

WAYS OF FERTILITY INCREASE ON ERODED SLOPES IN NON-CHERNOZEMIC ZONE IN RUSSIA

Tatyana Anisimova

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Abstract: Designing the landscape in order to build an optimum structure for the crops areas is mainly based on the differentiation between the arable lands. In addition, the improvement of the environment conditions specific to each cultural plan kind is taken into account. In this way, the full use of the bioclimatic resources is possible. This article presents several methods of reducing the water erosion of the arable slopes by harnessing the potential of the bio-based agrocenosis. The efficiency of the long-term use of the lupin as quality manure and fitomeliorant on the eroded soddy-podzolic sandy soils of the Vladimir area has been proven.

Keywords: arable slopes, green manure, long-term lupine, water soil erosion

Introduction:

The most widespread kind of soil degradation in the world is water erosion. In Russia the strengthening of water erosion at the end of the last century has been caused by excessive plowing ground and arable slopes, irrational industrial activity of the agricultural enterprises. At the end of the last century 60% of the land plants were grown in arable land, and only 29% in world's agriculture land (Romanenko and Tyutyunnikov 1999). The ploughed land along slopes and small ploughing was extended. As is known, formation of a superficial drain begins at biases 0.5° - 1° . For the last 20 years there has been a 5 to 6-time depletion of organic fertilizers at entrance, 8-10 times of mineral exhaustion and

productivity of cultures on slopes and the security of soils crops from erosion has decreased (Pannikov 2003). As a result of a mineralization, washout nurturing soil and oozy fraction of soil, it is lost humus.

The consolidation of arable and cultivation horizons is assured thanks to the great depths of agricultural machines. But all of these contribute to ecological degradation of land due to water erosion and demands of urgent system measures (Kiryushin 2010).

One of the prominent measures to protect ecosystems and landscapes is undoubtedly improving soil structure by applying the law of minimum. This is actually one of the basic laws of agriculture.

According to this law, soil fertility and production efficiency are not closely related only to the soil properties, mechanization, fertilizers or technicians' knowledge, but also to the factors set at a minimum (Zaydelman 1991).

On the slopes such a factor is moisture and for its rational use an important role is played by improvement of land vegetation.

Tatiana Anisimova:

National Research Institute of Organic Fertilizers and Peat (VNIIOU)
Vladimir, Russian Federation
Phone/Fax: +7 4922 426010
e-mail: anistan2009@mail.ru

In the geomorphological relation the territory of Meshchersky lowland represents glacial lake, sandur, with small difference between height and low plain. Regional parts of watersheds and gentle slopes up to 2° are most suitable for arable lands.

According to land plant existing classification the best landscape soils are in the levelled plains (Kiriyushin 2010).

In Meshchersky the lowland flat surfaces, owing to the rehumidifying and high integrated approach of a soil cover, are of little use for cultivation exacting to conditions of aeration winter grain and row cultures. However application of erosion control actions is required here to prevent soil washout and loss of biogenic substances from an arable land. In crop rotations in adaptive-landscape system it is necessary to pay attention to revitalization of biological factors (cultivation of leguminous and bean cultures, farmlands levelling of green manure, straw, crops of intermediate cultures), their placing depending on a slope exposition, cultures' conservation influence etc.

To sod-podzolic soils, which are widespread in Meshchersky lowland, adverse water-physical properties are inherent: they swim away from a moisture lack and surplus. The structure and agronomic valuable properties of these soils require constant improvement (Zaydelman 1991). Organic fertilizers including green manure, promote optimization of many important soil properties. The important role in the formation of structure soils, especially a nutrient-poor sod-podzolic one belongs to long-term lupine with its powerful root system deeply getting into soil layers (Solovyev 1971). Long-term lupine crops not only prevent the display of various kinds of erosion, but also interfere in the leaching mobile nutrients in the roots area. In connection with sharp deficiency of manure and composts (by which now it is fertilised no more than 7.6% of crops in the agricultural enterprises), the use of peat as a fertilizer triggers increasing value mobilization of vegetative resources

directly on a place of their growth (ROSSTAT 2013).

Their use can compensate unproductive irrevocable humus losses and food elements in the big geological circulation of substances on the arable slopes subject to water erosion. Traditional fertilizers should be applied first of all on the best, instead of the eroded land. It concerns especially liquid manure applications: on slopes it can be used only in the presence of intrasoil entering techniques to prevent liquid fraction washout.

Materials and methods:

Researches have been developed on the land plants of the skilled-industrial economy National Research Institute of Organic Fertilizers and Peat (VNIIOU), located in the territory of Sudogodsky district of the Vladimir area. The methodical basis of researches was stationary field experience on studying the efficiency of lupine long-term use as green manure for fertility increase slope soils at the outline-strip organization of the land tenure territory. The experience has been put in according to the standard techniques on a slope of a south - southwest exposition, the slope steepness made 2°-3.5° (Lyahov et al 1975; Dosphehov 1968; Ivanov and Derzhavin 2008). The site of soil (about 6 ha) is a superficial soddy minimal podzolic, generated on glacial adjournment.

All mechanised processings of soil, except for a control site performed across a slope, and their direction coincided with the district contours. A strip with a lupine long-term was placed between grain and row culture. Strips of identical width (10-12) have been located along a contour (horizontal) of a slope running parallel to each other (Fig.1).

The row crops was cultivated with corn on silage and winter rye. Before culture crops a mineral fertilizers (N60P60K60) has been introduced in the soil. Lupine green biomass was in ripeness of beans phase and scattered on the soil with mower KIR 1.5.

Lupine green biomass under a winter rye enclosed up in soil after mowing and crushing 10-14 days prior to crops.

Lupine green weight before interrow processings brought at corn cultivation. Volume of the washed off soil on a slope defined on total volume washouts, formed owing to washout and a pulling down of soil streams of thawed and storm water.

If considered that the section of undermining remains invariable for a slop strip of 10 m width (5 m upwards and 5 m downwards from the planned alignment), then it is calculated the volume of the washed off soil in the area of 0,1 hectares. Further the weight of the washed off soil is known if its average density is defined (Sobolev 1948; Surmach 1976).

Figure no. 1 Outline of strip crops placing across a slope



Results and discussion:

The soil washout at the outline strip placing of cultures it was compared with the traditional longitudinal one. As a result of researches it was established that the soil washout after 3 years of supervision has decreased in average for 2.9-3.7 t ha⁻¹, in it than 200 kg humus, 10-15 kg of nitrogen, 50-60 kg of phosphorus and 120 kg potassium contained more.

For the second year of lupine long-term in the ripeness phase formed on the average 28.7 t ha⁻¹ of elevated weight which contained 300-370 kg NPK.

For differentiated use of slope soil fertility with a high agroecological efficiency of outline strip placing the crops in a

combination of long-term lupine application on fertilizer is revealed. Positive influence of this complex on efficiency of cultures, soil fertility indicators, agrophysical soil properties, stocks of productive moisture in plants vegetation is thus established.

Superficial levelling green lupine biomass is promoted by its fast mineralization, thereby resupplying with nutrients the arable layer of earth, positively influencing its agrophysical properties (Tab. 1).

Improvement of the agrophysical properties of the soil under cultures crops planted by strips across a slope has positively affected the process of water infiltration that is confirmed by the stocks definition of productive moisture in soil.

Stocks of productive moisture on a control longitudinal ploughed land and inter-row processing in a root penetration layer of earth at corn planting from May till September were the least. On a watershed and an average part of a slope this indicator was above in comparison with the bottom part of a slope and the control with longitudinal processing. That suggests not only of the absence of a drain at the outline strip of the territory organization, but also the raised maintenance of clay and affinity of the

waterproof layer (Tab. 2). So, at winter rye cultivation, stocks of productive moisture on the top and average part of a slope after grown plants were in the spring half more in comparison with the bottom part of a slope and the eroded control, at corn cultivation on a silo - 40% on average. Towards the beginning of cleaning of cultures (August) the difference in stocks of productive moisture on different elements of a slope is levelled.

Table no. 1 Influence of the outline strip organization of land tenure territory on some agrophysical properties of soil

Placing of crops concerning a slope	Density (g/sm ³)	Density particle (g/sm ³)	Poriness (%)	Total moisture capacity (%)
Along a slope (control)	1.37	2.58	47.0	25.6
Across a slope	1.30	2.50	48.0	28.7

Table no. 2 Stocks of productive moisture in soil (cm)

Experience variant	Culture	Layer of soil (cm)			
		0-60		0-100	
		May	August	May	August
Control	Winter rye	42.4	85.8	54.7	100.8
Watershed		57.5	88.3	116.4	170.9
Average part of a slope		81.0	84.2	134.0	161.0
The bottom part of a slope		40.5	87.0	78.4	169.0
Control	Corn on silage	55.2	58.2	124.6	118.6
Watershed		60.7	73.7	113.1	134.8
Average part of a slope		66.0	68.7	126.0	124.0
The bottom part of a slope		34.0	75.4	130.0	136.1

There have been established a positive influence of studied soil-protective and entering into soil of the green manure as agrochemical indicators on an arable land layer. The greatest maintenance of mineral nitrogen has been noted on a separate water segment and average parts of a slope. The decrease of the humus at longitudinal processing was about of 0.14-0.16 t/year, which is 15-18% more than at the outline-strip organization of land tenure. Losses of biogene elements in the control sample in comparison with other variants of

experiment on average were more for mobile phosphorus of 18.5%, exchange potassium of 37% and the exchange bases sum of 44%.

There is a marked difference regarding the productivity of crop yields between, along (control) and across (experiment) of slope, with an increase in productivity for crops experiment. For winter rye the increase of green biomass is between 51.8-60.1% and for corn is 27.8-65.2% (Tab. 3).

The provided approach highlights the complex problem of soils slope protection against water erosion, increase of soils'

fertility and efficiency of cultivated cultures. Thus ways of processing of soil, application of fertilizers and cultivation of agricultural crops interact:

- outline strip placing;
- cultivation long-term lupine as green manure in strips between grain and row cultures;
- uniform scattering of the crushed biomass on the next strips with the

subsequent levelling in soil long-term lupine in the experiment is the basic source of organic fertilizer and soil-protective culture.

Also its cultivation promotes decrease in a superficial drain of water, translating it in intrasoil and finally plays an important business role in preservation of the increase fertility on slope soils.

Table no. 3 Influence of application fertilizers and slope elements on the productivity of grown cultures (an average on 3 years) (t ha⁻¹)

Experience variant	Winter rye		Corn on silage	
	Productivity	Increase	Productivity	Increase
Placing of crops along a slope				
Control	1.64	-	11.5	-
Placing of crops across a slope				
Watershed	2.49	0.85	19.0	7.5
Average part of a slope	2.62	0.98	14.7	3.2
The bottom part of a slope	2.65	1.01	15.8	4.3
The least essential difference		0.42		3.0

In adverse conditions throughout years of deposits the herbage long-term lupine which grew with weed vegetation, strongly dropped out. Therefore lupine it is necessary to combine with other steadier cultures against a drought and, first of all, with long-term cereal grasses. According to Kashtanov and Yavtusenko (1997), long-term grasses reduce erosive humus loss and biogene elements 2-3 times in comparison with grain crops and 10 times compared to pure steam. Grasses practically hamper water erosion and by that they create a basis for an ecologically safe and biologically balanced system of agriculture on arable slopes. In adaptive crop rotations and outlet fields on eroded slopes it is recommended to sow in highly low productive weather conditions to counter grass anomaly mixture, calculated on long use. At formation competitive fodder agrocenosis is necessary to consider more complex economic-biological features of long-term bean and cereal grasses (***) (2000).

Conclusions:

Infringement of balance of biogenic elements in agriculture conducts not only to a reduction of production and deterioration of its quality, but also to a decrease in the stability of agricultural landscapes. The indemnification of nutrients deficiency at the expense of maximum use of bio resources, mineral and organic fertilizers should be considered as ecologically necessary issue. Thus the agricultural land can play an important role in regulating biological-economic circulation of nutrients in agriculture and animal industry (Kiryushin 2010).

The landscape approach of working out an optimum structure of cultivated areas assumes strengthening of differentiation of an arable land for the purpose of full use of bioclimatic resources of an agrolandscape by cultural plants, on the one hand, and realizations features of cultivated kinds of plants, on the other.

Differentiation area on slope elements, fertility of soil and ploughed land direction is fixed by the system of protective afforestations, whose participation decreases the steepness of slope and destruction of soils. Thus it is necessary to consider that with the increase of relative density long-term legume-cereal in a corner of a slope the grass mixtures should grow too.

Grass planting in crop rotations is necessary not only on slopes, but also on flat lands. However the importance of grasses repeatedly increases on slopes where they can and should prevent soil erosion.

Forage crops are not only a source of manufacture of forages, but also preservations of soil fertility and ecological stability of the farmland. Thus by forage crops the humus loss are compensated by up to 49% due to plant debris.

Rezumat:

MODALITĂȚI DE CREȘTERE A FERTILITĂȚII PE PANTELE ERODATE ÎN ZONELE NE-CERNOZIOMICE DIN RUSIA

Proiectarea peisajului în scopul realizării unei structuri optime pentru zonele cu culturi agricole se bazează în primul rând pe diferențele dintre terenurile arabile. De asemenea, se are în vedere și îmbunătățirea condițiilor de mediu specifice fiecărui tip de cultură. În acest fel pot fi utilizate la maximum resursele bioclimatice de către plantele cultivate. Acest articol indică câteva căi de reducere a eroziunii apei pe pantele arabile prin valorificarea potențialului biologic al agrocenozelor. S-a demonstrat eficiența folosirii pe termen lung a lupinului ca îngrășământ verde de calitate și fitoameliorator pentru solurile podzolice nisipoase erodate din zona Vladimir.

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