"PRESENTATION OF THE NATURAL ORGANIC RESOURCE – FRESHWATER LAKES SAPROPEL AND INNOVATIVE PATENTED SAPROPEL PROCESSING AND USAGE TECHNOLOGIES FOR CREATION OF FERTILE SOIL IN DESERTS AND RESTORATION OF DEGRADED SOIL"

According to the data of the United Nations, 12 million hectares of fertile soil degrade annually, decreasing overall agriculture production capacity in whole world[1]. This problem relates not only to the deserts, but also to the regions at risk, where the fertile soil is destroyed due to natural conditions, usage of chemical fertilizers, overexploitation or other human activities.

Lithuanian scientist and the International Community of the Users of Lakes Organics proposes to use unique organic fertilizers and ameliorants produced from natural resource i.e. freshwater lakes sapropel, which enables to:

1) Create a durable fertile soil in the desert;
2) Restore the agronomic parameters of degraded soil;
3) Stabilise and retain the productivity and efficiency of the soil, as well as improve its ecologic consistence and agronomic characteristics within the territories of high degradation risk;
4) Satisfy the 100% of the organic materials demand for organic farming activities.

This presentation pursues to overview the main characteristics of freshwater lake sapropel as the natural resources, its processing and application methods as well as innovative patented technologies invented by Lithuanian scientists. Additionally, this presentation covers preliminary economic estimation of the sapropel product costs and further steps, which must be taken to expand the usage of sapropel to the global scales.

I. THE CHARACTERISTIS FRESHWATER LAKES SAPROPEL AND AGRONOMIC RESULTS OF SAPROPEL USAGE

Freshwater lakes sapropel (hereinafter – the **"Organic sapropel"**) is a complex sediment of organic and mineral materials, which accumulated in freshwater lakes for the last 10.000 years. Organic sapropel is ecologically clean natural resource, rich of active biological materials and consisting mainly from biomass of water plants and residues of planktonic creatures.

Organic sapropel resources accumulate only on the bed of lakes located Northern Hemisphere territories due to anaerobic conditions with the amount of approx. 2mm per year. Large deposits of clean organic sapropel suitable for organic fertilizer and ameliorant production are found in Lithuania, Latvia, Estonia, Belarus, Canada, Russia and others. According to preliminary calculations, lakes in the Republic of Lithuania alone contain about 1.5-2 billion m^3 of clean organic sapropel and it is the largest source of organic sapropel available in the Europe Union.

Following the initiative lead by Ministry of Agriculture of the Republic of Lithuania, sapropel was included in Annex I to the European Commission Regulation (EC) No. 889/2008 laying down detailed rules for the implementation of Council Regulation (EC) No. 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control in 2014. It means that sapropel-based fertilizers can be used in organic farming activity in EU.

[1] Data from official United Nation organisation site http://www.un.org/en/events/desertificationday/background.shtml

Organic sapropel contains biochemically active nitrogen, phosphorus, potassium, trace elements, as well as organic materials important for plant development (humic acids, vitamins, enzymes and others). After insertion into the soil organic sapropel slowly mineralises creating a source, ensuring sufficient amounts of main nutrition components necessary for the plant vegetation process for the period up to 5 years.

At the same time the usage of organic sapropel results in the following effects:

(1) *Onetime insertion of s*oil improver based on organic sapropel *creates a fertile soil up to 5 years*

During scientific researches and field tests in Egypt, United Arab Emirates and Kingdom of Bahrain it was proved, that due to the slow mineralisation process onetime insertion of soil improver based on organic sapropel into the desert sand is effective and ensures the sufficient source for formation of main oranic nutrition materials necessary for the plant vegetation for period up to 5 years.

(2) *The use of* soil improver based on organic sapropel *significantly increases the crop yield in the soil created in desert as well as in restored degraded soil*

The scientific experiments has shown that the use of soil improver based on organic sapropel in the desert allows to reach substantially higher results in comparison to other soil improvement materials. In particular, harvested yields of land plots of Egypt desert with inserted soil improver based on organic sapropel correspond to the level of yields of Nile Delta. The comparative table below based on experiments in Egypt[2] was presented by Dr. G.Sokolov in *Interantional scientific conference „Organic sapropel: Extraction, Processing and Use"* hosted in Vilnius, Lithuania as of 2014:

The method of soil improvement	**Yield t/ha**				
	Corn		**Lucerne**	**Onion**	**Okra**
	Green mass	**Corncob**	**Green mass**	**Heads**	**Fruit**
1. Non-organic fertilizers (N; P; K)	7,9	3,1	1,3	2,9	-
2. Local organic compost	36,2	19,1	-	9,1	2,1
3. Organic sapropel based soil improver	46,3	24,7	23,6	13,2	3,3

Table No 1. "Effectiveness of organic sapropel in creating soil in desert. Egypt."

(3) Soil improver based on organic sapropel *inserted into the soil reduces watering consumption norm*

Soil improver based on organic sapropel significantly increases soil susceptibility to water and reduces the watering norm up to 50 percent, from the standard amounts necessary to grow the agro cultures in desert conditions. The practical results of scientific field experiments in Egypt[3] with cabbage cultivation were also presented by Dr. G.Sokolov in the *Interantional scientific conference „Organic sapropel: Extraction, Processing and Use"* hosted in Vilnius, Lithuania as of 2014:

[2] Experiments performed by the International group of Egypt, Japan and Belarus scientists.
[3] *Ibid.*

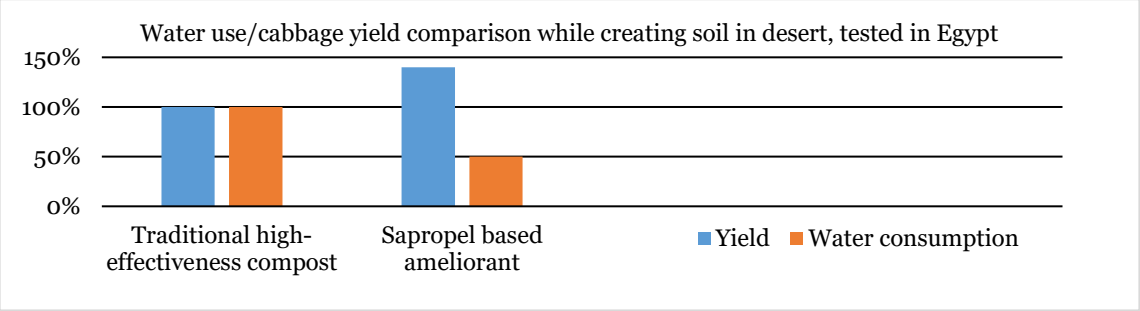

Table No 2. "Results of field experiments with cabbage cultivation in the desert. Egypt."

Furthermore, organic sapropel as the clean natural resource has a wide range of other utilisation areas. Organic sapropel may be added as the supplement for domestic animal feed as well as applied in health promotion activities.

II. THE CURRENT DEVELOPMENT ISSUES OF THE USE OF ORGANIC SAPROPEL

Currently the organic sapropel resources are mainly used for the local needs in the countries, where it is extracted and processed. Thus, the global potential of the use of organic sapropel, where the demand of creation of the fertile soil and restoration of agronomic soil characteristic is the highest, is weakly used.

The main obstacles from global use of organic sapropel are the following:

(1) Difficult composition and consistency of the organic sapropel

Organic sapropel consists of 95% of water, whereas the most efficient humidity for the use of organic sapropel as the fertilizer and (or) ameliorant is 50-60%. Therefore, after mining, before the application organic sapropel needs to be significantly dewatered.

Moreover, the structure of natural organic sapropel is formed as colloidal complex (i.e. it comprises complicated connections between water molecules and organic fractions). If the colloidal connections are not destroyed, during natural drying process the organic sapropel transforms into ceramic mass and it becomes not suitable for fertile soil creation and improving purposes. One of the most efficient ways to break up the organic sapropel colloidal complex is the freezing of organic sapropel – after freezing-defrosting process the colloidal connections do not restore.

(2) Lack of industrial technologies introduced into practice for processing and preparation of soil improver based on organic sapropel for use

Currently in order to freeze and dewater organic sapropel mainly natural winter conditions are used. However, outdoors field methods have crucial drawbacks limiting the accessibility of this resource for export purposes:

- Global warming reduces the winter intensity in north Europe and causes unfavourable meteorological conditions for freezing organic sapropel using natural methods;
- Large land plots for freezing of organic sapropel stocks are necessary as the most efficient freezing layer amounts only 0,2-0,3 meters depth;
- Outdoors conditions leads to the contamination of organic sapropel with extraneous plant seeds and insect eggs, therefore such organic sapropel does not meet the export phytosanitary requirements.

- Slow organic sapropel dewatering process may be accelerated with chemical sorbents, however they significantly increase the costs of the final organic sapropel product and worsen its quality and efficiency.

Without efficient industrial-scale processing technology, billions of cubic meters of organic sapropel deposits are not being utilized on global level. In addition to local consumption of organic sapropel, currently only couple of small scale organic sapropel processing entities for export purpose operates, hence only small batches of production are being exported to Jordan, Saudi Arabia and other Middle East region countries.

In order to accelerate the slow process of bringing organic sapropel to the global market use, there is a clear need introducing into practice of industrial organic sapropel technologies, which in recent years has been created and patented by Lithuanian scientists.

III. "TURNING-POINT" IN DEVELOPMENT OF INNOVATIVE INDUSTRIAL TECHNOLOGIES FOR ORGANIC SAPROPEL PROCESSING

Since 2012 a group of Lithuanian and Latvian researchers have been actively analysing and developing the industrial organic sapropel dewatering technologies pursuing to solve the drawbacks, causing obstacles for the global utilization and export of organic sapropel.

During 2012-2017 three international scientific conferences on organic sapropel utilisation possibilities were held in Lithuania and Latvia. As a result the initiative group of experts, including scientists, researchers and inventors were gathered and united with aim to increase the organic sapropel's practical usage – creating the International Community of the Users of Lakes Organics.

The research and experiment activities also resulted in creation of two innovative patented technologies for organic sapropel processing and use, namely:

1. *Organic sapropel based organic fertilizer and method of production thereof* (Patent No 6043, registered The State Patent Bureau of the Republic of Lithuania).
2. *Method of water removal from organic sapropel* (Patent No 6247, registered The State Patent Bureau of the Republic of Lithuania).

Following aforesaid patents, first industrial prototype of technological equipment was made and tested in an operational environment in natural conditions. Production results show that innovative technologies allows to exclude all drawbacks of organic sapropel freezing and processing methods, described in the Part II of this presentation. Therefore, these innovative solutions and technologies creates preconditions to start the industrial and efficient processing of organic sapropel all over the world.

According to economic calculations, the fertilizers from organic sapropel will be cost efficient and competitive product in comparison to other analogous organic fertilizers in EU.

For illustrative purposes, below please find example comparison of fertilizers from organic sapropel and organic fertilizers from manure (the closest equivalent to the organic sapropel fertilizer) following the prices in fertilizers market of Germany:

Product name of fertilizers from the cattle manure	Retail price of 1 ton of cattle manure in Germany market
1. "Beckman cattle manure"	1356 Eur
2. "Cuxin cattle manure"	1085 Eur
3. "Guther cattle manure"	1096 Eur

Table No 3. "Review of retail prices of cattle manure in Germany market"

Based on the scientific researches it was found out that one ton of fertilizers from organic sapropel (60 % humidity) gives the same soil fertilization effect as 0,7-0,8 tones of fertilizer from cattle manure. Therefore, in order to reach the same effect[4] equal to 1 ton of fertilizers from cattle manure the amount of 1,42 tones of fertilizers from organic sapropel must be used. However, the price of these two types of fertilizers significantly differs.

It is the estimated that, wholesale price of 1,42 tones of industrially produced fertilizers from organic sapropel including transportation costs to Germany from Lithuanian manufacturer would be **355 EUR** andretail trade service price would amount **approx. 125 EUR** resulting in the final product retail price of approx. **480 EUR**. For the calculation purposes taking the average retail price of 1 ton of fertilizers from cattle manure in Germany – 1000 Eur, the difference between the retail price fertilizers from cattle manure and retail price of fertilizers from organic sapropel would reach approx. **520 EUR**.

Aforesaid amount would be considerable and ensure sufficient reserves for the development of competitive retail sales and export activities. Thus, it may be concluded that the Lithuanian industrial technologies may create highly efficient and competitive product, which needs to be introduced to the markets.

IV. DEVELOPMENT OF INOVATIVE TECHNOLOGY OF ORGANIC SAPROPEL INSERTION IN DESERT

In the territories significantly affected by land desertification and degradation processes the price of sapropel products, including transportation costs, would cause the high demand of the initial investments.

Therefore, in order to reduce the insertion costs of fertilizers and ameliorants from organic sapropel for creation of the fertile soil in desert, Lithuanian scientists have developed "know-how" of localized insertion technologies into desert subsoil, which significantly reduces the amount of inserted organic sapropel products.

These methods allows to use fertilizers or ameliorant from organic sapropel not covering all area of the land plot, but use targeted injections, which would result in **reduction of the necessary sapropel products amounts up to 50% per hectare**. Currently the patenting process is being carried out and further experiments needs to be continued.

[4] It must be noted that the duration of fertilizers from cattle manure is usually effective for 2 years, while sapropel will give effect for 5 years.

V. NECESSARY SUPPORT FOR SUSTAINABLE DEVELOPMENT OF INTERNATIONAL USAGE MARKET OF ORGANIC SAPROPEL

Despite the number of organic sapropel advantages and outstanding potential of soil agronomic characteristics improvement, today the world's market is unprepared for an objective assessment of application and usage of new products from organic sapropel as well as opportunities and perspectives thereof.

Markets lacks reliable scientific information on the methods of organic sapropel application. Moreover, it is important for the potential foreign partners that the product from organic sapropel would be tested and internationally acknowledged by the scientific and agricultural organisations.

Without direct involvement and support of influential international organizations in the movement for usage of organic sapropel for soil restoration, the issues related to the obstacles for the global organic sapropel utilization will not be solved quickly.

Therefore, organic sapropel usage initiative needs strong international support. We see the following activity areas where international organizations could contribute and act:

1. International promotion of scientific proof of organic sapropel usage for soil restoration at the international level;
2. Exchange and provision of reliable information about the application possibilities of organic sapropel to potential customers;
3. Collection of information about needs and opportunities of soil restoration in countries across the world;
4. Coordination of activities related to inclusion of organic sapropel as a soil restoration material in international environmental and agricultural programs and projects.

Any and all support would be crucial for the promotion of sapropel usage in the world. Therefore, we appeal to the international organisations suggesting to cooperate on abovementioned issue and together contribute to the combat against land desertification and soil degradation as well as the usage of sapropel for restoration and improvement of agronomic properties of the soil.

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