The organization of the territory of agricultural land use in the South of Russia on an environmental-landscape basis (using the example of an agricultural enterprise)

E V Pismennaya, I A Volters, M Yu Azarova and V A Stukalo
Stavropol State Agrarian University, 12, Zootechnichesky str., Stavropol, 355017, Russia

E-mail: azarova778@gmail.com

Abstract. The key position of grain farming and livestock in the South of Russia in the economic sphere is due to the fact that it can be the main factor in ensuring food security and the main condition for the sustainable development of agriculture and the agro-industrial sector as a means of using soil, climatic, orographic and conditions of the land use effectively. These factors make it possible to consider an increase in grain and livestock production for the market a strategic task for the region, and first of all, as an indicator of the most efficient use of the natural resource potential of the territory. An analytical study is conducted on the database management of two multi-parameter systems, the environment and the crop and livestock production state on the basis of reports and statistical materials. The analysis of the current industries state is aimed at identifying decision-making methods for managing agricultural land productivity based on agro-ecological and landscape zoning of the territory of an agribusiness. Currently, there are conditions when it is necessary to switch to a new scientifically based model of the spatial business organization. This will allow implementing the strategy of environmentally adaptive intensification of crop and livestock production. This approach is based on the identification of seven agro-ecological groups of lands and the placement of field, forage and soil-protection crop rotations on them, taking into account the proposed model of the soil-protective complex, reducing the manifestation of water and wind erosion. Such an approach in the use of the territory of an agribusiness will correspond to the grain and livestock specialization of the third agricultural zone of the Stavropol region.

1. Introduction
To increase agricultural productivity of land, stabilize yields of leading crops and livestock, crop and livestock industries need scientific support to uncover the natural resource potential of the territory, to eliminate the contradictions between market relations and natural historical changes of climate and soil, i.e. in the management of agricultural land productivity in specific agro-ecological business land groups [1, 2].

To address these issues, studies of the dynamics of two interacting systems are required - a multifactorial system of conditions for the development of an agricultural enterprise and the natural resource potential of a territory. The methodology of this scientific study fits into the scheme of basic research with access to the production conditions of an agricultural enterprise.

2. Materials and methods of research
To perform the work, a data bank was created, reflecting the natural resource and economic potential. For each selected agro-ecological group of land, the bank contains information on topography, soils, plant biodiversity, eroded territory, and a sectorial scope for a 55-year period. The analysis and systematization of the data allowed the agricultural enterprise to offer an adjustment to the agricultural enterprise's specialization: from grain to grain-cattle breeding (with the restoration of small livestock at least 2000 heads and number of cattle - at least 1000 heads).

3. Research results and discussion
The Agricultural Consumer Credit Cooperative (ACCc) “Dubovskiy” is located in the north-eastern part of the Shpakovskiy area of the Stavropol region (unstable moisture zone with a hydrothermal index equal to 0.9–1.1) [3]. The sum of daily average temperature is 3000–3200°C. The average annual temperature is +10.3°C. The average temperature of the warmest month is + 23.4°C, the coldest one is 4.2°C. The amount of precipitation for the period of active vegetation is 450–550 mm.
Most of the precipitation falls during the growing season. In spring and summer, they are torrential in nature. Evaporation over a period with a temperature above 10°C significantly exceeds the amount of precipitation. East and southeast winds prevail. In winter, they contribute to snow blowing from the fields, freezing of winter crops. Spring strong winds can blow seedlings out of crops or damage crops. In summer, dust storms and dry winds are common.

The agribusiness is located on a high erosion-denudation plain with valley-beam dissection. Conventionally, land use can be divided into three parts, which differ in geomorphology, soil, and erosion processes.

A significant part of the agricultural enterprise is subject to water and wind erosion. If anti-erosion agricultural measures are not respected, a situation may arise when arable land set aside from the land turnover.

Pre-Caucasian chernozem dominates on land use. In the flood plains of the Razvilka and Kizilovka rivers, meadow-chernozem, meadow and alluvial meadow soils, to varying degrees of salinity and alkalinity tolerance, were formed on beams. A characteristic feature of chernozem is the low content of humus, but its significant distribution along the profile in depth. By the thickness of humus horizons, powerful chernozem with a thickness of horizon A+B are identified - more than 80 cm, medium thickness А+В = 40–80 cm, low power А+В less than 40 cm. The particle size distribution of soils varies from light loamy to heavy loamy.

Soil-forming rocks are surface loam, eluvium of sandstones, talus deposits and alluvial saline deposits. The soil-forming rocks of the farm are represented by the following species: carbonate medium and heavy loam, talus deposits, talus saline deposits, sandstone eluvium, and alluvial saline deposits. As a result of the soil survey, 37 soil varieties and 6 soil combinations were identified.

The territory of the agricultural enterprise belongs to the steppe zone [4]. The natural vegetation of forage lands is preserved on the slopes of the beams. Unsystematic use of them led to the lack of soil cover and soil loss of grass, and its place was taken by few productive species.

At the time of formation (1965), the agricultural enterprise specialized in livestock (milk and meat) with the number of small livestock 13238 heads and cattle 1868 heads. Nowadays (2017) it specializes in grain production.

At the present stage, the ACCc “Dubovsky” is a farm of intensive farming. There is no irrigated land on the farm. The area of agricultural land is 10038.5 ha, incl. arable land - 8259.1. Grain and legumes predominate in the structure of sown lands, which occupy up to 58% of the land area. The leading grain crop is winter wheat. There are favorable conditions for the cultivation of sunflower. The yield of cultivated crops is determined by climatic, soil, orographic and ecological conditions, and has growth.

The total area of natural forage lands is 1746 ha. Long-term unsystematic use of these lands has led to the loss of perennial grass vegetation, and their place was taken by poorly productive annual and wild species. The yield of natural forage lands is low and amounts to 12–14 c/ha of green mass eaten, and on improved pastures - 40–60 c/ha.
Taking into account the geomorphological and soil conditions, it is proposed to allocate seven agro-ecological groups on the territory of the agricultural enterprise: four land groups of field agricultural landscapes and three - natural forage (table 1).

Table 1. Recommended agro-ecological grouping of agricultural land.

| No. | Agro-ecological group                                      | Area, ha |
|-----|------------------------------------------------------------|----------|
| I   | Tillage of the 1st agro-ecological group                   | 3522     |
| II  | Tillage of the 2nd agro-ecological group                   | 3470     |
| III | Tillage of the 3rd agro-ecological group                   | 1216     |
| IV  | Tillage of the 4th agro-ecological group                   | 64       |
| Total|                                                             | 8272     |
| V   | Pastures improvement 5th agro-ecological group             | 189      |
| VI  | Pastures surface improvement 6th agro-ecological group     | 174      |
| VII | Pastures of rational use of the 7th agro-ecological group  | 1383     |
| Total|                                                             | 1746     |

The first agro-ecological group includes especially valuable land: flat areas of arable land with a slope of up to 1° suitable for the cultivation of all crops. The group unites fertile soils: the carbonate thick and medium thick Pre-Caucasian chernozem; low humus and slightly humus, medium and heavy loamy. The total area of this group of arable land is 3,522 ha, mainly field crop rotations will be placed on it and not many pastures (after a surface and radical improvement on an area of 95 ha) [3]. The main factor determining crop yield is moisture here, so agro-technical measures should be aimed at the accumulation and conservation of moisture in the soil. Of great importance for raising yields is the introduction of partly-activated fertilizers. On the lands of this group, the main types of field crop rotations are grain tillage. It is recommended that grains be placed on these lands in an area of 57.9%, for the rest - industrial crops and clean pairs. Feed crops should be given only 8.5%: predominantly silage in field crop rotations and perennial grasses on irrigated land [5, 6].

In order to protect the soil from wind erosion, it is recommended to carry out the band placement of crops and vapors across the prevailing winds, reduce the number of operations in tillage, planting forest shelter belts [7]. To improve pasture productivity and grass stand, improvement of surface is needed.

The second agro-ecological group is the land with a score lower than the average level or close to it, with a slope of 2–3° and zonal soils subject to degradation processes in a weak degree. Their area is 3,470 ha (including grasslands for radical improvement, 41.4 ha), where 62.5% of arable land is allocated to fodder crops (41.6% of which are perennial grasses). On these lands, it is better to place grain-grass-tilled crop rotations. Agriculture and all activities on the developed soils should be aimed at increasing the resistance of the soil to blowing and reducing the wind speed in the surface layer [8]. It is recommended to create a network of forest shelter belts [7]. To improve pasture productivity, a radical improvement is recommended [5,6].

The third agro-ecological group is arable land with a slope of not more than 5°, degraded to an average degree, suitable for the cultivation of agricultural crops with restrictions. The group includes weakly erodible soils – salt-washed, normal, calcareous, weakly-alkalinized, thick and medium thick, thin-humus, slightly humus, nonrubble and slightly rubble, nonsaline and slightly soline Pre-Caucasian chernozem, of various mechanical composition, coupled with thick slightly humus at 10-25% weakly-erodible and meadow up to 10% weakly-alkalinized Pre-Caucasian chernozem and in combination with thin calcareous slightly humus and at 10% weakly washed chernozem. The land area is 1216 ha, of which 63.1% is allocated for forage crops (of which 90% are perennial grasses). The creation of soil-protective crop rotations with a wide range of perennial grasses and winter wheat was recommended [8]. All activities should be carried out across the slopes. The lane placement of crops is appropriate, in which perennial grasses alternate with annual or annual crops of continuous sowing with tilled crops. On the lands of the third group, grain grass rotations are most acceptable. On pastures, it would
seem sensible not to allow overloading of livestock, to carry out measures for the surface improvement with grass seeding.

The fourth agro-ecological group includes normal and carbonate thick and thin, weakly humus, not covered with rock debris and slightly covered with rock debris, erodible and weakly-erodible, medium-erodible Pre-Caucasian chernozem. They lie on gentle and penchant slopes of different exposures and are suitable for perennial grasses and pastures. The soils of this group are relatively not widespread and are used for arable land and pastures. Land plots that have lost their properties, it is advisable to lay down with perennial grasses. It was recommended to transform these lands from arable land to hayfields and pastures of radical improvement.

The fifth agro-ecological group includes normal and carbonate, thick and thin, weakly humus, not covered with rock debris and slightly covered with rock debris, medium-erodible Pre-Caucasian chernozem. It is recommended to use this land for pasture. Therefore, the plowed land needs to be laid down with perennial grasses. It would seem sensible to strictly normalize cattle grazing. All cultivation works are to carry out across the slopes.

The sixth agro-ecological group combines the black soils of normal and carbonate, slightly humus, not and covered with rock debris, highly erodible weakly humus covered with rock debris Pre-Caucasian chernozem and their combinations with the black soils of the carbonate thin medium-covered with rock debris at 10-25% erodible with 10-25% gullies with 10-25% dense rocks Pre-Caucasian. They occupy penchant and steep slopes to the river Razvilka. The total area is 189 ha. Land resting with perennial grasses is necessary. All soil treatment work should be carried out across the slopes. Cattle grazing must be limited. Gully afforestation is recommended.

The seventh agro-ecological group includes meadow and meadow alluvial alkaline saline soils. The soil of the group has excessive moistening, especially during the spring floods. The total area is 1383 ha. It is better to use soil for sowing perennial salt tolerant grasses [5, 6]. On the banks of rivers and ponds, it is advisable to plant water conservation forests.

Such an agro-ecological grouping of land will reduce the manifestation of water and wind erosion. In this regard, it is recommended to use the model of the soil-protective complex of an agricultural enterprise, which is presented in the table 2.

**Table 2.** Model of the soil-protective complex with the effects of water and wind erosion.

| Production type of agricultural enterprise: grain and cattle breeding | Erosion control organization | Soil protection technology | Reclamation work |
|---|---|---|---|
| The introduction of the 8-dipole field grain processing of rotation, a 10-dipole field grain-grass-row crop rotations, 7-dipole field grain-grass crop rotation | Contour-band placement of crops on the slopes with a high risk of erosion | Planting of forest shelter belts through 300-500 m in the borders of fields | Rationing of the load of pastures with cattle. The device of cultural pastures. Introduction of pastures |
| Soil conservation tillage with preservation of crop residues for winter wheat after high-stemmed row crops, for spring crops | The use of techniques with the formation (fake) irregularities for the detention of rainfall runoff | Radial and superficial improvements. Grassing | Afforestation of ravines, formation of water protection plantings |
| Transformation of arable land into pasture. Conservation of land. Snow retention. Slitting. Creation of a network of forest shelterbelts |

Thus, the creation of such an agro-ecological framework from a system of field, forage and soil protection crop rotations contributes to the ecological management of agricultural production.
Improving the economic system will increase the productivity of agricultural land [8]. At the same time, it is advisable to analyze and assess the economic burden based on the ecological-landscape approach [9]. When obtaining the value of the coefficient of environmental sustainability (0.36), the territory of the farm is classified as ecologically unstable. The anthropogenic load factor (3.15) indicates a strong impact of the organizational and production structure on the state of nature in the whole economy. The index of ecological diversity of the territory (23.1) reflects a low index of compliance of the agro-landscape with the natural one. In the organizational and production structure of the farm, the territory of the natural boundaries, Razvilka, has better environmental indicators (than in other landscapes), which affects the stability of agricultural landscapes, and in general, the growth of the ecological and economic efficiency of land use.

4. Conclusions
The final result of the work was recommendations to the agricultural enterprise on the use of agricultural land, namely: the first agro-ecological group of arable land should be used for field crop rotations (grain tillage); the second group - under field crop rotations (grain-grass-tilled). In this crop rotation, grain crops occupy 70% of arable land, incl. under winter wheat - 40%; the third group - under field crop rotations (grain-grass); fourth group - it is recommended to transform arable land into hayfields and pastures for radical improvement and conservation of land. Thus, the combination of approaches makes it possible to adjust the development of agricultural production taking into account the ecological-landscape requirements for the placement of agricultural land and crops, to develop proposals for modernizing the organization of the agricultural territory of the economy.

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