INTERACTIONS: FOOD, AGRICULTURE AND ENVIRONMENT

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Summary

In every country of the world agriculture always faces complex problems: how to significantly increase production of agricultural products to supply the population with sufficient food, and industry with sufficient raw materials, and how to satisfy the permanently growing demand. The acuteness of this task has always been linked with the demographic factor and the need to guarantee the population with a high living standard free of starvation and poverty. In fact, the twentieth century has witnessed an extraordinary phenomenon, the increase of the global human population from two to six billion people.

Solutions of these problems have involved historical, national, socio-political and socio-economic conditions, and a high degree of scientific and technical achievement.

By the middle of the twentieth century, extensive methods of agricultural production had virtually been exhausted. Progress in science and technology was required to facilitate intensification of agriculture.

At the same time, intensification of agricultural production and its technogenic feature, having provided significant growth of food production in Western Europe and the United States, could not solve all the world's food problems. Hundreds of millions of starving people still remain in many countries of Asia, Africa, and Latin America, but

these states are not able to use the European-American model of intensification because of lack of energy (power) resources.

Humanity, when developing the technology for agricultural production and processing, and solving the global food problem, came constantly into conflict with nature, and thus intensified the global ecological crisis. During the period of extensive agriculture, increased production was based on plowing up the steppes and the destruction of forests and natural landscapes. In the course of agricultural intensification, millions of hectares of fertile and improved land was lost as a result of the increasing scale of inappropriate management, erosion, flooding, salinization, contamination with nitrates, phosphates, pesticides, and pollution of the environment with industrial effluent that disturbs ecological balance in agri-ecosystems and the biosphere as a whole.

By the end of the twentieth century, humanity had recognized the limits of the nature-resource potential and could objectively estimate its capacity to sustain a growing level of consumption for the permanently increasing population. Orientation onto predominantly technogenic intensification of agriculture has exhausted itself. A change of criteria and indicators was required.

This resulted in the creation of the theory of transition to sustainable development. The ecological aspects of this model are a complex of measures aimed at conservation of the environment and the rational use of natural resources, above all, of land and water. That is why in the new century humankind must search for new concepts and strategies of food production that could allow the best use of new nature-protecting technologies, providing ecological balance in a process of interaction between the rural commodity producers and nature, as well as the agreement of ecological and economic interests in the agri-industrial complex.

1. Introduction

Development of agriculture and food production must be in dialectic unity with the surrounding natural environment.

Agriculture has a pronounced effect on ecological balance over a greater part of the land surface of our planet. The limits of natural land-resource potential for purposes of agricultural production create a need to expand and to develop steppe and forest areas; a process that disturbs the natural balance, aggravates degradation processes, and reduces fertility of soils. These ideas of technological agricultural-ecological “improvement” of lands only lead to the destruction of land resources and pollution of the atmosphere, water resources, and forest territories. Water erosion and soil deflation proceed, and land desertification becomes more intensive. Food production decreases, and its quality and the nutritional content are worsened. This requires a qualitatively new approach to the “know-how” of production of food and raw materials, and increase of the ecological quality of food.

The food production industry must use nature-saving technologies that can promote the implementation of a permanent sustainable management and control of natural resources, and the elimination of inefficient production models and consumption of

foodstuffs. In this connection, optimization of agrochemical application, introduction of landscape agriculture, systems of adaptive plant growing, and ecologically pure technologies for food processing become the basis for production of ecologically pure products.

There are also ecological problems in industrial cattle breeding and in the use of its wastes. Some kinds of artificial and natural forages contaminated by heavy metals become carcinogenic and have an adverse effect on ecological quality of livestock production.

Food production from both the oceans and freshwater resources, including that from aquaculture, is adversely affected by pollution of fish and other seafood by heavy metals, organochlorine compounds, and other toxic elements. Parasitism, which is a widespread phenomenon among species of freshwater and marine fauna, can be exacerbated. To avoid such problems, strong control of the production quality, and regulation of anthropogenic inputs and the catches of fish and shellfish are required.

The problem of protecting human health against off-standard and poor quality agricultural methods is stipulated within the technologies of production, which should require reduced volumes of mineral fertilizers, chemical compounds, and so on. To protect the population against poor quality of animal food there must be stronger control of the pathogenic agents of zoonoses, which, in addition to people, can also strike a broad variety of susceptible animals. Permanent control of food product quality is necessary to prevent diseases and possibly food poisoning.

2. Natural Resources and Features of Agricultural Production

In the socio-economic aspect, agriculture is the most important life support area of material production, supplying the population with foodstuffs, and industry with raw materials.

Every form of agricultural production uses the basic natural resources: solar energy, internal heat of the Earth, land, water and mineral resources along with plants and animals, that is, the major components of the environment.

The most important element of agriculture is the land. It is a space for realization of a productive process as well as the object and instrument of agriculture work. In his fundamental work *Capital*, Karl Marx wrote:

the Earth (from the economic point of view it also includes water), originally providing man with food, and ready means of life support; it exists without any assistance from the human side as a general object of human labor.

Agriculture and food production use about 4.69 billion ha of land, which is about 35 percent of the land total area on the Earth (13.401 billion ha). Arable land occupies 1.48 billion ha, i.e. 11.04 percent of the total area of the land.

According to calculations of R. Lal, to provide the human population with a balanced

diet, including plant and animal products, on average, not less than 0.5 ha of arable land is needed per capita. However in 1990, on average, only 0.27 ha of arable land was available for each of the 5.5 billion of the Earth's inhabitants. This value is permanently declining, as growth of the human population is greater than the increase in the area of agricultural land. By 1999, this area had decreased to 0.23 ha, while the population had grown to 6 billion inhabitants.

Provision of arable land is rather irregular in different countries of the world. A comparative value of that is the area of arable land per capita in different countries, a parameter largely dependent on the density of human settlements. Thus, the area of arable land per capita in different countries is as follows:

- Australia 2.66 ha
- Kazakhstan 2.40
- Russia 0.80
- Argentina 0.70
- United States 0.68
- Canada 0.58
- Poland 0.36
- Brazil 0.33
- France 0.31
- Angola 0.26
- Italy 0.14
- India, and Armenia 0.17 ha each
- Germany and China 0.07 each
- Israel 0.06
- Japan 0.03 ha.

However, most land that is potentially good for agriculture is unsuitable, being too hilly, boggy, dry, or cold to permit a reasonable crop yield. According to some forecasts, in the twenty-first century the increase of cultivated lands might be up to 500 million ha, but it will mostly be unproductive land. Development of these lands for agricultural use requires large investments in complex and expensive amelioration, including irrigation, drainage, liming, dealkalization, desalinization, uprooting, and stumping out, stone removal, and heating. This kind of work is required not only for millions of hectares of arable land, but also for hay-making and pasture-land. Therefore, conservation and rational use of lands previously developed for agriculture, and increase of its fertility, is an important national task of each country.

A vital natural resource of any agricultural production is water. Agriculture takes two thirds of all the freshwater used in the world. Despite the abundance of water on Earth, freshwater makes up only 2.5 percent of the planet's water resources. Extraction and consumption of the water necessary for plant growth proceeds mainly from soil by means of the root system. During the growing period, plant roots pump from the soil

into the atmosphere thousands of tons of water from each hectare. Thus, a hectare planted with corn consumes 3,200 tons of water. To grow 1 kg of a dry wheat grain, it is necessary to use 750 kg of water. At present, 16 percent of developed lands in the world are artificially irrigated and they produce yields several times greater than those from dry farming systems.

Water is one of basic elements of nature, without which development of the organic world, including plants, animals, and humans, is impossible. Where there is water, there is life and civilizations develop.

Chemically pure water is not present in living organisms or soils used for agriculture; it always contains dissolved salts. The Earth's freshwater resources are strictly limited, especially for agricultural needs. Therefore, mankind faces a vitally important problem, that is, preservation of these resources, prevention of contamination of water resources, including groundwater, and use of optimal methods for supplying agricultural crops with water.

For the foreseeable future, wild plants will be indispensable in agriculture. They are vital to every living animal on the Earth, directly or indirectly, including our own species. Plants require natural ecosystems including the following principal components: soil cover, environmental conditions created and controlled by other plants and animals, and micro-organisms. The human society will modify natural ecosystems. New technology will modify soil-ecological systems to increase the yield of forages and foodstuffs. However, the natural resources will remain the primary source, as cultivated plants constitute a very minor proportion of the 500,000 known plant species. Therefore, the use of natural meadows, pastures, and hay-making in agricultural production should be improved. It is important that the natural grasses have high potentials even under conditions of the heat deficit and short growing season. Use of these possibilities in agriculture allows more efficient development of cattle breeding.

In future, the interrelations of forestry and agriculture will be strengthened. At the global scale, the forest exerts an integrated protective influence on the environment and supplies vital services through water, soil, fauna, air, and limiting the effect of direct solar radiation. As the forest is a renewable resource, scientists consider it will be necessary to substitute fossil fuels by fuel wood, as oil is likely to be practically exhausted before the end of the first half of the twenty-first century.

Integrated management of forests will result in development of agricultural landscapes where fields are protected by trees, and there are also possibilities of protection and rational use of water resources for agricultural purposes. In addition to agricultural production, forests will yield various natural products: fruits and berries, fungi and herbs, along with hunting of wild animals and limited livestock production.

The environmental threats to agriculture include atmospheric pollution from industrial wastes, acid rains, and radioactive contamination of soil, water, and vegetation. At the same time, agriculture, especially large cattle breeding complexes, pollutes the air space, surface and subsurface water, and soil.

The specific characteristics of agriculture include:

- Agriculture is a vital life-supporting industry producing complex and essential biological materials, without which humankind cannot survive.
- Unlike industrial enterprises, agriculture takes place on vast areas over the biological-geographical domain, so, it is dependent on natural-climatic and seasonal weather conditions.
- Agriculture involves biological production through plants, animals, and micro-organisms.
- Agriculture utilizes solar energy harnessed by plants and converted into chemical energy.
- Agriculture uses both individual and collective labor to divert biological production for use by individuals and society.
- Agriculture combines both ecological and economic interests.

Although agriculture uses natural resources (land, water, plants and animals, natural fuel, and energy resources), it is essentially different from the processes involved in natural ecosystems. Anthropogenic influence on agriculture is constantly increasing, with both positive and negative consequences for the environment. Therefore, the ecological and economic efficiency of agriculture completely depends on natural conditions and processes and sustainable management.

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Bibliography

Bogatyrev, A. N.; Panfilov, V. A.; Tuzhilkin, V. I. 1995. *System of Scientific and Engineering Support of Food and Processing Branches of the Russian Agro-Industrial Complex.* Moscow, Food-processing industry (Pischevaya promyshlennost). 528 pp. [Conceptions on the scientific-technical policy in the field of healthy food are presented. Basic scientific problems of processing of agricultural raw materials are considered. Problems and main directions of realization of the priority innovations under conditions of the marketable economics are discussed.]

Burton, C. H. 1994. Research into Effective Treatment of Pig Slurry (Great Britain). *Agr. Engr*, 1994, Vol. 49, No.2 [Problems of the pig farm discharges use are discussed and ways to solve the problems are proposed.]

Chromov, Yu. S. 1995. *Problems of Food Safety of Russia (International and Domestic Aspects).* Moscow, RISI. 252 pp. [Problems of the food safety together with those of the sustainable agriculture are discussed with respect to limited capability of natural resources of agriculture.]

Sizenko, E. I. (editor), 1999. Reference book *Secondary Raw Resources Food and Food-processing Industry of the Russian Agro-industrial Complex and Environmental Protection*. Moscow,

Pischepromizdat. 468 pp. [This book contains data on the sources and scales of formation of the secondary raw material resources and wastes of the Russian food and food-processing industry. Information on the waste effect on the environment and methods of greening of food production are presented.]

Kashtanov, A. N.; Lisetsky, F. N.; Shvebs, G. I. 1994. *Fundamentals (Bases) of a Landscape-ecological Land Use (Agriculture*). Moscow, Kolos. 127 pp. [Evolution of the agriculture systems and the modern problems of soil protection against degradation are considered. Agri-landscape is determined as a natural landscape in its unity with the economic transformation, industrial and natural infrastructure.]

Kovda, V. A. 1978. *Land Resources of the USSR, Their use and Protection.* Moscow, VASKhNIL. 187 pp. [An integrated approach for estimation of a state and rational use of natural resources is proposed. Ways for improvement of the agriculture conditions and elimination of limiting factors are determined.]

Lemeshev, m. ya. (ed.) 1990. *Ecological Alternative* (Collection of articles). Moscow, Progress. 800 pp. [The collection of papers concerned with analysis of crisis ecological and economical situation in both Russia and the world.]

Lysenko, E. G. 1997. *Problems of Economy and Agro-ecology of Agriculture* (proceedings), Moscow, RASKhN. 120 pp. [New land relations and their connection with ecological factors of the environment are considered. Ecological problems arisen under conditions of increasing anthropogenic and technogenic loads upon the land resources are discussed.]

——2000. *Ecological–Economical Fundamentals of the Agriculture Efficiency*, Moscow, RASKhN. 253 pp. [Theoretical and methodological bases and the essence of the ecological-economical development of the agriculture are considered. Prospects for development of the sustainable agriculture are discussed.]

Makarov, I. P.; Mukha, V. D.; Kochetov, I. S. 1995. *Fertility of Soils and Stability of Agriculture.* Moscow, RASKhN. 288 pp. [New step of the agriculture development in Russia is based on the adaptation-landscape directedness of agricultural systems. This book explains the essence of this system as that providing relevant conditions for ecologically safe and economically expedient use of both natural and anthropogenic resources.]

Romanenko, G. A.; Tyutyunnikov, A. I.; Pozdnyakov, V. G.; Shut'ko, A. A. 1999. *Agro-industrial Complex of Russia (State and Its Place in the Agro-Industrial Complex of the World).* Moscow, TsINAO. 540 pp. [Problems of the current state of agriculture and its influence on the environment are discussed with a presentation of the great statistics on the development of agro-industrial complex in Russia.]

United Nations. 1991. *Status of Desertification and Implementation of the United Nations Plan of Action 8*$_1$ *Combat*. Nairobi, UNEP. 88 pp. [Current state of the land degradation in the global scale are presented together with statistics for the planet as a whole and for individual continents.]

Yablokov, A. V. 1990. *Poisonous Spice (Problems of Application of Agricultural Poison Chemicals and Ways of Greening of Agriculture)*, Moscow, Mysl. 125 pp. [Summarized material on a tendency to use toxic chemicals in the food production and the consequences for nature, agriculture, and humankind is presented.]

Yal, R. 1991. Land Degradation and its Impact on Food and Other Resources, In: D. Pimmentel, *Food and Natural Resources*. Pp. 85–104. [Forecasts are made for a balance between the global population growth and increase of agricultural lands. Problems of supply the planet Earth inhabitants with optimal food are discussed.]

Zhuchenko, A. A. 1990. *Adaptive Plant Growing (Ecological and Genetic Basis Fundamentals*). Kishinev, ShTIINTsA. 432 pp. [The essence of adaptive plant growing is explained. The problem of the complete use of renewable and inaccessible natural resources in the production and the medium-forming processes of the agroecosystems is discussed.]

Biographical Sketch

Professor Evgeny Grigorievich Lysenko was born in Donetsk city (Ukraine) on 13 May 1938. He graduated from Azovo-Chernomorsky agricultural institute in 1960 and became a specialist agronomist. He is a full Doctor of Economic Sciences and a Corresponding Member of the Russian Academy of Agricultural Sciences. He worked first in a collective farm, then in research institutes. For the last ten

years, he has worked in the Russian Academy of Agricultural Sciences. He is also a Professor of Moscow State Agronomical-Engineering University by V. P. Goryachkin. His basic scientific interests are the land ecology and economy, land relations, greening of agricultural production, and socio-ecological problems of rural territories. He has published more than 150 papers and several books, including: *Efficient Method of Using Micro-Fertilizers, Ecological-Economical Efficiency of Land Use, Land Relations and Development of Personal Small Farms,* and *Ecological-Economical Fundamentals of Agriculture.*