global
trend. Russia is the most forest-rich country; therefore, it is necessary to take into account this trend
and increase the volume of harvesting and collection of Russian non-timber forest resources.
According to experts from the UN Food and Agriculture Organization (FAO), a sharp increase in the
global demand for forest products and forest services is expected in the near future.

According to experts, the market value of non-timber products from the world’s forests, despite the
fact that most of these products are not available on the commodity markets, is about US $ 20 billion
per year.

2. Methods and Materials
As a study object, the plots of the forest fund were considered, designated for long-term lease or for
permanent use for one or several types of forest use. Most of these sites were located in a relatively
easy accessible zone with a fairly well-developed road network, which makes it possible to increase
the number of forest uses permitted by forest legislation at minimal costs. Of all types of non-timber
forest resources harvested, including waste from logging and wood processing, the ones that are of the
greatest practical importance and are in high demand on the markets were considered. A comparison
was made of the income received from the sale of wood (for one type of forest use, timber harvesting)
with the income received from the sale of timber and non-timber forest resources (for several types of
forest use, including harvesting of non-timber forest resources).

3. Results and Discussion
Of the non-timber forest resources used, the greatest attention was paid to those resources that are in
high demand on the markets and can be processed into goods with the greatest profitability. First of
all, this is the harvesting of resin.

The resin of coniferous trees is a raw material for the production of rosin and turpentine [2].
According to reference data, in 2015 the world produced 494 thousand tons of rosin, the demand for
which amounted to 515 thousand tons in Asia alone. In Russia, the annual demand for rosin is about
23 thousand tons and increase by about 3.1–3.4% yearly, despite the fact that there is practically no
production of rosin in Russia. Due to the increase in the production of adhesives, ink, rubber, plastics
and other materials in the production of which rosin is used, a shortage of rosin is expected at about
546 thousand tons. Therefore, the recommencement of harvesting of resin in coniferous forests is
highly necessary. It is advisable to return to the practice of obligatory tapping of conifers four to five
years before felling. It has been experimentally established that as a result of tapping (without
deteriorating the state of the stand), it is possible to harvest up to 300 kg of resin from 1 hectare of
coniferous forest [3]. The average market price of resin is 1000 rubles per kilogram. Thus, by
harvesting resin before the start of harvesting coniferous timber, it is possible to increase the
profitability from the sale of forest products by 300 thousand rubles per 1 ha, which is comparable to
the income received from the sale of timber (approximately 450 thousand rubles per 1 ha).

In birch plantations, it is possible to harvest birch sap and bark. Birch bark can be removed both
from growing trees without damaging the bast layer once every 8–10 years, and felled trees. The
market price of birch bark is approximately 350 rubles per square meter. Birch bark is a valuable raw
material for the production of birch tar and betulin, which are used in medicine and pharmacology for
the production of antibacterial and anti-burn agents, and in cosmetology for the production of soaps
and shampoos. Birch bark has bactericidal properties due to the silver ions contained in it. Because of
the low thermal conductivity and high water resistance of birch bark, it is used for the manufacture of
souvenirs, containers for storing food, and roofing materials.

For the production of tar, the bark of other forest trees, both coniferous and deciduous, can be used,
although the quality of the tar obtained is lower. The market price of tar is 1800–2000 rubles per
kilogram. The tar yield from birch bark of the second grade is 25–27% [4].
On average, about 1000 m² of birch bark can be harvested per hectare of ripe birch plantations once every 8–10 years, which makes it possible to increase forest productivity by 350 thousand rubles per 1 hectare.

Branches and needles of pine, spruce and fir are used as raw materials for the production of a wide range of products. Branches of conifers are processed by a mechanical grinder into pro-vitamin flour used in animal husbandry and poultry farming. To obtain biologically active substances, pine and spruce branches and needles are used as the main raw material for chemical processing by means of extraction in gasoline. These substance are used to obtain chlorophyll-carotene paste, which is used in medicine for the treatment of ulcers, burns, frostbite, skin diseases, in the cosmetic and perfumery industry as a bioactive component, and in animal husbandry and poultry farming as a vitamin feed additive. Chlorophyllin sodium concentrate and pro-vitamin concentrate, pine wax, essential oils, terpene alcohols, coniferous balsamic paste, etc. are also obtained, which are used in medicine and pharmacology to produce drugs and in cosmetology for the production of perfumery and cosmetic products.

Branches and needles can be harvested from felled trees during logging as well as when pruning growing trees during silvicultural activities to create knot-free coniferous wood, when widening quarter clearings, etc. For harvesting branches with a high chlorophyll content, it is advisable to grow conifers in plantations. When clearcutting forests with a predominance of coniferous trees, it is possible to harvest up to 8–10 tons in winter and 12–15 tons in summer of coniferous branches from 1 hectare [5], from which chlorophyll-carotene paste can be obtained in a volume of up to 230 kg from spruce and up to 900 kg from pine [6]. With an average price of chlorophyll carotene paste of 2700 rubles per kilogram, as a result of harvesting and chemical processing of needles and coniferous branches it is possible to increase the productivity of 1 hectare of coniferous forest by 2,400,000 rubles.

In accordance with Article 34 of the Forest Code of the Russian Federation [1], another area of forest use is the harvesting of forest foods, including wild fruits, berries, nuts, mushrooms, seeds, birch sap, etc. and the collection of medicinal plants. The use of forests for these purposes is possible both under a lease agreement and without it, which is why it is very difficult to draw a line between the use of harvested foods and medicinal plants for the own needs and entrepreneurial activity (where the lease of a forest plot is mandatory): this presents difficulties in implementation of the requirements of the forest legislation. Therefore, many legal entities do not enter into lease agreements that impose certain obligations on them, including financial ones, but act according to the procurement and collection rules applicable to individuals, which allows them to be competitive in the market where they sell harvested forest foods and medicinal plants.

The use of a forest plot for harvesting mushrooms and berries refers to two types of forest use: "Harvesting food forest resources and collecting medicinal plants" and "Growing forest fruit, berry, ornamental plants, medicinal plants" defined in Article 25, paragraphs 4 and 10, and Articles 34 and 39 of the Forest Code of the Russian Federation [1]. If these types of use of forest plots are identified, then it is possible to rent them. However, in practice this type of lease is hardly ever used.

According to Article 11 of the Forest Code, paragraph 1, “citizens have the right to stay freely and free of charge in the forests and for their own needs to harvest and collect wild fruits, berries, nuts, mushrooms, other edible forest resources (food forest resources), and also non-timber forest resources” [1]. On a forest plot suitable for harvesting forest foods, collecting medicinal plants and growing forest fruit, berry, ornamental plants, medicinal plants (hereinafter FP NR), competition for a resource between individuals and tenants of the forest plot can happen. The tenant uses FP NR to collect and grow mushrooms and berries, while local residents can freely pick these mushrooms and berries in the forest area. The tenant can restrict their access to the site only in two cases: to ensure fire safety and sanitary safety in the forests and to ensure the safety of citizens when performing work (Forest Code of the RF, Art 11, p 5); in other cases, restricting access is not allowed by the legislation (Forest Code of the RF, Art 11.p 6, 8) [1]. This situation can lead to social tension.
There are several options for a tenant when renting a FP NR. The tenant can lease remote, hard-to-reach areas of the forest fund. However, when using a forest plot, the tenant needs to develop its infrastructure, including the road and transport network necessary for the transport of finished products and ensuring fire safety. This increases product costs, lowers rental income and makes the use of the site unprofitable. Another option for the tenant is to lease FP NR with large volumes of resources, hoping that local residents will not be able to harvest the entire resource. This option leads to an increase in rental costs for the tenant, a small volume of the resource collected from the area, which again makes the lease of FP NR unprofitable for the tenant. In addition, it is not profitable to carry out forest regeneration activities on the leased FP NR, since the increased anthropogenic load on the forest area from citizens gathering mushrooms and berries will negate all the tenant's efforts to improve the forest area.

For the development of the lease of FP NR, the solution may be a legislative restriction of visits to the leased FP NR by the population, preferably without enticing social tension.

Three participants in forestry relations are interested in solving this problem, pursuing their own goals:
- citizens - to harvest forest resources for their own needs free of charge;
- tenants - to get the maximum profit from the leased site;
- lessors - to increase the flow of money to the budget and increase the resource capacity of the forest fund.

To meet the requirements of each participant in forestry relations, we offer the following compromise solution:
- State authorities carry out an inventory and assessment of forest areas to determine availability, actual and potential volumes of mushrooms and berries;
- FP NR which have the largest actual volumes of mushrooms and berries are not subject to lease under "Harvesting food forest resources and collecting medicinal plants" and "Growing forest fruit, berry, ornamental plants, medicinal plants" and remain in the public domain;
- FP NR in which the actual volume of resources can be increased will be leased for harvesting forest foods, collecting medicinal plants, growing forest fruit, berries, ornamental and medicinal plants.

When leasing a plot for growing forest fruit, berries, ornamental plants, medicinal plants, a tenant is interested in increasing the amount of mushrooms and berries on the plot, since the plot is usually leased for a long period. It is possible to pick mushrooms and berries from the existing resource base of the forest plot in the same year, but creating and maintaining a resource base on an “empty” plot takes more time and effort. As mentioned earlier, the tenant's main goal is to get the highest profit with the lowest cost. The more products received from the forest plot, the large the tenant's income. The solution to the problem of increasing the resource concentration on the site can be solved by reducing the anthropogenic load (due to the restricted citizens’ access to the site, as well as by creating a technological road and path network) and by the tenant carrying out forest management activities (draining, thinning the canopy, etc.). It should be noted that forest management activities should be carried out with extreme caution, because ground cover (including mycelium and small shrubs) are easy to damage. Subsequently, if the tenant has competently carried out forest reclamation measures and there is a positive dynamics of increasing resource concentration in the forest area, the state can provide the tenant with a subsidy that will partially cover his/her investment.

When selling products (mushrooms and berries) in market conditions, a tenant will compete with procurement companies that buy the resource from the local population and resell it to retailers. Since a tenant is forced to bear additional costs (rent, costs of preparing documentation for the forest area, the cost of caring for forest products), the final price of a unit of his products will be higher compared with that of a procurement company. The tenant's advantages over procurement companies are that he has a certain technology for growing the product, the origin of which is controlled at all stages of the procurement process. Procurement companies do not control the origin of the resource purchased from the local population, and when the number of products is large, there is no guarantee that some of
them have been collected in environmentally hazardous conditions (places polluted with heavy metals and oil products, landfills, sites of radiation contamination, etc.) or with damage to and depletion of the resource base. In the market conditions there is currently no mechanism to distinguish products of controlled origin from the rest of products. The introduction of certification of products (mushrooms and berries) can improve the situation. The certification costs will be paid by a tenant, but part of the certification costs as well as the costs of forest management activities may be covered by a subsidy provided by the government. Certification further increases the cost of the final product, but at the same time it guarantees its environmental friendliness. In the modern commodity market, there is a growing demand for environmentally friendly products from buyers with medium and high incomes. Analyzing the above, we can predict that certified products will take a certain place in the market, and their sale will be profitable.

To solve the above problems, it is necessary:

- To ensure that forest plots that have the greatest actual volumes of mushrooms and berries are left in the public domain, and plots in which the actual capacity of resources can be increased must be leased for harvesting forest foods, collecting medicinal plants, growing forest fruits, berries, ornamental and medicinal plants.
- To consider the possibility of state subsidies for tenants for increasing the productivity of the forest fund.
- To introduce licensing, which allows increasing the competitiveness of forest products, the origin of which is controlled at all stages of the process of obtaining them.

For a more comprehensive use of forests for this type of forest use, a number of problems should be solved:

- eliminate shortcomings of forest legislation concerned with the regulation of forest relations between tenants and legal entities engaged in industrial harvesting and individuals engaged in harvesting for their own needs;
- develop a methodology for assessing reserves of forest foods and medicinal plants and a form of statistical reporting on the volume of their actual harvest;
- create a forest infrastructure for this type of forest use in developed forest areas and in remote areas that are difficult to access; it is necessary to eliminate the problem of forming forest plots for putting them up for auction for the right to conclude a lease agreement for this type of forest use at the expense of the budget of the corresponding region;
- create a network of specialized procurement and processing enterprises; to provide in the forest legislation the possibility of short-term use of a plot of the forest fund for the specified type of activity, taking into account the seasonality of harvesting, environmental and climatic conditions.

The execution of the above tasks will make it possible to create industrial harvesting, including that by individuals, and the processing of forest foods and medicinal plants; in the process of industrial production new technologies will be created using techniques and mechanisms to increase the productivity of harvesting, collecting and processing of these forest products. All of the above will allow to reduce the costs of not only procurement and collection, but also of processing, as a result of which it is possible to significantly reduce the price of finished products.

Today humanity faces a global food shortage. According to Food and Agriculture Organization of the United Nations (FAO), 17.2% of the world's population, i.e. 1.3 billion people are moderately food insecure. These people do not have regular access to adequate and nutritious food; even if they are not hungry, they are at greater risk of all forms of malnutrition and health problems. Taking into account those living with both moderate and severe food insecurity, the estimated aggregate rises to 26.4 percent of the world's population (about two billion people). At the same time, the area of arable land per capita decreased from 2228 m² / person as of 2008 down to 2054 m² / person as of 2018. The widespread use of forest foods will help to relieve some of the pressure on agriculture. The problem of food shortages has not yet affected the population of Russia, but there is no doubt that forest foods are more useful than artificially grown ones, since they do not contain pesticides, nitrates and other substances that have a detrimental effect on human health and cause allergic reactions. Moreover,
doctors recommend certain types of forest food for the treatment and prevention of diseases of the cardiovascular system, gastrointestinal tract, nervous system, kidneys, etc.

A promising area of forest use is the cultivation of forest fruit, berries, ornamental and medicinal plants using the plantation method. This will reduce the cost of creating the necessary infrastructure and increase plant productivity.

4. Conclusion
1) To improve the efficiency of forest use, it is necessary to increase the number of types of forest use by harvesting and collecting non-timber forest products, including resin and forest foods, and by collecting medicinal plants.

2) The use of forests for the proposed types of forest use will increase the proceeds from the sale of additionally harvested resources by more than 10 times per unit of forest area in comparison with the proceeds from the sale of harvested timber.

3) For a more comprehensive use of forests, it is necessary to develop a methodology for assessing stocks of non-timber forest resources, create the necessary infrastructure and eliminate gaps in forest legislation.

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