Agroforestry Systems **42**: 61–80, 1998.

Streuobst: a traditional agroforestry system as a model for agroforestry development in temperate Europe

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Key words: biological diversity, fruit trees, orchards, sustainable land use, temperate zone agroforestry

Abstract. The development of agroforestry for industrialised countries can be furthered by an understanding of the history and present functioning of traditional systems. In temperate Europe, fruit trees were traditionally grown on agricultural land undersown with crops or managed grassland (*Streuobst*). The historical evolution of this agroforestry system has been driven by the interaction of technical progress, market development and intervention by public authorities. *Streuobst* reached its peak in the 1930s, but has since been in continuous decline due to the development of intensively managed dwarf-tree orchards. However, even today, it still occupies approximately one million hectares in 11 European countries and has a strong impact on the European fruit market. The profitability of *streuobst* is relatively poor due to its low labour productivity, but it has advantageous ecological and socio-cultural features, particularly in terms of biological diversity and landscape aesthetics. Accordingly, it finds strong acceptance among the general public, such that subsidised eradication programs have been abandoned and, in a number of countries, *streuobst* is now supported by non-governmental organisations and by state conservation policies. Modern agroforestry in temperate, industrialised countries should be oriented towards the creation of similar ecological and socio-cultural benefits in order to receive public support as a land-use system.

Introduction

Novel agroforestry systems are being developed as an alternative form of land use in many temperate industrialised countries (e.g. Gold and Hanover, 1987; Auclair and Cailliez, 1994; Gordon and Newman, 1997). However, relatively little is known about traditional agroforestry in these countries, although such information might hold valuable insights for the design and development of modern alternatives, as demonstrated by the research on Mediterranean agroforestry (see, for example, Glencross, 1978; Hubert and Allezard, 1987; Joffre et al., 1988; Poly, 1991; Pinto-Correia, 1993; Dupraz, 1994; Etienne et al., 1994; Bland and Auclair, 1996; Makhzoumi, 1997; Papanastasis et al., 1997; Bacharel and Pinto-Correia, in press).

The best known and researched traditional agroforestry systems in the temperate (as opposed to the Mediterranean and boreal) zone of Europe are hedgerows and windbreaks. They are still common in many European agricultural landscapes (Hahn-Herse and Bäuerle, 1979; Pavlovsky, 1993; Bazin and Schmutz, 1994; Reif and Richert, 1995; Burel, 1996; Balleux et al., 1997; Brandt et al., in press) and the ecological interactions among hedgerows and

the adjacent farmland have been analysed by, for example, Basedow (1987), Küppers (1992), Bairlein and Sonntag (1994), Schulze and Gersberger (1994) and Bernacki (1994).

Other traditional agroforestry systems exist, but have been less studied. Greif (1992) estimates that in Austria, legal regulations permit the pasturing of about 400,000 hectares of forest, feeding more than 80,000 cattle and 55,000 sheep and goats (von Maydell, 1994). In the Jura mountains of Switzerland, there are approximately 52,000 hectares of wooded pastures (Gillet and Gallandat, 1996; Herzog, 1998). In Britain (Brownlow, 1992; 1994) and Yugoslavia (Djordjevic-Milosevic et al., 1997) forestry is occasionally integrated with wild boar (*Sus scrofa* L.) and pig (*Sus scrofa domestica*) husbandry.

Another system, which is still widespread throughout western, central and eastern Europe, is *streuobst*. It is defined as 'tall trees of different types and varieties of fruit, belonging to different age groups, which are dispersed on cropland, meadows and pastures in a rather irregular pattern' (translated from Lucke et al., 1992, p. 10). It can be classified, according to Nair (1993), as 'plantation crops with pastures and animals' or as a 'plantation crop combination' (if the fruit trees are combined with arable crops). Tree density varies from about 20 to 100 trees per hectare or more. Fruit tree alleys along streets are also considered a form of *streuobst*. Fruit trees in gardens, on the other hand, are not treated as *streuobst*. Typically, the standard fruit trees have logs of length 1.60 to 1.80 meters or more, but half-standard trees occur as well (1.00 to 1.20 m log length). The most common fruit types are apple (*Malus domestica* Borkh.), pear (*Pyrus communis* L.), plum (*Prunus domestica* L.) and mazard cherry (*Prunus avium* L.). Other fruits which can be found are sour cherry (*Prunus cerasus* L.), Persian walnut (*Juglans regia* L.), quince (*Cydonia oblonga* Mill.), peach (*Prunus persica* (L.) Batsch), apricot (*Prunus armeniaca* L.), almond (*Prunus dulcis* (Mill.) D. A. Webb), mulberry (*Morus* spp.), sweet chestnut (*Castanea sativa* Mill.) and common fig (*Ficus sativa* L.) (Lucke et al., 1992).

In this paper, the historical development of *streuobst* is summarised and its present distribution is estimated. The system is evaluated according to its ecological, economic and socio-cultural properties. Possible lessons which can be learned from history and from recent public and scientific discussions about *streuobst* are then considered in the context of the design of novel agroforestry systems for temperate industrialised countries.

Streuobst – history and present distribution

The development of streuobst

The formal development of *streuobst* began in the 17th century when fruit production for market started to gain importance and fruit trees were increas-

ingly planted in the open landscape (Küster, 1996). Formerly, the majority of fruit trees had been kept for subsistence in homegardens. However, the new plantings suffered as a consequence of the wars and epidemics of these times (particularly the 30 years war 1618–1648), which depopulated and devastated entire landscapes. Among the measures which were later taken by the authorities to revitalise the landscape were the creation of nurseries and the publication of regulations which linked permission for citizenship or marriage with an obligation to plant fruit trees. Laws also made provision for the strict punishment of anyone damaging fruit trees (Weller, 1994). Extension activities were intensified during the 18th century, and priests, as well as school teachers, were asked to promote fruiticulture. In 1752, Frederick II (the Great) ordered that: 'In each village, a co-operative, well furnished tree nursery must be installed and run by a man trained in the handling and nursing of trees and capable of educating the villagers. In these tree nurseries, an adequate stock of fruit trees must always be available so that, once all gardens have been planted, the planting can be extended to streets in and near the village. (. . .) If a surplus of fruit is produced, it is to be sold to the cities' (translated from Lucke et al., 1992, p. 22).

The plantings started on sites with particularly favourable conditions, such as river valleys and south facing slopes, which until then had been reserved for vines. When wine production was affected by changing climatic conditions and pest attacks (especially by phylloxera *Viteus vitifoliae* Fitch), many vineyards were transformed into *streuobst* interplanted with crops and vegetables (Weller et al., 1986). In many regions, fruit trees were planted on roadsides in order to produce some food on this otherwise unproductive land. They were also planted on arable (mainly community) land (Lucke, 1990; Lucke et al., 1992; Wawrik, 1992; Weller, 1994).

Large-scale fruit production on farms mainly relied on robust varieties well adapted to the locality. In the early 19th century, pomological societies started to collect, describe and evaluate fruit varieties in order to select those of particular value (see, for example, Kittel, 1895). When the development of railways made it possible to sell fresh fruit to urban markets on a larger scale, the need for standardised quality production lead to the increased planting of selected varieties. Over decades, this process was encouraged by extension services (Lott, 1993).

The long-term success of *streuobst* plantings is confirmed by census data from the beginning of this century. In 1900, the average density of fruit trees across all agricultural land was 4.8 trees per hectare in the German Empire of the time; ranging from 1.3 in the province of East Prussia to 15.6 in the Neckar district (Kaiserliches Statistisches Amt, 1902). Thirteen years later, the number of trees of the four dominating species (apples, pears, plums, cherries) had increased by 13.2% (Kaiserliches Statistisches Amt, 1915) and the system reached its peak between the two world wars (Statistisches Reichsamt, 1940). At the same time, most silvoarable *streuobst* was converted to fruit tree meadows, which were easier to farm, and the development of

orchards managed exclusively for fruit production began. In 1938, 6.4% of the apple and pear trees on agricultural land were already in the form of dwarf trees, pyramids, spindle bushes and trellis (Statistisches Reichsamt, 1940). The development of orchards led to the desegregation of the agroforestry system into its components. The replanting of fruit trees increasingly meant using an orchard system, which no longer allowed for the production of an understorey crop. Mechanised crop and fodder production, on the other hand, was also more efficient if not hampered by trees.

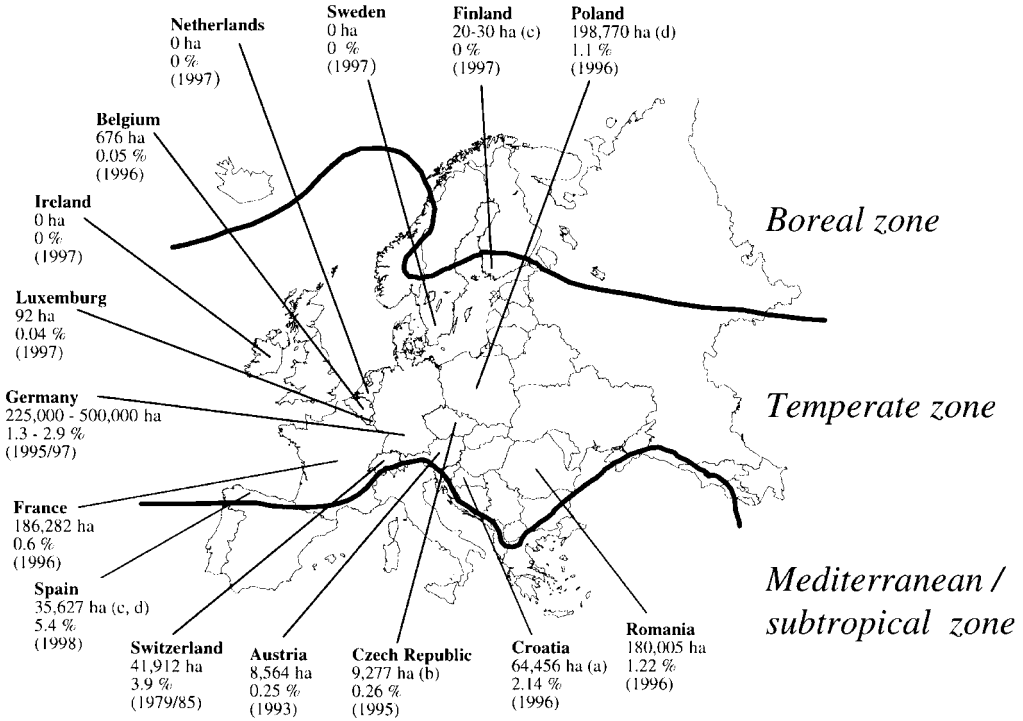
This lead to a shift of market-oriented fruit production from *streuobst* to intensively managed orchards (Table 1). Governments supported this process by subsidising the clearing of standard fruit trees. National programs were combined at the European level and, in 1969, the European Economic Community decided to support the removal of apple, pear and peach trees. These measures mainly addressed *streuobst*, which was no longer considered profitable (Opitz, 1970), but they also affected intensively managed plantations. From 1970 to 1972, in Germany, 17,239 hectares of plantations were cleared, of which 37% had been streuobst (Petzold and Hahn, 1973). In Southern Germany (Baden-Wurttemberg), roughly 15,700 hectares of fruit tree meadows were destroyed between 1957 and 1982; this corresponds to about 35% of the total area of *streuobst* in that region (Stadler, 1983). Similar reductions have taken place in most European countries. In Austria, the number of fruit trees in *streuobst* was reduced by 31% between 1968 and 1988 (Eichwalder, 1990). In Switzerland, there was an equivalent reduction from 1951 to 1991 of around 70% (Bundesamt für Statistik/Eidgenössische Alkoholverwaltung, 1993).

Streuobst in temperate Europe today

An enquiry regarding the current state of *streuobst* fruit production was sent to the national statistical services of 32 European countries located (at least partly) in the temperate zone. Only about half of them were able to provide the data requested, because agricultural statistics focus mostly on intensively managed orchards. The data which is available (Figure 1) provides a general overview on the current extent of *streuobst*. However, figures from different

Table 1. Percentage of fruit trees in Germany in intensively managed orchards, in *streuobst* and along roads according to fruit tree censuses between 1934 and 1965. In the 1965 census, fruit trees in *streuobst* and along roads were no longer recorded separately. Source: Statistisches Reichsamt, 1940; Statistisches Bundesamt Wiesbaden, 1954; 1966.

	Orchards	*Streuobst*	Alleys
1934	0.0	83.3	16.7
1938	3.3	82.1	14.7
1951	8.3	86.1	5.6
1965	34.5	65.5	n/a



(a) excluding olive groves; (b) designated as "extensive orchards"; (c) only the country's temperate part; (d) estimated from the number of standard fruit trees assuming 100 trees per hectare

Figure 1. Streuobst in some temperate European countries: overall surface area covered and share of agricultural land. *Source:* Pers. comm. of the countries' central statistical offices, except for France (Ministère de l'Agriculture, de la Pêche et de l'Alimentation, 1996), Germany (Rösler, 1995; Riecken et al., in press), Romania (pers. comm. 1998 Ministry of Agriculture and Food) and Switzerland (Bundesamt für Statistik, 1992).

countries cannot be compared directly because of the different years and collection guidelines they are based on.

In the temperate part of the Scandinavian countries, *streuobst* has almost completely disappeared. This is mainly due to the climate, which is rather unfavourable for fruit production, but also due to the intensification in those few regions where profitable production is feasible. The latter reason also applies to the Netherlands, where fruiticulture is concentrated exclusively in intensively managed orchards.

More toward the south, a belt of *streuobst* stretches through northern France, southern Germany and Switzerland to Poland. Amongst the countries which could provide relevant information, northern Spain and Switzerland are the countries where *streuobst* occupies the largest proportion of the agricultural area. About two thirds of the Swiss *streuobst* are located below 600 m above sea level, but some areas can be found as high as 1,200 m a.s.l. (Bundesamt für Statistik, 1992). The country's hilly topography limits the potential for converting meadows with fruit trees into intensively managed orchards or arable land. This limitation also applies to some extent to northern Spain and to the French departments Normandy, Lorraine and Alsace, where *streuobst* covers up to 4% of the agricultural surface (Ministère de l'Agriculture, de la Pêche et de l'Alimentation, 1996) and to the German federal state of Baden-Wurttemberg, which is famous for its *streuobst* landscapes.

It is mostly the silvopastoral form of *streuobst* which has survived. In France, only about 15,000 hectares are underplanted with other crops (mainly in the departments of Normandy and Rhône-Alpes) (Ministère de l'Agriculture, de la Pêche et de l'Alimentation, 1996). In the eastern part of Germany, silvoarable *streuobst* was re-introduced during the period of agricultural collectivisation in the former German Democratic Republic. Cooperative farmers were allowed to farm a small portion of land (generally 0.5 hectares) for their personal profit. Some increased the productivity of this limited area by combining fruit trees with crops such as potatoes (*Solanum tuberosum* L.), turnips (*Beta vulgaris* L.), oats (*Avena sativa* L.) and alfalfa (*Medicago sativa* L.). This type of *streuobst* is now only practised occasionally for subsistence. In Poland, where small-scale family farms are still predominant, fruit trees are frequently underplanted with, for example, vegetables, strawberries (*Fragaria* × *ananassa* Duch.) and other fruit bushes (K. Gañko, pers. comm., 1997).

Streuobst – a sustainable form of land use?

Land use is sustainable when – over generations – it supports the natural regulatory functions of landscapes (biotic, abiotic) while allowing for profitable economic activities and while providing an environment which enhances the physical and mental well-being of the people who live in it (Barrett, 1992;

Herzog and Gotsch, 1998). Therefore, the sustainability of land-use systems must be judged according to their ecological, economic and socio-cultural properties (Lefroy et al., 1992). In the following sections, the properties of *streuobst* are evaluated according to these three criteria.

Ecological functions

Streuobst is receiving considerable attention from advocats of nature protection because of its contribution to the conservation of biological diversity. This diversity can be assessed at three hierarchical levels: (i) genetic diversity, (ii) organismal diversity and (iii) ecological diversity (Heywood and Baste, 1995).

With respect to genetic diversity, fruit trees in *streuobst* consist of many varieties and types. These have often been selected locally by farmers and are thus adapted to specific site conditions (Marchenay, 1981; Kottrup, 1990; Heller, 1995). There are an estimated 10,000 varieties of apples and 1,000–2,000 varieties of plums in the world (Ramming and Cociu, 1990; Way et al., 1990). In Germany alone, there are about 1,400 varieties of apples and – altogether – 1,500 varieties of pears, cherries, walnuts and plums (Rösler, 1995). By far the largest proportion of these varieties can be found exclusively in *streuobst*, whereas commercial production in intensive fruit plantations is based on only a few dozen genotypes (Way et al., 1990).

The genetic diversity in *streuobst* is, however, decreasing. A case study in eastern Germany – based on field surveys and an analysis of the past and present catalogues of tree nurseries – revealed that in the area of investigation (about 700 km^2) the number of varieties has dropped by 55% since the beginning of this century, and that this decrease is likely to continue (Figure 2). Old varieties are being replaced by new ones, often provided by nurseries which operate at a regional level, thus local varieties are likely to disappear (Herzog and Oetmann, 1997). In order to preserve this genetic material, non-governmental organisations (NGOs) and national and international institutions conserve local varieties in gene banks and – more recently – on farm/*in situ* (see, for example, Case, 1996; Food and Agriculture Organisation, 1996; Gass et al., 1996; Schwärzel and Schwärzel, 1996).

There have been numerous investigations of species' diversity in *streuobst*; Bünger and Kölbach (1995) list 174 publications on the flora and fauna of this system. In a systematic inventory of *streuobst* sites in Rhenish Palatinate (Germany), 2,391 plant and animal species were counted, 408 of which were rare or threatened with extinction (Simon, 1992). This abundance of species can be explained by the numerous physical structures and ecological gradients found in *streuobst* (dry – moist, shaded – sunny, mown – not mown, exposed to – protected from wind), which create a variety of ecological niches and offer a range of habitats for plants and animals with different environmental requirements.

The type (pasture or mowing or both) and frequency of meadow utilisa-

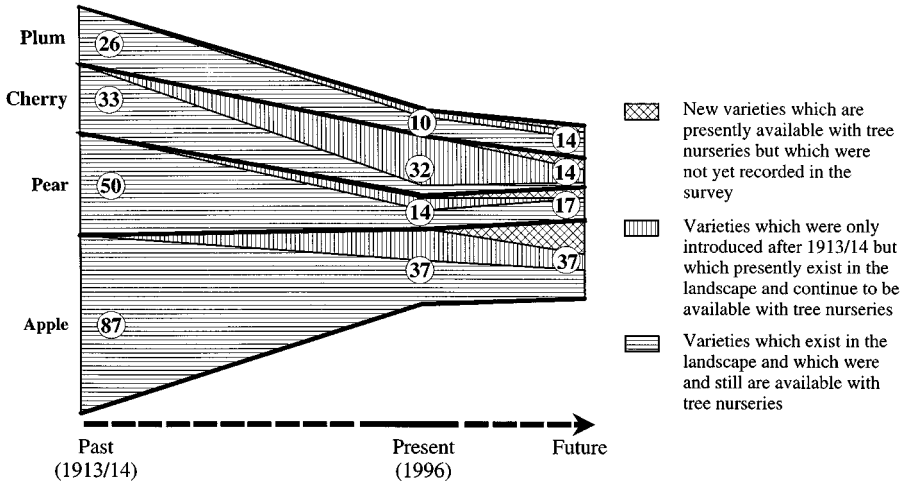


Figure 2. Evolution of the number and distribution of fruit varieties in *streuobst* systems in an area of about 700 km^2 south of Leipzig (Germany). Number of varieties of standard fruit trees of plums, cherries, pears and apples in the past (based on the catalogue of the tree nursery 'Gartendirektion GmbH Rötha' in 1913/14), present (field survey) and future (current catalogues of three tree nurseries). *Source:* Herzog and Oetmann, 1997 (modified).

tion, as well as fertiliser application, strongly influence the plant associations found at a site. In the pre-alpine zone of Bavaria (Germany), Wiesinger and Otte (1991) examined 44 *streuobst* sites covering 48 hectares. They found a total of 134 vascular plant species, the number per site varying from 16 to 52. A higher number of species occupied sites which were mown rather than grazed, and which received no or little fertiliser. If the sites were overgrazed, the number of plant species decreased and plant associations were dominated by species which indicate disturbance (e.g. *Stellaria media* (L.) Vill., *Veronica filiformis* S. M.) and soil compaction (e.g. *Rumex obtusifolius* L., *Ranunculus repens* L., *Plantago major* L.). This was the case on 26.5% of the sites. Similar results were obtained in Hesse (Germany) by Breunig and König (1988), who found 385 species of vascular herbaceous plants on 180 hectares of *streuobst*. They concluded that the extensive utilisation of meadows in *streuobst* is better for environmental and species protection. Transect studies showed that the variety of species increases with the availability of light, and decreases with the intensity of the meadow's utilisation (Breunig and König, 1986).

Streuobst is an important refuge for small mammals (including bats), birds, reptiles, amphibians and arthropods (Blab, 1993). Mice (Arvicolidae, Scoridiae), squirrels (*Sciurus* spp.), badgers (*Meles meles* L.) and dormice (Gliridae) feed on the fruits themselves. Predators such as the hedgehog (*Erinaceus* spp.), the polecat (*Muskla putorius* L.), the weasel (*Mustela nivalis* L.), the marten (*Martes foina* Erxl.) and birds of prey such as hawks (*Falco* spp.), buzzards (*Buteo* spp.) and the screech-owl (*Athene noctua* Scop.) are

attracted by the insects, birds, snails and mammals present in *streuobst* (Wiesinger and Otte, 1991). *Streuobst* provides habitats for birds such as the red-backed shrike (*Lanius collurio* L.), the screech-owl, the wryneck (*Jynx torquilla* L.), the red-headed shrike (*Lanius senator* L.) and the hoopoe (*Upupa epops* L.), whose populations are declining, endangered, or even threatened with extinction (Jedicke, 1997). Woodpeckers, nuthatches and tree creepers feed on insects in the trees' wood and bark. Holes or crevices in older trees provide nesting opportunities for birds that nest in caves (Mader, 1982; Ullrich, 1987; Zwygart, 1989). In addition, frogs, toads, lizards, slow worms and – occasionally – salamanders and snakes (adders) have been observed (Wiesinger and Otte, 1991).

Funke et al. (1986) found that in streuobst, the overall biomass of arthropods was 2.5–7.0 times higher than in nearby forest ecosystems. They suggested this was due to the abundance of easily decomposing biomass, the close interaction between consumers and producers in a small area and the lower tree density than in forests, leading to a greater variety of ecological niches. Different horizontal layers (soil, moss, herbal and several tree layers) host different species. Recently, for example, three new species of insects (Sciaridae) have been discovered in *streuobst* in Germany (Rudzinski, 1992; Rudzinski and Drissner, 1992). Mader (1982) found that the number of species of ground beetles (Carabidae) and of spiders (Arachnidae) in *streuobst* was between two and three times the number found in intensively managed orchards. There, a single species dominated, accounting for three quarters of the total number of individuals. That this was not the case in *streuobst* indicates intact biological regulation mechanisms.

Farmers actively encourage species diversity by providing nesting opportunities for titmice (*Parus* spp.), which feed on the fruit pest the codling moth (*Cydia pomonella* L.). In addition, they often mix *streuobst* with apiculture, with benefits for both fruit and honey production. The mixture of tree species and varieties, which flower at different periods, increases the availability of nectar and pollen over time, and the bees (*Apis mellifera* L.) are not affected by pesticides, as is often the case in intensively managed orchards.

At the landscape level, *streuobst* links agriculture to nature protection because it provides habitats which have become scarce, and because of its favourable abiotic features. The mosaic structure of agrarian landscapes reached its maximum diversity in the middle ages and changed only slowly until the 19th century. Industrialisation, land improvement and modern agriculture then initiated a decline in landscape diversity, a process which is still continuing today (Bastian and Schreiber, 1994; Jacomet and Schibler, 1996). *Streuobst* has resisted change better than most of the other elements of the landscape mosaic which provided the ecological infrastructure for plant and animal species adapted to compartmentalised agricultural landscapes. With respect to abiotic landscape regulatory functions, the combination of trees and permanent pasture is very resistant to erosion. This is particularly important in highlands, where *streuobst* is still relatively widespread. Reduced erosion

also reduces the eutrophication of surface waters, and *streuobst* thus contributes to the protection of water resources. At the same time, the trees provide shelter for grazing animals through buffered temperatures (reduced extremes), reduced wind speed and comparatively high relative air humidity compared to open agricultural land (Danzeisen, 1992; Baldy et al., 1993; Eckert 1995).

Economic importance

The economic impact of streuobst is often underrated. In 1981–86, for example, an average 74.3% of the fruits harvested in Germany came from *streuobst* and from fruit trees in gardens (Maag, 1992). The *streuobst* harvest varies considerably from year to year, whereas the yield from plantations is more stable (Figure 3). The yield of apples from *streuobst* is negatively correlated with the market price for cider apples and for dessert apples, indicating the dependence of the European fruit market on this traditional agroforestry system (Rösler, 1996a).

In Germany, about half of the fruit produced in *streuobst* systems is for household consumption. The other half is sold, either for direct consumption (10–15%) or for the production of juice (20–30%) or spirits (5%). Every year, 5–10% of the fruits are not harvested and are left to rot (Rösler, 1996a). Although only a small portion of the harvest reaches the high value market for fresh consumption, the overall monetary value of the apple harvest from *streuobst* exceeds the value of apples from plantations (Weller, 1996).

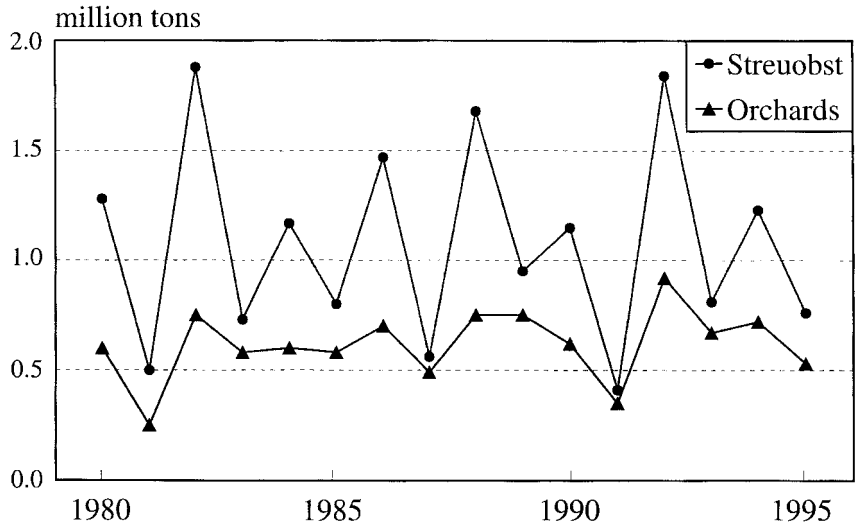


Figure 3. Apples harvested from *streuobst* and from intensively managed orchards in Western Germany (million tons from 1980 to 1995). Redrawn from Janßen (1993) and Rösler (1996a).

Despite its strong impact on the fruit market, the role of *streuobst* in the farming economy has been little studied. Assessments of the profitability of cider production in Germany and Switzerland have suggested annual losses of ECU 0–55 (USD 0–60) per tree (Berger and Roth, 1994; Hitz and Locher, 1996; Rösler, 1996b; Schnieders, 1997). This is mainly due to the low labour productivity when compared to intensive orchard fruit production (Dabbert, 1994). Generalised assessments are, however, not possible, because the management of the system (tree type and density, meadow or crop management) is highly variable, and because profitability depends on the local economic conditions of different countries (especially labour costs and subsidies).

The fact that *streuobst* is still an important form of land use in the hilly parts of temperate Europe indicates that, under such conditions, it has comparative advantages over other land-use types. *Streuobst* integrates well into medium-size family farms with cattle and crop production, if the fruit-picking season is between the labour intensive planting and harvesting seasons, and if family members are available to help with the harvest.

Socio-cultural properties

The landscape not only fulfils ecological and economic functions, but also provides socio-cultural services essential for human well-being (e.g. Wohlwill, 1976; Abt, 1984; Spitzer, 1988). Streuobst has particular value in terms of landscape aesthetics, recreation and regional identity.

Lucke et al. (1992) state that the visual quality of most traditional European agricultural landscapes is due to harmonious contrasts between landscape elements, i.e. darker forest, structured arable fields and green meadows, interspersed with small woods, hedgerows, etc. Fruit trees are part of this ensemble, linking landscape elements, but also contrasting with them (Weller et al., 1986). They are often grouped around settlements, thereby connecting them to the open agricultural land. Due to their size, trees provide a contrast to low level agricultural crops, and serve as land marks for orientation. As patches, rows, scattered individuals and even as single trees, *streuobst* can enhance or counterbalance the local topography. Experiments have shown that ‘the landscapes most preferred internationally are characterised by moderate to high depth or openness, relatively smooth or uniform-length grassy ground surfaces, and scattered trees or tree-clumps’ (Porteous, 1996, p. 27). This is a description of an East African savannah, where *Homo sapiens* is thought to have originated. From an evolutionary perspective it is suggested that human beings experience pleasure in landscapes which satisfy their biological needs (Herrwagen and Orians, 1993; Appleton, 1996). Both hunters and hunted (animals, as well as early man) prefer landscapes which provide the possibility of seeing without being seen. *Streuobst* provides a good balance between view and refuge and this could underlie even modern man’s preference for this kind of landscape.

With their varying shapes and sizes, and the different blossom, leaf and fruit colours, fruit trees bring variety and diversity to the scenery – in space as well as time. Even in winter, diversity is provided by the various, often bizarre, forms of the leafless branches, and by the individual overall shape of each tree. In many regions, the blossom of fruit trees is both highly regarded and considered a symbol of spring. These aesthetic properties are one of the main reasons why the replacement of *streuobst* by intensively managed orchards is often rejected by the non-farmer population (Jacob et al., 1986). This is reinforced by the fact that many such trees play a role in myths and traditional customs (Haerkötter and Haerkötter, 1989).

The aesthetic qualities of *streuobst* enhance the attractiveness of landscapes for recreation. The animals often associated with this system are an additional asset. In southern Germany, a particularly relevant form of recreation is hobby fruit production (Weller et al., 1986; Weller, 1994). *Streuobst* is most appropriate for this, since intensively managed orchards require more regular and professional care. Numerous small parcels of *streuobst* are owned or rented by city dwellers seeking recreation through physical work in the open. Parents want their children to establish a close relationship with nature and to experience the production of a natural and healthy food product.

The socio-cultural importance of *streuobst* can often exceed its economic importance. The economy of Basel-Land (Switzerland), for example, is based on industry, trade, services and the public sector. Only 2% of employment is in agriculture which contributes less than 1% to the economic output of the region (Lienin et al., 1994). Nevertheless, when this region presents itself to the outside world, *streuobst* is always featured, be it in government information leaflets or on the welcome signs at the border of the district. Both show a stylistic coat of arms and a tree with red fruit. The actual raison d'être of *streuobst* in this modern, industrialised society, where 98% of the population have no economic interest in agriculture, is the need for identification with the native place (Herzog, 1994).

Discussion and conclusions

Streuobst is a traditional European agroforestry system which is fairly widespread in the continent's temperate part and which has a considerable, though largely unrecognised, impact on the European fruit market. Until the 1950s, both silvo-arable and silvopastoral forms existed; today the silvopastoral type dominates.

Despite its advantageous ecological and socio-cultural features, *streuobst* is not a sustainable form of land use given the present economic environment in most European countries. Its comparatively low labour productivity leads to an insufficient operational efficiency when compared to monocropping of fruit, arable or fodder crops. However, this judgement must be qualified. The public goods provided by *streuobst* increase its social efficiency,

which is more relevant than private economic efficiency in evaluating the sustainability of land-use systems (Barbier, 1990). This concept has gained increasing recognition during the last decade (although it is not formalised in the terminology of the sustainability debate). NGOs, as well as the public authorities of a number of European countries, now aim to protect remaining areas of *streuobst*, based on the general perception that it is an indispensable part of cultural landscapes and provides valuable ecological services. NGOs label products from *streuobst* (e.g. apple juice) as particularly environmentally friendly and healthy, in order to justify a higher product price and thus increase the profitability of the system (Rösler, 1996b; Schnieders, 1997). The public authorities have adopted a protection policy which contrasts with the subsidised eradication programs of the 1960s and 1970s. In a number of Federal States of Germany, for example, *streuobst* has the legal status of a nature protection zone. Even the owner is not allowd to convert it to other forms of land use without permission from the local nature protection agency. In addition, subsidies have become available for maintenance and replanting in programs based on EEC regulation 2078/92.

This examination of *streuobst* has three lessons for the development of novel European agroforestry systems: (i) agroforestry provides environmental services, namely biodiversity; (ii) in order to expand, agroforestry needs marketing opportunities and support from the authorities; (iii) public support, based on the recognition of environmental and socio-cultural benefits, can further the spread of an agroforestry system.

Environmental benefits which can be obtained from agroforestry are a major argument for its development and implementation (see e.g. Carruthers, 1990; Herzog, 1997). Experimental results (e.g. Peng et al., 1993; McAdam et al., 1997) have not yet delivered sufficient data to support this argument. This is mainly due to the small size of trees in recently established trials, and to comparatively small experimental plots. Investigations of the flora and fauna of fully developed *streuobst* systems confirm that the habitats associated with the presence of trees in agricultural landscapes lead to an increase in the abundance and number of wild plant and animal species. To some extent, this can be expected of novel agroforestry systems as well, even if their design (species and arrangement of trees) differs from the one of *streuobst*.

The history of *streuobst* demonstrates the impact governments and authorities have on the propagation of agroforestry. For centuries, the planting of fruit trees on agricultural land has been strongly encouraged by extension and favourable regulations. The breakthrough was then triggered by expanding marketing opportunities for fruit. Both policy support and marketing opportunities are needed to again make agroforestry a widespread land-use system. Dupraz and Newman (1997) argue that the production of high-quality hardwoods is a promising marketing opportunity for modern agroforestry in Europe. However, as they point out, only trees planted in a forestry scheme receive public financial support. The second condition for the spread of agroforestry is thus not fulfilled. At present, agroforestry is not generally seen as

a viable option and must first be moved into the mainstream of the debate on European agricultural policy (Sibbald, 1997).

If the primary opportunity for developing temperate agroforestry in industrialised countries is in the area of ecology and environmental protection (Nair, 1994), the systems must be designed to fulfil these requirements. They will then find similar public support to that received by *streuobst*. Experience with tropical agroforestry shows that the management of intercropped systems can be rather intensive, requiring considerable intervention. In industrialised countries, where labour is comparatively expensive, this may even lead to an increased input of pesticides and fertiliser in order to master undesirable tree-crop interactions. This would counteract the claim of agroforestry to be particularly environmentally friendly and should thus be avoided. Synergies should be sought between agroforestry and the well established techniques of organic (or ecological) agriculture, i.e. production systems which do without agrochemicals and which are officially recognised, controlled and certified by the International Federation of Organic Agriculture Movements (IFOAM, 1997) and/or by the European Union (EEC regulation 2092/91). Organic farming in Europe has expanded exponentially during the last decade and in 1997 was practised on about 80,000 holdings covering nearly two million hectares (Lampkin, 1997). Agroforestry can increase the environmental benefits of organic agriculture at the landscape scale by incorporating new habitats for wildlife. Organic agriculture, on the other hand, stands for the low input production of healthy foods. The example of *streuobst* shows that an agroforestry system can find public support if both features (environmental services, quality products) are present.

Acknowledgements

The author would like to thank Svenne Eichler, Frank Wätzold and Mark Brownlow for their comments on earlier drafts of this manuscript. Helpful comments of two anonymous referees of this journal are greatly appreciated.

References

Abt T (1984) Fortschritt ohne Seelenverlust. Hallwag, Bern, 367 pp

Auclair D and Cailliez F (1994) Les besoins de recherche en agroforesterie. Rev For Fr XLVI, no. sp. 1994: 141–151

Appleton J (1996) The experience of landscape. Chichester, John Wiley and Sons, 282 pp

Bacharel F and Pinto Correia T (in press) Land use, nature conservation and regional policy in Alentejo, Portugal. In: Krönert R, Bowler IR, Baudry J, Reenberg A (eds) Land Use Changes and Their Environmental Impact in Rural Areas in Europe. Man and the Biosphere Series. Paris, UNESCO and Parthenon

Bairlein F and Sonntag B (1994) Zur Bedeutung von Strassenhecken für Vögel. Nat Landsch 69(2): 43–48

Baldy C, Dupraz C and Schilizzi S (1993) Vers de nouvelles agroforesteries en climats tempérés et méditerranéens. I: Aspects agronomiques. Cah Agric 2: 375–386

Balleux P, Devillez F and Michalowski JM (1997) Valorisation des boisements linéaires dans le pays du Chimay (Belgique). Book of Abstracts Intern Workshop Agroforestry for Sustainable Land-use, pp 31–34. Montpellier, France

Barbier EB (1990) Economics for sustainable production. In: Prinsley RT (ed) Agroforestry for Sustainable Production, pp 389–404. London, Commonwealth Science Council

Barrett GW (1992) Landscape ecology: designing sustainable agricultural landscapes. J Sust Agric 2(3): 83–104

Basedow T (1987) Die Bedeutung von Hecken, Felrainen und pflanzenschutzmittelfreien Ackerrandstreifen für die Tierwelt der Äcker. Gesunde Pflanzen 39(10): 421–429

Bastian O and Schreiber K-F (1994) Analyse und ökologische Bewertung der Landschaft. Jena, Stuttgart, Fischer, 502 pp

Bazin P and Schmutz T (1994) La mise en place de nos bocages en Europe et leur déclin. Rev For Fr XLVI, no. spécial: 115–118

Berger W and Roth D (1994) Kosten- und Preiskatalog für ökologische und landeskulturelle Leistungen im Agrarraum. Jena, Sonderheft der Thüringer Landesanstalt für Landwirtschaft, 258 pp

Bernacki Z (1994) Influence of main types of ecotones on the decomposition of organic matter in agricultural landscapes. In: Ryszkowski L and Balazy S (eds) Functional Appraisal of Agricultural Landscape in Europe, pp 143–151. Poznan, Polish Academy of Science

Blab J (1993) Grundlagen des Biotopschutzes für Tiere. Bonn-Bad Godesberg, Schriftenreihe für Landschaftspflege und Naturschutz, Heft 24, 479 pp

Bland F and Auclair D (1996) Silvopastoral aspects of Mediterranean forest management. In: Etienne M (ed) Western European Silvopastoral Systems, pp 125–142. Paris, INRA

Brandt J, Primdahl J and Reenberg A (in press) Rural land use and landscape dynamics – analysis of driving factors in space and time. In: Krönert R, Bowler IR, Baudry J, Reenberg A (eds) Land Use Changes and Their Environmental Impact in Rural Areas in Europe. Man and the Biosphere Series. Paris, UNESCO and Parthenon

Breunig T and König A (1986) Geobotanische Untersuchungen. In: Jacob H, Breunig T, König A, von Königsmarck K, von Lossau A, Pelz G, Stähr E: Erfassung und Massnahmen zur Erhaltung des Streuobstbaues in Hessen. Forschungsanstalt für Weinbau, Gartenbau, Getränketechnologie und Landespflege, Geisenheim am Rhein (unpublished)

Breunig T and König A (1988) Vegetationskundliche Untersuchungen in zwei unterschiedlich intensiv genutzten Streuobstgebieten bei Ober-Rosbach und Rodheim. Beitr Nat kd Wetterau 8(1-2): 27–60

Brownlow MJC (1992) Acorns and swine: historical lessons for modern agroforestry. Q J For 86(3): 181–190

Brownlow MJC (1994) Towards a framework of understanding for the integration of forestry with domestic pig (Sus scrofa domestica) and European wild boar (Sus scrofa scrofa) husbandry in the United Kingdom. For 67(3): 189–218

Bundesamt für Statistik (1992) Die Bodennutzung der Schweiz – Arealstatistik 1979/85: Kategorienkatalog. Bern, 191 pp

Bundesamt für Statistik/Eidgenössische Alkoholverwaltung (1993) Schweizerische Obstbaumzählung: der Obstbau in der Schweiz (Feldobstbau/Obstkulturen). Bern, Land- und Forstwirtschaft 7, 200 pp

Bünger L and Kölbach D (1995) Streuobst-Bindeglied zwischen Naturschutz und Landschaft. Dokumentation Natur und Landschaft, Sonderheft 23, Bibliographie Nr. 69, Bonn, Bundesamt für Naturschutz, 166 pp

Burel F (1996) Hedgerows and their role in agricultural landscapes. Critical Rev Plant Sci 15(2): 169–190

Carruthers P (1990) The prospects for agroforestry: an EC perspective. Outlook Agric 19(3): 147–153

Case HJ (1996) (ed) European *Malus* Germplasm. Proc workshop 21–24 June 1995. Rome, International Plant Genetic Resources Institute, 119 pp

Dabbert S (1994) Integration of environmental, economic and social systems. In: Welte E, Szabolcs I and Huettl RF (eds) Agroforestry and Land Use Change in Industrialized Nations. Proc 7th CIEC Symposium, pp 423–440. Berlin, Germany

Danzeisen HH (1992) Vergleichende Untersuchungen zum Mikroklima von Streuobstwiesen im Nordpfälzer Bergland. Beitr Landespfl Rheinland-Pfalz 15: 5–56

Djordjevic-Milosevic S, Lazarevic R, Rakocevic M, Stavretovic N, Zujovic M and Zakonovic M (1997) Agroforestry in Yugoslavia – revival of tradition. In: Book of Abstracts Intern Workshop Agroforestry for Sustainable Land-use, pp 51–54. Montpellier, France

Dupraz C (1994) Les associations d'arbres et de cultures intercalaires annuelles sous climat tempéré. Rev For Fr XLVI, no. spécial: 72–83

Dupraz C and Newman SM (1997) Temperate agroforestry: the European way. In: Gordon AM and Newman SM (eds) Temperate Agroforestry Systems, pp 181–236. Oxon, New York, CAB International

Eckert G (1995) Untersuchungen zur Geschichte der Landnutzung und zur Landschaftspflege auf brachgefallenen Wacholderheiden und Steinobstwiesen im Neidlinger Tal (Kreis Eßlingen). Stuttgart, Verlag Ulrich E. Grauer, 178 pp

Eichwalder R (1990) Obstbäume und Obststräucher im Besitz von Privathaushalten. Stat Nachr 45(6): 364–373

Etienne M, Hubert B and Msika B (1994) Sylvopastoralisme en région méditerranéenne. Re For Fr XLVI, no. sp. 1994: 30–41

Food and Agriculture Organisation (1996) Global Plan of Action for the Conservation and Sustainable Utilisation of Plant Genetic Resources for Food and Agriculture. 4th International Technical Conference on Plant Genetic Resources. Leipzig, Germany, 17–23 June 1996

Funke W, Heinle R, Kuptz S, Majzian O and Reich M (1986) Arthropodengesellschaften im Ökosystem 'Obstgarten'. Verh Ges Ökol 14: 131–141

Gass T, Tobutt KR and Zanetto A (1996) (compilers) Report of the Wortking Group on *Prunus*. Fifth meeting, 1–3 February 1996, Menemen-Izmir, Turkey. Rome, International Plant Genetic Resources Institute, 70 pp

Gillet F and Gallandat JD (1996) Wooded pastures of the Jura mountains. In: Etienne M (ed) Western European silvopastoral systems, pp 37–54. Paris, INRA

Glencross RN (1978) Trees, their use and implications in diversification of land use for agriculture. In: Howes KMW and Rummery RA (eds) Integrating agriculture and forestry, pp 15–23. Dehra Dun, Natraj Publ

Gold MA and Hanover JW (1987) Agroforestry systems for the temperate zone. Agrofor Syst 5: 109–121

Gordon AM and Newman SM (1997) (eds) Temperate Agroforestry Systems. Oxon, New York, CAB International, 269 pp

Greif F (1992) Waldweide in Österreich aus agrar-, forst- und volkswirtschaftlicher Sicht. Monatsber österr Landwirtsch 7: 515–526

Haerkötter G and Haerkötter M (1989) Macht und Magie der Bäume: Sagen – Geschichten – Beschreibungen. Frankfurt, Eichborn, 235 pp

Hahn-Herse G and Bäuerle M (1979) Landschaftswandel durch Agrarstrukturwandel. Teil 1: Die Dezimierung der schleswig-holsteinischen Wallhecken durch Flurbereinigung. Garten + Landschaft 8: 606–614

Heerwagen JH and Orians GH (1993) Humans, habitats and aesthetics. In: Kellert S and Wilson E O (eds) The Biophilia Hypothesis, pp 138–172. Washington, Covelo; Island Press, Shearwater Book

Heller R (1995) Obst in der Altmark. Verein KULTUR-Landschaft Haldensleben-Hundisburg e.V., 106 pp

Herzog F (1994) Multipurpose trees in traditional farming systems, two case studies (Africa, Europe). In: Welte E, Szabolcs I and Huettl RF (eds) Agroforestry and Land Use Change in Industrialized Nations. Proc 7th CIEC Symposium, pp 219–232. Berlin, Germany

Herzog F (1997) Konzeptionelle Überlegungen zu Agroforstwirtschaft als Landnutzungsalternative in Europa. Z Kult techn Landentw 38(1): 32–35

Herzog F (1998) Agroforestry in temperate Europe: history, present importance and future development. In: Keulen H van, Lantinga EA and van Laar HH (eds) Mixed Farming Systems in Europe, pp 47–52. Dronten, A. P. Minderhoudhoeve-Series 2

Herzog F and Gotsch N (1998) Assessing the sustainability of tropical tree crop production in West Africa: a methodological outline. J Sust Agric 11(4): 13–37

Herzog F and Oetmann A (1997) *In-situ*-Erhaltung von Streuobst – Synergien zwischen Naturschutz und der Bewahrung genetischer Ressourcen. Nat Landsch 72(7/8): 339–345

Heywood VH and Baste I (1995) Introduction. In: Heywood VH and Watson RT (eds) Global Biodiversity Assessment, pp 1–20. Cambridge, UNEP and Cambridge University Press

Hitz T and Locher M (1996) Wirtschaftlichkeitsberechnungen in der Mostobstproduktion. Diplomarbeit, Höhere Wirtschafts- und Verwaltungsschule Aargau (unpublished)

Hubert B and Allezard V (1987) (eds) La forêt et l'élevage en région méditerranéenne française. Fourrages: 1–294

IFOAM (1997) What is organic agriculture? Tholey-Theley, International Federation of Organic Agriculture Movements. URL: http://ecoweb.dk/ifoam/generel.htm#What is organic agriculture

Jacob H, Breunig T, König A, von Königsmarck K, von Lossau A, Pelz G and Stähr E (1986) Erfassung und Massnahmen zur Erhaltung des Streuobstanbaues in Hessen. Forschungsanstalt für Weinbau, Gartenbau, Getränketechnologie und Landespflege, Geisenheim am Rhein (unpublished)

Jacomet S and Schibler J (1996) Biodiversität und Archäologie. Uninova 75: 26–35

Janßen H (1993) Der Streuobstbau und der Obstmarkt. In: Rösler M and Kraus J (eds) Vielfalt in aller Munde – Perspektiven für Bewirtschaftung und Vermarktung im bundesweiten Streuobstbau, pp 85–95. Bad Boll, Materialen der Evangelischen Akademie

Jedicke E (1997) (ed) Die Roten Listen: Gefährdete Pflanzen, Tiere, Pflanzengesellschaften und Biotoptypen in Bund und Ländern. Stuttgart, Ulmer, 581 pp

Joffre R, Vacher J, De los Llanos C and Long G (1988) The dehesa: an agrosilvopastoral system of the Mediterranean region with special reference to the Sierra Morena area of Spain. Agrofor Syst 6: 71–96

Kaiserliches Statistisches Amt (1902) Ergebnisse der Obstbaumzählung im Deutschen Reiche im Jahre 1900. Vierteljahreshefte zur Statistik des Deutschen Reichs 11(2): 224–237

Kaiserliches Statistisches Amt (1915) Ergebnisse der Obstbaumzählung im Deutschen Reiche im Jahre 1913. Vierteljahreshefte zur Statistik des Deutschen Reichs 24(2): 49–62

Kittel G (1895) Die wertvollsten Obstsorten Deutschlands. Düsseldorf, Ferd. Richter Verlag, 207 pp

Kottrup C (1990) Obstsortenempfehlungen für Pflanzungen in der Landschaft. Nordd Nat schutzakad-Ber 3(1): 18–21

Küppers M (1992) Changes in plant ecophysiology across a central European hedgerow ecotone. In: Hansen AJ and di Castri F (eds) Landscape Boundaries, pp 285–303. New York, Springer Verlag

Küster H (1996) Geschichte der Landschaft in Mitteleuropa: von der Eiszeit bis zur Gegenwart. München, C. H. Beck, 424 pp

Lampkin N (1997) Organic farming in Europe. Aberystwyth, Welsh Institute of Rural Studies, University of Wales. URL: http://www.aber.ac.uk/~wirwww/organic/europe/

Lefroy EC, Salerian J and Hobbs RJ (1992) Integrating economic and ecological considerations: a theoretical framework. In: Hobbs RJ and Saunders DA (eds) Reintegrating Fragmented Landscapes, pp 209–244. New York, Springer Verlag

Lienin A, Füeg R and Christoffer J (1994) Nordwestschweiz: Zahlen, Daten, Fakten. Regio Wirtschaftsstudie Nordwestschweiz. Liestal, Statistisches Amt des Kantons Basel-Landschaft, 24 pp

Lott K (1993) Der historische Obstbau in Deutschland zwischen 1850 und 1910. Geschichte,

Dokumentation, Aussagen für den aktuellen Streuobstbau. Dissertation, Band 1. Berlin, Humboldt Universität, Bachbereich Agrar- und Gartenbauwissenschaften, 191 pp
Lucke R (1990) Obstgehölze an Straßen? Taspo Magazin 4/90: 34–36
Lucke R, Silbereisen R and Herzberger E (1992) Obstbäume in der Landschaft. Stuttgart, Eugen Ulmer, 300 pp
Maag G (1992) Zur Situation im Obstanbau. Baden-Württemberg in Wort und Zahl 9: 445–453
Mader H-J (1982) Die Tierwelt der Obstwiesen und intensiv bewirtschafteten Obstplantagen im quantitativen Vergleich. Nat Landsch 57(11): 371–377
Makhzoumi JM (1997) The changing role of rural landscapes: olive and carob multi-use tree plantations in the semiarid Mediterranean. Landsc Urban Plan 37: 115–122
Marchenay P (1981) Ethnobotanique et conservation génétique: l'exemple des arbres fruitiers. J Agric Trad Bot Appl XXVIII(2): 85–158
McAdam JH, McFerran DM, Toal L, Agnew R, Dennis P, Sibbald AR, Teklehaimanot Z, Jones D and Eason W (1997) Developing silvopastoral systems and the enhancement of biodiversity. Book of Abstracts Intern Workshop Agroforestry for Sustainable Land-use, pp 109–113. Montpellier, France
Ministère de l'Agriculture, de la Pêche et de l'Alimentation (1996) L'utilisation du territoire en 1996. AGRESTE, Données Chiffrées – Agriculture 87
Nair PKR (1993) An introduction to agroforestry. Dordrecht, Kluwer Academic Publ, 494 pp
Nair PKR (1994) Agroforestry: two decades of development. In: Welte E, Szabolcs I and Huettl RF (eds) Agroforestry and Land Use change in Industrialized Nations. Proc 7th CIEC Symposium, pp 35–64. Berlin, Germany
Opitz W (1970) Zuschüsse für Obstbaum-Rodung. Deutsche Gartenbauwirtsch 3: 20–21
Papanastasis VP, Platis PD and Dini-Papanastasis O (1997) Productivity of deciduous woody and fodder species in relation to air temperature and precipitation in a Mediterranean environment. Agrofor Syst 37: 187–198
Pavlovsky YeS (1993) (ed) Agroforestry and landscape. Volgograd, Vnialmi, 223 pp [in Russian with English summary]
Peng RK, Incoll LD, Sutton SL, Wright C and Chadwick A (1993) Diversity of airbonre arthropods in a silvoarable agroforestry system. J Appl Ecol 30: 51–562
Petzold R and Hahn O (1973) Ergebnisse der Rodungsaktion in der EWG und in der Bundesrepublik Deutschland. Der Erwerbsobstbau 15(1): 5–9
Pinto-Correia T (1993) Threatened landscape in Alentejo, Portugal: the 'montado' and other 'agro-silvo-pastoral' systems. Landsc Urban Plan 24: 43–48
Poly JP (1991) Agrosylvopastoral practices in Mediterranean Europe. In: Muthoo MK and Chipeta ME (eds) Trees and forests in rural land use. pp 137–151. Rome, FAO
Porteous JD (1996) Environmental aesthetics. London and New York, Routledge, 290 pp
Ramming DW and Cociu V (1990) Plums (*Prunus*). In: Moor JN and Ballington JR (eds) Genetic resources of temperate fruit and nut crops, pp 233–288. Wageningen, International Society for Horticultural Science
Reif A and Richert E (1995) Naturnahe Hecken durch Verwendung autochthoner Gehölze. Mat ländl Entw 33: 1–59
Riecken U, Klein M, Schröder E, Messer D and Faulenbach A (in press) Naturschutzfachliche Zielsetzungen und Handlungskonzepte für ausgewählte gefährdete Kulturlandschaftstypen. Schr reihe Landsch pflege Nat schutz
Rösler M (1995) Einführung zum Thema Streuobst. In: Bünger L and Külbach D: Streuobst-Bindeglied zwischen Naturschutz und Landschaft. Dokumentation Natur und Landschaft, Sonderheft 23, Bibliographie Nr. 69, Bonn, Bundesamt für Naturschutz
Rösler M (1996a) Marktwirtschaftliche Bedeutung des Streuobstbaus. Auswertung des EU-Streuobstforums im Rahmen der 2. Rhöner Apfelmesse, pp 3–10. Zella, Rhöner Apfelbüro
Rösler M (1996b) Erhaltung und Förderung von Streuobstwiesen: Modellstudie dargestellt am Beispiel der Gemeinde Bad Boll. Gemeinde Boll, 300 pp
Rudzinski H-G (1992) Beiträge zur Kenntnis der Trauermückenfaune Nordwestdeutschlands (Diptera, Nematocera: Sciaridae). Drosera 92(1): 35–45

Rudzinski H-G and Drissner J (1992) Neue Sciariden aus Deutschland (Diptera: Nematocera). Entomol Z 102(12): 223–227

Schnieders K (1997) Aufpreis-Vermarktungskonzept für Streuobstprodukte als Beitrag zur Erhaltung und Nutzung von Hochstamm-Obstwiesen im Landkreis Göttingen. Landschaftspflegeverband Landkreis Göttingen e.V., 45 pp

Schulze E-D and Gerstberger P (1994) Functional aspects of landscape diversity: a Bavarian Example. In: Schulze E-D and Mooney HA (eds) Biodiversity and Ecosystem Function, pp 453–466. Berlin, Springer-Verlag

Schwärzel H and Schwärzel M (1996) Sicherung obstgenetischer Ressourcen im Land Brandenburg unter Berücksichtigung von Obstbau, Landespflege und Landschaftsökologie. In: Begmann F and Vögel R (eds) *In-situ*-Erhaltung pflanzengenetischer Ressourcen in der Bundesrepublik Deutschland am natürlichen Standort und *on farm*, pp 55–62. Bonn, Schr reihe Genet Ress Bd 2

Sibbald AR (1997) Agroforestry and land-use management – an European perspective. Book of Abstracts Intern Workshop Agroforestry for Sustainable Land-use, pp 183–186. Montpellier, France

Simon L (1992) Entwurf, Ergebnisse und Konsequenzen der wissenschaftlichen Begleituntersuchungen zum Biotopsicherungsprogramm 'Streuobstwiesen' des Landes Rheinland-Pfalz. Landesamt für Umweltschutz und Gewerbeaufsicht Rheinland-Pfalz, Begleituntersuchungen zum Biotopsicherungsprogramm 'Streuobstwiesen'. Oppenheim, Beitr Landespfl Rheinland-Pfalz 15: 5–56

Spitzer H (1988) Einführung in das Thema: Landschaftsästhetik als regionale Lebensbedingung? In: Spitzer H, Ipsen D, Hoisl R and Wilamowitz-Moellendorff U (eds) Raumästhetik, eine regionale Lebensbedingung, pp 1–12. Bonn, Forschungsgesellschaft für Agrarpolitik und Agrarsoziologie e.V.

Stadler R (1983) Der landschaftsprägende Streuobstbau und sein Einfluss auf den Erwerbsobstbau. Baden-Württemberg in Wort und Zahl, Stat Monatsh 31: 173–181

Statistisches Bundesamt Wiesbaden (1954) Die Obstbaumbestände 1951. Statistik der Bundesrepublik Deutschland. Stuttgart und Köln, Kohlhammer, 88 pp

Statistisches Bundesamt Wiesbaden (1966) Obstbaumzählung 1965. Fachserie B, Land- und Forstwirtschaft, Fischerei, Reihe 2, Gartenbau und Weinwirtschaft. Stuttgart und Mainz, Kohlhammer, 52 pp

Statistisches Reichsamt (1940) Obstbaumzählung 1938 und Obsternte 1938. Berlin, Verlag für Sozialpolitik, Wirtschaft und Statistik, Statistik des Deutschen Reiches, Band 541, 369 pp

Ullrich B (1987) Streuobstwiesen. In: Hölzinger J (ed) Die Vögel Baden-Württembergs. Band 1: Gefährdung und Schutz, pp 551–570. Karlsruhe, Ulmer

von Maydell H-J (1994) Agroforestry in Central, Northern and Eastern Europe. In: Welte E, Szabolcs I and Huettl RF (eds) Agroforestry and Land Use Change in Industrialized Nations. Proc 7th CIEC Symposium, pp 65–74. Berlin, Germany

Wawrik H (1992) Auch dem Obstbaum eine Chance als Alleebaum geben. Neue Landsch 12/92: 873–875

Way RD, Aldwinckle HS, Lamb RC, Rejman A, Sansavini S, Shen T, Watkins R, Westwood MN and Yoshida Y (1990) Apples (Malus). In: Moor JN and Ballington JR (eds) Genetic Resources of Temperate Fruit and Nut Crops, pp 1–62. Wageningen, International Society for Horticultural Science

Weller F (1994) Obstwiesen – Herkunft, Bedeutung, Möglichkeiten der Erhaltung von Streuobstweisen. Der Bürger im Staat 44(1): 43–49

Weller F (1996) Streuobstwiesen. In: Konold W (ed) Naturlandschaft – Kulturlandschaft, pp 137–161. Landsberg, ecomed

Weller F, Eberhard K, Flinspach H-M and Hoyler W (1986) Untersuchungen über die Möglichkeit zur Erhaltung des Landschaftsprägenden Streuobstbaues in Baden-Württemberg. Stuttgart, Ministerium für Ernährung, Landwirtschaft, Umwelt und Forsten Baden-Württemberg, 77 pp

Wiesinger K and Otte A (1991) Extensiv genutzte Obstanlage in der Gemeinde Neubeuern/Inn:

Baumbestand, Vegetation und Fauna einer traditionellen, bäuerlichen Nutzung. Ber Bayrisch Akad Nat schutz Landsch pflege 15: 69–94

Wohlwill JF (1976) Environmental aesthetics: The environment as a source of affect. In: Altmann I and Wohlwill JF (eds) Human Behaviour and Environment, pp 37–86. New York and London, Plenum Press

Zwygart D (1989) Obstgärten. In: Imbeck-Löffler P (ed) Natur aktuell: Lagebericht zur Situation der Natur im Kanton Basel-Landschaft im Jahr 1988 – Grundlagen für ein Natur- und Landschaftsschutzkonzept, pp 180–187. Liestal, Verlag des Kantons Basel-Landschaft