

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Forestry and Wood Science



**Comparison of Czech and Russian Forest Technology and Processes,
Analysis of Productivity, Efficiency and Progress**

Bachelor Thesis

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BACHELOR THESIS ASSIGNMENT

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Forestry

Comparison of Czech and Russian Forest Technology and Processes, Analysis of productivity, Efficiency and Progress

Objectives of thesis

The objective of this thesis is to analyze and compare difference in forest development between Russia and Czech Republic. During this thesis the forest cover, development, laws, subsidy policies and technology will be compared. The following research will consist of statistical and literary information gathered from present day. The goal of this thesis is to compare the forest productions and mechanisms in each respective country.

Methodology

- 1) This bachelor study will be based on literature research and overview.
- 2) Research on each machine and its impacts on logging, skidding, forwarding, and harvesting processes within the forest will be conducted from its country of origin.

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forest, technology, efficiency, work safety, hygiene

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DVOŘÁK, J., 2005: Analysis of Forest Stands Damages Caused by the Usage of Harvester Technologies in Mountain Areas, Electronic Journal of Polish Agricultural Universities, Vol. 8, Iss. 2.

LUKAČ, T., KOREŇ, J., 2004: Selected Ecological Aspects of Fully Mechanized Logging Technologies and Wood Skidding Utilization in the Thinnigs, Electronic Journal of Polish Agricultural Universities, Vol. 7, Iss. 2., s. 1 – 10.

PURFÜRST, Thomas; ERLER, Jörn. The precision of productivity models for the harvester—do we forget the human factor. In: Precision Forestry in Plantations, Semi-Natural and Natural Forests. Proceedings of the International Precision Forestry Symposium. Stellenbosch University, South Africa. 2006. p. 5-10.

RANTA, P.: Added values of forestry machine simulator-based training. In: International conference on multimedia and ICT education, Lisbon, Portugal. 2009.

SELLGREN, U. et al.: Model-Based Development of machines for sustainable forestry. In 12th European Conference of the ISTVS, 2012.

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Declaration

I hereby declare that I have done this thesis bachelor thesis independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague 13.3.2021

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Mikhail Nizevich

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Abstract

With the industrial revolution of the twentieth century, came many new technologies that have in many ways shaped and successfully formed the world we live in today. It has created efficiency, decreased manual labor, and most importantly gave agriculture and forest management the means of accelerated production all over the world. While analyzing and comparing forest technologies and processes around the world, it becomes evident that while the industrial revolution has had a global impact on forest processing techniques, some countries have proven to have superior production and use of such tools in comparison to other. The aim of this thesis is to highlight the differences in forestry techniques and overall development between Russia and the Czech Republic. Through the research done in each respective country, this work will compare and analyze the history of forest cover, development, safety, and subsidy policies, and finally mechanization tools and work procedures. The comparison of use and success in each country of these tools will be revealed and concluded in this thesis.

Key words: Harvesting, Technology, Russia, Czech Republic, Subsidy, Safety

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1.0 Introduction

Over the last two centuries, forest management around the world has experienced a great deal of improvement regarding mechanized processes and automated tools that were introduced into this field. This can be observed by analyzing the specific impacts which the industrial revolution has had on the production of various forest equipment and consequently the impact which these tools had on forest management. The analysis begins with understanding that prior to the industrial revolution, human beings had very limited means through which they achieved desired results. The achievement of forest logging and harvesting results prior to industrial revolution was attained through hard physical labor and mechanical tools such as the use of animals in combination with simple tools such as the axe, saw, and different handmade cutting devices. While analyzing the impact of the industrial revolution it became evident that it has provided human beings completely new means of managing forest management activities that has decreased the need for physical labor, increased productivity and most importantly gave the means to speed up with the supply and demand needs of the forestry sector around the world.

This impact can be directly correlated through the analysis of development in forestry, mechanization, and work procedures in both countries. By analyzing such metrics and factors in Russia and Czech Republic, one can further deduct how these factors impacted overall forest management and contrast the success of each. It is necessary to first and foremost analyze and compare the general forest cover, development of forest managing mechanisms such as harvesting, safety laws, subsidy policies, and finally mechanization tools and work procedures that have directly contributed to such development.

2.0 Goals Of The Thesis

The objective of this thesis is to analyze and compare various technologies and procedures between Czech and Russian forest management and production. During this thesis general analysis of types of forest grounds (including forest cover, representation of plants, forestry companies and owners), inspection of safety and subsidy policies and finally mechanization and work procedures will be compared between the two countries. The following research will consist of literary analysis gathered from statistical and literary data from both countries. The goal of this thesis is to compare the above-mentioned factors, and their impact on forest management and production in each respective country.

3.0 Methodology

This thesis will be based on literary research and statistical analysis of available resources in both Russia and the Czech Republic. Both methods will be pertained to analyzing forest cover, laws and subsidy policies, machinery, and overall forest management.

4.0 Literary Review

4.1 Forest Cover

Forestry in Russian Federation is one of the oldest sectors in the economy of the country. Even though the country has around 1/5 of the world's reserves of wood, roughly over 20% of the world's forests, the country since the fall of the Soviet Union, has been slow in adapting and reforming the forest sector. At the beginning of 2010 the estimated total area with forests was at 1 183,7 million hectares, from which 1 143,6 million hectares were of forest estate land, which includes forest land that is covered by forest vegetation, forest land not covered by forest vegetation but available for forest regeneration and non-forested land determined for forestry management, 4 745,9 were of defense and security lands, 1 350,4 of urban forest, 26 944,0 of protected forest, 7078,2 of lands of other categories and 4 603,8 forest estate parcels previously owned by agricultural organizations, therefore the area of forested land accounts for 46,6% of the country (FAO, 2012)

More than half of the forests are young forests that have been changed by the anthropogenic effect and less than 15% can be classified as frontier forests. Compared with other similar vegetations zones from the North, Russian zones even at this time have higher proportion of patches close to their natural state, such as the forests in Republic of Karelia (North-West). Unfortunately, the forests from the European part of Russia have the highest rate of anthropogenic disturbances.

Russian forests and forestry activities are concentrated in boreal forests, which cover about 65% of the forest area and grow in a harsh climate, which makes them relatively unproductive, Low marketing of stands and high costs of wood harvesting and transport. As the largest country in the world in terms of land area and its considerable natural and climatic diversity, Russia has an equally significant diversity of forests. The country's forests are unevenly distributed owing to the diversity of climatic zones. Forests grow mainly in areas where the average temperature of the warmest month of the year is not less than 10 C and the humidity is moderate or elevated. The anthropogenic factor is also a key factor, especially the level of development of territory and area like it happened around 150 years ago when forestry management was beginning to grow. The factor of the more ancient development dominates in the Volga Region, North-West part, and the Central part. The average forest cover of the territory

of Russia increases from west to east, reaching the highest levels in Siberia and the Far East. The regions of Russia currently have the highest forest cover in Irkutsk oblast, where it accounts for 82.6 per cent of the territory (69.4 million hectares), as well as in parts of the Perm and Komi Republics, Vologda oblasts, Kostroma oblasts, The smallest in Kalmykia: 0.2 per cent (55,400 hectares), in parts of the Astrakhan and Stavropol regions where steppe predominates, and in the arctic regions of Taimyra, northern Yakutia and Chukotka, where tundra predominates. About 22% of Russia's forests are covered by swamps - mostly low-lying since the upper reaches are less frequently forested (Ministry of industry and Trade, 2018)

When comparing this to forest cover in the Czech Republic, we see some clear differences. The total land area in Czech Republic is 7,728,00(ha) of which the area of forest stands accounts for 2 675 670 (ha), which is approximately 34 % of total land of Czech Republic. The forests of the Czech Republic are amongst the most productive in Europe.

The total area of forest land in Czech Republic has been constantly increasing, mostly after second half of the twentieth century and especially each year since 2016 approximately by 1 809 ha, this is due to afforestation of new land, that exceeds the expanse of transformation of forest land for other purposes and also thanks to improvements in the precision of data in Land Register. The forest area has also been increasing thanks to afforestation of agricultural land, which started after 1966 (Ministry of Agriculture, 2019)

Year	2000	2005	2010	2015	2018	2019
Forest land area	2 637 290	2 647 416	2 657 376	2 668 392	2 673 392	2 675 670

Table 1. Forest Land Area Increase in the Czech Republic (Ministry of Agriculture, 2019)

4.2 Species Composition

Forests in the territory of Russia form four natural zones: wooded tundra, taiga, mixed and broad-leaved forests, and forest steppe. Among forest-forming tree species in Russia, the majority group are coniferous, due to the relatively cold climatic conditions, which are not very favorable for the mass distribution of deciduous species. The warmer-loved hardwoods, except for birches, form mainly in the southern regions of Russia - the Black Sea and the North Caucasus.

Deciduous forests - light coniferous, sometimes mixed forests with predominance in larch stands (*Larix*). The main masses are in Eastern Siberia, Urals, in the mountains of Southern Siberia and Zabaikal, in the Far East, small areas are occupied in the northern European part of Russia. This type of forest account for 278 mln ha. As of 2010 the standing larch species account for 275 785,9 (thousand ha).

Pine forests - light coniferous forest with the dominance of different types of two-wave pine (*Pinus*). They are represented by clear stands as well as mixed with spruce, larch and other coniferous species and broadleaved species as well as, oak, lime, birch, hornet. Widespread in forest and forest steppe areas. This type of forests account for 41 mln ha. Standing pine species account for 120 227.1(thousand ha).

Birch forests - clean and mixed plantations with predominance of birch (*Betula*) occupy the third place in Russia by area (85.5 million ha). They grow in almost all zones, but they predominate in the forest and forest steppe, as well as in the forest belt of mountains. Standing birch trees account for 115 723.5 (thousand ha)

Spruce forests - evergreen dark coniferous forest with predominance of spruce (*Picea abies*) in the wood layer. Spread in Russia from western to eastern borders; total area of about 78 million hectares. In north-western Russia, where wildfires were common, spruce forests were replaced by pine trees, in which spruce is actively being reintroduced. They account for more than 30% of wood production, most of which is used in the pulp and paper industry. Standing spruce species account for 77 660.7 (thousand ha).

Aspen forests- deciduous forests with predominance in of aspen (*Populus tremula*). Formed only on the richest soils in a favorable climate such as Southern Forest Area of European Russia, in the forest steppe, south of Western Siberia. This

type of forest accounts for 18mln ha. Standing poplar species account for 23 739.5 (thousand ha).

Fir forests are dark coniferous, often mixed forests, with a predominance of fir (Abies). Distributed mainly in taiga. Total area in Russia - 15.4 million ha.

Oak forests - plantations with a predominance of oak (Quercus robur). It is found in broad-leaved forests and forest steppes, in the foothills and mountains of the North Caucasus and in the Far East. Oak is most often accompanied by ash, maple, ilm, lime, in the mountains by grab, beech and aspen. Standing oak species account for 6876 (thousand ha). As a summary – coniferous species group account for 68,4 percent, hard-leaved deciduous species account for 12.3 percent and soft-leaved deciduous species account for 19,3 percent.

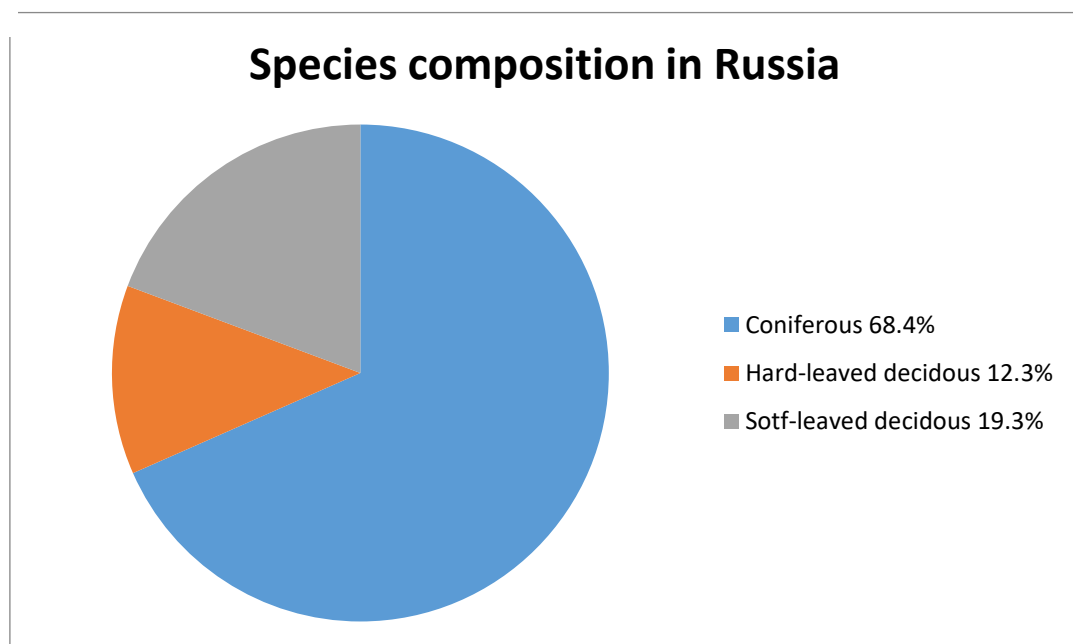


Figure 1. Species composition of Russian Federation (FAO, 2012)

Due to anthropogenic factor in the past, the diversity of the forest in the Czech Republic was altered in favor of coniferous species. Starting in the second half of the 18th century, the forest sector got a concept of high quality timber production, therefore efforts were put to increase timber production, so because of a lack of timber, the mainly deciduous and mixed forests were replace by coniferous monocultures which

consequentially resulted in a higher rate of coniferous species and particularly spruce (*Picea abies*) and also these changes have resulted in a low biodiversity and a low ecological stability of the forest stands, which have led to the devastation of forests by biotic (bark beetles) and abiotic (wind, emissions) factors .The conversion of mixed and deciduous forests by coniferous monocultures have led to loss of habitats of thousands of plant and animal species, some of them today survive only in fragmented areas (Zdenek Postulka, 2008). Also, the widespread coniferous monocultures have led to damage to forest soils by acidification however field experiments have shown that plantation of deciduous species can undo this process. The coniferous species today account for 71% or 1 852 922 ha, while the broadleaved species account for 29%, or 723 146 ha. In the recent years, the total area of conifers is declining while the deciduous area is increasing, due to new policies of forest management and regeneration, which favor more deciduous and non-invasive species. The cover of broadleaves species doubled since last 50 years, even though the representation of native broadleaves species is still insufficient in Czech conditions. This can be observed by looking at the share of broadleaved species in artificial regeneration which have greatly increased, in 2019 it was 51,3 %, which was higher by 6,6% than in 2018 (Ministry of Agriculture, 2019).

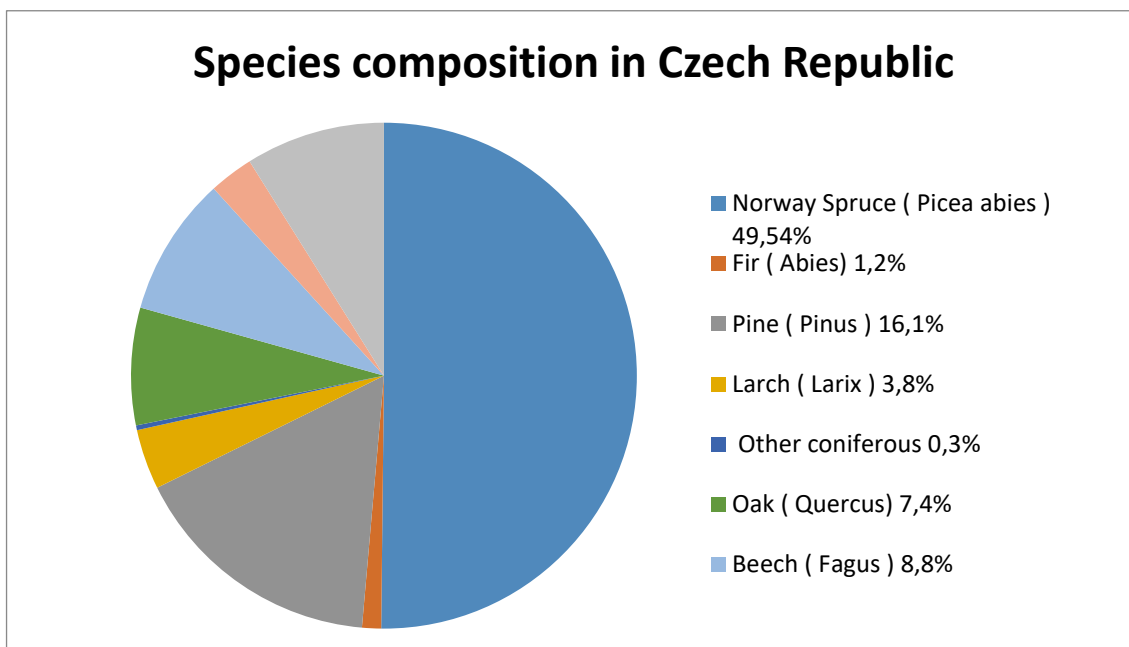


Figure 2. Species Composition in Czech Republic (Ministry of Agriculture, 2019)

4.3 Forest Owners

There is no privately-owned forest in Russia - all forests are state-owned. Companies or individuals are entitled to utilize the forest resources of the State. The Federal Forestry Agency of Russia (Rosleshoz) is a federal executive body administered by the Government of Russia from 2010 to 2012 (until August 2010 by the Ministry of Agriculture). It is responsible for the implementation of State policy, the provision of State services and the management of State property in forestry. Since 2012 it is under the Ministry of Natural Resources and Ecology of the Russian Federation. Its responsibilities are: regulations on the management, sustainability of forest management, the reproduction, conservation and protection of forests, wildlife (excluding those designated as hunting grounds), and the implementation of measures for forest seed production; water reclamation and other forestry activities, sustainable, protective, water-conservation, recreational and other natural benefits of forests, provision of public services related to the provision of information on the state of forest land parcels, selection of forest parcels for permitted forest uses, state forest protection and monitoring of forests, maintenance of the State Forest Register of the Russian Federation and national parks management in Russia (Pisarenko, 2003).

In the Czech Republic on the other hand, there does exist some private ownership even though still a big proportion of the forests are owned by the state. The

ones owned by it account for 54,09%, the forests owned by municipalities own around 17,7% and private owners own around 28,21 %. According to the Act No.289/1995, 76,7% are commercial forests, special purpose forests account for 19,8% and 3,5% are protection forests. Forests which are in the protected areas account for 25,3% of the total forest area, which is roughly 700 000 ha and exceeds the European average. (Ministry of Agriculture, 2019)

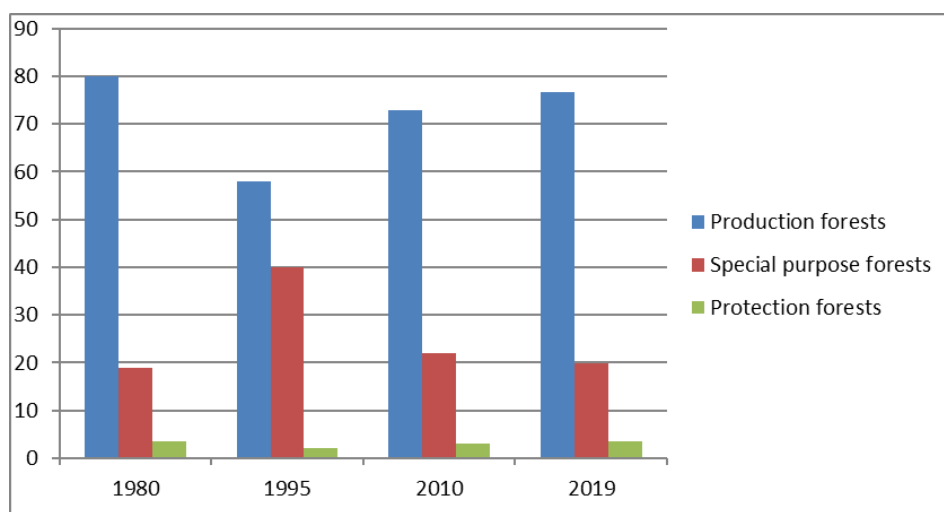


Figure 3. Forest Categories by Their Functions in % (Ministry of Agriculture, 2019)

Ownership	Area of Forest Stands (ha)	Area of Forest Stands (%)
State Forests	1 413 914	54.09
LČR	1 168 796	44.71
Military Forests	123 015	4.71
Ministry of the Environment (National Parks)	95 417	3.65
Regional Forests (secondary schools and other)	2 352	0.09
Other	22 758	0.87
Ministry of the Environment (Nature Conservation Agency of the Czech Republic)	1 575	0.06
Legal Persons	85 523	3.27
Municipal Forests	448 792	17.17
Forests Owned by Churches and Religious entities	130 639	5.00
Forest Cooperatives and Associations	31 051	1.19
Forests Owned by Individuals	503 737	19.27
Other forests (not listed anywhere)	237	0.01
Total	2 613 894	100.00

Table 2. Ownership of Czech Forests (Ministry of Agriculture, 2019)

4.4 Timber

In Russia since 2009, there has been a gradual increase in logging, although current harvests have not reached the level of the 1980s; the use of the allowable cut for all types of logging in recent years is 28.4-30.3%, these ratios are almost invariably present in domestic forests, that is 62-70% of the theoretically possible amount of cutting remains unused.

The gradual recovery of the global economy from the crisis has also had a positive impact on wood production in Russia. According to the data of the website of the Federal State Statistics Service, in 2010 the volume of timber harvested was 112.2 million m³, in 2011 - 120.5 million m³. The imposition of tariffs on roundwood exports, without significant development of the domestic forest-processing sector, coupled with adverse climatic factors, again reduced harvests in 2012. Logging fell below 73 million m³. a year, withdrawing Russia from dozens of the world's leading logging countries. In 2014, it was 203 million m³. Logging in 2016 amounted to 213.8 million cubic meters. It has been increasing annually for the last 5 years. The involvement of wood waste in biofuel production is being intensified. There are some technical and economic problems in involving bio-resources in the forest sector (Korpachev, 2016).

At present, the wood resources that are flooded, floating and scattered on the banks of Russia's reservoirs and rivers are not used and are not involved in production. In the reservoirs of the Siberian hydroelectric power station alone 33.0. million m³. of wood was flooded. The low use of the allowable sawing, unused wood waste from logging, flooded wood resources in the rivers and reservoirs of the hydroelectric power station, competition in the external market have made the Russian forest complex work at a loss (Korpachev, 2016).

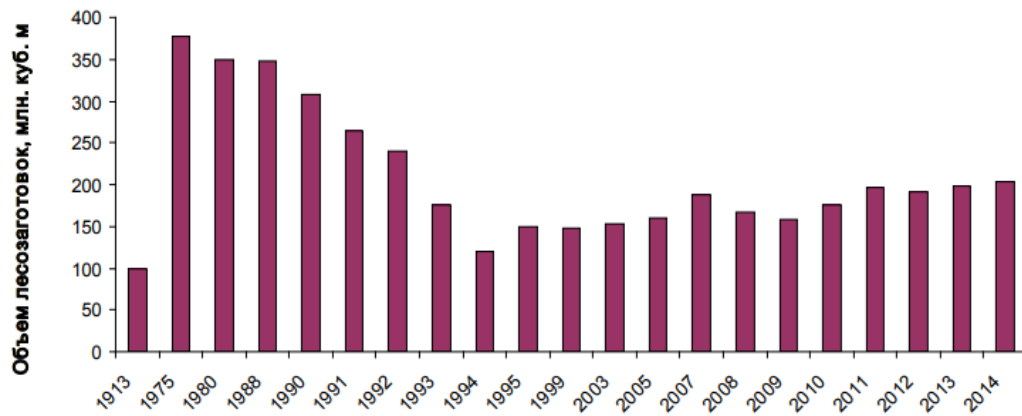


Figure 4. Amount of Timber Harvested in mil.m3 (Korpachev, 2016)

About 81% of wood in the country is harvested by forest leaseholders for different uses of forests. Logging on leased plots increases annually, but on average does not exceed 67% of the amount specified in leases. More than 5,700 legal entities and individual entrepreneurs carry out the work on leasehold rights. The largest number of businesses are in the Volga Federal District (about 1,400), and the smallest (less than 500) in the Far Eastern Federal District. The overwhelming number of market participants, around 4,200 refers to small business with annual production up to 20,000 cubic meters, enterprises that deal with medium amounts are around 1200, therefore small and medium-sized firms account for 48 per cent of the output. There are large companies (around 261) with annual production of 100,000 to 500,000 cubic metres (Ministry of Industry and Trade, 2018).

Forest leaseholders are responsible for most forestry activities. Every year a set of activities is carried out on leased forest plots for forest management, forest conservation, protection and regeneration, seed and planting, inventory and reforestation for a total amount of 12.9 billion RUB (equivalent for 3 724 531 795,50 CZK).

The total amount of raw harvested timber in Czech Republic have been exponentially increasing since 2000's. in 2019 was 32.58 million m³, which compared with the previous year was more with 6,89 million m³, This was thanks to salvage cutting which in 2019 with its share of 95% contributed to this volume and totaled 31.31 million m³. On the amount of timber harvested by species, conifers species accounted for 31.31 million m³ and broadleaves species accounted for 1.27 million m³. The utilization of raw wood material in processing industry and recycling of wood products is very low. A lot of harvested timber, more than half, is exported raw or as semi-products, mostly because of participation of strong foreign capital on wood and semi-products with big proportion of raw material and low proportion of value added by processing (Krejzar, 2009).

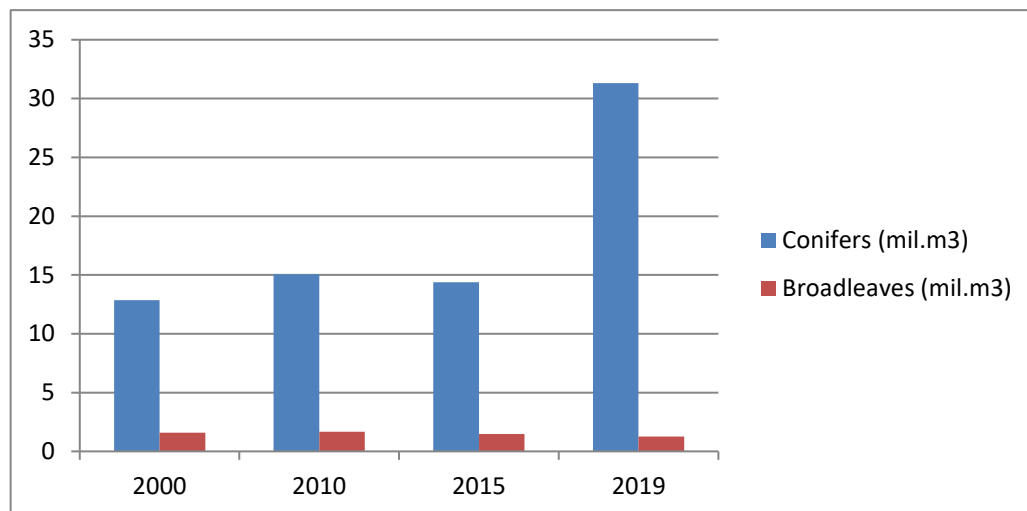


Table 3. Share of conifers and deciduous species in timber harvesting mil.m³
(National Forest Programme, 2009)

Starting with 1930's, the volume of growing stock has been exponentially increasing, in 1930 it was 307 million m³, in 1980 – 536 million m³, in 2006 it reached 668 million m³, so the total growing stock has more than doubled. It continued to extend in 2019, where it reached 704,9 million m³ even though there was a decrease that was caused by the salvage cutting in 2019. This was also due to an increase in stand stocking and an increase in percentage of older stands, although not all of the stock has same availability for felling , as in examples with special purpose and protection forests,

because no felling operations are allowed in nature reserves, forests with high protection etc (Krejzar, 2009)

4.5 Forest Workers

In Russia, the forest sector of the economy is traditional, generates substantial revenue to the State treasury, and in 40 constituent entities of the Russian Federation it has become the main economic activity. More than 30,000 enterprises and organizations are engaged in industrial logging, wood processing and trade in wood-based products. About 9500 forestry enterprises are operating in the country's forestry management system. However, the number of forest owners is low. The timber industry and forestry account for 7.4% of the country's total working population. A. In general, about 5 million people depend directly and indirectly on the forest sector in Russia.

At present, workers in the forest, pulp and wood processing and forestry industries are organized by the Russian Federation Forest Workers' Union. This is one of the oldest voluntary organizations of employees in Russia established in 1905. The Union carries out its activities in 66 constituent entities of the Russian Federation. It has approximately 1,360,000 members and more than 3,050 primary organizations. According to Russian legislation, the Trade Union of Forest Workers is registered with the Ministry of Justice of the Russian Federation. (Polyakov, 2003)

Today, there are many technical, economic, and social problems in cellulose, wood and forestry industries. In the timber industry, average wages are 33.4 per cent lower than in the Russian industry as a whole and several times lower than in the extractive industries. In forestry, wage problems are much more acute. Foresters continue to have the lowest wages in the country. The average wage is 36 per cent lower than the average in the Russian Federation and barely exceeds the subsistence level. The point is that the employer, in accordance with the position of the State, does not want to set the guaranteed wage, which is the minimum tariff at this level. By taking advantage of the gaps in the legislation, it is advantageous for him to make the remuneration of workers as dependent as much as possible on the results of the work of the enterprise by establishing numerous bonuses. As a result, the guaranteed wage is only 20-30%, and it must be at least 60% of the wage (Musin, 2011)

Employment in forestry is facing a lot of changes in the recent time, the number of workers in forestry is decreasing but the demand for forest workers is increasing, especially there is demand for more temporary workers for such tasks as redevelopment work and planting. The average number of registered employees in the Czech Republic in the last five years have not changed that much, but this doesn't correspond to the amount of work for remediation of calamity wood. In 2018 there was a small increase in the number of workers to 13,386 that was result of remediation of bark beetle calamity. In 2019 the number was increased by a few hundred employees and additional staff from other countries that was employed for cultivating and forestry. But this was just a superficial increase because after the bark crisis the number of workers dropped again, while having the demand for 4000 or 6000 more workers. On average, since 2000's there was a decrease by 1000 workers each year. Low-average wages have discouraged the interest in forestry work, the average crude wage in forestry was 28,858 CZK and even though there was an increase in the average crude nominal wages in forest sector in the last 5 years it is still lower than the average nominal wage, which is 34,263 CZK. The decrease in the number of workers is not just an economic problem but also a social and environmental one (Toth, 2019).

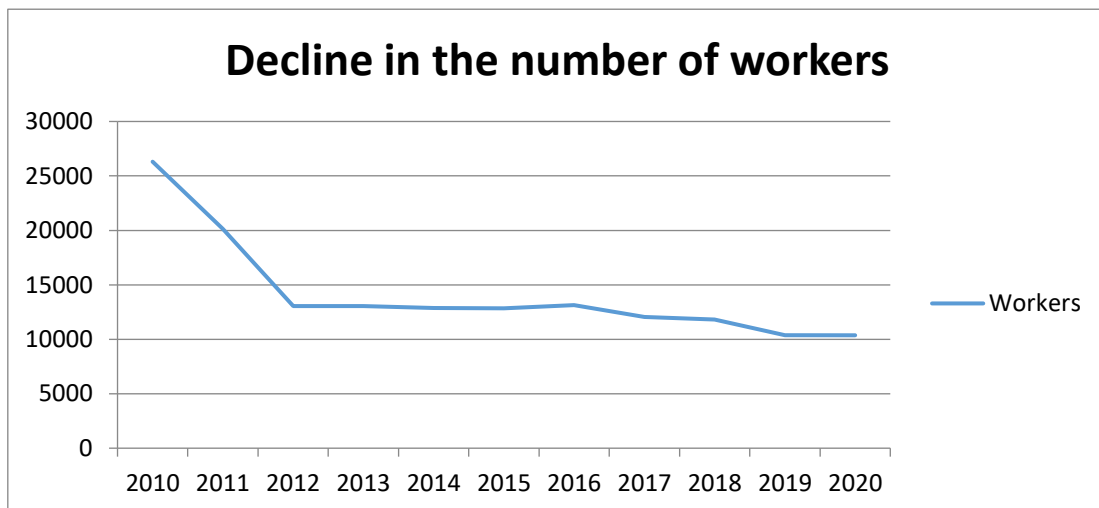


Figure 5. Decline of the Number of Workers in the Czech Republic (Toth, 2019)

4.6 Laws

The Forest Code of the Russian Federation defined the legislative basis for the forest management. The Forest Code of the Russian Federation adopted at the beginning of 1997 established the State's right to ownership of all forests in Russian Federation and as the owner of them it is the State's responsibility for organizing the management of the forests.

The foundations of such forest management are laid in these national documents: The Constitution of the Russian Federation, the Forestry Code of the Russian Federation, and the Concepts of sustainable management of Russian forests. The Constitution of Russian Federation article 58, The State Duma and the Council of the Federation have set the priorities of the State in the field of forest management by entrusting specially authorized federal authorities with the exercise of forest ownership functions. The article 72 of the Constitution of the Russian Federation authorizes the political basis of federal relations in the management of natural resources (Pisarenko, 2003).

The concept of sustainable forest management in Russia, developed and approved by the former Rossleshoz, has defined priorities for the planning and activities of forest management bodies in accordance with the Constitution and the Forestry Code of the Russian Federation. After the liquidation of Rossleshoz and the transfer of the functions of forest management to the Ministry of Natural Resources of the Russian Federation, the Russian Federation Forestry Development Plan for 2003-2010 was developed, in accordance with Government's law from 18'th of January 2003 № 69.

Criteria and indicators for sustainable forest management adopted in early 1998 by Rosselhoz provide a realistic assessment of the country's progress towards sustainable forest management. The Forest Certification Scheme includes regulations, rules and standards governing forest management and extraction. It was completed in 1998 and should have been operational since 1999. Unfortunately, it has not yet been approved (Pisarenko, 2003).

In the Czech Republic, the Ministry of Agriculture is the central authority body that is responsible for the overseeing forest management. It supervises the decisions that are taken by the District Authorities and inspects their state administration in forestry.

Currently Regional Authorities are created as the first level of state administrative organization. The Ministry of Environment is the central body of the state that is responsible for forest administration, game management and fisheries within the national parks. The National State-Supervision body and the Czech Environmental Inspection Agency have responsibilities concerning just inspection and are both subordinated to the Ministry of Environment (Pacourek, 2003).

The forests that are in the military areas are responsibility of Ministry of Defense (Postulka, 2008).

The main legal documents concerning biodiversity in forests are:

- The Forest Act No. 289/1995
- The Nature Protection and Landscape Preservation Act No.114/1992
- The Game Management Act No. 449/2001
- Government directives and regulations regarding the execution of these laws.

4.7 Injuries

The working conditions of forest workers are strongly influenced by natural and climatic factors: low winter temperatures, especially when combined with wind, and high summer temperatures, often without wind, with intense solar insolation; duration of winter and depth of snow cover; thaw and intense precipitation (wet snow and rain in winter), rain in summer-autumn period; mountainous terrain; big size of some specific species of trees, During the spring and the first summer months, forest workers are often bitten by ticks, and during the summer, by gnats, mosquitoes, flies.

Occupational disease rate by 10,000 workers for forestry workers in 2004-2008 was significantly higher than the Russian average. Diseases caused by physical factors predominated 64.6%, with physical overload and stress on individual organs and systems (24.6%) and biological factors 8.7%. Diseases caused by exposure to physical factors were represented by vibration disease, which accounted for 56.8%. The second rank was professional pathology related to loss of hearing (neurosensory silence) - 24.5%. Mono-polyneuropathy, a pathology related to heavy physical labor was 18.7%.

The main conditions the development of these diseases were structural deficiencies in the means of work, defective working methods and imperfections in the workplaces. There are deficiencies in the sector regarding periodic medical

examinations of workers. Diseases from the biological factor were represented by three nosological forms: tick encephalitis, echinococcosis, and brucellosis.

Thus, occupational diseases among forest workers are generally unfavorable. Sanitary and epidemiological regulations are not complied with. Employers in general need to strengthen the monitoring and supervision of the working conditions of forest workers and medical specialists should take over the occupational diseases of forest workers (Stepanov, 2010).

4.8 Subsidy Policy

The basis of the State policy on the use, protection, protection and reproduction of forests up to 2030 was approved by the Order of the Government of the Russian Federation of 26 September 2013 under the name "Forestry development" 2013-2020".

The objective of the programme is to improve the use, conservation, protection, and reproduction of forests. To ensure that the public needs for forest resources and services are met in a sustainable manner, while preserving the environmental and resource potential and global functions of forests.

The total budget allocation is 522.8 billion rubles (156 060 944 352,00 CZK) from which 261,9 billion (78 172 211 613,60 CZK) is from Federal Budget, 67,2 billion rubles (20 050 531 200,00 CZK) are from Budget of subjects of Russian Federation and 193,7 billion rubles (57 819 780 064,80 CZK) are from extrabudgetary sources.

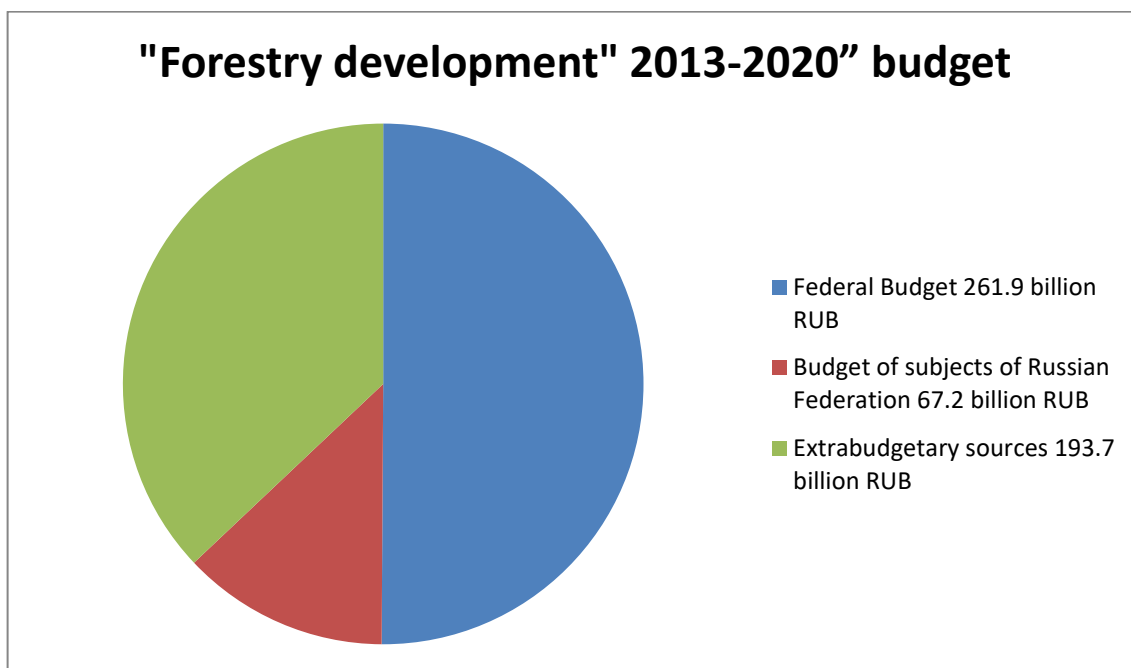


Figure 6. Budget use for Forestry Development 2013-2020 (FAO, 2012)

The four sub-programs of "Forestry development" 2013-2020" are as follow:

1. Protection and preservation of forests - Reduction of forest losses from fires, harmful organisms, and illegal logging. Development of a system and means of fire safety in forests; Prevention of the occurrence and spread of forest fires; Extinguishing forest fires; Prevention, containment, and elimination of hotbeds of harmful organisms
2. Sustainable management of the forests - Enable the sustainable and intensive use of forests, while maintaining their ecological functions and biological diversity, and improve the monitoring of forest use and reproduction
3. Forest restoration - Balance deforestation and reforestation, increase forest productivity and quality. Establishment and operation of a single genetic breeding complex; Reforestation and forest care
4. Ensuring the implementation of the State programme - Research and analytical support for the State programme. Forecasting and strategic planning of forest management; Scientific and analytical support for the implementation of the

State programme; Training, retraining of forestry personnel; Support for the performance of State functions by Rosselhoz (Government programme, 2019)

The grant policy of the forestry sector in Czech Republic is splintered in various providers and is subsidized from a lot of different sources, therefore forest owners in different parts of the country are evaluated from different subsidy policies. Support from the state in the form of subsidies which are granted for selected game management and forest management activities are provided under the Government decree No.30/2014, which determine the rules for granting subsidies from the state budget. This form of subsidies is given to forest owners (persons that have the rights and obligations of forest owners established by the Forest act) and users or owners of hunting grounds. From the budget of Ministry of Agriculture in 2019 subsidies for these kind of activities have been given : regeneration of forests affected by air pollution – 16,8 million CZK , regeneration establishment and tending of stands until 40 years of the stands- 545,4 million CZK , green and environmentally friendly technologies- 92,4 million CZK, subsidies to users of hunting ground- 36,2 million CZK, elaboration of forest management plans- 23,2 million CZK, forest protection- 17,5 million CZK, breeding and training of national hunting dog breeds and hunting birds of prey- 2,6 million CZK, numbering in total 734,1 million CZK. (Ministry of Agriculture, 2019). In 2019, Czech Republic have allocated around 263,5 million CZK under obligations that are determined by the Forest Act. (Ministry of Agriculture, 2019)

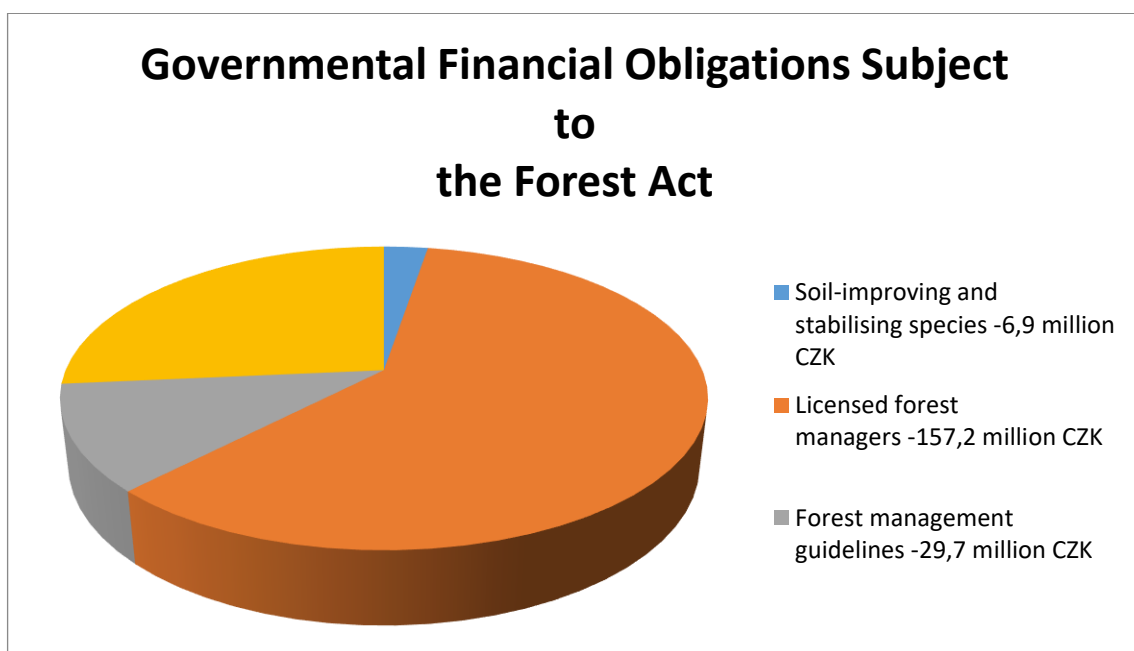


Figure 7. Governmental Financial Obligations based by activities in CZK
(Ministry of Agriculture, 2019)

4.9 Forest Machinery

The problems of logging and logging machinery are becoming more and more urgent in Russia. It is also undeniable that logging equipment and machinery, a fundamental sector of the forest business, should be modern, high-quality, reliable, and accessible to the domestic market, because the future of the whole timber industry depends on it. In Russia, the practice of using a limited nomenclature and specialized track-type tractors for wood continues. The main advantage of domestic technology is a relatively low price. The demand for foreign-made machinery is determined by a wide range of special wheeled and universal tracked tractors and machines with different consumer and functional capabilities. Individual Russian producers use foreign technologies, individual aggregates, and components. The quality of such machinery and equipment becomes comparable to the quality of foreign, and the price is 20-30% lower than the price of imported analogues. The growing interest of the State in the forestry sector and the development of a strategy for the development of the sector up to 2020 are extremely positive factors that demonstrate the State's desire not only to optimize the production and processing of timber, but also create conditions for the development of domestic industry for the development of domestic industry to meet the growing demand for machinery and equipment. The size and conditions Russia's forest-based territories impose special requirements for technology and, together with the conditions of regional forest-based enterprises, determine the market situation. Domestic producers and importers of specialized and universal logging equipment are fiercely competing in the market. There has been a marked increase in the number of logging tractors and machines in the world in recent times, with a wide variety of types and models. By 2010, foreign firms and factories of the CIS countries (Russia, Belarus, Ukraine) had offered around 300 models of logging tractors and machines, of which 67 skidders, 114 harvesters and 83 forward models and others. The leading positions in the timber tractor and machine market are held by three leading firms, which determine the technical level and policy in this area of engineering: John Deere, Caterpillar and Tigercat. In recent years, the Russian market has seen an increase in the number of

small European manufacturers of wheeled equipment for tree-length and sorting technologies. Russian enterprises today offer 32 models of tractors and machines weighing from 11,2 to 24,6 t, with engines ranging from 88kW to 125 kW, including 5 wheeled chassis models. Of these, 8 are for sorting technology. The production of logging machines OOO «Kovrovsky excavator factory» ceased and it got replaced by ZAO «Transport» (N. Novgorod), specializing on production of 2 models of harvesters on excavator base and forwarder on chassis 8x8. The largest increase remains for tractors and heavy-duty vehicles, which account for 62 per cent of the total number of models. There has been a twofold increase in the number of foreign-made harvesters created on a tracked excavator base in the recent period. This is due to the fact that the forest resource base of the most developed countries (USA, Canada, South America, Russia) is concentrated in areas with heavy natural production conditions - rocky soil, wetlands, rugged terrain with high gradients, climatic conditions where snow can cover up to 1.5 m. Their development requires the use of tractors and vehicles on track chassis. The most common models in this line are tracked and wheeled chassis skidders with a mass exceeding 15 tonnes, harvesters on track-chassis with mass between 20-30 tonnes, and and wheeled chassis with mass between 14-20 tonnes, forwarders on wheeled chassis 6x6/ 8x8 weighing 15-20 tonnes and carrying capacity 14-18 tonnes. It should be noted that the improvement of logging equipment continues. Their operational quality is improved by optimizing the parameters of basic tractors, machines, and wood-processing equipment, and they are equipped with engines of a wide range of power. This expands the range of applications for different sizes of wood harvesting conditions and technologies. Technologically necessary logging equipment systems should be identified with the main objectives: assessment of the saturation of the timber industry in developed countries and Russia with mobile machinery, taking into account trends over the last 10 years, forecast for nomenclature and equipment purchases; developing recommendations for the development and application of a range of machinery and wood-processing equipment in terms of mass-capacity and mass-geometry, considering the conditions of the logging areas. Domestic producers of logging equipment are countered by fierce competition from companies in advanced countries, which forces domestic enterprises to follow world technology trends

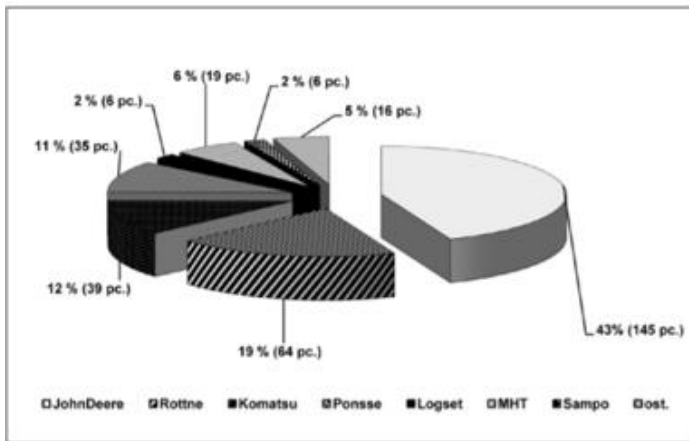
Parameters	Power range, kW			
	<80	80-120	120-160	> 160
Skidders				
Number of models	3	15	3	3
Power range, kW	60...77	88...109	130...132	173...184
Mass, tonnes	5...12	11,2...16,8	10,4...14,5	10,4...19,0
Volume of timber, m ³	4...5	7...14	6...7	6...7
Harvesters				
Number of models	–	15	4	1
Power range, kW	–	88...114	125...154	205
Mass, tonnes	–	11,0...21,7	17,7...24,8	18
Diameter of tree cut (processed), cm	–	35...100	63...90	63,5
Forwarders				
Number of models	3	5	3	1
Power range, kW	60...77	88...100	132...154	169
Mass, tonnes	7,8...10,3	14,5...18,4	15,7...17,0	17,5
Load capacity, tonnes	5...9	10...11	14...15	14

Table 4: Classification of Wood Harvesting Machinery in CIS Factories (Strelstov, 2010)

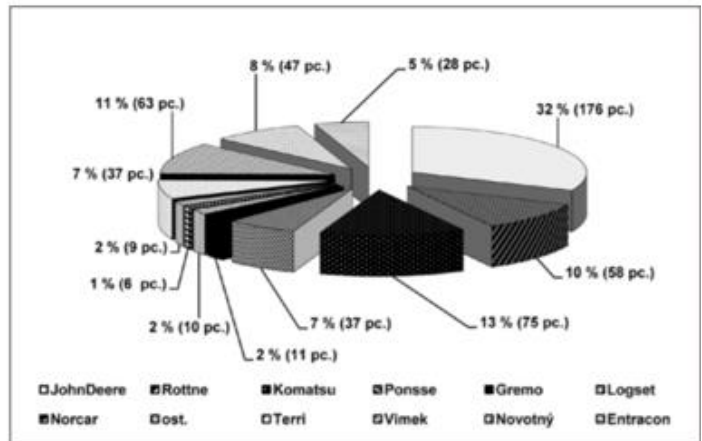
In the Czech Republic, starting with second half of 1980's new generations of harvesters started to appear in Czechoslovakia such as single-grip harvesters etc. In some situations, some technologies in the Czechoslovakia got along without harvesters, using only forwarders, Zbiroh Forest Enterprise for example utilized Norcar 490 which replaced Volvo BM 462 (Dvorak, 2017). These technologies were based on cut-to-length method with motor manual felling and forwarding the timber. This rather laborious, yet harmless method had its significance in young and malleable stands.

With the beginning of 1990's there has been a lot of development regarding the more modern cut-to-length method, as well as an increase in the number of harvesters in forestry in Czechoslovakia. In the present day 25-30% of harvester technologies are used in forest harvesting. The most popular brands now are: John Deere, Rottne and Komatsu. Figure 10 clearly shows which harvesters and forwarders were used most

often in the forest management of the Czech Republic, a study that was provided by the Ministry of Agriculture in 2010.



*The use of harvesters in the CR forest management
(Source: Ministry of Agriculture, 2010)*



*The use of forwarders in the CR forest management
(Source: Ministry of Agriculture, 2010)*

Figure 8. Use of Harvester and Forwarders in CR Forest Management (source: Ministry of Agriculture, Dvorak, 2017)

The change in logging methods led to the discovery of the first advantages and disadvantages of harvester technologies (Dvorak, 2017). The assortments were produced at the stump. Another advantage consisted in a lower capacity of log conversion depots and in the saving of work up to 70.5 % as opposed to manual technology, and fast and easy transfer of technological units. On the other hand, the deployment of harvester technologies has led to the increase in production costs about 35.5 % and to the impossibility to perform quality handling and required sorting.

In a more present context Czech forestry has seen a lot growth and changes in multi-operational harvest technologies. Therefore, there has been a reduced number of unskilled workers in forest operations as well as a deficit of qualified specialists in harvest operation, although the use of modern technologies increased a lot the growing productivity of work. The development of domestic production of tractors (Zetor, Škoda - Heavy Engineering Works) and trucks (Praga, Tatra, Škoda, Liaz, Avia), as well as the scientific research and production base of the forestry sector, had a significant impact on the nature and pace of mechanization of forestry. The growth of

harvester technologies in logging resulted in a 25-30% share in annual volume of logged timber and the volume could be increased if harvester technology would be deployed on a bigger area of forest estates, however there are a lot of unknown factors that currently are making this impossible (Dvorak, 2017). Table 3 represents harvester technologies in the Czech Republic based on forest owner and shows the total harvested amount volume in relation to the harvester technology that was used.

Subjects	Total Harvested Volume (thous. M3)	Harvester Technology (volume)	Share (%)
Forests of the CR, State Enterprise CR	7,867	2,705	34
Military Forests and Estates CR, State Enterprise	882	351	40
Lany Forest Administration	23	21	91
National Parks	444	279	63
Private Forests	3793	163	4
Forests belonging to townships	2,493	234	9
Total	15,502	3,753	25

Table 5: Classification of Total Harvested Volume Amount in Relation to Technology

Source: Ministry of Agriculture, Dvorak, 2017

When it comes to Slovakia, which separated because of the separation of Czechoslovakian state in the early 90's the development was not as progressive as it was in Czech Republic. According to Dvorak, motor-manual technologies dominated over automated ones. With time however this began to change when in the late 90s the LKT 90H and LKT 120T-H harvesters were constructed (Dvorak, 2017). The situation began to change rapidly since 2004 which resulted in harvester technology becoming

more popular with each year (Dvorak, 2017). Currently there are 7 harvester machines working in Slovakia. Up to this day the major owners of the forests located in Slovakia is the Czech Republic. Even though Czech Republic had a period of stagnation in regard to forestry, mostly forest equipment etc. Most of it was because of the political regime at the time and the lack of scientific – now it's a forerunner and example of how forest machinery should be handled, thanks to how fast and adaptable was the so called "Czech school" of forestry, which is a purely Czech way of combining forest mechanization with biological-based forestry also backed up by investments in this sector, also as a key factor is the implementation of technologies and policies used by forest-dominated countries such as Finland, Norway or Sweden and also the usage of modern brand of harvesters such as John Deere or Komatsu. The work that is done by machinery such as harvesters and forwarders have a high performance thanks to high technical-organizational requirements (Dvorak, 2017).

5.0 Discussion

There hasn't been always information and research related to specifics, efficiency and development of forestry mechanization in Russian Federation as compared to that of Czech Republic because of factors that were mentioned earlier such as : the size of the country is too large to have an unified information in regards to the number of the machines used, efficiency and progress of these specialized machines and that's why the part of the thesis about the Czech Republic was much easier in comparison to the Russian part, where a lot more information had to be gathered in order to present a more-or-less unified picture of the situation.

Based on the results that have been gathered there can be seen a lot of differences in regards to : age of the specialized machines that are used in both countries in their current state, with Russian Federation having a large number of old machines that have to be replaced and thus contribute negatively to the efficiency of their work while Czech Republic maintains more-or-less new machines which contributes positively to the efficiency factor; the use of high performance machines, obviously Czech Republic uses a lot more high performance brands such as Komatsu, John Deere etc. which positively affects the potential of the forestry mechanization, while Russian Federation's forest mechanization park features a majority of national-produced machines, and even though the new ones produced have characteristics at the same or below level as their foreign counterparts, the characteristics of the old ones are without any doubt far inferior and thus contribute negatively to the over-all efficiency; the maintenance of the specialized machines, Czech Republic's operators are usually more qualified than their Russian counterparts because of better training and education, which means that the machines are being handled better and thus are degrading at a lower pace than the Russian ones, the repair of the forestry machines in Russia require a lot more attention and time because its park of machines is so diverse that not always all the components are interchangeable, especially in regions with more foreign machineries a full-repair is not always an option because of lack of alloys that are used in some specific parts of these machines, such as molybdenum which is not manufactured in Russia.

6.0 Conclusion

Forest management around the world was heavily progressed thanks to industrialization that was seen during the beginning of the twentieth century. Thanks to this we have been able to see that many countries have gained the possibility to increase efficiency and overall management of forestry methods around the world. Some countries, in this specific case the Soviet Union have proven to have engaged more rapidly in such development due to a variety of reasons. While this research has highlighted that the USSR was more technologically advanced than Czechoslovakia until a certain point in time, later research shows that Czechoslovakia was able to efficiently catch up to this progress and further surpass it in modern day Czech Republic. Globalization has further allowed for countries to start sharing resources, which has also contributed to the rapid development. While there have been many positive impacts of industrialization on forest management processes, we see that there have also arisen aspects of other questions with it. More specifically it has required people within the industry to invest more financial means into modern technology, along with careful planning and engineering of such processes in order to attain the best result. Today, the Czech Republic has most definitely surpassed modern day Russia in forest management. As mentioned previously, due to several various factors such as the countries geographical and demographical positioning. It becomes evident that while the Soviet Union and afterwards Russian Federation did indeed focus on domestic production due to its political situation, that in the end, Czechoslovakia and modern-day Czech Republic have benefited heavily from beginning to engage with international production. When speaking about the efficiency of the forestry logging equipment it can be said conclusively that Czech Republic, has a better park of forestry machinery, more precisely – a lot of machines are new or relatively new, most of the operators are highly trained specialists, the brands of specialized machines that Czech Republic uses are among the top brands used in modern-day forestry such as John Deer, Komatsu. Russian Federation on the other hand, even though it benefitted at the beginning with a greater park of machines left-over from the Soviet Union, now is experiencing difficulties in this domain because most of the machines are older than 20-30 years which means that they are breaking more often and are not working at full performance as they did back in the days, a lot of the factories that flourished during the Soviet Union and made a lot of specialist forestry machines such as forwarders, skidders etc.

have either stopped their existence due to collapse of the Soviet Union (or subsequently got bankrupted after the 1990's) or are producing a lot smaller quantity of the machines. The quality and the performance of such machines still cannot compete with foreign brands, which is why even though small – but there is a trend of adding foreign machines to the existing park in the last couple of years. Russian forestry is more and more interested in foreign brands even though before its main attention was on either domestic or Community of Independent States products, now it is focusing more on foreign brands, based on the performance of such equipment. Such trend of course leads not only to positive but negative factors as well, one of it being the lack of the coating materials in the domestic engineering such as molybdenum and titanium which is used in the foreign machines, meaning that a lot more resources will be spent on maintaining and repairing such machines, which in the long-term means that domestic producers will be facing a lot more fierce competition in which not all of them will be able to compete. Another problem related to the repair of foreign machines is that refurbishment of such parts is not possible in the field and without special training and equipment but must take place in repair plants. This requires the selection of appropriate. modern materials and equipment as well as the training personnel in repair plants. Also the renovation the domest park of forestry machines is happening in different parts of Russia with different speed, being such a big country it means that not all parts of Russia can benefit from this renovation equally, an example being Karelia which because of its geographical closeness with Finland, Sweden and Norway, countries which are leading in the forestry world, receives a lot more attention, cooperation and investments than Far-East district for example which is closer to China, which fortifies again the geographical issue that Russia has. It can be concluded then that in different parts of Russian Federation there are different indicators of efficiency and productivity.

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