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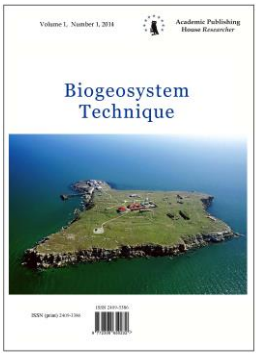

Soil Fertility in Agriculture: Russia – Western Europe – USA: in the Past and Today

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Abstract

An overview is presented of how scientific agriculture perceived soils as stocks for minerals for crop production, and to what extend this perception, as it is accepted in agronomy, is considered as relevant in related scientific fields. In the nineteenth century the role of microbiology in soil ecosystems was revealed, the balance of crop remnants and manure conversion was studied, as well as seasonal crop feeding at different systems of manuring, crop rotation, tillage and mixed systems, to manage the balance of crop- and livestock production under low external input conditions. Particularly after World War II, the long-term experience of 'living soils' was ruined by the practice of excessive external inputs of agrochemicals – fertilisers and subsequently pesticides. On a minimized scale, soil-friendly agriculture was and still is present in organic and biodynamic movements, together with various other agro-ecological approaches, attempting to overcome the disadvantages of industrial agronomical agriculture. On this way the FAO declared the year 2015 as the year of soil, while very the same FAO had supported the chemical agriculture for decades in the recent past. This metamorphose has appeared because the shocking soil-destructive role of industrial agronomy causing soil degradation (soil erosion, poisoning and compaction) with flooding followed by drought – the total anthropogenous uncertainty of agricultural land and biosphere as a whole is now becoming more and more obvious. Today soil-ecosystem awareness arises in plant breeding, biosphere & climate, human health, rural development, manuring and phytopathology's pesticide effects on soil ecosystems. In organic (agro-ecology) systems the main problem is the transition period, wherein the mentioned problems of soil compaction, dead-end porosity, low soil nitrogen production, low rate of crop remnants and manure conversion, soil productivity stagnation on the low level are critical. Over and again new approaches are needed to overcome the shortcomings of industrial agriculture and thus attain the higher level organic agriculture. It will be shown that organic/agro-ecological farming systems produce much better that usually known. Moreover, Biogeosystem Technique is a promising transcendental integral approach to overcome the conflict of technology and biosphere.

Keywords: soil fertility, fertilisers, manure, plant nutrition, carbon cache.

1. Introduction

The consequences of soil fertility, human health and global nutrition issue are important question to properly perceive plant nutrition, crop- and soil-management. The soil ecosystem is crucial to sustainable soil fertility. The main nutrient for the soil ecosystem is Carbon (as carbohydrates), that delivers the much needed energy to the soil meso- and micro-organisms.

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Straw rich manure and well composted crop remnants increase quality and quantity of the yields, provided well elaborated crop-rotations and minimal ploughing. The organic and biodynamic farms have been screened on their long-time production and on their effects on the environment (up to climate effects) (Van Mansvelt, 2016).

The key notes on plant nutrition are as follows: plants feed themselves from fertile soils, and supply the conversion soil-ecosystems with exudates and remnants. Von Liebig senior has himself revised his early perceptions on exclusively mineral plant fertilization by appreciating soil life and the biological N fixation (Von Liebig, 1861).

The soil fertility is to be focused on the time and global scale including various neighbouring disciplines of agronomy such as plant breeding, biosphere & climate, human health, rural development, manuring, and pesticide effects on soil ecosystem (Van Mansvelt, 2017).

2. Method

Vavilov wrote in 1935 (Vavilov, 1997): "in the past the care for the soil – fertilizer, tillage, etc, came to the fore. But our main goal is in the other – in agricultural plant building". Thus he shifted his attention to genetically improving plant species to existing biotopes and left the improvement of biotopes to fit plant species to others like the microbiologists. The leading role of leguminous crops in supplying both people and livestock with protein, increasing soil fertility is a base of the organic agriculture method (Loskutov, 1999; Dragavtsef, Kurtener, 2016).

3. Discussion

Winogradsky (1856–1953) – the famous Russian microbiologist and agronomist was the first who started determining microbial species in a medical and later in an agricultural context (Winogradsky, 1952). Winogradsky eye opener was that the microbial species' particular properties could be easily lost in artificial conditions, as being estranged from nature (Chung, Case, 2001). On the other hand, the microbial species could be ruined by agro-chemical inputs in natural ecosystems. This could become the cause of its collapse – unfavorable positive feedback in the anthropogenous ecosystem.

In 1922 Winogradsky set up the new agricultural bacteriology division of the Pasteur Institute in Brie-Comte-Robert (France) which activity was based of biological N-fixation. The studies of bacterial complexes in the soil nitrogen cycle were started. It was revealed that the complexity of soil bacteria required studying them not only in laboratory cultures but preferably in their natural habitats. As a result of competition, the majority of soil organisms are in a dormant state – it had been shown on example of the *Azotobacter* – active in isolation, but remaining "obstinate into soil in situ" – so the use of laboratory methods in pure culture, and bacteriological media, could not be base of the real soil science. While at Brie, Winogradsky showed the bacteria of rhizosphere as an active agent of N-fixation. These findings triggered a development of commercial nitrogen-fixing bacteria cultures by Ira Baldwin at the University of Wisconsin.

Between 1926 and 1929, Winogradsky embarked on a study of aerobic organisms involved in cellulose decomposition and recognized a series of bacterial genera degrading cellulose and synthesizing polyuronides in soil. He was the first to describe the fusiform, cellulose-degrading cells in the genus *Cytophaga*. Winogradsky started the concept of reductionism and single action-reaction relationships to be studied both under natural or artificial conditions. He realised the natural soil as a complex ecosystem. The safe wide range of interacting organisms requires a holistic multidisciplinary approach, in order to establish sustainable land-use.

Also V.R. Vil'yams (1895–1898) was an adherent of soil-ecosystem good care.

Nikolai Aleksandrovich Krasi'lnikov (1896–1973), the director of the Institute of Microbiology of the Academy of Science of the USSR, in his 'Soil Microorganisms and Higher Plants' (Krasi'lnikov, 1958, 1968, Gutina, 1982) mentioned the soil's microbial life and its interactions with the crops growth, the utility of fertilisers, the crop rotation.

Anton Nigten (2017) summarised Krasi'lnikov's main points as follows:

1. Organic fertilisers cannot be (completely) replaced by chemical salts (such as the well know NPK fertilisers of today);
2. Using composts as fertilisers in his experiments, he found yield increases of 10–50 %, as compared to using chemical fertilisers. However, there were considerable differences between crop species;

3. Remnants of crops and animals must be converted into humus before crops can feed on them;

4. Fertile soils contain more amino-acids then infertile ones;

5. Crops can feed on organic substances only (Palladin, 1924), with a positive effect on their quality as crops as well as of their seeds (Samokhvalov, 1952; Kursanov et. al., 1946);

6. Most plants can interact symbiotically with mycorrhiza fungi, as well as with bacteria. They feed the soil ecosystem and derive specific nutrients in return. This happens most strongly in the early phases of plant development;

7. Mycorrhiza fungi, algae and bacteria exude biotic substances into the soil, such as vitamins, amino acids, auxins, antibiotics, nitrogen compounds, organic acids and phosphor compounds. The B vitamins are very important to plants, like vitamin B_1 for O_2 rich combustion, of B_6, B_2, B_{12}, PP and H for formation of amino acids and their transamination;

8. Several organic compounds can be taken up directly as such by plant roots, see for example Laurent and Marchal (1903), so complete mineralisation of the organic compounds is not a requirement as often presumed. Moreover, when bacteria and mycorrhiza fungi are present, phosphorus is taken up more easily;

9. Each and every plant species creates its own rhizosphere in the soil, with its own microorganisms. Thereby the soil, climate and management conditions are crucial. For example do microorganisms produce organic metal components (note that plants cannot take up inorganic iron). So, depending on the situation, nourishing or toxic conditions can occur in the rhizospheres;

10. During crop growth there are mainly non-sporulating bacteria, fungi, and algae. When crops ripen the sporulating species, feeding on plant remnants, become most present. The latter can be detrimental to crops as they exude toxic substances: a monoculture effect that cannot be countered through fertiliser use;

11. In fertile soils less harmful microorganisms are found as compared to infertile soils. By adding $CaCO_3$, MgO and NaOH Krasil'nikov accomplished important improvements of soil quality. On the contrary, by adding KNO_3 and KPO_3 azotobacter, a healthy soil indicator, was killed. These experiments were done in podzol soils that presumably lacked Ca, Na and Mg, and presumably where still rich in K;

12. All micro-organisms have their own antagonists in the soil ecosystems. To increase their positive effect on plant growth, Krasil'nikov mixed them with compost, thus keeping them in a good balance;

13. Plants growing in soils treated with manure or compost where found to contain more 'active plant juices', with antibiotics from the soil. Their resistance against plant diseases was increased as compared to non-treated plants;

14. Epiphytes on over ground crop parts scan have positive or negative effects on the plant growth, similar to those of microorganisms in the soil;

15. In his last book "Microbes and toxic chemicals in the struggle against plant pests", Krasil'nikov argues strongly in favour of microbial balances in the soil ecosystem to prevent diseases, and thus against killing those living soils by using pesticides.

It is now obvious that – even long ago Winogradsky and Krasil'nikov and their successors – Rudolf Steiner (1861–1925) (Steiner, 1924, 1993), Sir Albert Howard (1873–1947) (Howard, 1940), William Albrecht (1888–1974) (1975), Hans Peter Rusch (1906–1977) (2004) and Masanobu Fukuoka (1913–2008) (1975 & 2009) – were much aware of the complex living soil ecosystem, abundance of microbial species (not focusing on the single microorganism producing natural antibiotics), interactions of the soil systems as cause for crops to grow well (Chaboussou, 1987, 2004; Besson, 2017) on the healthy soil (Semenov, Sokolov, 2016). Unfortunately, the perception of soil as living organisms was overruled by the agro-chemistry adherents and ever less applied in agriculture – agronomy specialising on the distorted perception of linear chemical interactions only. The awareness of soil ecosystems as a living wholes must be restored, in order to reach a truly sustainable agriculture.

In USA John Marler (2009a, 2009b) manifested soil-ecosystem awareness of today and listed the benefits of biotic fertilizers as follows:

1. Full genetic potential: Crops grown with the steady nutrition provided by the complex ionic nutrients contained in soil acids are usually superior in appearance, size and nutrient density to crops grown with conventional fertility formulations;
2. Equal or greater yields: Biotic fertilizers have equalled or excelled in crop yields when compared with conventional fertility programs in both organic and NPK + biotics formulations;
3. Cost: Biotic fertilizer costs are equal to, or less than, costs associated with conventional fertilizers. When oil prices and natural gas prices increase, the cost of conventional fertilizers increases, but the cost of biotic fertilizers stays relatively stable;
4. An end to arable soil erosion and loss of topsoil: Conventional fertilizers are easily over applied. The result is an imbalance in the carbon: nitrogen ratio in a soil, which accelerates the loss of topsoil. Biotic fertilizers work in a natural manner to rebuild soil acids and soil acid gels that act to hold topsoil in place;
5. Soil remediation: Biotic fertilizers have the ability to grow a crop to its full genetic potential while remediating and building soil organic matter, in the form of complex nutrition soil acids;
6. Less toxicity: Biotic fertilizers come in both organic and non-organic forms. While organic forms are naturally less toxic, even the non-organic forms have been shown to require less use of pesticides and fungicides. As a result, conventional fertility programs fortified with biotic fertilizers are not only less toxic, but also have lower costs normally associated with pesticide and fungicide applications;
7. Less crop attack by pests: Organic growers have noted that organic crops experience fewer attacks by pests when compared to crops fertilized with conventional fertilizers. Biotically fertilized crops, particularly those grown with USDA National Organic Program fertilizers, typically exhibit little attraction for insects. Nature has a means for protecting healthy plants from insects, and biotic fertilizers enable these protective mechanisms;
8. Less fungal attacks and disease: biotically fertilized crops have repeatedly shown an ability to resist fungal attack and plant disease. Growers with many different crops in diverse regions have reported that the incidence of powdery mildew, fungus, and other specialized fungal attacks, such as club root in cole crops, are diminished by the use of biotic fertilizers. The mechanism behind this ability is suspected to be the chelated forms of natural elemental fungicides, such as copper, magnesium and zinc that are contained in the biotic formulations.

Marler shares the soil fertility awareness of Winogradsky and Krasil'nikov.

In Russia the idea of soil-ecology based agriculture is presented by A.A. Zhuchenko (1995) and Evgeny Lysenko et al. (2010). They criticise the agriculture trend of industrial chemisation (fertilisers & pesticides) killing soil life in monocultures and soil mouldboard ploughing, compaction of soil, which become impermeable for air and water. Fertiliser application causes the decline in soil micro-organisms, the crops lose their resilience, and the use of pesticides that kill the soil ecosystem more and more is badly stimulated. This positive feedback ruins the soil ecosystem – short-term socio-economic, institutional and governmental policies, short-time money making contradict dramatically a sustainable land-use future (Van Mansvelt, Van der Lubbe, 1999).

The post 2nd WW FAO's policy has been linked with war-driven centralised chemo-technical mono-cultural high external input approach rather than non-violent soil ecosystem. Now FAO's Deputy Director-General Maria Helena Semedo warns that agriculture is discovered as a big threat in the fight against climate change and is to be integrated as a sector of the urgent government climate policies (Semedo, 2015). Vananda Shiva (1999) appeals for decades for the agro-ecology/organic agriculture political support. Agriculture on carbon enriching soils is a strong measure against greenhouse gases (Van Mansvelt, 2016).

Decades after the crucial shift to post 2nd WW chemisation, the need to go back to soil fertility production is finally accepted as very urgent. There are attempts to generate and apply knowledge required for economically and environmentally sustainable crop production systems and products, as well as in developing land management strategies that protect the quality of soil, water and air resources as the key for sustainable agriculture (Crop and Soil Sciences, 2017), practical recommendations are proposed by Forschungs Institut Biologisch Landbau (FIBL) on the basis of sustainable soil fertility ins and outs, improving land management (Anonymous, 2012).

The Soil Biology Prof Lijbert Brussaard, from Wageningen University in October 2016 summarizes the agenda on the own three decades research basis:

"Over the years, my interest has broadened from straight soil biology to ecosystem services mediated by the soil biota, the (synergies and trade-offs between) ecosystem services and how scientific knowledge may inform land use planning and decision-making by actors in agricultural landscapes. In particular, my research focuses on:

- Biodiversity in agricultural landscapes. Agricultural landscapes are important for the survival of a great deal of wildland biodiversity. The challenge is to make wildland biodiversity more meaningful for the functioning of agricultural landscapes and the provision of ecosystem services. The challenge I am working on is to understand and integrate soil biodiversity in this picture;

- Soil biota – soil structure interrelationships. As a result of agricultural management the contributions of the larger soil biota, such as earthworms and termites, to the formation of soil structure and porosity has diminished, with likely negative effects on the build-up and maintenance of soil organic matter. My research is aimed at understanding and restoring the activity of the soil biota and associated ecosystem services;

- Element cycles as influenced by the soil biota. With mounting pressure on increasing biomass production, while reducing nutrient and greenhouse gas losses from soil to the environment, my research is aimed at understanding and managing of soil biotic interactions for increased nutrient use efficiency in agriculture;

- Biological soil quality. The concept of biological soil quality recognizes that soil characteristics, soil properties, ecosystem functioning and soil ecosystem services are mediated by the soil biota. The research is aimed at scientific underpinning of the concept and making it operational for farmers and other land users.";

Also, the importance of crops breeding which have wide and deeper root systems is mentioned, in order to improve carbon sequestration and soil-ecosystems development as a whole, as needed for good crop yields. D.B. Kell (2011) states:

"The soil represents a reservoir that contains at least twice as much carbon as does the atmosphere, yet (apart from 'root crops') mainly just the above-ground plant biomass is harvested in agriculture, and plant photosynthesis represents the effective origin of the overwhelming bulk of soil carbon. However, present estimates of the carbon sequestration potential of soils are based more on what is happening now than what might be changed by active agricultural intervention, and tend to concentrate only on the first metre of soil depth.

Breeding crop plants with deeper and bushy root ecosystems could simultaneously improve both, the soil structure and its steady-state carbon, water and nutrient retention, as well as sustainable plant yields. The carbon that can be sequestered in the steady state by increasing the rooting depths of crop plants and grasses from, say, 1 m to 2 m depends significantly on its lifetime(s) in different molecular forms in the soil, but calculations (http://dbkgroup.org/carbonsequestration/rootsystem.html) suggest that this breeding strategy could have a hugely beneficial effect in stabilizing atmospheric CO_2. This sets an important research agenda, and the breeding of plants with improved and deep rooting habits and architectures is a goal well worth pursuing."

E. Charles Brummer et. al. (2011) from the Forage Improvement Division, The Samuel Roberts Noble Foundation, Ardmore, UK, states that:

"Plant breeding programs primarily focus on improving a crop's environmental adaptability and biotic stress tolerance in order to increase yield. Crop improvements made since the 1950s – coupled with inexpensive agronomic inputs, such as fertilizers, pesticides, and water – have allowed agricultural production to keep pace with human population growth. Plant breeders, particularly those at public institutions, have an interest in reducing agriculture's negative impacts (sic. JDvM) and improving the natural environment to provide or maintain ecosystem services (e.g. clean soil, water, and air; carbon sequestration), and in creating new agricultural paradigms (e.g. perennial polycultures). Here, we discuss recent developments in, as well as the goals of, plant breeding, and explain how these may be connected to the specific interests of ecologists and naturalists. Plant breeding can be a powerful tool to bring "harmony" between agriculture and the environment, but partnerships between plant breeders, ecologists, urban planners, and policy makers are needed to make this a reality."

Biosphere and climate is the awareness of European environment (2010) because agricultural intensification including bio-fuels means decreased crop diversity, simplified cropping methods, fertiliser and pesticide use, exacerbating biodiversity loss and homogenised landscapes. Industrial chemicals, heavy metals, nitrate and phosphorus, pharmaceutical products end up in the soil or in water, excess atmospheric nitrogen content is a dangerous issue across the EU (Soil and climate change, 2017), the costs of degradation are inappropriate (The Union of Concerned Scientists, 2017):

"Industrial agriculture is currently the dominant food production system in the United States. It's characterized by large-scale monoculture, heavy use of chemical fertilizers and pesticides, and meat production in CAFOs (confined animal feeding operations). The industrial approach to farming is also defined by its heavy emphasis on a few crops that overwhelmingly end up as animal feed, biofuels, and processed junk food ingredients.

From its mid-20th century beginnings, industrial agriculture has been sold to the public as a technological miracle. Its efficiency, we were told, would allow food production to keep pace with a rapidly growing global population, while its economies of scale would ensure that farming remained a profitable business.

But too often, something crucial was left out of this story: the price tag.

In fact, our industrialized food and agriculture system comes with steep costs, many of which are picked up by taxpayers, rural communities, farmers themselves, other business sectors, and future generations. When we include these "externalities" in our reckoning, we can see that this system is not a cost effective, healthful, or sustainable way to produce the food we need.

And the good news is that it's not the only way. Scientists and farmers are developing smart, modern agricultural systems that could reduce or eliminate many of the costs of industrial agriculture—and still allow farmers to run a profitable business. It's time for farm policy to move into the 21st century and prioritize these innovative methods. As I could show last year in Skolkovo, a range of rresearches has shown that average organic farms have a better yield and a higher income than comparable conventional farms (Van Mansvelt, 2016).

Industrial farming has negative effect on environmental safety. The effect on health of workers, eaters, and downstream neighbours is often neglected. The health impacts:

Pesticide toxicity. Herbicides and insecticides commonly used in agriculture have been associated with both acute poisoning and long-term chronic illness (like Alzheimer's disease, obesities, diabetes etc.).

Water pollution from fertilizer runoff contaminates downstream drinking water supplies, requiring costly clean-up measures with an annual price tag of nearly $2 billion.

Ecosystem pollution from the Antarctic snow (Zhang et al., 2015) to the sea water in the deepest oceans pesticides in tiny quantities (0.1 Nano grams per litre water) have been found, which are enough to pose potential threats to wildlife by accumulation in the food chain.

Junk food. Industrial agriculture, especially in the central United States, mostly produces commodity crops like corn, sugar beets and soybeans. These crops are used to make the processed foods that dominate the US diet, with serious – and enormously costly – health impacts. All those foods contain small quantities of dozens of different agro-chemicals that are used on those crops (like glyphosate and imidacloprid). Some chemicals are added during food processing (like MSG and dozens of other), and other pesticides (like glyphosate and imidacloprid) are developed in order to be absorbed by the plant roots, which thus increases the risks of passing the whole food chain to the end users.

Antibiotic resistance. The overuse of antibiotics in CAFOs has accelerated the development of antibiotic-resistant bacteria, which has taken a toll both in lives and health care dollars.

In former days the American Corn Belt soils were fertile, just as the Russian Chernozems! Now, under industrial farming, soil fertility is considered as a resource to use, not to maintain, additional shortcomings and costs appear:

Depletion. Monoculture exhausts soil fertility, requiring costly applications of chemical fertilizers.

Irrigation. Soils used to grow annual row crops and then left bare for much of the year have poor drought resistance, increasing irrigation costs.

Erosion. Monoculture degrades soil structure and leaves it more vulnerable to erosion, resulting in costs for soil replacement, clean-up, and lost farmland value.

Lost biodiversity. Industrial farms don't support the rich range of life that more diverse farms do. As a result, the land suffers from a shortage of the ecosystem services, such as pollination, and insect pest antagonists that a more diverse landscape offers.

Social and economic impacts

The pressure to "get big or get out" is fundamental to industrial agriculture – and takes a toll on communities.

Loss of mid-sized farms. Once the backbone of US agriculture, medium-sized farms are a dwindling breed, which means that fewer and fewer Americans make their living as farmers—a trend that has been bad for the economies of rural communities and farm states.

Well known fact is that industrial agriculture causes expensive equipment to remove fertilizer by-products from public drinking water supplies, repair the "dead zones" and toxic algae blooms, the pollution problems reduce liveability and depress property values (Von Liebig 1863, Chaianov, 1927).

There are hidden agriculture effects and costs (Advancing sustainable agriculture, 2017; (Hidden Costs of Food, 2017; Spot-Chemi, 2017). Altogether they are additional dangers for our world-wide agro-ecosystems.

The symposium on the use of organic matter amendments at Ohio State University concludes (Baysal-Gurel, 2013):

• The addition of organic matter such as cover crop-green manure (single and mixed species), seed meals, dried plant material, good quality compost, organic waste and peats can aid in reducing diseases caused by soil-borne pathogens.

• Organic matter amendments can be very effective in controlling diseases caused by pathogens such as *Fusarium spp., Pythium spp, Rhizoctonia solani* and *Sclerotinia spp*.

• Organic matter improves soil structure and its ability to hold water and nutrients; it also supports microorganisms that contribute to biological control.

• Our study has shown that mixed-hay cropping during the transition periods can enhance soil suppressiveness to damping-off caused by *Pythium* and *Phytophthora*.

• In addition, although compost amendments applied during transition can improve crop vigour by significantly enhancing soil fertility, their effects on soil-borne diseases are not predictable when transitioning to certified organic production

• Organic matter amendments have great potential. However, they sometimes can cause;

• Inconsistent control, increased disease severity and Phytotoxicity.

• Correct management of crop residues and wastes is necessary to avoid phytotoxic effects.

• This can be achieved by optimizing application rates and the timing between organic matter applications and planting the vegetable crop.

• In the early stages of decomposition, and especially when the available oxygen is low as in saturated soil, crop planting should be avoided, or at least delayed to avoid phyto-toxicity and/or diseases caused by *Pythium* and related pathogens.

• Although cover crops contribute many benefits to agricultural system, they may play a significant role to increase soil-borne diseases. Grower management of brassica cover crop residues could greatly affect bio-fumigation effectiveness.

• For maximum effect, residues need to be completely shredded and immediately incorporated into sufficiently moisten soil. Here I allow myself to add that the application of dry organic materials (like crop remnants) can be applied to dry soils after harvest as a soil cover, to reduce soil erosion on slopes and increase percolation when rain comes or catch dew in the early morning.

In organic farming the Earthworms are justifying a dream of Sir Charles Darwin as 'unheralded soldiers' of mankind and 'friends of farmers'. One of the leading authorities on earthworms and vermiculture Dr. Anatoly Igonin has said: "Nobody and nothing can be compared with earthworms and their positive influence on the whole living Nature" (Sinha et al., 2009).

After seven years of compost and slurry high amount applying the soil activity becomes higher, the yields improve as well (Hopkins et al., 2016). At the same time it has been revealed that amount of applied nutrients could be decreased considerably without decreasing the yields, once the soil ecosystem is re-established by proper soil management and become fertile with minimal inputs (Van Mansvelt, 2016).

In rhizosphere the root exudates force the interaction between roots of different plant plants, microbes, and nematodes which are highlighted on the scale from molecular to ecosystem level (Harsh P. Bais et al., 2006).

According the studies on "plant growth – promoting" and 'plant health – promoting" bacteria the plant microbiota is enabled through diverse biochemical mechanisms Davide Bulgarelli et al. (2013).

Cooperating Fujian University departments in China found that novel bio-organic fertilizer effectively suppresses *Fusarium* wilt by enriching the antagonistic bacteria and enhancing the bacterial diversity (Linkun et al., 2016).

It is obvious that cooperation of soil ecologists, plant breeders, microbiologist, phytopathologists and other specialists helps to avoid simplified model of "pest – plant" interactions that promote fighting nature and turn to nature-friendly models allowing the long-term fruitful development. Healthy soils mean healthy crops.

The pesticides disastrously contaminate the soil and the food. Regulations on new pesticides use don't solve the fundamental issue – the pesticides behaviour in the food chain – the role of final experimental rabbits for us and nature is undesirable (Buijs, Tennekes, 2017).

Already in the last century's fifties the Germans Hermann Druckrey (1904–1994) and Chemistry Nobel laureate (1939) Adolf Butenand (1903–1995) warned about the dangerous policy of pesticides dose-effect *risk-prevention*, irreversible effects of pesticides. But the French René Truhaut promoted the acceptableness of daily intake as the *risk-management* strategy for pesticide wide use. With massive support from industry this point of view is prevailing until now, and results in irreversible pollution of ecosphere with pesticides and their metabolites – the neonics can kill all insects, then all birds (Tennekes, 2010; Tennekes, Sánchez-Bayo, 2013) and other organisms inhabiting various trophic levels, including humans (Lew, 2009). The microorganisms – the kings of nature – are the first to respond these synthetic compounds deposites in the environment (Tano, 2011).

There is a need to stress – thousands organic farmers worldwide prove so – that pesticides are not required to grow healthy crops. The switch of FAO policy from industry driven to global survival driven in 2015 is an important indicator for the nearest future.

In July 2017 the Netherlands Food and Consumer Product Safety Authority discovered (NFCA, 2017) the fipronil insecticide in eggs and in chicken meat. It is *unavoidable* that *anything* that is used in feed and in the stable will become present in eggs and in chicken meat. From 2016 till July 2017 all contaminated eggs and chicken meat had been consumed, the contaminated life waste become applied to the soil and water systems. In Russia fipronil and similar chemicals are widely advertised and sold for use in poultry. The only way out of the dangerous environment situation is to forbid the use of all those substances in the food chain and to control it in transparent procedures.

The contaminants and infections are spreading on the wide scale, including super-bacteria resistant to any modern antibiotics. Therefore, the health of the soil and the sanitary and epidemiological conditions of life become worse (Sazykin et al., 2016; Sazykina et al., 2014). The dangerous biological objects resistance to modern medicines can only be eliminated by natural antibiotics, which, as a waste, in small concentrations, can be dispersed and integrated into the soil ecosystem. Another way is a gasification of biological waste and subsequent disperse intra-soil placement of ecosphere-safe gasification product, whose mass is 10-20 times less than the initial product, inside the soil as a fertilizer, a structure-forming agent, an ameliorant. However, the technical means of standard industrial farming, insofar as they are unchanged in organic farming systems, are not able to solve such tasks.

In some marginal types of organic (agro-ecology) systems, critical problems of soil compaction, dead-end porosity, low soil-nitrogen production, low rate crop remnants and manure conversion, can result in soil productivity stagnation on an unwanted low level (Semenov et al., 2016).

The soil, disturbed by standard agricultural techniques, needs the creation of starting conditions for a new evolution under organic farming system, otherwise the transition to the new system will be difficult, or impossible at all. The new approaches are needed to overcome the shortcomings of industrial agriculture. The Biogeosystem Technique is a promising transcendental integral approach to overcome the conflict of technology and biosphere, to create starting conditions for sustainable vector of the fertile healthy soil evolution (Batukaev et al., 2016; Glazko V., Glazko T., 2015; Glazko, Sister, 2016; Kalinichenko, 2016; Kalinitchenko et al., 2016).

The methods and technical means of Biogeosystem Technique are of interest for synthesizing the dispersed system in 20-45 cm soil layer, most compacted in a standard farming system. An attractive opportunity is to apply in a dispersed way the biological waste within synthesized intra-soil dispersed system. It helps to eliminate an uncontrolled spread of dangerous substances, which in standard farming practice are applied to the soil surface layer. The plants will be supplied with additional nutrients, the possibility will be obtained for carbon sequestering from the atmosphere by increasing soil biological capacity, a larger productive carbon cache will be created into the healthy soil.

In organic (agro-ecology) system the main problem is the transition period, wherein the problems of soil compaction, dead-end porosity (Shein et al., 2016), low soil nitrogen production, low rate of crop remnants and manure conversion, soil productivity stagnation on the low level are critical. Over and again new approaches are needed to overcome the shortcomings of industrial agriculture and thus attain the higher level organic agriculture. It will be shown that organic/agro-ecological farming systems produce much better that usually known.

4. Conclusion

In the light of above survey it is clear that agronomist academicians have the responsibility and, at the same time, have a considerable challenge to revise our research policy and contribute more than ever for sustainable food production and the sustainable future.

Disciplinary research alone is not enough anymore – such research are dangerous because disorientate the scientific community, the population, the government (Van Mansvelt, Van der Lubbe 1999).

Now a vast knowledge is available on different aspects of soil ecosystems degradation and healthy soil ecosystems regeneration, to grow healthy crops, best possibility for cattle breeding, healthy food for humans.

Let us more contribute to a non-violent agriculture, create an international multidisciplinary, practice based, non-violent, sustainable agro-ecosystem management.

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