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Research paper

Nanotechnology as a Means of Forming Benefits for the Sustainable Development of Ukraine's Economy

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Abstract

The research of modern trends of nanotechnology market development was conducted. The basic prospective directions of introduction of nanotechnologies that influence the vital activity of the society and allow to solve problems in the infrastructure and other branches of economy are determined. It is substantiated that it is in the conditions of the crisis that it is necessary to innovate and stimulate the development of nanotechnologies. They allow to increase the efficiency and rationality of using resources at the level of enterprises and industries. Create competitive advantages and prerequisites for sustainable development.

Keywords: *Nanotechnology , sustainable development, competitive shifts, development.*

1. Introduction

Under the conditions of the crisis, the development of the Ukrainian economy on the basis of innovation and nanotechnology has the potential for solution of not only the urgent needs of society, but also the opportunity to meet vital interests in conditions of growing shortages of raw materials, energy resources, foodstuffs. Strengthening requirements for the processing and transportation process, increasing the role and importance of safety and environmental standards.

This creates new challenges for the institutional provision of innovation in Ukraine. The main vector of Ukraine's economic development should be "an advanced accumulation in the non-material sphere, especially in the person itself, its mind, knowledge, science, education, culture, without which it is impossible to hope for GDP growth, increase of efficiency in material and non-material production" [15, c. 134], that is, the result of innovation development should be sustainable economic development.

2. Main body

At the present stage, the leaders of economic development in the world are countries that pay much attention to the development of innovation activities and the introduction of innovative technologies.

As the result of foresight assessment of innovative technologies of the XXI century in the EU, the USA and Japan, it is possible to distinguish four of their priority areas:

1) technology of new materials (11 technologies);
2) technologies of the information society (12 technologies);
3) technology of life sciences, genomics and biotechnology (8 technologies);
4) technologies for sustainable development, global climate change and ecosystems (9 technologies).

Every year the scope of nanotechnology and nanomaterials is constantly expanding. In particular, for the treatment of malignant tumors, filtration of water and other liquids; for the creation of materials necessary for the treatment of burns and wounds; in dentistry; in cosmetology; for the manufacture of military equipment; in the production of special grades of glass, which does not precipitate dirt (used in automotive and aircraft construction); at the production of ink; in the manufacture of clothes that cannot be dirty and soiled, etc.

Experts predict that the nanotechnology market will reach $ 90.5 billion by 2021 from $ 39.2 billion in 2016. The average annual growth rate is 18.2%. This will be due to the commercialization of products for sunscreen materials, as well as new technologies, such as nanotube film solar cells, nanolithographic tools and nanoscale electronic memory [10]. Their role and significance is confirmed by the adopted program "Horizon 2020", the largest research program in the history of the European Union, with a total budget of about 80 billion euros, for a period of seven years (from 2014 to 2020) [3]. It focuses on cutting-edge science (Excellent Science), industrial leadership (Industrial Leadership) and social challenges (Societal Challenges), which allow not only to concentrate resources but also to ensure sustainable development. The program budget is $ 80 million. In this program, Industrial Leadership [2] focuses on research and funding in the field of information and communication technologies (ICTs), nanotechnologies, materials improvement, biotechnology, advanced technology of production, processing, and space. Thus, all European countries are focusing on ensuring sustainable economic development through stimulating innovation, which allows not only to solve urgent problems, but also to provide vital interests of society: health care, education, transport safety, production, etc. Note that the findings of the foresight assessment of the priority innovative technologies of the XXI century require coordination with state development programs and strategic forecasts that will ensure satisfaction of the VIP (vital interests of the population) and serve as the basis for implementing the innovation paradigm of Ukraine's development (Table 1) [1].

Table 1: Recommended results of foresight estimation of the priority innovative technologies of the XXI century in the EU, USA and Japan during 2015 - 2030 years in the context of satisfaction of the vital interests of the population in Ukraine

№	Branch	Vital interests of population	Priority technologies	2015	2020	2025	2030	After 2030
1	Medical service	Health (preserva-tion, prevention of diseases, treat-ment)	1.1 Use of stem cells for the treatment of various human diseases	E*	E/G	G	M	M
			1.2. Tissular Engineering	E	G	G	M	M
			1.3. Technologies for the production of personalized medicines and treatment	E	G	G	M	M
			1.4. Biogenetics materials	E	E	G	M	M
			1.5. The genome of people, proteomics	E	E	E/G	M	M
			1.6. Surgery based on computer technology	E/G	G	G	M	M
			1.7. Protein Engineering	E	G	G	M	M
			1.8. DNA Technology for large-scale DNA analysis	E	E	G	M	M
			1.9. New instruments for diagnostics on a living organ-ism (in-vito)	E	E	E	G/M	M
			1.10. Cellular therapy	E	E	E	E	G/M
			1.11.Use of nanotechnologies and nanoparticles in therapy	E	E	E	E	E
			1.12. Diagnostic technique and ”repair” of human organs	E	G	G	M	M
			1.13. Artificial ”intellectual limbs”	E	E	E	E	E
2	Ecology and the environment for life	Housing, environ-ment environment	2.1Technology of absorption and conservation of CO2	E	G	G	M	M
			2.2.New technologies for air and water purification	E	G	G	M	M
			2.3. Active packaging materials	E	G	G/M	M	M
			2.4. Bioactive materials and coatings	E	E	G	M	M
3	Power engineering and energy saving	Housing, ecology of habitat	3.1. Technologies of more efficient energy consumption	E	G	M	M	M
			3.2. Inexpensive high-performance solar cell photocells	E	G	G	M	M
			3.3. New technologies for fuel cells	E	G	G	M	M
			3.4. Biofuels	E	G	G	M	M
			3.5. New energy saving technologies	E	G	G	M	M
			3.6. Nuclear energy	E	E	E	E	E
4	Electronics and ICT	Work, personal safety, freedom of speech, print, access to information, conditions of rest, leisure, success in life	4.1. Implementation of the global logistics chain	G	G/M	M	M	M
			4.2. Logistic chains based on the use of radio frequency identification (RFIDs) everywhere	E	E	E	M	M
			4.3. Software technologies for the transfer of digital data	E/G	E/G	M	M	M
			4.4. Modern technologies for data collection and high-performance information storage systems	E	G	G	M	M
			4.5. Broadband networks	E	E/G	G/M	M	M
			4.6. Mobile Communications (4th Generation Mobile Phones)	E	G	M	M	M
			4.7. Modern technologies for virtual reality	E	G	G	M	M
			4.8.Designing structures with intellectual behavior and feedback reactions	E	E/G	G	M	M
			4.9. Full simulation for material transformation and integration in databases - ”Virtual Chemistry”	E	E	G	G/M	M
			4.10. Technologies of integrated chips	E	E	E/G	M	M
			4.11. Video sensors	E	G	M	M	M
			4.12. Microsensors and nanosensors	E	E	E	E	E
			4.13. Biochips	E	E	E	E	E
5	Materials and technology	Education, science, ecology of habitat, health	5.1. Nanocomposite materials and nanometric enhance-ment of materials in electronics, chemistry, medicine, etc.	E	E	E	G	M
			5.2. Ultra-thin functional coatings	E	G	G	M	M
			5.3. Structurally "smart" materials	E	E	G	M	M
			5.4. Reproducible materials that are suitable for reuse	E	G	G	G	M

Symbols: E - expectations (being developed) technologies; G - technologies that are in the growth stage; M - finally developed technologies used for the production of commercial products and their commercialization. The term of the final development of the technology covers 10 - 15 years; Expected commercial usage terms - up to 15 years.

Source: generalized and adapted associate professor. O.V. Bondar-Podgorska and associate professor AO Glebova on the basis of working out a literary source [6].

In 2012, the medium-term priority directions of innovation activity of the national level were approved in 2016 - for the period 2017-2021 [4]. Appropriate regulations approve medium-term priority directions of innovation activity at sectoral level. This normative legal act contains a comprehensive list of priority directions of innovation activity in the areas of energy saving, implementation of resource saving technologies, development of new technologies, high-tech development of individual industries (transport, rocket and space industry, aircraft and shipbuilding, etc.), development of nanotechnologies and agro-industrial complex, creation of new technologies and equipment for medical care, etc. However, this is not enough. Determination of a large number of areas of innovation leads to the dispersal of financial resources and tasks, which significantly restrain innovation activity in Ukraine.

As Ukraine signed an association agreement with the EU, it has become possible to take advantage of "Horizon 2020" and focus on enhancing the implementation of nanotechnology in both industry and agriculture. In particular, E.Tarasova notes that it is nanotechnology in agriculture that can increase productivity, accelerate photosynthesis and increase resistance to natural conditions [14].

In particular, the development of agriculture is negatively affected by the accumulation and storage of solid domestic waste, number of which is constantly increasing. Landfills around large cities in Ukraine annually absorb more than 1,500 hectares of land; pollute soil with toxic substances, reservoirs, wells and agricultural crops. Diseases, pathogenic bacteria and viruses are spread on urban waste landfills. Also a big problem is cleaning the filtrate. As a result of the lack of facilities for treatment facilities, it is poured through protective dams, resulting in a major threat to land resources, water and agriculture in general. It is negatively affected by pollution of surface and groundwater. The quality of the latter is constantly deteriorating due to economic activity. So, in the territory of Ukraine there are almost 3 thousand filtering wastewater storage devices. Water is also polluted due to the use of mineral fertilizers and chemical plant protection products. The most unsatisfactory state of underground water is observed in the southern regions of Ukraine [7].

The use of nanotechnologies will allow the change of land processing techniques through the use of nanosensors, nanopesticides and decentralized water treatment systems [14]. This happens due to the fact that the world develops vertical and horizontal agricultural farms based on modern technology. In particular, Singapore has 710 square km, inhabited by 5 million people, while the total area of land suitable for agriculture, is only 6.6 square km. The country imports 90% of the products. Singapore's first Sky Greens commercial system features aluminum shelving up to 9 meters high, which can have up to 38 levels. Plants grown under this system receive a dosage amount of fertilizers and remedies, and the patented system of rotation of shelves helps to uniformly illuminate and moisturize plants with minimal energy consumption. In Japan, the vertical farm Mirai Corp occupies 2.3 thousand square meters compared to a standard farm with a similar area, a vertical farm consumes 40% less energy, 80% less fertilizer, and 99% less water.

Thanks to the efforts of designers and engineers, plants are now being grown on vertical surfaces. Vertical green gardens can be seen in Italy, Mexico, Colombia. The last is the largest of them - the Vertical Garden of Bogotá, which grows 115 thousand plants. Within a year they are able to dispose of carbon dioxide emissions, which are produced by 700 people, as well as offset the exhaust of 745 cars. In Montreal, only on the roofs of the central district there are more than a hundred vegetable lots. In the German city Stuttgart, about a quarter of all flat roofs are converted into small gardens, and in London, the area of such green plantations is 121 thousand square meters.

Thus, the development of a high-tech agricultural system using engineering nanotechnology can be an excellent strategy for the revolution in agricultural practice and, thus, reduce and / or eliminate the impact of modern agriculture on the environment, and improve the quality and quantity of yields [13].

An example of successful experience in implementing innovative agricultural solutions is Israel, which does not have such an abundance of fertile land, but covers a significant part of the domestic market in food alone. This is contributing to the low cost of water - this is the core of the successful pursuit of agricultural activity. Drip irrigation is used everywhere for open soil and aerosol irrigation in greenhouses. The process of irrigation is carried out in a computerized way, which allows supplying water just at the time when it is needed, undercut or overfilled in Israel, feasible technologically.

New types of phosphate, nitrogen, potassium and complex fertilizers of their production are fed to cultivated plants, usually with water and in concentrations that ensure 100% of their assimilation without accumulation in the soil. Microadditives are available in solutions that make it impossible to defect a particular mineral during the entire period of vegetation. Fat feeding is very widely used, and it is highly effective in increasing crop yields. It is the automation of computers with processes of dressing and irrigation that allows varying the set of useful elements in irrigation water in harmony with the life cycle of crops that require a variety of types of fertilization at different stages of its development. Coarse grasses are suppressed by systematic agricultural machinery and physical-chemical methods of struggle: film coatings, mulching of soil, the use of biodegradable chemicals, directed action and specific defoliants [8]. However, the implementation process is slow because it requires significant amounts of initial investment and has high dependence on consumer opinion of products.

There is a concern that consumers can opt out of products labeled as nanofood, and this rejection can also have the opposite effect on products (for example, nanocrystal line forms such as clay, silica) already on the market that involuntarily contain nanoscale materials and which can fall under the nano definition [11]. Thus, the issue of nanotechnology encompasses the ability to solve a significant number of tasks for improving efficiency at all stages of production in agriculture. From the effective use of land to increase yields and quality control.

For Ukraine, stimulating the development of innovation in agriculture will increase yields, reduce the negative impact on the environment and ensure the safety of food. Because the nano sensors, which are being developed at the present stage, allow controlling the process of irrigation of the land. Also, they carry out intelligent monitoring of food components (for example, sugar, amino acid, alcohol, vitamins and minerals) of contaminants (for example, pesticides, heavy metals, toxins and food additives) in the product, and in the earth. There is also a potential for product packaging based on recent trends in quality control of food freshness and the integrity of packaging during transportation, storage and sale [9].

Thus, nanotechnology allows solving food security issues and meeting the vital needs of the population in quality food products. It will be possible to reduce the amount of accumulated waste with which Ukraine has a critical situation. The State Statistics Agency informs that in 2016 11.6 million tons of household waste were collected, or 271 kg per one inhabitant of the country. Only 53% of the total collected waste was removed (processed), which is 1 percentage point less than a year earlier. Almost 70% of the processed rubbish was exported to specially equipped dumps, another 4% was burnt and only 0.1% was utilized.

In the regional context, the largest amount of household waste was formed in Kyiv and the Kiev region - more than 600 kg per inhabitant, the least produced waste Lugansk and Kherson regions - less than 100 kilograms. Instead, in the EU in the last 10 years there is a reduction in the amount of generated domestic waste. On average in the EU-28 this figure is 476 kg per inhabitant. Of the total amount of waste collected in the EU, 97% (465 kg) was processed. At the same time, in 11 EU countries, the share of treated domestic waste is 100% [3].

The problems of waste are partly solved in the cities, but they are becoming very relevant for the countryside. In rural areas there is almost no organized waste disposal, there are no schemes for sanitary cleaning of settlements and waste management programs. The untimely removal of waste worsens the sanitary state of the settlements, it can become the cause of illness and epidemics. At the same time, waste is a source of secondary resources, which necessitates a scientific approach to the choice of means of their disposal and utilization in relation to the specific conditions of Ukrainian cities. All this leads to the deterioration of the environmental situation and the need to develop organizational and economic measures that will stimulate the introduction of the results of innovation - nanotechnology. Development of international cooperation, transfer of technologies, state-affiliate programs allow, regardless of the political situation, to create not only new production based on high standards of high grade and safety, but also overcome the negative effects of the crisis. This is evidenced by global experience that demonstrates sustainable growth through innovation.

Thus, the future of Ukraine is precisely for nanotechnology and nanomaterials. It will solve not only problems of quality, energy conservation, energy efficiency, efficient functioning of all spheres and industries of economy, but will also create competitive advantages for domestic producers for a long-term perspective. While the priority innovative technologies of the 21st century in the context of satisfaction of the population will become the basis for implementation of the national paradigm for Ukraine's development, provided that technology is effectively transmitted.

In this case, the technology transfer involves participation, at least, of two most important subjects of this process, the presence of which is a prerequisite for its existence - the source and recipient of the technology. In particular, the Asian countries (Chile, Thailand, South Korea, Hong Kong and other countries) in the process of organizing innovation, which do not have in their cycle the formation of fundamental ideas and being focused on the export of high-tech products, are actively using technology transfer. It allows "a critical mass of innovations", which ensure the competitiveness not only of enterprises, but also of the economy.

Thanks to its skilled state policy, South Korea and Finland ensured the gradual growth of technology exports and took a leading position in the global high-tech market and secured leading positions in the market because of conducting market reforms and using the possibilities of international technology transfer. For Ukraine, which seeks to improve not only technological balance but also to increase its international ratings and competitiveness.

The analysis of foreign experience in the context of efficient technology transfer, the formation of innovation systems in Great Britain, France, Japan, USA and the implementation of national paradigms of economic development allowed to mark the general trends and characteristic problems that led to the necessity of solving such problems in the national economy:

1) creation of protection of knowledge with commercial value;

2) support by the state of scientific institutions and universities in developing their strategies in the field of knowledge transfer, development;

3) privileges system development for the introduction by scientific institutions and universities of objects of intellectual property rights;

4) allocation of state financing and the development of a state program for the foreign patenting of objects of intellectual property rights of scientific institutions and universities.

3Conclusion

In virtue of foreign and domestic experience studying in nanotechnology development and implementation, nanotechnologies are considered as the basis for implementation of the paradigm development of the national economy and ensuring efficient technology transfer. Due to the neglect of the innovative development problems in the future, they will only intensify, which will lead to deeper processes of de-industrialization in the country. Thus, an innovative model of Ukraine's economic development requires efficient management of knowledge, innovations and resources that will satisfy the vital interests of the majority of the country's population today and in the future. It is determined that the basis of sustainable development of Ukraine's economy is nanotechnology and nanomaterials, which will help solve not only problems of quality, energy saving and energy efficiency, but also create competitive advantages for domestic producers in the long-term period. It emphasized the need for efficient technology transfer and the provision of intellectual property rights within the national economy.

References

[1] Okcana Bondar-Podhurska, Alla Glebova, Irina Khomenko, (2017) «Nanotechnologies as a Basis for Realization of the paradigm of for National Economic Development», Economics end Region, Vol. 3(64), pp.22–31

[2] Horizon 2020 [electronic resource] available online : http://ec.europa.eu/programmes/horizon2020/h2020-sections, last visit:28.09.2018

[3] State Statistics Committee [electronic resource] available online : www.ukrstat.gov.ua [in Ukrainian], last visit:28.09.2018

[4] Decree of the Cabinet of Ministers of Ukraine «Some issues of definition of medium-term priority directions of innovation activity of the national level for 2017–2021 years». December 28, 2016, N 1056. Retrieved from http://zakon5.rada.gov.ua/laws/show/1056-2016-%D0%BF [in Ukrainian], last visit:25.09.2018

[5] Korzh Y, (2013) «Estimation of the modern market of parapharmaceutical products with photoprojectors properties, made on the basis of nanotechnologies», Zaporizhzhya Medical Journal, Vol.3(78), available online: http://www.nanosvit.com/downloads/NanoSvit-Ukraine.pdf/[in Ukrainian], last visit:25.09.2018

[6] Moiseienko U. (2014) «Government support and promotion nanotechnology in Ukraine», Effective economics, Vol.6, available online: http://www.economy.nayka.com.ua/?op=1&z=3143, last visit:24.09.2018

[7] Nagornaya V. (2014) Possible threats to Ukraine's agriculture from the standpoint of ecological security, Economy of Ukraine, Vol.2 (267), pp. 71 -81.

[8] Novitskaya O., Prudnik O (2012) «Foreign experience in creating innovations in the field of agriculture», Materials of the 2nd All-Ukrainian Scientific and Practical Conference « Actual problems of economic and social development of the region», Krasnoarmeysk,pp.247 –249.

[9] Leonardo F. Fraceto, Renato Grillo, Gerson A. de Medeiros, Viviana Scognamiglio, Giuseppina Rea and Cecilia Bartolucci (2016) « Nanotechnology in Agriculture: Which Innovation Potential Does It Have?», Frontiers in Environmental Science, available online: https://www.researchgate.net/publication/299344906_Nanotechnology_in_Agriculture_Which_Innovation_Potential_Does_It_Have, https://doi.org/10.3389/fenvs.2016.00020

[10] Nanotechnology Sees Big Growth in Products and Applications (2017), Wellesley, Massachusetts, Jan. 17, available online: release/2017/01/17/906164/0/en/Nanotechnology-Sees-Big-Growth-in-Products-and-Applications-Reports-BCC-Research.html, visit:24.09.2018

[11] Claudia Parisi., MauroVigani, Emilio Rodríguez-Cerezo (2015) Agricultural Nanotechnologies: What are the current possibilities?, Vol. 10, Issue 2, April 2015, pp 124-127/, https://doi.org/10.1016/j.nantod.2014.09.009

[12] The practical application of nanotechnology in the enterprises of Ukraine, available online: http://nanodiamond.com.ua/primenenie-nanotehnologiy-v-ukraine/, visit:24.09.2018

[13] Ram Prasad, Atanu Bhattacharyya, and Quang D. Nguyen, «Nanotechnology in Sustainable Agriculture: Recent Developments», available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5476687/, visit:25.09.2018

[14] Tarasova E., Korostileva V., Ponomarev V. (2012),» The use of nanotechnology in agriculture », Bulletin of Kazan Technological University, available online: https://cyberleninka.ru/article/v/primenenie-nanotehnologiy-v-selskom-hozyaystve, visit:25.09.2018

[15] Fedulova L., (2003) «The concept of humanistic-noospheric technological development in the theory of innovation», Ukrainian society, Vol.7., pp.126–138.