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Abstract. The key factor for sustainable development is the integration of sensitive methods *for early detection of environmental risk factors for nutritional health with efficient primary prevention* against contamination of the food chains as well as deficiency of biologically active trace elements in the human diet. Proper algorithms of laser photostimulation are recommended both for more efficient biological treatment of wastewater and also for a proper amount of essential elements in cultivated plants supplemented by other modern biotechnology for multiplication e.g. vegetables. Laser biotechnology is also recommended for better reclamation followed by enhancement of biomass and bioenergy production in different regions of the world as a contribution to sustainable development and the creation of many *green jobs*. This eco-innovation supplemented with the complementary biotechnologies e.g. *reclamation of semiarid areas, modern apiculture integrated with the cultivation of medical plants, cultivation of algae, aquaculture, energy plantations, reforestation and protection of biodiversity* could contribute to better adaptation to climate change and situation connected with COVID-19 pandemic and *risk of worsening human health*, malnutrition, and hunger.

1. Introduction

A system approach to evaluation quality of the total human environment is necessary for efficient primary prevention of risk factors to environmental health [1-3]. *Nutritional health related to sustainable agriculture* and *bio-based sustainable development* has very special role in motivation of both scientists, practitioners and consumers in *common action for better quality of life and prevention of common diseases* including incurable diseases of civilization e.g. Minamata disease [4-6]. This tragic lesson from Japan is a strong motivation supporting creation Sustainable Society (Miyamoto, 2006). Trans-disciplinary cooperation among experts in human ecology, ecotoxicology, and

radioecology is necessary for environmental impact assessment focused on *early detection of environmental/nutritional health hazard*. This hazard is connected both with the direct input of contamination of the air, drinking water as well as bioaccumulation of xenobiotic in the trophic chains of animal and human beings [2, 7-9]. Experimental study on the influence of different chemical, physical and biological factors on early development of the representative of different species of animals (both vertebrates and invertebrates) was a starting point for *introduction more sensitive embryological criteria* for evaluation these environmental *risk factors for reproduction of animals and people* [10]. Our team introduced also *computer-based image analyze for early detection of the impact of environmental stressors on morphogenesis during early development* of experimental animals as well as for *detection the first symptoms of trace amount of neurotoxic pollutants* of water on kinetic disturbance of juvenile stages of tested invertebrates [11]. Recommended wide scale application of these criteria are very *useful for more efficient protection of biodiversity* and ecological balance as well as *for prevention against congenital malformations and for breeding of animals* (including aquaculture). Such kind of *biological monitoring* should be *supplemented by modern environmental biotechnology for better treatment* of sewages, wastes eco-management and *primary prevention* against contamination water and the food chains.

The top priority in nutritional health is control of *proper chemical composition* of pollutants-free food. This strategic goal is connected with introduction of new biotechnologies both for protection of the natural environment as well as alternative bio-based technologies of cultivation of plants [2, 7, 11-17]. Empirically *selected algorithms of* high density *laser photostimulation* of different species of plants including algae and microorganisms *could significantly increase efficiency of bioremediation* of xenobiotics from contaminated soil and sediments and *improved process of reclamation of deteriorated areas* [7, 12, 16-21]. Recent achievements in biophotonics and progress of laser technology as basic research [22-24] are supporting research-developing study oriented towards optimization of bioprocesses and their application for better protection of life as well as for benefit of human beings. *Integration of laser biotechnology with ecological engineering could contribute to sustainable management of the biological resources* and *to modernization of agri*culture [11]. This is also promising for the future contribution to sustainability of the Biosphere based on green technologies [25] and could supplement environmental biotechnology focused on better biodegradation, bioremediation of different pollutants of the natural environment facing goals of sustainable development [26]. *This concept initiated by Prof. Geotel already in 1*956 at IUCN GA *is supported by ecosystems-based engineering for reduction of greenhouse gas* on example of China [27] as well as is supported by new paradigm of macroeconomics [28].

2. Laser Biotechnology for Bioremediation, Reclamation, Biomass and Bioenergy Production: Objectives of Selected Case Studies

The aim of study of the team of Dobrowolski and his international school of laser biotechnology for sustainable development (diploma, postgraduate and doctoral students) were conducted the tests on application of low power laser light for stimulation of growth rate of selected species of plants in contaminated environment for enhancement adaptation and increase bioremediation of toxic metals. Other research-developing applications of this biotechnology for worldwide greening cities; was *acceleration of formation of live fence of the plants resistant to the traffic output alongside main streets* in historical city recognized by UNESCO as the World Culture Heritage in Krakow, Poland (as contribution to *protection of the human health , cultural* and *nature heritage*s) . One more innovative case study was focused on more efficient reclamation of industrial areas polluted by metals and mining areas with salted soil (e. g. in the region of world famous the Wieliczka Salt Mine).

Selected algorithms of laser photostimulation of duck weed, reed and another water plants were very useful for much *more efficient waste water treatment* as contribution to prevention against acidification and eutrophication and *protection of ecological balance of aquatic ecosystems* and *biodiversity*. The efficiency of laser biotechnology-based applications for protection of the natural

environment was evaluated by sensitive biological tests using computer- based image analyses in biological monitoring of water and air quality in experimental areas versus control areas).
Laser stimulation for *better bioremediation and reclamation of deteriorated areas and enhancement of biomass and biofuel production*:
Case study 1. The purpose was increase the efficiency of sewage treatment by duckweed (*Lemna minor*) for hydrobotanic plants in climate of the Central Europe in cooperation with Sliwka, Trojanowska etc. Duckweed irradiated by argon laser irradiation increased resistance to low temperature and surface of these plants (according to computer-based image analysis) and their biomass production at spring time. Better even effects were after application of the laser diode of wavelength 660 nm (which is much cheaper than Ar laser). Application of proper algorithm of photostimulation by medical laser emitting also red light, significantly improved resistance to both hypothermia and contamination of the pond water with crude oil. Laser photostimulation increases bioavailability of biogens to the duckweed, reed and decrease intoxication of the plants by metals. These results are useful for prevention against eutrophication, enhancement of biomass production and protection of aquatic ecosystems.
Case study 2. The aim was in cooperation with Jakubiak for better adaptation of cuttings of different species and strains of willow planted in salted soil for reclamation of some mining areas. The most effective was irradiation of the cuttings of salix (*Salix viminalis varietas turbo)* with impulse medical laser after exposition time 3x30 sec for biomass production by sprouts and roots and for higher resistance to salt NaCl in soil and water deficiency.
Case study 3. The goal was enhancement of adaptability of willows cuttings (*Salix viminalis*) and roots of Virginian malva (*Sida hermaphrodita*) to pollutants emitted by cars and acceleration of formation of protective hedges alongside high polluted streets. He-Ne laser irradiation of willow's cuttings increases significantly growth rate and surface of leaves of the plants cultivated in areas contaminated by traffic output. Application in cooperation with Slazak of not expensive laser diode of wavelength 532 nm increase also resistance of Virginian malva *Sida hermaphrodita* to cars emissions and improve efficiency of formation protective green area against traffic output alongside main streets. Coherent light stimulate also bioavailability of such metals like Pb and Cd (according to AAS and X-ray microanalyse under Scanning Electron Microscope SEM).
Case study 4. The objective of this study was in cooperation with Knast and Sloniec the increase of phytoremediation of nickel by great miscant (*Miscanthus x giganteus*), increase biomass production and more efficient reclamation of industrial area. The best results of enhancement of bioremediation was after irradiation with impulse medical laser 3x30 sec; increase survival rate of young seedlings in polluted region as well as growth rate and biomass production by ca. 50% and two times higher concentration of Ni in comparison with control group of plants. Briefly reviewed results other long-term study of our team research related to application of laser stimulation of plants for better management contaminated areas [11]. Another promising for the future object is laser stimulation of soil bacteria and fungi for reclamation of deteriorated areas [12, 20] and photostimulation of inoculum of mycorthitic moulds for *more efficient recultivation of land contaminated* with metals.
Case study 5. Increase of biomass production under suboptimal condition and enhancement of bio-energy production. After five years of short time irradiation in cooperation with Sliwka of seedlings of *Rosa multiflora* before cultivation in energy plantation the energy content of biomass of group of experimental plants was 18.255 Mj/kg versus 17.574 Mj/kg of control group of rosa. Biomass of laser stimulated plants contains 0.15 % more hydrogen. In result of application of selected inorganic nickel-containing catalyst, significantly increased the value of bio-energy in result of gasification of biomass of laser-treated plants in relation to yield of synthesis gas from control biomass [11, 29-33]. According to the review book on photocatalysis including linkage to nanotechnology nobody applied lasers before [34]. Dobrowolski initiated preliminary successful experiments with application of laser photostimulation of selected plants and nanoparticles containing selected trace metals as photosensitizers. In result of long-term ecological disaster, dramatic water deficiency and progress in chemical contamination of all components of the natural environment desertification in great region

of the Aral Sea population over 3 million (children in particular) became victims of terrible health hazard [35]. Introduction of *laser biotechnology was recommended for more efficient bioremediation, reclamation and management of the most deteriorated region* in Uzbekistan. This concept is connected with *real perspective of improvement of environmental health by integration of more efficient sewage treatment for reuse water and replacement of over dosage of harmful pesticides by environmentally friendly photostimulation of the seeds* for *enhancement cotton yield*, as well as biomass and bioenergy production in energy plantations in semiarid regions.

3. Perspectives of application of laser biotechnology for improvement nutritional health

Global Action Zero Mercury recommended by WHO is very reasonable not only for prevention at the sources against new victims of incurable Minamata disease already reported in Japan, Iraq, Canada, Brazil, Peru and other regions [4]. Even trace amount or *organic mercury in human diet is connected with risk of congenital malformations of neural system*. Referring to antagonistic relation of some trace elements *coincidence of contamination the food with mercury with deficiency of selenium could increase risk* for *Minamata disease* [12]. Therefore was recommended supplementation of the diet of inhabitants of the Minamata region selenium reach see products as well as introduction laser stimulation of tomato seeds for higher bioaccumulation of selenium from soil supplemented with inorganic selenium compounds [12, 19]. Janicki's epidemiological survey stated significant correlation between *contamination of soil and human food chain with fungicide containing mercury and higher risk of incidence of human leu*kemia in rural regions. Mean concentration of mercury was higher in people suffering with leukemia to compare with healthy subjects as well as in body of cattle with bovine leukemia versus health animals [36]. Inyushin et al. introduced laser treatment of seeds instead of very toxic fungicides as valuable contribution both to agriculture and health of consumers [1]. Coincidence of contamination of the human as well as animals' food chain with different toxic metals like Cd, Pb, Ni etc. is connected with acidification of soil and water; could significantly increase bio-accumulation and related hazard for consumers [2, 7, 8, 12, 18]. Ecotoxicological survey of trace elements in human and cattle food chains in control areas and clusters of cancer and leukemia indicated higher concentration the above mentioned trace metals in soil and trophic chains in the clusters areas [7, 12]. Higher income in the diet of mercury, cadmium, lead, nickel etc. was accompanied by deficiency *in the human and cattle food chains* in the cluster of neoplastic diseases, such biologically active elements like iron, magnesium, zinc, etc. Excess or deficiency of selected elements in the clusters was accompanied by *similar differences in mean concentration the some elements at cellular level of blood cells of the people* and the cattle. There were stated also significant differences among health blood donors and the patients suffering with different types of leukemia [3, 37, 38]. President of the Hamdard University Hk. Hameed and Prof. Vohora initiated very fruitful trans-disciplinary cooperation on application of knowledge about biological effects of elements for improvement human health within the International Union of Elementology founde in New Delhi in 1983. This activity was supplemented also by complementary activity of other eminent experts like founder of the journal focused on nutritional health and the Environmental Health Nutritional Organization and the School of Environmental Science in the J. Nehru University Prof. Bhatia jr.and organizers and chair persons of series of international seminars and conferences on the role of different elements in human and animals health organized by Prof. Aleksandrowicz et al. at Com.for Protection Public Health of the Polish Academy of Sciences in Krakow, Prof. Anke in Germany, Profs. S. and S. Pollet in Greece and Prof. Pais in Hungary, Prof. Westermarc in Finland [18, 21]. Related publications are very valuable sources of valuable information from complementary disciplines and inspiration for development cooperation *integrating protection of the total human environment and nutritional health for more efficient primary prevention against health hazard*. Wide scale training at university and open for all education on medical elementology is one of new elements of common action for better environmental health (including personal health) focused nutrition adapted to biogeochemical predisposition of different regions, age groups, etc. [39]. Coincidence of deficiency of some biologically active trace elements, excess of toxic metals in the food chains with

contamination of soil and drinking water with nitrosamines and mycotoxins and higher incidence of toxicogenic fungi in buildings significantly increase risk of cancer and leukemia incidence in result of synergistic effects [3, 20, 21, 37, 40, 41].

One of promising for the future cooperation is prevention at the sources of water-borne diseases, especially against common in developing countries infective diseases by integration two fields of complementary activity. One of them is introduction of *laser biotechnology for more effective treatment of waste water* form living houses using bioreactors with laser irradiated inoculum of zooglea as well as hydroponic plant for cleaning sewage with stimulated with coherent light algae and water plants [11]. The second method is application of bee product propolis for therapy. Introduced by the Polish team of experts (initiated by Eng. Tomaszewski founding president of the "Apipol" Apiculture Company) in modern apitherapy; was very useful for cooperation with team of Prof. Dobrowolski with Profs. D. and S. Belsares'(from the Faculty of Biotechnology Bhopal University) for *more efficient treatment of victims of great ecological catastrophe* in Bhopal. In result of Indo-Polish cooperation of teams of Prof. Vohora (from Department of Medical Elementology and Toxicology of the Hamdard University in New Delhi) and Prof. Dobrowolski (from the Department of Environmental Biotechnology and Ecology of the AGH University of Science and Technology in Krakow and Polish Academy of Sciences Com. for Protection Public Health and Com. of Remote Sensing and Environmental Engineering); were *recommended wide-scale application of the propolis based products for successful therapy of some common in developing countries infective diseases of gastro-intestinal truck* [3]. Following the first successful experiments on impact of the laser biostimulation of the plants on increasing or decreasing accumulation of trace elements, depending on applied algorithms [1, 7, 19, 42] was reported enhancement of titanium accumulation from introduced by Prof. Pais (from the University of Agriculture and Food in Budapest and the Hungarian Academy of Sciences) titanium ascorbinate in maize in result of laser photo-stimulation of their seeds [21].

Adequate algorithms of low power laser stimulation of samples of carrot and beat *significantly improved biotechnology of androgenic and gynogenic multiplication of the high quality of vegetables* as result of experimental study of Prof. Dobrowolski, Prof. Gorecka and Dr.Kiszczak [43]. Integration of application of laser photostimulation for *enhancement yield of cultivated plants and amount of essential elements is also new perspective in phytotherapy and nutritional health*. Integration of this innovative biotechnology with modern beekeeping is a starting point for efficient research developing study on new generation of herb-honey or phyto-honey. In the result of initiated by president of the Apipol Apiculture Company Eng. Tomaszewski's; team of experts experiments was introduced new methods of feeding bees *Apis meliphica* with special extracts of medical plants and different species of vegetables. In result of cooperation Prof. Belsare and Prof. Dobrowolski in progress is initiated in 1985 Indian-Polish cooperation for introduction and wide-scale dissemination in poor regions of developing country cooperation *useful* not only *for apitherapy*, but also *for creation many green jobs* as contribution to *sustainable labor market integrated in more efficient protection of the nature heritage* including the biggest all over the world nature reserve of tigers (Prof. Belsare's 3 monographic books in press).

There are already tested on industrial scale very efficient technologies for nutritional prevention or therapy of common diseases. Some of herb-honey are supplemented by bacteriostatic and mycostatic propolis as well as pollen or bee-bread as valuable source of biologically active elements and vitamins useful for better nutritional health (e.g. prevention of iron-deficiency anemia) both in developing and developed countries [44]. Know-How connected with introduced in Poland modern system of beekeeping by Tomaszewski and Dobrowolski [44] would be useful both for introduction many *bee-products for nutritional prevention*, as well as for *enhancement of vegetables and fruits production and creation during short time a lot of green jobs as contribution to circular bio-economy and sustainable development in different rural regions* all over the world.

New trends in environmental biotechnology for improvement natural environment biodegradation and bioremediation have been proposed to support sustainable development including both socio-economic , ecological and health aspects of global warming [26]. Progress in design and synthesis of

photo-luminescent inorganic-protein hybrid bio-nanostructures and bio-nanoparticles for medical application [45, 46] should be integrated with progress in green synthesis of ecofriendly nanoparticles for better phytoremediation [25, 47]. Referring to our team research-developing study, we recommend supplementation of state of the art of bioprocesses oriented on better environmental and nutritional health by better use of real perspective of application of laser biotechnology and photosensitive NPs, including bio-nanoparticles for prevention common health hazard in developed and especially in developing countries.
Wider dissemination of practical output of included in this review innovative case studies could be useful for decreasing environmental and nutritional risk factors for human and animal health connected with anthropogenic contamination of the natural environment, as well as impact of climate change and COVID-19 pandemic.

4. Conclusions and Recommendations

Innovative applications of laser biotechnology for reduction of contamination of the air, water, soil and food chains are based on increase of adaptability of different species of plants and microorganisms to suboptimal environmental conditions (different pollutants, acidification, low and high temperature, etc.) – in the result of efficient stimulation of some enzymes, enhancement of bioenergetics processes and unspecific adaptability in the result of photo-stimulation of biological materials with empirically selected algorithm of laser irradiation.
One of fields of applications of this new biotechnology is more efficient bioremediation of wastewater, as well as contaminated land, acceleration of formation of protective green screens alongside main roads and greening cities, as well as more effective reclamation and higher biomass production in deteriorated areas as contribution to sustainable development of different regions.
Wide scale applications of the laser biotechnology (reasonable in terms of cost-benefit analysis) could contribute to decrease concentration of green-house gases and primary prevention of climate change and also to progress in re-notarization of the rivers regions, increase of water retention and prevention against flood incidences and promotion of bio-based sustainable development adopted to priorities of different kind of regions, *following concept of Dobrowolski J.W. introduced in 1975 supported by positive results of laboratory and field studies*.
Recommendations:
1. Laser light of adequate wavelength energy density and time of exposition could increase resistance of various species of plants to different pollutants of the air, water and soil (including traffic output, different industrial contaminants and salts).
2. Laser biotechnology is useful for more efficient treatment of wastewater in hydro botanic plants, phytoremediation of toxic metals from soil (as innovative contribution to environmental/nutritional health) and reclamation of regions of mining areas as well as metallurgical, chemical, cement plants , reforestation and *enhancement of biomass production in energy plantations in areas out of use for food production* and for *contribution to development of biofuel and bioenergy production instead of over exploitation of forest.*
3. Results of long-term experimental studies support also recommendation of laser biotechnology for *management of the green areas alongside main roads* for reduction of negative impact of motorization of the air pollution and contamination of animal and human food chains.
4. Wide-scale irradiation of native plants (seeds, cuttings, seedlings) could *increase their rate growth contribute to higher retention of water and prevention against flood incidence* as well as *increase carbon dioxide fixation* by photo-stimulated plants as prevention against global warming effect and related natural disasters.
5. New trends in environmental biotechnology for improvement natural environment biodegradation, bioremediation to support sustainable development including socio-economic aspects of global warming, green synthesis of eco-friendly nanoparticles (NPs) for better phytoremediation could be supplemented by laser biotechnology and photosensitive NPs.

6. Laser biotechnology and complementary eco-innovations are recommended for worldwide applications as modern tools for *system approach to reduction of emission and contamination of the air, water, soil and food by different mutagenic and carcinogenic factors* for better primary prevention of incidence new mutants e.g. of coronaviruses and for reduction of risk of new pandemics as well as for *decreasing frequency of incidence of cancer/lymphoma/leukaemia* and also for *reduction of frequency of congenital malformations, endocrynological and metabolitic disorders* (e.g. obesity, diabetics), *environmental allergies* etc.
7. There are scientifically proved many negative effects of common over dosage chemical compounds in agriculture and forest management. Over dosage of pesticides for long term is connected with decreasing their efficiency and increasing very negative impact on intoxication food chains of people and animals and associated with this tendency significant increase of frequency of related allergic diseases, congenital malformations, including endocrinological and metabolistic dysfunctions as well as increasing rate of incidence of some kind of neoplastic diseases e.g. lymphoma, leukemia, cancer etc. There are also very negative side effects of over dosage of pesticides on functions of ecosystems and also on populations of bees and other insects necessary for pollen transport among flowers and production of vegetables, fruits etc. There are also eco-toxicological risk factors for extinction rare species of protected birds and other animals in result of increasing concentration of xenobiotics at the end of trophic chains. Similar risk factors are related also to breeding animals and consummates of milk, meat and other kinds of human food. Therefore very useful are innovative experiments and research-developing studies focused on replacement of harmful for health, economy and nature chemical products by safety alternative methods for protection plants and stimulation their growth rate and productivity especially under suboptimal conditions e.g. connected with climate change. Physical methods of seed protection and preservation have several advantages over traditional chemical treatment methods; firstly, they reduce the use of fertilizers, thereby reducing the pollution of farm-produced raw materials. Another advantage is that physical methods can also be used to disinfect seeds before sowing and during storage. Hence, the development of scientific and technical fundamentals of environmentally friendly technology for the electric and laser disinfection of cotton seeds using electromagnetic fields and laser irradiation following the concept of Prof. Jan W. Dobrowolski et al. is highly recommended.
Referring to these conclusions experts interested in interdisciplinary cooperation for new applications of laser biotechnology for sustainable development focused on better adaptation of water management and food production to Climate Change, and nutritional health (e.g. deficiency of essential trace elements in human diet) in linkage to circular bio-economy.

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