Control of Wind Erosion on Agricultural Lands in the South-East Part of the Ukraine Steppe

V. I. Tarasov

1. INTRODUCTION

Natural conditions of the steppe region of South-East Ukraine are characterized by a continental climate, domination of gramineous vegetation on chernozems and treeless steppe. Forests here are found mainly along rivers banks and in gullies. The annual precipitation is in the range of *250* to *450* mm and they are not steady in character. Droughts and dust storms, periodically take place. So, in 1969 and 1969 dust storms on a large number of farms of the Ukraine caused much destruction of the soil surface under winter crops. In separately standing shelterbelts, about 1000 m^3 of the fine grained soil were sedimented. The most blowing soils sere on wind striking elopes and flat dividing hills.

For protection of the soil from erosion and deflation, a complex of soil control measures are utilized. One of the important elements used are forest shelterbelts with a different degree of arrangements.

2. OBJECTIVES AND METHODS

The aim of the work is to define quantitative indicators of fine grained soil transfer and sedimentation on agricultural lands under the influence of the wind and in what extent forest shelterbelts could be used as observing points for accounting of the soil losses from the fields.

Investigations were carried out on the experimental farm of the soil Conservation Institute, situated in Lugansk region, Ukraine. Some shelterbelts were used as observing points and used as locations for the forest litter sampling (Fig.1). This part of the farm is situated between two gullies, the east one of which was considered to be the baseline of soil erosion. The main deflation winds in the region are from the east. Fields situated on the east side of the shelterbelts were taken for the wind collecting areas. The main part of eroded material from the fields, sedimented in the observing points. The mass of the solid sediment in the observing points was defined by washing it from the samples of forest litter. Samples were taken in 5 repetitions, during the first half of May in 1996. The size of the sampling units were 25x25 cm.

Figure 1. Scheme of the observing points location

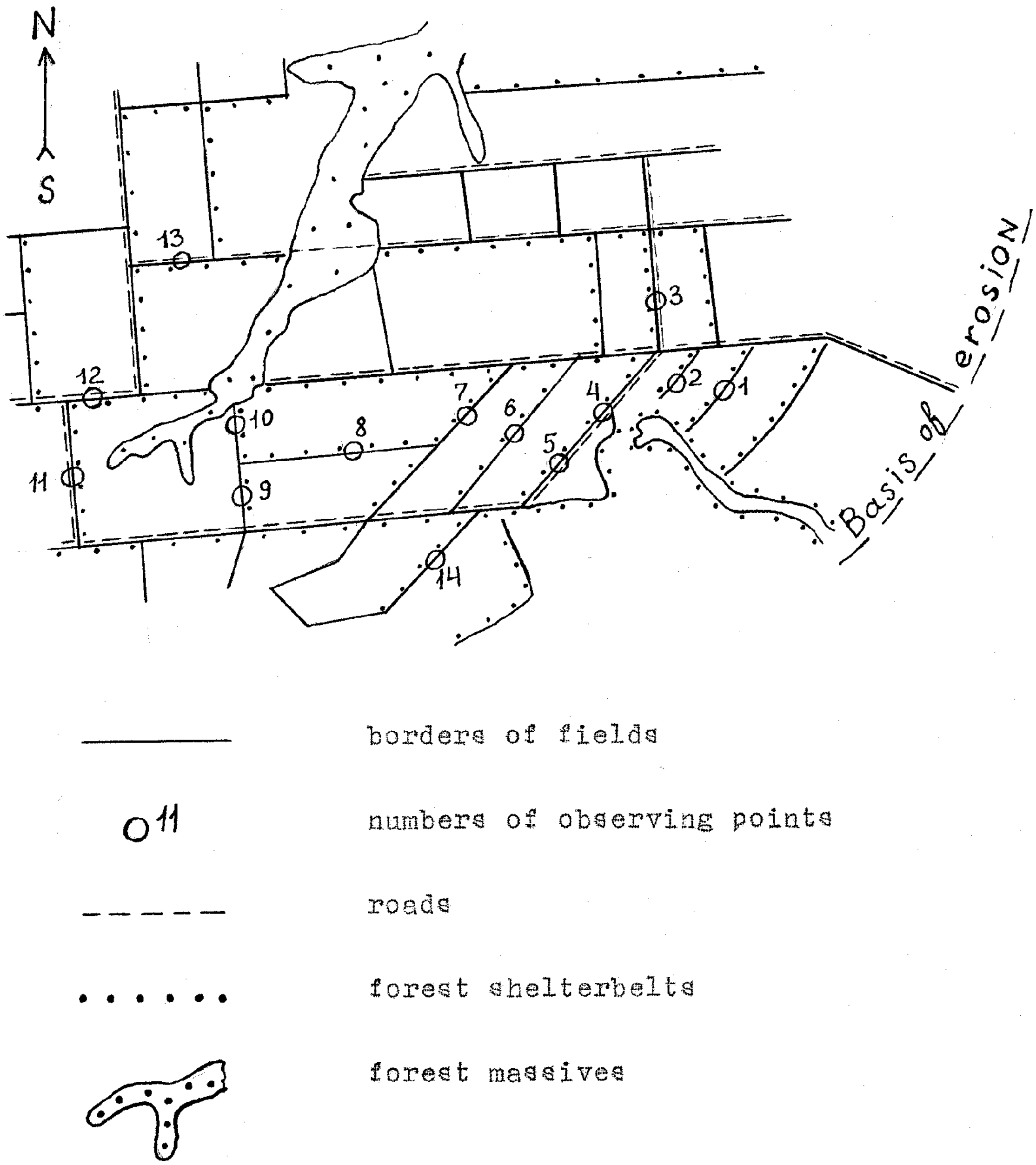


Table 1. Values of fine grained soil transfer and sedimentation in the system of forest shelterbelts

Number of Observing Point	Forest shelterbelts				Wind Collecting Area			
	Area (ha)	Average Height (m)	Width (m)	Mass of Sedimented Soil (t/ha)	Area (ha)	Type of Agricultural Land	Distance Between Shelterbelts (m)	Mass of Removed Soil (t/ha)
1	0.29	5.5	9.0	2.70	8.8	Temporary grasslands	460	0.089
2	0.14	5.0	6.0	1.79	7.0	Temporary grasslands	311	0.036
3	0.70	6.8	10.5	2.87	24.0	Perennial grass	300	0.084
4	0.50	7.0	10.5	3.41	75.0	Winter crops	250	0.023
5	1.00	4.7	15.0	1.08	8.0	Perennial grass	200	0.135
6	0.70	4.1	6.0	2.16	29.8	Interrilled crops	300	0.051
7	1.90	6.7	12.0	3.20	30.5	Interrilled crops	300	0.199
8	1.10	4.6	9.0	3.14	12.5	Interrilled crops	300	0.276
9	0.46	8.0	12.0	2.47	34.6	Winter crops	1000	0.033
10	0.34	8.0	12.0	2.03	50.0	Winter crops	1350	0.014
11	0.70	9.0	10.0	3.87	51.0	Winter crops	850	0.053
12	0.70	9.7	11.0	4.17	3.4	Winter crops	350	0.859
13	1.00	9.0	12.0	3.86	77.0	Winter crops	400	0.050
14	0.48	3.5	15.0	1.38	10.8	Perennial grass	500	0.061

3. PRELIMINARY RESULTS AND DISCUTION

Data shows sedimentation of the fine-grained soil in forest shelterbelts during the year from the spring of 1995 to spring of 1996 (Table 1). It should be noted, that during the period there were no dust storms. Wind velocity did not exceed 12 m/s and the soil was protected by vegetation, however fine grained soil transfer took place. Values of sedimentation varied from 1.03 to 3.87 t/ha. From the study data, a regression analysis was made showing a dependence of mass of the fine-grained soil, sedimented in shelterbelts with the height of shelterbelts, its width and the distance between shelter belts. A mathematical expression of the dependence follows:

$$Y = (0.795 + O.315X_1)\ 1/(2.24 - 0.28X_2 + 0.15X_2^2)\ (1.27 - O.00044X_3);$$

$R = 0.94 \pm 0.21$; where

Y - mass of the fine grained soil, sedimented in shelterbelts, t/ha;

X_1 - average height of a shelterbelt, m;

X_2 - width of a shelterbelt, m;

X_3 - distance between shelterbelts, m.

Statistical analysis carried out by remaining method (Brandon D.B., Developing mathematical models for computer control// GSAL.- 1959. -No 7) to provide both the study of the influence of every factor separately and in their composition. Graphic interpretation of the equation is represented in the figures 2-4. Influence of the factors is shown in order of their priority. The Y’, Y’’, Y’’’ ordinates signify the dependence of the sedimented mass of fine- grained soil from corresponding X_1, X_2, X_3 factors only. The analysis shows that with the increase of a shelterbelt height sedimentation of the fine grained soil increases (Fig. 2). With the increase of a shelterbelt width the sedimentation at first increases and afterwards begins to decrease (Fig. 3). Obviously, with a smaller width of a shelterbelt, part of a fine-grained soil moves through a shelterbelt. With a larger one, all particles are sedimented in a shelterbelt. Optimal width of a shelterbelt is about 10 m. Above this value the mass of sedimented fine grained soil, related to a bigger area, gives less value per unit area. With the increase of the distance between shelters in direction from east to west sedimentation of soil particles gradually decreases (Fig.4). With the large distance between shelterbelts a wind gets greater energy characteristics and part of the soil particles move through and above shelterbelts. It is necessary to add that for the period of investigations, the main transfer of soil sediment was observed in winter and early spring, when shelterbelts stand without leaves and are more penetretive for wind.

Figure 2. Dependence of sediment soil mass from the height of shelterbelts.

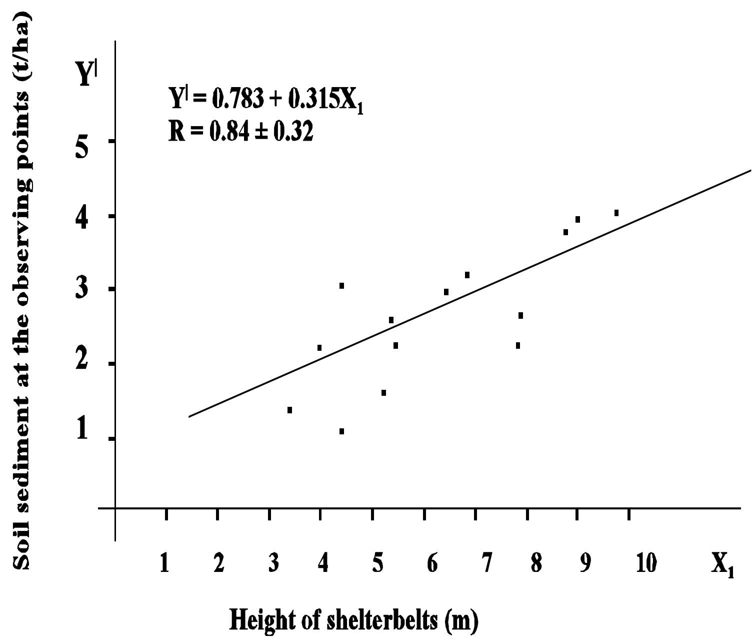


Figure 3. Dependence of sediment soil mass from the width of shelterbelts.

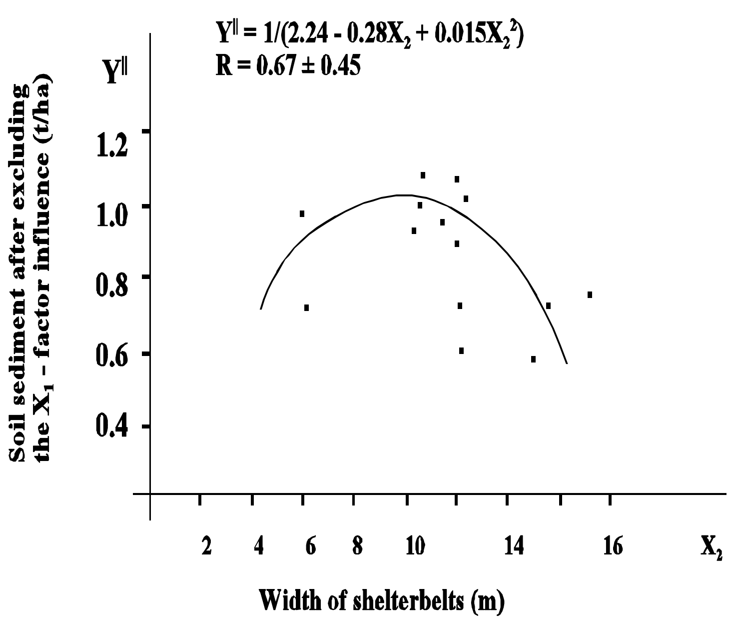
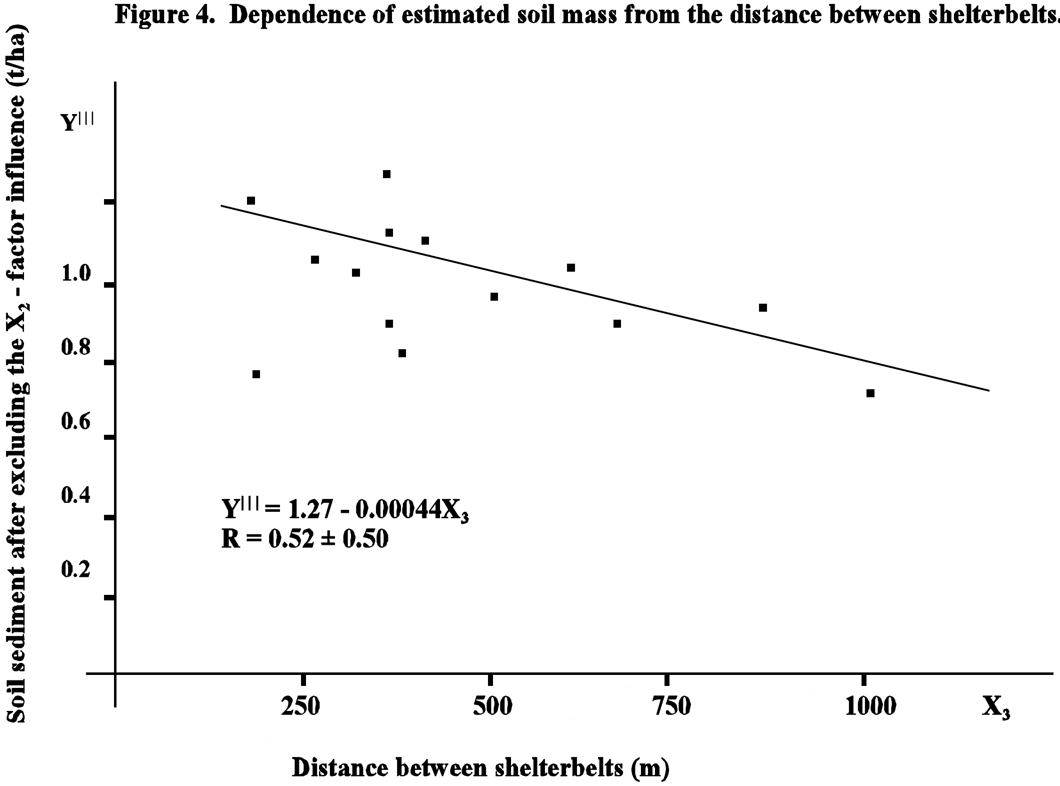


Figure 4. Dependence of estimated soil mass from the distance between shelterbelts.



The analysis at this point showed only the reliable influence of the above mentioned factors only. Losses of the fine-grained soil from the wind collecting areas were not big ones and varied from 0.014 to 0.859 t/ha (Table 1). There is not any regularity, but with some assurance it could be said that these values depend mainly on the distances between shelterbelts and the type of the agricultural land.

CONCLUSION

In the study region, even if dust storms are not observed, the wind transfer of the fine-grained soil on agricultural lands takes place. The result of our work do not give an exhaustive explanation of soil transfer, it was the first stage of investigation. However, it could be said, that forest shelterbelts with their system arrangement effectively protect the soil from deflation. The soil blowing from agricultural fields did not reach 1 t/ha. Shelterbelts could be used also as observing points for determination of soil losses from adjoining agricultural territories.