Agricultural models based on the rational use of land energy

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Abstract. The paper concludes that the models of modern agricultural technologies are based on energy reserves and huge planetary resources of chemically bound energy resulting from the interaction of organic and inorganic matter. In Russia these models were implemented by way of turning to environmentally friendly sustainable development of the country. The research object was land reserves available in the Russian Federation. The paper justifies a growing geographical fragmentation of labor and its integration into territorial networks and development systems of different levels. The use of natural resources and environmental protection, along with social development, correlate with a specific region, shaping a regional network, which is a diverse combination of specific natural, economic and social ecosystems. The interaction of organic and inorganic energy is a beneficial way to obtain energy, as evidenced by the analysis of planet development. The technospheric evolution into a nature-like product will reflect the interaction of matters and allow for a meta-disciplinary science. The paper presents a series of criteria for ecological assessment of soils for the future. In this regard, the creation and implementation of agricultural technologies adapted to modern conditions is of paramount importance. Based on a feasibility study, it was proposed to develop agricultural technologies that should maximize the use of new types of energy and the interaction between elements of ecosystems from notable to high-intensity, followed by adequate quality products obtained with minimal biological losses. The promotion of optimal agricultural landscapes in the regions will be facilitated by land management with inherent nature conservation measures that imply adopting scientifically based crop rotations and agricultural technologies. These results are applicable for agricultural regions of the country involved in the production of agricultural products within ecological farming.

1. Introduction

Models of modern agricultural technologies are based on energy resources and huge planetary reserves of chemically bound energy resulting from the interaction of organic and inorganic matter. So far, the world civilization has been driven by an anthropocentric paradigm, which led to the degradation of the litho-hydro-atmosphere-biosphere, a short-sighted use of chemically bound energy reserves made up of oil, gas, coal, etc. [1-3]. Fully aware of a severe ecological crisis that struck the entire world and Russia, in the last half century, theories and concepts have been recognized, aimed at combining ecological and economic demands, providing for environmentally safe sustainable development of society.
In Russia this model was implemented by turning to environmentally friendly sustainable development of the country as stipulated by the decrees of the President of the Russian Federation of 04.02.94, No. 236 “On the State Strategy of the Russian Federation for Environmental Protection and Sustainable Development”; dated 01.04.96, No. 440 “On the Concept of Transition of the Russian Federation to Sustainable Development”; of 19.04.2017 “On the Strategy of Environmental Safety of the Russian Federation for the Period up to 2025”.

Evidently, energy supplies are decreasing, although many models of agricultural technologies directly depend on the former. The 20th century is a time when it is necessary to overcome reliance on energy sources, and to enhance the intellectualization of production, science, and in agricultural technologies to reduce energy costs. Even-handed observations and analysis of resources, population, industrial production, food at the end of the last century resulted in a conclusion that by 2050 economic growth is unlikely to go on [4-12].

2. Materials and methods
A theoretical toolkit rests on scientific publications of domestic and foreign researchers and experts.

The research object is land reserves available in the Russian Federation. Modern world development features a growing geographical fragmentation of labor and its integration into territorial networks and development systems of different levels. This trend is significantly influenced by territorial differences in natural conditions, different degrees of availability and distribution of resources, a prevailing settlement system, traditions, etc. In other words, the use of natural resources and environmental protection, along with social development, are in all cases related to a certain region.

It is obvious that each regional network is a diverse combination of natural, economic and social ecosystems. This circumstance does not rule out, though, the unification of various networks (regions) into groups based on the similarity of the most essential features. However, a single methodological framework and uniform global criteria towards ad hoc modalities for achieving development goals, should be implemented by each region or their group with respect to significant differences and a profile of each network and the problems it addresses.

3. Results and discussion
In this regard, the creation and implementation of agricultural technologies adapted to modern conditions is of particular relevance. Today, the interests of chemical holdings are being actively accommodated. This requires multimillion costs and, unfortunately, crop rotations and the spread of monoculture are reducing.

Problems like soil compaction, nutrient supply to plants, crop protection have become increasingly acute, and all this is associated with the spread of minimal and no tillage based on ultra-expensive heavy machinery. A primary postulate of this approach to the technological support of the farming industry is the thesis concerned with natural resources as something endless and inexhaustible. Mirrored by depleting non-renewable resources, they must be decreasingly consumed. Modern advertised agricultural technologies are economically burdensome, environmentally unpromising, undermine the prospects for survival and lead to self-destruction of mankind.

Nowadays, there is an urgent need to come up with a new generation of agricultural technologies, which will integrate the minimum energy consumption and biological characteristics of plants. The interaction between the components of natural ecosystems should be addressed when a framework of farming and land management projects is developed on an agrolandscape basis [13-15]. Rotating crops is the simplest, cheapest and most effective way to prevent weeds, disease, soil compaction, and others.

As far back as the late 20th century, I. Ovsinsky [16] underscored that plants that have a powerful root system (lupins, perennial grasses) root deep enough and receive water, mineral nutrition from the subsurface reserves, and also make it possible to use these food sources to succeeding generations shallowly rooted, like potatoes, etc. Namely, well-established lupine roots, slowly decomposing, after
plowing the latter, form ductules for the roots of succeeding generations, shallowly rooting, to penetrate into the depths of the soil. This results in the plants rooted in this way to easily survive drought. Indeed, in 1893, potato planted in a field where lupine was sown for green manure, rooted down to the depth lupine roots could reach. In this case, the ability to root far protected the potatoes from harmful drought effects that dominated that year, which made them drought tolerant, while the potatoes sown nearby on the soil not manured with lupine suffered greatly; the plants were shallowly rooted and harvest was scarce.

Well-established plants intended for green manure have a beneficial effect on the succeeding plants. Each generation of plants (legumes, cereals) has the ability to deeply root and thereby leave a network of ductules that enable the growth of succeeding plants. Deep processing destroys this network.

Particular attention should be paid to limited fossil energy reserves that are formed through the existing processes in nature, and against this background, energy sources are renewed. The intellectualization of production and science must be applied when developing an economic model, which makes it possible to reduce energy costs in the economy. A geopolitical image of the world can be changed through the dematerialization of products.

In the future, humanity needs to operate within the existing planetary reserves provided by land and resource potential, in conditions of their depletion, ensuring the transition to fundamentally new types of energy and resources and the transition to an equilibrium state using the criteria for the state of natural ecosystems.

Criteria for ecological assessment of the state of soils elaborated by B.V. Vinogradov, V.P. Orlov and V.V. Snakin [17] with authors’ amendments are as follows (Table 1)

**Table 1. Criteria for ecological assessment of the state of leached chernozems**

| Index | Background | Variations | Permissible | Environmental risks |
|-------|------------|------------|-------------|---------------------|
| Humus content in the arable layer, % of the background | 7.0–7.5 | up to 15 % | >15 |
| Amount of chemical pollutants in the soil, maximum concentration limit | n/a | <0.5 | 0.5–1.0 |
| Pesticide content in soil, maximum concentration limit | n/a | <0.6 | 0.6–1.0 |
| Increase in soil density, multiplicity as contrary to the background | 1.0 | 1.1 | 1.1–1.4 |
| Decrease in soil acidity, % of the source | 1.0 | <10 | >10 |
| Reduction in the content of mobile phosphorus, % of the background | 1.0 | <25 | >25 |
| Decrease in the content of mobile potassium, % of the background | 1.0 | <25 | >25 |
| Increased alkalinity in alkaline soils by 10 percent or over | 1.0 | <10 | >10 |

Agricultural technologies develop subject to the ecological state and should maximize the use of new types of energy and the interaction of elements of natural ecosystems (Table 2).

It is important that the worldview being shaped should encompass the synthesis of scientific disciplines and the paradigm of science from analysis to synthesis [18]. Meanwhile, fundamental education and its concept of development can be developed at the national level alone. Unfortunately, today the leading role of education is declarative [19].

The interaction of organic and inorganic energy is a beneficial way to obtain energy, as evidenced by the analysis of planet development. The technospheric evolution into a nature-like product will
reflect the interaction of matters and allow for a meta-disciplinary science. Such sciences as information technology and nanotechnology, given the methodological nature, can be combined into a single whole. The key point in the development of modern civilization is convergence, which mirrors the world in a holistic way. In this regard, land management accompanied by nature conservation measures with integrated scientifically grounded adaptive crop rotations and agricultural technologies will be important for optimal agricultural landscapes to be encouraged in the regions.

Table 2. Sustainability of natural ecosystems and types of agricultural technologies

| Status of ecosystem | Status of natural ecosystem | Type of agricultural technologies | Quality of produce |
|---------------------|----------------------------|---------------------------------|-------------------|
| Balanced            | Sustainable                 | High intensity, intense         | Accumulation of energy is equal to its losses or higher |
| Pemissible          | Sensitive                   | Regular                         | Energy loss no more than 10% of the background |
| Slightly degraded   | Medium-resilient            | Extensive                       | Energy losses reach 10-20% of the background |
| Highly degraded     | Non-resilient               | Primitive                       | Energy losses reach 20-30% of the background |

4. Conclusion

1. A retrospective analysis shows that the interaction of two matters, organic and inorganic, led to the accumulation of colossal reserves of chemically bound energy and resources, which were the energy basis for the modern model of economic growth.
2. The economic development model that is currently in place greatly rests on energy carriers that are decreasing. The growing consumption of chemically bound energy and resources is associated with human activities, namely, interference in the processes of organic and inorganic matter. The quality of life is strongly affected by the man-made burden on the territory.
3. The 21st century model of economic development should include the principle of interaction between organic and inorganic matter. This calls for convergent technologies based on the methodology of information and nanotechnology.
4. The transition to a new model of economic development provides for a new educational paradigm, while recognizing the realities of the 21st century, which should be aimed at establishing relationships between different areas of the natural sciences, strengthening the fundamental nature of education. It is necessary to develop new meta-disciplinary courses, where the processes of analysis are complemented by the processes of synthesis. Convergence today, and, even more importantly, in the future, is a key component of education and science, and the further production of quality goods and services. Here, the initiated projects geared towards on-farm land management with adaptive agriculture fostered at the regional level, where optimal agricultural technologies are the key point, can also play a significant role in the rational use and protection of lands [20-21].

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