Chapter 21
The Traditions, Resources and Potential of Forest Growing and Multipurpose Shelterbelts in Hungary

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Abstract Livestock-keeping in forests is a traditional practice in both the plains and mountain areas of Hungary. It has ensured the stability of marginal areas and sustained diversity. Following ownership changes in 1989, Hungarian agricultural activities diversified again and, on private farms, opened a range of options to plan and revitalize agroforestry systems, mainly based on the shelterbelt-systems of the 1960s. This paper reviews trends and possibilities in landscape-management both in specific locations and countrywide. In addition to the agroforestry potential there are examples of conservation, landscape protection and ethnic heritage of these farming methods. Because of changes in land structure and the accession of Hungary to the EU, the economic objectives of afforestation are increasing. The protective functions of forests as shelterbelts, landscape enhancement and settlement-protection are also being felt. It is expected to be an increase in shelterbelts, windbreaks, forest belts, hedgerows and alleys. Surveys in forest, and non-forest scenarios need to be followed by long term planning, which should increase forest protection. Examples of experience, with potential uses of agroforestry in Hungary are given, but optimal exploitation needs further research and collaboration of all sectors concerned.

Keywords Livestock, multipurpose management, landuse, silvopastoral, restoration

Introduction

Nowadays the concepts of land development, agriculture and forestry are being more closely integrated. Hungary is committed to soil conservation and sustainable utilization through the recognition and the protection of environmentally-friendly

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A. Rigueiro-Rodríguez et al. (eds.), *Agroforestry in Europe: Current Status and Future Prospects*.

cultivation of plants and livestock-farming. Traditional management methods, like agroforestry, ensured the economic stability of the countryside until the 1940s.

There is a need for parallel management of the outskirts and the inner areas of rural settlements and villages. The basic goal is to build organic, natural units to permit ecological circulation through decentralization and bringing regionality to the fore by supplying small regions with independent infrastructure. Silvopastoral systems – livestock-farming and timber growing (forestry) on the same area – could be increased, modified and developed to help achieve these goals.

Livestock-breeding is an ancient tradition in Hungary. The benefits of ancient, traditional extensive stock keeping is currently being recognised and attracting attention in relation to the management of small scale farming. There is a tradition of keeping cattle, horses and sheep on the lowland plains or the pasturing of pigs in the uplands of Hungary. This type of extensive keeping is known as "*acorning*" or *pannage*. It is important to note that pasture-forests (where pasturing is one of subsidiary uses of forest) were primarily established for timber production, soil conservation and protection, but were used by local people for firewood and crops (Hegedűs and Szentesi 2000).

After 1945, collective farming and social reform almost eliminated such semi-natural types of farming. After both world wars the development of agriculture, including livestock-farming, occurred at a great rate. Large state farms, with intensive cattle and pig keeping and the socialization of private forests, signalled the demise of forest pasturing.

Current land-structure, is made up of shelterbelt-systems (established around the 1960s; and accounting for around 16,415.7 ha in 2001) (Bán et al. 2001). The connecting forest areas could permit the reintroduction of multipurpose management, e.g. semi-natural livestock-keeping combined with wood-management on agricultural areas. The modern concept of organic farming embodies principles of environmental sustainability, good farm management practices and animal welfare. However, forest law in Hungary forbids livestock keeping in state owned forests. Hence the integration of shelterbelt-systems, farm-afforestation and those small forest-sites (area < 1,500 m^2), which do not fit into the forest land use category come under the Hungarian "Forest Protection Laws" (1996. 54th Act), could be used for the abovementioned purposes.

One of the main aims of our research ("Woody biotop systems project", supported by The Hungarian Scientific Research Fund – OTKA, T043417), is to come up with acceptable ideas to reform agroforestry practices in Hungary.

History of Agroforestry in Hungary

Development of agroforestry-systems in Hungary started with *pannage*, through defforestation of forest to increase grazing areas. Initially, settlements of ancient tribes in the Carpathian-basin deforested areas to increase the available grazing lands. Besides the traditional transhumance grazing, *pannage* in oak-forests was mentioned in 1353 and these with the similar "pick-feed" grazing forests were common for centuries afterwards.

High densities of goats caused soil compaction and grazed seedlings, preventing regeneration. Hence, in 1769, during Queen Maria Theresia period a Regulation prohibiting goat grazing in forests was established. The use of cattle to graze seedlings was permitted. Until the 19th century (and further) the problem of forest grazing could not be solved, because the liberated tenant farmers were rewarded with areas of forest. By the end of the 19th century, the definition of "grazing forest" and "protection forests" became embodied in contemporary law. Grazing forests as a landuse option was defined when tree cover of 20–40% built up as forested tracts or by thinning of existing forest. The concept was familiar: forest management alone could not affect the development of a region. Also needed was modernization of infrastructure of sectors like agriculture. In 1923 an Act (XIX) "afforestation of plains" ordered the establishment of shelterbelts, tree rows and hedgerows, particularly on farmlands bigger than 50 ha and on grasslands with more than 20 ha. Forest grazing was prohibited in 1939 after the renewal of forest law.

The establishment of modern Hungarian forestry started after the Second World War (WW). The transfer of forest areas and forestry properties to the state ensured the establishment of an intensive forestry industry. This act basically changed the ownership structure and it introduced modern techniques in all forests in the country. Besides centralized control, it laid the foundations for long-term management. Before the Second WW the main aim of silviculture was profit, which caused irreversible damages to the sustainability of forested lands. After the war, reconstruction and restoration used up the forestry resources, but it was the start of a 10 year period of rapid forestry revolution. Reforestation happened to be the most important task of silviculture: establishment of new forests started quickly and the following 25 years were described as "the era of great establishment of stands" in Hungarian forest history.

Between 1946 and 1950 – as the first step in the great afforestation program – 136,000 ha were reforested (46% was naturally regenerated, 79,500 ha artificially regenerated). Trees were planted at a rate of 10,000–20,000 ha year^{-1} between 1951–1960 and the naturally reforested area was around 3,000–5,000 ha. Among the results achieved during this decade was the establishment of new forests in huge areas at higher level and of higher quality than previously. Natural regeneration priorities such as species selection were determined by research in the Silviculure Department between 1952–1968. Fast-growing species were preferred and the mechanization for stand establishment operations was imported from the Soviet Union. These events brought about changes in the type of technology used and determined the future operation of forestry over the next 50 years.

The natural climate is unfavourable in many ways in Hungary. Therefore forests with protective functions were important for a long time in ameliorating living conditions and environment, e.g. protecting urban or rural areas from dust storms caused by spring winds. Evidence can be found of efforts to establish forests on bare hilly areas and on the Great Plain of Hungary over a hundred years ago.

The Council of Ministers No. 1040/1954 decree was the first order which declared the multipurpose use of the forests addressing the enforcement of the environmental role of woody areas: "Care should be taken that forests fully meet their wood-producing, arable land sheltering, water-management controlling, soil protective, climate modifying, health-protective, aesthetical and other functions". The main functions of protective afforestation was to prevent soil erosion, avoid floods, to protect forest roads, railways, bridges and buildings on hillsides or other exposed areas. Trees were planted to provide shelter from the wind around hospitals, sanatoriums, farms and other estates (Keresztesi 1991).

On the other hand, the rapid development of agriculture in the 1960–1970s resulted in the establishment of farming systems forming large fields, in which use of heavy machines and aerial chemical control were widespread. Biodiverse good quality agricultural lands became bare, erosion and deflation occurred, the fauna of these areas, which also play a role in biological protection, started to decline. Only roads, railways, open surface water and the infrastructure of settlements and farms limited the expansion of these large fields.

To counteract this, protective afforestation needs to be established in cultivated areas with forest-belts and hedgerows which are be resistant to biotic and abiotic changes and suitable for multipurpose management. These forested areas can also be utilized for local timber needs.

After 1989, following political changes in Hungary, about 23.6% of the forest area was privatised. Most of the forest areas and properties remained in state or other common ownership (60.3%) and there is still 16.1% of forest area with uncertain ownership, due to the privatisation (Keresztesi 1991). Table 21.1 shows the protective forest areas of Hungary. To control and protect sustainable forestry with a legislative tool, the Parliament passed the LIV. Act of 1996 concerning forests and their protection.

The major goals of the current forest policy are (i) to organize co-operation between the interests of the management, owners of the land and the demands of society to run forestry in a sustainable way and (ii) to maintain the current rate of natural and semi-natural types of forest stands, made up of a high proportion of native species (Barátossy and Verbay 2001).

Table 21.1 Forests with primary function of environmental protection between 1975–2001 (After Keresztesi 1991 and Bán et al. 2001)

	1975	Planned for 1976–1990	2001
Type	(1,000 ha)		
Green belts	8.8	20.6	16.4
Soil protective forests	86.5	59.6	121.8
Forests for landscape and nature conservation	46.4	19.0	10.5
Protective plantations outside the forest	22.6	10.8	77.2
Total	164.3	110.0	225.9

Ecological Implications of Agroforestry Systems in Hungary

In the last few years the role, function and the protection of the countryside have been significantly re-evaluated. It is accepted that the countryside is not just for agricultural production, but also biological and social living-space, in which these functions complement each other.

The main types of agroforestry ecosystems in Hungary are areas such as forested pastures, shelterbelt-systems and other non-forest areas (where there are some trees but which are not classified as forest under the law). For example windbreaks (3–6 rows wide afforested belts made out of tree rows and/or hedgerows, protecting again wind, snow or sandblow) in agri-environment areas aim to protect crops and pasture growth against the harmful effects of the wind, as well as enhancing biodiversity by providing ecological corridors and promoting animal welfare. They also assure protection and cover for farming practices, stock-breeding, cultivated areas and their associated infrastructure. Establishing new windbreaks can also counteract the annual snow risk and also enhance the landscape, helping to change the whole region for the better.

Shelterbelt systems (meaning all protectional afforested areas bordering cultivated areas, where the area of the shelterbelt is less than 10% of the agricultural areas) are very important to agricultural production as they conserve soil and add spatial heterogeneity to the ecosystem. A well constructed shelterbelt can provide connectivity between the biotop-mosaics and the migration of wild animals (e.g. pheasant, roe-deer) connected to farmlands.

Special attention must be paid to the maintenance of afforested belts especially along roads and railroads, where the afforested belts act as a barrier from agricultural land. Another objective of shelterbelts is to protect against build up of drifting snow. Experiments have shown that artificial snow-catching barriers are only temporary, less efficient and more limited in protecting the traffic against snow accumulation than natural ones.

By establishing new shelterbelt systems we can achieve landscape variability and amenity especially in treeless areas. Well designed shelterbelts with a native species, proper structure can connect core-areas (greenways). The planted greenways have a slightly lower ecological value than wildlife corridors and will evolve into self-sustaining systems through time, by using well-chosen management and methods.

The importance of these afforested belt systems has promoted research during the 20th century. Some experiments dealing with agroforestry systems have been carried out in the recent past. Shelterbelts on farms to prevent snow drifting were established in the region of Sopronhorpács, Sarród from the late 1940s till the early 1970s, by the Department of Silviculture. One of the main goals of this research was to survey the existing shelterbelt systems to estimate their actual functions. We also tried to classify the main windbreak types established in 1950–1960s by their functions, structures and species composition, evaluating the effects and results of the applied silvicultural operations. From this work and including nature conservation and economic objectives, new recommendations for the formation, maintenance and regeneration of new types of windbreak can be proposed.

On the other matter, several agroforestry research experiments have been planted between 1957 and 1965. Although the experiments were mostly focussed in afforested belts (windbreaks and shelterbelts) the tree effect could partially be extrapolated into other types of agroforestry systems like silvopasture or forest farming. The results aimed to compare afforestation programmes between different parts of the country with similar conditions and to present techniques for establishment and management of afforested belts and other types of agroforestry. The main aspects evaluated in these experiments were afforested belts-microclimate (measuring wind speed, soil- and air temperature, air humidity, soil humidity, snow and rain distribution), the positive and negative effects of afforested belts on air pollution, plant protection and phytocoenological studies, shadow-effect and heat-stress. They also aimed to make an economic evaluation of the effects of the afforested belts on tree and pasture or crop production. This analysis would help form the basis of new recommendations for the delivery of new agroforestry practices (Frank and Takács 2003).

Microclimate (82 afforested belts) and snow-distribution (23 afforested belts) measurements were made over 3 years on 14 agricultural areas in Hungary. Air pollution analyses were carried out in a system over the year by measuring dust deposition and phytocoenological studies were conducted in 52 afforested belts. Pasture yield was assessed over 4 years and timber production of the shelterbelts was evaluated in some plots. The role of different tree species in windbreak systems was assessed.

The main results from this research can be summarized as follows:

1. Forest belts improve all the climatic, edaphic and biological factors and, as a result of this, they protect the soil in agricultural areas and improve yield and timber production.
2. Windspeed suppression in the area protected by the forest belt changes climatic and edaphic conditions and has an effect on biological processes. Wind reduction in front of the forest belt depends on distance from the belt. In the case of dense belts, the effect is felt 2–22 times the belt's height, 4–42 times for porous belts and 5–10 times for permeable belts. At the protected side of forest belts, the protected zone is 10–29 times wider than height in the case of closed belts. In gappy belts this zone is 20–51 times wider. In open belts, the protected zone is 10–20 times wider than its height.
3. Forest belts do not affect the amount of precipitation falling on the field, but their favourable effect on the precipitation of rainwater and snow is demonstrable. On the windward side, there is more rainfall (17%). In the case of wide, dense forest belts, the snow accumulates inside the belt, in medium-wide porous belts. The snow fortification's maximum height is on the windproof side, while in narrow, open forest belts snow aggregation risk is reduced.
4. Forest belts ameliorate the effect of evaporation on protected fields.
5. In daytime, up to 5 × tree height distance from the shelterbelt, the average air temperatures are lower than in the middle of the field. The opposite effect occurs at night time.

6. In fields protected by forest belts, the relative air humidity of the air layer above the ground surface is higher than on open, non-protected fields. In the forest belts' protected zones, the relative air humidity is 5–10% greater in most cases, and in extreme cases can be 38% above that found in open fields.
7. The snow catching capacity of a 15 m height shelterbelt at different distances from the shelterbelt was highest in a north-south orientation (Fig. 21.1).
8. Forest belts have an important function in protection from deflation and in diminishing air pollution. The air pollution study showed that on peat and on mull soil the dust content of air can reach 1,100 t^{-1} km^{-2} $year^{-1}$ (200 t^{-1} km^{-2} $year^{-1}$ on industrial fields, 50 t^{-1} km^{-2} $year^{-1}$ on living space).
9. The phytocoenological results showed that specific forest plant associations do not evolve in forest belts.
10. Pasture and crop yield was significantly increased by the presence of shelterbelts in proportion to the belt's site corrective effect. Where the protective effect is high, yield increase is greatest and where the affect is low, the yield is low also.
11. In forest belts the volume growth is especially rapid. From this it could be established that forest belts and belt systems have particular roles in controlling wind damage, increasing yields and have an important function in landscape aesthetics and in habitat improvement.

From the study of created forest belts it was found the following main technical conclusions:

a. Creating a regular grid at right angles to the prevailing wind in densely populated areas with roads, canals and intersected by water-courses is not possible and unnecessary.

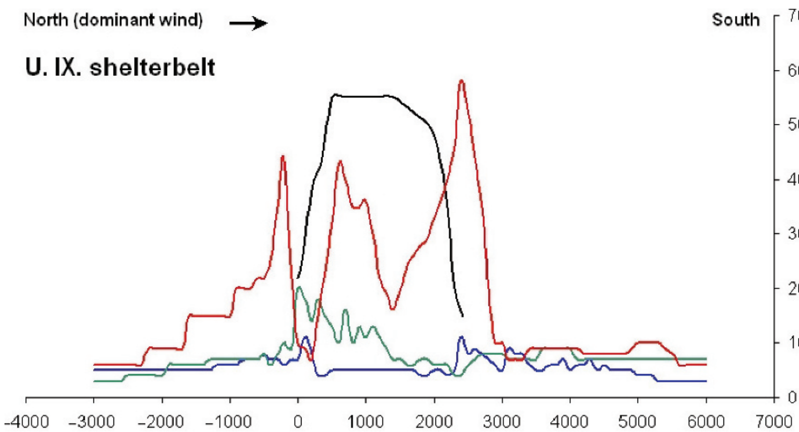

Fig. 21.1 Snow accumulation in a forest-belt at Sarród, 2004. Horizontal axis is distance in centimetres, vertical axis is snow deposition in millimetres

b. In locating forest belts, site conditions and rural output are more important factors than size.
c. Forest belts should be as wide as possible.
d. More attention should be paid to silvicultural properties in choosing tree and shrub species, especially their compatibility, sproutability regenerative capacity and their conservation and environmental protection value. Only use native and non-invasive species.
e. Effective protection can only be achieved by using structurally well-developed forest belts (snowbreak, deflation protection). Maintenance of this structure is necessary along the whole length of the belt.
f. It is very important to ensure the support and co-operation of private owners and state organisations when creating and maintaining forest belts. An agricultural subsidy support system needs to be supplied.
g. Do not forget that afforestation and tree planting will only give effective protection if they follow a standard system with the current forests, and clusters of trees. Afforestation has a similar effect but needs the requisite of spatial interconnectivity.

The Potential of Hungarian Agroforestry Systems

How can agroforestry systems contribute to the expansion of the Hungarian forested area? How can these spatial arrangements of woody plants be harmonised with the landscape, or how would new plantations integrate with or modify the current (or proposed) protection areas with or without tree cover? These are ongoing questions which should underlie the principles of environmental protection.

It must be realised that the integration of agriculture, forestry and their associated infrastructure make up what we understand as the natural and built heritage. Hungary is basically an agricultural country, as most (84%) of its land is a cultivable plain under 200 m and is highly productive. Over time the transport infrastructure (all road and railway networks) of the countryside was developed to meet the economic needs of the population. Agriculture, forestry and hunting developed side by side to form the regular and regional institutions which exist. Although we are taking forestry as the cultural landscape, the task is to put new thinking into issues of the landscape and traditional forest-management, based on such integrated studies. A strategic goal is to increase forest cover up to 25–27%, which would be reached by planting 15,000–18,000 ha year^{-1}. It is important that this aligns and evolves with current EU agricultural policy. One of its main elements is the utilization of specific agricultural areas for afforestation. There are potentially about 700,000 ha of arable land, which could be potentially taken from that land use category (Bán et al. 2001; Mészáros et al. 2003). To develop a region it is essential to look closer at its characteristics and to find the significant influences which shape the landscape. This information is necessary to introduce the conditions of the studies.

In 2000 the land area of Hungary was 93,030 km^2, which included 49% arable land, 15% other rural and 19% forest area. The distribution of land use in the Györ-Moson-Sopron County (GYMS) is similar to the country as a whole – 53% arable land, 10% other rural activities and 19% forest (Bán et al. 2001). The area is flat plain (Little Alföld of Hungary), but the climate is considerably influenced by the Alps and the dominant cold, strong north winds coming from the Wien basin. The region's natural potential (e.g. hydrogeology, productive soils) and geographic position (it has boundaries with two EU countries) with rich cultural heritage makes the county well placed to consider new, innovative land use ideas.

The potential of agroforestry systems will be evaluated in the GYMS region, but most of the results could be applied in the rest of Hungary. The evaluation of the different agroforestry systems will be structured in shelterbelts, windbreaks and roadside forest belts as well as alley crops (crops for interrow use on afforested areas) and silvopastoral systems, highlighting recent tree planting in grasslands.

Shelterbelts, Windbreaks and Roadside Forests

The area of all protection forests (soil, water, settlement, etc.) in Hungary is 225,862 ha (12.6% of all forest areas) (Table 21.1). There are only 16,416 ha of woodlands protecting agricultural fields. These are mostly shelterbelts and windbreaks with valuable timber. It is also worth mentioning that there are 11,393 ha of forest for other settlement protection functions.

At a regional level, estimates are more accurate and the total area of protectional forest is 4,726 ha. Thus, only 17% of the forests in GYMS-county have any protection function. From official forest data, 799 ha are for soil protection, 1,864 ha protect agricultural areas, and 570 ha are for further settlement protection.

Protected forests have well defined boundaries although they differ in management from the classic forestry management in Hungary. Hence we would like to deal with the afforestation of verges of motorways and ordinary roads. We find similar situations for roadside alleys, shelterbelt systems and road trees: all were planted (some of them restored) in the 1950–1960s. Most of the plans and documentation has been lost, only fragmentary records and examples of successful scenarios give an indication of the original aims and objectives.

Motorways and ordinary road verges have some important functions. They have a multifunctional use as protection, a habitat for wildlife, economic value, subsidiary use and wood production. This paper is concerned with such collections of trees and the economic, social and other additional benefits they bring. These trees can be categorised as belts like tree rows or alleys along railway tracks, windbreaks, shelterbelt systems, forests with protective functions and other continuous forestations/plantations (alleys, hedgerows, green-junctions). The margins and buffer zones have additional values such as subsidiary use as silvopasture. This multifunctionality associated with the margins will be discussed later.

It is clear that shelterbelts have been planted to reduce the damaging effects of strong winds in Hungary, mostly traditionally in lowland areas and mountain plateaus or wide valleys where a wind-tunnel effect is created. As a result of ownership changes after 1989, the farm structure diversified and nowadays shelterbelt-systems and the connecting forest areas allows some kind of multipurpose management on rural field and roadsides causing a review of the wood producing capacity of belts and rows.

Any piece of land can be divided into two parts – an outer and inner-belt. The function of the outer-belt is to permit the movement of livestock and machinery. This area should be sited to meet local conditions along the borderlines of the area, taking into account the prevailing wind direction and landscape.

The rows of trees that make up the inner-belt are perpendicular to the prevailing wind direction and the interrows are 20 H–25 H wide, where H is the average final height of trees. The main belts can be supplemented with perpendicular cross-belts.

Size and position should be according to the benefit that the agroforestry system can deliver. On hilly sites, forest belts should follow the valleys and additional belts planted around the sides of the hills. Shelterbelt systems would normally use 4–5% of the landscape on the plains and 8–10% on hilly sites to give the protection needed (Hegyi 1978).

Most shelterbelts were established in the past 40–50 years. In addition to the market value of their function, they also have non-market values such as conservation, landscape protection and retention of the ethnic significance of shelterbelts and farming methods. Some native shelterbelt tree species like *Pyrus pyraster* (L.) Baumg, recent invasive species such as *Prunus serotina* (Ehrh.) Borkh. and, for example, windbreak trees like sensitive *Populus alba* L. play an important role in this context.

Two representative windbreak systems were surveyed and studied between 2003 and 2006. The aim of this was to identify the changes over recent decades and analyse the future possibilities for regeneration, expansion, etc. The examples chosen were established after Soviet models and are representative of how the fields and forest strips complement each other.

The first example was a 17 ha windbreak system in Sopronhorpács (30 km south of Sopron), started in 1949 and finished in 1960. These belts protected 12 km^2 of land and crops (sugar beet, corn, etc.) against the wind. Some areas such as marginal hedgerows or in-row planted scrubs also functioned as snow-fences. Originally this system was called "experimental forest-belt system", which served the local Agriculture Research Institute for 40 years. The main species planted are *Acer* sp., *Quercus* sp., *Fraxinus* sp., *Tilia* sp. and *Robinia pseudoacacia* L. The commonest shrubs are *Rosa* sp., *Lonicera* sp., *Ligustrum vulgare* L. and *Maclura pomifera* (Raf.) C. K. Schneid. Some relatively rarely used species like *Gleditsia triachantos* L. or some *Salix* and *Populus* species were included to see how they would perform. From records and their present function it can be concluded that the desired aims of these belts, i.e. soil-, crop- and snow protection, were very successfully achieved. After a complete structural and silvicultural analysis, management in the near future should include thinning, replacement, regeneration and possible expansion of the length of these windbreaks (Takács 2003).

The second example was at Sarród-Nyárliget (Fig. 21.2), an area with a spacious shelterbelt, windbreak-network planted to protect the organic, boggy meadow soils on the eastern side of Lake Fertö. There is an area of 10 km^2 protected by 13 ha of forest-belts. These belts are mainly made up of species of genus *Populus*, *Quercus*, *Acer*, *Tilia* and *Ulmus*. Similar to the Sopronhorpács example, the spacing of the trees is 2 (3) m interrow and the plant-to-plant distances are 1–4 m, depending on the number of rows and local conditions. There are 30 forest-belts which influence the local rural landscape and have the widespread function of soil protection (Pintér 2003).

The same silvicultural tasks as in the previous experiment, thinning and regeneration, were necessary and the same functions of soil, wildlife and crop protection were fulfilled. Such shelterbelt systems (or at least their remains) can be found all over Hungary. It is in everyone's interest to explore, conservate and regenerate, these forgotten or scarce shelterbelt systems.

Windbreaks are beneficial in decreasing the speed of wind and in this way dissipate the active energy of soil- and snow-elements. When there are very strong winds from a typical direction, accompanied by a lot of snow, the effectiveness of the windbreaks is also reduced. Even one or two rows of a hedgerow can allow a considerable amount of an occasional 6–10 cm snow-fall when the wind-speed is 4–20 km h^{-1}.

The most complex a barrier to the wind's flow and direction, the better the expected result. The turbulence caused by the jointed structure will change the movement of the wind-vectors, the energy of transported snow and, deposit snow

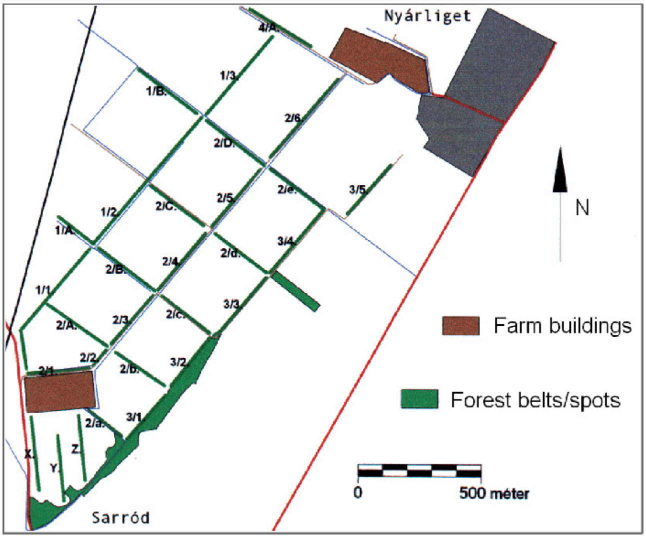

Fig. 21.2 Windbreak and shelterbelt network system at Sarród

on the lee side of the belt in the area between the windbreak and a row of trees or in a ditch between the row and the road (Ivelics and Takács 2006).

These windbreak-plantations can be combined with short-rotation linear tree energy plantations, which can be established on agricultural areas at adequate row- and stem-spacing. With fast-growing species such as hybrid poplars, osiers, black locust, plane or ailanthus planted on a 3-years rotation, yields of 15,000–20,000 kg ha^{-1} DM $year^{-1}$ are possible on first class sites.

A suggested planting (T) and harvesting (B1, B2) model of a four row wide forested belt is shown in Fig. 21.3. The second two rows (B2) would be planted after 1 year, to strengthen the first two rows (B1). The first harvesting period is year 4–5 and regeneration will be needed after the second harvest, 7–8 years after the establishment of the belt.

It is recommended to plant and establish energy plantations for snow-shields with twin-rows. Due to the harvest-technology, the two twin-rows should be planted 1 year apart. This assures continuous coverage and more structural and three-dimensional variation in the levels and effectiveness of the windbreaks.

Replanting is only required after five to six harvesting periods, because the plantations maintain their capability to regrowth quickly for 15–20 years. Efficient and economic harvesting machines are available to harvest these short-rotation plantations. Such plantation-like-windbreaks could help the economic viability of agricultural areas and promote the development of the countryside. The energy crop material out of these belts should be a source of production based on renewable energy.

In addition, the windbreaks would not lose their original functions, as shortly after planting they will be providing protection against snow and wind in agricultural areas.

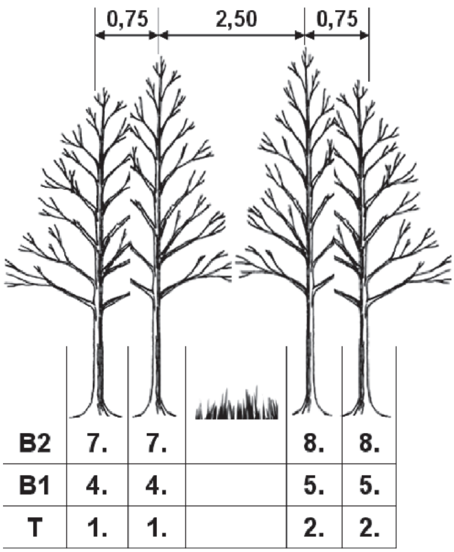

Fig. 21.3 Biomass production cycle in a forest-belt

The extraordinary snow-falls in recent years have taken road users and road maintainers by surprise. West-east snow-drifts mainly were reblown back into the road after they had been initially cleared. Features across and along the road such as ditches, traffic signs, trees, etc. consolidated the snow drift on the road in the absence of other snow-shield objects. For example, in Györ-Moson-Sopron county the officially recorded windbreaks are on 36 ha with 17 km of protected road-length (Takács and Ivelics 2005).

The road network of Györ-Moson-Sopron county is well distributed, mostly in a north-south orientation. The borders, the border crossing points and the two big cities (Györ and Sopron) influenced the radial and diagonal "distortions" and various road network directions. The main road network has 472.3 km of motorways and priority roads. Most of the roadside verges were planted with tree- or shrubs rows. As would be expected, there are several roads protected by old or newly planted forests, but unfortunately windbreak planting is infrequent in the county. Some of the major snow catching shelterbelts are at an age where they must be cut down and replanted to ensure continuity and traffic safety. In parallel with the development of the road network, it is necessary to integrate the landscape elements by connecting the man-made elements with those that have biological value.

A survey to estimate the tree species and windbreaks on roadside sites was carried out to investigate the old management system and give new guidelines on regeneration and planning of tree rows and other green belts along roads in collaboration with the road maintainers and the neighbouring farmers.

As well as being of aesthetic value, the traditional functions of roadside trees are to protect the outline of the road and lend structure to the area by delimiting land plots (fields) or other features, thereby naturally enhancing the landscape. They also improve traffic safety and protect the traffic against wind and snow.

To describe new structures and methods, it is necessary to define species suitability and the framework within which they will be planted. In recognition of the change in need and emphasis for shelterbelts more importance must be assigned, for example, to improved traffic and road safety. This can be done by comparing the actual conditions to the standards which were laid down some time ago. In light of all previous knowledge and experience roadside tree management (including regeneration) could be planned in a modern way involving decision support mechanisms and a systematic approach (Takács 2005).

Areas suitable for new afforestation are being reviewed to meet recent objectives. The potential areas for establishment of new plantings, windbreaks, shelterbelts and farm-forestations are the elements of the network. Potential sites for shelterbelt systems can be planned at a country level by setting down selection and designation criteria and by using geographical information systems (GIS), based on the digital maps, aerial photos, satellite pictures, State Forest Service and other databases. These territories should be areas of land which can be utilized for this aim and adequately meet the protective functions of the forests. On suitable sites the aim is to match conditions and expectations as much as possible.

In addition to the well-tried, traditional species there are some problematic, aggressive, spreading species such as black locust (*Robinia pseudoacacia* L.), black cherry (*Prunus serotina* Ehrh.) or Manitoba maple (*Acer negundo* L.). There is also the opportunity to plant other windbreak species such as *Populus nigra* 'Italica', replacing snow sensitive species currently growing on the road margins (ornamental or old trees, *Celtis occidentalis* L.). To minimise the ravages of diseases, like horse chestnut leaf miner (*Cameraria ohridella* Deschka & Dimic) or *Lymantria dispar* L. and risks from other potential problems mentioned above, a good structure and healthy conditions need to be ensured. Most of the roadside (alleys and windbreak) trees will reach their felling age (50–90 years) in 10–20 years, as shown in the poplar rows in Fig. 21.4. It is necessary to formulate special management protocols which would not disturb the traffic or agriculture. This will help preserve the existing natural habitats and the marginal semi-natural areas by ensuring continuous coverage with gradual regeneration.

Those responsible for the management of the road trees and forest belts should be aware of their responsibilities and road maintainers must be give the necessary up-to-date technical training to maintain and manage regeneration and planting of new rows. The integration of forestry and other contractors, into roadside management should be considered.

There is plenty of literature on forest regeneration in Hungary, but little relevant to roadside trees and forest belts. It is not known how these green rows of trees and silvopastoral sites will be regenerated. To reach the strategic forestry goal, i.e. increasing forest cover to 25–27% by planting 15,000–18,000 ha year^{-1} these issues will need to be addressed over the next 5–10 years.

Fig. 21.4 Roadside poplar rows in GYMS-county

The present agriculture and forest policy must comply with EU directives and there must be redefinition of EU classifications to accommodate the unique forestry and agriculture land use types found in Hungary.

Alley Crops and Silvopasture

In the past, agroforestry systems were managed without the use of fertilizers, just using the high nutritional values of forest soils and decades of continuous grazing and animals returning to the sites. Despite their efforts, the fertility of these areas was reduced, they lost nutrients, the composition of plants was affected, mainly the sensitive plants in the undergrowth, and weak trees were shadedout by unmanaged forestry development.

Intertilled crops were grown in forests and used for cropping and seedlings. In the first year buckwheat (*Fagopyrum esculentum* Moench) was planted, followed by spice-producing plants, potato and corn in the second year, and when in the third year canopy growth was too dense to permit agricultural use.

In an area designated for forestry, after 2 or 3 years, tree seedlings started to appear. If saplings are extensively planted in the clearcut areas of seedling-forests, agricultural crops could continue to be grown in rows beneath the trees until the 5th–8th year when the seedlings had grown enough to shade them. This leads to a so-called “woody agriculture”, a form of agroforestry.

Because of the paucity of countryside pastures or this unfavourable use, it was common to graze the undergrowth and clearings in forests. These areas derived from fallows, stubbles or meadows after harvesting, and primary grazing fields (forest-grasslands). Forest grazing must always be carefully managed because if it is not at the right time (e.g. avoiding bud sprouting) and place, it can cause serious damage.

Forest grazing was a common practice in the 19th century, opening up closed forests, and allowing grass to grow under the canopy and in clearing. The main tree types in such forests were vörösfenyö (higher regions), oaks, chestnut, wild fruit-trees. The fodder value of forest grazing was approximately one quarter of that from meadows.

Currently people realize the need for official control and regulation of the relative potentials of grazing land both in forests and meadows. They are aware of the reduction in nutritional value of swards, the slowing-down of the humus producing process, erosion, deflation, compaction of soil, forest renewal, declining water supply to households and problems with the abiotic components of the landscape. Cattle created less problems than goats, sheep and horses.

Pannage is the grazing of beech mast and oak acorns with pigs from the end of September until the new year or later. Scarifying the forest cover leads to a rich and balanced acorn-crop. However, regeneration from acorns is almost impossible, not because of the lack of acorns; it is just because of the compaction and digging of animals searching for acorn, roots, snails and other edible material (Benkovits 1956).

However, traditional forest grazing has nowadays almost disappeared. There are no more shepherds or competent people and the area of grassland has declined. The role of pastures has declined against the use of stock-yards. Meadow and grassland management is localized into small scale areas for producing quality green forage. There does, however, seem to be hope for renewing old traditions under the newer type of ecological management which is becoming more common in Hungary. There is now the possibility of re-discovering the facilities of forested grasslands and developing them into agroforestry systems.

Grassland Afforestation

Afforestation on grasslands with forested plots and regular plantations can add additional value to the grassland ecosystem. In some cases this is the only way to maintain a meadow on which species like negundo (*Acer negundo* L.) or black locust (*Robinia pseudoacacia* L.) can spread. At the same time, trees on grassland will help soil protection, prevent waterlogging, desiccation from wind and sunshine and protect grazing animals against the harmful effects of the weather. Figure 21.5shows fenced pastures in the Fertö-Hanság and Örségi National Park area near Sarród.

Tree species for grassland afforestation should be grown rapidly under the site conditions and complementary species would be wind-proof deciduous and

Fig. 21.5 Trees protecting pasture near Sopron

coniferous species. Scrub and low-growing species could also form edges. Physical protection is best obtained from spiny, pickly species like honey-locust (*Gleditsia triacanthos* L.) and blackthorn (*Crataegus monogyna* Jacq.).

Stock-farming or plant-growing with supplementary trees, forest plots or shelterbelt can give enhanced yields due to the protection offered by the trees, a good example of multi-functionality. When agriculture activities are introduced into forests, every effort should be made to have minimal effect on the ecology of the forest. When planting trees such as birch, poplar, maple or pines into grasslands the correct grazing density of livestock must be chosen.

From experience, multifunctional forest management or agriculture is needed where the natural resources are so reduced, that the farmers have no other choice. If areas that need similar management are integrated, all the potential benefits can be obtained from the interaction of forestry and agricultural species.

Future Perspectives of Agroforestry Systems in Hungary

Tree species which are native (*Quercus* spp., etc.), tall, shading (*Tilia* spp., *Acer* spp., etc.) and/or fruit-producing (*Pyrus* spp., *Prunus* spp., etc.) have a key role to play in the development of agroforestry systems in Hungary. Treatment, management plans and directives need to be specified to: (a) remove windbreak-sensitive species (*Populus* spp., etc.) (b) suppress aggressively spreading introduced species (*Prunus* spp., etc.). However, some introduced species could be useful as natural barriers and for fencing (*Maclura* spp., *Gleditsia* spp., etc.). From currently available information, the most appropriate, shelterbelt types and pasture or crop tree planting patterns should be chosen to suit the particular site conditions and end use.

Shelterbelts containing the slower-growing species (these are usually not classified as forest area), are suitable for grazing if they are thinned to a wider-spaced structure which benefits the pasture. They can be located on agricultural lands, mostly close to livestock-farms, and animals can graze the herbaceous layer, the main ground cover vegetation. The tree spacing (2–3 m interrow and trunk spacing) facilitates cultivation and grazing.

The issues are how silvopastoral systems can contribute to the expansion of the Hungarian forest area and how can silvopastoral systems be integrated into the restructuring of existing shelterbelts or the establishment of new shelterbelt systems.

To address these issues the available resource must be quantified.

Combining forestry use and grazing on the same land base (silvopastoralism), allows a range of objectives such as multipurpose use of forest, timber and forage processing, landscape protection, protection from wind, revitalization of traditions or rehabilitation of individual farms to be achieved (Takács and Frank 2005).

Since accession to the EU the present agricultural policy has had to adapt to a certain set of common standards. One of its main policy elements is the utilization of particular agricultural areas for afforestation. It is proposed that about 700,000 ha of land currently in arable crops could potentially be converted to agroforestry.

Planting new forests with grasslands are a potential alternative way to use land in areas of poor productivity and arable lands with unfavourable site conditions. Based on research by the Hungarian State Forest Service, the potential area recommended for change of land use is 683,900 ha of arable land, 56,100 ha of pasture and 38,300 ha of meadow. From this area it is suggested that an area of 174,000 of afforestation be earmarked for the 2001–2010 period. It is necessary to study how the establishment of silvopastoral systems fits this concept.

These areas should have a tradition of farming, should be suitable for tree growing, should be suited to this type of land use and adequately perform the necessary soil protection and other ecosystem functions. Suitable sites will meet as many of these conditions as possible. Our research is at the stage of defining categories and conditions by studying a chosen sample area in the northeast of Hungary where data and information are available from the past 60 years both in agriculture (livestock, forage, weather) and forestry (forest, shelterbelts). To help draw up a viable proposal, a land owner can apply to different forums like the government, ministries and others funds for agricultural development and forestry (afforestation) grants to help develop the proposal.

Proposed structural changes in Hungary's agricultural policy, as a result of EU membership, will increase the economic objectives of afforestation and take into account wind-farming, landscape- and settlement-protecting functions of forests. The range and importance of these alternative land use options will expand. After the survey, long term planning must occur with a goal of increasing the rate of forest protection. The full potential of the land structures should be exploited based on past experience. Further research and involvement of all interested parties will be essential for optimal land use.

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