FOLIA OECOLOGICA – vol. 43, no. 2 (2016). ISSN 1336-5266

Share of scattered woody vegetation in landscape ecological stability and agriculture sustainability

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Abstract

Supuka, J., Uhrin, P., 2016. Share of scattered woody vegetation in landscape ecological stability and agriculture sustainability. *Folia Oecologica*, 43: 193–203.

Scattered woody vegetation in the agricultural landscape includes more or less fragments of original biotopes and cultivated cultural vegetation as are groves, windbreaks, and infiltration forest belts on slopes, tree alleys, as well as orchards and vineyards. The contribution describes their effectiveness in agriculture sustainability through defined categories of functions and services. At the studied territory, the development of landscape structure was assessed in three time periods of 1869, 1949 and 2010s with regard to the share of scattered vegetation and woody species composition. In 2010, 23 vegetation formations were surveyed, from these 20 are in linear formations and the others in areal formations. Regarding species composition, 47 woody plant species were identified, from these 28 native, 12 alien and 7 fruit trees. The share of scattered vegetation has been proposed to be increased from 5% to 6%. The studied scattered vegetation should be considered as an important contribution to biodiversity conservation, climate, water and soil quality amelioration, pest and disease control and finally crop yield increasing.

Key words

agriculture landscape, scattered woody vegetation, sustainable support

Introduction

Agricultural landscape of Slovakia has passed over many changes during the last 50 years related to land ownership, technologies of agriculture and landscape structure. The wide-ranging land consolidation of small private plots to large cultural blocks ranging from an area of 10 to 200 ha is visible in structural landmarks. Industrial chemicals as fertilizers, pest and diseases control as well as large agricultural machines and tools were involved during the intensification process. The arable land share reached up to 70%, less on uplands and more in lowlands and a new surface water system was constructed and managed. Many wetlands and marches as specific biotopes were drained (Supuka et al., 2013).

Such substantial changes have reflected on the improvement of crop yield production, but were accompanied with many negative factors impacting underground water, soil quality and climate characteristics. Similar situation related to agriculture intensification, land consolidation and successive landscape structural changes have passed in developed western countries as is described by Forman and Godron (1986).

A significant decreasing of scattered woody vegetation after land consolidation has caused potential

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and real damages to agricultural land by surface erosion, when 47.7% of the overall agriculture land is endangered by water erosion and 6.2% by wind erosion (Grešová and Streďanský, 2011; Miština, 2009). Soil erosion and large scale land structural changes have decreased of ecological stability and agriculture sustainability. With an effort to reduce this degradation features of predominantly lowland countryside in the sense of wind erosion and decreased ecological stability, 6,082 ha of linear woody vegetation were planted as windbreaks in the period between 1950s and 1964s, later between 1980 and 1989, 800 km of linear-form woody vegetation were planted in Slovakia (Zachar and Tešliar, 1989). In the present, the scattered woody vegetation achieves different proportions depending on land use forms, relief conditions and historical development of the landscape.

In the hilly region of Kysuce, more than 10% of share in landcover was inventoried (Špulerová et al., 2011). In lowland of Trnava region on 11 cadastal territories, a share of 1–4% was identified (Hreško and Guldanová, 2012). The optimal areal share of scattered vegetation in the agriculture landscape of Slovakia was stated of 3–7% for lowlands and 8–12% for hillands according to different relief and land-use conditions (Supuka et al., 2008). In many European documents e.g. High Nature Value Farmland (HNVF) as a part of the European Environmental Agency (EEA), there is recommended close to 7% share of scattered woody vegetation (Andersen et al., 2004; Špulerová et al., 2011).

Concerning woody plant species composition in linear-form vegetation at south-western Slovakia, 56 deciduous woody plant species were identified and from these 19 native and 21 alien species (Varga et al., 1999). At the Žitný ostrov near the Danube River, 28 woody plant species were identified in 19 windbreaks, from these 11 species were alien (Supuka et al., 2013).

The scattered woody vegetation in agricultural landscape is an important contribution to water balance regime as was described in Nete catchment of Belgium (Staes and Meire, 2007). Decreasing of forest cover, scattered woody vegetation and permanent grassland in landscape has had negative effect on erosion processes and deposition of floated sediments to the water basins (Yoo et al., 2014). Permanent vegetation formations and scattered forest remains as a complex of green infrastructure caused an increase in landscape connectivity, ecological stability and sustainability of agriculture through supporting and regulating services and inputs to the crop yields (Leal, 2004; Plieninger et al., 2006; Reyers et al., 2009; Tóth et al., 2016; Zhang et al., 2007).

Cultural and recreational services of permanent vegetation in different regions of agricultural landscape and its transmission zones are described by Pröpper and Haupts (2014), and Cieszewska et al. (2010). There is an evidence of aesthetic, cultural, historical and production functions of vineyard landscape through permanent fruit trees and vine plants (Supuka et al., 2011; Štefunková et al., 2011; Verešová and Supuka, 2012). Elements of scattered vegetation are also assessed as important features supporting an ecological and sustainable agriculture (Šarapatka et al., 2010).

Material and methods

For assessment of scattered vegetation in the landscape structure, the study territory of Oponice cadastre in the south-western part of Slovakia was chosen. In the first part of our contribution, we have focused on categorisation and content structure of scattered permanent vegetation as a result of continual land-use forms and features of current landscape structure (Supuka et al., 2013). The subsequent part is devoted to functions and service characteristics of permanent scattered vegetation and its penetration to the sustainable agriculture. For this chapter, published sources and our theoretical and practice accomplishment have been used (e.g. Reyers et al., 2009; Supuka et al., 2008; Supuka et al., 2013; Swinton et al., 2007; Zachar, 1982).

The last chapter is devoted to a survey and assessment of scattered woody vegetation in the study territory with an emphasis on landscape structure development and the share of permanent vegetation in this structure, space distribution and woody species composition. In this chapter, we describe the development and share of landscape elements within three time periods (1869, 1949, and 2010) with an accent on permanent vegetation at the studied territory of Oponice cadastre with a total areal cover of 1,232.55 ha. The location and boundary of the mentioned studied area are shown on maps (Figs 1, 2) and statistical area values of landscape elements are stated in Table 1. Landscape structure in the historical period of 1869 has been elaborated from the map document of the 2nd military mapping of the former Austrian-Hungarian Empire. Later periods were elaborated using the cadastral database and the aerial photo of 1949, next by using of remote sensing orthophoto map of 2010 (Figs 1, 2). Scattered woody vegetation was assessed with regard to external and internal structure and context. The internal characteristics involve areal and spatial landmarks (areal, linear, group and solitaire types), categories according to origin (natural, planted, mixed), and according to functions and land distribution (e.g. grove, orchard, windbreak, accompanying vegetation of roads and streams, tree alley, shrub hedge, etc.). Internal features of scattered vegetation represent the layer structure, area, density, average height and width, spatial composition, share, gene-pool and heritage values (Supuka et al, 2013; Tóth and Feriancová, 2014).

In the conclusion, functional importances of scattered vegetation for ecological stability and sustainable agriculture are described.

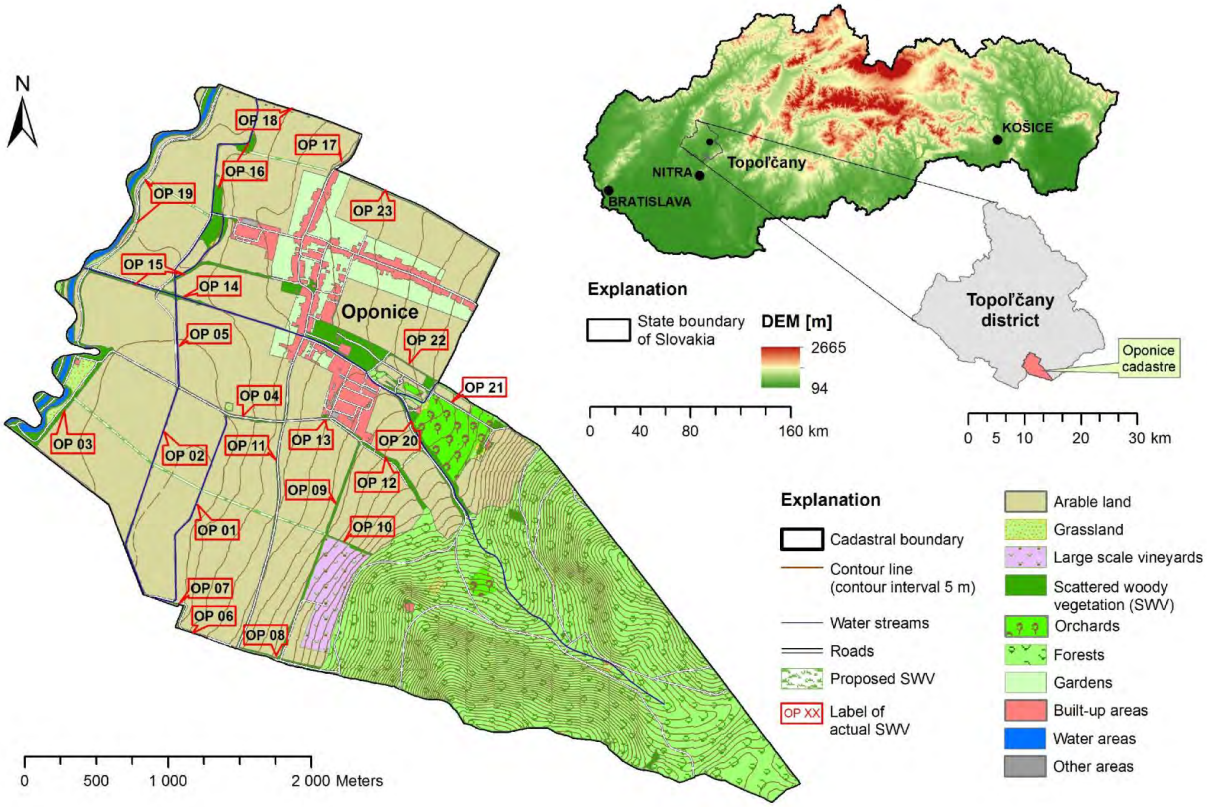

Fig. 1. Secondary landscape structure of Oponice cadastre in 2010 with regard to distribution of scattered woody vegetation, state and proposal (elaborated by Karol Šinka and Ján Supuka, 2014).

Fig. 2. Comparison of landscape structure of the Oponice cadastral territory by aeral photos in different time periods of a) –1949, b) – 2010 with regard to distribution of scattered woody vegetation (elaborated by Karol Šinka, 2013).

Table 1. Area of Oponice cadastral territory in historical land-use

Landscape element	Area in ha according to years			
	1869	1949	2010	Proposal
Arable land	665.82	685.60	647.92	642.97
Grassland	115.24	80.91	10.51	10.51
Orchads	0.00	0.00	20.15	20.15
Vineyards	0.00	15.66	18.82	18.82
Scattered woody vegetation	38.94	36.73	64.24	+4.95 69.19
Forests	362.52	334.94	362.23	362.23
Water streams and areas	11.25	21.58	13.96	13.96
Gardens	19.68	26.17	45.23	45.23
Built-up areas	14.41	22.60	43.50	43.50
Roads	4.69	8.36	9.49	9.49
Other areas	0.00	0.00	1.45	1.45
Sum	1,232.55	1,232.55	1,232.55	1,232.55

Results

Categories of scattered woody vegetation in the landscape

Scattered woody vegetation in the agricultural landscape should be categorised according to origin, spatial and areal composition, main functions, utility values and stand interior characteristics. Basically, they are divided to following categories.

Natural vegetation – this has been developed by natural successive ways on uncultivated land, extreme relief and dry or wet soil hydrology conditions without direct man intervention and management. In many cases, their character is similar to the potential natural vegetation with native woody plant species composition and herbs in stand undergrowth. They have group, areal and linear composition consisting of permanent grassland, shrubs and trees in vertical layers. In terms of ecosystem, they represent, more or less fragments of original biotopes with high ecostability and wild life biodiversity effectivness.

Semi-natural and synanthropic vegetation – most often grown on anthropogenic relief and land arranged areas as are terraces on boundary lines, along roads, bank side of water streams and basins, on dumping and disposal sites. This category also includes extensive and abandoned orchards, vineyards and woody plantations. Concerning the woody plant species composition, they consist of native and planted cultural species, varieties and sorts as mixed biotopes and plant communities. Former grasslands as part of woodlands have been regularly cut and represent therefore a very rich herb species composition with aesthetic perception qualities. They represent very effective biotopes, which keep and support wild animal biodiversity (birds and mammals), thanks to rich fruits as food sources and suitable habitats for wildlife and reproduction.

Cultivated cultural vegetation – arranged composed and planted woody vegetation, permanently or occasionally maintained. Regarding woody species composition, they consist of plants of native and alien, fruit, forest and landscaping importance. This category includes cultivated orchards, vineyards, biomass and energetic production plantations, windbreaks, infiltration forest belts on slopes, road and water body bank side vegetation, tree alleys as component of historical landscape structure, groves, rural parks, small groups and tree solitaires in the landscape, composed vegetation at farm yards, agritourism and recreation centres, gardens at cottages and village family houses and others.

In different geographical conditions, with different land-use forms, diverse formations of scattered vegetation and its combinations should be inventoried through historical periods. Very often, the occurred elements have a group form, diverse and mosaic form, with dominat solitaire trees, with dominat linear forms and or dominant areal composition. A special attention should be dedicated to old, oversized and rare species, as well as valuable utility trees occurring in the countryside and having an importance as gene pool and cultural heritage elements as well as recreation usage.

Functions and services of scattered vegetation in relation to sustainability of agriculture

In traditional classification approaches, the positive influences and importance of scattered vegetation in the agricultural landscape were defined as functions. Basically, they are divided to two categories as are natural and anthropogenic. The first group includes positive influences on abiotic landscape elements related to bedrock, soil, water and climate characteristics. Woody vegetation has improving effectiveness to quality and quantity properties, conservation and counterbalance

of mentioned elements. Regarding biotic elements, scattered vegetation supports and keeps the plant, animal and microbial biodiversity at the natural (wildlife) and cultural level (as cultural biodiversity). The second anthropogenic group includes economic functions related to agriculture, forestry, water, hunting etc. management and improving their production and yields. In the sphere of social anthropogenic importance, there are effective cultural, educational, researches, spatial, compositional and aesthetic functions.

Many scientists have been interested in research and consequent categorisation and definition of vegetation functions in the landscape. In a wider and general view, the activities in this field were focused on describing and defining ecosystem services, where the category of ecosystems and realised groups of services should be derived. Wider approaches regarding functions and services of vegetation are described in the so called Netherland Model, founded on nature function contributions for human society. Following functions are categorised in this schematic model:

Production functions – takes most important position founded on biomass and energy flow from nature resources to human society.

Carrier functions – ecosystem components including vegetation formations have been granted spaces for setting, dwelling, recreation etc.

Information services – related to information needs of human society as are spatial orientation and identification, research and education, culture and historical values.

Regulating services – consist of ability of natural and cultural ecosystems to regulate principal ecological processes and life supporting systems.

A similar approach to classification of ecosystem services with an emphasis on forest components has been described in the document of MEA (Millenium Ecosystem Assessment 2005) where they were divided to four groups. We have paid higher attention to these functional categories and service characteristics because scattered woody vegetation is a spatial fragment of forests having important effectiveness in landscape ecological stability and sustainable agriculture.

Supporting – support sustainable production features of internal and adjacent ecosystems and living spaces through photosynthesis and oxygen production, water and nutrient cycle, soil fertility and production potential as basic assumption for biology and agriculture production.

Provisioning – represent biological products and natural sources obtained from ecosystems, e.g. forest and agriculture, as are cultural crops, fruits, farm animal breeding and fishing, representing food production in a broad sense, energy and technical biomass, pharmacy plants, gene pool resources, etc.

Regulating – there are benefits from internal self keeping ecosystem ability and self regulation processes led into air and water quality, climate characteristics regulation, erosion, pests and diseases control, biodiversity regulation, insect pollination supporting and reproduction, habitats functioning and conservation.

Cultural – represents spiritual values and features reflected in human perceiving process. They involve spatial composition, aesthetic, cultural, historical and educational features, natural and cultural (tree) heritage, genius loci space or element, recreation supply, etc.

Regarding scattered woody vegetation, it represents a compositional component of the agricultural landscape ecosystem with long life span, supporting ecological stability, biodiversity, cultural visual landmarks and sustainable production potential. When describing positive effectiveness and contribution of scattered vegetation to sustainability of agriculture, we have to analyse functions and services according to certain criteria. We need to take into account a specific position of scattered vegetation in the landscape. It is not an independent landscape ecosystem but an important biological component in the entire agricultural ecosystem. On the other hand, an agricultural ecosystem has a mixed character composed by anthropogenic and natural or semi-natural elements. The agricultural landscape is under a continual management and maintenance involving subsidiary energy regime, alternating crop rotation resulting to land-use changes trough growing seasons, predominantly in arable land. Other biological, natural and cultural elements considered as permanent biotopes have been supporting and counterbalancing effectiveness in relation to annual crops and their growing environment. There are involved all categories of permanent grasslands and woody vegetation in different formations, original and managed in different intensity. They are relatively stable in internal meaning and have also stabilizing influences in course to the external space and to neighbouring cultivated crops and plants. Those are principal reasons why scattered woody vegetation is considered an important contribution to agricultural sustainability and landscape ecological stability.

General characteristics of functions and services of permanent woody vegetation are the basis for understanding its participation in agricultural sustainability of rural landscape ecosystems.

In this paragraph, we try to define main features of agricultural sustainability: a) rational and thrifty utilisation of natural resources; b) avoidance of soil, water and air pollution, their degradation under loading capacity and healthy limits; c) keeping and supporting biotic values, fertile capacity and production potential of soil; d) application of progressive technologies in land management, such as precision agriculture, organic and other alternative forms including integrated pest and disease control; e) organisation of optimal land use forms with equable share of landscape structure elements; f) increase in the share of ecology stabilising elements in the landscape as are scattered woody vegetation, permanent grassland and water network

elements; g) sustaining landscape diversity, gene pool and biodiversity with an emphasis on nature protection, specific habitats and biotopes of wild life; h) sustaining and supporting cultural and historical values, cultural biodiversity, aesthetic landmarks, objects and localities of cultural heritage; i) increase in the recreation potential, dwelling and life quality of the countryside; j) increase in food production and achieving food safety for people.

Assessment of landscape changes in the study territory with an emphasis on scattered vegetation and agriculture sustainability

The study territory within the period from 1869 to 1949 is characterised by small plots of agricultural land use farmed by individual peasants with simple technologies and animal power utility (see Fig. 2a). The southern part of the cadastral territory was arranged to larger size blocks of arable land, because that land section was owned by the lordship of the Aponyi family. Regarding landscape structure changes within the assessed period, the forest covered nearly 27%, and then this proportion has slightly decreased. A similar situation is shown in scattered woody vegetation, which in the first period covered 3.16%, during next period slightly decreased by 0.18%. Arable land as the dominant land use covered almost 54% and slightly increased by 1.60% (Table 1). The built up areas of the village have been under progressive development and also adjacent gardens as part of family houses. The western part where the River Nitra passes through the cadastral boundary was covered by permanent meadows and pastures and annually flooded by river. There is a visible a rapid decrease in the share of meadows decreasing from 9.35% to 6.56% during the surveyed periods.

Regarding ecological stability of the assessed cadastre, the representing landscape elements of this feature have been balanced and covered 41.93% (forests, grasslands and scattered woody vegetation). Small size plots in the northern part of the cadastral territory provided mosaic field structure and supported ecological stability partially. Oak-beech forest in the eastern part and flooding willow-poplar forest in the west, along the Nitra River as well as meadows and scattered vegetation contributed to ecological stability and it should be declared that also agriculture fulfilled almost all mentioned criteria of sustainability. No chemistry was used in agriculture, just simple technologies, hard work, low crop yields and low life quality, therefore at the turn of the 19th and 20th century, many people emigrated overseas to the "New World". The criteria of food safety and sufficiency, as well as social aspects of rural people were not fulfilled in that time.

Within the assessed period of 1949 and 2010, remarkable changes in the landscape structure arose. There was a considerable decrease in land cover of permanent grassland (6.56% in 1949 / 0.85% in 2010), partially also arable land (55.62% / 52.17%). The area of vineyards has slightly increased (1.27% / 1.53%), forest area has increased due to afforestation of shallow and unfertile soils (27.17% / 29.39%), a new large-scale orchard has occurred (0% / 1.63%). Built-up areas of Oponice village have increased rapidly (1.83% / 3.53%) and adjacent family house gardens (2.12% / 3.67%) as well as land cover of scattered woody vegetation due to planting new windbreaks and shelterbelts (2.98% / 5.21%) (Area values in hectares are stated in Table 1).

As reflection of agriculture intensification processes mentioned in the introduction of this article, the small size plots have been altered by large blocks of arable land (these achieved 50–150 ha), meadows have been drained up-ploughed, many linear-form vegetation along plot boundaries have been removed. On the other hand, new windbreaks and shelterbelts were planted according to the model of foreign countries. In spite of that, ecological stability and wildlife biodiversity have decreased, the cultural and visual aspects have changed and new landmarks and values have occurred. Progressive technologies and new techniques have influenced soil, water and air characteristics but rather in negative ways. On the other hand, the crop yield, food safety, and life quality of rural people have substantially increased.

At the studied area of Oponice cadastral territory, we have surveyed all categories of scattered woody vegetation and their woody species composition in 2012. There were inventoried 23 vegetation formations, of these 20 are in linear forms and the other are in areal ones. In terms of their origin, the 3 formations have been considered natural, 11 mixed and 9 of cultural character. At tree layer, 21 woody species were identified from those 6 alien and 5 fruit tree species. In the shrubby layer, 15 woody species were inventoried, from these 6 alien and 2 fruit shrub species. In the shrubby layer there also surveyed 10 woody species which belong to tree growth formations but achieved under 3 m height only according to inventory methods. The dominant tree species in the floodplain forest and at river banks were *Populus alba* L., *P. nigra* L., *Salix alba* L., *S. fragilis* L., *Alnus glutinosa* (L.) Gaertn. In windbreaks, the most common inventoried species were *Robinia pseudoacacia* L. (dominated in 15 line form woody vegetation), *Populus x canadensis* Moench., *Fraxinus excelsior* L., *Tilia cordata* Mill., *T. platyphyllos* Scop., *Ulmus leavis* Pall., *Acer platanoides* L., *A. pseudoplatanus* L., *A. campestre* L., *Negundo aceroides* Moench., *Cerasus avium* L. and other. In floodplain biotopes some bank sides of river streams are covered by remains of flooded forest with old and oversize trees of poplar (*Populus alba* L., *P. nigra* L.) and willow (*Salix alba* L., *S. fragilis* L.) species as important gene pool elements. Particular overview of woody plants occurrence according to non-forest woody vegetation formations from OP 1 till OP 23 (see Fig. 1) is given in Table 2 and Table 3 for tree and shrubby woody species separately.

Table 2. List of tree species and their frequency occurrence according to formations of the non-forest woody vegetation in Oponice cadastral territory

Tree species	Occurrence in formation of the non-forest woody vegetation (NFWV) according to map Fig. 1 = OP1– OP23																							
NFWV OP1 – OP 23	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	*FO
Acer campestre L.		+					+	+		+		+		+	+	+			+	+				10
Acer platanoides L.													+							+		+		3
Alnus glutinosa (L.) Gaernt.		+																	+					2
Cerasus avium (L.) Moench.								+	+	+				+	+				+	+	+	+	+	10
Fraxinus excelsior L.	+		+	+		+	+	+		+		+		+	+	+		+		+		+	+	15
Juglans regia L.	+			+					+	+	+		+	+	+	+	+	+	+			+	+	14
Malus domestica Borkh.														+					+			+	+	4
Morus alba L.															+					+				2
Negundo aceroides Moench.			+	+			+							+					+	+				6
Populus alba L.			+																+	+				3
Populus nigra L.													+						+	+				3
Populus tremula L.		+		+																				2
Populus x canadensis Moench.			+																					1
Prunus cerasifera Ehrh.	+			+	+									+		+							+	6
Prunus domestica L.	+			+	+					+			+	+								+	+	8
Prunus padus L.							+			+					+	+		+	+					6
Robinia pseudoacacia L.		+	+	+	+	+	+	+	+	+		+	+		+					+		+	+	15
Salix alba L.																+			+					2
Salix fragilis L.		+			+										+	+			+	+				6
Tilia cordata Mill.		+		+																+				3
Ulmus laevis Pall.		+	+		+		+	+												+				6
*FO	4	7	6	8	5	2	6	5	3	7	1	3	5	8	8	7	1	3	11	12	1	7	7	127

*FO, frequency of occurrence in NFWV formations.

Table 3. List of shrubby woody species and their frequency occurence according to formations of the non-forest woody vegetation in Oponice cadastral territory

Shrubby woody species	Occurence in formation of the non-forest woody vegetation (NFWV) according to map Fig.1 = OP1–OP23																							
NFWV OP1–OP 23	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	*FO
Clematis vitalba L.								+	+	+					+					+		+		6
Cratageus monogyua Jacq.	+	+			+		+	+	+	+		+	+	+	+	+	+	+	+	+		+	+	18
Cornus mas L.								+												+				2
Enonymus europaeus L.	+	+	+		+	+	+	+	+	+			+			+				+		+		13
Ligustrum vulgare L.	+		+		+	+									+	+				+				7
Prunus spinosa L.	+	+	+	+		+	+	+	+	+			+			+				+			+	13
Rhamnus catharticus L.		+																		+				2
Rosa canina L.	+	+			+	+	+	+	+	+		+	+	+	+	+	+	+	+	+		+	+	19
Rubus fruticosus L.								+		+			+	+	+	+		+	+					8
Sambucus nigra L.	+	+	+	+	+	+	+	+	+	+		+	+		+	+		+	+	+		+		18
Swida sanguinea (L.) Opiz	+	+								+			+							+		+		6
Symphoricarpus albus L.																				+				1
Syringa vulgaris L.								+																1
Ulmus minor Mill.								+																1
Viburnum opulus L.		+																						1
*FO	7	8	4	2	5	5	5	10	6	8	0	3	7	3	6	7	2	4	4	11	0	6	3	116

*FO – Frequency of occurrence in NFWV formations.

From the point of view of current woody species composition, it should be considered a very rich contribution to higher level of biodiversity, habitat conservation in plant and animal groups. A rich and variable biodiversity has a positive impact on insect pollination processes, regulation of pest and diseases and finally crop yields. Beside these positive landmarks there are many problems with *Robinia pseudoacacia* L. (black locust) because of its invasive growth manifestation, which is in conflict with principles of nature protection. Therefore, we propose to successively replace them by native forest trees and to add also more fruit trees to windbreaks for supporting animal wildlife. Spatial distribution of scattered woody vegetation contributes to an improvement of the water regime, mitigation of extreme climatic characteristics, as well as erosion control. In order to improve biotic, abiotic and social services of woody vegetation in the agricultural landscape, we have proposed to increase its share by 5.0 ha in order to reach near 6% and divide large-size arable blocks to smaller plots. This proposal should be also reflected by an enhancement of the cultural and aesthetic values and qualities of the countryside.

The described spatial distribution of scattered woody vegetation and species composition richness in the studied territory can be perceived as supporting landmarks of sustainable agriculture theory and practice.

Discussion

Many branches of science may contribute to solution of real issues which have been cumulated during land use development in the countryside. At the present time, particular functions and services of terrestrial ecosystems have been described, but each landscape is covered by different and specific biotopes and plant communities including competent animal world. Agricultural landscape represents one of the most important ecosystem categories, where nature resources and individual landscape elements are being overlapped by a wide spectrum of social economy activities, e.g. setting, building, industry, transport, water network, energy supply, forestry and food production as dominant phenomena. Within the tertiary landscape structure, there are cultural and spiritual values, as well as ineterests of nature and landscape protection. It is difficult to find a balanced consensus between particular activities, interests, potentials and services. On the other hand, a human population has wishes to get chance for sufficient amount of accessible and healthy foods. Therefore, scientists are looking for gentle agriculture technologies with minimizing impact on natural resources and environment and to achieve food safety (Anderson et al., 2004; Plieninger et al., 2006; Reyers et al, 2009; and others). This complex approach is defined in the theory of sustainable agriculture which has a wide scale of individual criterias and subdefinitions (Leal, 2004; Šarapatka et al., 2010 and others) as we also described in this article. Scattered woody vegetation has been long ago a structural and compositional part of agricultural landscapes when farmers completely used the wide spectrum of their benefits and services. This is confirmed by our studied territory and also in other historical landscape structures (Špulerová et al., 2011) as well as in modern approach of windbreaks and hedges establishment and management (Kurz et al., 2011; Soltner, 1991) or in ecological restoration of biotope remains (Jongepierová et al., 2012).

Concerning woody plant species composition in scattered vegetation, the more species the more biodiversity and space for topical and food chain services. But invasive alien species have a destructive effect on natural gene pool and plant communities. Variable space formations of scattered vegetation and variable species proportion increase cultural and visual values and landscape recreational potential (Cieszewska et al., 2010). Scattered woody vegetation fulfils a wide spectrum of described services in the landscape. Agriculture in the mentioned sustainable theory and practice actions should act as provider and recipient of ecosystem services, including services of scattered vegetation and reflecting in agricultural economy parameters (Swinton et al., 2007).

Conclusions

The agricultural landscape has been since long-ago impacted by permanent human interventions with a dominant interest to produce sufficient amount of foods. These actvivities are connected with landscape structure changes, which increase or decrease landscape values and characteristics. Current fields of natural and agricultural sciences have defined criteria and properties of ecosystem services including agricultural ecosystems. To achieve a balanced production of healthy food for people, it needs a new biology and technology approaches defined in theory and practice of sustainable agriculture.

Scattered woody vegetation should be one of the most important elements supporting landscape ecological stability through described services and functions. There are external positive influences leading to modification and mitigation of extreme values of abiotic environmental elements and also land conditions of cultivated crops and fruit orchards. On the other hand, scattered vegetation has kept internal space of plant and animal biodiversity and rare gene pool resource conservation. Achieved and presented results confirm this characteristics and services. From the social aspect, scattered vegetation is a landscape design element with cultural aesthetic values. The main conclusion of this paper is the proposition to increase the share of scattered vegetation up to 6% by new added linear forms in order to divide the land of the studied territory and decrease the area size of plots and increase its multifunctional services in context of sustainable agriculture enhancement.

Acknowledgements

The paper was elaborated thanks to the financial support within the grant project KEGA No. 003SPU-4/2014 of the Ministry of Education, Science, Research and Sport of the Slovak Republic.

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Received May 10, 2016
Accepted May 25, 2016