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Cultivated Lands of Kuban and Features of Their Development

Ivan S. Belyuchenko*

Kuban State Agrarian University, Krasnodar, RUSSIA

ABSTRACT

The basis of cultivated lands consists of the interacting populations of annual and perennial weeds and updated annually cultural annual plants, which have very limited data on the aboveground net production, and even less information about the yield of their underground organs. The aim of the research is scientific and theoretical development of crops agriculture in Kuban region also with analysis of land systems and practical mistakes in the agriculture. The development of the agricultural system operation management systems provides a basis to solve the problems of environmental management, their protection, as well as ecological safety at the level of the cultivated land system formation through improving the soil, increasing the vegetation structure complexity, and including corresponding life forms in the vegetation composition. The results of study shows that management of cultivated lands is provided from the outside, where it takes place in a faster way, so it is more reasonable to organize agricultural ecosystems. Besides, the colloidity of wastes of different industries and their role in the formation of complex compost changes the aggregate composition of ordinary chernozem and impacts other aspects of the formation and development of soil and plants in the system of cultivated lands.

KEYWORDS
Cultivated lands; cultural annual plants; mixed crops; soil disturbance.

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Introduction

On the subject, the Department has received 18 patents and held 5 international scientific conferences. In the development of this theme, it is planned to hold international scientific conferences: in March 2017, generally on the topic of cultivated lands; in March 2017, on the development of technologies in farming rotation with application of various doses of complex composts; and in March 2018, named "The Role of Forest Strips as Determining the System of the Nature of Cultivated Lands." It is also planned to conduct studies jointly with a number of international scientific organizations involving the use of complex composts in crops and on the role of forest strips in the functional arrangement of cultivated land systems.

The origins of combined crops in cultivated lands originate from the beginning of our era in China, where they have been used and are developing until the present day. The main components of combined crops in China are soybeans and maize, and their harvest varies from year to year less than in pure plant stands. Mixed crops

CORRESPONDENCE Ivan Stepanovich Belyuchenko bioeco@inbox.ru

form more stable yields in almost all areas in comparison with single crops (Belyuchenko, 1976; 1976; 1985). To use the herbage and silage, one can sow in tropics the jack beans legume (Canavalia ensiformis) with maize and sorghum. The mixed fodder will have the most successful ratio of C:N (19-20:1).

The use of a mixture of forage bean herbage and sorghum improves the animal productivity. We sowed these crops (jack beans and maize) as follows: 2 rows of maize (90x90) and 1 row of beans (90x30). Bean plants grew very successfully and with maize formed a high yield of herbage with a significantly increased share of nitrogen in their chemical composition. Mixed crops of the autumn and spring period showed better development of beans than in single sowing of beans in the same period. The average weight of a single plant in the combined crop was similar to the single-crop sowing. It definitely makes sense to study the experimentally combined crops of jack beans (*Canavalia ensiformis* (L.) DC.) with maize *(Zéa máys* L.) and sorghum (*Sorghum almum).* The period of the growing season for forage sorghum's herbage was 80-90 days, and it is enough for the good development of beans, in which the formation of beans starts by that time. If irrigated, jack beans grow and three months later provide the second mowing of herbage (Belyuchenko, 1964; 1965; 1966; 1971; 1977). The herbage of the combined crop of the cereal and the bean is rich in protein and carbohydrates, and was once used in Cuba to feed cattle, as well as prepare silage. This work was carried out by us in the national estate Gose Garseran de Val de Madruga during the period of 1962-1965. Similar studies were conducted by us with jack beans in Abkhazia, Turkmenistan, and Tajikistan. The experimental results were quite acceptable.

The productivity of the most common cultivated lands in Kuban is determined by a number of limiting factors, the most important of which are moisture, nutrients (primarily nitrogen supply), and often the extreme infestation of sown areas. The productivity of irrigated lands is substantially limited by the low content of nitrogen and high soil clogging. Nutrient reserves in the irrigated lands decrease year to year, which is due, primarily, to the intensive mineralization of organic matter with the application of mineral fertilizers in the circumstances of a strong leaching regime and high insolation.

In the northern part of the region, plant cultivation is represented by annual cereals, industrial and vegetable crops (winter wheat, winter barley, maize, sugar beet, sunflower, tomatoes, etc.). Perennials are represented by grapes and certain herbs. Main crops are grown in field farming rotations with the predominance of cereals (up to 50% or more).

The ecological balance of cultivated lands is disturbed to a certain extent by seemingly minor anthropogenic conditions: plowing river valleys, plowing extra land area up to river beds, to villages, plowing slopes, using pesticides (especially herbicides), saturation of farming rotations with cultivated crops, burning stubble and straw after the harvest, failure to change and renovate strains, etc. These and other events determined the increase in erosion, water-logging, and salinization of river systems, reduction in the amount of organic matter in soil, field contamination, deterioration of their physical and chemical properties, an increase in pathogens in microbiocenoses, etc. (Belyuchenko et al., 2009). In some places of the region, erosion processes are increasingly developing, particularly in its southwestern part; and the formation of a gully network is clearly observed in the southern part (Belyuchenko, 2002; Belyuchenko et al., 2007; Belyuchenko et al., 2008).

Methodological Framework

Given the specifics of soil degradation observed in the territory of a large part of the region and caused by human activity (water and wind erosion), the system of environmental protection measures in the region requires a thorough analysis and rigorous implementation at the level of both farms and individual cultivated lands, based on their peculiar features: the depth of the arable layer, slope exposure, etc. It should be emphasized that when carrying out any operations, which may have an impact on rather fragile cultivated lands in some parts of the region, it is necessary to strictly ensure the development of an Action Plan for their stabilization based on local and regional monitoring and relevant annual adjustment of the operations. The recommendations limited to smoothening the disturbances of existing cultivated lands will not solve the issue successfully and will contribute to further destruction of natural and cultivated land systems, especially in the agricultural zone and on their territory related to slopes (Belyuchenko and Melnik, 2010; Belyuchenko and Nikiforenko, 2010).

The plain districts of the region are used for agriculture: cereals (wheat, corn, barley, rice), legumes (peas, soybeans, alfalfa), technical (sugar beet, sunflower), vegetable, essential-oil, medicinal, and other economically valuable crops are grown there. Steppe communities are mainly located in lowland areas, also occupying eroded slopes along rivers and gully systems. Herbaceous groups, which include the species, differing by the pronounced rhythmic development and relatively low productivity, seasonal floral lack of integrity, due to the specificity of the annual temperature mode, as well as the geographical isolation of the region under study, are functionally stable. Mountain communities, especially in the coastal strip of the Black Sea, are severely degraded due to strong recreational pressure, especially in the summer period. In the coming years, we should expect an increase in the recreational pressure on natural communities in the area, which is determined by an abrupt change in the socioeconomic structure of the affected area (Belyuchenko, 2009; Belyuchenko et al., 2010).

Plant cultivation in the steppe region is mainly represented by annual cereals, industrial and vegetable crops (winter wheat, winter barley, maize, sugar beet, sunflower, soybeans, tomatoes, etc.). The perennials grown there include alfalfa, more seldom sainfoin and some cereals (orchard grass, awnless brome, etc.). The main crops, including vegetables and legumes, are grown in field farming rotations with the predominance (50% or more) of winter wheat. All crops with appropriate technology used are very productive (the wheat grain yield in certain years reaches up to 0.8 t/ha in some areas of Kuban). Maize also gives high yields, as well as sugar beet, sunflower, etc. In Kuban, they grow rice, less soybeans, vegetables, potatoes, cereal (wheat, corn) and industrial (sugar beet) crops on irrigated lands in large areas. Growing crops with irrigation differs by the permanently increasing energy costs, including processing, fertilization, and other costs (Belyuchenko, 2010).

The soil cover is dominated by ordinary chernozems and southern chernozems, as well as typical sod-calcareous soils. Additionally, the presence of large areas of solonetzic varieties of chernozems was detected. The humus content is in average 3.5-3.7% in ordinary chernozems and 2.6% in other types of chernozems; no other differences in the content of humus between the selected types of landscapes were detected. In the steppe soils of the region, a small amount of basic humus formers—earthworms and enchytraeids—was noticed. For the main areas, a high microbial pool is typical, which determines the maintenance of the homeostatic state of the soil cover. The dominant position in microbiocenoses is held by aminoautotrophic microorganisms; the average rate of organic matter mineralization is 1.53.

Three main types of vegetation have been determined: zonal, intrazonal, and the vegetation of disturbed areas. The unique forest vegetation of the coastal strip in the region is almost completely devastated and cannot recover itself. In forest strips, no improvement cutting takes place, and they are overrun everywhere by undergrowth and shrubs, which significantly reduces the effectiveness of their field-protective effect (Belyuchenko and Nikiforenko, 2010).

Soil contamination with heavy metals and oil products is generally insignificant; the difference between their content in certain areas of the region, identified through the study within the determined types of cultivated lands, is not significant; the presence of organochlorine pesticides in the arable layer of soil is mainly below the maximum permitted level of concentration. However, some contamination plots were localized (these are mostly private gardens), which requires a more thorough study of their sources and areas of contamination, etc.

The predominance of annual crops in the southern region, especially when irrigated, causes the intense destruction of soil aggregates, the increasing soil erosion and mineralization of organic matter, nitrogen leaching, the reducing use of incoming solar radiation, reducing populations of individual species of microorganisms, micro- and macrofauna, etc. The environmental situation at growing row crops, especially sunflower, sugar beet, and soybeans, which form a low-volume root system and generate almost no turf, is problematic, and therefore in their crops, wind and water erosion is manifested most intensively (Belyuchenko and Gukalov, 2011).

Results and Discussion

Complex herbage mixtures in cultivated lands

Positive aspects of complex mixtures are rather noticeable. The spatial separation of species and even populations divides the spheres of the space occupied and used by each of them at the beginning dramatically reduces the competition between them for the supply and light conditions and provides the most powerful development of individuals. The row placement of crops allows providing respective application of fertilizers, enabling the more effective consumption of them, and thus lesser pollution of groundwater. The row placement of components that differ in the extent of seasonal development provides a step-by-step transition to intensive productivity of not only individual species of plants but also individual sections of herbage mixtures, which indicates the need to optimize their timely supply with water and nutrients. With this method of creating a herbage mixture, almost complete grassing of the entire area is ensured (especially during the autumn and spring season), which increases the resistance of herbage to weeds (Belyuchenko, 2011; 2012).

The spatial fragmentation of individuals of certain species contributes to limiting the invasion of their pests, diseases, etc. (for example, in such grass mixtures, the pockets of dodder on alfalfa are restricted in comparison with its pure crops). The spatial separation of the individual components of mixtures, contributing to a more complete implementation of their potential, provides a good yield of the aboveground mass and roots, the best balance of organic and mineral substances in fodders, as well as the improved physical and chemical properties of the soil. This method of herbage mixture creation is the most reasonable in terms of the organization of an optimized infrastructure of plant stands, close by their parameters (seasonal development, the ratio of components) to conditionally natural plant stands, in which the spatial and technological (irrigation, fertilization) delineation of ecological niches reduces the competition between species, supports their high stability and productivity in the year seasons that are the most favorable for individual components (Belyuchenko, 2012; Belyuchenko et al., 2012; Belyuchenko and Nikiforenko, 2012).

Perennial crops, particularly grass, are less costly as compared to the annual ones: they form a stronger turf, protect the soil from erosion better, etc. In the steppe zone of the region, alfalfa, sainfoin, and several perennial species (fescue, timothy, etc.) are grown as fodder herbage mixtures, but their share in the farming rotation is very small, and, therefore, their impact on the overall situation of the soil cover of ecological systems is very weak.

We have tested several methods of herbage mixture creation in the south of the CIS: 1) The traditional method (seeding a mixture of cereal and legume seeds in the same row); 2) Sowing the cereal by the wide row method in spring and additional sowing of the bean component in autumn; 3) Sowing the components in alternating rows and in different seasons, as well as other forms. The best results according to the first estimates were obtained with the following composition of herbage mixtures: blue panic grass (C_4 photosynthesis type cereal) and alfalfa (C_3 photosynthesis type herb) are sown in spring in separate rows, and in the autumn, a separate row of a boreal cereal (tall fescue, orchard grass, slender wheatgrass, perennial ryegrass) is sown in each 120 cm, and an annual herbage mixture strip is sown as a separate strip (a “mash” of 2-4 components).

To gain high yields of grains and other crops (except alfalfa), it is necessary to improve constantly the standard values of mineral fertilizers, and increase the number of treatments, enhancing water and wind erosion, the organic matter mineralization, the leaching of nutrients from the soil, etc. in the sown row crops. With wheat, maize, and other crops, according to our calculations, in the conditions of the central region of Kuban, between 60 and 100 kg/ha of nitrogen (with the content of humus of up to 3.5–3.7% in the soil); the input of nitrogen into the soil with the roots, plant litter, and other waste types is not more than 25–40 kg/ha (Belyuchenko, 2012; 2013).

At the cultivation of annuals in the province, a negative nitrogen balance develops in the upper layer of soil. The main conclusion as a result of the study is the decline in the soil fertility at the cultivation of annual crops of continuous sowing (winter wheat) and row crops (sugar beet, sunflower), which is caused by their intense leaching of nutrients and the development of erosion processes. The study of soil microflora shows that the populations of certain ecological groups of microorganisms under pure crops are very small, compared to the combined ones. For example, the abundance of ammonifying microorganisms under the control plots of crops (no fertilizers, no bean components) during the growing season did not exceed 100 million per 1 g of dry soil a year, whereas in the crops combined with peas (no fertilizers), the abundance of such organisms was an order of magnitude greater (Belyuchenko, 2012; 2013).

Modern technologies have increased the production. Single-species agricultural systems are highly productive, but potentially unstable, and totally dependent on significant external resources. They are poorly adapted, have less transformation capabilities for food, energy, minerals, are more subjected to stresses caused by weather conditions, highly vulnerable to the effects of water and disease-causing organisms, more strongly affected by soil erosion, and they actively deplete its fertility. Self-regulation of complex agricultural systems will be enhanced by the species and trophic diversity. The biological and structural difference of agricultural systems will support many inherent processes characteristic of natural systems. The diversity (diversification) of steppe systems is a major key to understanding the prospects for creating stable and multi-species cultivated lands. Therefore, the concept of diversification of agricultural systems becomes strategic in solving environmental problems in agriculture. The practical implementation of combined cultivation of different crops should be considered as a prospective direction (Belyuchenko and Slavgorodskaya, 2013; 2013; Belyuchenko and Mustafaev, 2013).

Cultivated lands including several species of cultivated plants in the Krasnodar region (two or more) have a number of advantages over single crops, taking into account the different peculiar features of their development: 1) The formation of a more powerful leaf apparatus in various layers, which increases the efficiency of solar radiation interception by plants and its participation in photosynthesis; 2) The placement of the root systems of different species in separate layers of soil ensures the best use of mineral substances and moisture; 3) The differences in the consumption of moisture and nutrients by the farm ecosystem types by layers and time of consumption allows avoiding peak situations and better meeting the needs of individual taxa in major life factors; 4) The inclusion of species with different biological and ecological features in the crops leads to a better use of hydrothermal resources in some years and more leveled crops; 5) The establishment of a denser plant stand allows actively suppressing weeds; 6) Crops combined with different ecological types are less likely to suffer from outbreaks of pests and diseases, than pure crops; 7) The introduction of crop legumes enhances the nitrogen nutrition of plants; 8) The dense vegetation cover reduces the development of water and wind erosion, and maintains soil fertility better; 9) The study of biotic relations formed in combined crops is very important, as their competitiveness is less pronounced; 10) Combined crops, on the example of China, have long been known in agriculture, and an example of mixed plant stands is strongly advocated by the nature (Belyuchenko, 2013; 2013; 2014).

In the south of Russia, it is proposed to sow herbage mixtures by placement of individual components in separate rows (Namoknov and Sidorenko, 1980). The strip planting method providing the placement of two rows of alfalfa between the rows (30 cm) of awnless brome is successfully used. When small doses of nitrogen were applied with using *Macroptilium tropurgureum*legume, experiments in Texas showed that up to 15% of nitrogen accumulation by this legume is transferred to the cereal, while at high doses, only 5% of total nitrogen is concentrated in the cereal's biomass. Experiments in India resulted in the protein content in the feed of pure crops of cereals more than 8% while the content of fiber was equal to 32.2%. With the inclusion in the plant stand of *Controsema pubescens*, the protein content in the mixture increased to 9.3%, and the fiber dropped to 30.5%. In our experiments in Yavan (Tajikistan), the fiber content in the mixed crop of cereals and legumes in the fodder equaled to 28.4%, the protein content reached 8.6%. With alfalfa, the protein share rose to 8.9%, and the fiber content dropped to 25.9% (Belyuchenko, 2013; 2013).

In view of the prevailing situation in the plant breeding in the region, it is reasonable to analyze the set of crops in farming rotations and seek environmentally friendly technologies that would contribute to the stabilization of soil fertility. The imbalance of nitrogen in the soil is significantly reduced when using combined crops of cereals and legumes and applying lower doses of mineral fertilizers (20-25 kg/ha of the active ingredient). The use of the biological nitrogen of legumes (up to 37% with the bean plant and up to 20% with the associated cereal), as well as the fixed nitrogen by free-living nitrogen-fixing organisms reduces the consumption of the soil reserves of this element (Belyuchenko and Antonenko, 2015; Belyuchenko, 2015).

Problems of soil disturbance

Practical mistakes in the agriculture of the region have caused a large loss of soil resources and set the goal of sound soil management, increasing its productivity and resistance to the negative impacts of anthropogenic and natural factors. The study of these problems showed that the prudent management of such processes in the natural and economic complex of cultivated lands are yet to be improved. The development of the agricultural system operation management systems provides a basis to solve the problems of environmental management, their protection, as well as ecological safety at the level of the cultivated land system formation through improving the soil, increasing the vegetation structure complexity, and including corresponding life forms in the vegetation composition. Among the first researchers in our country who paid greater attention to the presence of multiple ecological functions of the soil were Professor G.V. Dobrovolsky, E.D. Nikitin (Dobrovolsky et al., 1986; 2000; 2012), V.A. Kovda (1971, 1985), as well as I.A. Sokolov and V.O. Targulyan (1976) who defined the greater multifunctionality of soil and justified the doctrine of its ecological functions.

An integral indicator of the anthropogenic destruction of soil is the condition of its humus, which is determined by two processes with opposite effects: the humification of plant wastes on the one hand, and their mineralization on the other. The balance between these processes in vivo is stable and equalized. The equilibrium is disturbed and basically is negative in the circumstances of cultivated land systems (the mineralization of humus increases compared to its formation), and the main problem consists in the following: in the process of soil formation, natural vegetation generates more waste than cultivated lands (stubble, the underground part: roots, the tillering zone), and the lack of organic matter is almost never compensated by the application of organic fertilizers (it takes about 10-12 t/ha of semi-fusty cattle manure per year) or needs practicing the cultivation of forage grasses, the harvest of which need to be plowed in the soil.

For ordinary chernozem formed by the meadow-steppe vegetation, especially in the hilly areas, the loss of humus reaches up to the 50-60 t/ha per year. The humus of ordinary chernozem is fairly stable, tightly bound to clay minerals of the montmorillonite group, and resists to the negative effects of the destruction of microbiocenoses and the loss of humus. The waste of herbaceous vegetation forms a sufficiently stable humus. The semi-decomposed organic waste in the soil increases the total reserve of organic matter, but it is rapidly mineralized and is virtually absent from cultivated soils. Soil is a single integrated system, in which the loss of humus takes place around the entire genetic profile. The main form of soil degradation of ordinary chernozem is deflation, the loss of humus, and water erosion (Belyuchenko, 2015).

After harvesting cereals, straw is crushed and scattered evenly over the entire area, then shelling is provided to a depth of 8-10 cm, then plowing by clover fellow to a depth of 25-27 cm or autumn plowing to a depth of 27-30 cm. Such soil becomes loose, soft, does not crack during the drought, and is easier to process. Along with straw, up to 80% of potassium and 20% of phosphorus is applied to the soil, the humus reserve increases, and the straw plowing increases the winter wheat grain yield up to 0.8 t/ha.

Burning stubble, straw, garbage, coal, oil, and other organic waste, typical of the main territory of the steppe area of the region enhances the reactions of nitrogen, sulfur, and oxygen in the atmosphere, forming nitrogen oxides and sulfur dioxide, which react with water and form nitric acid and sulfuric acid. Falling with precipitation, the nitric and sulfuric acids in the soil dissolve and leach out nutrients and heavy metals assimilated by plants, and subsequently by humans; the ground (drinking) water is contaminated; acid rains cause the destruction of forests, as well as the crops of a number of vegetables (e.g. cucumbers), etc. (Belyuchenko and Melnik, 2010; Belyuchenko, 2015, 2016; Dzybov, 2007).

In the region, erosion processes widely take place, especially in the eastern mountainous part; the formation of a gully network is very clearly seen in the northern and western regions. Regional scholars (Nomokonov and Sidorenko, 1980; Dzybov, 2007) developed very effective methods for the recovery of vegetation in the eroded areas. However, the whole process of erosion control was suspended after the innovative developments of the authors and appearance of a small number of their adherents and followers (Muravyov and Belyuchenko, 2007).

Despite very obvious environmental shortcomings observed frequently in the territory of Kuban, exacerbated by direct or indirect human intervention, no system of soil conservation measures has yet been developed, which is necessary not only to declare, but to have it and strictly follow in specific areas with account of features specific of them only (the relief, depth of the plow layer, area slope, etc.). Unfortunately, we have to state that there is no sound and rationally distributed network of permanent long-term monitoring sites either at the local or, even more so, regional level. This situation indicates that the recommendations of individual research centers are not supported by systematic analyses of the actual dynamics of the state of soil, vegetation, fauna, air, groundwater, etc. Therefore, scientific recommendations are mainly limited to the extension or deepening of previously developed solutions in agriculture, agricultural chemistry, soil science, and crop production. There are virtually no elaborated long-term programs for the search of new approaches to the development of farming systems and soil science (Dobrovolsky and Nikitin, 1986, 2000).

Cultivated land systems of the steppe zone, characterized by a certain specificity of the climatic conditions, mainly comprise the basis of arable lands and are used for growing agricultural crops. The intensive plowing of this territory, violation of farming rotations and production processes at their cultivation are the main reasons, which determine the decrease in soil humus. Furthermore, significant amounts of heavy metals, pesticides, and petroleum are concentrated in soils. Despite the fact that these pollutants are still below the maximum permitted limits, however, by a number of points pollutants, such as neocide and its derivatives, exceed the maximum permitted limits, and thus significantly increase the contamination of soil, which ultimately is the cause of the deterioration of the agricultural products' quality. Soils of all landscapes of the region need a careful approach in terms of the reduction in the amount of pollutants in the applied organic and mineral fertilizers, which will contribute to the preservation of the basic principle of cultivated lands—the preservation of their soil cover (Belyuchenko, 2015).

Soil acts as the main accumulator of pollutants in the biosphere, protecting the atmosphere and hydrosphere from them, while remaining the major producer of food for all levels of life, including humans. The environmental monitoring of pollution accumulation plays an important role for soil. The question of self-purification of soil is often discussed, although its practical implementation is a complicated issue. By self-cleaning, we mean the elimination of pollutants from the biological cycle that is possible in the following cases: their conversion into a non-toxic state; conversion of some of them into the gaseous form; formation and transfer of them from the soil to the atmosphere; removal and preservation with plant yield; leaching into the hydrosphere (Belyuchenko, 2013).

Complex composts increase the buffer capacity of soils with respect to contaminants, providing it with colloidal and electrostatic properties, shares of organic matter and fine clay complexes, redox, acid, or alkaline and sorption properties. Hence, it is clear that integrated environmental monitoring is mandatory. Without it, it is impossible to assess objectively the functional stability of cultivated lands.

The absence of a uniform methodology for the study of the most important environmental problems of agricultural production, organization of a stationary monitoring, environmental design, simulation, and programming of agricultural systems does not allow them to anticipate possible changes tomorrow. In the system of measures addressing the environmental problems of Kuban, it is possible to allocate conditionally a number of areas that should be considered when developing Programs.

Complex crops

The intercropping of grain cereals, legumes, and other life forms through mutual support of themselves because of their ecological differentiation. Despite the complexity of technological nature, these crops are widely popular in some countries. Legumes, which fix atmospheric nitrogen through a symbiosis with nitrogen fixers, provide 20% and more of nitrogen needed by cereals, which cover a significant portion of energy requirements of free-living microorganisms in the rhizosphere of the farm ecosystem by eliminating carbohydrates. In addition, the joint cultivation of cereals and legumes significantly limits the spread of diseases of individual crops. This is evidenced by the studies carried out in England and Germany, as well as other countries, of economically important crops without reducing the crop production, but helping improve its quality and environmental health. To this end, the components are selected for certain crops, the development of soil biota of the communities to be created are studied, the crop yield and its quality are determined.

The first encouraging results were obtained with regard to winter wheat, corn, sugar beets, soybeans. For example, when growing winter wheat and legumes during the period of 1995-2005, a significant increase in the number of ground fungal germs, as well as bacteria and actinomycetes, performing an important role in suppressing the development of crop plant pathogens, was determined. The introduction of ecological groups of microorganisms to the farming rotations of combined crops changes the abundance and species composition of microarthropoda (springtails, mites) and their morphological groups (soil, litter-soil, and upper and lower litter), earthworms, enchytraeids and many other groups of invertebrates (insects, centipedes), as well as representatives of the microfauna (nematodes, protozoa) in the soil. It is important to emphasize the higher biological productivity of combined crops, the reduction in accumulation of nitrates, heavy metals, etc. in the yield (Muravyov and Belyuchenko, 2008; Nomokonov et al., 1980).

In combined crops, for example, some of the features of certain vegetation species and the direction of growth of lateral roots of sugar beet in the direction of the root systems of legumes are noticed. In pure legume crops (Lathyrus, peas), the number of nodules on the roots of plants and their weight were greater than in the combined crops. The number of nodules in a combined crop is about 20 per plant, and in a pure but unfertilized crop, it is up to 35. The abundance of ammonifying microorganisms (millions per 1 g of dry soil) in combined crops was 4-6 times greater than in crops of sugar beet and grain legumes. When organic fertilizers were applied, the abundance of microorganisms with Lathyrus reached 350 million per 1 g of soil. The number of earthworms in a combined crop of sugar beet and peas was higher (3 specimens per m^2 of soil).

In this regard, littoral cultivated lands play a particular role. Littoral communities existing on the coasts of the Black and Azov Seas are exposed to a significant anthropogenic load. The species composition is not very diverse, but the role of these communities in the coastal ecosystem functioning is significant. Psammophytes that are edificators of such communities *(Leymus sabulosus, Crambe pontica, Eryngium maritimum, Glycyrrhiza glabra*) contribute to the consolidation of sand dunes and prevent erosion processes (Belyuchenko, 2000; 2001).

In this area, the reserves of medicinal, essential-oil, and honey plants in the flora of the southern districts of the region are of certain scientific and practical interest. These types should be interesting for introducers in terms of the feasibility of adding to the crop a large number of commercially valuable species, since harvesting their raw materials will cause significant changes in the structure of communities that are in a rather fragile state. As an example, we can consider the state of populations of *Glycyrrhiza glabra*—a medicinal plant of comprehensive use, which is widely found in coastal areas of Taman. The studied populations are included in the composition of plant communities, dedicated to the slopes of the hills, the shores of estuaries, areas of the Azov and Black Seas, and their small areas (in some places up to 0.5-3.0 ha), occupied by certain populations of such life forms.

The raw material productivity of roots and rhizomes of *G. glabra*reaches 0.7-1.1 kg/m^2, the biological reserve of subterranean organs varies from 1.7 to 22.8 tons per population. It should be noted that the findings indicate a high density of liquorice feedstock. However, industrial harvesting of the raw material on the peninsula is not recommended, as part of the habitats of *G. glabra* and other species belong to the only remaining relatively undisturbed ancient substrate type—the littoral strip with psammophilous vegetation represented by specific protected Mediterranean species. Furthermore, even non-systematic, but massive harvesting can lead to the process of increased sliding, water and wind erosion, especially of the top layer of soil (Belyuchenko, 2000; 2001).

Plant communities of the coastal areas of the region are in a very fragile state, they are characterized by the processes of zonal and intrazonal communities degradation, as well as their flora's synantropization. The share of the incoming solar energy use by combined agricultural crops is much higher than that of single species, as evidenced by our data on the example of winter wheat and sugar beet—the most important crops of the region (see Table 1).

Table1. The consumption of received sun energy by pure and mixed crops (average annual for 1995-2015)

Sq.No.	Indicator	Unit of measurement	Winter wheat – crop		Sugar beet – crop	
			pure	pure + vetch	pure	pure + Lathyrus
1.	Dry weight	kg/ha	11.500	15.300	8.200	10.150
2.	Ash weight in the yield	kg	950	1230	750	920
3.	Organic weight (OW)	kg	11.050	14.350	8.000	9.700
4.	OW in terms of glucose	kg	12.300	16.800	8.700	11.900
5.	Energy spent for transpiration and respiration	kg	3.900	4.500	4.600	6.100
6.	Total weight of synthesized glucose	kg/ha	15.500	19.900	14.000	17.400
7.	Energy required for the synthesis of 1 kg of glucose	kkal	4.500	4.600	4.300	4.800
8.	Energy required for the synthesis of organic matter per 1ha	million kkal	69	94	62	74
9.	Sun energy available for crops per 1ha	million kkal	5.400	5.400	5.400	5.400
10.	The share of the available sun energy	%	1.3	1.7	1.25	1.76

The research results indicate the practicability of continuing the scientific research on the development of new technology of crop combination. If not today then tomorrow, there will be a demand for optimization of the farming rotations in the southern region of Russia, and the emerging ecological trend in agriculture will play an important role in the system of arrangements, since it provides for increasing the organic presence in the soil, reducing the use of chemical agents (primarily various pesticides), using more rationally the biological potential of individual crops, and reducing the use of fertilizers (Belyuchenko, 1964).

In the development of the agricultural production of the Southern region of Russia, along with the improvement of existing prospects (agronomic, chemical, breeding and seed), the environmental and ecological line, based on intercropping with biologically and ecologically differing cops, using different ecological niches, that approximate by their structure the farm ecosystems to natural communities, is found important. Such crops better meet the set of current requirements for agricultural production, as they are able, on the one hand, to optimize the productivity, and on the other hand, use natural resources (rainfall, soil resources, solar energy, etc.) more efficiently, while maintaining the soil fertility and obtaining better products than in the case of unilateral improvement (e.g., chemical) of a line (Belyuchenko, 1965, 1966, 1971).

Antierosion soil protection

To organize systematic state monitoring of the ecological condition of natural and natural-economic (agrolandscape) systems, especially of living organisms of the soil biota in various conditions of a large region, to develop a program of environmental activities throughout its territory, up to individual plots, and strictly implement it, are the main tasks of the organization of research in cultivated lands. It is necessary to provide in the system of such actions for an opportunity of removing from the farming rotation the plowed lands around villages (this will significantly improve air basin around settlements, reduce the erosion processes, etc.), along river beds up to 50 m and more (to reduce the soil washout and silting of riverbeds, etc.), as well as planting forest strips along roads, river beds, around settlements, and other events (Dobrovolsky and Nikitin, 2012).

The development of soil drifting in the steppe regions manifests itself in a very contrasting way: wind erosion is typical of the northern regions, where it reaches maximum values, and it reduces in plains to a weak one. The water-planar erosion is observed in foothills of the regions where plots with a slope of up to 3^{o} are described as erosion-threatening and are located mainly in the valleys and valley depressions. In case of violation of the vegetative ground cover, the manifestation of rill and sheet erosion, and of rill erosion along the river banks, is possible. In the foothills, where the terrain slopes are greater than 5^{o}, medium water erosion manifests itself. In case of violation of the soil cover, channel erosion can occur. The mountainous part of the area is extremely erosion-threatening, where in violation of the natural cover the channel erosion is inevitable (Belyuchenko, 2014; Belyuchenko and Antonenko, 2015).

The agrotechnical line of the improvement of the agricultural crops cultivation technology (optimization of the main operations timing, development of a set of crops in the farming rotation, etc.) should be enhanced. There is no doubt that the improvement in technology today is impossible without the improvement of the agricultural machinery. The reasonable use of chemistry achievements, application of mineral fertilizers in proportional combination with organic ones, and chemical control of pests and diseases should be combined with achievements of the selection, farming rotation, and strain changing, with the improvement of farming rotation techniques, etc. Although the chemical line in the practice of the southern region of our country remains the most important and effective one, providing high yields, the further development of agricultural production should be substantially reoriented to the "organic" approaches. On the one hand, it is caused by the fact that chemistry capabilities are not limitless, and the upper limit of major crops yield has been almost reached, and on the other hand, the use of chemicals has become cost demanding in terms of energy and ecology. For example, the application of nitrogen increases the yield, but also dramatically increases the content of heavy metals and nitrates in the crop (Muravyov and Belyuchenko, 2007; Muravyov et al., 2008).

It is safe to say that only the combination of the use of biological and mineral nitrogen in agricultural production is the most important line of development of energy-saving and environmentally friendly technologies for saving fertilizers, fuel, and other expenses, providing for the functional stability of cultivated lands. A simultaneous reserve in this respect is seen in creating crops consisting of two or more components (such as primary culture + a bean component) that enables to change (enrich) significantly the biota microbiocenosis, increase the biological nitrogen flow into the soil, compact the turf in the topsoil, and lower erosion, especially in growing row crops (Kovda, 1985).

To improve the introduction and breeding line, as well as the seed-growing line in the development of farming rotation, improving the structure of cultivated areas by replacing old breeds (or crops) with new ones that are highly productive and valuable in the economic and environmental terms. As the region has become an important transit point of the agricultural product import, it is necessary to provide for the strengthening of the quarantine service and strict adherence to the rules of the introduction of various life forms of plants and animals. Relevant services should improve the smuggling control with respect to wild seeds, plants, cuttings, herbarium, etc., crossing the border, and departments of agriculture should revise the systems of strain changing and strain renovation that will help prevent the spread of pests, diseases, and weeds.

The mountainous areas in the region typically feature the development of the deflation processes: wind erosion is quite a frequent event, and in conjunction with water generally exerts a strong influence on individual cultivated lands, especially in the foothills and in the coastal strips of water basins. Disturbance of the soil and vegetation cover of the coastal strip of the Black Sea increases the rill erosion. On the whole, the territory of the resort cities features mountainous formations and therefore are very dangerous in terms of erosion, as the channel erosion inevitably develops in case of the soil or vegetation disturbance (Petrenko and Belyuchenko, 2014; 2012).

It is necessary to expand the area of forest strips on the borders of fields, along highways and river systems, around towns, villages, and cities, optimize their species composition, the proportion of different species of trees and shrubs. The established forest strips will generate their own ecoclimate, different from the conditions of the open terrain, and they are able to significantly influence on the microclimate of the entire area of the cultivated landscape (Muravyov et al., 2008; 2008).

Among the most important environmental problems of the studied areas are: the increasing anthropogenic load on the main area, and especially on the coastal parts of the land and sea, the destruction of natural systems, due to increased urbanization, coastal erosion, etc. All the problems are differentiated by the origin, the degree of symptoms, solution mechanisms, etc. Their solution seems possible in case of the strict compliance with environmental interests in the use and development of certain landscapes. The need to address these problems is dictated by the high specificity of agricultural systems of the allocated region, the natural, scientific, economic, and aesthetic value of its cultivated lands with the unique diversity of the biota, as well as the need to ensure stable functioning of systems.

These problems can be solved on the basis of integrated planning taking into account the resource potential of the agricultural systems of the region's steppe zone and the need to protect the unique natural enclaves of mountainous areas and the coast of the Black Sea (Belyuchenko, 1978; 1979).

It is possible to improve the reduction of the anthropogenic loads on cultivated lands only through improving the training of agricultural and environmental personnel, based on the revision of curricula, addition of new disciplines and the deepening of general biological and ecological orientation of the educational process, which will help to expand the horizon of scientific experts and their scientific proficiency. For example, in the province an extensive work on introduction is carried out, but the curricula of the region's universities do not provide for a discipline of a similar profile, and this is one of the main factors determining the low effect of the introduction. Of course, there is a need in the inclusion of a course in cultivated land ecology into the curricula of universities training ecologists and agricultural experts. The curricula of universities should find a place for a high volume one-year course in general biology and ecology, one-year course in environmental monitoring, providing for summer practice, etc. The biological reorientation of the specialist training will immediately have an effect on the improvement of environmental activities in the region, increase the level of university education and its involvement in the ennobling of nature in general and the agricultural production in particular (Belyuchenko, 2005, 2005).

It is necessary to develop the environmental direction of agricultural production, basing it on the maximum use of the biological and ecological features of crops, achievements of the agricultural science, objective evaluation of the climatic situation features, level of soil fertility, etc.; to organize on this basis simple or combined sowing, capable of creating dense farm ecosystems to resist weeds, improve the yield, restrain soil erosion, enhance the biological activity of their flora and fauna, nitrogen fixation processes; to improve significantly the whole package of the composition of the cultivated lands as a whole Belyuchenko, 2015, 2016).

Multicomponent crops should be implemented as a result of the search for technologies based on biological and ecological approaches acceptable for the nature and humans, and on the allelopathic compatibility included in the sown species or breeds of plants. These technologies are based on the ecological and biological means of farm ecosystems' regulation (the selection for combined crops taking into account their biological features and environmental compliance of plants and physicochemical properties of the soil, use of biological agents to increase crop productivity, protection of plants from pests, diseases, weeds, etc.). These requirements are essential for farming rotations of the intensive type with high saturation of winter wheat, maize, and row crops, strategically determining a decline in organic matter in the soil due to its intense mineralization, silt flushing, and removal by wind as a result of the water and wind erosion. Noticeable impoverishment of the soil is also caused to a significant extent by the removal from the soil with the harvest of crops the major nutrients (N, P, K, Ca) and a variety of microelements (Belyuchenko, 1977, 2005).

Maintaining wheat grain crop at the level of 0.6-0.7 t/ha and of sugar beet at 40-50 t/ha requires an annual increase in the standards of mineral fertilizers application, especially of the nitrogen fertilizers. Replacement of organic matter and nitrogen in the farming rotations of cereals and row crops is possible to a certain extent by making semi-fusty cattle or pig manure or preparation of complex compost at the standard rate of 65-70 t/ha every 6-7 years, and the introduction in the farming rotation of combined crops, differing by the environmental and biological characteristics. In other words, the existing situation in the agricultural production requires a revision of the methods of management and, above all, arable farming, subjecting them to the laws of nature, thus contributing to the preservation of the environment and improvement of human health. In this regard, intercropping by combining plants of different life forms should be considered as one of the directions (Belyuchenko, 1978; 1979; Belyuchenko and Antonenko, 2015).

Complex composts

An important condition for composing complex composts is the selection of several types of waste—from 3-4 to 8-10, and even more. In such a selection, the successful accounting of features of the physical, chemical, and biological compatibility of various wastes will determine the success of the task completion. A very important part of the preparation of complex compost is the species and population structure of their microbial communities. The biological basis of the compost is determined by the behavior of prokaryotic communities, and the physical and chemical basis is determined by the combination of organic and chemical compounds, separation of the soil adsorption complex of complex compost, and other forms of the combination of the processes set. Combining wastes with different morphological characteristics differing by the density, the moisture content, and chemical composition determines significant fluctuations in the abundance of organisms in the first two to three weeks after the beginning of the formation of complex compost, especially in summer. The development of various lines of the formation of composts is noticed, which include the combination of organic and inorganic wastes, differing by the dispersion, physical, chemical, and biological properties, expanding the abundance of populations of living organisms of some taxa and reducing others (Belyuchenko, 2013, 2005, 2014).

In the production of waste, many organisms are not able to ensure the original system of stability and balance, and, therefore, their communities are scattered and unrelated. For example, when different wastes were mixed in the summer, it was observed on the 10^{th}–12^{th} days that the mycological and trophic group of microorganisms diverged by species and populations and after one month could be distinguished quite clearly by the similarity of their nutritional characteristics. First of all, it was related to the ammonifying, amylolytic, and oligotrophic microorganisms.

Mixing the waste after 2–3 weeks of microorganisms' development provided for a quick combination of microorganisms into functional groups by the use of amino acids, enzymes, organic acids and other compounds as organic matter resource materials and its transformation into humus and other compounds. The share of microorganisms in the organic material is quite large in the complex compost biomass, which significantly lengthens the circulation of carbon and nitrogen (Belyuchenko and Mustafaev, 2013; Belyuchenko, 2015, 2016).

In complex compost made up of semi-fusty manure, phosphogypsum, and chicken manure with the addition of winter wheat and barley straw, the total number of microorganisms on the 30^{th} day was more than 240 million cells, and about 107 million cells in pure manure. The combination of wastes in complex compost levels the response of the medium based on its chemical properties of neutralization of the entire selected mixture and with account of the specific microbiocenoses by using alkalizing organic constituents. For the development of complex compost, the excrete of different organic substances (amino acids, vitamins, enzymes) is used very widely. The production itself influences the waste composition and its medium response, which weakens the processes of microorganisms' development. Decomposing organic matter, microorganisms significantly enhance breathing and accelerate the circulation of a number of elements. The decomposition of organic matter increases the denitrification and causes gaseous losses of molecular nitrogen. With the development of sophisticated compost, the activity of microorganisms in it increases, which has a positive effect on the management of the processes of organic matter conversion through the stabilization of formation of microbial cells in them and the biomass growth (Sokolov and Targulyan, 1976; Belyuchenko, 1971, 1977, 2014).

Enzymes that are characterized by a short period in the development of complex compost very quickly lose the ability to change processes taking place in it. The decomposition of organic matter in compost is provided by microorganisms, the intensity of which at the time of application to the soil reaches 80-90% and lasts 3-4 months near the enzyme source. The development of complex compost reaches an optimum value with its ability to move towards a balance and depends on the level of biological activity of certain wastes. The abundance of microorganisms, for which it is possible to determine their biomass, is a deviation from the minimum, typical of specific waste. Their abundance is associated with the composition of all wastes included in complex compost, its inherent physical and chemical characteristics, and causing a major change in a relatively short period of time, especially in the summer (Belyuchenko, 2015).

The optimum of complex compost resources is determined by non-predictable factors of the medium of all waste and the C:N and C:P proportion in them, the quantity of organic matter in them, the real changes in temperature and precipitations, and also the proportions of microorganisms in given time periods. In connection with the expansion of the complex compost composition, new aerobic and anaerobic processes occur and the abundance of nitrogen-fixing and ammonifying microorganisms using organic and mineral colloids for their development increases. As complex compost matures, the decomposition of organic matter intensifies with simultaneous reduction in the activity of nitrification and denitrification, and the composting system achieves an optimum, including systems of microorganisms in the process of its development (Belyuchenko, 2013, 2014).

In the system of microorganisms, including bacteria, fungi, actinomycetes, unicellular algae, and other groups of living organisms, a special place in complex compost is held by fungi representing a diverse group of organisms at various stages of evolution. Fungi have an important quality—energy-saving metabolism and the use of large amounts of carbon and nitrogen from the compound degraded by them to build their bodies. This group of microorganisms is actively involved in the complex compost development, and with the transition to the soil—the process of soil formation, in which it enhances the biological activity and productivity of crops.

Today, humans actively use in their work nature-destroying technologies that are being developed in the following areas: preservation of the sustainable and dynamic development of the biosphere undergoing the growing anthropogenic pressing; preservation of human health exposed to the boomerang response of nature to their own negative attitude towards it; alleviation of human contradictions with the environment; a realistic assessment of the environmental situation between humans and the environment; development of scientific basic principles of forecasting the development of local and regional ecological systems, aimed at their stabilization, which will contribute to the preservation of humans as a species (Belyuchenko and Antonenko, 2015).

A very dangerous source of cultivated land pollution are dumps and particularly chemical reagents (sulfuric and nitric acids, sulfates, nitrates, pesticides, heavy metals), which reach them in different ways through different waste dumping and their careless storage in natural systems. The most important component of the environment is water, as a source of life, heat, and energy on the earth, determining the land climate condition. It is important to determine main measures of pollution control, among which the most effective ones are the low-waste production, reduction in the use of chemical agents, in the level of water systems' contamination with human wastes, and the optimization of energy costs.

One way to reduce the negative impact of humans on cultivated lands is the use of combined crops. Combined crops for the livestock purposes are well-studied. Experts select different crops, differing by the life form, ecology, physiology, biochemistry, that allow to obtain under certain conditions stable yields in versatile dynamics of climate and soil protection from water and wind erosion (Belyuchenko, 2015).

As for field farming rotations, which involve grain and industrial crops growing, we will try to assess the biological essence of combined crops. There are multiple publications that do offer engaging in crop combination for farming rotations. Main part of the information relates to two-crop and rarely three-crop combinations. It is very difficult to achieve in more complex mixtures the behavior of certain crops as in two-crop combinations. The combination of different crops in a single farming rotation is limited by a series of farming practices. Their planting is carried out by simultaneous sowing of the seeds of all crops, sowing seeds of different crops apart, sowing randomly, in a certain order, etc.

Combined crops of wheat, sugar beet, soybean with other crops of peas, Lathyrus, and others are rather complicated systems to manage than single crops. Expanding the study of combined crops can provide good material for the development of the basic principles of the ecological agricultural engineering theory. The most important components of combined crops (such as in China) are maize and soybean. Their combined crops produce approximately 20-25% greater yield than their pure crops. Combined crops also are distinguished by the similarity of yields from year to year in comparison with pure crops. They are also more resistant to dry weather conditions, pests, and diseases and more competitive to weeds.

When combined crops are created, a decrease in the yield of certain crops is noticed. For example, in our experiments, sorghum significantly reduces the yield when sown together with soybeans. The mixed crops of maize and pole bean in South America, wheat and pea in Kuban, and other examples characterize the expression of peculiar features in the interrelations of certain combined crops. It is possible to understand the nature of the interaction of these crops through the study of the behavior of individual species in pure and mixed crops. Of course, manual labor costs characterize combined crops, which are related to the insufficient technology development level (Belyuchenko and Mustafaev, 2013; Belyuchenko, 2016).

In small and large farms, the development of the cultivation and growing of agricultural crops requires different approaches. In large farms, it is reasonable to try the new direction, which includes two main forms: sowing and harvesting. Such a process as preparing the soil should be substantially adjusted with account of the ecology of plant species and soil and the increased use in the upper layer of mulch, especially in dry years. The direction of intensive farming has led to an impasse. Due to the emergence of new technologies and deepening in our views today on the nature of the cultivated land functioning, we need to look for new approaches to the use of soil (Belyuchenko and Slavgorodskaya, 2013; Belyuchenko, 2015).

The need to give agriculture the natural character is supported by many research factors: the behavior of the soil organic matter and living organisms, the ratio of carbon, nitrogen, and phosphorus, and a number of other features. In this regard, modern training of scientific agricultural personnel should solve such problems on an ecological basis.

The first energy link of the food chain of many bacteria, fungi, protozoa, millipedes, insects, earthworms, moles, etc. in the soil is detritus. Adding complex compost increases the abundance of living organisms, partially turning the remains of dead organisms in humus, mixing them with the neutral part of soil, and structuring them to a noticeable extent. An important role in this process is played by earthworms, which pass up to 40 t/ha of soil per year through their digestive tract, combining mineral and organic parts into solid structures. Humus is not an eternal organic matter, is not absorbed by any organisms, and according to different estimates from 30 to 50% of humus is annually decomposed based on the volume of soil. Organic matter is subdivided into humus and organic debris, still preserving its original anatomical structure (Belyuchenko, 2013, 2015).

There are the following components of humus: humic acids, humins, fulvic and hymatomelanic acids. The main role in the formation of humus is played by soil organisms. The first phase of humification is mainly carried out by mold fungi and bacteria nonspore-forming bacteria, the second by spore bacteria, the third by cellulose myxobacteria, and the fourth by actinomycetes. The reduction in the humus reserves in soil is determined by the following causes: water and wind erosion, excess of physiologically acidic fertilizers and received organic residues when the natural biocenoses are replaced by farm ecosystems, prevalence of certain crops in farming rotation and monocrop farming, land plowing, draining of hydromorphic soils, irrigation, increase in the activity of the microflora and microfauna, contamination with heavy metals, oil, and other substances, the role of the mixed crops in the functional stability of cultivated lands (Belyuchenko, 2013, 2015, 2016).

Cultivated lands as a whole consist of several species of cultivated plants and weeds and have a number of advantages over pure crops, including the formation of the photosynthetic apparatus of a large area in different tiers, with the increasing number of which the efficiency of solar radiation interception by plants and their participation in photosynthesis increases. A better use of minerals and water is provided due to the placement of root systems and other species in different layers of soil. It becomes possible to avoid peak situations and competition due to the difference in the maximum moisture and nutrients consumption, as well as to meet the crop needs in basic life factors. In connection with the introduction of species different by the types of biological attributes, the full use of hydrothermal resources during certain years and the formation of stable yields is ensured. The crops of different species suffer from outbreaks of pests and diseases less often. The dense vegetation slows the development of water and wind erosion and maintains soil fertility. Nitrogen in mixed crops is used more rationally, as well as and other nutrients, and heavy metals are transformed into a condition inaccessible for plants (Belyuchenko, 2015; 2016; Muravyov et al., 2008).

An important role in the functional stability of cultivated lands is played by forest strips, which are characterized by a large leaf surface and a frequent deep root penetration in edaphotope. Forest strips ensure good protection of soil and transfer moisture into the subterranean rainwater runoff. In addition, due to the growth of their roots, trees form clefts in the bedrock, which is also beneficial to the improvement of communication between the underground and top environments. In general, forest strips should be an important prelude to the general improvement of disturbed cultivated land systems, of which we have innumerable quantities, even without affecting the arable land.

Functional stability of cultivated lands

Application of complex compost to soil supports all forms of particles in separate granules in the substrate structure. Mineral soil particles are divided by weight into the heaviest part—the sand—followed by dust and clay. Compared to the control plot, this approach helps us to determine the share of individual particles in the soil, and the application of complex compost facilitates their structuring in time and maintenance of such functions for 5–6 years. The ratio of the specified particles in the soil determines its properties. Loams containing 40% of sand, 40% of dust, and 20% of clay with the application of complex compost extend the functional stability of the soil cover in the cultivated land to 6–7 years.

The granulometric texture with the application of complex compost generally improves the basic quality characteristics of soils: the ion exchange capacity, the infiltration and water-holding capacity, and high aeration. Complex composts have a significant impact on the soil particle size, comprising lipophilic inorganic wastes (phosphogypsum, halites, chalk, ash, etc.), are characterized by high thermodynamic equilibrium and dispersion, are formed as wastes in the manufacture of products from natural raw materials, and are structurally stable for a long time (Belyuchenko and Antonenko, 2015; Belyuchenko, 2015).

Lyophobic disperse systems of vegetation and animal wastes, crop residues, household wastes, etc. are not balanced thermodynamically and have a large excess of energy. Therefore, complex compost generally carries comprehensive information on certain quantitative and qualitative properties. Cultivated lands are to provide humans with food, water, and clean air, promote healthy living, so they must be harmoniously connected with natural systems, presenting a joint version of a life-support system (Belyuchenko, 2010; 2015).

Conclusion

Thus, agriculture in the region seeks new methods of farming and expands human knowledge on the transformation and movement of nutrients and water in artificial communities. This will facilitate the transition to minimum tillage; improvement of energy efficiency; reduction in water loss and soil erosion caused by irrigation; reduction in the consumption of mineral and organic fertilizers and improvement of their efficiency; use of crop residues and stubble mulching; increase in the number of crops in the farming rotation; reducing use of pesticides of particularly broad range of use; saturation of farming rotations with perennial and especially legume crops; selection of breed varieties with high efficiency in certain areas; increasing soil fertility and reducing contamination of them with chemicals. The management of cultivated lands is provided from the outside, where it takes place in a faster way, so it is more reasonable to organize agricultural ecosystems, so that their internal regulators would contribute to increasing their efficiency and stability. We have published nearly 20 scientific articles on the formation of cultivated lands in Kuban and their functional stability, summarizing the results of studies on the influence of complex composts on the top layer of ordinary chernozem and the efficiency of agricultural crops. The study of colloids in various waste products, the ratio of organic carbon and nitrogen as an important property of complex compost, ecological principles of symbiogenetic development of plants in combined crops, as well as waste production and consumption constitute the raw material basis of complex composts. Complex compost acts as an important source of the saturation of soil with nutrients and influencing the physical, chemical, and biological properties of soil, playing an important role in the ecological niches in cultivated lands, based on the functioning of combined crop and the use of complex compost in the cultivation of winter wheat, maize, sugar beet, transforming nitrogen in the upper layer of ordinary chernozem and detoxifying cultivated land systems. The dispersity of wastes and their properties, the colloidity of wastes of different industries and their role in the formation of complex compost changes the aggregate composition of ordinary chernozem and impacts other aspects of the formation and development of soil and plants in the system of cultivated lands.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Ivan Stepanovich Belyuchenko holds a PhD in Biology and now is a Professor at Kuban State Agrarian University, Krasnodar, Russian Federation.

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