IMPACT OF THE IMPLEMENTATION OF AGROECOLOGICAL ECOSYSTEM SERVICES ON THE AGRICULTURAL LANDSCAPE

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ABSTRACT

More than a third of the Earth's total land area is used for agriculture and grazing, leading to alarming rates of land conversion and loss of habitat for various plant and animal species. The conventional production of agricultural products as methods and practice of application is the reason for the high rates of deterioration of biodiversity, soil erosion, reduction of water potential, as well as on a number of ecosystem services.

In Bulgaria, research on economic and other issues related to agro-ecosystem services is at an initial stage (Kazakova; Nedkov; Nikolov; Todorova; Bachev; Grigorova and Kazakova; IAOS; Yordanov et al.; Chipev et al.). With few exceptions, there is practically no research on the dominant forms of management of agro-ecosystem services in the country (Bashev; Bashev et al.; Bachev, 2021; Todorova).

This paper aims to investigate the impact of implementing ecosystem services on landscape shaping in agricultural holdings.As well as deepening understanding of the impact of multiple agroecological ecosystem services on the agricultural landscape.

KEYWORDS: agro-ecological services, landscape, impact, implementation

ABSTRAKT

Mehr als ein Drittel der gesamten Landfläche der Erde wird für die Landwirtschaft und die Weidewirtschaft genutzt, was zu alarmierenden Raten der Landumwandlung und zum Verlust von Lebensraum für verschiedene Pflanzen- und Tierarten führt. Die konventionelle Erzeugung landwirtschaftlicher Produkte sowie die Methoden und Praktiken ihrer Anwendung sind der Grund für die starke Beeinträchtigung der biologischen Vielfalt, der Bodenerosion, der Verringerung des Wasserpotenzials sowie einer Reihe von Ökosystemleistungen.

In Bulgarien befindet sich die Forschung zu wirtschaftlichen und anderen Fragen im Zusammenhang mit Agrarökosystemleistungen in einem Anfangsstadium (Kazakova; Nedkov; Nikolov; Todorova; Bachev; Grigorova und Kazakova; IAOS; Yordanov et al.; Chipev et al.). Bis auf wenige Ausnahmen gibt es praktisch keine Untersuchungen zu den vorherrschenden Formen des Managements von Agrarökosystemleistungen im Land (Bashev; Bashev et al.; Bachev, 2021; Todorova).

Die vorliegende Arbeit zielt darauf ab, die Auswirkungen der Umsetzung von Ökosystemleistungen auf die Landschaftsgestaltung in landwirtschaftlichen Betrieben zu untersuchen und das Verständnis für die Auswirkungen der vielfältigen agrarökologischen Ökosystemleistungen auf die Agrarlandschaft zu vertiefen.

STICHWORTE: agrarökologische Dienstleistungen, Landschaft, Auswirkungen, Umsetzung

RÉSUMÉ

Plus d'un tiers de la surface totale de la Terre est utilisé pour l'agriculture et le pâturage, ce qui entraîne des taux alarmants de conversion des terres et de perte d'habitat pour diverses espèces végétales et animales. La production conventionnelle de produits agricoles ainsi que les méthodes et pratiques d'application sont à l'origine des taux élevés de détérioration de la biodiversité, de l'érosion des sols, de la réduction du potentiel hydrique, ainsi que d'un certain nombre de services écosystémiques.

En Bulgarie, la recherche sur les questions économiques et autres liées aux services agro-écosystémiques n'en est qu'à ses débuts (Kazakova ; Nedkov ; Nikolov ; Todorova ; Bachev ; Grigorova et Kazakova ; IAOS ; Yordanov et al. ; Chipev et al.). À quelques exceptions près, il n'existe pratiquement aucune recherche sur les formes dominantes de gestion des services agro-écosystémiques dans le pays (Bashev ; Bashev et al. ; Bachev, 2021 ; Todorova).

Cet article vise à étudier l'impact de la mise en œuvre des services écosystémiques sur l'aménagement du paysage dans les exploitations agricoles, ainsi qu'à approfondir la compréhension de l'impact des multiples services écosystémiques agroécologiques sur le paysage agricole.

MOTS CLÉS: services agro-écologiques, paysage, impact, mise en œuvre

INTRODUCTION

The ecosystemis a system consisting of biotic and abiotic components that function together as a unit. Biotic components include allalivecreatures, while the abiotic components are non-living things. Thus, the definition of ecosystem science includes an ecological community consisting of different populations of organisms that live together in a particular habitat.

Essentially, the definition of an ecosystem in biology is that it acts as the basic unit of nature. Just as a living organism is made up of cells that act as the structural and functional units of life, nature is also made up of basic units called ecosystems.

In fig. 1 presents the structure of ecosystems, which shows the interrelationship between its individual components.

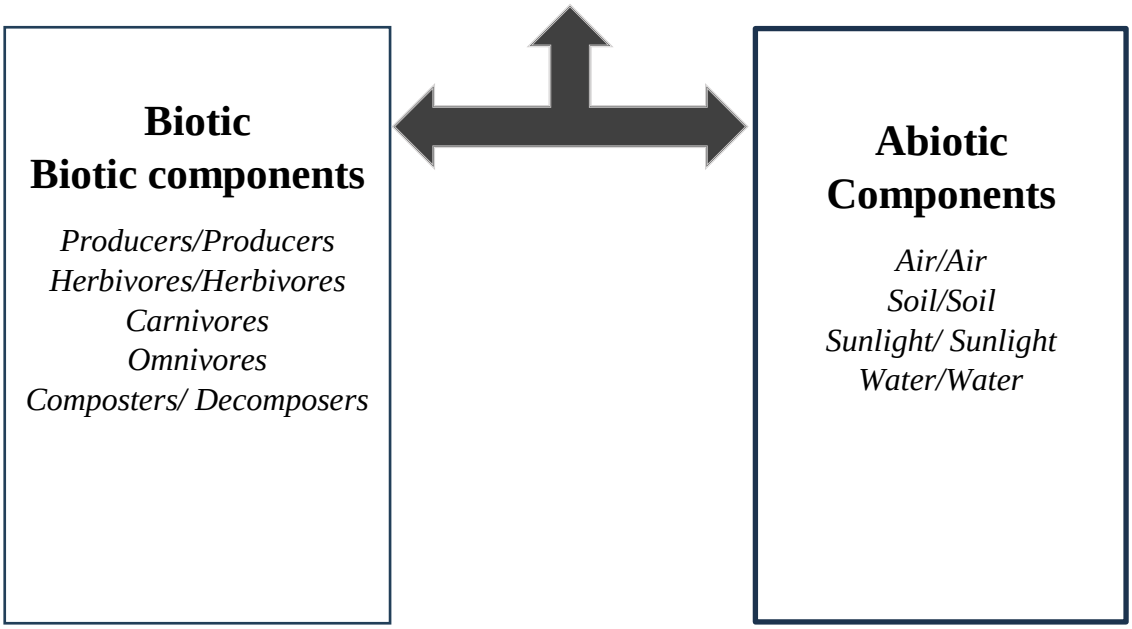
Ecosystem services are products and other benefits that people receive from natural ecosystems (MEA, 2005). Or it can be summarized that ecosystem services are the benefits that people receive through their interactions with nature. These benefits are linked to several metrics such as people's quality of life, need for food, water, health, security and livelihoods, to cultural and spiritual significance, including identity, that people acquire through their relationship with ecosystems. A large part of agroecological ecosystem services are applied precisely in agriculture. Although the primary purpose of agriculture as a sector of the economy is food production, in recent times farmers have been encouraged to provide a wide range of ecosystem services to meet the needs of the population.

Agricultural landscapes are seen as interconnected social-ecological systems and are the result of the interaction between the biophysical and social environments. Therefore, the combination of factors such as climate, geology and ecology, as well as management practices, technologies, skills, institutions and public demand leads to the provision of the influence of ecosystem services on the construction of the landscape in agricultural holdings.

According to the authors Zhang W., Ricketts TH, Kremen C., Carney K. & Swinton SM (2007), depending on how farms are managed, agriculture can be the source of many harmful methods and practices, resulting in lead to loss of wildlife habitats, soil and air pollutants, sedimentation, greenhouse gas emissions, pesticide poisoning, and more. Any trade-offs related to the use of appropriate agricultural

management methods and practices are critical to realize the benefits of ecosystem services and reduce environmental damage.

Figure 1. Ecosystem structure. Source: author's work



Agroecosystem services can provide farmers and societies with a set of different rules, divided into two groups:

- Governing Rules. These include flood control, water quality control, soil carbon storage, climate change mitigation, pesticide use reduction and appropriate crop management.
- Cultural rules could include education, recreation, tourism, vitality of the area and others. Biodiversity conservation can also be considered a cultural ecosystem service influenced by agriculture Daily GC (ed.) (1997).

Swinton SM, Lupi F., Robertson GP& Hamilton SK (2007) conclude that the conversion of natural habitats to cropland can on the one hand have a strong impact on the ability to produce important ecosystem services, but on the other hand many agricultural systems also can be important sources of certain services. Agricultural land use can be considered as a certain intermediate stage in human development between natural and agricultural ecosystems.

RESEARCH METHODOLOGY

According to Bashev (2020), "Agrarian" ecosystems and "agrarian" ecosystem services are those related to agricultural "production". The hierarchical system of agroecosystems includes multiple levels (from individual agricultural plot/plot, area, microdistrict, macrodistrict, etc.), while their (ecosystem) services are classified into different categories (sustaining, economic, recreational, aesthetic, cultural, educational, conservation of biodiversity, water treatment and retention, flood and fire protection, climate regulation, etc.) (MEA). The term "management of (agro)ecosystem services" refers to the

management of human actions and behaviors related to the conservation, enhancement and restoration of ecosystems and ecosystem services (Bachev 2021).

The present study aims to deepen the understanding of the application of multiple agroecological ecosystem services on the shaping of agricultural landscapes. Measuring the value of ecosystem services and ensuring an efficient level of their provision requires three main approaches in the application of agroecological ecosystem services (Polasky S.. 2008).

- Provision of agroecological ecosystem services ("ecological production function");
- Determining the value of agroecological ecosystem services ("valuation");
- Development of policies, tools for effective provision of agro-ecological ecosystem services ("incentives, management").

Regarding the first approach, a number of scientists and ecologists have been engaged in research for decades to improve the understanding of how ecosystem services are produced (Costanza et al. 1997; Daily 1997; MEA 2005). Basic knowledge of ecosystem structure and function is constantly increasing, yet we know considerably less about how these factors determine the provision of the full suite of agroecological ecosystem services to an individual ecosystem (NRC. 2005). A better understanding of the processes that influence agroecological ecosystem services will allow predicting the results of their implementation, taking into account their specific characteristics and, accordingly, the negative impacts on them. This means that a "green production function" can be generated. In practice, most "ecological production function" studies focus on the provision of one or two well-understood and researched ecosystem services. Thus, as a result of analyzing the various processes, the predictability of the application of ecosystem services on the agricultural landscape will increase. Despite much research, this is one area that needs significant attention.

According to the second approach, determining the value of agro-ecological ecosystem services usually uses a market, but may also use a non-market valuation. Valuing the services resulting from agricultural activities is a relatively easy task because agricultural goods are traded in different markets. Individually, some ecosystem services provide a high contribution to agricultural production, and their value can be measured by assessing the change in the quantity or quality of agricultural production, as a result of increasing, decreasing or removing some services. This approach has been used to estimate the value of pollination services and biological control services (Gallai N., Salles JM, Settele J.& Vaissiere BE. 2009). Additionally, the values of such services can be easily determined by comparing the opportunity costs: different substances, pesticides that will replace natural pest control. The other main method is the use of non-market valuation. It can be based on a certain consumer choice - behavior or a certain attitude as a result of marketing research. Thus, as a result of these studies, for a certain "conditional" evaluation or attitude, consumers are asked what they are willing to pay for the implementation of the agroecological ecosystem service of their choice. The important thing here is to understand the views of agricultural producers as farmers: what they would be willing to accept in exchange for the provision of a certain ecosystem service (Swinton SM, Lupi F., Robertson GP& Hamilton SK. 2007).

One of the main difficulties in managing agro-ecological ecosystem services is that those who provide such services do not always benefit from them. Many ecosystem services are synonymous with public goods. Although farmers benefit from various ecosystem services, their activities can greatly affect the provision of services to third parties who do not control their production. An example can be given with: the impact of different agricultural practices on the conservation of water resources, pest population and many others. Therefore, the main goal of measuring and valuing ecosystem services is to use this

information to create and implement certain policies and specific incentives for farmers for better and efficient management of both agricultural holdings and limited natural resources.

In the implementation of the third approach, namely the development of policies, tools for the effective provision of agro-ecological ecosystem services ("incentives, management"), the stimulation of farmers can be in the form of government payments for the provision of agro-ecological services or initiatives of various private organizations by implementing environmental programs (Swinton SM. 2008). Agro-ecological schemes aim to mitigate the negative environmental effects of intensive farming by providing financial incentives to farmers to adopt environmentally friendly farming practices. In the US, they provide support for investments in soil conservation and other easily observable practices to maintain or enhance certain ecosystem services, as exemplified by the Farm Bill's Security Protection Program of 2002. Many European countries also provide government support for environmental clean agricultural practices that support ecosystem services. A recent evaluation of over 200 field pairs in five European countries showed that agri-environmental programs had a small to moderately positive impact on biodiversity, but largely failed to protect rare or threatened species (Kleijn D., et al. 2006).

RESULTS AND DISCUSSION

Agri-environmental services have been identified as a practice that can be supported through the eco-schemes under the first pillar of the Common Agricultural Policy (CAP). They are also highlighted as some of the sustainable farming practices that can help achieve the goals of the European Green Deal and the related Farm-to-Fork and Biodiversity strategies. Under Horizon 2020, the EU funds several research projects dedicated to the development of agroecological research. These projects contribute to a better understanding of the practical implementation of ecological and low-intensity agricultural practices, as well as their benefits for the environment, climate and society.

Types of agroecological ecosystem services and the impact on the construction of the agricultural landscape

Almost 40% of the earth's surface is associated with agricultural production: cultivation of agricultural crops, production, grazing of livestock, allowing enormous opportunities for humanity and increased economic development (Ramankutty, N., Evan, AT, Monfreda, C., and Foley , JA 2008). Different types of agroecological ecosystem services generate different impacts on the agricultural landscape. There are a number of studies in this direction that compare different types of agro-ecological systems and the services they offer. An example of this can be given with conventional monoculture production and organic farming, in particular the effects that agricultural intensity has on biodiversity and ecosystem services (Björklund, J., Limburg, KE, Rydberg, T. 1999). Other studies present comparative analyzes between small and large farms and focus on factors such as: productivity (Lele, M., and Agarwal, U. 1990), soil erosion and loss (Essiet, EU 1990), diversity of different bird species and plants (Andersson, E., and Lindborg, R. 2014), and not least adaptation to climate change. However, none of these examples provide what the impact of implementing ecosystem services would be on the agricultural landscape and the environment. Simultaneous assessment of multiple agroecological ecosystem services is necessary to understand the interrelationships between individual services, how they respond to change, such as management innovations, but also how a change in one service affects all others (Bennett, EM, Peterson, GD, and Gordon, LG 2009). The types of agroecological ecosystem services are:

- Pest control- biological pest control in agroecosystems is an important ecosystem service that is often supported by natural ecosystems. The non-crop landscape provides the habitats and diverse food resources required for arthropod predators, insectivorous birds and microbial pathogens that act as natural enemies of agricultural pests and provide biological control services in

agroecosystems (Tscharntke T., Klein AM, Kruess A., Steffan -Dewenter I.& Thies C.. 2005) These biological control services can significantly reduce pest and weed populations in agriculture, thereby reducing the need for pesticides. Natural pest control services have been estimated to save about $13.6 billion annually to US farms (Losey JE& Vaughan M.. 2006) This estimate is based on the estimated value of crop losses from insect damage as and the cost of insecticides. Studies show that insects account for approximately 33% of natural pest control (Hawkins BA, Mills NJ, Jervis MA& Price PW1999);

- Pollination- pollination is another important agroecological ecosystem service for agriculture that is provided by natural habitats in agricultural landscapes. About 65% of plant species require pollination. An analysis of data from 200 countries shows that for 75% of crops of global importance for food production, farmers rely primarily on insect pollination (Klein AM, Vaissiere BE, Cane JH, Steffan-Dewenter I., Cunningham SA, Kremen C. & Tscharntke T.. 2007). Very often, crops of economic importance to honey bees also have wild insect pollinators. Of the most important crops pollinated by insects and animals, over 40% depend on wild pollinators. The economic impact of insect pollination on world food production in 2005 in the 162 FAO member countries was estimated at €153 billion, but the vulnerability to loss varied across geographic regions (Gallai N., Salles JM, Settele J. & Vaissiere BE. 2009).
- Protection of water resources- the provision of sufficient quantities of clean water and the level of quality is an essential agro-ecological service. According to various data, about 70% of global water consumption is consumed in agriculture. Perennial vegetation in natural ecosystems such as forests can regulate the retention, infiltration, and flow of water across the landscape. Vegetation cover plays a central role in regulating water flow by retaining soil and modifying its structure. Forest soils tend to have higher infiltration rates than other soils, and forests reduce flooding while maintaining constant inflow levels (Maes WH, Heuvelmans G. & Muys B.. 2009).
- Another type of agroecological ecosystem service is the availability of water in agroecosystems, which depends not only on infiltration and inflow, but also on soil moisture retention. With climate change, increased variability in rainfall is predicted to lead to greater risk of drought and flooding, in addition to higher temperatures increasing demand for water. Farm management practices can significantly alter this water scarcity. By changing the way of soil cultivation or introducing mulching, water evaporation can be reduced by 35-50%. (Stefanie Rost) and others predict that global crop production could increase by nearly 20% as a result of implementing water management practices on farms;
- Soil condition– the soil with its structure and fertility provides essential ecosystem services for agroecosystems.Well-aerated soils rich in organic matter are fundamental to crop nutrient uptake as well as water retention (Zhang W., Ricketts TH, Kremen C., Carney K. & Swinton SM 2007). The structure, soil aggregation and decomposition of organic matter are influenced by the activity of bacteria, fungi and macrofauna (earthworms, invertebrates, etc.). Agricultural management practices that degrade soil structure and soil microbial communities include mechanical plowing, discing, cultivation, and harvesting, but management practices can also protect soil and reduce erosion. Conservation tillage and other soil conservation measures can maintain soil fertility by

minimizing nutrient loss. Incorporating crop residues can maintain organic matter in the soil, which aids in water retention.

CONCLUSION

Agriculture as a whole system provides a variety of agro-ecological ecosystem services that are essential for human well-being. They also provide and use a range of other ecosystem services, including regulating services. Maximizing the provision of agroecosystem services can lead to the enhancement of other ecosystem services, but careful management can greatly reduce or even eliminate harmful effects. Agricultural management practices are key to realizing the benefits of ecosystem services and reducing harm from agricultural activities. These challenges will be magnified as a result of climate change. Our ability to estimate the value of different agroecological ecosystem services will increase the potential in analyzing future agricultural management.

Applying agri-ecological system services is a holistic approach that supports sustainable agricultural production while caring for the environment—it works with nature and ecosystem services, increases the resilience and diversity of farms, and has the potential to lead to a complete transformation of agriculture and food. systems. Agro-ecological system services influence a range of agricultural practices, from the breeds and varieties used to soil management practices and crop diversification strategies, to integration into value chains and business models that can support locally adapted practices and to provide greater market opportunities for farmers and consumers. Examples of agricultural practices applying agroecological principles are organic farming, agroforestry and mixed farming.

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