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ORIGINAL ARTICLE

Environmental conservation of agrarian landscapes in the Steppe zone of Ukraine

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The concept of identity of the environment is formulated as one of the basic characteristics of the environment. As measures for the preservation and sustainable development of the environment identity of the agricultural landscapes of the steppe zone of Ukraine, the effectiveness of the use of forest shelterbelts and complete fallow has been determined. The significant role of artificial forest plantations in the migration of radioactive elements in the ecosystem has been confirmed. The indices of the content of natural radionuclides and the effective specific radioactivity decreased in the surface layer of the soil as the age of the trees increased. A set of features has established the high efficiency of care for complete fallow by the type of early fallow in the Steppe of Ukraine: high ecological erosion preventive safety, water-accumulating ability, high economic efficiency, which provides for the replacement of deep fall plowing with surface mulch spring cultivation.

Keywords: Steppe zone of Ukraine, agrarian landscape, stable environmental identity, soil erosion, radioactive contamination.

Introduction

The Ukrainian Steppe is a natural zone in Ukraine, occupying almost 300 thousand km^2 (40%) of the Ukrainian ethnic territory and 460 thousand km^2 (48%) of all Ukrainian lands. This area is an example of Ukrainian identity as a historically developed adaptive evolutionary system of signs and properties that distinguish Ukrainian nature, Ukrainian community, Ukrainian culture, and humans from other similar objects (phenomena) (Zhulinsky, 2015).

The architectural and spatial features of the environment are a materialized expression of a long historical development and reflect changes in political, social, and economic conditions and factors. Regards the heredity of the architectural environment development, it can be assumed that architectural identity also changes over time; thus, it becomes necessary to classify the Ukrainian architectural identity from the standpoint of the possibility and degree of its transformation in time. There are three levels of environmental identity: frozen identity, stable identity, and plastic identity (Grabovska, 2014). A frozen identity is inherent exclusively in objects of the historical and architectural environment, and fragments of the landscape environment belong to the reserve fund or territories of significant historical and cultural value (conservation) and are recommended for restoration and preservation in their original state. They are fixed in social consciousness as identical signs and symbols. A stable identity is based on continuity, including the previous stages of developing the environment, history, and culture. Plastic identity is in the stage of formation and formulation. Consequently, the most common level is sustainable identity.

The natural environment component, along with anthropogenic and socio-cultural components, is one of the three main groups in which architectural identity can be traced and develop a sustainable identity of the region (Cherkes, 2008; Shevchuk, 2010). The natural component contains the original natural landscape – the territory, the character, and appearance of which results from the action and interaction of natural and human factors, landscapes, climate, flora, and fauna. From this perspective, it is crucial to study the perception and formation of the environment of the Ukrainian Steppe.

The steppe is the central agricultural region of Ukraine due to the high fertility of its soil resources, among which Chernozems prevail. In the north-steppe subzone, the emergence of ordinary chernozems with a significant humus content is observed (up to 7.2 %). The climate of the steppe zone is temperate continental, arid. Due to low air humidity, dry, hot winds, droughts, dust, and black storms often occur, which harm agriculture. Wind erosion in the steppe zone of Ukraine manifests itself almost throughout the entire territory, mainly in the winter-spring period and dry years, with rapid changes of temperature and an active wind regime when soils do not have vegetation and are most vulnerable to erosion. There are 8-21 days per year when the wind speed exceeds or is equal to 15 m/s. East winds most often create the danger of erosion, the speed of which exceeds 12 m/s (Pabat, 1992). In Ukraine, more than 11.9 million hectares of agricultural land in some regions (Vinnytsia, Ternopil, Kirovohrad) – more than 90 %, are subject to water and wind erosion. The most eroded soils are found in Donetsk (70.6 %), Luhansk (61.6 %), and Odessa (55.8 %) regions. In general, the annual increase in eroded land in Ukraine is up to 80–90 thousand hectares. It has been proven that water erosion is most pronounced on short slopes (100–200 m), where the average steepness reaches high values – 2.8°–3°. If the length of the slopes is 700 m or more, then their average steepness decreases to 1.5°–2.0°, respectively, the erosion of the soil cover decreases (Zaitseva, 1970; Shiyatov, 1971, 1973; Cherepanov, 1991; Medvedev, 2007). The steppe zone is extremely rich in minerals. The mineral resource base is characterized by significant fuel and energy reserves (black and brown coal), uranium, construction raw materials, iron, and manganese ores. Accumulation of mining dumps, radioactive waste from the uranium mining and uranium processing industry in the Dnipropetrovsk region, unsatisfactory storage conditions for tailings remains a key problem, which requires constant radiation monitoring in adjacent territories and agricultural landscapes and the adoption of a system of measures to prevent further radioactive and chemical pollution of the environment, disturbance of agricultural lands, harmful effects on public health (Furdychko, 2003; Trokhymchuk, 2015).

As can be seen from the above, soil degradation because of erosion and radiation-chemical pollution, which occurs under the influence of physical-geographical and anthropogenic factors, occupies an essential place among the leading processes of environmental transformation in the steppe zone of Ukraine. Our work aims to consider environmentally sustainable measures to preserve the stable identity of the natural environment of agrarian landscapes of the Ukrainian Steppe zone.

Materials and methods

General scientific methods of analysis, synthesis, and comparison of text and graphic materials were used to form a theoretical background.

Radioecological analysis of soil and forest litter in artificial forest plantations of *Robinia pseudoacacia L.* in the summer-autumn period was carried out to study the features of the migration of radioactive isotopes ^{226}Ra, ^{232}Th, ^{40}K, ^{137}Cs, and ^{90}Sr in the biogeocenosis of the sanitary windbreaker on the territory of agricultural land (Alekseeva, 2014; Gritsan et al., 2016). According to the Robinia group, sample plots were selected with a predominance of 60-, 15- and 5-year-old trees in the age structure. The thickness of the forest litter was, respectively, 4.0, 2.5, and 1.0 cm. Soil samples were taken at a depth of 20–25 cm. The specific activity of radionuclides was determined in samples weighing 10–20 g with a scintillation spectrometer of gamma radiation SEG-001 "AKP-S" and a spectrometer of beta radiation SEB-01-150 (Ukraine) in Bq/kg of dry weight.

The integral indicator of the effective specific activity of natural radionuclides in soil and forest litter was calculated using the formula (Radiation Safety Standards of Ukraine-97, 1997):

$$A_{ef} = A_{Ra} + 1.31A_{Th} + 0.085A_{K} \qquad (1)$$

To assess the risk of radiation exposure to biota, the absorbed dose rate was calculated using the conversion factors recommended by the Scientific Committee on the Effects of Atomic Radiation, 2000 (Abedin et al., 2019; Abba et al., 2018; Gad et al., 2019):

$$D = 0.462C_{Ra} + 0.604C_{Th} + 0.0417C_{K} \qquad (2)$$

The background radiation intensity was measured using a digital dosimeter radiometer RKS-01 "STORA" (Ukraine). The power of the background radiation in the study area did not exceed the acceptable sanitary and hygienic standards; the value ranged from 0.085 to 0.275 μSv/h (Chorna, Ananieva, 2020).

During 2002–2015, in stationary field experiments of the Institute of Grain Crops of the National Academy of Agrarian Sciences of Ukraine, the agrotechnical and soil protective efficiency of various primary processing methods were complete fallow was studied (Dnipropetrovsk region). Fallows were placed after stubble and row crop forecrops (spring barley, sunflower, maize). The stubbles of the forecrops were crushed and evenly distributed over the field during harvesting with a combined harvester. The scheme of experiments in 2002–2009 provided for the following methods of the primary treatment of the soil with complete fallow after barley and sunflower:

1. Mouldboard (25–27 cm), control – plowing with PO – 3–35, PLN – 4–35;
2. Nonmoldboard (chisel, 25–27 cm) – Canadian chisel cultivator Conser Till Plow with C-like spring struts and semi-screw furrow opener – chisel;
3. Nonmoldboard (disc, 10–12 cm) – BDT–3;
4. Nonmoldboard (early fallow, 12–14 cm) – flat cutting in spring with KP–4.5 or KShN–5.6 "Resident".

In 2011–2015, three methods of primary processing of complete fallow after maize were studied:

1. Mouldboard (25–27 cm), control – plowing with PO – 3–35, PLN – 4–35;
2. Nonmoldboard (disc, 10–12 cm) – BDT–3;
3. Nonmoldboard (early fallow, 12–14 cm) – flat cutting in spring with KP–4.5 or KShN–5.6 "Resident".

Further processing (cultivation) of autumn fallows was based on minimization and different depths from 10–12 cm in spring to 6–8 cm before sowing winter wheat treatment with cultivators to reduce drying of the sowing layer. In the field of early fallow, after the main cultivation of the soil in spring, the following cultivation was carried out according to the type of autumn fallow. Winter wheat was fed with ammonium nitrate in the tillering phase (2002–2009), according to soil diagnostics – N_{30-60}. In 2011–2015, a fixed dose of nitrogen fertilizer was used for top dressing without fertilizers; N_{30}; N_{60}.

The erosion-preventing resistance of agricultural background, agrophysical indicators, and accounting for the yield of winter wheat was determined according to generally accepted methods (Tsikova, Pikush, 1983; Bulygin et al., 1999; Bulygin, 2000), calculations of economic efficiency were carried out according to the recommendations of the National Scientific Center "Institute of Agrarian Economics" (Spucak, 2003).

The soil of the experimental site is ordinary clay loam chernozem with a humus content in the 0–30 cm layer – 4.2 %, nitrate-nitrogen – 13.2 %, the content of mobile forms of phosphorus and potassium (according to Chyrykov) – 145 and 115 mg/kg, respectively.

The obtained numerous data were subjected to mathematical processing by the generally accepted methods of variation statistics for a small sample. The standard statistical error of the measurement results was 5–7 %.

Results and discussion

Forest improvement is one of the priority measures to protect and rational use of land and the reproduction of soil fertility. Forests are a significant factor in counteracting the arid climate of the steppe regions of Ukraine; they serve to protect the natural environment, perform significant soil-protecting and water-regulating functions, preventing the formation of dry, hot winds and dust storms, changing the hydrological regime of the territory (Travlieiev et al., 2005; Rozum et al., 2017; Melnyk, 2020). The expansion of forest protective, recreational, decorative, and forest improvement plantations in the steppe Ukraine contributes to improved soil fertility and an increase in the efficiency of using the territory's natural resources (Gritsan et al., 2019). Resistant vegetational cover traps solid flow, which shields part of the soil surface. The formation and development of the vegetation cover are accompanied by an increase in its buffer role in radionuclides migration (Irklienko et al., 2001; Gudkov, Vinichuk, 2006; Markovic et al., 2019).

As a result of the research, data were obtained on the content of natural and artificial radionuclides ^{226}Ra, ^{232}Th, ^{40}K, ^{137}Cs, and ^{90}Sr; it was revealed that in soil samples, the concentration of ^{226}Ra varied from 19.8 to 27.2 Bq/kg, moreover, in locations where 60-year-old trunks prevailed, the level of ^{226}Ra in the soil was lower by an average of 16.1 % compared to arrays of younger trees (Fig. 1). The content of ^{232}Th in the soil of the studied points was more uniform. The absolute values of the specific radioactivity of ^{232}Th were found in the range from 29.8 to 35.4 Bq/kg; the average decrease in older trees' areas was 8.0 %. The level of ^{40}K in the soil ranged from 32.6 to 41.2 Bq/kg and decreased with an increase in the age of trees by an average of 17.1 %.

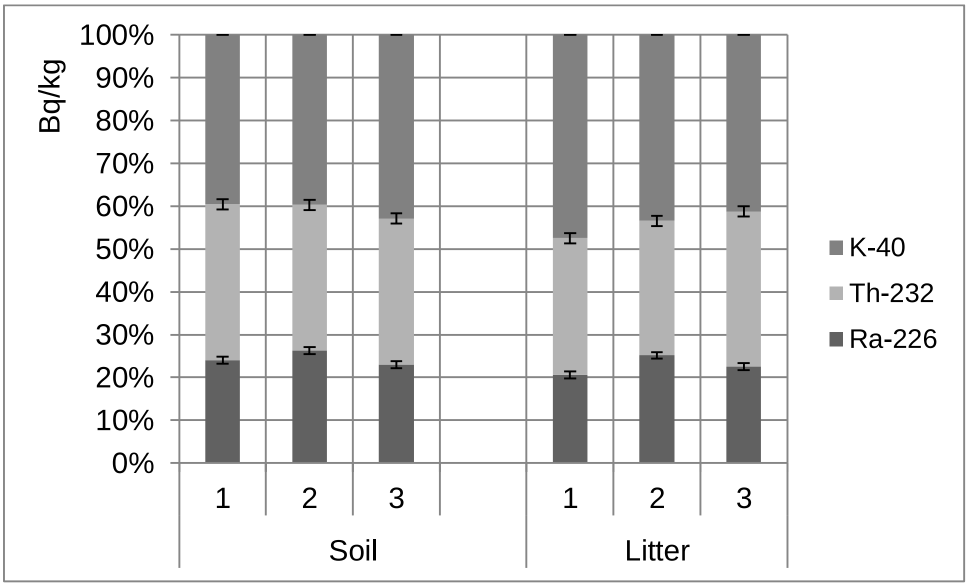

Fig. 1. Content levels of natural terrigenous radionuclides (Bq/kg of dry weight) in the components of the ecosystem of artificial forest plantations of *Robinia pseudoacacia L.* with a predominance in the age structure of 60-year-old trees (1), 15-year-old trees (2), 5-year-old trees (3).

The average concentrations of natural radioactive isotopes in the forest litter were significantly higher than in the surface soil layer and varied for ^{226}Ra – from 24.0 to 25.7 Bq/kg, ^{232}Th – from 32.1 to 40.2 Bq/kg, ^{40}K – from 44.4 to 55.3 Bq/kg. Fluctuations in the measured values at the three points under study were more uniform than the data obtained from soil samples and amounted to 5.5 %, 2.9 %, and 22.6 %, respectively, for ^{226}Ra, ^{232}Th, and ^{40}K. The leaf litter formed by plant components – fallen leaves, branches, and the remains of the grass cover acts as a buffer and primary link in the formation of the radiation background in edaphotopes.

To assess the overall level of radioactivity, which is created in the components of the ecosystem by the main dose-forming radionuclides, and the possible effect on the biota, the integral indicators of the effective specific radioactivity and the absorbed dose rate were calculated (Table 1).

The value of the effective specific radioactivity varied, respectively, from 59.04 to 77.07 Bq/kg in the soil and from 71.52 to 81.66 Bq/kg in the forest litter; the absorbed dose rate – from 28.69 to 35.67 nGy/h in soil and from 33.11 to 37.79 nGy/h in the forest litter. The data obtained indicated that the levels of radioactivity in the study area were within the permissible level and did not pose a risk to biological objects.

The measured concentrations of ^{137}Cs and ^{90}Sr artificial radionuclides in the components of the ecosystem of the artificial forest belt of *Robinia pseudoacacia L.* were 20–40 times lower than in the natural one (Fig. 2). Low artificial radionuclide concentrations in the biotic and abiotic components of the ecosystem are associated with their successive "aging" – a decrease in radioactivity because of the expiration of the half-life, removal outside the territory due to solid and liquid surface flow. The concentration levels of ^{137}Cs and ^{90}Sr artificial radioisotopes in the soil and forest litter did not depend traditionally on the age structure of groups of tree plantations of Robinia pseudoacacia in the study area.

Table 1. Integral indicators of effective specific radioactivity (A) and absorbed dose rate (D) in biogeocenosis of artificial forest plantations of *Robinia pseudoacacia L.* with a predominance in the age structure of 60-year-old trees (1), 15-year-old trees (2), 5-year-old trees (3).

Indicator	Sampling point	Soil	Forest litter
Effective specific radioactivity (A, Bq/kg)	1	62.0 ± 3.44	77.43 ± 4.33
	2	77.07 ± 4.25	71.52 ± 4.14
	3	59.04 ± 3.54	81.66 ± 5.23
Absorbed dose rate (D, nGy/h)	1	28.69 ± 1.64	35.87 ± 2.19
	2	35.67 ± 2.21	33.11 ± 1.92
	3	28.8 ± 1.98	37.79 ± 2.68

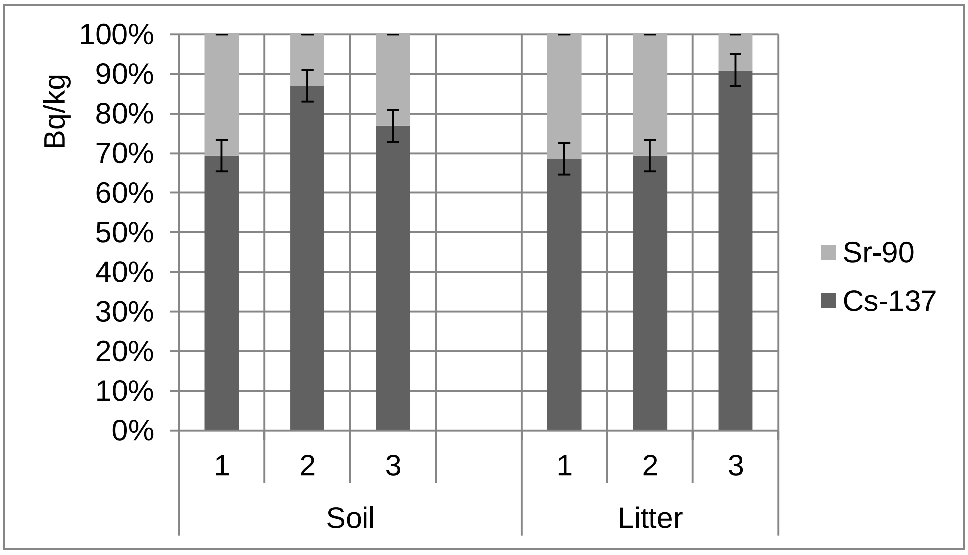

Fig. 2. Content levels of artificial radionuclides (Bq/kg of dry weight) in the components of the ecosystem of artificial forest plantations of *Robinia pseudoacacia L.* with a predominance in the age structure of 60-year-old trees (1), 15-year-old trees (2), 5-year-old trees (3).

Complete fallow is used as an effective agrotechnical means of combating drought; it significantly increases the productivity and stability of steppe agriculture. Provided that the soil is adequately prepared and processed, it is equated to irrigation and guarantees the receipt of 6–8 t/ha of high-quality grains of winter wheat, and it also has a beneficial effect on the growth and development of subsequent crops in crop rotation (Pikush et al., 1992; Gorbatenko et al., 2008; Tsyliuryk et al., 2008). Notwithstanding, complete fallow is the most vulnerable crop rotation field, where environmental threats often arise, namely, it is complicated to stop soil erosion processes, normalize technogenic loads, compensate the balance of nutrients and energy turnover (Chumak et al., 2002; Gorbatenko et al., 2008; Tsyliuryk, 2014). For these reasons, the development and assimilation of effective, environmentally friendly methods of maintaining and caring for fallow fields to prevent further destruction of chernozems, save energy resources, and funds remain relevant.

The soil deflation determines the resistance of the soil to deflation (wind erosion). Deflation (wind transport of soil particles) is the most objective indicator of the degree of wind resistance of the soil. It depends mainly on the topsoil properties (granulometric composition, tuberosity, and cohesion of soil aggregates, the amount of stubble). For most soils, when there are lumps of more than 1 mm in the upper layer of 0–5 cm and an amount of more than 60 % of the dry mass, favorable conditions for resistance to wind blowing are created, and with an amount of less than 50 % of the blowing of soil particles, it increases (Zaitseva, 1970). In our study, immediately after cultivation in the fall, the tuberosity (aggregates> 1 mm) of the upper layer (0–5 cm) of the soil, regardless of the cultivation of fallow land, amounted to 61.0–62.9 %, and did not decrease below 60 %, that is, the surface of the field was wind-resistant. During the winter period, as a result of the impact of oppositely directed processes of freezing-thawing, moistening – draining, soil aggregates collapsed to dangerous erosional sizes, the tuberosity of chernozem decreased by 1.3–1.4 times and amounted to only – 43–45 %, as a result of which they can undergo deflation on open plains and wind-blown slopes (Table 2).

According to theoretical calculations, the soil deflation by wind according to the method of E.I.Shiyatov (1971) is allowed up to a limit of 120 g per 5 minutes of exposure. With an erosion rate less than or equal to 50 g, the soil surface is considered highly wind-resistant, and values of 50–120 g are moderately wind-resistant (Shiyatov, 1971). In spring conditions (the period of manifestation of maximum deflation), to prevent soil blowing, it is necessary to have 8–10 pcs/m^2 of conventional stubble 20 cm long in terms of winter wheat for each percentage reduction in lumpiness of the upper layer (Shiyatov, 1973).

Therefore, in the destruction of erosion-resistant particles (aggregates> 1 mm), plant crop residues of the forecrop left on the soil surface are of great importance; they protect the surface from blowing out dust-like fractions in spring. The most significant amount of conventional stubble on the surface remains, of course, in the early fallow (without tillage in autumn) – 396–630 pcs/m^2. A significant amount of conventional stubble was also obtained after disking (72–333 pcs/m^2) and chiseling (96–124.8 pcs/m^2). Early fallow is a reliable method of dealing with wind erosion (deflation) in the spring. Even strong winds with a speed of more than 15 m/s in the early fallow are not able to blow out more than 5–12 g/m^2 of soil in 5 minutes of exposure, while with moldboard plowing, these indicators increase 15–26 times and amount to 134–185 g/m^2 (Table 2).

Table 2. Indicators of anti-deflationary soil resistance in spring in complete fallows, depending on the method of processing

Indicators	Cultivation	Forecrop barley (2002–2007)	sunflower (2003–2008)	maize (2011–2015)
Amount of conventional stubble on the soil surface, pcs/m^2	mouldboard (plowing)	10	12	20
	nonmoldboard (chisel)	124.8	96	-
	nonmoldboard (disking)	72	-	333
	nonmoldboard (flat-cut, early fallow)	465	396	630
Tuberosity (aggregates> 1 mm) in a layer of 0–5 cm	mouldboard (plowing)	44	45	46
	nonmoldboard (chisel)	43	44	-
	nonmoldboard (disking)	44	-	43
	nonmoldboard (flat-cut, early fallow)	45	45	45
Mechanical stability of lumps, %	mouldboard (plowing)	81	83	82
	nonmoldboard (chisel)	72	74	-
	nonmoldboard (disking)	69	-	67
	nonmoldboard (flat-cut, early fallow)	74	73	75
Deflation of the soil by wind, g/m^2/5 min.	mouldboard (plowing)	150	185	134
	nonmoldboard (chisel)	20	25	-
	nonmoldboard (disking)	131	-	113
	nonmoldboard (flat-cut, early fallow)	8	12	5
Coefficient of surface wind resistance	mouldboard (plowing)	0.86	0.64	0.89
	nonmoldboard (chisel)	6.0	4.8	-
	nonmoldboard (disking)	0.96	-	1.06
	nonmoldboard (flat-cut, early fallow)	15.0	10.0	24.0

The coefficient of surface wind resistance (the ratio of the permissible deflation level of 120 g/m^2 to its actual value) was the highest in the early fallow (10–24) due to the protection of the surface by plant residues. Chisel cultivation should also be noted; in the process of such cultivation, the coefficient of wind resistance was also high, however, 2–2.5 times less than in early fallow. In summer, when tending the fallow during cultivation, the risk of soil deflation increases, even in early fallow. However, notwithstanding the soil of the nonmoldboard, the cultivation option was more resistant to wind operation than mouldboard plowing. The use of mouldboard plowing in fallow and all crops in the crop rotation contributed to the manifestation of the maximum indicators of wind erosion (deflation).

Early fallow is a revolutionary method of wind erosion control and a method of water erosion control. In this case, the snowmelt runoff in spring does not create significant soil erosion. This is facilitated by an increase in its density protection by snow and plant residues. Water flow breaks up into small streams and loses speed mainly due to mechanical braking. With a high clogging ability of the agricultural background, soil washout outside the field was 1.5–4.3 t/ha, which is 4–12 times less than with plowing (18.6 t/ha).

The resistance of early fallow to erosion of pouring summer precipitation increases when there is more than 2.5 t/ha of plant substrate on the surface and the time of the primary cultivation is postponed to the time of mass regrowth of weeds (May), carrying it out with nonmoldboard tools to a loosening depth of 12–14 cm to preserve the mulching screen and create a lumpy structure of the upper soil layer. Under the conditions of artificial sprinkling with an intensity of 3.5 mm/min (end of June, slope with a steepness of 2.5°), in the area of dump autumn plowing with the recommended fallow care technology for the zone, the runoff began in 3.2 minutes at a feed rate of 11.2 mm, while in early fallow during spring cultivation – after 7.6 minutes and feed rate of 26.6 mm. Soil water permeability and runoff turbidity here were 1.08 mm/min and 25 g/L, versus 0.65 mm/min and 39 g/L in control, respectively.

The transition from autumn fallow to early fallow, against the background of mulching of the soil surface with stubble, remains of the forecrop, improves the structure of common chernozem while reducing the number of dust fractions (<0,25 mm), which are most susceptible to anthropogenic pressure up to a safe level of 5.4–5.6 %. The content of agronomically valuable aggregates with a size of 10–0.25 mm, at the end of fallowing in the arable layer, on the contrary, grows concerning autumn plowing up to 89–90 %. The level of these indicators makes it possible to assert that with a positive balance of biogenic compounds and the absence of erosion, the restoration of the structure in early pairs is carried out in a self-regulation model, which is inherent in natural analogs of ravines or virgin lands (Medvedev, 2007).

Early fallow had an annual advantage over mouldboard plowing in terms of winter precipitation accumulation, especially after barley and maize. This can be explained by forming a very thick protective shield created by standing stubble and chopped stubble remains. In areas uncultivated since autumn, there is a significant decrease in wind speed in the aboveground airspace and an earlier and more uniform deposition of snow, an increase in its viscosity and density. In combination with the early fallow high buffering and retention properties, this results in less water loss from runoff, evaporation, freezing, and blowing out. As a result, it contributes to an increase in the coefficient of assimilation of precipitation and additional accumulation of moisture in the root-active layer of the soil (0–150 cm) compared to mouldboard plowing by an average of 130 m^3/ha.

The data on the yield of winter wheat for complete fallow, obtained in years different from the meteorological situation, calls into question the statement about a decrease in early fallow efficiency compared to autumn fallow.

Strict adherence to the technical regulations for the preparation of early fallow allows getting timely seedlings and forming highly productive crops of winter wheat. For example, the grain yield of wheat after early fallow for sunflower in all years was at the level of autumn plowing and averaged 6.30–6.66 t/ha (Table 3).

After the stubble, fore crop, and maize, there was a slight decrease in grain yield in the early fallow by 0.17–0.25 and 0.13–0.20 t/ha, respectively, which was often within the experience error the years (Table 4). This is mainly due to the higher garbage of wheat crops, as well as the probable possibility of soil intoxication and oppression of plants by substances, which are released during the decomposition of straw (phenols, acids), especially in crop rotations with a high saturation of cereal crops (Cherepanov, 1991).

According to our calculations, the best indicators were obtained when growing winter wheat against the background of shallow mulching spring cultivation (early fallow). In such conditions, the maximum profit was 3358–3584 UAH/ha and a high level of profitability of 77.5–81.3 %, as well as fuel economy 19.9 l/ha, reduction of labor costs by 0.33–0.38 human×h/ha and funds – 306–324 UAH/ha compared to moldboard plowing. The use of other technologies to cultivate the fallow field led to an increase in the cost of grain products and lower profitability of a hectare of autumn plowing.

Table 3. Winter wheat yield in complete fallow, depending on soil cultivation and fertilization, t/ha

Fertilizers (factor A)	Cultivation (factor B)	Forecrop													
		barley							sunflower						
		years													
		2004	2005	2006	2007	2008	2009	average	2004	2005	2006	2007	2008	2009	average
Stubble remains	nonmoldboard (disking)	6.36	5.64	5.52	5.11	8.43	7.10	6.36	–	–	–	4.59	8.05	6.78	–
	nonmoldboard (chisel)	6.30	5.48	5.34	5.02	8.50	6.98	6.27	6.50	5.73	5.72	4.53	8.34	6.99	6.30
	mouldboard (plowing)	6.32	5.75	5.43	5.16	8.57	7.02	6.38	6.55	5.81	5.71	4.69	8.21	6.87	6.31
	nonmoldboard (flat-cut, early fallow)	6.27	5.19	5.23	4.94	8.36	6.79	6.13	6.46	5.82	5.77	4.70	8.23	6.80	6.30
Stubble remains + N_{30-60}	nonmoldboard (disking)	6.59	6.52	5.97	5.25	8.00	7.13	6.58	–	–	–	4.98	8.27	6.95	–
	nonmoldboard (chisel)	6.47	6.38	5.90	5.17	8.03	7.09	6.51	6.93	6.45	6.07	4.95	8.37	6.84	6.60
	mouldboard (plowing)	6.64	6.58	5.95	5.27	8.08	6.94	6.58	6.90	6.40	6.10	5.01	8.33	6.83	6.60
	nonmoldboard (flat-cut, early fallow)	6.58	6.02	5.67	5.24	7.94	7.00	6.41	6.77	6.56	6.15	5.03	8.46	6.97	6.66
$HIP_{0,5}$ t/ha	by factor A	0.13	0.22	0.14	0.09	0.19	0.15	–	0.24	0.18	0.18	0.09	0.18	0.15	–
	by factor B	0.19	0.31	0.19	0.12	0.27	0.22	–	0.30	0.22	0.23	0.13	0.26	0.21	–
	for AB interaction	0.23	0.33	0.31	0.10	0.38	0.30	–	0.39	0.34	0.35	0.11	0.36	0.29	–

Table 4. Winter wheat yield in complete fallow after maize, depending on soil cultivation and fertilization, t/ha

Cultivation (factor A)	Fertilizers (factor B)	Years					Average
		2011	2012	2013	2014	2015	
Mouldboard (plowing)	without fertilizers	5.48	2.01	6.05	5.83	6.32	5.24
	$N_{30}P_{30}K_{30}$	5.57	2.19	6.22	6.49	6.72	5.52
	$N_{60}P_{30}K_{30}$	5.59	2.32	6.31	6.00	6.93	5.50
Nonmoldboard (disking)	without fertilizers	5.28	1.86	6.20	6.23	5.73	5.17
	$N_{30}P_{30}K_{30}$	5.43	2.08	6.79	6.71	6.29	5.55
	$N_{60}P_{30}K_{30}$	5.48	2.23	6.95	6.38	6.55	5.60
Nonmoldboard (flat-cut, early fallow)	without fertilizers	4.85	1.98	6.08	6.40	5.67	5.04
	$N_{30}P_{30}K_{30}$	4.97	2.21	6.41	7.19	5.95	5.37
	$N_{60}P_{30}K_{30}$	5.34	2.35	6.77	6.55	6.51	5.52
HIP_{05}	by factor A	0.32	0.11	0.23	0.22	0.22	–
	by factor B	0.32	0.10	0.20	0.23	0.23	–
	for AB interaction	0.46	0.19	0.40	0.38	0.39	–

Conclusions

The data obtained confirm the important role of artificial forest plantations in migrating radioactive elements in the ecosystem. The highest concentrations of natural terrigenous radionuclides, ^{226}Ra, ^{232}Th, ^{40}K, and the values of integral indicators of effective specific radioactivity (A) and absorbed dose rate (D) were found in forest litter. The values of both integral indicators (A, D) in the soil and forest litter were within acceptable levels and did not pose a risk to biological objects. As the age of the trees increased, the indices of the content of natural radionuclides and the effective specific radioactivity decreased in the surface layer of the soil. Changes in the concentrations of artificial radioisotopes ^{137}Cs and ^{90}Sr in the soil and forest litter did not show a steady relationship with the age structure of dendroflora groups. However, they were determined, probably, by other factors, such as the rate of their removal from the biological cycle, distance from the source of radioactivity.

The content of complete fallows of early fallow in the Steppe of Ukraine makes it possible to avoid environmental threats, namely, to significantly reduce soil deflation to a safe level of 5–12 g/m^2/5 min, and reduce soil loss by 4–12 times. This is ensured by keeping the maximum amount of plant residues 396–630 pcs/m^2 and lowering the share of erosive dust-like fractions (aggregates <0.25 mm) to a minimum of 5.4–5.6 %.

The use of early fallow, in comparison with the traditional technology of its maintenance based on moldboard plowing, makes it possible to increase the coefficient of assimilation of precipitation in the autumn-winter period and additionally accumulate 130 m^3/ha of moisture in the root-active soil layer (0–150 cm), which is essential in the arid conditions of the Steppe zone.

The best economic indicators are achieved when growing winter wheat against the background of shallow mulching spring cultivation (early fallow). This makes it possible to obtain the maximum production profitability of 77.5–81.3 % and save fuel by 19.9 l/ha and reduce labor costs – 0.33–0.38 human×h/ha and funded by 306–324 UAH/ha compared to traditional plowing.

The concept of environmental identity was formulated as one of the essential characteristics of the environment. Preservation and sustainable development of the environmental identity of a particular region helps to preserve its uniqueness, economic feasibility and makes its type more attractive.

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