ECOSYSTEM SERVICES PROVIDING SHELTERBELTS

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In Ukraine, the largest user of natural resources is the agricultural complex. About 60% of the country's lands are used for agricultural purposes [1]. During the years of independence, the system of land use in agriculture has completely changed. Emergence of a large number of owners and lessees of farmland increases the range of stakeholders in Agriculture and Natural Resources. New land users, in most cases, have no agronomic knowledge and take land and agro-ecosystems as a source of quick profits [2]. Farmland cannot be considered only as an economic object, place to work and receive products or food. Fields, pastures, fallow and other farmland with surrounding elements and components of the ecosystem are a dynamic complex of vegetation, animals and microorganisms with nonliving environment interacting as a functional unit. Man in agroecosystems is a part and at the same times one of the main factors that determines its activity status and future of these ecosystems. Against this background, it is important to introduce new tools for an ecosystem approach to the farm management, not only for the preservation of the ecological balance, but also to increase the economic efficiency of agricultural sphere.

The aim of our study is to determine the range of ecosystem services that provide shelterbelts according to the system of ecosystem functions and services proposed by de Groot et al.

It is known that shelterbelts reduce wind speed, snow delayed on the fields, reduce runoff, increase soil moisture, prevent wind erosion, increase and stabilize crop yields, and thus play an important role in the environment shaping.

For example, 40-80 mm increase of the average precipitation, mean annual temperature amplitude decreased by 2-3 º C, the amount of dry winds decreased to 7-15 days, snowmelt runoff and rain water fell at 1.9% was marked under the influence of artificial forest plantations and network of shelterbelts in Mariupol Forest Research Station during the past 30-40 years. Under the influence of shelterbelts: wind speed reduced at 25-60%, and the humidity of air is increased at 5-20%, soil moisture on the fields increases at 15-30%, evaporation is reduced at 20-25% [3]. Under conditions of high and increased amounts of shelterbelts increase plant water content and heat loss by evaporation grow to 21-23%. Approximately the same number of reduced turbulent heat flux in the surface air compared to the open field. A dense network of shelterbelts with well blown by wind constructions best to ensure the preservation and distribution of snow in the fields. Mass of snow under the protection of shelterbelts increases to 101% as compared to the open field, the rate of equal distribution the snow is 0.64. In the fields protected by shelterbelts of other constructions and consistency these parameters are 72-16% and 0,23-0,15 respectively. Spring soil moisture on the fields is determined mainly by supplies snow water that accordingly affects productivity and other indicators [4]. Shelterbelts up to 10 H on slope lands contribute to the formation more powerful soil horizons, up to 76-95%. Accumulation of calcium confirms improve soil structure also increases the humus content by 20-40% compared with control and increased soil pore - to 9% [3,5]. Increase of humus in the layer 0-50 cm under 42-year-old shelterbelts was 14.79 t/ha, under fields - 3.36 t/ha. [6].

Forest shelter belts positively influence the biotic factors of soil adjacent directly to them. Shelterbelts with well blown by wind constructions commit the biggest impact, their influence can be traced to 30 H, there is an increased biological (destroying cellulose) activity of soils (38.3%), microbial biomass (1627 mg/day/kg), enzyme (5.702 sm 3 /gr/min) nitrogen-3fixing activity (64 mg/kg), the number of earthworms (57 ind./m 2) and their biomass (56.8 g/m 2), for comparison with dense structure and openwork design of shelterbelts, where rates on average below 3.5 -49.1% [7].

Reserves of biomass in shelterbelts depend on the type of soil, climate, age, type of plantings and other factors. Maximum biomass accounted for in forest belts into the forest-steppe zone is 1540-1780 kg/ha, less in the steppe zone - 990-1290 kg/ha. Mixed plantings have more biomass compared to pure plantings. The accumulation of chemical elements in biomass of shelterbelts reaches the largest quantities into the forest-steppe zone is 2410-3260 kg/ha in the steppe zone is 1340-1480 kg/ha. In mixed plantings there are more chemical elements than in pure plantings. The bulk of nitrogen and ash elements are stored in the tree layer. Chemical elements contained in the leaves of trees and partly in plants over the soil surface actively participate in the biological cycle. Those elements that are fixed in branches, roots and trunks of trees are especially longly excluded from circulation and returned to the ground only with the collapse of plant communities. Return of the chemical elements into plantations of forest-steppe zone and steppe zone is 340-580 kg/ha. Calcium, nitrogen, silicon, potassium, magnesium in large quantities and phosphorus, sulfur in smaller quantities are returned into soil. From 4% to 40% of the chemical elements are taken out from shelterbelts to adjacent fields. Thus the introduction culturphitocenoses in agricultural landscapes activates metabolic processes in them [8]. In addition, shelterbelts not only mean ameliorative effects - they participate restore ecological and biological balance in the agricultural lands. Belts contribute to the formation of useful fauna, creating new trophic relationships, balancing new biogeocenosis and thus serve as a reliable means of forming biological usefulness of farmland. [9]

Protective forest plantations help to increase the species diversity of flora and fauna in agroecosystems, including flora (20-80%), entomofauna (25-60%), zoofauna by 1.5 - 3 times [3]. According Budnichenko in 1965 the number of breeding birds increased to 90 species as compared to the original (zonal) more than 5 times. Birds, in its turn, control the number of other species of fauna that can be pests - insects and murine rodents and peck the seeds of various weed species [10]. Analysis of the distribution of entomofauna found 7 times more herbivores on the field compared to the number of insects in the shelterbelts. At the same time, the number of insectivorous was higher by 1.7 in shelterbelts. It should be noted that the population of insects on the edge of the forest shelterbelts is 31-48% higher than in the middle of the shelterbelts. Assessment ratio herbivores and entomophagous nearby shelterbelts edge creates conditions for natural control of pest populations and corrections the chemical processing of field [11]. Floral diversity in forest belts increases with their age and reaches 70-87% of the local natural flora. At the same time, component of segetal and ruderal flora of the forest belt is reduced by 1.5-2 times compared with flora of the field. [11,12].

Ameliorative effect regarding increasing crop yield is well known and appreciated by many researchers. G. Gladun describes generalized figures concerning crop increase for Ukraine to 5.3 t/ha with an increase in field-protecting forest cover by 1%. On average, with sufficient forest belts fields' security, grain harvest increases at 12-19%, technical crops at 20-33%, forage crops at 22-36%. Especially noticeable is effect on the action belts in acutely dry years when productivity increases up to 30-33% compared with control. Average profitability of crops which growing within the system of shelterbelts is at 8.5% above control level. Additional harvest from the influence of 441.9 hectares shelterbelts of Ukraine is equivalent to harvest of 1 million hectares of fields. [3,5]. These are the numbers that will help you to quickly assess productive ecosystem services of shelterbelts (production function) and express this evaluation in percentage harvest and appropriate monetary equivalent.

Much more difficult is to distinguish, identify and evaluate other ecosystem functions and services, such as regulatory or information. Protective agroforestry plantations performing regulatory functions (supporting and regulating services) contribute to overall improvement of the microclimatic conditions, which in turn increases the yield and quality of productive ecosystem services.

Ecosystem functions of shelterbelts as components of agroecosystems are integral parts of the ecosystem processes that occur here and produce substantial list of ecosystem services. According to the results of our typology of ecosystem services shelterbelts found ability to perform 23 ecosystem functions presented by de Groot et al. [13] and found opportunity to supply 55 ecosystem services.

Assessment of the economic effectiveness of security contributions of the ecosystem approach to managing farms, particularly landscape farming systems shows that the most cost-requiring part of their implementation is to create forest protection plantations, including shelterbelts. When calculating the complex economic effect from the introduction of such systems, where more than crop production estimated cost of humus and other indicators revealed that the payback period of creating shelterbelts is only 1,0-2,8 years [11]. Calculations of other researchers using fewer indicators point to more long term, but the average time the payback period shelterbelts is not over 10 years.

References:

1. Державна служба статистики України. Статистичний збірник Україна 2011. / Київ. – 2012. – с.27.

2. Фурдичко О.І. Управління агроландшафтами лісомеліоративними методами на засадах збалансованого розвитку / Фурдичко О.І., Стадник // Агроекологічний журнал. – 2009. - №3. – С. 5-12.

3. Гладун Г.Б. Значення захисних лісових насаджень для забезпечення сталого розвитку агроландшафтів / Г.Б. Гладун // Національний лісотехнічний університет України Науковий вісник. – 2005. – вип. 15.7. – С. 113-118.

4. Вдовин Н.В. Экологическая и агроекономическая еффективность полезащитных лесных полос разной системности на черноземах Среднего Поволжья. / Автореферат. – Волгоград. – 1985. – http://www.dissercat.com/content/ekologicheskaya-i-agroekonomicheskaya-effektivnost-polezashchitnykh-lesnykh-polos-raznoi-sis.

5. Колесникова Л.В. Лесные полосы и их влияние на плодородие чернозема обыкновенного и продуктивность угодий в степи Приволжской возвышенности. / Автореферат. – Саратов. – 2006. – с.20.

6. Штеба А.Н. Лесопригодность почв и агролесомелиаративное обустройство юго-востока Приволжской возвышенности. /Автореферат. – Волгоград. – 2009. – с.20.

7. Михина Е.А. Агроэкологическая роль полезащитных лесных полос в условиях Липецкой области. /Автореферат. – Воронеж. – 2009. – http://www.dissercat.com/content/agroekologicheskaya-rol-polezashchitnykh-lesnykh-polos-v-usloviyakh-lipetskoi-oblasti.

8. Дубовская Л.В. Влияние древесных пород на биологический круговорот азота и зольных элементов в полезащитных лесных полосах Поволжья. / Автореферат. – Волгоград. – 1984. – http://www.dissercat.com/content/vliyanie-drevesnykh-porod-na-biologicheskii-krugovorot-azota-i-zolnykh-elementov-v-polezashc.

9. Виноградов В.Н. Роль полезащитных лесных полос в повышении производительности земель / В.Н. Виноградов //Плодородие почв и пути его повышения. – М. 1983. – С. 16-22.

10. Будниченко А.С. Птицы искусственных лесонасаждений./ А.С. Будниченко // Ученые записки Тамбовского государственного педагогического института. Выпуск XXII. – Воронеж. – С. 7,8.

11. Котлярова Е.Г. Агроэкологическое обоснование эффективности ландшафтных систем земледелия в центральном черноземье./ Автореферат. – Курск – 2011. - с.42.
12. Чиркова О. В. Структура лісосмуг як складових елементів екологічної мережі / О. В. Чиркова // Проблеми екології та охорони природи техногенного регіону. – Донецьк: ДонНУ, 2010. – № 1 (10) – С. 97-104.
13. de Groot R.S. A typology for the classification, description and valuation of ecosystem functions, goods and services / R.S. de Groot, M.A. Wilson, R.M.J. Boumans // Ecological Economics. – 2002. – Val. 41(3). – P. 393-408.
14. Shibu J. Agroforestry for ecosystem services and environmental benefits: an overview. –Published online: – Springer Science+Business Media B.V. – 2009.

Економіка для екології: матеріали XIX Міжнародної наукової конференції, м. Суми, 30 квітня – 3 травня 2013 р. / редкол.: Д. О. Смоленніков, М. С. Шкурат. – Суми : Сумський державний університет, 2013. – С. 126-130.