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РЕСПУБЛИКИ КАЗАХСТАН

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KAZAKHSTAN DANDELION TARAXACUM KOK-SAGHYZ – AN ALTERNATIVE SOURCE OF NATURAL RUBBER (TARAXACUM KOK-SAGHYZ L.E. RODIN)

Abstract. This article contains general information about the natural rubber production in the world and the search for new alternative sources, and about recent studies of the properties of dandelion Taraxacum Kok-Saghyz. The authors present an overview of various methods and technologies for the creation of high-yielding varieties and obtaining natural rubber and sugar from dandelion Taraxacum Kok-Saghyz in the framework of research projects in Europe. This article also contains the biological features and botanical description of dandelion Taraxacum Kok-Saghyz. The expected increase in prices of natural rubber and lack of raw materials in the coming years have convinced of the need for urgent revival of the production of natural rubber from Kok-Saghyz in Kazakhstan, which has all the necessary prerequisites. For sowing in Kazakhstan, KeyGene AgroBusiness Park has provided special varieties of Taraxacum Kok-Saghyz with properties that allow getting from 0.7 ton to 1 ton of latex from 1 ha of crops.

Keywords: natural rubber, dandelion Taraxacum Kok-Saghyz, research, production of rubber.

Introduction. Natural rubber (NR) is a raw material that is widely used in the manufacturing industry, medicine, transportation, aviation, defense, and at home. Nowadays, the main source of natural rubber in the world is the rubber tree Hevea (Hevea brasiliensis), which grows in industrial plantations of South East Asia. The quality of NR is significantly high in comparison with the synthetic substitute, and it is indispensable in tire production. Technology of cultivation of NR sources is friendly to the environment and safe for humans. Obtaining of NR from Hevea relies on heavy manual labor, which cannot be mechanized due to the nature of the tree, while processing and extracting of NR Kok Saghyz can be readily automated.

One of the objective of the Concept of Innovative Development of the Republic of Kazakhstan by 2020, approved by the Decree of the President of the Republic of Kazakhstan dated June 4, 2013 № 579 is "The use of the raw materials potential of the country for expansion of cooperation with foreign investors and companies on attracting advanced technologies and creation of high-tech industries". The development of national innovation is expected to make the most decisive contribution to the development of Kazakhstan.

The solution of many problems of Kazakhstan's economy could be the production of NR in Kazakhstan from its own endemic, listed in the Red Book of Kazakhstan, dandelion Taraxacum Kok Saghyz. Modern studies show that within 5-6 years from the first crop of high-grade seeds of Taraxacum Kok Saghyz on an area of 50 hectares followed by gradual increase to 50 thousand hectares, Kazakhstan could meet the needs of the internal market in natural rubber and within the following 2-3 years could enter the world markets with their domestic products. This process is not easy, requiring internal and external investments, not only in terms of funding but also in terms of knowledge and experience. Nevertheless, this process is quite reliable and promising.

Evaluation of the world production of natural rubber. According to the forecasts of the International group for the study of the rubber market, IRSG (International Rubber Study Group) [1], in the next 10 years, the growth in demand for natural rubber will be 3.7% per year, reaching 15.4 million tons by 2020. China will remain being the main consumer, with projected cumulative annual growth rate for natural rubber consumption of 6.1%.

Analysis of the price for natural rubber on the Tokyo Stock Exchange for July 2016 (Fig. 1) shows a steady growth. The sale volume of NR on the Tokyo Stock Exchange since 2012 remains consistently low and continues to decline due to the decrease in the number of delivered natural rubber in Southeast Asia (Fig. 2). This did not change in the first half of 2016. The short increase in sales volumes of natural rubber in the world markets in March and April to July 2016 has decreased significantly, which made inevitable impact on the growth of prices for one ton of natural rubber, mostly supplied from South East Asia (Fig. 3).

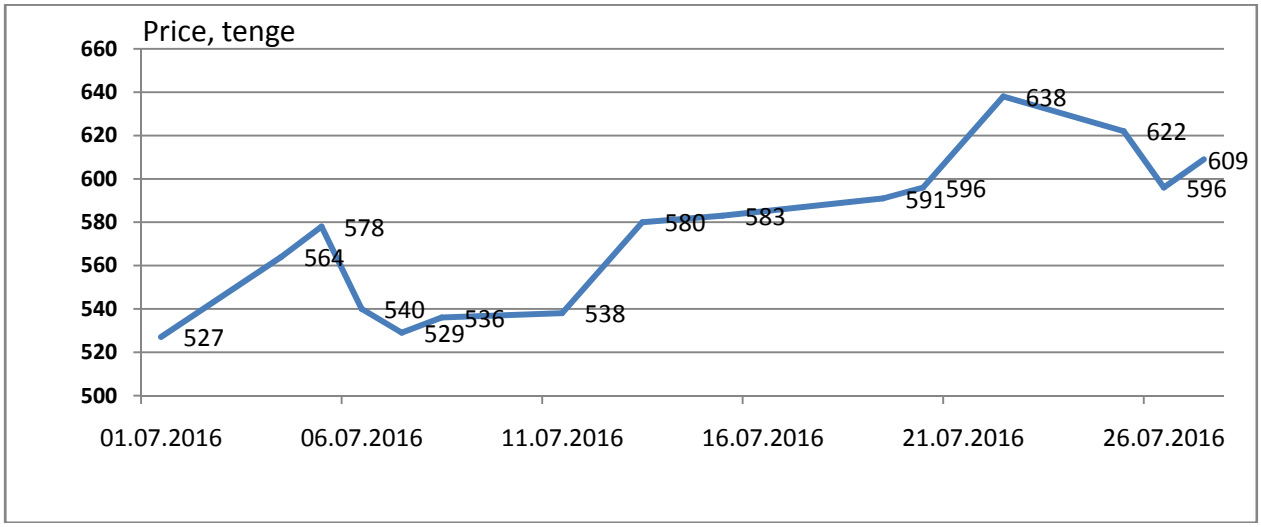

Figure 1 - Diagram of rising prices for natural rubber on the Tokyo Stock Exchange for July 2016

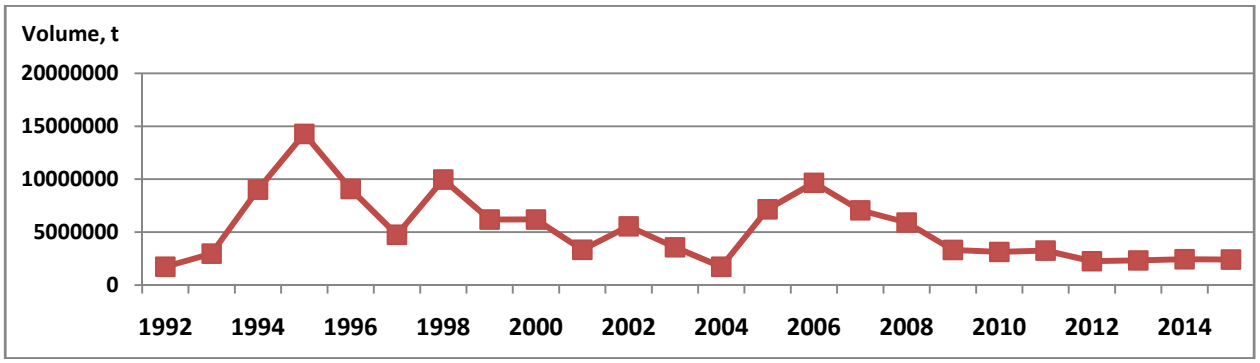

Figure 2 - The volume of worldwide sales of natural rubber according to the Tokyo Stock Exchange for 1992-2015

According to the Association of Natural Rubber producing countries (Southeast Asia) [1], accounting for 92% of the total world production of natural rubber from Hevea Brasiliensis, the deficit of global rubber supply may persist until 2018. In addition, with the emergence of new dangerous diseases and pests, adverse climate changes, limited land resources, impossibility to mechanize the process of collecting and extraction of rubber, high human factor, long period of trees' maturing (6-8 years), etc., it is unlikely that the region and the main source of obtaining natural rubber from Hevea will be able to provide the world needs in natural rubber. In addition, the three largest producers of natural rubber – Thailand, Indonesia and Malaysia, whose combined share accounts for up to 70% of the world production of this material, plan to cut down old trees on the area of 100 000 hectares. According to the International Council of the tripartite rubber (ITRC), this will reduce the market supply to 450 000 tons per year.

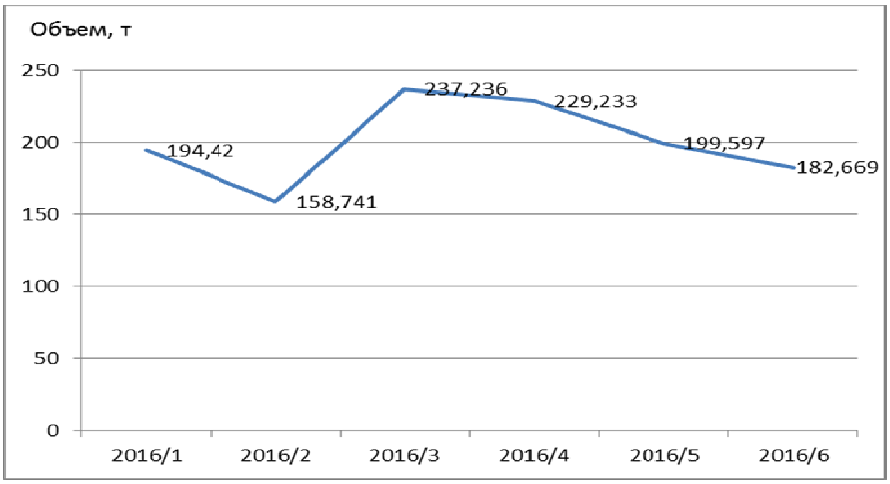

Figure 3 - The volume of worldwide sales of natural rubber according to the Tokyo Stock Exchange for 2016

According to the latest research, the fungus Microcyclus ulei, which virtually destroyed the plantation of rubber trees in South America, is currently threatening to spread throughout Southeast Asia [2]. The emergence of the fungus in locations associated with the world's leading producers of natural rubber is only a matter of time. In this regard, all countries producing natural rubber in Southeast Asia have developed control standards of possible spread of the fungus; however, all these measures are confined to the control of cross-border traffic flows. Additionally, a number of factors, first of all, the weather, may destabilize the natural rubber market. Hevea resets foliage in drought and is later incapable of producing juice (latex) even when it rains, because there is no juice coagulation, whereby the plant may die. Heavy rains and flooding in Thailand and Indonesia in recent years have caused significant damage to the production of natural rubber.

The instability of natural rubber market, as well as price fluctuations may lead manufacturers of automobile tires to search alternatives to this product, because it is not only about the rise in price of production due to the high cost of raw materials, but also the threat of its cease as a result of the termination of the supply, if any biological or climatic emergencies happen. In this regard, many countries have started the search for alternative sources of natural rubber production.

Alternative sources for natural rubber. Nowadays, the main source of natural rubber for industrial use all over the world is Hevea brasiliensis, the rubber tree in Brazil. In the XIX century, the British exported it from Brazil to Indochina to establish industrial plantations and the production of rubber. According to the world markets, Southeast Asia provides 92% of natural rubber in the world market, and the birthplace of Hevea, Brazil, – only 0.8%.

It should be noted that the presence of the latex is observed in many plants. The total number of these plants identified in the Soviet Union amounted to 903, including shrubs, trees, flowering plants, houseplants such as pipal, and even vegetables, such as potatoes. The manufacture of one car tire used about 500 potatoes. Generally, in the USSR the need for natural rubber was considerable, taking into account the rapidly growing industry, and especially the automotive industry. In 1926 the Soviet government announced a worldwide competition for the production of synthetic rubber and has spent enormous effort to find sources of natural rubber in the country. It was the most important state program that provided strategically important raw materials to its own industry. In 1931 dandelion Kok-Saghyz was discovered in Kazakhstan and in the beginning of the 1940s the Soviet Union has already employed 300 factories for the production of natural rubber from the Kok-Saghyz. During the Second World War, USSR exchanged the Kok-Saghyz seeds for necessary weapons with the USA. Unfortunately, due to the rapid development of the oil industry and high labor costs to obtain rubber from the Kok-Saghyz, the unwillingness to spend money on mechanization and automation of planting, processing and cleaning of Kok-Saghyz, this promising culture has been forgotten, and the rubber producing plants gradually closed.

In the late 1990s and early 2000s, the world felt the first signs of deficiency of natural rubber. American and European scientists have calculated that by 2015-2020 the need for the world in the natural

rubber industry will grow, and its production may decrease due to a number of factors related to environmental, economic and political problems in the world. The European Union Framework Programs, as the main EU instrument for funding research and innovation, supported several projects that explore alternative sources of natural rubber.

The Sixth Framework Program has financed several small projects in the social, economic and foresight studies that draw conclusions about the upcoming changes in the world economy associated with a reduction in the world supply of natural rubber and recommended consideration of new alternatives and the possibility of resuming the development of the old, already known natural sources for rubber, such as a Mexican bush guayule and the Kazakh endemic called Russian dandelion Taraxacum Kok-Saghyz. Back in the late 1940s - early 1950s pilot tires from guayule and Kok-Saghyz were manufactured and tested showing that after driving for 8000 miles the tires from guayule practically come into disrepair, whereas those made from the Kok-Saghyz do not change their appearance and qualities even after 22 thousand miles of intensive testing.

The European Union Seventh Framework Program for Research, Technology and Innovation has announced a special call to research alternative sources of natural rubber. Project proposals should have set a goal to determine the best alternatives to the Hevea Brasiliensis, studies of their properties availability for industrial development in terms of ecology, economy and geographical coverage.

The EU-PEARLS, EU-based Production and Exploitation of Alternative Rubber and Latex Sources, project [3], despite its name, attracted scientists from Kazakhstan, where the Kok-Saghyz is freely growing. The project consortium brought together 14 universities, research centers and manufacturers from 8 countries: the Netherlands (Wageningen University, the International Centre for Plant Research, Agro Business Park Keygene, Apollo Vredestein, Company for the production of tires, Stramproy Contracting, commercial and industrial company), Germany (University of Münster), Switzerland (University of Lausanne), Spain (Basque Institute for Agricultural Research and Development), the United States of America (Yulex Corporation), Italy (Trelleborg Engineering Company), Czech Republic (Institute of Botany of the Czech Academy of Sciences), Belgium (Bayer Crop Science, Bayer BioScience), France (CIRAD, International Centre for cooperation in agronomic research and development). InExCB-KZ, Independent Expert Advisory Board to Promote Scientific Research in Kazakhstan, has been a consultant for research of Kok-Saghyz in Kazakhstan and further implementation of the project results.

There is important to note that the consortium of EU-PEARLS project is the world's only group of scientists, which has received official permission for the collection and study of the Kazakhstan Red Book plant Taraxacum Kok Saghyz (Resolution of the Government of the Republic of Kazakhstan dated July 9, 2009 № 1046 "On approval of the volume of dandelion collection Kok Saghyz (Taraxacum Kok-Saghyz)). Taraxacum Kok Saghyz in the world literature is still called as "the Russian dandelion". The information about this plant and its properties was first published by Dr L. Rodin, who worked in the Botanical Institute of the USSR Academy of Sciences [4, 5]. In those days, everything that came out of the countries of the Soviet Union was called "Russian" in the world. So, the Kazakhstani endemic became a Russian plant, despite the fact that the similar dandelion has been found in Sweden and Norway, where it was also subjected to a long-term study.

The consortium examined the development and sustainable use of Parthenium argentatum (guayule) and Taraxacum Kok Saghyz as an alternative source of rubber in the European Union. To ensure the sustainable development and exploitation of both crops, the development and creation of idioplasm, biochemistry, genetics, breeding, cultivation, processing and the final product carried out and investigated throughout the research of a collection of wild plants. The whole of the rubber biosynthetic chain was analyzed and potential weaknesses were identified. The genes involved in the biosynthesis of rubber were charted; a strategy of reproduction was defined. Recommendations on the establishment of industries with commercially sustainable rubber harvesting were developed. Experimental production facilities for the testing and evaluation of efficient growth and rubber production under different climatic and soil conditions in Europe were created. Technical performance and economic potential of rubber obtained at these production sites were evaluated by obtaining some prototypes, such as surgical gloves and tires.

The project results were presented at the International Congress 2012, "BioRubber for Europe in a global perspective", which was also attended by a delegation from Kazakhstan, which included Vice

Minister of the Ministry for Investment and Development of Kazakhstan Kahysh Tuleushin, Deputy CEO of the National Agency for Technological Development Zhumatay Salimov, director of InExCB-KZ Dr. Kamila Magzieva, deputy director of InExCB-KZ Sulushash Magzieva, representative of the International Center for Maize and Wheat Improvement in the Republic of Kazakhstan, Prof. Dr. Murat Karabayev, Director of the Institute of Plant Biology and Biotechnology, Prof. Dr. Kabylbek Zhambakin. The EU-PEARLS project consortium presented achievements, pointing out that the main research focus was guayule and Kok-Saghyz, because Hevea is highly susceptible to disease and the impact of pests and requires much more energy to grow and manual processing. Moreover, Hevea often causes allergic reactions. In contrast to Hevea, dandelion Kok-Saghyz and guayule are less fastidious in growing, planting and processing; the processes of seeding and developing are able to be mechanized.

Scientists of KeyGene AgroBusiness Park, the largest Dutch company in the field of research and improvement of plant genetics, conducted a study on the creation of highly productive hybrids with Kazakhstani wild Taraxacum Kok-Saghyz. By breeding and crossbreeding of wild Kazakh Kok-Saghyz and large Dutch dandelion, scientists have created a new variety of KeyGene Taraxacum Kok-Saghyz, which can revolutionize the rubber industry, and provide new value-added and easy cultivation of crops for farmers. The impact on the environment has also been taken into account. During the research, KeyGene scientists identified genes associated with apomixis, the ability to produce seeds without fertilization. Understanding of these genes can dramatically change agriculture, as any plant can potentially be cloned by seeds from the maternal plant. Currently KeyGene continues work on creation of drought-tolerant specimens of Taraxacum Kok-Saghyz and a cultivated variety that is able to produce from 700 to 1000 kilograms of natural rubber out of 1 hectare. The cost of handling for one hectare of land is approximately 250 dollars, which is about three times cheaper than the cost of growing flowers or food on the same area.

The first tests conducted in the laboratories of the EU and the US showed that rubber from Taraxacum Kok-Saghyz is not inferior to latex rubber trees. Another advantage of this type is that 45% of its roots consist of inulin, natural hydrocarbon, which can be converted into ethanol. Inulin is used for the manufacture of pharmaceutical preparations and dietary supplements prescribed for diabetes, obesity, coronary disease and heart attack, arthritis and osteochondrosis.

American scientists from Ohio believe that the quality of the rubber from dandelions and Hevea are same. However, the project consortium has proven that it is faster to get the rubber from dandelions. [6] The guayule bush grows 3-4 years before latex accumulates in roots. Kok-Saghyz at the end of the first year of life can collect the required amount of rubber. In addition, the mechanization and automation of seeding, processing and harvest of Kok-Saghyz is much easier, faster and more economical than the same processes for guayule.

During EU-PEARLS, a Dutch company producing tires, Apollo Vredestein, has produced an experimental tires Quatrac Lite (size 155/65 R14) from guayule and Kok-Saghyz [7]. Producers indicated that these tires have a much higher adhesion to the road surface, particularly at high humidity. The company is ready to start production of tires for airplanes and large-sized cars from Kok-Saghyz, taking into account its high durability.

Figure 2 - The tire, made of Kok-Saghyz

EU-PEARLS project, led by the Wageningen University, negotiated with the Kazakh scientists to participate in the European project for the purpose of subsequent use of the results in Kazakhstan. There were two reasons. The first concerns the issues of compliance of the Convention on Biodiversity; Kazakhstan became its member in 1999, and the provisions of the Red Book of Kazakhstan and the country's laws on protecting the right of its endemic. The second reason was that probably Kok-Saghyz will better grow and multiply in the territory of its endemic habitat. The experiments of 2015 showed the results of crops and cultivation Taraxacum Kok-Saghyz in Almaty region. The percentage of germination was up to 60%. Actually, germination of the fine seeds in the field does not exceed 50%.

The project results were also presented to the President of the Republic of Kazakhstan Nursultan Nazarbayev at the Astana Economic Forum in May 2013, as well as on the technology exhibition during the Nuclear Security Summit in May 24-25, 2014, in Hague (the Netherlands).

Figure 4 - Demonstration of the results of the EU-PEARLS project to the President of the Republic of Kazakhstan N.A. Nazarbayev during AEF 2013

Figure 5 - Presentation of the new varieties in Hague

During the summit in the Hague, KeyGene and “Kok-Saghyz-TM” JSC in the presence of Minister for Investment and Development of Kazakhstan Mr. Asset Isekeshev and the Netherlands Ambassador to Kazakhstan HE Hans Driesser signed an agreement on long-term partnership in the production of natural rubber from Taraxacum Kok-Saghyz.

The agreement covers the selection and delivery of new and improved varieties of Kazakh dandelions designed and optimized for the production of natural rubber in Kazakhstan. In the next stages of the project, Kazakhstan dandelions will be interbred with typical Dutch varieties in order to obtain a high-yield hybrid that will combine the quality of Kazakhstan dandelions' rubber with adaptability and productivity of Dutch varieties. The agreement gives more opportunity to the industrial life of Kazakhstan, which has all the possibilities for the production of both natural and synthetic rubber. Strong government support, along with a partnership with one of the top breeding companies in the world is definitely will fasten this process. Kazakhstan dandelion can be used for molecular breeding, getting the seeds of new varieties of dandelion suitable for commercially viable production of natural rubber, and to meet the global demand for high-quality biomaterials [8]. Land resources and agricultural capacity of Kazakhstan plays a leading role in this process.

The Government of Kazakhstan and the Ministry for Investment and Development supported the initiative of the project developers on transferring the technology for planting, growing and processing of Taraxacum Kok-Saghyz in the framework of European EU-PEARLS project in Kazakhstan. Thanks to an innovation grant of the National Agency for Technological Development for the implementation of the project "Development of Kazakhstan's natural rubber seed - dandelion Taraxacum Kok-Saghyz and guayule Parthenium argentatum and business plan for the project «KZ-PEARLS» - Production and operation of alternative sources of natural rubber in Kazakhstan", the project executors, InExCB-KZ, and its daughter compeany Kok-Saghyz-TM JSC received a high-quality seed stock. KeyGene presented special grade Taraxacum Kok-Saghyz with properties that allow getting 1 ha of crops from 700 kg to 1 t of latex for sowing in Kazakhstan. Over a two-year period of the project activities from 2013 to 2015 over 2 million seeds of Taraxacum Kok-Saghyz were collected, which allows sowing an area of over 4 hectares.

The project was based on the main results of the European project EU-PEARLS and implemented in Kazakhstan by two main project executors, KeyGene and Kok-Saghyz-TM JSC. During the project, KZ-PEARLS were obtained technology for seed sowing, land cuttings, harvesting and storage of Kok-Saghyz, and valuable genetic resources, qualified personnel were prepared, the necessary work prior to implementation for rubber extraction technology in wide production and produce high-quality natural rubber was carried out. In addition, some experience in growing of Kok-Saghyz under greenhouse conditions for seed multiplication was gained. The Dutch company KeyGene has launched new tests for even more fruitful varieties of Taraxacum Kok-Saghyz.

The European Commission is currently funding a project DRIVE4EU, Dandelion Rubber and Inulin Valorization & Exploitation for EU. This project is implemented within four years from 2014 to 2018, brought together seven industrial companies and six research institutions from 6 countries of the EU and Kazakhstan: The Netherlands (Foundation for Agricultural Research at Wageningen University, KeyGene AgroBusiness Park, Company for the production of tires Apollo Tyres Global, Pilot farm "Rusthoeve", QEW Engineered rubber, an industrial company for the production of high-quality rubber), France (Agriculture Tereos Syral, producer of sugar, which has one of the plants in Belgium, Aalst city), Germany (GEA Westfalia Separator Group GmbH, one of the world's leading manufacturers of machinery and development of technological processes in the field of mechanical separation technology centrifugation, NETZSCH Feinmahltechnik GmbH, a manufacturer of industrial equipment for wet grinding, mixing and dispersion), Czech Republic (Institute of botany of the Academy of Sciences, MITAS as, a company producing tires for agricultural machinery), Sweden (Trelleborg Sealing solution Kalmar, Trelleborg a global leader in engineering polymer solutions), Austria (Joanneum research Forschungsgesellschaft MBH, innovation and engineering company), Belgium (ILVO, Institute for agriculture and fisheries research), and Kazakhstan (InExCB-KZ, a private research institution).

The project has a unique competitive advantage, entirely focusing on biotechnology, plant breeding, agronomy, gathering and processing of biological materials, as well as the production of rubber and inulin from Taraxacum Kok-Saghyz. The main task of DRIVE4EU is to build a bridge between science, industry and market. The aim of the project is to create a European chain for the production and processing of natural rubber and inulin from Taraxacum Kok-Saghyz, in order to reduce the EU's dependence on imports of natural rubber and at the same time respond to the threat of global rubber shortage. Inulin can be used as raw material for environmentally friendly chemicals such as polymers based on the furan. The combination of latex and inulin in one plant demonstrates the technical and economic feasibility of using Taraxacum Kok-Saghyz as a production platform for high-quality rubber and inulin-containing preparations.

This project provides Kazakhstani participants with a valuable knowledge to obtain more benefits from cultivation Taraxacum Kok-Saghyz in Kazakhstan, including non-waste production by extraction of natural rubber. Assuming that the necessary funds, one field with size of 48 hectares could produce a high-quality honey, sugar, rubber, biofuels and cattle feed at the maximum energy consumption.

Thanks to the unique properties of natural rubber, Kok-Saghyz is indispensable in the production of large-size tires, and able to withstand loads up to 75 tons. Most manufacturers make tires from a mixture of natural and synthetic rubber, therefore, it is still the main field of application of natural rubber left tire industry (70%).

In addition, natural rubber is used in the manufacturing of conveyor belts with high capacity, corrosion-resistant coatings of boilers and pipes, glue, thin-walled high-strength fine products, including products for medical and sanitary purpose. Roots of Taraxacum Kok-Saghyz contain 35-50% of natural hydrocarbon. Inulin is well absorbed by human body, it is used as a diabetes starch and sweetener, for diagnosing renal function (test inulin), as well as to obtain fructose. Waste is used to feed farm animals and for the production of biofuels. Production of natural rubber from Kazakhstan endemic Taraxacum Kok-Saghyz can be done completely without waste, taking into account its features.

So far, technological lines for rubber extraction as well as technological lines for the production of similar products, for example, sugar beet, have been studied. In addition, a pilot mini-line, using the latest high-tech for rubber extraction profitable in terms of economy and safety from the point of view of ecology in cooperation with European partners has been developed.

A Belgian partner, a subsidiary of the famous French sugar producer, TEREOS, located in the city of Aalst, received a trial consignment of sugar from dandelion Kok-Saghyz in 2016. The technology of processing of Kok-Saghyz into sugar proved to be not most time-consuming. Almost all European partners have technological possibilities at this stage.

However, the transfer of these technologies in Kazakhstan and the acquisition of necessary equipment remain inaccessible for the Kazakh partner due to lack of funds. At the same time, only Kazakhstan due to its extensive land and experience in processing it can provide all partners with necessary raw materials. Kazakhstani scientists were the only researchers who grow crops in the open field, and not in a greenhouse. Kazakh partners have shown a direct correlation between the biomass Taraxacum Kok-Saghyz root and thickness, as well as the seeding rate and doses of mineral fertilizers, so being able to achieve almost 60% of germination.

Participation of the most advanced researchers of Taraxacum Kok-Saghyz in the consortium is extremely useful for Kazakhstan agronomists and farmers, who will contribute to the creation of an entire industry in Kazakhstan. Researching of heritage of the USSR, a modification of the previously used development in the production can help in innovative cooperation in the EU project.

The history of the use of Taraxacum Kok-Saghyz in the USSR. In the 30s of the last century, the Soviet Union studied 1048 species of plants, 990 of which were found to synthesize rubber. But most rubber plants were not suitable for obtaining natural rubber. The country was in need of natural rubber, especially for machine-building industry, which could not generate any tire without natural rubber. In 1931, a search expedition of a Scientific Research Institute led by Dr. Leonid Rodin discovered dandelion Kok-Saghyz (named by locals) in the foothills of the Tien Shan in the south of Kazakhstan. A year later, in 1932, Kok-Saghyz occupied 900 hectares, and in 1940 – 55.0 thousand ha. The area of planting Kok-Saghyz grew very quickly. In 1936 compared to 1935, the area of the farms increased by 13.5%, in 1937 - by 146%, in 1938 - by 408%, in 1939 - by 592% and 1940 - 1531%. Thus, within five years it expanded by a factor of 15 [9].

Kok-Saghyz is Kazakhstan's endemic, introduced in the "Red Book" of Kazakhstan, №338 [10]. Natural vegetation is limited to a fairly small area, an area of 10 thousand km^2, mainly in three mountain valleys in the eastern Tien Shan in the south-east of Almaty region: Kegen, Saryzhaz, Tekes (partly Karkarinsk, Cheldysuy and Aschilla valley), between 79 - 80°30' east longitude and 42°20' - 43°20' north latitude. Valley stretches from north-west to south-east and situated at an altitude of 1800-2100 meters above sea level [11, 12].

The first scientific studies have shown that Kok-Saghyz is better than many other plants in terms of domestication. Moreover, it gives a high yield of the roots with the highest content of rubber in the first year. The increase in the number of collective and state farms, to achieve high yields of roots and seeds of rubber plants, requires the construction of a huge number of both large and small plants for processing of rubber plant roots, in order to obtain natural rubber.

Kok-Saghyz dandelion is an alternative source of valuable vegetable raw materials for the production of natural rubber. The roots of Kok-Saghyz contain 6-14% rubber (in the roots of wild plants it is up to 27%), which is not worse than the traditional raw material for the production of rubber, obtained from Hevea brasiliensis. But unlike Hevea, the manufacturing process of collecting and processing of Kok-Saghyz is fully amenable to mechanization.

The latex, which fills milky vessels of Kok-Saghyz root contains rubber. When you cut the root, the latex flows out in the form of a white, quickly solidifying liquid, which forms durable elastic rubber film. Overwintered plants begin further root growth in spring, last year's living root tissue dies and collapses, but instead, as a result of the cambium, there will grow a new tissue. Rubber of old dead latex of Kok-Saghyz turns into yarn, and their dense mesh forms a thin cover of tubes. It contains all rubber that has been accumulated in the root on the 1st year of life. By the end of the period of mass fructification, it will be a thin film easy to destroy and it can remain in the soil. After harvesting the seeds for the biennial plantations, digging of roots is carried out in the shortest period. The roots of Kok-Saghyz contain 10-12% on the green weight of rubber (2-2.5% green weight) by the end of the 1st year of life, in the 2nd year of life is from 11 to 14%.

The Soviet Union allocated an area of 500 thousand hectares of land in more than 15 areas to planting crops of Kok-Saghyz, Tau-Saghyz, Crimea-Saghyz, and other rubber. These measures allowed developing up to 50 thousand tons of rubber in 1942. More than 300 plants have been built for the processing of vegetable raw materials. [13]

Properties and possibilities of industrial use of additional crops, growing in Kazakhstan, such as Tau-Saghyz, Crimea-Saghyz are still poorly studied. Comparative analysis of properties of the most studied rubber sources, such as Hevea, guayule, Kok-Saghyz, Tau-Saghyz, Crimea-Saghyz (Table 4), shows a special attraction is the Kok-Saghyz for industrial development, taking into account the high rubber content in the roots, unpretentious plant, low cost in growing and harvesting, as these processes for Kok-Saghyz is fully amenable to mechanization.

Table - Comparative analysis of the properties of four rubber sources

Plants	Resistance to tensile stress (kg/cm^2)	Extention rate (%)	Permanent extension after tensile stress (%)	Aging factor (by Geertz)
Kok-Saghyz	180-220	650-780	18-24	0,3-1,0
Tau-Saghyz	208-220	700-720	17-20	0,5-0,9
Crimea-Saghyz	180-230	700-780	26-33	0,6-0,9
Guayule	140-160	600-630	28-30	0,4-0,6
Hevea	200-260	700-760	16-18	0,7-0,9
Synthetic rubber	130-160	700	27-28	-

Kok-Saghyz: in culture, accumulates 10-12% of rubber and about 2.5% of resin in roots by the end of vegetation by the 1st year, indicators increased almost twice by the end of the second year.

Tau-Saghyz: in culture, 3 years of age, accumulates 12-15% of rubber and about 2-3% of resin in the roots.

Crimea-Saghyz: in culture, 2 years of age, accumulates 5-6% of rubber and about 3% of resin.

Guayule survives well in dry subtropical zone in Central Asia, the South, in the culture of 3-4-year-old it collects 8-10% of rubber and 8-10% of resin on absolutely dry weight axial organs.

Conclusions. Testing and introduction of an alternative source for natural rubber that can be grown in most parts of the country, establishment of seed production, development of vegetable raw processing technology to produce a qualitative product, industrial production of natural rubber, creation of appropriate infrastructure and human resource base will help to quickly create a stable foundation in Kazakhstan for the production of domestic rubber and gradually bring it to the world markets. It should be noted that the production of natural rubber from the domestic plant endemic Kok-Saghyz will greatly reduce or even completely eliminate the import-dependence of the country.

Thanks to the long-term research of global scientists, it may be concluded that dandelion Taraxacum Kok-Saghyz is a rare natural phenomenon that combines the amazing features of the source of natural rubber, as well as sugar and inulin.

Kok-Saghyz has a great potential as an alternative rubber culture, but is in need of further increase in the roots biomass harvest as well as the level of the rubber content. At the University of Wageningen (the Netherlands), a pilot plant for the extraction of rubber was built. Researchers have noted [2] that the tires obtained from the Kok-Saghyz have the same quality as the rubber from Hevea tree. The results of the European projects show that Taraxacum Kok-Saghyz grows best on Kazakh soil, especially in the areas of their endemic habitat in the foothills of the Tien Shan. Creation of the rubber industry in Kazakhstan will require large investments in the initial phase and it will be highly profitable. Unpretentiousness of dandelions helps them to exist even in areas not suitable for agriculture. Other advantages include the lack of vulnerability to serious pests that simplifies cultivation, and, of course, the short growing season of dandelions, which lasts only one year after which the plant is ready for collection and processing.

In order to produce natural rubber in the country, the domestic demand for natural rubber must be estimated. Thus, according to the Kazakh Statistics Agency, Kazakhstan has imported more than 2 million tires in 2012. If one tire requires 50% of rubber and the average rubber tire for a passenger car weighs approximately 8 kilograms, the country needs 8000 tons of natural rubber per year only for providing the domestic demand for tires. Not taking into account the growing demand, the country requires over 8000 tons of natural rubber per year. According to the Agency, the average price per ton of imported natural rubber in 2012 for the needs of Kazakhstani producers of technical rubber products amounted to $ 8800. Thus, the size of the domestic market for natural rubber in Kazakhstan is exceeds $ 70 million per year.

The current situation in production of natural rubber in the country and the world is affected by the following facts and circumstances:

– The limited world reserves of non-renewable sources of synthetic rubber, the negative impact of its production, use and recycling for the environment and human health;

– Constantly increasing global demand for natural rubber and its irreplaceable role in a number of industries (automotive, aeronautics, medicine);

– Increase in the cost of production of natural rubber;

– The limited global production of natural rubber both in terms of the plants acting as sources of rubber, and the territory of their cultivation. Nowadays, it is Hevea and South-East Asia;

– The need for new sources of natural rubber and areas of cultivation.

In this regard, Kazakhstan has a unique position and advantage, since it is home to the endemic rubber plants Kok-Saghyz and its homeland has enough land resources for industrial cultivation.

Nowadays, there is a struggle for the domestication of the Kok-Saghyz around the world, although it is an endemic of Kazakhstan and is included in its Red Book. Ohio University (USA) has received $3 million from the US government budget for the cultivation of Kok-Saghyz in America. Russia is trying to resume the production of the Kok-Saghyz rubber. Canada, China and Europe are interested in commercialization of rubber products from Kok-Saghyz in their countries.

Kazakhstan has clear advantages in obtaining and commercialization of products made of natural rubber. Kok-Saghyz is a natural endemic of Kazakhstan. It included into the Red Book as the Kazakh endemic. Therefore, it has to be called the Kazakh Dandelion.

Kazakhstan signed the Convention on Biological Diversity in 1994, which protects the right of Kazakhstan to the commercial production of its own endemic. Kazakhstan takes part in the EU projects and has the right of access to the technologies developed in the framework of the European projects under specific agreements. Finally, Kazakhstan has land, natural and financial resources for implementation of technologies for production of rubber and may become a leader in the production of natural rubber in the world. Revenues from natural rubber may well compensate the expenditure, suffered from the decline in oil prices. Vehicles of the future will be able to find a replacement for gasoline, but any car and aircraft will require natural rubber for decades.

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КӨКСАҒЫЗ (*TARAXACUM KOK-SAGHYZ L.E.RODIN*) – ТАБИҒИ КАУЧУКТІҢ БАЛАМА КӨЗІ (*TARAXACUM KOK-SAGHYZ L.E.RODIN*)

Аннотация. Ұсынылып отырған мақала әлемде табиғи каучукті өндіру және оның жаңа балама көздерін табу, Тараксакум Көксағыз бақбағының қасиеттерін заманауи тұрғыда зерттеулер туралы жалпы мағлұматтарды қамтиды. Авторлар әлемдік табиғи каучук өндірісіне талдау және болашаққа болжау жасай отырып, Еуропаның зерттеу жобалары шеңберінде Көксағыздың жоғары өнімді сұрыптарын шығару және одан табиғи каучук пен қант алу тәсілдері мен технологияларына шолу келтірген. Сонымен қатар мақалада Көксағыздың биологиялық ерекшеліктері мен ботаникалық сипаттамасы келтірілген. Әлемдік табиғи каучук өндірісіне баға беру және жуық арада табиғи каучук бағасының өсуі мен шикізат тапшылығына қатысты болжаулар Қазақстанда шұғыл түрде Көксағыздан табиғи каучук өндіруді қайта жаңғырту қажеттілігін айқындайды, және де бұл үшін қажетті жағдайлардың барлығы дерлік бар.
KeyGene АгроБизнесПаркі Қазақстанда егу үшін 1 гектар дақылдан 1 тоннадан 0,7 тоннаға дейін латекс алуға мүмкіндік беретін қасиеттері бар Көк-Сағыздың арнайы сортын қамтамасыз етті.
Тірек сөздер: Табиғи каучук, бақбақ Тараксакум Көксағыз (*Taraxacum kok-Saghyz*), зерттеу, каучука өндірісі.

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КАЗАХСТАНСКИЙ ОДУВАНЧИК ТАРАКСАКУМ КОК-САГЫЗ – АЛЬТЕРНАТИВНЫЙ ИСТОЧНИК НАТУРАЛЬНОГО КАУЧУКА

Аннотация. Предлагаемая статья содержит общую информацию о производстве натурального каучука в мире и поиске новых альтернативных источников, о современных исследованиях свойств одуванчика Тараксакум Кок-сагыз. Авторы представляют обзор различных методов и технологий создания высокоуро-жайных сортов и получения натурального каучука и сахара из одуванчика Тараксакум Кок-сагыз в рамках исследовательских проектов в Европе. Статья также содержит биологические особенности и ботаническое описание одуванчика Тараксакум Кок-сагыз. Ожидаемый рост цен на натуральный каучук и дефицит сырья в ближайшие годы убеждают в необходимости возрождения производства натурального каучука из Кок-сагыза в Казахстане, для чего есть все необходимые предпосылки. Для посева в Казахстане АгроБизнесПарк KeyGene предоставил специальные сорта Тараксакум Кок-сагыз со свойствами, позволяющими получить с 1 га посевов от 0,7 тонны до 1 тонны латекса.
Ключевые слова: Натуральный каучук, одуванчик Тараксакум Кок-сагыз (*Taraxacum kok-Saghyz*), исследования, производство каучука.

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