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Agroecological assessment of soils in the system of agricultural land use

Ramil R. Mirsayapov, Ilgiz G. Asylbaev, Nadegda G. Kurmasheva*, Rustam A. Lukmanov, Ilnur R. Miftakhov

Federal State Budgetary Educational Establishment of Higher Education "Bashkir State Agrarian University", Ufa 450001, Bashkortostan, Russia
**Corresponding author:* n.kurmasheva@mail.ru

Abstract

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Soil monitoring plays an important role in the soil fertility control. It includes systematic observation over agrochemical, agrophysical and other soil changes. As things stand at the moment, farming industry is impossible without continuous land monitoring. The objects of the research are the soils of the Bugulma-Belebey Upland of the Belebey region of the Republic of Bashkortostan. According to the soil zoning, the Belebey region belongs to the Pre-Urals steppe zone. Geomorphologically it is situated in the south-easternmost tip of the Bugulma-Belebey Upland which is mostly a plateau-like plain. Thanks to the research results, agricultural manufactures got the possibility to use land resources effectively and to develop scientifically based arable farming systems. During the research soil maps of 1985 were corrected. A new actual digitized map of the Belebey region of the Republic of Bashkortostan was created.

Keywords: soil monitoring; widespread soils; parent rocks; farming; humus.

Introduction

Soil monitoring plays an important role in the soil fertility control. It includes systematic observation over agrochemical, agrophysical and other soil changes. As things stand at the moment, farming industry is impossible without continuous land monitoring.

GIS technologies (Geographical Information Systems) make land monitoring readily available. This allow making light assessment of the soil fertility. Thus, it is recommended to conduct field researches to study the soil fertility in great detail (Debella-Gilo et al., 2009; Collard et al., 2014; Asylbaev et al., 2018, Mendes et al., 2019).

The research of the quantity and quality soil fertility indicators allows estimating the level of anthropogenic impact on particular land plots. The results of the research can be used to develop a science-based system of the land use. Monitoring researches are also important to study soil ecological functions and carbon biogeochemical cycle under the conditions of the global climate change. (Ishbulatov et al., 2018; Chen et al., 2019; Khabirov et al., 2015).

The goal of our research is to analyze agrochemical and morphological soil parameters of the Pre-Urals steppe zone of the Republic of Bashkortostan.

Materials and Methods

The objects of the research are the soils of the Bugulma-Belebey Upland of the Belebey region of the Republic of Bashkortostan. According to the soil zoning, the Belebey region belongs to the Pre-Urals steppe zone. Geomorphologically it is situated in the south-easternmost tip of the Bugulma-Belebey Upland which is mostly a plateau-like plain.

The system of small tributaries and a complex erosional pattern divide the territory into separate interfluves, which sometimes look like flat-topped hills up to 200 m height above surroundings. Denudation geological deposits stability results in bench-like form of high relief elements with the bedding rocks exposure on hillsides. The length of the ravine net is 0.5-1.5 km, the splitting depth is 50-150 m. Parents rocks are mostly represented by deluvial carbonate loams and residual deposits.

Climatic conditions of the territory are characterized by strong contracts between winter and summer temperatures (from -19°C in winter to +22°C in summer). The sum of active temperatures is 2000-2200°C. The frost free season lasts for 110-140 days. Yearly precipitation data is 400-450 mm (Khaziyev et al, 1995).

In 2018 field soil survey of the lands of agricultural use of the Belebey region municipality was made according to the subcontractor agreement with the "VolgoNIIgiprozem" company. The works included the laboratorial inspection of the field survey materials, farming land list forming and dividing of the farm lands into groups. Areas of soil varieties and groups of farm lands were determined. Electronic soil maps were made and corrected. And finally, there was made a project list of outstanding productive farm lands meant to be used only for agribusiness purposes.

Results and Discussions

When making soil maps, special attention is paid to the soil survey of geomorphological territory conditions. This survey allows correcting the present maps in future, morphological and agrochemical soil indicators being very important factors in this case. The research revealed numerous soil varieties characterized by a wide range of features determining the soil fertility rate.

On the farm lands with an area of 88528.98 ha black soils were the most widespread and made 80.44%. Gray forest soils occupy 11912.83 ha (10.82%) and go second. Alluvial-meadow and meadow-boggy soils occupy 2930.53 ha of the lands (2.66%) (Figure 1).

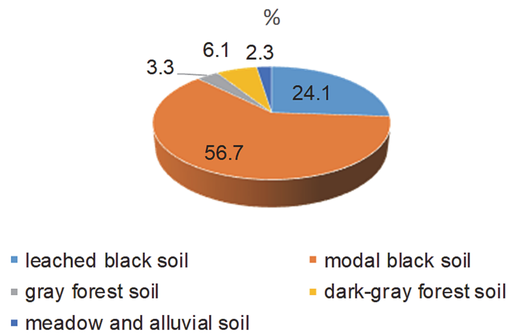

Fig. 1. The most widespread soils of the Belebey region

The percentage of the total farm land area of 110054.2 ha is taken into consideration. The gradation doesn't include ravine plantation soils, sand-and-gravel deposits, live ravines, disturbed lands and pits occupying the area of 3643.01 ha (3.31%).

One of the research tasks was to study the humic soil state of the objective territory. According to the literature data, in Russia the loss of the fertile layer reaches 1.5 bln tones yearly. About 85 bln ha of farm lands should be protected from the soil retirement. However, yearly shortfall in crop production which is due to the soil fertility deterioration makes 110 bln tones expressed in grain equivalent. The soil fertility of biogeocenosis is a naturally renewable property. It reflects dynamic equilibrium level of the feed stuff necessary for plants and accumulated in the soil and the soil conditions admitting air, water and feedstuff to plants from the soil. The fertility of arable lands in its turn is an artificial property. It reflects the real level of the feedstuff necessary for plants. The feedstuff is biologically accumulated and anthropogenically added to the soil. This property also reflects soil conditions admitting air and feedstuff from the soil to domestic plants (Chekmarev et al., 2017; Kiani-Harchegani et al., 2019; de Oro et al., 2019).

The chief problem of the modern farming is soil fertility improvement. The main indicator of the fertility is the amount of humus in the soil. As commonly known the amount of humus in the soil decreases in case of high farming (Yakovlev et al., 2018).

Neither organic matter entering with root and crop remains do no fertilizers to be applied not replenish the humus loss during its mineralization? Such are the present structure of the cropland acres, the system of cultural operations and the levels of the farm crop capacity. As a result of the above mentioned the amount of humus in the soils of the Republic of Bashkortostan decreased significantly during the last 15-20 years. (Mirsayapov et al., 2018).

According to the research results, medium power humus occupying 65065.16 ha (59.12%) precedes low power humus which occupies 34079.38 ha (30.97%) in humus-accumulated power. Shallow and deep soils with the territories of 4137.17 ha (3.76%) and 2208.12 ha (2.01%) respectively occupy a smaller area. Moreover, the gradation doesn't include ravine plantation soils, sand-and-gravel deposits, live ravines, disturbed lands and pits occupying the area of 4564,36 ha which makes 4.15% (Table 1).

Medium humus soils predominate in humus amount and occupy 71754.45 ha (65%). There are also fertile soils which occupy 19238.37 ha (17%) and low-humic soils with the territory of 12774.67 ha (12%) (Table 2). Modal and leaches black soils contain most of humus. Its amount varies from 4.6-11.2 to 4.1-10.3 depending on land use.

Table 1. Distribution of soils according to the humus-accumulated power

Characteristics of the topsoil power	Area, ha
Deep soils	2208.12
Medium soils	65065.16
Shallow soils	36703.81
Very shallow soils (shallow cut soils)	1512.74
Soils not included to the gradation	4564.36
Total	110054.2

Table 2. Soil characterization according to humus amount in it

Humus amount	Area, ha
Fertile soils (hyperhumus)	19238.37
Medium humic soils	71754.45
Low-humic soils	12774.67
Slightly humic soils	1707.28
Micro-humic soils	15.06
Soils not included to the gradation	4564.36
Total	110054.2

65.58% of soils suffer from water and wind erosion. Herewith, slightly washed-out soils occupy 57590.94 ha (52.33%), medium washed-out soils – 10171.41 ha (9.24%), highly washed-out – 3279.99 ha (2.98%), and very much washed-out soils occupy 23.55 ha (0.02%). Soils not suffering from erosion occupy 34574.46 ha which makes 31.42%. The gradation doesn't include ravine plantation soils, sand-and-gravel deposits, live ravines, disturbed lands and pits occupying the area of 4413.84 ha (4.01%) (Table 3).

According to the dry-wet percentage, soils were divided into heavy-textured loamy soils, light-textured clay soils and medium-textured loamy soils. Heavy-textured loamy soils are dominant and occupy 56606.86 ha (51.44%). Light-textured clay soils come next occupying 32202.16 ha (29.26%). Then comes medium-textured loamy soils with the territory of 13804.64 ha (12.54%). Light-textured clay soils and medium-textured loamy soils account for 1.97% and 0.58% respectively. The gradation doesn't include ravine plantation soils, sand-and-gravel deposits, live ravines, disturbed lands and pits occupying the area of 4592.38 ha (4.17%) (Table 4).

Table 3. Soil distribution according to erosion features

Degrees of erosion	Area, ha
Unwahed-out	34574.46
Slightly washed-out	57590.94
Medium washed-out	10171.41
Highly washed-out	3279.99
Very much washed-out	23.55
Soils not included to the gradation	4413.84
Total	110054.2

As follows from the soil survey and according to the soil classification of 1997, there were revealed 9 types, 17 main subtypes and over 30 soil varieties. Black soils got more widespread. As for model black soils, they made 56.7% (Figure 2).

Table 4. Soil characterization according to the dry-wet percentage

Dry-wet percentage	Area, ha
Heavy-textured clay soils	0
Medium-textured clay soils	639.34
Light-textured clay soils	32202.16
Heavy-textured loamy soils	56606.86
medium-textured loamy soils	13804.64
Light-textured loamy soils	2167.3
Sabulous soils	41.51
Sandy soils	0
Soils not included to the gradation	4592.38
Total	110054.2

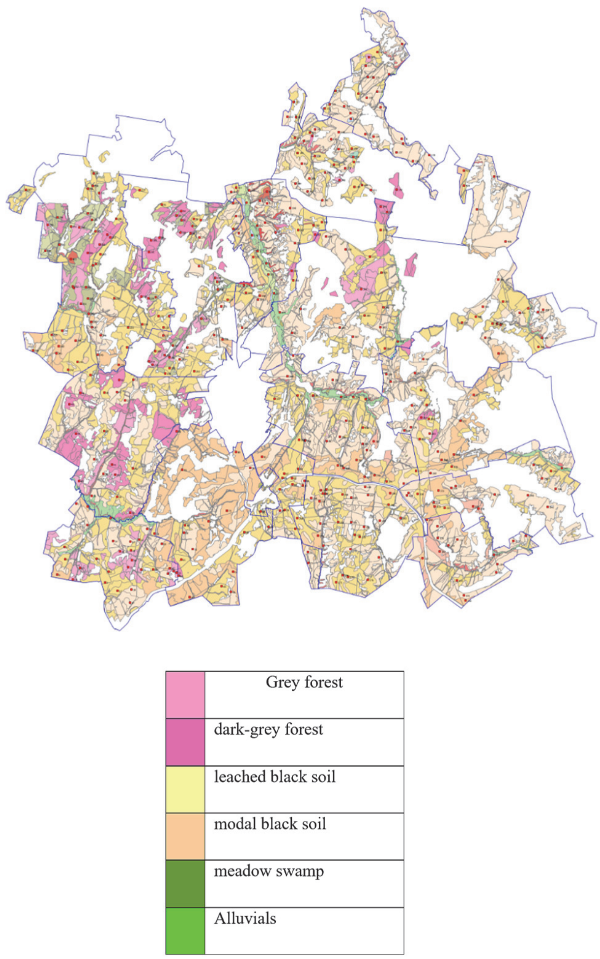

Fig. 2. Soil map of the Belebey region

Conclusion

Thanks to the research results, agricultural manufactures got the possibility to use land resources effectively and to develop scientifically based arable farming systems.

During the research soil maps of 1985 were corrected. A new actual digitized map of the Belebey region of the Republic of Bashkortostan was created.

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