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SSI ALL-RUSSIA RESEARCH INSTITUTE OF ARABLE FARMING AND SOIL EROSION CONTROL

SSI V.V.DOKUCHAEV SOIL SCIENCE INSTITUTE

SSI KURSK RESEARCH INSTITUTE OF AGROINDUSTRIAL PRODUCTION

V.V.ALEKHIN CENTRAL CHERNOZEMIC STATE BIOSPHERIC RESERVE

LONG-TERM FIELD EXPERIMENTS ON CHERNOZEMIC SOILS OF KURSK REGION, RUSSIA

(Guide)

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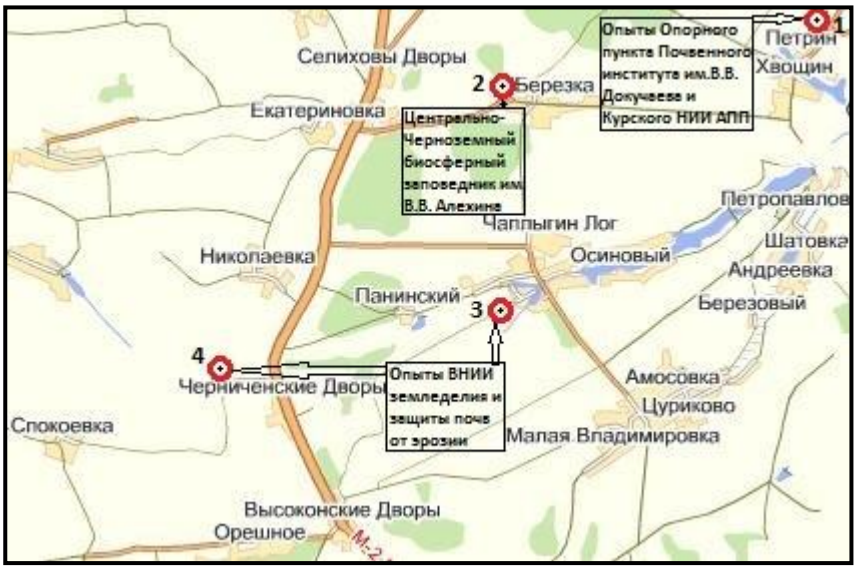

Location of long-term field experiments on chernozems of Kursk Region on the map: 1. the field trials of the Petrinskiy Base Station of the V.V. Dokuchaev Soil Science Institute and the Kursk Research Institute of Agroindustrial Production; 2. V.V. Alekhin Central Chernozemic State Biospheric Reserve, unmowed steppe; 3. the multiple-factor field experiment on biologization (biological adaptation) of crop farming of the All-Russia Research Institute of Arable Farming and Soil Erosion Control; 4.the field experiment on the arranging of contour-ameliorative farming of the All-Russia Research Institute of Arable Farming and Soil Erosion Control.

Photographs on the front cover: on the left – V.V.Alekhin Central Chernozemic State Biospheric Reserve, unmowed steppe; on the right – the multiple-factor field experiment of the All-Russia Research Institute of Arable Farming and Soil Erosion Control, continuous crops.

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INTRODUCTION

The long-term field experiments of the V.V. Alekhin Central Chernozemic State Biospheric Reserve, the Petrinskiy Base Station of the V.V.Dokuchaev Soil Science Institute, the Kursk Research Institute of Agroindustrial Production, the All-Russia Research Institute of Arable Farming and Soil Erosion Control are located in the forest-steppe zone of the Central Russia Heights. The territory of the experimental plots is typical enough for the Central Chernozemic Area.

The climate is temperate-cold; the continental character of the locality by Ivanov equals 166-184. Average annual temperature is 4.8-5.3°C. The warm period of a year with the monthly average air temperature above zero is 230 days on average, and the vegetation period with the temperature above 5° C is 186 days. By annual average data winter duration is 135 days. Annual average precipitation is 540 mm, but in every 3-5 years droughts of a different extent of intensity are common. In dry years already in spring moisture deficiency in topsoil can be observed. A major part of precipitation, i.e. 60-65 percent, falls in the warm season. Annual evaporation in the Streletskaya Steppe area equals 636 mm. Annual moisture index by Vysotskiy-Ivanov is equal to 0.89. A maximum precipitation amount falls in July-August, simultaneously the highest air temperature is also observed, the moisture index keeps less than one which is of great importance for the process of soil formation (Ivanov, 1948; Afanasyeva, 1966; Denissova, 1967).

Parent rocks in the area of the prevalence of deep chernozems of the forest-steppe belt of the Central Russia Heights are marl and chalk, and also tertiary sands of poltavskiy layer. Almost everywhere they are overlapped by loessial rocks of fluvio-glacial origin (Afanasyeva, 1966). The layer of loessial rocks is heterogeneous. It is distinctly divided into two parts: the upper layer of heavy loam 2 to 3.5 m deep and the underlying medium loam 5.5 to 8 m deep. Under the loams there lie clays frequently gleyed. Groundwater lies 12 to 14 m deep (Bolshakov, 1961).

The soil cover is mainly presented by combinations of typical and leached deep chernozems (black earth) which on virgin plots form patches related to the microrelief.

In the steppe minor round depressions and in other distinctly pronounced depressions where the soils get significant additional surface moistening leached, frequently podzolized deep meadow-chernozem soils are usually formed.

The forest-steppe zone of the Central Russia Heights has been developed by humans from the earliest times. That is why natural herbaceous vegetation plots, especially on plain areas, have not almost been preserved. With some approximation one can form a notion of the natural vegetation of the forest-steppe landscape by the virgin land grass stands of the Central Chernozemic Reserve (Afanasyeva, 1966).

CENTRAL CHERNOZEMIC STATE BIOSPHERIC RESERVE (CCSBR)

The Central Chernozemic State Biospheric Reserve comprises Streletskaya Steppe, Kasatskaya Steppe, Bukreevy Barmy, Barkalovka, the flood-plain of the Psel river, Zorinskiy plot. The total area of the reserve is 5288 ha.

Streletskaya Steppe plot of the reserve occupies 2046 ha, of which 1127 ha are under forest. For 200-300 years Streketskaya Steppe has been used as hay field and pastureland. Years ago it was mowed. Cattle was mainly grazed on aftergrass in the second half of summer. Phytocoenotic formation of the grass stands of the mown areas of Streletskaya Steppe proceeded for a long time (Alekhin, 1926). The vegetation of the watershed plots of Streletskaya Steppe is presented by motley grasses-meadow steppe. It is a zonal type of herbaceous vegetation of the middle part of the forest-steppe zone of Central Russia Province. Vegetation of these steppes is characterized by high specific and quantitative saturation. V.V.Alekhin found up to 77 plant species and up to 1939 plants per 1 m^2 . Scientific value of the Central Chernozemic Rezerve is in the maintenance of several regimes of reservation on its territory, they are: steppe plots with unmown regime and an oak-forest as an example of absolute reservation; steppe plots with moderate grazing and mown steppe variants as regimes of anthropogenic protection; a long-term fallow plot as an example of anthropogenic influence on soil.

Unmown steppe *is* the oldest plot with an absolutely reserved regime (the last mowing was performed in 1940). Plant association is motley grasses-needle grass-awnless grasses. Soil is typical deep heavy loam chernozem.

On the territory of the Central Chernozemic Reserve and in its vicinity on the upper parts of the slopes, and sometimes on the watershed plateau oak-forests are widely distributed. ero. ***The oak-forests*** *of the* reserve are mainly of park character, where groups of trees, and sometimes smaller forest areas alternate with glades of different size and contour. Closed stands of oak-trees can be found mainly in the lower parts of the slopes towards the ravines. The prevailing plant association of the oak-forests of the Streletskaya Steppe plot is gout-weed (*Aegopodium podagraria*) oak-forest (Afanasyeva, 1966).

Mowed steppe are plots mowed annually and with cycles of hay-field rotation

Pastureland is used for cattle grazing with the rate of stocking 0.9 livestock capita per hectare.

Continuous fallow. In April 1947 a plot of 0.6 ha of virgin motley grasses-meadow steppe was plowed up. Before plowing up that plot of Streletskaya Steppe had been used as a hay meadow. The fallow plot is situated on the watershed plateau 200 m to the north-east of the reserve estate. The long-term experiment was laid out by A.F.Bolshakov, a scientific worker of the Soil Science Institute named after V.V.Dokuchaev, with the aim of comparative study of the water regime of deep chernozems under virgin land grass stands, under wheat and without vegetation. Since the spring of 1947 up to now the black fallow plot has been maintained in relatively clean condition. Weed control is carried out by soil cultivation and periodical plowing 22 to 24 cm deep.

Description of the soil profile cut (photo), laid out in the unmown steppe on the watershed plateau under the grass stand of motley grasses - needle grass - awnless grasses.

Ao (0 to3cm) is the steppe litter consisting of indecomposed and semi-decomposed grass residues and dead grass interlaced with grass roots.

Asod (3 to14 cm) is fresh, dark-grey, heavy loamy, the structure is fine granular, worm coprolites can be found, it is densely interlaced with grass roots, practically every aggregate is permeated with thin roots. It is loose, the borderline is distinct, even.

A (14 to 65 cm) is dry, dark-grey, tinged with greyish-brown towards the bottom, clay loamy, the structure in the upper layer of the horizon is granular-fine crumb, pulvered, at the bottom it is nutty-crumb with granularity, it is

indurated, permeated with thin grass roots, the borderline is distinct, uneven.

AB (65 to 90cm) is dry, heterogeneously coloured: brown-grey, brownish-grey, pale-yellow-and-brown patches with diffuse borderlines, clay loamy, the structure is not strong, crumby-nutty, pulvered at the bottom, the horizon is more dense than the previous one, plant roots are found, dark-grey and brownish-grey coprolites of worms are well seen, they are mostly «soldered» and lost the initial form, the borderline is distinct, uneven.

Bca (91 to 120 cm) is dry, pale yellow-brown, heavy loamy, lumpy-prismatic, dense, porouos; pseudomycelium of carbonates, mole passages, humus tongues can be seen, the borderline is clear, uneven.

BCca (120 to 180см) is fresh,the colouring is heterogeneous: on the pale-yellow background there are pale-yellow-brown humus tongues, spots of mole passages, it is heavy loamy, structureless, unclearly flaky, less dense; there is pseudomycelium, single puppets of a diameter about 5 mm, the borderline is sharp, uneven.

Cca (>180cm and deeper) is fresh, very pale yellow, clay loamy, porouos, indurated, structureless with horizontal banding, pseudomycelium content is distinctly less.

Weak effervescence begins from 92 cm depth, vigorous one begins from 110 cm depth.

The soil is typical deep heavy loamy chernozem on loessial loams.

PETRINSKIY BASE STATION OF V.V.DOKUCHAEV SOIL SCIENCE INSTITUTE AND KURSK RESEARCH INSTITUTE OF AGROINDUSTRIAL PRODUCTION

The stationary field experiment of Petrinskiy Base Station of V.V.Dokuchaev Soil Science Institute and Kursk Research Institute of Agroindustrial Production was established in on the initiative of Ye.T.Musychkin, it occupies 24,2 ha and is located on a plain area.

The soil of the plot is presented by a complex of deep typical chernozems with a small inclusion of leached chernozems. The structure of the soil cover is characterized by slight contrasts because the soil cover composition is remarkable for the supremacy of rather close soils, (Denissova, 1967; Fridland et al., 1971).

The profile of the typical chernozems of the experimental plot has the following morphological features:

A_{arable} (0 to 24 cm) is of dark grey colour with crumb-pulvered structure. Single crumbs up to 5-10 cm in diameter occur. Heavy loam.

A (24 to 70 cm) is of dark grey colour tinged with brownish at the bottom. The soil strucrure is fine-crumby-granular, getting integrated towards bottom. The soil horizon is permeated with numerous worm holes 3 to 5 mm in diameter. There are a lot of caprolites. In $A_{arable}+A_1$ maximum of living roots is concentrated.

B_{1Ca} (70 to 120 cm) is of grey-brown colour, heterogeneously coloured, with significant humus content. Effervescence begins from 65 to 70 см deep. The soil structure is crumby-nutty. There are a lot of mole passages 10 cm in diameter, filled with dark grey carbonateless loam from the humus horizon and yellow-brown carbonated loam from the underlying horizons. A lot of pseudomycelium can be found..

B_{2Ca} (120 to 160 cm) is of yellow-brown with yellow and grey-brown spots of numerous mole passages of different diameter.The structure is crumby. The transition to the soil forming rock presented by loessial loams is extended to the depth of 150-200 cm depending on the extent of disturbance.

C_{Ca} (160 to 300 cm) is yellow-brown loam of unstable-crumby structure with streaks of carbonates.

In the profile of chernozems with the lowered depth of effervescence the carbonated horizon lies lower than the transition one that is why the latter can be free from carbonates. The upper borderline of the carbonated horizon lies lower than 90 cm, but most frequently it is coincided with the depth of 120-150 cm (Denissova, 1967; Kuznetsova, 1977).

By granulometric composition the soils are related to heavy coarsely silty loams. The content of physical clay (particles < 0, 01 mm) in the soils of arable plots in the layer 0 to 50 cm fluctuates within 48 to 51percent, the silt content (particles < 0, 001 mm) fluctuates within 25 to 30 percent.

The specific feature of deep typical chernozems of Kursk Region is favourable soil consistence through all the soil profile. The soil density changes from 1.03-1.05 g cm^{-3} in the topsoil up to 1.14-1.2 g cm^{-3} in 2 m depth and amounts to 1.4 g cm^{-3} only in 3 m depth.

Typical chernozems are characterized by high value of total porosity. On arable plots the total porosity is within 60 percent. The high value of total porosity and water stable structure of soil aggregates bring about favourable water-physical properties and primarily high water permeability of these soils. Due to the high value of moisture capacity of typical chernozems the range of active moisture is satisfactory and amounts to 21 to 22 percent in the layer 0 to 40 cm (Kuznetsova, 1967;1977).

Humus content in the topsoil is 5.9 to 6.4 percent, sometimes amounts to 7 percent. The humus content rather evenly decreases down through the profile amounting in the depth of 100 cm to the value of 2.4 to 3.2 percent. The total nitrogen content in the top- and subsoil does not exceed 0.34 percent. The nitrogen of deep chernozem by 96 to 98 percent is presented by organic compounds.

There are few mobile forms of nitrogen in these soils. The nitrification capacity of typical chernozem ranges within 25 to 35 mg kg^{-1} of soil (Musychkin et al., 1979).

The content of mobile phosphorus in 0 to 25 cm soil layer (by Chirikov) is 10.1 to 14.5, the exchange potassium content (by Maslova) is 16.8 to 19.0 mg 100^{-1} g of soil (Lazarev, 1997).

The reaction of soil medium changes from slightly acid to neutral. Having a high amount of exchange cations (32 to 49 mg·equ 100^{-1} g of soil for the soil layer of 0 to 10 cm) deep chernozems are highly saturated with bases (85 to 99 percent). Among the cations calcium prevails, the share of magnesium and other cations is 15 to 20 percent (Musychkin, Kakhuta, 1972).

Characteristic of Long-Term Field Experiments of Petrinskiy Base Station and Kursk Research Institute of Agroindustrial Production (Fig. 1,2)

Experiment № 1. ***«Crop productivity in different types of field crop rotations on different levels of fertilization»***

Foundation year: 1964.

Trial arrangement: 8 schemes of five-field crop rotations with different saturation of grain-, row crops and perennial grasses were laid out in all. The schemes of crop rotations are displayed temporally on one establishment in triple replication. The total area of the plot is 370 m (50x7.4), the accounting area is 160 m (40x4). The total area under the experiment № 1 is 9 ha.

CROP ROTATION 1

1.Peas: unfertilized, FYM 20 t ha^{-1}
2. Winter wheat: unfertilized, N30P60K60
3.Sugar beet: unfertilized, N90P120K120
4.Maize: unfertilized, N80P70K70
5.Barley: unfertilized, aftereffect

CROP ROTATION 2

1.Peas: unfertilized, FYM 20 t ha^{-1}
2. Winter wheat: unfertilized, N30P60K60
3. Sugar beet: unfertilized, N90P120K120
4.Maize: unfertilized, N80P70K70
5.Winter rye: unfertilized, aftereffect

CROP ROTATION 3

1.Clean fallow: unfertilized, FYM 20 t ha^{-1}
2.Winter wheat: unfertilized, N30P60K60
3.Sugar beet: unfertilized, N90P120K120
4.Maize: unfertilized, N80P70K70
5.Barley: unfertilized, aftereffect

CROP ROTATION 4

1.Maize: unfertilized, FYM 20 t ha^{-1}
2.Winter wheat: unfertilized, N30P60K60
3.Sugar beet: unfertilized, N90P120K120
4.Maize: unfertilized, N80P70K70
5.Spring wheat: unfertilized, aftereffect

CROP ROTATION 5

1.Clover 1st yr: unfertilized, aftereffect
2.Winter wheat: unfertilized, N30P60K60
3.Sugar beet: unfertilized, N90P120K120
4.Maize: unfertilized, N80P70K70
5.Barley+clover: unfertilized, FYM 20 t ha^{-1}

CROP ROTATION 6

1.Clover 1st yr: unfertilized, aftereffect
2.Winter wheat: unfertilized, N30P60K60
3.Sugar beet: unfertilized, N90P120K120
4.Maize: unfertilized, N80P70K70
5.Spring wheat+clover: unfertilized, FYM 20 t ha^{-1}

CROP ROTATION 7

1.Peas/oats: unfertilized, FYM 20 t ha^{-1}
2.Winter wheat: unfertilized, N30P60K60
3.Sugar beet: unfertilized, N90P120K120
4.Spring wheat: unfertilized, aftereffect
5.Sugar beet: unfertilized, N90P90K90

CROP ROTATION 8

1.Clover 2nd yr: unfertilized, P30K30
2.Winter wheat: unfertilized, N30P60K60
3.Sugar beet: unfertilized, N90P120K120
4.Barley+clover: unfertilized, FYM 20 t ha^{-1}
5.Clover 1st yr: unfertilized, aftereffect

Experiment № 2 «Efficiency of continuous crops» [in crop rotation in comparison with continuous crops]

Foundation year: 1964.

Trial arrangement:

Winter wheat

1. Control (unfertilized)
2. N45 P60 K45

Potatoes

1. Control (unfertilized)
2. N45 P60 K45
3. FYM 20 t ha^{-1}
4. FYM 10 t ha^{-1}+N23 P30 K23

Peas

1. Control (unfertilized)
2. P60 K45
3. N45 P60 K45

Maize

1. Control (unfertilized)
2. N60 P60 K60
3. NPK +20 kg ha^{-1} of simazine +interrow cultivations
4. NPK + 20 kg ha^{-1} of simazine without Interrow cultivations

The replication of the experiment is fourfold. The amount of the plots is 52. The size of plots is 7.4x40 = 296 m^2. The total area under the experiment № 2 is 2.5 ha.

The plot of the long-term experiment on the continuous crop growing is ajoined by the plot of continuous fallowing of typical chernozem (15 x 200 m), established 1964, which was modified 1998: 2/3 of the experiment area was retained under continuous soil fallowing, and 1/3 of it was allotted under idle land.

Fig. 1.

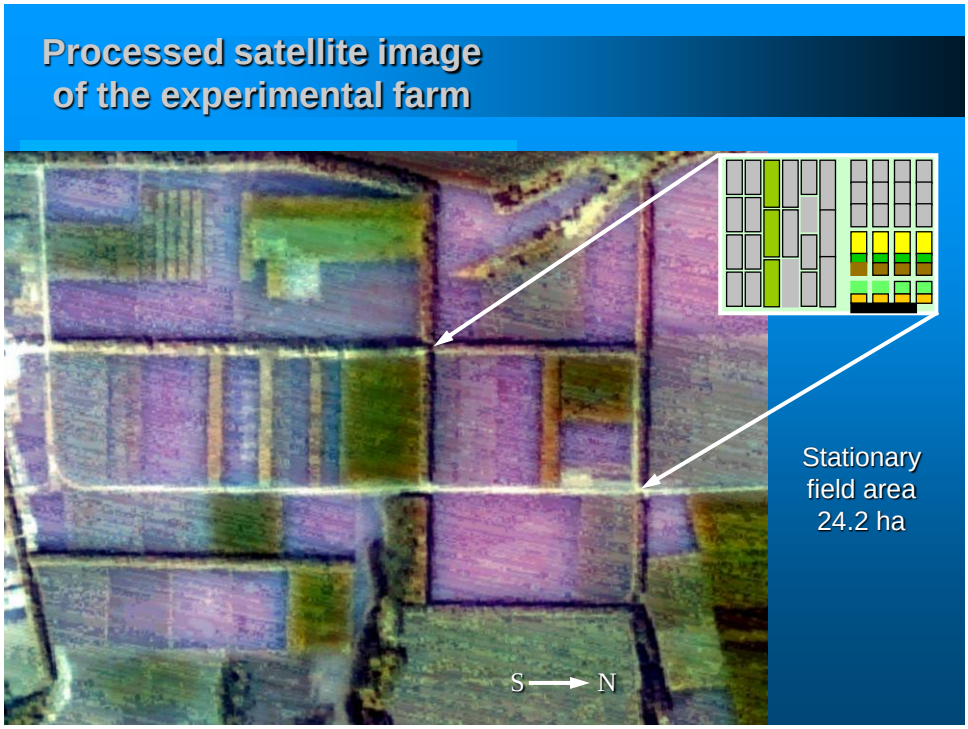
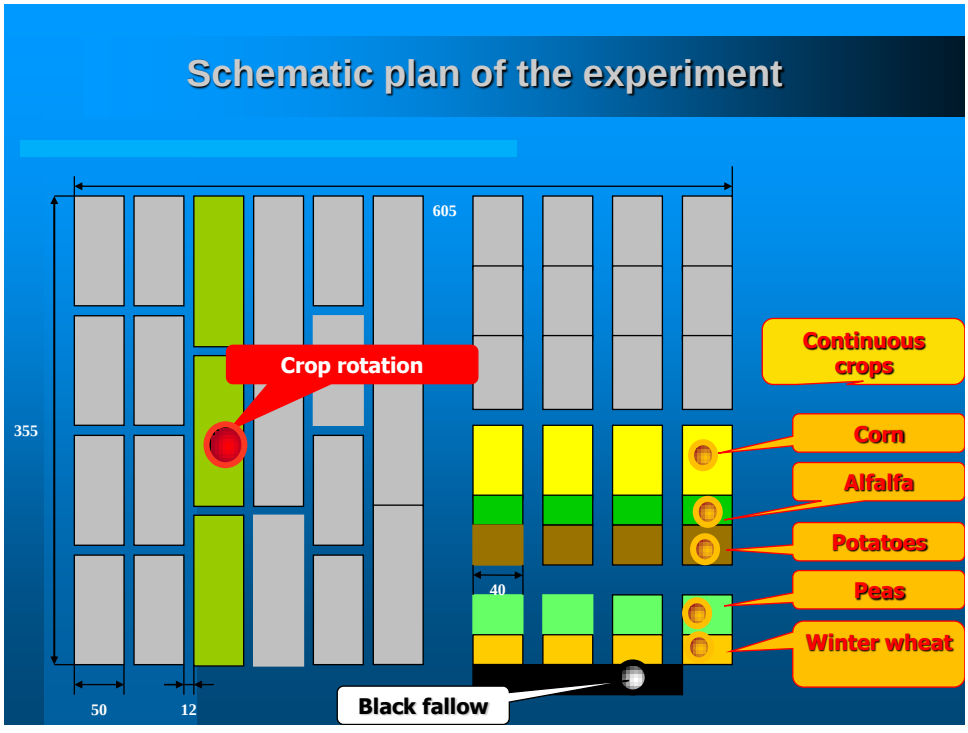


Fig. 2.



LONG-TERM FIELD STATIONARY EXPERIMENTS OF ALL-RUSSIA RESEARCH INSTITUTE OF ARABLE FARMING AND SOIL EROSION CONTROL

1. Multifactor field stationary experiment

The multifactor field stationary experiment (MFSE) of the All-Russia Research Institute of Arable Farming and Soil Erosion Control was established in **1984**. In 2010 the sixth cycle of crop rotations is coming to an end. The distribution of treatments by trial plots is randomized. The lengh of the plot ranges from 25 to 40 m, the width from 5 to 7 m depending on the location in the relief. The replication is twofold. The total area under the experiment including passages is 25.5 ha.

The soils of the experimental plot depending on the exposure are chernozems typical slightly leached and leached of granulometric composition from medium loamy to heavy loamy. Agrochemical soil characteristic is presented in Table 1.

1. Agrochemical soil characteristic of the experimental plot (2007)

Indicators	North slope		Watershed plateau		South slope	
	0-20 cm	20-40cm	0-20 cm	20-40 cm	0-20 cm	20-40cm
Humus content, %	6,0±0,34	5,6±0,22	5,9±0,44	5,6±0,30	5,3±0,20	4,7±0,21
pH KCl	6.4	6,5	6,5	6,4	7,1	7,4
Alkali-hydrolyzable nitrogen by Cornfield, $mg100^{-1}$ g of soil	17,0	14,9	18,0	15,8	15,0	11,5
Mobile phosphorus by Chirikov, $mg100^{-1}$ g of soil	10,3	9,3	14,8	11,2	12,6	10,0
Mobile potassium by Chirikov, $mg100^{-1}$ g of soil	8,8	8,2	11,7	8,5	9,2	6,8

At present time the experiment comprises block «**Fertility**», block «**Continuous Crops»** and **«Idle Land».**

Block «Fertility»

Block «Fertility» is located on watershed plateau, slopes of north and south exposure. On the watershed plateau 55 treatments are located, on the slope of north exposure there are 161 treatments (47 of them in the first field, 114 in the second one), on the slope of south exposure there are 55 treatments (Fig. 3). Factors under study and their gradations in the block «Fertility» are presented in Table 2.

2. Factors under study and their gradations in the block «Fertility»

Factors	Levels		
Crop rotations	*Grain crops-fallow-row crops:* - black fallow, - winter wheat, - maize, - barley	*Grain crops-grasses-row crops:* - clover, - winter wheat, - maize, - barley + clover	*Grain crops-grasses:* - clover, - clover, - winter wheat, - barley+clover

Tillage	*Nonmoldboard tillage of different depth* with a subsurface cultivator under all the crops of crop rotations Including tillage under maiz, в т.ч. 25-27 cm deep with preliminary skimming	*Moldboard plowing of different depth* under all crops of crop rotations including plowing under maize 25-28 cm deep with preliminary skimming	*Combination of tillage types:* plowing under maize, surface tillage under winter wheat, shallow nonmoldboardtillage under barley.
Organic fertilizers	Unfertilized	24 t ha^{-1} per cycle	48 t ha^{-1} per cycle
Mineral fertilizers	Unfertilized	N – 30 % P – 90 % K – 35 % of the removal of $N_{140}P_{150}K_{160}$ kg prim.nutr. per cycle	N – 60 % P – 180 % K – 70 % of the removal of $N_{280}P_{300}K_{320}$ kg prim.nutr. per cycle
Liming	Unlimed	Unlimed	Compensation rate Ca, 6 t ha^{-1} of marl per cycle
Exposure	*North*	*Watershed*	*South*

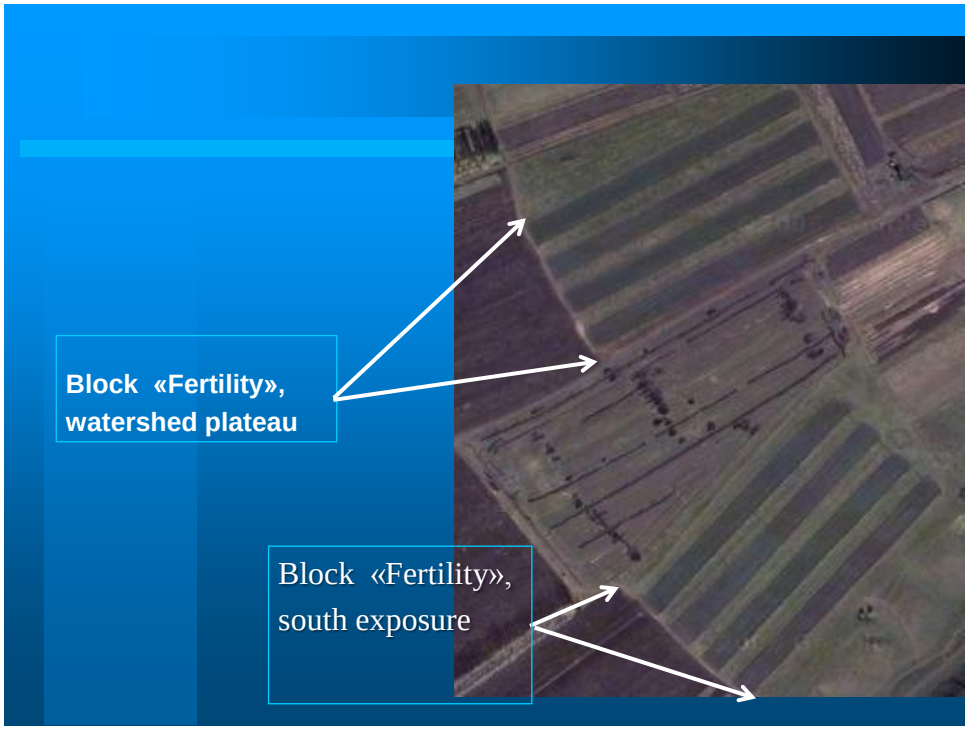


Fig. 3. Multifactor field stationary experiment

Block «Continuous Crops»

The block **«Continuous Crops»** is located on the slope of north exposure, it includes 24 treatments. Replication is twofold. The schematic plan of the experiment in the block «Continuous Crops» is presented in Figure 4.

Fig. 4. Arrangement of the block «Continuous Crops» of the multifactor field stationary experiment

Idle Land

The idle land is located on the slope of north exposure lower than water regulating forest belt, it is has not been plowed since 1983. The vegetation cover of the idle land is presented by densely bushy-motley grasses-cereal vegetation.

The soil of the idle land is typical, poor humus, deep, medium loamy chernozem on loessial loams. The profile of the typical chernozem on 26-year idle land has the following structure: Asod (6 to7 cm) + A (7 to 69 cm) – AB (69 to 86 cm)– B_{Ca} (86 to 110 cm) – BC_{Ca} (110 to 135 cm) – C_{Ca} (>135 cm). The morphological structure of the typical chernozem profile on the arable land located near the idle land is characterized by the following sum of horizons: A_{arable}(0 to 25 cm)+ A(25 to 56 cm) – AB (56 to 77 cm) – B_{Ca} (77 to106 cm) - BC_{Ca} (106 to 127 cm) - C_{Ca} (>127 cm).

2. Scientific-Production Experiment

Scientific-production experiment was established in 2002, it is located on the watershed plateau and the upper part of the slope of south exposure. The total area of the experimental plot is 7 ha. The area of the plot under crops is 270 x 21.6 m. The alternation of crops in the crop rotation: clean fallow/green manure fallow – winter wheat – buckwheat – barley. Basic tillage is plowing 20 to 22 cm deep. When the experiment was laid out the retaining of a technological track was provided for

tractors and other agricultural machines to go during the performance of field works. The scheme of the experiment (Table 3) consists of a fallow and three crops. The peculiarities of the technologies used are presented in Table 4.

The soil in the model experiment is presented by typical medium deep heavy loamy chernozem. The humus content in the topsoil amounts to 5.8 to 6.1 percent, alkali-hydrolyzable nitrogen by Cornfield is 205 mg kg^{-1} , mobile potassium by Chirikov is 13 mg 100^{-1} g of soil, mobile potassium by Chirikov is 12 mg 100^{-1} g of soil, pH_{salt} is 5.6.

3. The arrangement of crop rotations of the scientific-production experiment

Black / green manure fallow		Winter wheat		Mustard		Buckwheat		Barley	
Basic technology	Intensive technology	Basic technology	Intensive technology	Basic technology	Intensive technology	Basic technology	Intensive technology	Basic technology	Intensive technology

4. Specific features of the technologies used

Crop	Factor	Technologies	
		basic	intensive
Winter wheat	Fertilizer (prim. nutr. ha^{-1})	$N_{60}P_{60}K_{60}$	$N_{100}P_{100}K_{100}$
	Toxic chemicals*	5,0	5,4
Buckwheat	Fertilizer (prim. nutr. ha^{-1})	N_{10}	$N_{30}P_{40}K_{40}$
	Toxic chemicals *	4,0	4,0
Barley	Fertilizer (prim. nutr. ha^{-1})	$N_{40}P_{50}K_{50}$	$N_{50}P_{70}K_{70}$
	Toxic chemicals *	1,0	4,4

*Herbicides, seed dressers, fungicides, insecticides inclusive

3. Experiment on the organization of contour-ameliorative farming (CAF)

The experiment on the organization of contour-ameliorative farming (CAF) of the All-Russia Research Institute of Arable Farming and Soil Erosion Control is established in 1982. The total area of the experiment is 271.11 ha. The coefficient of dissection of the plot by ravine network is 0.79 km km^{-2}, the depth of dissection is 5 to 15 m. Prevailing elements of the relief are gentle (flat) slopes of watershed and a watershed plateau. The areas of abrupt slopes of ravines and their bottoms are not large, 14.0 and 9.0 ha, respectively. Ground water on the watersheds lies about 50 m deep, in the ravine bottoms 3.0 to 5.0 m. The object comprises five dingle-ravine watersheds with the area ranging from 45 to 88 ha. On the watersheds about 12 km of

plowed channel terraces with banks are built up and run и эксплуатируется около 12 км напашных валов-террас (they are 0.4 to 0.5 high, the ratio of the slopes 1:10 to 1:12), 5.2 km of narrow 2-row runoff-controlling forest shelterbelts (the age is 20 years), reinforced with water-catching ditches and banks are planted, 1.5 km of grassed waterways are created, three anti-erosion ponds and five hydrometric constructions accounting surface runoff, soil loss and removal of biogenic substances are built, 28 hydrometric boring wells 10 to 75 m deep are established, a meteorological station is equipped, landscape-ecological contour forest belts 300 to 1500 long with the radius of curvature of anti-erosion linear borders 70 to 500 m are created.

On the first two treatment plots plowed channel terraces with banks having the interval of 216 m between them (Watershed 2) and 108 m (Watershed 1) are located, on the third trial plot (Watershed5) narrow 2-row runoff-controlling forest belts with ditches with the interrow space of 216 m (the height of the shelterbelts is 22 to 26 m) are planted, the fourth treatment (Watershed 4) is similar shelterbelts with added channel terraces with banks, at the interval of 54 m. On the control (the fifth treatment, Watershed 3) forest belts and hydraulic structures are not available.

Soil-forming rocks of the plot are loessial loams of quaternary age, only for alluvial-deluvial soils of ravine bottoms soil-forming rocks are fluvial sediments of quaternary age. Sediments of cretaceous and tertiary ages (chalk, clays, sand, etc.) lie under the soil-forming rocks.

Soils of the experimental plot of CAF

In 1983 a special soil-erosion survey of the plot, the scale to be 1:5000, on the topographic base of the same scale was carried out by the workers of the Kursk affiliation of the Institute TsChO Giprozem and All-Russia Research Institute of Arable Farming & SEC.

Chernozems are presented by the following subtypes, types and varieties:

1. Leached, medium deep, medium humus chernozem, the depth of the humus horizon (A+AB) is 66 to 80 cm, the average humus content in the topsoil horizon is 6.0 to 6.4 percent, medium and heavy loamy.

2. Leached, medium deep, poorly humus, weakly eroded, heavy loamy chernozem, the depth of the humus horizon (A+AB) is 56 to 70 cm, the average humus content in the topsoil horizon is 5.1 to 5.7 percent.

3. Leached, weakly deep, poorly humus, weakly eroded, medium loamy chernozem, the depth of the horizon (A+AB) is 55 to 59 cm, the humus content is 4.9 percent.

Effevescence from HCL in leached chernozems begins from the depth 98 to 118 cm. The reaction of salt extract is weakly acid (pH=5.3-5.5) or close to neutral (pH=5.6-6.0), that of weakly eroded varieties – pH = 6,0-6,3.

4. Typical, medium deep, poorly humus chernozem, the depth of the humus horizon (A+AB) is 63 to 80 cm, the humus content in the topsoil horizon is 5.3 to 5.9 percent. Effevescence from HCL begins from the depth 56 to 66 cm. The reaction of the salt extract in the topsoil horizon is close to neutral (pH=6.3-6.8).

Soils of ravine slopes and bottoms

1. Leached heavy loamy chernozem on loessial loams;the depth of the humus horizon ranges within 78 to 94 cm, the humus content in the upper horizons is 5.3 to 6.9 percent, effervescence from HCL is from the depth 120 cm, the area is 11.5 ha.

2. Typical weakly eroded medium loamy chernozem on loessial loam and cretaceous tertiary rocks; the depth of the humus horizon amounts to 62 cm, the humus content does not exceed 5 percent, effervescence from HCL is from the surface the area is 2.0 ha.

3. The soddy soils of the ravine bottoms are of medium loamy and heavy loamy granulometric composition on fluvial sediments; in the profile banding is well pronounced, the depth of the humus horizon is 44 to 57 cm, the average humus content is 5.4 to 6.1 percent, no signs of gleying, effervescence from HCL is directly under the humus horizon, the reaction of salt extract is close to neutral (pH = 5.7-5.9), the area is 9.0 ha.

4. Stationary field experiment «Development of efficient combinations of biological and anthropogenic means of cropland productivity increase»

The experiment is established in 1991, it is located on near-watershed part of the slope of north exposure with inclination up to 3°. The distribution of the treatments is systematic. The area of the plots under crops is 202.5 m^2 (8.1 x 25.0 m). The replication is threefold, the number of treatments is 32, that of trial plots is 480. The experiment occupies 11 ha.

The soil of the experimental plot is typical, heavy loamy, medium deep chernozem.

The factors under study (Table 5) and their combinations (Table 6) are laid on the background of temporally and spatially displayed crop rotations:

I. 1) black (even treatments) or green manure (odd treatments) fallow, 2) winter wheat, 3) sugar beet, 4) maize for silage, 5) barley.

II. 1) clover for 1st cutting, 2) winter wheat, 3) sugar beet, 4) peas, 5) barley+ clover under cover.

5. Factors under study

Factors	Code sign and levels of variation	
	0	1
Crop rotation	grain crop-fallow-row crop	field crop rotation
Mineral fertilizers	not applied	applied
FYM, t ha^{-1} of a crop rotation	6	12
By-product	not left in the field	used as fertilizer
Alternate crops for green manure	not applied	applied

As green manure crops the following crops are used: peas in the phase of bean formation in green manure fallow; peas as stubble crop after winter wheat; spring rape as a stubble crop after peas and maize.

Manure is applied once a crop rotation cycle in every field at the rate 30 t ha^{-1} or 60 t ha^{-1} (according to the arrangement of the experiment) under the black fallow in the grain crop-fallow-row crop rotation and after the clover harvesting in the field crop rotation.

On the treatments with the application of mineral fertilizers their annual rate per hectare of crop rotation area is planned in the amount of $N_{37}P_{37}K_{40}$ to $N_{60}P_{60}K_{60}$ under winter wheat, $N_{90}P_{90}K_{90}$ under sugar beet, $N_{35}P_{35}K_{50}$ under maize and peas. On the treatments with straw incorporation into soil additional application of nitrogen in order to compensate its microbiological fixation is not provided for by the programme of the experiment.

The farming culture of major crops in crop rotations is generally accepted for the area. For the sowing of stubble green manure crops surface tillage is performed. Green manure in the fallow field is incorporated with a heavy disc harrow. Chemical means of plant protection are not applied, seed dressing exclusive.

6. Combination of factors in the experiment

№№ treatments	Factors under study				
	Crop rotation (A)	FYM (B)	Mineral fertilizers(C)	By-product (Д)	Green manure crops (E)
1	*0*	*1*	*1*	*1*	*1*
2	*0*	*1*	*1*	*1*	*0*
3	*0*	*1*	*1*	*0*	*1*
4	*0*	*1*	*1*	*0*	*0*
5	*0*	*1*	*0*	*1*	*1*
6	*0*	*1*	*0*	*1*	*0*
7	*0*	*1*	*0*	*0*	*1*
8	*0*	*1*	*0*	*0*	*0*
9	*0*	*0*	*1*	*1*	*1*
10	*0*	*0*	*1*	*1*	*0*
11	*0*	*0*	*1*	*0*	*1*
12	*0*	*0*	*1*	*0*	*0*
13	*0*	*0*	*0*	*1*	*1*
14	*0*	*0*	*0*	*1*	*0*
15	*0*	*0*	*0*	*0*	*1*
16	*0*	*0*	*0*	*0*	*0*
17	*1*	*1*	*1*	*1*	*1*
18	*1*	*1*	*1*	*1*	*0*
19	*1*	*1*	*1*	*0*	*1*
20	*1*	*1*	*1*	*0*	*0*
21	*1*	*1*	*0*	*1*	*1*
22	*1*	*1*	*0*	*1*	*0*
23	*1*	*1*	*0*	*0*	*1*
24	*1*	*1*	*0*	*0*	*0*
25	*1*	*0*	*1*	*1*	*1*
26	*1*	*0*	*1*	*1*	*0*
27	*1*	*0*	*1*	*0*	*1*
28	*1*	*0*	*1*	*0*	*0*
29	*1*	*0*	*0*	*1*	*1*
30	*1*	*0*	*0*	*1*	*0*
31	*1*	*0*	*0*	*0*	*1*
32	*1*	*0*	*0*	*0*	*0*

Note: A: *0* – crop rotation: grain crops-fallow-row crops, *1* – field crop rotation; B: *0* - 6 t ha^{-1}, *1* – 12 t ha^{-1}; C.: : *0* – not applied, *1* – applied; E: *0* – not applied, *1* – applied.

Contents

Scientific edition
LONG-TERM FIELD EXPERIMENTS ON CHERNOZEMIC SOILS OF KURSK REGION, RUSSIA (guide). Kursk: SSI All-Russia Research Institute of Arable Farming and Soil Erosion Control RAAS, 2010. 35 pps.

Photographs on the back cover: upper row left – the scientific-production experiment of All-Russia Research Institute of Arable Farming and Soil Erosion Control: upper row right – the experiment on contour-ameliorative farming of All-Russia Research Institute of Arable Farming and Soil Erosion Control; lower row – the experiments of the Petrinskiy Base Station of V.V. Dokuchaev Soil Science Institute and Kursk Research Institute of Agroindustrial Production.