Walnut as a Farm Crop in the Netherlands: an Agroforestry Project in the East and Selection of Cultivars for Organic Cultivation in the North

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Abstract

Foreign and Dutch walnut cultivars have been evaluated in experiments at the Research Station for Fruit Growing located in the Southwest. The cultivars that performed best in these trials originated from British Columbia (‘Broadview’) and The Netherlands (‘Buccaneer’). In an agroforestry project in the East, 8 farms planted 10 ha of walnut (‘Broadview’, ‘Buccaneer’), cherry and sweet chestnut at a spacing between 10-20 metres. The initial investment for trees, poles, wire netting to protect against animals, resulted in a low net income for the first 5 years. Thereafter, the income from the combination of walnut and quality timber with grass is reasonable and may exceed the income from subsidised, extensively managed grass. The grass production varied from 3 to 9 tons of dry matter per hectare per year. In the 4 years of investigation there was no visible evidence that the presence of the trees had influenced the composition and production of the grass vegetation. Based on predicted crown development grass production will be possible for a long period. So far, the nut production from the young plantations has not been profitable. In order to find walnuts that were better adapted to the cooler weather conditions of the North, walnuts were selected from green areas in the North and evaluated for their characteristics. This resulted in at least two cultivars (‘Dionym’, ‘Amphyon’) with excellent yield potentials together with a good external and internal quality. Both cultivars have a low susceptibility to disease and are particularly suitable for organic cultivation. ‘Dionym’ and ‘Amphyon’ are planted in private gardens but also in a commercial organic orchard of 1.5 ha in which the 200 walnut trees are grown together (mixed cropping) with hazelnuts and Sea Buckthorn.

INTRODUCTION

An Agroforestry Project in the East

Intensive agriculture that uses herbicides and artificial fertilisers generates high income but in the long term leads to environmental problems, which is why alternative, less intensive, types of land use are desirable. One way a farmer could compensate for the fall in income that would accompany more extensive land use (for example, with fewer livestock per hectare) would be to expand the area he or she farms. But as land is extremely expensive in The Netherlands, it would be better to seek alternative sources of income. One possible option is to combine the grass and animals with multipurpose trees in a two-layer system. This type of agroforestry is not new in The Netherlands: there used to be a large area of orchards (apple, pear or cherry) which were integrated in a dairy-farming system. In today’s land use systems, however, it is a challenge to combine grass production and multipurpose trees. Since 1999 a few projects were started primarily in order to find out what cultivars fit well for Dutch circumstances (especially in the northern part of the country) and to demonstrate and investigate how the production of grass, quality timber and fruits can be combined and can generate income from agricultural production and agrotourism today.
Selection of Cultivars in the North

Foreign and Dutch walnut cultivars have been evaluated in experiments at the Research Station for Fruit Growing located in the Southwest (Wertheim, 1997). The cultivars that performed best in these trials originated from British Columbia (‘Broadview’) and The Netherlands (‘Buccaneer’). The trial started in 1981, but later also other cultivars were included in the trial including a selection named ‘Amphyon’ from the cooler provinces in the North. The selection was planted at the Research Station in 1990 and the first results were published 6 years later (Wertheim, 1996). In 1996 ‘Amphyon’ did not perform particularly well in number of nuts and quality compared to for example ‘Broadview’ and ‘Buccaneer’. Due to other priorities in the research programme of the Research Station, the walnut trial was not continued after 1996. The aim of this paper is to provide additional information regarding the selections from the cooler provinces in the North to illustrate that they are very suitable for organic cultivation and present results of an organic commercial orchard in which ‘Amphyon’ and ‘Dionym’ are intercropped with hazelnuts and Sea Buckthorn.

MATERIALS AND METHODS

An Agroforestry Project in the East

Financial prospects for multipurpose plantations. The project group consists of representatives of farmers, landowners, a nature resource organisation, a water management organisation and researchers. Its first step was to ascertain the financial prospects for such a system compared to a subsidised extensive grass management system. To do so, the net income from plantations of three tree species over a period of 40 years was calculated. The three tree species considered were walnut (*Juglans regia* or hybrid), cherry (*Prunus avium*) and sweet chestnut (*Castanea sativa*); they were chosen for their ability to produce good quality timber in The Netherlands and their suitability for multipurpose plantations (Oosterbaan and Van den Berg, 1997; Peeters et al., 1996; Wertheim, 1997; Oosterbaan, 2000). The calculations were done for two tree spacings: 10 and 20 metres. In both cases, an undergrowth of grass was assumed. The net income calculated by these plantation models was compared with the net income from subsidised, extensively managed grass monoculture (Fig. 1). Due to the initial investment required (trees, poles, wire netting to protect against animals), for the first 5 years the net income from the multipurpose plantations is low. Thereafter, the income from the combination of multipurpose trees (fruits and quality timber) with grass is reasonable and may exceed the income from subsidised, extensively managed grass.

Design of the project. From 1999 to 2003 a series of 8 multipurpose plantations with a total area of 10 hectares was established. All the plantations are on arable land, on sandy soils in which the water table falls below 100 cm during the growing season. Several types of farm are participating in the project: an organic livestock farm, four extensive farms (two with agrotourism) and three estate farms. The tree species planted are walnut, cherry and sweet chestnut (multipurpose trees yielding fruits and timber). The trees have been planted in existing or newly sown pastures, at a spacing varying between 10 and 20 metres. The grass management also varies: in some plots, grass has been harvested for fodder or has been grazed by sheep, cows or horses. Table 1 gives an overview of the tree species, their planting distances and the grass management regimes. On the two farms already involved in agrotourism, some fruiting shrubs (red and black currant, blackberry etc.) have also been planted in otherwise unprofitable corners to enhance the attractiveness for tourists.

Selection of Cultivars in the North

From 1983 onwards E. Kwanten has intensively selected superior types in the natural populations of *Juglans regia* L. in gardens and farmyards in the northern provinces. Types with superior characteristics have been singled out, propagated and planted at his selection orchard in Overschild to evaluate their characteristics in more
detail. Branches were collected, grafted on rootstock of *Juglans regia* L., and planted in the selection orchard. The trees were grown organically, that is without use of fertiliser and agrochemicals. Characteristics of the trees and nuts were monitored and described.

In 1996 and 1997, ‘Dionym’ and ‘Amphyon’ were planted in an organic commercial orchard together with pollinators and intercropped with hazelnuts (*Corylus avellana* L.) and Sea Buckthorn (*Hippophaë rhamnoides* L.).

**RESULTS AND DISCUSSION**

An Agroforestry Project in the East

The investigations carried out from 1999 to 2003 focussed on grass production and composition, tree development and growth, fruit production, ways of harvesting the nuts and the channels for selling them, biodiversity, and the prospects for income from tourism. In order to predict the development of trees and grass production, data on the young plantations were combined with data from older plantations on similar soil types in the eastern part of The Netherlands.

1. **Tree Development.** In most cases the trees planted were quite large: 2-2.50 m tall. Most of the trees established well and showed a good vigour after establishment. Figure 2 shows the mean height growth of the different tree species. Of the three species, walnut grew least in height during the first few years. Chestnut did better, and cherry did best of all; this species seems to be able to grow very rapidly on arable land. As the conditions for the crop between or under the trees depend on the crown cover, crown expansion is an important issue in agroforestry. Measurements of the crown diameters of the young plantations and of some older plantations outside the experimental plots resulted in a model for predicting the crown cover per hectare. In Figure 3 the predicted crown development of walnuts has been shown in relation to the distance between the trees. In the first few years after planting, the crowns of walnut expand relatively slowly. If the trees are 20 metres apart the canopy will still not have closed 40-50 years after planting. If the trees are planted 10 metres apart it will take about 30 years for the canopy to close.

2. **Grass Production and Influence of Trees.** During the period of investigation, the botanical composition, production and fodder value of the grass were monitored. The botanical composition of the grass vegetation was found to vary greatly, depending on whether the plots had previously been manured and, if so, on the rate of manuring. Some of the plots consist nearly entirely of highly productive grass species such as *Lolium perenne* and *Lolium multiflorum*. In other plots that have not been manured or have received very little manure in recent years, the vegetation is less productive but more diverse and consists of *Agrostis* spp., *Holcus lanatus* and composites. Each year, the grass vegetation was sampled, to ascertain the feed value of the crop. The latter varied, depending on the plant species composition. It was lowest for crops with a high percentage of poorly productive grass species like *Holcus*. In the 4 years of investigation there was no visible evidence that the presence of the trees had influenced the composition and production of the grass vegetation.

3. **Biodiversity of Multipurpose Plantations.** Planting trees in pasture in itself increases the biodiversity. Walnut trees are less attractive to insects and birds than, for example, oak, which is associated with several hundred insect and bird species. In 2003 the plantations were surveyed for the presence of butterflies, grasshoppers and crickets. It was found that compared with flower-rich grasslands, the multipurpose plantations harboured more grasshoppers.

4. **Fruit Production and Opportunities for Income from Tourism.** So far, the nut production from the young plantations has not been profitable. The oldest plantations have produced several kilograms of nuts per hectare. The participating farmers have experimented with different harvesting methods (by hand and handtools) and have jointly looked for good selling channels.
Selection of Cultivars in the North

1. Origin. In 1987, a walnut tree was found in a private garden in Tjuchem, a village in the province Groningen, that produced a lot of nuts of a good quality. This tree, producing up to 50 kg of nuts per year, was probably planted around 1947 and was a seedling from another tree in Tjuchem. This selection was named ‘Amphyon’. In 1991, a 15 year old seedling was found on a farm yard in Ten Boer, a village in the province of Groningen. The tree originated from a tree nursery. This selection was named ‘Dionym’.

2. Characteristics of ‘Dionym’ and ‘Amphyon’. ‘Amphyon’. The tree is intermediate to strong in vigour and forms a relatively dense crown with a larger width than height. The timing of the budbreak is intermediate, its winter hardiness is good. The tree carries many catkins and female flowers, the flowering is intermediate. In most years, production of ripe catkins and receptive female flowers overlap, but also apomixis occurs. The tree enters bearing in its third or fourth year, has a strong spur bearing habit (and some lateral bearing) and the productivity is high. The nuts are carried in clusters with 2-4 nuts. The nuts shed without husk in the second half of October. The sulcated nuts are large and are clearly longer than wide (Table 2). Deficient shells hardly occur. The shell is easily opened by hand. The light yellow coloured kernels completely fill the shell, are easily taken out and have a very good taste. The kernels can have a weight of up to 5 gram. The % kernel in 2004 was 54% (Table 2).

‘Dionym’. The tree is very vigorous and forms a dense crown. The buds break intermediate to late, its winter hardiness is good. The flowering is intermediate to late with usually enough overlap for self-fertilisation but apomixis also occurs. The tree enters bearing in its third or fourth year, has a strong spur bearing habit (and intermediate lateral bearing) and the productivity is high. The nuts are carried in clusters with 2-5 nuts. The nuts shed without husk in the first half of October. The sulcated nuts are large, and are somewhat longer than wide (Table 2). The shell is not easily opened by hand. The light yellow coloured kernels completely fill the shell, are easily taken out and have an excellent taste. The kernels can have a weight of up to 5 gram. The % kernel was 47% in 2004 (Table 2).

Although no chemical crop protection was carried out, both selections were not seriously damaged by diseases or pests indicating that the susceptibility for bacterial blight is low.

3. Commercial Orchard. The orchard of 1.5 hectare is situated on a sandy soil in Luttelgeest (province of Flevoland) and is surrounded by a hedge row of 5 m wide. Rows were alternatively planted with Sea Buckthorn and nuts (walnuts & hazelnuts) The distance between the rows was 3.5 m. The walnuts and hazelnuts were planted alternatively with a distance of 3.5 m. In total, 44 ‘Amphyon’ trees were planted and 119 ‘Dionym’ trees together with a number of pollinators (also selections from E. Kwanten). The orchard was managed as an organic farm since 1996 and is officially certified. Plants were not irrigated and no manuring took place. In order to generate income before the walnuts would produce a good yield it was decided to intercrop the walnuts with earlier-yielding crops. Sea Buckthorn produces berries that can be processed in juices, jams, wine etc. and oil can be extracted from it which can be used in cosmetics (Pikaske, 2002). In 1999 the first berries were harvested. Since then berries have been harvested every year. The Sea Buckthorn plants are now being pruned dramatically to prevent competition with the nuts. The hazelnuts started to produce in 2002. The walnuts entered bearing in the third or fourth year after planting. In 2004 a number of trees produced several dozen of walnuts. All walnuts are collected by hand and dried.

An Agroforestry Project in the East

As in other countries (Balandier and Dupraz, 1997), the widely spaced trees established and grew very well. The conclusions are not yet clear-cut. Just as in the United Kingdom (Newman and McAdams, 1997), in the first few years nut production was low. Given the expected yield of the cultivars used and the results of the financial model, it seems probable that the income from nuts will increase later and that during the
years the yields are small, grass production will hardly be affected by the presence of the trees. The nuts could be sold in various ways: for example, to tourists (pick-your own), directly to consumers (at the farm gate or in farm shops) or to factories that process nut meat. Alternatively, oil or other products could be made on-farm from the nuts. The fruiting shrubs and bushes will also make the locality more attractive to tourists. It is interesting to speculate about the age at which the trees will have a significant influence on the production and composition of the grass vegetation. Assuming that the conditions for an undergrowth of grass will deteriorate seriously when the crown canopy intercepts more than 50% of the light before it reaches the ground (this is assumed to be when the crown cover exceeds 50%), grass will grow very well under the trees for 10-20 years (see also figure 3). The investment required in trees, poles and protection materials is high.

The Dutch Ministry of Agriculture is intending to introduce grants for nut plantations shortly (2004/2005). This will help the enterprises through the first few years of deficit. Multipurpose plantations (fruit, timber, agricultural crop, landscape and biodiversity) will be established of hardwood species like walnut, cherry and sweet chestnut. The timber component will require formative pruning in the first few years (Balandier, 1997). The more the crowns are pruned, the more favourable the crown density will be for good grass production. Advances in the breeding of cultivars could also contribute to this. Although questions remain about the financial viability of these multipurpose plantations, such plantations can clearly deliver more diversification, both in terms of tangible products as in terms of landscape and ecosystem enhancement. It would be worth investigating in which landscape types and on which farm types the multipurpose plantations can contribute positively to the environment and to farmers’ income and future.

Selection of Cultivars in the North

Only limited results regarding productivity and nut and kernel quality of ‘Amphyon’ was obtained (Wertheim, 1996). Also the relevance of these limited results is questioned because ‘Amphyon’ was not included in the trial from the beginning but was planted 9 years after the trial started on places where other cultivars had been removed because of a poor performance. ‘Dionym’ was never included in the trial because it only became available after the trial was stopped. Therefore the potential of the cultivars could ‘only’ be judged qualitatively in the selection orchard of E. Kwanten and in commercial orchards that were planed with these cultivars. Important differences between the trial site at the Research Station and the selection and commercial orchards were crop protection, fertilisation, soil conditions and the weather. In the trial weeds were controlled by covering the ground with water permeable black polythene cloth. Aphids were controlled with insecticides in some years and all trees were fertigated. In the selection and commercial orchards the ground around the trees was not kept weed free, fertilisation was not carried out and no chemicals were applied to control insects or diseases. The soil in the trial was a clay soil whereas the soils of the selection and commercial orchards are sandy soils. The weather conditions at the trial site, which was located in the Southwest are clearly milder than the weather conditions in the Northeast where the selection and commercial orchards are located. Although no quantitative data are available to compare the performance of ‘Amphyon’ and ‘Dionym’, which were both selected in the North, with for example ‘Broadview’ and ‘Buccaneer’ the observations under organic growing conditions were promising enough for growers to plant these cultivars in their organic orchards. Planting of ‘Amphyon’ and ‘Dionym’ in the orchard in Luttlegeest in 1996, was followed by planting 600 ‘Dionym’ trees on a bio-dynamic farm in 2001. In 2004 again 400 ‘Dionym’ trees were planted in a commercial orchard.

The promising yield perspectives and the good kernel quality obtained with ‘Amphyon’ and ‘Dionym’ under an organic management regime together with a low susceptibility to pests and diseases and an increasing demand of Dutch consumers for locally grown organic walnuts with a high quality, will certainly lead to a larger acreage grown with ‘Dionym’ and ‘Amphyon’ in the near future.
**Literature Cited**


**Tables**

Table 1. Overview of the treatments.

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<td>mowing</td>
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<td>Walnut</td>
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<td>Sweet chestnut and cherry</td>
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<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thickness (mm)</th>
<th>Fresh weight (g)</th>
<th>Dried weight (g)</th>
<th>% kernel</th>
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<td>31.8</td>
<td>16.7</td>
<td>9.1</td>
<td>54</td>
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<tr>
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<td>30.7</td>
<td>14.6</td>
<td>8.7</td>
<td>47</td>
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<tr>
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<td>13.2</td>
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<td>33.4</td>
<td>12.0</td>
<td>8.8</td>
<td>47</td>
</tr>
</tbody>
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Figures

**Fig. 1.** Comparison of net income from multipurpose plantations and subsidised grass-land.

**Fig. 2.** Height growth of the tree species.
Fig. 3. Predicted crown development of walnut.