



The Development of the Slovak Agricultural Landscape in a Changing World

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The agricultural landscape, which serves as a space for food production and a habitat for all kinds of living organisms, is under constant pressure to use the land in various different ways, causing constant changes in the environment. Various socio-economic, technical or political drivers have caused land use changes, which are linked to a number of socio-economic and environmental problems, e.g., different possible land uses competing with each other, changes of landscape character, increasing anthropisation of the territory and disruption of spatial ecological stability, threatening the environmental quality and causing overexploitation of natural resources. The aim of this paper is to evaluate land use changes in Slovakia since the 18th century, to identify key periods of land-management practices and prevailing drivers, and to specify the socio-economic and environmental impacts of land-use change. We organized a workshop with guided brainstorming to identify individual eras of agricultural development and their impacts. In total, we identified five main periods of agricultural landscape development and specified the characteristic landscape structure. Knowledge of the basic drivers of land use change as well as of its effects on the land is important for development of effective policies and for ensuring effective protection of the values of traditional agricultural landscape.

Keywords: Slovakia, land-use change, agricultural landscape management, policy instrument, historical development

INTRODUCTION

The current land use, i.e., how the landscape is exploited by human society, is the result of long-term historical development of the landscape. Different landscape types have developed over time, through mutual adaptation and possibly co-evolution (Loh and Harmon, 2005), from natural to cultural landscape types. Land use changes are associated not only with the creation of specific landscape structures and landscape character, but also with the emergence of various environmental problems. These can deteriorate water and air quality, disrupt river basin functions, cause soil degradation and the accelerated occurrence of other natural hazards, and endanger biodiversity, the environment and also public health (Wu, 2008; Young et al., 2011; Ochoa-Hueso et al., 2019). These processes can result in the formation of degraded landscape structures. Sustainable land use is therefore an important factor in sustainable development, which takes into account aspects of the cultural landscape (Olah, 2003).

The current landscape structure is a mix of several types of landscape, ranging from natural to semi-natural to artificial man-conditioned and degraded land types. Individual types have different

ecological, landscape and cultural-historical values (Brabyn, 2009; Hong, 2014; Bezák et al., 2020), depending to a large extent on the form of management (Jepsen et al., 2015). This dependence is particularly significant for agricultural landscape, which is a landscape system made up of elements specifically focused on the production of food and raw materials, to ensure the life of the human population. Unlike other production processes, agricultural production has several peculiarities (Izakovičová et al., 2010): a larger area of land for production; increased dependence on the environment, especially on soil and climatic conditions; and the impact of many pressures of human activities undertaken in the surrounding open landscape. Therefore, conflicts naturally arise between possible uses of the productive agricultural landscape, as the land that covers almost the entire economically-used area is also a space for all social activities in the landscape, as well as the spatial basis for all elements of the natural landscape.

The existence of the human population is completely dependent on the land. Land is a source of food and raw materials without which man could not exist, and at the same time, it is the space in which take place all productive and non-productive activities, without which the development of human society would not be possible. Land management practices lead to the creation of diverse farmland structures.

Land management is influenced by a number of factors—natural, socio-economic, cultural-historical, political and others (Jepsen et al., 2015).

The aim of this paper is to evaluate land use changes at the national level in Slovakia since the 18th century and:

(1) to identify key eras in land use management at the national level and predominant drivers of land-use change that have led to today's landscape

(2) to specify the basic socio-economic and environmental impacts of the current landscape character

(3) to specify the effects of land use on the development of landscape types and landscape character and give more attention especially to the most valuable landscape structures.

The results will help us understand:

- the impact of management approaches on the character of the landscape and relationship of landscape types to individual forms of farming
- management approaches with the greatest negative impact on the environment and which forms of farming should be avoided
- the management method that needs to be applied in order to preserve the most valuable landscape structures.

This knowledge can not only be used in the protection and preservation of valuable landscape structures at the national level of Slovakia, but also contribute to the protection of the common European heritage, as defined by the European Landscape Convention (Council of Europe, 2020).

The approach presented is a contribution to the implementation of the European Landscape Convention, Article 6, point C, which requires each Party to analyze their characteristics and the driving forces and pressures that

shape them, and to take note of changes. Thus, the approach presented may be a suitable inspiration for other countries in the implementation of the European Landscape Convention.

STUDY AREA

Slovakia is a small, but geographically diverse country. The total area of Slovakia covers 49,034 km². According to the last census (2021) (Statistical Office SR, 2022), there are 5,449,270 inhabitants in Slovakia. The density is 111.2 inhabitants/km². The territory of Slovakia is part of the continental landscape. According to the European Landscape Classification and the country's dominant land use (Mucher et al., 2010; Rega et al., 2020), Slovakia can be considered a rural agricultural landscape. This is evidenced by the nature of the landscape and the settlement structure. Rural settlements make up 95% of the total number of 2,891 settlements in Slovakia; the rest are 141 towns (Statdat, 2021). Agriculture and forestry are crucial for land use and natural resource management in rural areas.

The surface of Slovakia belongs to the Pannonian Basin and the Carpathians, which results in a division into two biogeographical regions—Alpine and Pannonian. About two thirds of the territory is covered by the Carpathians. Most of the landscape is slightly undulating and the average altitude is 392 m a.s.l. The climate is in the temperate climate zone and is significantly influenced by altitude and the type of relief. In the lowlands, the average annual temperature reaches 9–10°C, while in mountain areas (above 2,500 m above sea level) only –3.7°C. Slovakia has a dense river network and its territory is crossed by the main European watershed between the Black and Baltic Seas. The vast majority of the area is drained by the Danube into the Black Sea; only a small part in the north belongs to the basin of rivers flowing into the Baltic Sea. Slovakia has relatively large reserves of groundwater and mineral water, which are unevenly distributed. Natural conditions are a determinant of the diversity of ecosystems. A total of 126 representative landscape types have been identified in Slovakia (Miklós et al., 2006). Mountain types occupy the largest proportion of Slovakia (53% of the land area). Lowland types of land occupy 29%. Agricultural land covers 48.4% of Slovakia, dominated by arable land that creates typical large-block fields with a low degree of ecological stability; this landscape type is predominant in the lowlands and basins of Slovakia. High-quality, dark, very fertile agricultural soils constitute more than 5% of Slovakia. Less than 5% of the area of Slovakia is covered by meadows and grasslands, which have seen a gradual slow decline, mainly due to their abandonment, especially in plots which are difficult to access, which leads to the gradual overgrowth of these areas. Vineyard landscape forms the smallest proportion of agricultural land and covers only 0.43% of the area of Slovakia. Vineyards are predominant in the highlands, forest and grasslands in the mountain land of Slovakia. Forests cover 37.83% of the area of Slovakia, and comprise a variety of different forest types, with no single type dominant. Deciduous forests cover the largest area (16.46%). Coniferous forests cover 14.09%, and mixed forests 7.28% of the area of Slovakia. Mixed agricultural and forested land, consisting of

mosaics of arable land, meadows, vineyards, orchards, grasslands and forest vegetation in various combinations, covers 7.41% of the area of Slovakia. This landscape type forms transition zones between agricultural and forest lands. Less than 1% of the area of Slovakia is covered by subalpine and alpine land linked to the alpine terrain of Slovakia.

METHOD

We used the form of a participative workshop of experts, aimed at obtaining basic information about changes in agricultural management approaches and determining the basic drivers of these changes. The workshop took place as part of the APVV Demetra project (Assessment of recent changes and trends in agricultural landscape of Slovakia). The workshop was attended by 25 experts in agriculture, who were representatives of scientific organizations, government agencies whose competencies include agriculture, NGOs and representatives of the Ministry of Agriculture and Rural Development. The selection of stakeholders was carried out by experts from the APVV DEMETRA project. The idea was to gain individual reflections and views from previous experiences, as well as to gather new insights regarding agricultural management practices (Kumer and Urbanc, 2020). The method of guided brainstorming was used at the workshop, where respondents were asked pre-prepared questions (Toledo-Aceves et al., 2021). This is a qualitative method of data collection commonly used to explore and construct knowledge about a specific topic, in which the moderator (or researcher/evaluator) asks a set of targeted questions designed to elicit collective views about the topic (Ryan et al., 2014). Discussion was focused on the specification of the main periods in the development of agriculture in Slovakia, as well as the identification of the drivers and basic environmental and socio-economic impact. The following group of drivers were discussed (Munteanu et al., 2014): political and institutional (national and regional policy, institutional changes, incentives and subsidies); economic (market, urbanization, infrastructure, industry, innovation and technology), socio-economic (migration, colonization, employment by sector, population density), cultural (public attitudes, traditional ecological knowledge and practices, regional values and beliefs), and climatic (climate changes, temperature, precipitation). The workshop consisted of five rounds of questions and answers (brainstorming), after which the discussion was continued in order to summarize and formulate the outputs for the given question. The discussed issues were:

- Which stages would you consider important in the development of agriculture in Slovakia? Output: specification of the main periods.
- What are the main drivers of a given stage? (Respondents then commented on each period.) Output: specification of basic drivers for each period.
- State the basic characteristics that are typical for the given period. Output: characteristics of each period

- What are the basic environmental and socio-economic impacts of a given period? Output: specification of environmental and socio-economic problems of each period
- List the dominant landscape types of an individual period. Output: identification of the landscape structures typical of the period.

The outputs were formulated by mutual consensus after discussion.

The characteristics of the individual stages of agricultural development were then identified and the impacts of these stages, and related problems, were then evaluated on the basis of analysis of documents, literature review and assessment of available statistical data that consisted of:

- historical information—legal standards in the field of agriculture, which were used to specify the socio-economic drivers and to determine the time period of the period
- statistical yearbooks of Slovakia, which were used to assess the environmental and socio-economic impacts—land use changes of main land use elements and statistics of animal and crop production (EEA, 2019; EUROSTAT, 2021; Statdat, 2021)
- available land use maps (current and historical) used to describe the landscape structure and identify the basic types of agricultural land (TU Zvolen, 2021; ÚGKU SR, 2021)
- literature devoted to changes in the agricultural landscape of Slovakia, which was used for a more detailed description of individual periods (Demo, 2001; Podolák, 2008; Martuliak, 2010; Lieskovsky et al., 2013; Petrovič and Petrikovičová, 2021).

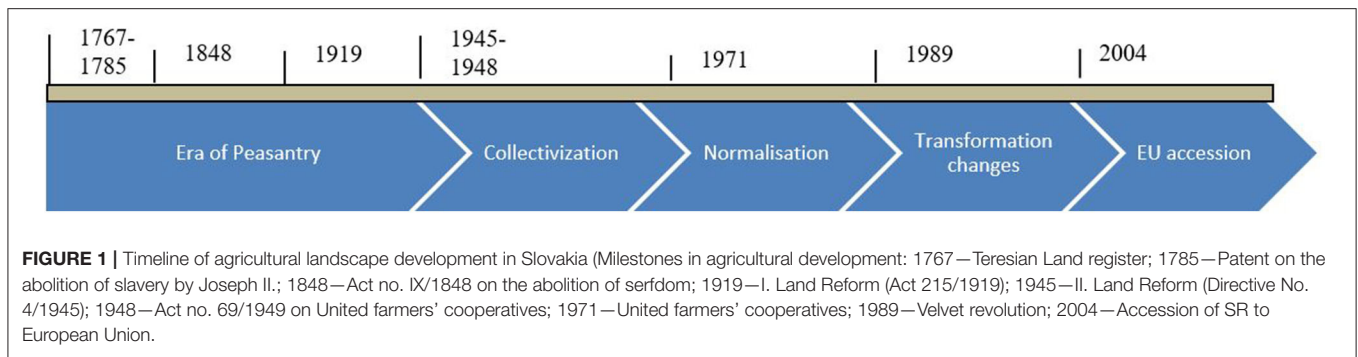
RESULTS

Eras of the Agricultural Landscape Development

We have identified the following five eras of agricultural landscape development (Figure 1).

Era of Peasantry

This era is linked to the period of feudalism. It is characterized as a period of traditional agriculture and subsistence farming (Podolák, 2008). Large landowners and small farmers owned the land. In accordance with the inheritance law and ownership relations, the land was fragmented into smaller plots; this was reflected by the emergence of mosaic landscape structures (Dobrovodská, 2006). The structure of the cultivated crops was diverse, with a predominance of crops necessary for providing food. However, the attitude toward land cultivation gradually began to change after the introduction of reforms in 1768. A new system of management was introduced into agricultural production—the three-field-crop-rotation system (called the fallow system), which persisted in Slovakia until the late 19th century. This system was replaced by a rotating system without fields lying fallow. A number of socioeconomic and technological drivers, such as increased market demand for agricultural crops, improved plowing technology, the application of fertilizers and the introduction of new crops (fodder and root crops) caused the introduction of the rotational farming system in Slovakia.



Farmers were very close to the land, as they were dependent on it. Land was often the only source of livelihood and was therefore highly valued and appreciated by farmers (Martuliak, 2010). They tried to manage it in such a way as to protect and increase its yield as much as possible; therefore, this period can be considered as a period of sustainable land management.

Collectivization Era

This era is associated with the period of socialism and industrialization. Industrialization began during the period of capitalism, but continued and intensified during the period of socialism. The guilds were closed down, which resulted in the decline of small-scale production and in the concentration of production in large industrial plants (Ivan et al., 2014). The collectivization period is characterized by a manifestation of power and aggression, by the confiscation of the property of private farmers and by the establishment of cooperatives. The Nationalization Act (NA CSR, 1949) reduced and restricted ownership of private farms. Some small farmers joined the cooperatives voluntarily, some involuntarily, and others commuted to neighboring towns for jobs in industry and services (Martuliak, 2010). The establishment of cooperatives started the process of land concentration and consolidation, and also the gradual formation of mono-functional agricultural landscapes. Boundaries and terraced fields were plowed and meadows and pastures were destroyed. To compensate for the destruction of small woodlands and agricultural greenery, alleys of fruit trees and windbreaks were planted along roadsides according to the Soviet model, but they were insufficiently maintained and they did not fulfill their functions in many cases (Supuka and Stepankova, 2004).

Heavy machinery was introduced in agriculture and the application of industrial fertilizers produced in industrial plants increased, having negative effects on the natural ecosystem due to significant production of foreign substances and by the subsequent contamination of the environment (Jepsen et al., 2015). Inappropriate tillage methods led to the development of erosion-accumulation processes. Increased doses of fertilizers, pesticides, and other protective substances led to an increase of contaminants in soil and water, with the permitted limits of some chemicals (especially nitrates and heavy metals) being exceeded. A number of hydro-melioration measures led to the disappearance of many valuable habitats of flora and fauna,

especially wetland ecosystems, and bank vegetation. This resulted in the creation of a monofunctionally intensive agricultural land with a low degree of ecological stability (Michaeli et al., 2015).

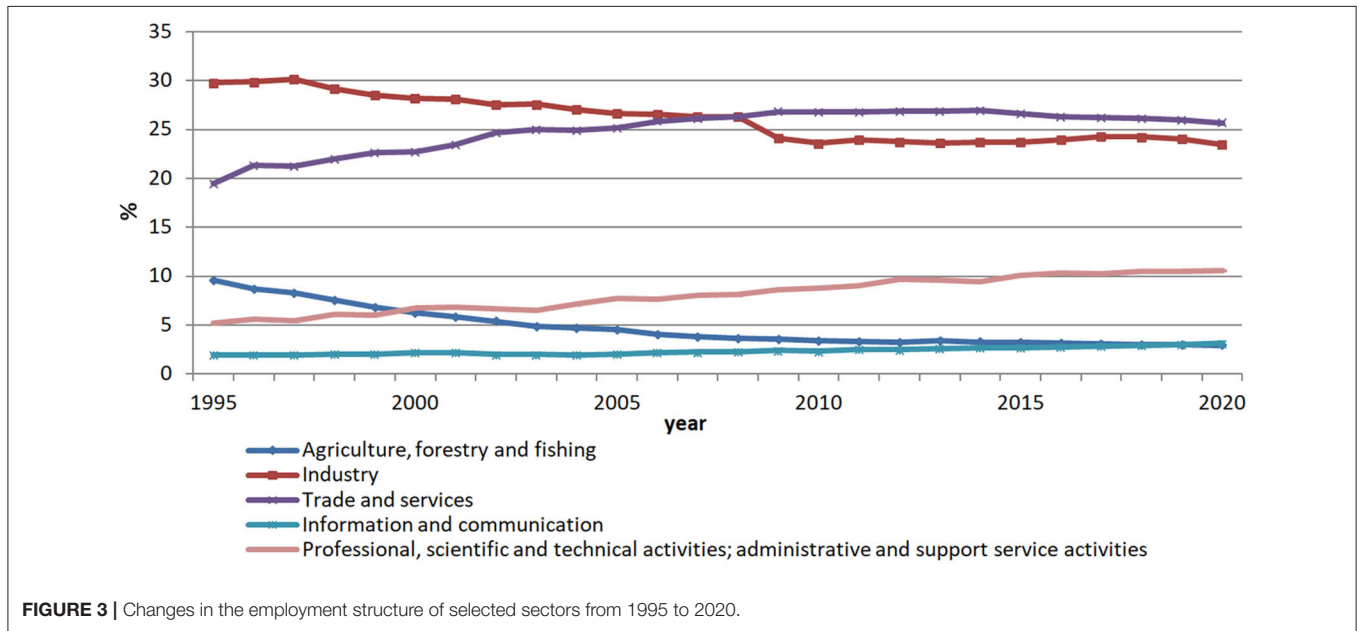
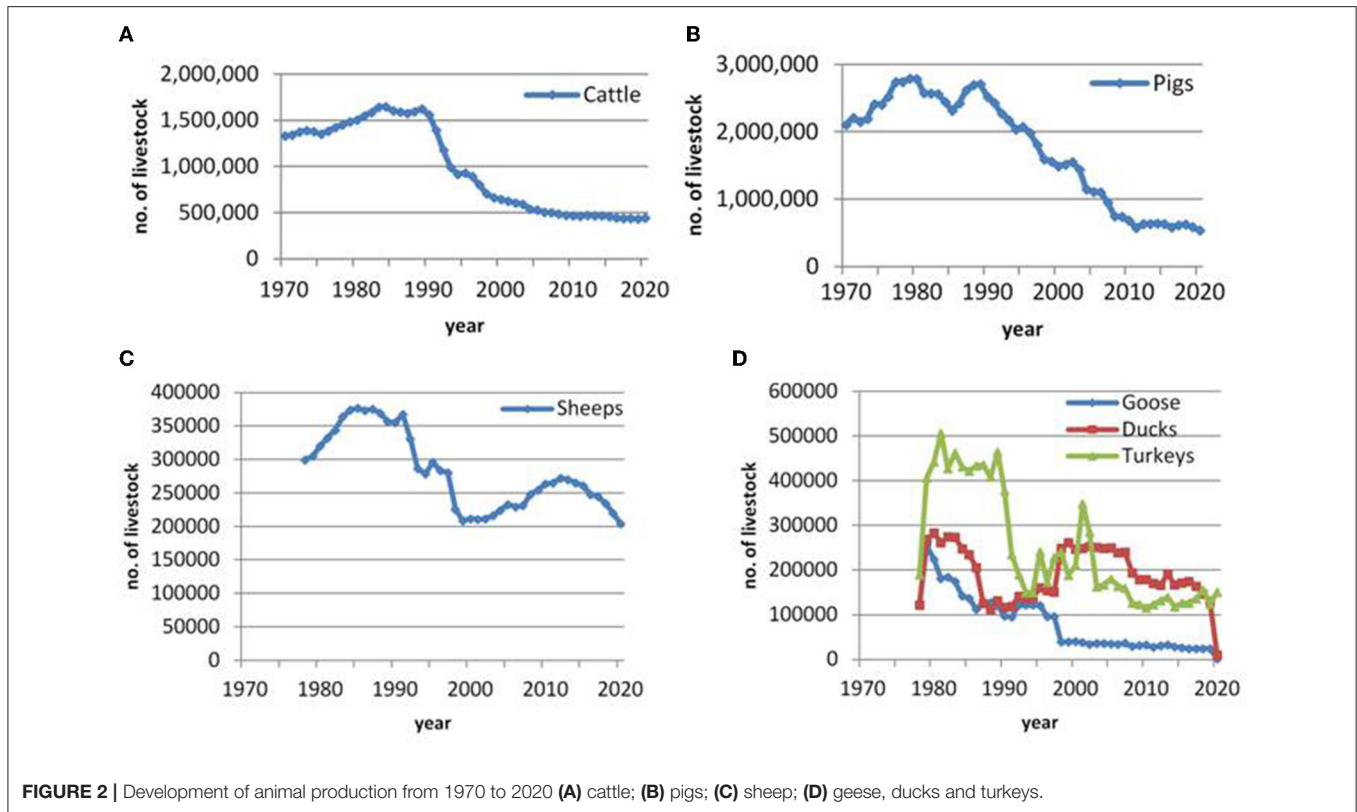
Era of Normalization

This era is associated with the period of communism after 1968, when the position of the communist party was strengthened due to the help of the Soviet Union. The goal of socialist agriculture to constantly increase yields per hectare led to the establishment of new agricultural giant collectives, which arose from the merger of individual farms across a region covering several villages. With the division of labor and the modernization of cooperatives came new pressures on the land. The last remnants of groves, small woodlands, and permanent grasslands were occupied, marshes and ponds were drained, and watercourses were repaired; meanders, valuable wetlands and riparian vegetation were liquidated. Similarly, small-block vineyards began to be liquidated and replaced by industrial cooperative large-block trellised vineyards. Hectare yields tripled compared to the period before World War II. Efforts to achieve the highest possible yields per hectare led to a constant increase of chemical use, and production modernization increased the growth of mechanization, which had significant negative consequences on the landscape—increased erosion processes, drying and soil relief, contamination of environmental components, etc. The intensification gradually pushed out the small private farmers who grew agricultural products for their own consumption, and so the small “ruins” (overgrown stone piles by fields) gradually disappeared, as did the mosaic structures of the landscape soon after.

The land consolidation and establishment of big cooperatives caused the relocation of a large amount of agricultural labor from the countryside and a concentration of the population in the cities, to employed in industry, and later also in services (Podolák, 2008).

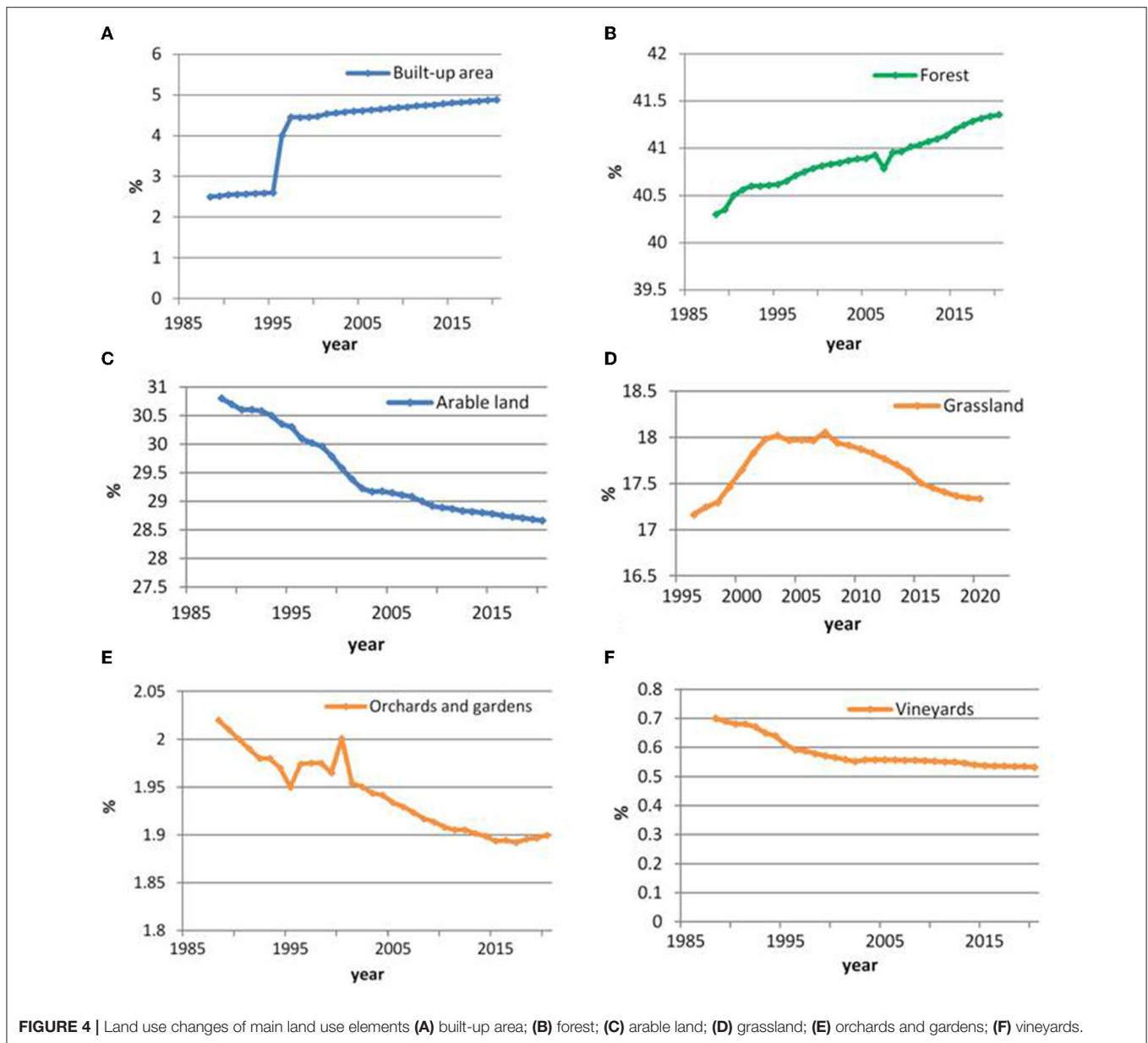
Era of Transformational Changes

This era is associated with the period after the Velvet Revolution (the period of democracy) when the transition from a centrally-controlled economy to a market economy was realized. The transition from central control to a market economy brought many advantages and disadvantages. The collapse of traditional markets, an underdeveloped land market, and a faster growth



of input prices than output prices in agriculture weakened the competitiveness of Slovak farmers. Thus, the previously very successful and well-performing cooperatives began to disintegrate. Livestock production began to decline first because it was very labor-intensive and could not compete with products imported from abroad (Figure 2).

The disintegration of agricultural holdings significantly weakened the economic base of many rural settlements, as the agricultural cooperatives were the most important source of income and employment in many places (Figure 3). The transformational changes brought with them a gradual settlement of property issues. The land was returned to its

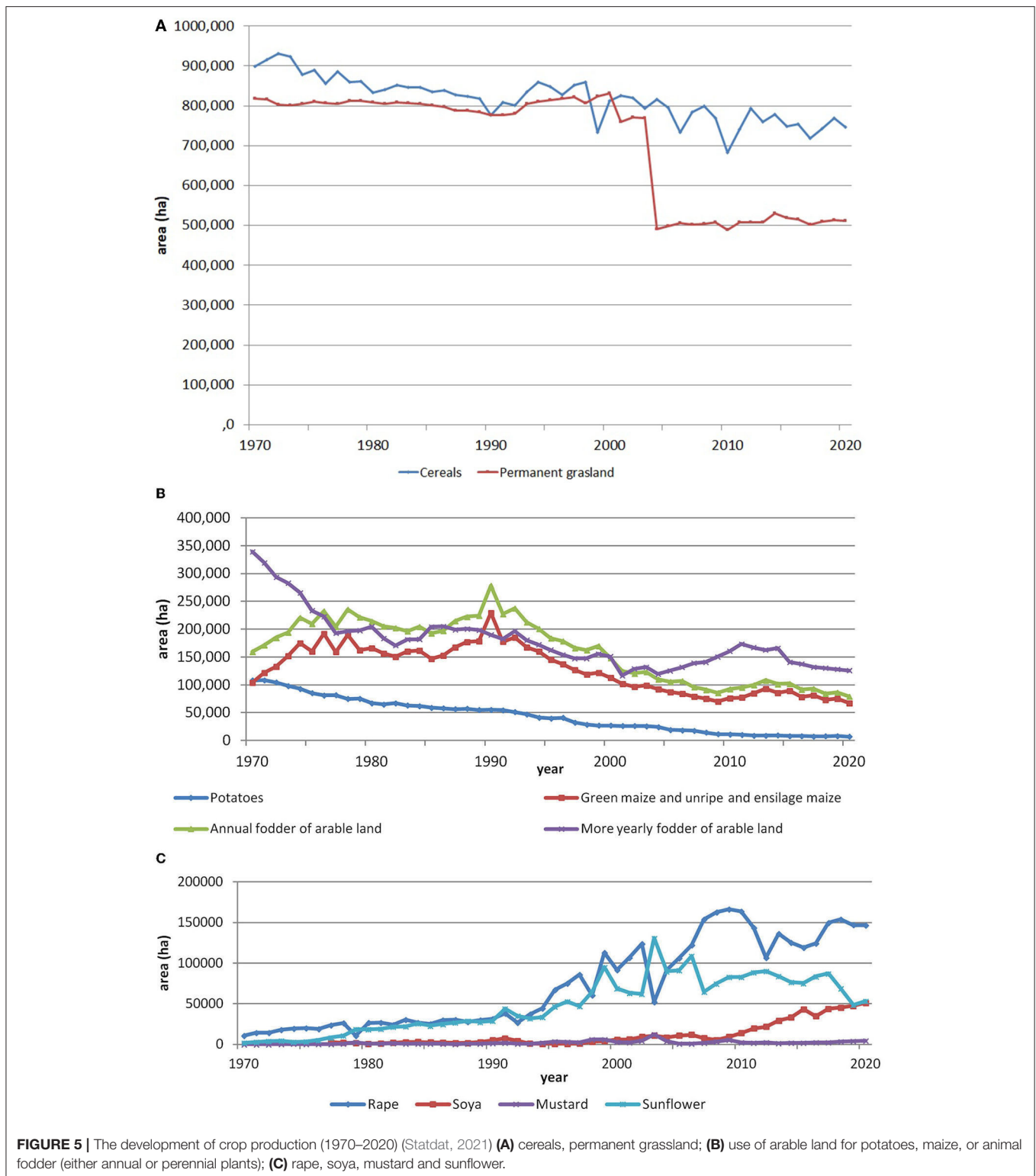


original owners, many of whom were no longer interested or had inappropriate technical, financial or human resources to cultivate the restituted land. Some of the less fertile and difficult-to-access land remained uncultivated and abandoned, which was reflected in the increase of forestland.

The return of agricultural land to the original owners also affected land trading. Some owners leased the land to farmers; only a small part began farming. Due to the favorable price of the land, many owners sold the land to investors and thus massive construction began on agricultural land; in many cases even land of the highest quality was used for construction (Figure 4). Agricultural land after the transformation was used not only for housing construction, but also, in significant amounts for the

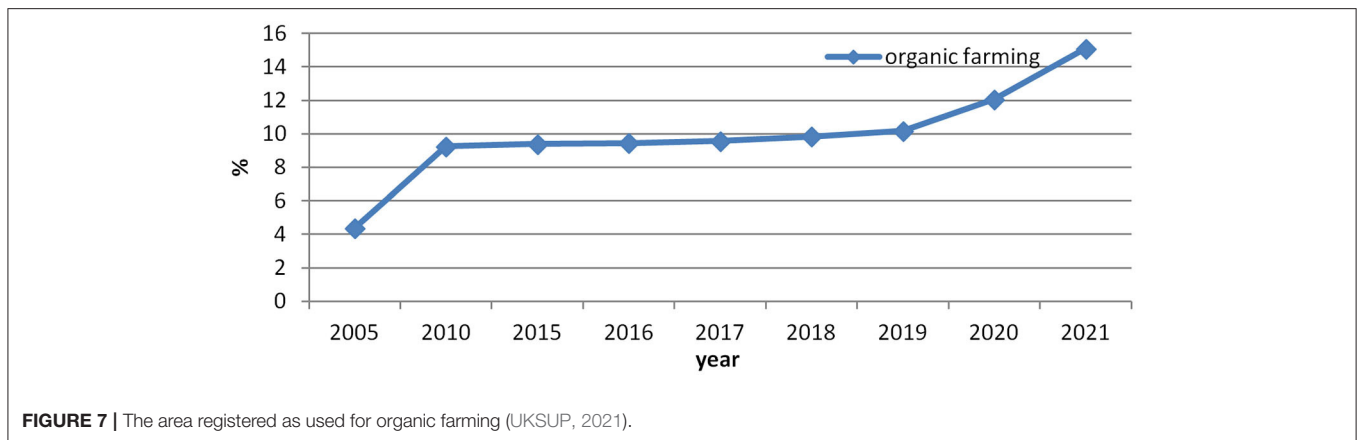
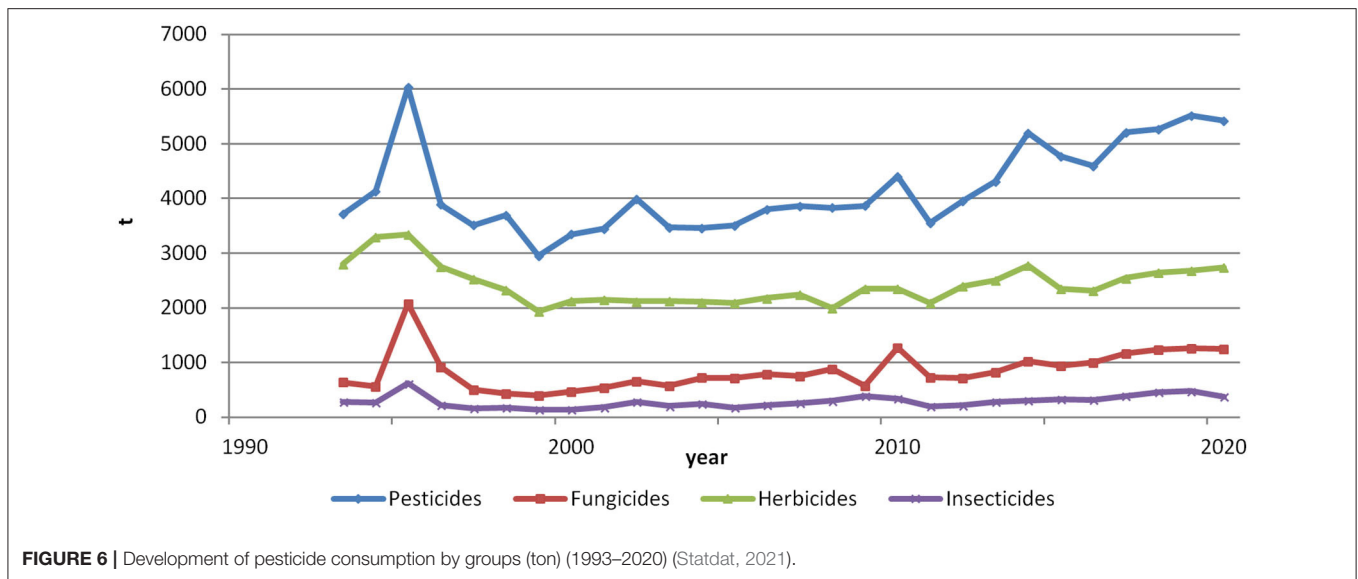
construction of industrial parks, shopping and logistics centers, including the necessary infrastructure.

The open market was also reflected in the change of the structure of cultivated crops. The loss of traditional markets, underdeveloped land trade, and input prices rising faster than output prices, weakened the competitiveness of Slovak farmers in the market. The structure of crops began to diversify, with preference given to those that were lucrative in the market (Figure 5). Currently, in addition to cereals, it is mainly energy crops that are grown, such as sunflower, corn, and rapeseed and so on. The area of energy crops has increased by almost 200%. Cereal area decreased slightly by 5% (Statdat, 2021) compared to 1990. The largest decline was recorded in the cultivation



of fodder, sugar beet and potatoes. Uncontrolled cultivation of energy crops can be a threat not only to natural ecosystems but also to individual landscaping components (Fehér et al.,

2020). The landscape structure is still dominated by large-scale arable land, but its use has changed to reflect market prices for particular crops.



The Era After Accession to the EU

Slovak agriculture has been affected by many reforms since 1990; and the entry of Slovakia to the EU meant adoption of commitments in the field of environmental legislation. Ecological and environmental limits were applied, which meant reduced use of chemicals and machinery; the result was a lower burden on individual landscape components. As intensification decreased, there was a significant decrease in industrial fertilizers consumed in agriculture. While in 1980 the consumption of pesticides was 19,016 tons, by 1993 it had decreased to 3,904.5 tons, a decrease of 79.5% (Statdat, 2021). In contrast, since 1993, the consumption of pesticides has slightly increased (Figure 6).

More attention is now being paid to greening measures and support for organic farming, which is much more sensitive to nature protection, natural resources and the environment. A positive trend was recorded for organic farming in the long term (1993–2020), which increased by 11.45% (UKSUP, 2021) (Figure 7). Increasing the share of organic farming to at least 13.5% by 2030 is one of the main goals of the Environmental Strategy 2030 of the SR in the area of sustainable

land management (ME SR, 2019). The goals of the European Commission presented in the Farm to Fork strategy aim to move the EU food system to a more healthy and sustainable level, and the area used for organic farming should grow to 25% of total farmland for 2030 (EUROPEAN COMMISSION, 2020).

The characteristics of individual periods, the main drivers, and the environmental and socio-economic impacts are summarized in Table 1.

Characteristic Landscape Structures

Each period also led to the creation of certain characteristic landscape structures and in the creation of the specific landscape character (Table 1).

In terms of landscape diversity and stability, the most valuable landscape structures were created in the era of the peasantry, which is characterized by small-scale extensive management and the creation of mosaic landscape structures. These landscape structures represent a traditional farmland of high nature value and are important not only from a biological, but also from a cultural-historical point of view (Dobrovodská et al., 2019;

Šatalová et al., 2021). These landscape structures were formed over the course of decades and are linked to particular forms of management (Petrovič and Petrikovičová, 2021). However, many of them have changed or disappeared due to various management approaches. These traditional agricultural landscapes provide various benefits and perform a number of other functions, for example: (1) hotspots of biodiversity and landscape diversity; (2) traces and remnants of traditional farming; (3) being beautiful or aesthetically pleasing; (4) regulation of baseline flows and extreme events, which has positive impact on the quality of the environment; (5) lifecycle maintenance, habitat and gene pool protection; (6) sources of knowledge, and the subject of spiritual, symbolic and other interactions with the natural environment; (7) inspiration for artists; (8) a testimony of human harmony with nature; etc.

Traditional ways of farming used to be more environmentally friendly and sensitive to natural resources (Angelstam et al., 2021). Traditional agricultural landscapes often provide know-how for organic farming, and become a template for restoring the natural potential of the surrounding intensively-used agricultural land. They grant the Slovakian landscape a specific character. We have identified three of the most important biocultural types of agricultural landscape in Slovakia:

Vine-growing landscape—these are dominated by cultivation of grapes and wine production. Vine growing regions in Slovakia present the northern boundary of the large Southern-central European vine region. The warmest slopes, regardless of relief, are used for vine growing. The oldest reports record vine-growing dating back to the 7th–8th centuries BC (Demo, 2001). The 18th century was the golden age of viticulture, when the vineyard area covered more than 50,000 ha. The results of traditional farming are specific small-scale features and technical elements of the vine-growing landscape. From a landscape point of view, the most picturesque are the especially-valuable staked vineyards, often combined with wine cellars. In addition to cultural and historical value, they often harbor habitats of rare and endangered species, and these habitats enhance the ecological stability of the landscape. There are six main vine-growing areas in Slovakia: the Small Carpathians, South Slovak, Central Slovak, Nitra, East Slovak and Tokaj vine-growing regions (Figure 8). Each vine-growing region contains typical settlements composed of a wine-maker's house or cellars, and press-shed outside the wine-maker's house. Some wine cellars were carved into volcanic rocks up to a depth of 16 m from the 17th century onwards. There are up to 20 km of underground corridors in the village of Trna. The Tokaj region, in the Zemplín Hills which bestride the border between Slovakia and Hungary, is the most significant and the most attractive vine-growing region in Slovakia. This area has been declared a UNESCO World Heritage Site. Thanks to this, Tokaj wine is internationally well-known and popular. The Tokaj region is one of the few areas in the world which produces naturally sweet wines. Viticulture has experienced a significant decline in the last decade (Lieskovsky et al., 2013). The total area of vineyards dropped by 24.1% between 1990 and 2021 and wine production by almost 40%. Traditional small-block vineyards are particularly at risk. The collectivization and intensification of agriculture

had a massive impact on traditional vineyards, as many small-block vineyards were replaced by large-block vineyards, often with wide terraces, which were technically easier to cultivate. The construction of large-block vineyards has significantly changed the landscape physiognomy.


Landscape with various forms of dispersed settlement—Dispersed settlement is a preserved form of historical settlement combining certain types of settlement and exploitation of the land. Different regional names are used in different areas for dispersed settlements, for example (Figure 9): lazy, štále, rale, place, klčoviská, kopánky, nivky, vrchy (hills), etc. Variations in name are based on regional specifics, e.g., the method of acquisition and cultivation of newly-acquired land, etc. The settlements are located in the foothills and highlands with an altitude between 500 and 800 m a.s.l. Establishment of dispersed settlements in Slovakia was related to three waves of colonization—Wallachian and highlander (both of whom were shepherds) and “Kopanitse” settlement. Wallachian colonization involved colonization of the mountain regions of north and central Slovakia by shepherds, and mostly took place from the 15th to the 17th century. Highlander colonization took place in the 17th and 18th centuries.

The establishment of “Kopanitse” settlements was related to the extended amount of remote land, which was difficult to access from the village center, but had some livelihood potential, especially for the poorer inhabitants. There was an inner colonization of the mountain and foothill areas of Slovakia by the native population in the 16th–19th centuries.

Five main regions of dispersed settlement have been identified in the territory of the Slovakia, which are divided into sub-areas (Figure 10). Each of these areas has its own unique features.


Traditional meadow-pasture landscape—This landscape was not affected by strong human pressure in the previous century, and therefore its traditional character of Wallachian colonization has been preserved, generally in peripheral or hardly accessible areas, often with a lack of infrastructure (Figure 10). From a historical point of view, the use of meadow-pastures (to produce hay and thus keep animals) represented the main traditional livelihood of our ancestors. The higher lands and more remote valleys began to be used economically (with agriculture supplemented by crafts and trade) in the 13th–14th centuries. Mountain meadows began to be used by shepherds, who later built the first mountain shelters and haystacks in these locations. These were also the first preconditions for the establishment of smaller settlements in some localities. Terrace fields with strips of trees and shrubs were created in the more climate-friendly areas. In this way, mosaic landscape structures arose composed of narrow-strip arable land, meadows, pastures, and remnants of tree and shrubs with scattered dwellings. Extant traditional meadow-pasture landscape is characterized by the following features: extensive management; high landscape diversity; preserved traditional wooden architecture; preserved traditional management practices; biotic, ecological and landscape value; social value; harmonization of the interests of agriculture, forestry and water management, recreation, tourism and nature protection with the landscape ecological values of the territory.

TABLE 1 | The periods of development of the agricultural landscape—main characteristics, drivers, impact on the landscape and the characteristic landscape structure.

Period and basic drivers	Characteristics	Impact	Landscape structure
<p>Era of peasantry—improved plows, new crops, private land rights, land reforms</p>  <p>Dolná Seč 1950 (Historical orthophotomap © GEODIS SLOVAKIA, s.r.o)</p>	<p>Self-sufficient farming Fragmentation of parcels Extensive farming Low level of technology</p>	<p>Extensive sustainable land management (+) Environment-friendly management—respect for the soil, protection of the soil (+) Diversified landscape structure (+)</p>	<p>Traditional agricultural landscape</p>
<p>Collectivization—confiscation of property, collectivization and industrialization, guaranteed prices, mineral fertilizer</p>  <p>MATADOR factory Púchov (Historical orthophotomap © GEODIS SLOVAKIA, s.r.o.)</p>	<p>Massive development of the Slovak industry after World War II, oriented mostly toward heavy industry Production of heavy machinery and chemical treatments for agriculture Land consolidation Collective husbandry and ownership Productivity as the only target (intensification) Establishment of cooperatives Use of heavy machinery</p>	<p>Increased mechanization for agriculture—work facilitation (+) Decline of extensive farming, orientation toward large-scale intensive farming—mono-functional landscape (–) Destruction of green infrastructure (–) Guaranteed purchase of products by the state (+) Abandonment of inaccessible localities due to remote location (–) Soil and water pollution due to using more chemicals (–) Physical soil degradation (–)</p>	<p>Industrialized urban landscape, Homogenous intensive agricultural land</p>
<p>Normalization—central management, strengthening the communist regime, increasing the intensity of using chemicals, maximization of ha yields</p>  <p>Dolná Seč (1985 Landsat-5 image courtesy of the U.S. Geological Survey)</p>	<p>Occupation of land on extended built-up areas Creation of agricultural unions Central planning, market managed by the state Use of heavy machinery Increased use of artificial chemicals Construction of mass urban settlements—flat houses Decreased importance of agriculture in general</p>	<p>Central planning (+) Guaranteed right to work (+) Increase in production (+) Increase of built-up area—occupation of arable land (–) Orientation toward large-scale intensive farming—mono-functional landscape (–) Degradation of natural resources (–)</p>	<p>Large-scale intensive land use with a low degree of ecological stability</p>
<p>Transformation—market economy, application of international conventions, progressive environmental legislation</p>  <p>Volkswagen, Devínska Nová Ves (1992 Landsat-5 image courtesy of the U.S. Geological Survey)</p>	<p>Transition from centrally-governed society to civil society, from central planning to free market Economic crisis, increase of unemployment Collapse of heavy industry and common agriculture</p>	<p>Break-up of cooperatives (–) Decline of livestock production (–) Increase of unemployment (–) Return of land to the original owner (+) Large-scale occupation of agricultural land for construction (–) Change in crop structure (–) Significant drop of agricultural support (+) Expansion of abandoned agricultural areas (–)</p>	<p>Homogenous market-oriented agricultural landscape</p>

(Continued)

TABLE 1 | Continued

Period and basic drivers	Characteristics	Impact	Landscape structure
EU accession—CAP, agro-environmental schemes, precision farming, applications area-based subsidies 	Availability of pre-accession and EU funds, boost of economy Implementation of CAP since 2004 (incl. agro-environment scheme) Strengthening of international cooperation—adoption of international conventions Application of environmental legislation	Low competitiveness of Slovak farmers (–) Poor market for selling agricultural products, hard to compete with imported products (–) Revitalization of agroecosystems (+) Slow application of greening and more attention to green infrastructure (+) Chemical regulation (+) Growth of organic farming areas (+)	Increase in extensively-used farmland (application of organic farming and greening measures)

Hrušov lazy, School of permacultures (2020
Google earth imagery)

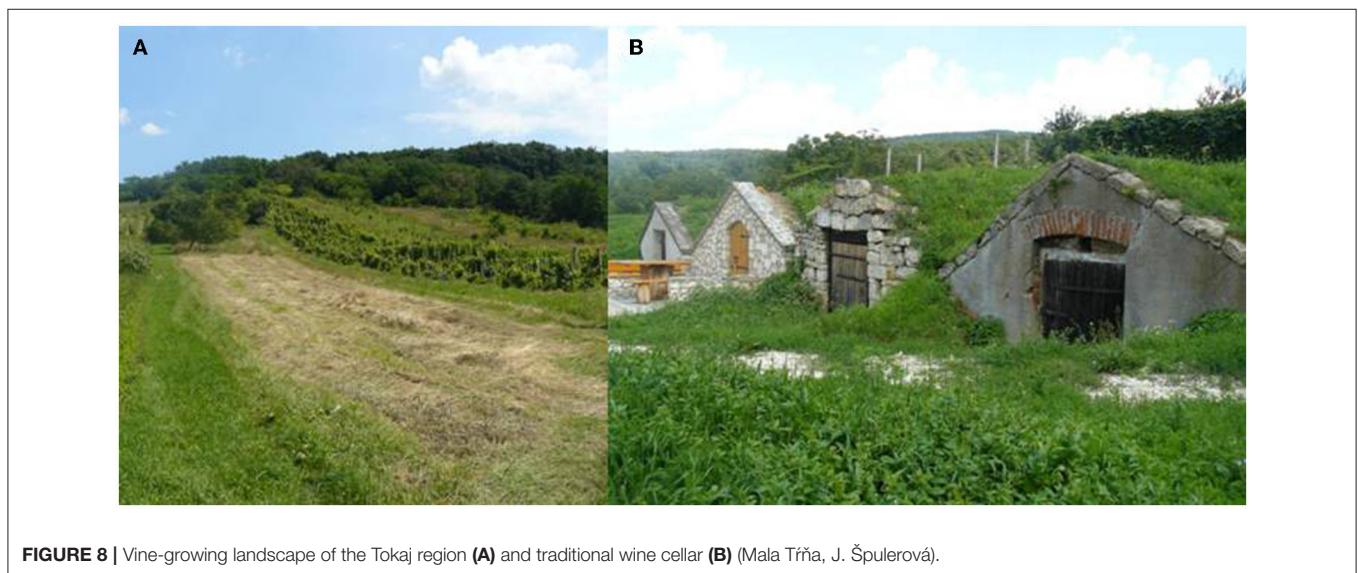


FIGURE 8 | Vine-growing landscape of the Tokaj region (A) and traditional wine cellar (B) (Mala Trňa, J. Špulerová).

The preservation of the traditional meadow-pasture landscape is complicated because the abandoned land not used extensively for cattle breeding or hay making is threatened by succession, which causes loss of biodiversity. On the other hand, many valuable localities were destroyed by intensification during collectivization, which not only caused irreparable losses and damage to nature, but also led to the extinction of our ancestral historical legacy. The revitalisation of these valuable habitats will require considerable investment.

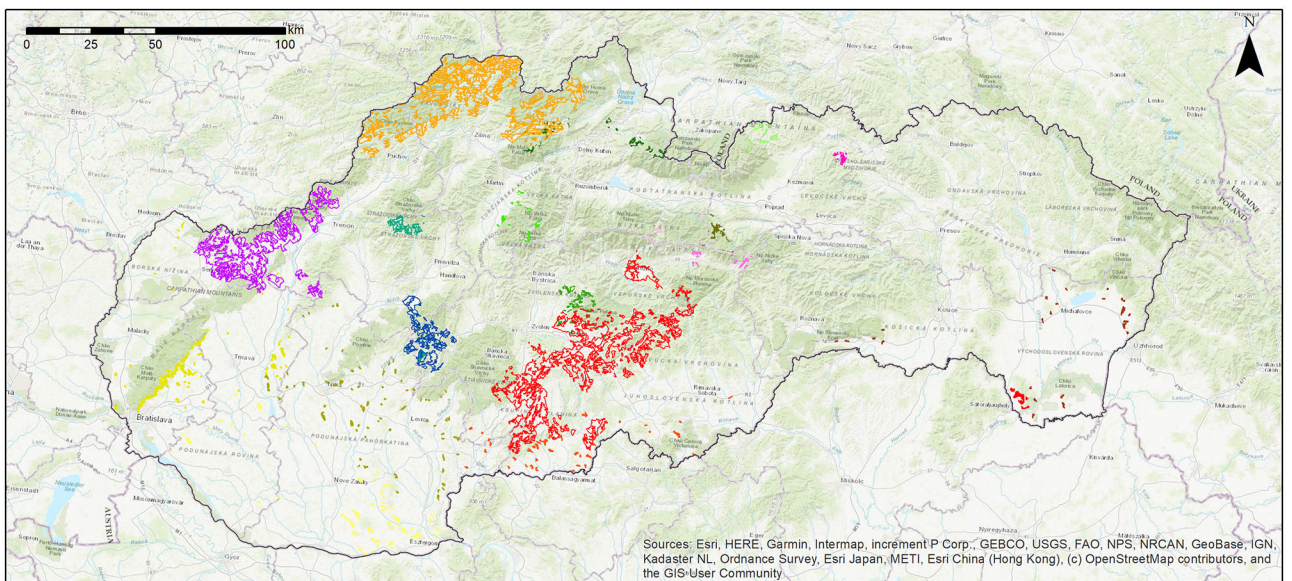
At present, these traditional agricultural landscapes cover a limited area and are constantly under pressure from human activities, so it is necessary to pay increased attention to them (Halada et al., 2017). Landscape with dispersed settlements is the most common form of traditional agricultural landscape (covering 6.3% of the area of Slovakia); the meadow-pasture landscape covers <5% (4.82%) and the wine-growing landscape is relatively under-represented (<1% of Slovakia's area).

DISCUSSION

Each era of development of the Slovak agriculture led to the creation of certain landscape structures and gave the landscape a certain character. This character was influenced or determined by the management approaches and method of tillage of the time, as well as by governmental policies and ownership of the land (small farmers, collectives, corporations). Special transformation trends reflect more local conditions, human needs and preferences (Boltiziar et al., 2016). Many types of land, especially biocultural types of agricultural land, depend on human labor and on the application of traditional knowledge. The inheritance law caused the division of land between several owners, which led to more diversified land use and the creation of valuable mosaic landscape structures in the era of peasantry. During this period, land management was more sensitive to the environment, as the farmers regarded their land as the most important source of livelihood and they shared their



FIGURE 9 | Landscape with dispersed settlement in the Detva region (Hrínová, J. Špulerová).



Legend

- | | | | |
|--|---|--|---|
| | Regions of dispersed settlement | Traditional meadow-pastures landscape regions | Vine-growing regions |
| | <ul style="list-style-type: none"> Slovenské Rudohorie Mts. and surrounding mountains of the Slovak Highlands (Detva region) Javorníky Mts. and the Beskydy Mts. Biele Karpaty Mts. and Myjavská pahorkatina Hill Land Nová Baňa region („štále“) Strážovské vrchy Mts. | <ul style="list-style-type: none"> Bocianska Dolina Horehronie Jakubany Kostofany – Lehota region Liptovská Teplička Orava Podpoľana region Turiec Zamagurie | <ul style="list-style-type: none"> South Slovakia Small Carpathian Nitra Central Slovakia Tokaj East Slovakia |

FIGURE 10 | The most significant regions of traditional agricultural landscapes.

knowledge of sustainable land management in order to maintain its fertility. They used organic fertilizers and non-mechanized equipment, as the conditions did not support more intensive management (lack of technology, chemicals, etc.). The period of collectivization and normalization has the most significant effect on the landscape and its components. This period is characterized by the emergence of large-scale intensively-used agricultural land, burdening the environment with the use of heavy machinery and intensive application of chemicals. Massive waste and degradation of resources was recorded in several cooperative farms. Cooperatives had no incentive to improve efficiency, and joint ownership caused a growing lack of interest in soil protection (Stanis, 1976; Zagata et al., 2020). Intensively-used agriculture was practiced in Central and Eastern Europe and the USSR until the fall of socialism; since then, the phenomenon of land abandonment has increased rapidly (Pazur and Bolliger, 2017; Janus and Bozek, 2019). We can find positive examples of post-socialist transformation in Croatia, where agro-committees were transformed into joint-stock companies, which, using new business strategies, sought to become profitable firms on behalf of their shareholders (Hadelan et al., 2008). With the accession of Slovakia to the EU, the application of the CAP supported more environmentally-friendly forms of farming, but this is a long process and is only slowly having an effect on the landscape.

Similar trends have been observed in other European countries, although countries vary in how strong are the effects of governmental changes on the agricultural landscape, and how quickly they appear (i.e., with what time lag). The shifts in agricultural eras have often been linked to transnational institutional reforms (such as changes in EU agricultural policy or the emergence and the end of the collective Soviet style of land management), to technological innovation and their spread across Europe.

The most significant changes occurred mostly after the Second World War: Western European countries entered the period of industrialization, and the countries of the Eastern bloc began the collectivization process with the confiscation of property and land consolidation (Jepsen et al., 2015; Guiomar et al., 2018). Exceptions can be seen in Poland or Bulgaria, where subsistence agriculture and part-time farming continued to be significant forces in the rural economy (Creed, 1995; Hornowski et al., 2020). The process of collectivization in Slovakia was one of the strongest within the socialist countries (Bezák and Dobrovodská, 2019). Traditional forms of farming rapidly disappeared, and almost all small private farmers were abolished. The socialist approach of industrialization and globalization of agri-food systems ruled out any possibility of a sustainable rural society involving small-scale farmers and alternative local forms of production, consumption and distribution (Mincyte, 2011). Forms of traditional farming have survived only in less favored areas, especially in mountainous areas, where the use of agricultural technology has been limited by natural conditions (Gerard et al., 2010).

European agricultural countries represent a type of cultural landscape with many specific and unique cultural, historical and biodiversity patterns (Agnoletti et al., 2008; Slámová and

Belčáková, 2019). Similarly, the landscape of Slovakia is the result of intensive management in recent decades, but there are valuable landscape structures as remnants of historical eras. There are high nature value farmlands, often shaped by specific mountainous natural conditions and environmentally-friendly farming (Bezák and Mitchley, 2014; Šatalová et al., 2021), but their prevalence in Slovakia is very low. They are the result of an interaction between nature and man. A study of habitats of European importance has shown that 63 habitat types of European importance either depend on (or otherwise benefit from) the continuation of agricultural practices or are spatially extended by blocking or reducing secondary succession through agricultural activities, in particular grazing and mowing (Halada et al., 2011).

The area of traditional agricultural landscapes is constantly declining, mostly due to abandonment or intensification, as their extensive management is time-consuming and costly (Kizos et al., 2010). These landscapes are mostly managed by the older generation and their existence is threatened by insufficient interest of the younger generation in continuing this way of farming. One positive trend for preservation and maintenance of high nature value farmland is the growing interest in organic farming, which is also supported by the Rural Development Plan.

The basis of research such as this must be a careful selection of respondents who have some knowledge of the issue. In Slovakia, it is a problem to get suitable respondents representing different spheres, as people have certain inhibitions in expressing their opinions to the public. This appears to be a holdover from the former communist regime and its limited freedom of expression (Soliva et al., 2008; Dick et al., 2018). The interviewer also plays an important role in a well-run guided interview. They must have the ability to capture the substance of the answers and must guide the discussion (Conrad et al., 2011; Ryan et al., 2014). Together with respondents, we agreed on the selected major milestones, and various indicators, historical sources and statistical data supported these milestones. Minor deviations may occur in the identification of the exact time limits of the individual eras and in the specification of the main drivers and impacts.

This can be corrected and supplemented, based on statistical monitoring and evaluation of processed historical sources, whether text or maps. In Slovakia and in several Eastern European countries, it is difficult to obtain the appropriate statistics, as many phenomena and processes have not been continuously monitored. The big issue is obtaining environmental data from the period of industrialization and collectivization. During this period, almost no attention was paid to environmental issues. The situation changed with Slovakia's accession to the EU, when regular data collection and evaluation started.

Despite this uncertainty, this paper clearly and reliably describes the main eras of agricultural development in Slovakia and especially their specifics, adverse impacts and current trends. Based on the information, it is necessary to set up suitable management of the agricultural landscape so that the described socio-economic and environmental problems are gradually eliminated.

CONCLUSION

The development of the agricultural landscape in Slovakia has proceeded through several land management regimes. Each of them is associated with the emergence of specific landscape structures and the emergence of diverse environmental and socio-economic issues. Individual landscape structures have different values, some being more, and others less, valuable. The most valuable are traditional agricultural structures, which were created in the era of peasantry and are linked to specific forms of farming. These are landscape structures valuable not only in terms of cultural heritage but also in terms of biodiversity; they are important biocultural types of landscape. Their preservation depends not only on protection but also on the preservation of certain forms of management and traditional farming practices.

These landscape types are not sufficiently protected in Slovakia. There is no established protection for specific landscape types, even though Slovakia signed the European Landscape Convention. Some of these sites are preserved as part of nature protected areas; in particular, they form part of protected landscape areas or national parks. Protection of natural areas focuses more on the protection of biodiversity; the protection of cultural and historical value is secondary.

Many of these sites are also under threat due to unsuitable socio-economic conditions. It is not possible to maintain them without a suitable subsidy policy. Their management is time- and money-consuming. Young people are not interested in traditional farming, as it is unprofitable. Elderly people with an emotional attitude toward land and traditional farming do not have enough physical strength to manage land in the traditional way; they often do not even know about the technical means to facilitate farming or the possibility of obtaining subsidies for organic farming. Therefore, it is necessary to pay increased

attention to these preserved traditional agricultural landscapes by creating an appropriate support scheme under the Recovery and Resilience Facility and within the Strategic Plan of the Common Agricultural Policy 2023–2027. Also important is the promotion of the values of traditional agricultural landscapes, their material and non-material benefits for society, and their inclusion in the legislative protection. Slovakia now has the opportunity to do so, as a new law on the landscape is being prepared. The protection of Slovakia's biocultural landscapes will also contribute to the protection of the common European wealth defined in the European Landscape Convention. The Convention combines the protection of the natural and cultural heritage with the protection of inseparable natural and human values.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found here: Statdat (2021).

AUTHOR CONTRIBUTIONS

ZI: conceptualization. ZI and JŠ: methodology and writing manuscript. AR and JŠ: visualization. All authors have read and agreed to the published version of the manuscript.

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