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AGROFORESTRY - POSSIBILITIES OF MULTIFUNCTIONAL LAND USE

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Abstract

The paper aims to point out the importance of applying the methods and technologies of agroforestry in the countries of the region. This is a practice that has been used with great success throughout the world, in different climatic zones. The advantages are numerous – besides increased crop production, benefits from properly designed and managed agroforestry practices include: economic gain, healthier environment, soil conservation and improved soil quality, sequestration of atmospheric carbon, increased biodiversity, improved landscape and many others. Though the possibilities for multifunctional land use are numerous, benefits large and quality of plants grown in association with trees often improved, in Serbia and other countries in this region agroforestry is not implemented enough. Some of the agroforestry components are separately applied in some parts of the region, e.g. wind protection belts, planting of soybeans or corn in the poplar plantations of E.A. cultivars, pig's nutrition in the forests of oak or beech. Methods and technologies of agroforestry that can be applied in temperate regions are much more numerous and this paper discusses some of them.

Key words: agroforestry, land, multifunctional use, benefits

Introduction

Agroforestry is not a new methodology or technology. It has a very long (although often forgotten, or with a different name) history - from man's earliest attempts at agriculture to the present time. Since the Greek and Roman Antique time, when olive trees contributed to the culture of wine, cereals and legume, it is one of the most integrated and intensive approach to agricultural production system that includes trees and shrubs as a very important component to achieve environmental, economic and social goals. Traditional agroforestry has progressively been replaced by more simplified production systems. Agroforestry has been modernized over the last years. It is no longer focused on single species plantation. It is now a side by side cohabitation of local field and forest species.

Agroforestry systems have often been neglected in Europe because administrative structures within many national governments have considered that only agriculture or forestry is legitimate within their remit. This has resulted in the loss of agroforestry systems in European countries and an impoverishment of the benefits that they provide (McAdam *et al*., 2008). But today, agroforestry becomes the part of the EU culture. This system can play a key role in meeting today's needs such as food security, climate change mitigation, water storage and purification as well as biodiversity preservation etc.

The integration of agriculture, farming and forestry can provide numerous benefits, because the land can simultaneously be used for many purposes and also make easier the transition from one type of crop to another as market demand.

But, agroforestry does require more planning than simpler land uses, because it must be taken into consideration the diverse needs of each component. In agro-forestry, combinations of trees, crop and livestock are designed and managed as a whole unit. In order to enhance the agricultural production, the biological and physical interaction between the crop and the livestock components are managed.

Agroforestry in Serbia

In Serbia, agroforestry is not applied systematically, organized and on large areas, but sporadically, intuitive and in smaller households. Some of the agroforestry components are separately applied in some parts of Serbia. Thus, for example, wind protection belts are very intensively and successfully applied in the province of Vojvodina, impacting significantly on increasing the quality and yield of crops. In order to obtain more stable ecosystems in Vojvodina and primarily prevent the removal of fertile topsoil by wind erosion, there is a great need to increase the network of forest windbreaks, which would also increase the current forest cover. By measuring the change of wind speed at several points in front of the belt, in the belt, and behind the belt, there were obtained values which indicate the effectiveness of the belt in reduction of wind speed.

Besides windbreak shelterbelts, in Serbia is sporadically applied planting of soybeans or corn in the poplar plantations of E.A. cultivars. Soybean intercropping increases soil microbial biomass, microbial substrate use efficiency, and soil N fertility. Soybean intercropping also results in higher aboveground biomass increment and higher soil N response efficiency of hybrid poplar trees.

Formerly more often used form for pig's nutrition in the forests of oak (acorns) or beech (beechnuts), now is again returned to practice, especially for the old pig breeds such as "Mangulica".

Photo 1. Grazing system which includes natural resources of pasture and oak woodland

The similar way of pig breeding is applying in Croatia with Black Slavonian "Pfeiffer" breed. Traditional Black Slavonian pig production is an outdoor, grazing system which includes utilization of natural resources of pasture and oak (*Quercus robur* L.) woodland with supplement of a small amount of corn seed or some other grains (~0.15 kg per head daily) (Karolyi *et al.*, 2010).

Benefits of agro-forestry

Research over the past 20 years has confirmed that agroforestry can be more biologically productive, more profitable, and be more sustainable than forestry or agricultural monocultures.

Temperate agroforestry systems are already widespread in many parts of the world, due to the fact that they can: increase crop yield, reduce soil erosion (losses of water, soil material, organic matter and nutrients), maintain soil fertility, some tree and shrub species can increase nitrogen in soil, decomposition of tree litter and prunings can also contribute to soil fertility, reclaim polluted soils, utilize solar energy more efficiently than monocultural systems, lead to reduced insect pests and diseases, moderate microclimates, create a healthier environment, enrich biodiversity and improve

landscape, provide a more diverse farm economy and stimulate the whole rural economy, leading to more stable farms and communities. Economic risks are reduced when systems produce multiple products.
Benefits of agroforestry are still insufficiently known, but they are numerous and significant.

Methods and technologies of agroforestry that can be applied in temperate regions

Windbreaks (also: shelterbelts, wind protection belts)

Rows of vegetation - linear plantings of trees and shrubs designed to reduce and redirect wind, enhance crop production, protect people and livestock, and benefit soil and water conservation.
Crop yield increases in fields adjacent to shelterbelts have been reported in many studies. These increases occur because of improved microclimates and better moisture retention, reduced wind speeds and thus reduced wind erosion and damage to crops. *Field windbreaks* protect a variety of wind-sensitive crops, improve crop yields and water-use efficiency, reduce wind erosion, and increase bee pollination and pesticide effectiveness. *Livestock windbreaks* help reduce animal stress and mortality, reduce feed consumption, and help reduce visual impacts and odors. *Living snow-fences* keep roads clean of drifting snow and increase driving safety. They can also spread snow evenly across a field, increasing spring soil moisture. *Farmstead windbreaks* enhance living and working environments, add value of home and help conserve energy.
The effectiveness of windbreak forest belts depends significantly from their density, height, width, permeability and choice of tree and shrub species.
As a rule, wind protection belts of tall, long-lived trees combined with shrub species, planted in rows perpendicular to the prevailing winds direction provide the greatest yield increases. In the case of areas where the direction of the prevailing wind it is not clearly defined, the belts can be built on all sides the fields in the rectangle or square form. In addition to its function to reduce wind speed, wind protection belts also reduce the evaporation from the soil and transpiration. They also affect on the balanced distribution of the snow cover preventing its removal, and increase the soil moisture. The fields that are protected by belts have higher soil moisture, and also higher air humidity. Crops differ in their responsiveness to shelter. Winter wheat, barley, rye, alfalfa and hay are highly responsive to protection, while spring wheat, oats and corn respond to a lesser degree.
Well planned shelterbelts can provide many benefits to livestock during winter and summer as well as screening noises, unsightly areas from neighbors, roads, and living areas and filter dust from roads. Odors can be diffused by properly placed shelterbelts and some odors can be absorbed onto the trees within the shelterbelt. They protect livestock from wind chill in winter and provide shade in the summer. This protection lowers animal stress and diseases, increases feeding efficiencies. There is also snow control and energy savings for heating during the winter period and cooling during the summer period.

Silvoarable (intercropping and alley cropping)

This is practice where trees are grown in rows with wide alleys in-between for cultivating crops. In this way, agricultural or horticultural crops are grown simultaneously with a long-term tree crop to provide annual income while the tree crop matures. Overwintering crops (i.e. autumn-sown) are very efficient users of the almost full light available over the dormant season of deciduous trees
Benefits from this method are numerous: wood or tree products are produced in addition to agronomic crops, with no reduction in crop yields. Crop quality and yields can be even increased by enhancing microclimatic conditions and increasing of soil nutrients. Biodiversity is enriched, wildlife habitat and corridors are created and aesthetic of landscape is improved.

Forest farming

The usual definition of Forest Farming System (FFS) implies that it is "*a distinctive approach to land management that combines management practices of conventional forestry with those of*

small-scale farming or gardening to attain an environmentally and economically sustainable land-use system." Most often, FFS is established by thinning an existing woodland or plantation to leave the best canopy trees for continued timber production and to create the appropriate conditions that favor the overtopped crop. It's not just a question of self-increase profits, but also special pleasure collecting or growing non-timber forest products as part of their cultural and family tradition. Many high-value specific crops, cultures and forest products can be cultivated or grown under the protection of existing forests.

It is a way of utilizing forests for short-term income while high-quality trees are being grown for wood products. The amount of light in the stands is altered by thinning, pruning, or adding trees. Existing stands of trees can be intercropped with annual, perennial, or woody plants. The most commonly are grown five main categories of crops: food - mushrooms, nuts, vegetables, honey from bee plants, herbs, fruits (blueberries, elderberries, blackberries, raspberries, strawberries, etc.), edible flowers, sap products (e.g. maple syrup), then botanical products (medicinal plants, ornamental (decorative plants), handicrafts (willows for basketry materials), short-term energy coppice and wood products (charcoal, fuelwood, etc.). Areas used for forest farming are usually small, and systems usually focus on a single crop plus timber, but can be also designed to produce several products. Economic benefits of forest farming can be significant.

Silvopasture

These systems comprise trees or shrubs deliberately introduced into a forage production system, the whole designed to produce a high-value tree component, while continuing to produce the forage and livestock component indefinitely or for a significant time. Deciduous trees (fuelwood, fruit crops as tree component, chestnuts, and hazelnuts) are more readily browsed than conifers. Trees can be planted at wide spacing, in rows with forage alleys between, or in clusters. Trees provide shade and wind protection, which reduce heat stress and wind-chill of livestock, so performance is improved and mortality reduced.

The combination of tree and pasture production has been recently promoted by the EU. Pasture production under trees produces annual farm outputs which promote long term rural population stabilization compared with exclusively forest systems.

Forest gardening (home gardening)

Designed agronomic system based on trees, shrubs and perennial plants. These are mixed similarly to the structure of a natural forest - the most stable and sustainable type of ecosystem in specific climate. These systems are biologically sustainable, productive and require low maintenance. The crops which are produced include fruits, nuts, edible leaves, spices, medicinal plant products, poles, fibers for tying, basketry materials, honey, fuelwood, fodder, mulches, game, and sap products. A large number of species used, gives great diversity and the careful inclusion of plants increase fertility of soil (f.e. nitrogen fixers).

A forest garden is organized in up to seven 'layers': Canopy trees - the highest layer of trees, small trees and large shrubs, mostly planted between and below the canopy trees, shrubs (mostly shade tolerant), herbaceous perennials, ground covers, climbers and the final 'layer' is the root zone or rhizosphere.

Forest gardens provide a long-term biologically sustainable system for growing food and other products for a household, requiring little work for maintaining.

Riparian forest buffers

Riparian forest buffers represent vegetation strips that physically separate agricultural land or pasture from water bodies. The main task of these protection belts, consisting of trees, shrubs, herbaceous plants and grasses is to prevent conflicts that may arise between agriculture or animal husbandry, and protection of water resources. Agriculture and animal husbandry are serious sources water contamination because they generate non-point source pollution. Plants in riparian forest buffers have the ability to filter and capture sediment, absorb and store nutrients, heavy metals and other pollutants that would otherwise enter the waterways. In addition, they prevent erosion of water banks and surrounding land through stabilization of substrates by their root system. Riparian forest buffers also act as a physical barrier that can prevent or reduce over-the-bank flood waters. These vegetation strips create suitable habitat for a variety of aquatic and terrestrial animals. Large trees on the banks form a shadow on the water surface and thus regulate the temperature of the water. Such trees and shrubs also provide birds and animals with food, shelters and nesting places. Riparian forest buffers are significant travel corridors for wildlife. Typical construction of riparian forest buffers can be seen in figure 1. The first zone (nearest to water) usually represents a narrow section of natural forest vegetation adapted to flooding conditions (AFTA, 2012). The primary role of trees and shrubs in this part of the belt is to provide stabilization of banks, a suitable habitat for aquatic plants and animals, and act as the last barrier for the filtration of substances that are removed by passing through the buffer. The second zone, which usually consists of fast-growing trees and shrubs adapted to periodical flooding conditions (AFTA, 2012). The primary role of vegetation in this zone is uptake, storage and decomposition of sediments, nutrients and other non-point source pollutants. The third zone is adjacent to agricultural fields or pastures and consists of grass and meadow vegetation (AFTA, 2012). It provides a high degree of infiltration, sediment removal and uptake of nutrients and other substances and facilitates in converting concentrated flow to sheet flow.

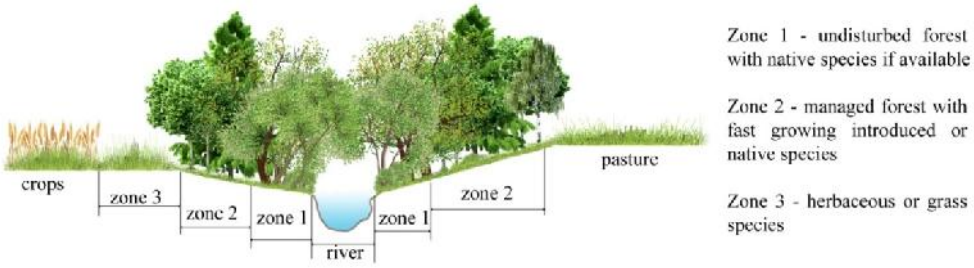

Figure 1. Different zones of riparian forest buffers (orig.)

Conclusions

Though implementation of agroforestry could considerably contribute to the improving of agricultural production and the quality of life of the population in the areas of with moderate-continental climate, it is insufficiently applied in the countries of this region. Besides the mentioned, benefits are large and numerous. In the sphere of environmental protection, trees and shrubs contribute the air, soil and water quality. The quality of plants grown in association with trees is often improved. Agroforestry practices can improve both terrestrial and aquatic habitat, as also landscape characteristic. Populations of many wildlife species often increase with the addition of trees and shrubs into agricultural areas, and this increase provides opportunities for recreational uses. Agriculture, especially those related to protected areas, as well as agroforestry in areas with high natural value are of great importance for the conservation of biodiversity.

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