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## Designing the network of ecological corridors among organic farms in South Bačka district of Vojvodina Province

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### Introduction

In the predominant agricultural area such as Vojvodina Province the main threat to biodiversity is the fragmentation of nature habitats. Biodiversity decline started with the large scale clearing of forest and wetlands and expansion of the agricultural. Recent biodiversity deterioration is linked with the intensive management used in conventional agriculture. Protected areas, as main source of biodiversity, covers approximately 5,5% of total of 2.150.600ha land in Vojvodina Province that is considered as insufficient for species expansion. Under the artificial cropping systems cultivated and weed species suppress native vegetation and inhibit its proliferation.

Sufficient number of terms are associated with eco corridors that might lead to terms misuses. They differ in relation to the ecological significance, environmental protection, landscape and spatial planning and relationship with sustainable agriculture systems. The following terms are used for the plant belts: (i) **eco corridors** aims to link protected ecosystems with biological corridors and allow migration of plant and animal species, (ii) **protective-insulation belts** primarily represent the spatial isolation i.e. living belt between the surface under organic and the surfaces under conventional agriculture production. The main purpose of this belt is to prevent the influence of the application of synthetic agents that are used in the environment of organic production. (iii) **Buffer zones** are areas that provide and maintain the function of the protected zones and have special significance for geo-systemic balance. These are areas that are raised around potential sources of contamination i.e. all those objects that endanger the environment. This model in agriculture contributes to the protection from wind erosion.

Formation of the protective-insulating belt in organic production represents a legal obligation to which the organic crop must be separated or isolated from crop under conventional production. Family farms organized according to the principles of organic production represent micro-ecosystems with its own biodiversity, and are core areas for biodiversity expansion among the agriculture areas.

The main objective of this study is to assess the relationship between core areas, which in this case are family organic farms, and biological corridors and to allow proliferation of plant and animal species. Based on the established link between the core areas and corridors, we propose ecological networks with a permanent connection. The idea is to emphasize development of an ecological network which will be gradually established in the future.

### **Background/Literature Review**

Ecological planning in agriculture is an environmentally friendly approach to the entire area and its surroundings, and it is defined as the use of insulating belts, mixed crops and floral belts with diverse plant species that serve as habitat for beneficial insects and birds.

According to The German Federal Agency for Nature Conservation (Bundesamt für Naturschutz – BfN) farming has made the landscape more diverse, fostered biodiversity and shaped the cultivated landscape for many centuries. Since the 1950s, however, farming has become more intensive and many marginal sites have been abandoned. This caused extensively farmed ecosystems to disappear together with animal and plant species that had adapted to them. To counter this trend, a target has been adopted under the Convention on Biological Diversity (CBD), with areas under agriculture to be managed sustainably by 2020 in order to ensure conservation of biodiversity. According to the National strategy for Biodiversity genetic resources in Serbia are rich and include a number of native varieties of cultivated plant species and breeds of domestic animals. Genetic resources that are important for the food production are kept in traditional agricultural systems or in *ex-situ* conditions.

Agri-environmental measures (AEMs) are a voluntary scheme in which farmers accept to follow nature and environment-friendly farming practices that go beyond legal requirements. The BfN agri-environmental encompasses a wide range of measures such as organic farming, reduced use of synthetic inputs, management of grassland in accordance with nature conservation objectives, contractual nature conservation management agreements, landscape and habitat conservation measures, setting aside arable land. Those are sometimes described as ‘light green’ AEMs. In contrast, ‘dark green’ measures are those with a strong positive impact in terms of conserving and promoting biodiversity. Examples include leaving field borders uncultivated, turning arable land into extensively grazed grassland, and conserving orchards and hedges.

According to FiBL there are 43,7 million hectares of organic agriculture including inconversion areas. The collection of wild harvested crops (including

beekeeping) is on 37,4 milion hectares in 2014. Increased participation of world countries in organic production indicates that world public shows a growing interest in nature conservation and human health. Increasing demand for healthy food in Serbia led to the conversion of conventional farms to organic, which significantly contributed to increasing the overall sustainability of agricultural production (Lazić and Šeremešić, 2010).

Therefore, organic farming can make a substantial contribution in enriching our biodiversity and protecting it from further degradation. This is because sound management, enhancing biodiversity and stimulating the biological processes of the farm ecosystem plays a central role to all organic farming concepts and practices. Organically farmed areas usually have a much higher abundance and diversity of micro-organisms, plants and animals. Three broad management options are particularly beneficial to farmland biodiversity: prohibition/reduced use of chemical pesticides and inorganic fertilisers; sympathetic management of non-crop habitats and field margins and preservation of mixed farming (Hole *et al.*, 2005).

Development of bio-agro-technical measures applicable in ecological production systems, primarily in organic production, will underline the importance of various protective - insulation belts in protection of specific plant species and agro-ecosystems (Ugrenović and Filipović, 2012).

### **Method(s)**

Protective-insulation belts at South Bačka district of Vojvodina Province are used sporadically and because of it this is the first issue that this paper refers to. At each organic farm protective-insulation belts are obligatory measure and should be established from bioactive plants with attractant influence sown and planted in strips 1-2m in width at the margins of the farm or crop, or lengthwise, dividing crop every 50 to 100m (Vucković, 2008).

The recommendation from BfN is that increased cultivation of native protein crops can help to the conservation of natural biodiversity and the genetic diversity used in farming. As well as having beneficial uses for agricultural biodiversity, for instance as an important food source for pollinators, protein crops have a particularly strong positive impact on nitrogen fixing in the soil, humus enrichment, erosion prevention and soil water storage capacity.

Eco corridors are mostly established in lowlands, like Vojvodina, where the dominant activity of the population is agriculture. Secondly this paper referes to eco corridors as a network among organic farms at South Bačka district of Vojvodina Province. As protective-insulation belts established at organic farms

are the initial point of this network, ecological corridors are those who connect these links. Of specific interest is to establish the connection of organic farms with natural or semi-natural habitat in its surrounding.

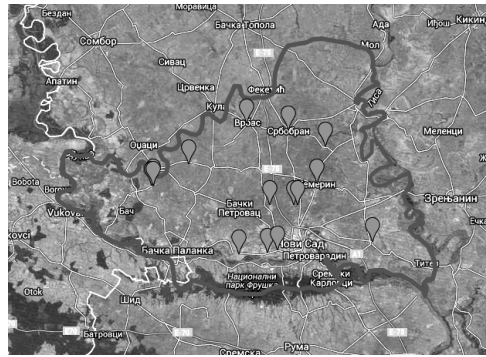
Regarding the relief there are three types of ecological corridors: (i) **tunnel type** (ii) **type overpass** and (iii) **line type**. Generally, suitable for Vojvodina lowland are green corridors established in accordance with the principles of planting the line corridors. These are long, uninterrupted strips of vegetation, such as hedges, strips of forest, and the vegetation growing on banks of rivers and streams. However Vojvodina today can be considered as “combed panel” of monoculture with rarely existing wild vegetation. Alternatively stepping stone corridors will be recommended as series of small, non-connected habitats which are used to find shelter, food, or to rest.

As this paper is starting point for further research, in the first phase general floristic research is planned as well as collection and determination of plants according to Josifović (ed.) (1970 to 1986) and Tutin (ed.) (1964 to 1980) and also plant number assessment (Braun-Blanquet, 1964) which would allow an insight into the current state flora diversity at the study sites.

## Results

The rural landscape is transformed by the increase in intensive farming that has resulted in a dramatic decline in riparian zones and has been a detriment to agroforestry areas. The estimated area of the forest is 140.717,68 ha i.e. 6,51% land of Vojvodina Province. Regions with lower soil fertility suitable for meadows and pastures are progressively replaced by cash crop, that put additional pressure on soil properties. However most biodiversity loss and soil quality deterioration comes from intensive cropping and agrochemicals.

According to the Ministry of Agriculture and Environmental Protection total organic vegetable production in Republic of Serbia is conducted on over 9.500ha, of which Vojvodina takes over more than 5000ha. South Bačka district is known for the production of organic vegetables and farms are spread throughout the district (Figure 1). Development of eco corridors that will link organic farms at South Bačka district of Vojvodina Province will contribute to the migration of wild species. Protective-insulation belts and eco corridors will serve as habitats and places where wild species will find shelter and food. This type of network will have multiple yet complementary purposes. The network will have a direct human benefit providing the possibility of using the corridor as greenways suitable for plain walking and cycling country areas. Wherever possible, corridors will be placed along contry roads to enable usage in recreational purposes. Also, this will be a way to link existing alleys together.



**Figure 1. Map of organic farms in South Bačka district of Vojvodina Province**

Agro-ecosystems, rich in biodiversity, will be connected with biological corridors what will contribute to the integrity of the farms. Additionally, these corridors will contribute to beekeeping since 80% of plants are pollinated by insects, and the stake of bees in the pollination of plants is great. In the pollination of fruits, vegetables and forage crops bees account for about 90% (Jaćimović, 2006; Jaćimović et al., 2012; Jašmak, 1980).

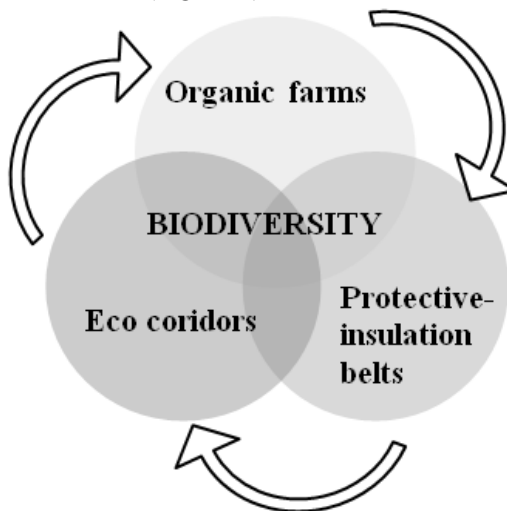
For fields that are close to conventional production protective-insulation belts can be established of plant species that have robust aboveground mass and grow in height (e.g. Fennel) for more effective protection. Plant species that attract honeybees and bloom successively during the year are recommended for isolated parts of farm (family *Asteraceae*, *Polygonaceae*, *Apiaceae*).

Good example is an international biodiversity program Operation Pollinator. It works by creating specific habitats, tailored to local conditions and native insects. According to their Growers Guidelines (2013) belts around farms could be established from different seed mixtures. These are some of the them: (i) **standard mix** (20 kg/ha) provides a good source of pollen and nectar and some cover for many species and attracts a wide range of insects. (ii) **Legume + wildflower only mix** (12 kg/ha) provides a lot of pollen and nectar to attract bumble bees and other bees. (iii) **Tussocky with flower mix** (20 kg/ha) provides a denser and thicker margin, and good habitat for small mammals. It also provides pollen and nectar to attract a wide range of insects. Additionally this mixture can be used to protect watercourses from agricultural runoff.

Due to the extremely small area under the forests and forestland of Vojvodina and great potential for agriculture eco-corridors should be planned according to the principles of raising shelterbelts. Traditional wind protection belt consists of three or more rows of trees and shrubs, of which at least one row

should be composed of dense conifers. Most often, the distances are as follows: 2 to 7m for deciduous trees, 3 to 6m for conifers and 1,5 to 3m for shrubs. Spacing between these rows is usually 3,5 to 5 meters.

Ability of protective-insulation belts and eco corridors to provide sufficient funds for living to insect and other species have a direct impact on the size or number of population. The availability of food and habitat are key determinants in achieving all phases of the life cycle. Agro-ecosystems provide habitats to insect, birds and other species thus significantly increase biodiversity and promotes real benefit to the environment. In this cycle farmers continue their efforts efficiently, productively and profitably in the most productive agricultural areas (Figure 2).



**Figure 2. Ecological network cycle of biodiversity**

### **Discussion/ Conclusion**

Nowadays, it is recognized that in landscape planning greenways have evolved towards a multipurpose approach: “Greenways are systems and/or networks of protected lands that are managed for multiple uses including: nature protection, biodiversity, management, water resources, recreation, and cultural/historic resource protection” (Ahern. 2002).

Ecological networks are understood as the basic landscape system governing the functioning of the natural dynamics, with specific aptitudes for human activities and having multiple yet complementary purposes, such as agro-forestry, conservation of natural and cultural heritage, leisure activities and tourism (Andresen et al, 2005).

Greenways planning system is known since the 1970s. However, in the absence of a long-term strategy for the development of biodiversity, spatial planning and agriculture in Serbia, greenways and ecological networks approach is used sporadically. Our paper discuss this type of network, that is used in agriculture, for the first time because it is considered necessary to inform the public to the benefit of this approach and its wide implementation not only within the farm as a "protective fences", but also as a holistic system of spatial planning of landscape.

Eco corridors and protective-insulating belts will contribute to raise awareness of agriculture production in accordance with nature conservation. Not only are the rates of urban growth accelerating, but the patterns of urban expansion was become more dispersed. In future, more sustainable approaches must be considered for areas where the agricultural landscape is threatened by land use change. Although study has examined the land use change and landscape fragmentation, attention has focused on the potential use of protective-insulation belts as initial links in the chain of eco corridors and their capacity to improve the connectivity between organic farms.

Vojvodina is a region with a fertile soil and it fields could meet the entire needs for food of the Republic of Serbia. This great potential should be used for the mutual benefit of both man and nature. Organic food production on small family farms is the perfect way to connect shared interests. As stated above the recent studies (Ugrenović and Filipović, 2012; Hole *et al.*, 2005) show that belts used in organic production have great impact to biodiversity. This would help to protect the environment and encourage biodiversity in South Bačka district. Also it should emphasize the impact of this type of network on a larger green system. Vojvodina occupied more than half of organic production of Republic of Serbia therefore south Bačka district ecological network can represent core area of biodiversity and the initial point for the spread of ecological networks at the whole region of Vojvodina.

The wide introduction of protective-insulation belts to certified farms could be a very effective method of enhancing biodiversity. Until now mixtures of annual, biannual and multiannual species were used, but the introduction of eco corridors as a link in the chain provides an opportunity for diversifying the species that can inhabit these areas.

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