COMPARATIVE STUDY OF C SEQUESTRATION BY NEW FORESTS ON FORMER PASTURE LANDS

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ABSTRACT

The research compares the C sequestration of on the one hand an old pasture and on the other hand two young forest stands, planted on former pasture lands. The stands are respectively ash and pin oak stands, planted 27 and 26 years ago, with a basal area of 21.3 m^2 and 13.10 m^2.
C-content was assessed, based upon Hohenadl's model trees, for all compartments. The total C-content of the pasture land presently amounts to 128 t/Ha, whereas it reaches respectively 173 t/ha and 118 t/ha for the ash and pin oak stands. The soils of the forest stands contain respectively 74 and 50 t carbon/ha. So, remarkable changes occurred in the C quantity and allocation by the afforestation. Afforestation of a rich pasture leads in the first phase to a noticeable decrease of the C content in the soil. The C content of the A1 horizon is significantly greater in the pasture than in the young forest stands.

Nevertheless afforestation of a pasture considerably increases, already after 25 years, the C sequestration of the ecosystem, provided the used tree species are suitable, i.e. they should be fast growing and produce a good quality litter. This way, not only the aboveground C accumulation is useful, but also the quantity and the quality of the soil humus.
Research on the evolution of the C sequestration after afforestation of agricultural lands deserves priority.

1. INTRODUCTION

The current annual release of C towards the atmosphere is estimated at 7.3 Gt. After partial absorption by oceans and land biotics, still 3.3 Gt remain in the atmosphere (Watson et al., 1990 ; Cannell et al., 1992). The existing forests are outstanding means to sequester part of the released CO_2, in expectation that the industry can switch over to environmentally friendly fuels (Sedjo, 1989 ; Anderson, 1990).

The overall C-content in the living biomass is estimated at 550 Gt, whereas the amount of C in the organic soil matter on earth is calculated on 1500 Gt (Watson et al., 1990). Mellilo et al. (1990) distinguish the following components within the C-storage : living biomass, litter, humus and resistant C. The C-content of the living biomass in the tropical forest is somewhat greater than the C-content of humus and resistant C. On the contrary, the humus content and the resistant C clearly prevail in the boreal and temperate forests. Nabuurs et al.

(1994) estimate that 60 % of the overall C in forests is stored in stable humus. In pastures, featured by a high carbon amount in the soil, the above earth share of C is very limited.

Forest extension is often considered as a means to neutralise CO_2-emission. Also the EU-directive 2080/92, which provides significant incentives for the afforestation of abandoned agricultural lands, defines C sequestration as its secondary objective. In industrialised countries, forest extension has often to occur on more or less fertile pastures. The question arises herewith, how C-content evolves in young forest ecosystems, planted on pastures. Therefore, this research compares the C-content of a centuries old pasture with the C-content of two young forest ecosystems (an ash stand (Fraxinus excelsior) and a pin oak stand (Q. palustris)), planted on such pastures.

Schlesinger (1977) estimates the C-amount in the full soil profile of the temperate forests over the world at 11.8 kg/m^2, whereas this represents 19.2 kg/m^2 for the temperate pasture lands. Important questions are : how does the C-content of pasture soils evolve after afforestation ? To what degree does the C-content of the ecosystem increase by afforestation ?
It is evident, that the result will depend on the one hand on the starting situation of the pasture and on the other hand on the afforestation method. The afforestation has simultaneously to strive for a maximal absorption of C and for a minimal release from the system. This means, that the biomass increment should be as high as possible, whereas the mineralization in the soil should be as low as possible. Soil disturbance should be limited to ensure sustainability. Intensively managed forests with fast growing tree species, such as plantations, absorb per surface unit higher amounts of CO_2 than natural forests (Freedman et al., 1992). However, the total C-amount, stored in such an ecosystem, is not necessarily higher.

Indeed, on the one hand biomass is exported and on the other hand losses occur by accelerated mineralization in the soil layer. Depending on soil texture, management measures will more or less affect the C-content of the soil. Up to 36 % of the C is immobilized in fine texture soils by formation of organo-mineral complexes, whereas C is only for a small percentage stabilized in sandy soils (Paul, 1984). Afforestation on pastures, existing on sandy loam soils and with an active earthworm biomass, leads to the maintenance of the mull-humus, if the produced litter is of good quality. If not, the humus evolves to moder and the stable humus decreases (Muys & Lust, 1994).

Soil preparations increase mineralization, by which the humus content decreases and significant nutrient losses occur (Burger & Pritchett, 1988). On soils, where the mixture of the organic material is minimal, ploughing accelerates the natural incorporation and increases the amount of physically stabilized C (Carlyle, 1993). Johnson (1993) found a rise of the soil carbon content by fertilisation and adding of N-fixing organisms. However, CO_2 is again released during the production of fertilisers, what might rectify the positive effect (Nabuurs & Mohren, 1994).

Cannell et al. (1992) modelled the C-evolution with the afforestation of peat lands by Sitka spruce with a rotation of 55 years and a life expectancy of the timber products equal to 45 years. Afforestation of such soils does not increase the C-pool. On the contrary, it diminishes by a higher decomposition rate, due to the disturbance of the soil up to a depth of some 80 cm during successive rotations. These authors also modelled the C evolution with a plantation of fertile arable soils with poplars, with a rotation period of 10 years and timber products with a life expectancy of 15 years. The C-content rises very fast and significantly. After a number of rotations the average C in the system reaches a maximum of 12 kg C/m^2, thanks to the strongly increased C amount in the mineral soil. They conclude, that the speed, with which the C is stored, is the greatest with fast growing tree species with a short rotation, and by which the timber products have a relatively long life expectancy. The effect is the greatest, if it is planted on soils poor on organic C.

2. METHODOLOGY

2.1. Description of the site

The research has been carried out in the experimental forest of Aelmoeseneie (Flanders, Belgium). The total C-content of two young stands, planted on former pastures, has been investigated and compared with the C-content of the adjacent original pasture. The present pasture and the former pastures have probably been pasture lands for several centuries. They were intensively used during the last decades. The first sample plot is located in an ash stand, with an area of 1 ha, planted in the autumn of 1968. The soil belongs to the series "wLep". Before the afforestation, a complete soil preparation, up to a depth of 15 cm, was carried out by a rotary cultivator. A light understorey of elderberry (Sambucus nigra) has settled spontaneously under the ash cover. The herbaceous layer mainly exists of well developed Urtica dioica and Ranunculus repens. pH of A1 horizon ranges from 5 to 6.2. The humus belongs to the mull-type. Mass and diversity of earthworms is remarkable (Muys, 1993). The second stand is a plantation with an area of 70 ares, planted in spring 1970, without a preceding soil preparation. The upperstorey exists of pin oak, planted at a distance of 4 x 4 m. The understorey mainly exists of hazel, also planted in 1970 and already cut back two times, and of spontaneously settled elderberry shrubs and a few maple saplings. The soil belongs to the series "whdc". The pin oak litter slowly decomposes and forms a moder humus. Muys (1993) found that in this stand, mainly by the impact of the tree species, the Ca-content in the A1 horizon and also the earthworm biomass are already lower than in the ash stand.

2.2. Assessment of the C-content

The C-content in the forest stand has been assessed for the entire ecosystem : trees, shrubs, herbs, litter, roots and mineral soil. The investigation in the pasture was limited to the soil, since the aboveground biomass is negligible (Schlesinger, 1977).
The measurement of the trees was done on three model trees. In the ash stand a sample plot of 25 ares was laid out in the centre of the stand. As the pin oak stand is less homogeneous, a sample plot of 0.525 ha was laid out (= whole stand minus surround).
The model trees were determined according to the Hohenadl method. The tree model trees are : the tree with the average diameter (dm) and the two trees with diameter equal to average diameter, respectively increased and decreased with the standard error (d+ and d-). In order

to calculate the height curve, the height of some ten trees was measured.
The three model trees were cut in each stand. The tree length was exactly measured. All leaves were gathered and the total fresh weight was determined. Of this a sample of 100 leaves was taken. It was weighed again in the laboratory and afterwards the dry mass was determined. This way the total dry weight of the leaves was calculated.
All small branches with a diameter $\leq$ 1.5 cm were considered as twigs. Branches were divided into two classes, diameter ranging from 1.5 cm to 7.5 cm and more than 7.5 cm. The same procedure as with the leaves was followed. The fruits too were gathered.
Dry weight of stems was assessed, starting from the volume and the volume density (see also Nabuurs and Mohren, 1994). The volume of the lying trees was determined by means of the Simpson formula. Therefore, the stem diameter was measured each half meter. To assess volume density, segments out of the stem (or big branches) were taken each meter. The volume and the dry weight of these segments were determined, of which the bulk density was calculated.
It was accepted that the C amount of the trees equals to 50 % of their biomass (Matthews, 1993 ; Poller & Knappe, 1988 ; Agstay et al., 1987).
In order to convert the data of the model trees per hectare, a quadratic regression was calculated. This way, starting from the diameter, the biomass of each tree and the C-content of the stems, branches, twigs and leaves was determined.
Two shrub species appear, i.e. hazel and elderberry. By analogy with the stand, also 3 model poles were designated. Of these the global aboveground biomass was calculated. A transect was laid out in order to determine the model poles. The dimensions were : 5 x 50 m in the ash stand and 5 x 100 m in the pin oak stand. All shrubs were counted. All poles were counted and d 1.30 measured with ten, at random selected shrubs. This way the three model poles according to Hohenadl were determined. With each of these poles, biomass of leaves, twigs and stems was assessed by assessment of fresh weight on the field and afterwards by determination the fresh and dry mass in the laboratory.
Next to the shrubs, the maple regeneration (up to a d = 1.5 cm) was treated separately. In order to assess the biomass some individuals were selected at random, of which the whole biomass was determined.
It was also accepted that the C-content of the shrubs and the regeneration equals to 50 % of the biomass.
The herbal layer was not sampled separately. It was accepted that it was included in the litter layer, which was sampled just before leaf fall. Therefore, twelve at random selected plots, with an area of 0.5 x 0.5 m, were selected in each stand. A distinction was made between L, F an H layer. The different layers were sampled and freshly weighed. Afterwards the fresh weight and later the dry weight of a sub sample was assessed. Muys (1993) found with ash and pin oak, that the C-content in the L layer reaches 42.04 %, against 36.72 % in the F-layer. Dead wood was gathered separately. As for the living trees it was calculated with 50 % (Muys, 1993 ; Maddelein, 1993). The total C-content of the litter layer equals to the sum of L, F and H layer, plus dead wood.

The root biomass was calculated, based on literature data. It was accepted that the below-ground biomass amounts to 20 % of the total above-ground biomass (Duvigneaud, 1984 ; Satchell, 1971 ; Maddelein et al., 1993 ; Harris et al, 1980).

The C amount of the soil was assessed, in the two forest stands as wzll as in the pasture, in twelve at random selected plots. On each plot samples were taken on several depths : 0-5 cm, 5-15 cm, 15-50 cm en 50-100 cm. C was determined via the Walkley and Black method (results of this analysis were multiplied with a factor 4/3). In order to calculate C/ha, the weight of the ground layers must be known. This was calculated out of the volume and density of each layer.

3. RESULTS

At the time of measurements ashes and pin oaks were planted respectively 27 and 26 years ago. The number pro ha amounted to 1156 with ash and 405 with pin oaks. Basal area reached respectively 21.3 m^2/ha en 13.10 m^2/ha, which means that the basal area of ash was 63 % greater than this of pin oak.
The relationship between diameter and height is as follows :

- with pin oak : $h = -0.011\ d^2 + 0.5813\ d + 10.266$
  with level of significance 0.06 and $Ra^2 = 0.64$
- with ash : $h = -0.0488\ d^2 + 2.2865\ d - 5.352$
  with level of significance 0.004 and $Ra^2 = 0.84$

Ashes have a lower diameter, but are taller than pin oaks. This is mainly due to the density of the plantation.

Table 1 gives some basic data for the two forest stands. The signs -, m and + indicate the model trees with d-, dm and d+.

Table 1 : Basic data for model trees

Tree	dbh (cm)	height (m)	volume (m)	crown length (m)	number of leaves
OAK -	15	15.9	0.13	9.3	13.252
OAK m	20	16.9	0.21	9.3	21.366
OAK +	25	17.9	0.30	10.9	33.327
ASH -	10	17.7	0.04	5.6	993
ASH m	15	19.8	0.20	7.7	5.390
ASH +	20	22.8	0.36	14.2	20.817

The individual oak trees have, due to the large planting distance, a much greater number of leaves, but their stems are shorter.

The average bulk density of the wood reaches for :

- oak : 527.4 kg/m^3
- ash : 523.5 kg/m^3

Biomass of the different compartments is shown in table 2. It allows to calculate the overall biomass and the C-content of each tree (table 3).

Table 2 : Biomass of the model trees (kg), divided into compartments

Tree	leaves	twigs	fruits	branches < 7,5 cm	branches > 7,5 cm	stem
OAK -	4.56	9.29	0.14	10.46	-	40.25
OAK m	5.75	13.04	0.07	19.87	-	70.68
OAK +	9.23	21.04	0.06	73.95	46.46	70.34
ASH -	0.60	1.72	-	0.72	-	15.30
ASH m	4.32	8.15	0.42	15.42	-	80.66
ASH +	6.62	9.99	0	49.26	-	121.02

Table 3 : Overall biomass and C-content of model trees (kg)

Tree	Biomass (kg)	C-content (kg)
OAK-	64,70	32,35
OAKm	109,41	54,71
OAK+	221,08	110,54
ASH-	18,34	9,17
ASHm	106,97	53,48
ASH+	186,89	93,44

The main model trees of oak and ash have practically the same C-content, despite their different diameter.

In order to determine, starting from $d_{1,3}$, for each tree of the sample plots the desired values, the following equations were calculated :

1. For pin oak

$$V = -0.00298 \,.\, d + 0.00072 \,.\, d^2$$
$$C_{leaves} = 0.076 \,.\, d + 0.0041 \,.\, d^2$$
$$C_{twigs} = 0.100 \,.\, d + 0.0125 \,.\, d^2$$
$$C_{branches} = -1.358 \,.\, d + 0 \,.\, 109\, d^2$$
$$C_{stem} = -1.84 \,.\, d + 0.25 \,.\, d^2$$
$$C_{tot.} = -3.015\, d + 0.371 \,.\, d^2$$

2. For ash

$$V = -0.00752 \,.\, d + 0.00129 \,.\, d^2$$
$$C_{leaves} = 0.052 \,.\, d + 0.0113\, d^2$$
$$C_{twigs} = 0.0425 \,.\, d + 0.0122 \,.\, d^2$$
$$C_{branches} = -0.041 \,.\, d + 0.059\, d^2$$
$$C_{stem} = -1.947 \,.\, d + 0.337 \,.\, d^2$$
$$C_{tot.} = -1.982\, d + 0.419 \,.\, d^2$$

The volumes of the oak and ash stands amount respectively to 95.4 m^3 and 223 m^3. The above ground C-content of the trees, calculated per ha, is shown in table 4.

Table 4 : The above ground C-content of the trees (ton/ha)

Stand	C leaves	C twigs	C branches	C stem	C tot
OAK	1,3	3,0	7,3	26,9	37,7
ASH	2,2	3,8	15,3	58,6	80,2

The C-content of the above ground part of the ash stand is, after 27 years, twice as great as that of the oak stand, although it is only one year older. The share of the stem is respectively 71 and 73 %, whereas the branches take up each time 19 %.

Muys (1993) found that, the degree of cover of the trees amounted to 70 % in both stands, whereas that one of the understorey accounts for 43% with pin oak, but only 2 % with ash. Biomass and C-content of the model poles of the shrubs are much higher with pin oak (table 5).

After conversion per ha, it appears that the C-content of the ash understorey is almost negligible, whereas it represents already 12t with pin oak, being some 25 % of the above ground C of the trees (table 6).

Table 5 : C-content (g) of model poles of shrubs and of regeneration of maple.

	C leaves	C twigs	C branches	C tot
1. OAK stand				
Samb. d-	0.8	3.9	-	4.7
Samb. dm	7.2	37.0	29.7	73.8
Samb. d+	100.6	234.1	916.5	1251.1
Cor. d-	4.6	94.2	0.0	98.7
Cor. dm	50.9	171.8	673.2	895.9
Cor. d+	134.4	377.1	1997.4	2508.9
Acer 1	3.0	8.5	-	11.6
Acer 2	0.1	1.3	-	1.4
Acer 3	5.9	15.1	-	20.9
2. ASH stand				
Samb. d-	2.7	9.4	-	12.2
Samb. dm	7.2	37.0	29.7	73.8
Samb. d+	23.0	87.9	82.1	193.0

Table 6 : C-content of the shrubs (kg/ha)

	Sambucus		Corylus		Acer		Total C
	N poles	C	N poles	C	N poles	C	
1. Oak stand	4,360	1,923	8,660	10,099	3,200	36,2	12,059
2. Ash stand	2,000	186,00	/		/		186,00

Dead wood (D.W.) is still very limited in both stands. With the ash litter, only an L-layer was found, whereas with pin oak an L and F layer were present. The latter contained most C (table 7).

Table 7 : Content of litter layer and of dead wood (D.W.) in ton/ha (+ standard error)

	L-layer	F-layer	D.W.	Tot C.
Oak stand	1.18 (0.19)	5.39 (3.97)	0.84 (0.36)	7.41
Ash stand	1.18 (0.21)	-	1.30 (1.31)	2.48

Since it is accepted, that the C-content of the roots represents 20 % of the above ground part, the C-content of the roots amounts to :

- 9.94 ton/ha with pin oak ;
- 16.08 ton/ha with ash.

The C-amount in the mineral soil is often significantly different between the several investigated layers (table 8).

Table 8 : C-content (%) of the mineral soil on different depths (* means significant differences)

C	0-5	5-15	15-50	50-100
Ash	2.03	1.46	0.69	0.14
Oak	1.72	0.80	0.39	0.12
Pasture	5.70	3.09	1.03	0.14

0-5	Ash	Oak	Pasture	5-15	Ash	Oak	Pasture
Ash	0	0	*	Ash	0	*	*
Oak	0	0	*	Oak	*	0	*
Pasture	*	*	0	Pasture	*	*	0
15-50	Ash	Oak	Pasture	50-100	Ash	Oak	Pasture
Ash	0	*	*	Ash	0	0	0
Oak	*	0	*	Oak	0	0	0
Pasture	*	*	0	Pasture	0	0	0

- In the A1-horizon (0-5 cm), the C-content on the pasture is significantly greater than in the forest stands.

- In the 5-15 cm layer, the C-content of the pasture remains significantly greater, but differences also appear between ash and pin oak. Almost the same situation occurs in the 15-50 cm layer.

- Under the 50 cm, the C-content is limited on all places.

The C-content of the soil was calculated, after foregoing assessment of the bulk density, the mass and the moisture content in different layers (table 9).

Table 9 : Bulk density, mass, moisture content and C-content of the mineral soil

	Layer-thickness (m)	Bulk density (kg/m^3)	Mass (ton/ha)	Moisture %	C-content (t/ha)
Ash	0.05	1.168	584	35.2	11.86
	0.10	1.218	1.218	28.5	17.82
	0.35	1.390	4.865	29.5	33.75
	0.50	1.575	7.874	23.2	10.73
	1		14.541		74.16
Oak	0.05	1.094	547	29.7	9.38
	0.10	1.257	1.257	24.5	10.05
	0.35	1.514	5.298	20.6	20.84
	0.50	1.677	8.383	17.8	9.85
	1		15.485		50.12
Pasture	0.05	932	466	55.1	26.54
	0.10	1.214	1.214	35.6	37.47
	0.35	1.482	5.188	26.3	53.29
	0.50	1.584	7.918	21.4	11.23
	1		147.857		128.53

Great differences obviously appear in the C-content of the mineral soil of the three research objects : the pasture contains almost 75 % more C than the ash stand, that on its turn contains almost 50 % more C than the pin oak stand.

Finally the C-amount on stand level can be calculated (table 10).

Table 10 : The C-amount stored in the different compartments (ton/ha)

	Trees	Shrubs	Litter	Roots	Min. soil	TOTAL
OAK stand	37.70	12.06	8.19	9.94	50.12	118.01
ASH stand	80.22	0.19	2.48	16.08	74.16	173.13
PASTURES	-	-	-	-	128.53	128.53

- The amount of C stored in the ash stand is by far the greatest : it is 35 % greater than in the pasture and 47 % greater than in the pin oak stand.
- In both forest stands, the mineral soil contains 43 % of the total C (fig. 1).
- The trees represent with ash and pin oak respectively 47 % and 32 % of the total C-amount.

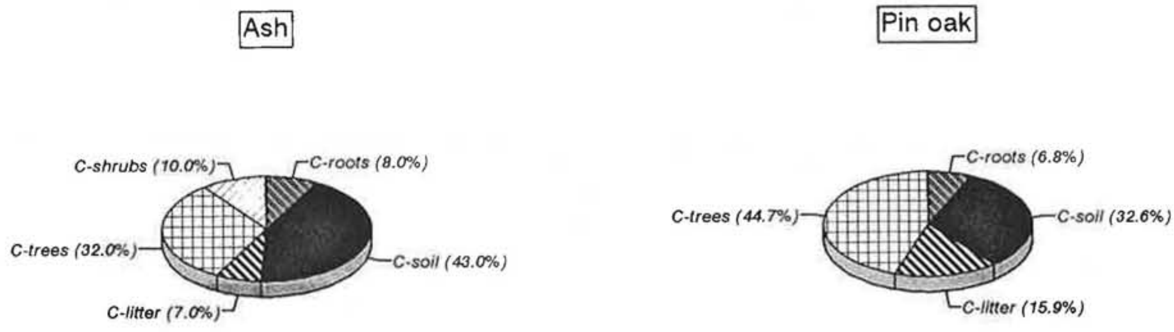

Fig. 1 : The share of each component in the total C amount

4. DISCUSSION

25 years after the plantation of intensively used pasture lands, the C-content in the ecosystem is thoroughly changed. In comparison with the pasture, that contains 128 ton C/ha, the C-storage is on the one hand increased to 173 t/ha by afforestation with ash, whereas on the other hand the C storage is decreased to 118 ton/ha by afforestation with pin oak. It is to be expected that in both forest stands the C-storage will still increase in the future, as C has not yet reached its maximum in any of the forest stands. So, the statement of Nabuurs & Mohren (1994), i.e. the C-storage per surface unit is much greater in forest ecosystems than in agricultural lands, can be confirmed.

However, the rise of C-content after afforestation does not occur linearly, depending on the forest biomass. Indeed, it is also found that the change of use of the pasture land leads to great changes in the C-storage of the mineral soil. Unfortunately it is not known in this research how much C was stored in the pasture at the time of afforestation. Due to the very intensive exploitation and fertilisation, it is accepted that it has still increased afterwards. In an adjacent pasture, that in former times also belonged to the original pasture, but that was abandoned since 25 years, Muys (1993) measured a C-content in the A1 horizon equally to 2.9 %. This value should be compared with the present C-content in the pasture, i.e. 5.7 %, and with the contents in the forest stands (2.0 % with ash). So there is a significant difference in C-content between the managed pasture and the abandoned one. It is also evident, that the C-content in the new forest soil is lower than in the abandoned pasture. So, it has to be accepted that the afforestation of a pasture involves a decrease of the C-content in the soil. The course of these C-dynamics, both on the pasture and on the afforested pastures, is unknown. This should be investigated by priority.

The question also arises to what extent the C-content in the new forest soils will still increase. Schlesinger (1977) states, that soils of pasture lands in temperate regions normally contain much more C than the forest soils : 19.2 kg/m^2 against 11.8 kg/m^2. To be remarked herewith is the very high C-content in pastures, at least in comparison to the high value in this investigation (19.2 <-> 12.9 kg/m^2). It is not clear how this difference can be explained. Muys (1993) on his side found in the A_1 horizon (0-5 cm) of a nearby semi-natural stand of pedunculate oak (Quercus robur) a C-content equal to 5.68 %. This figure is identical to the high value of the pasture, but much higher than in the A_1 horizons under the young plantations of ash and pin oak. Muys explains this high value by the presence of epigeic earthworms, which are acidophile and are living in the litter of forests with a moder and mor humus.
So it is possible that the C-content in the new forest soils will still strongly increase in the future. In this respect the presence of earthworms will be of great importance, not only for the C-content in the upper horizons but also in the deeper layers. At the time significant differences exists in the C-content of the soil layers up to a depth of 50 cm. The differences become relatively smaller with increasing depth. It is expected, however, that the area of the A_1 horizon in the new forests, especially under ash, will be reduced.

The C-dynamics are obviously determined by the forest management. It appears that the choice of tree species is very important. It determines not only the C-content by the tree biomass, but also the C-sequestration of the mineral soil. In this research, especially the C-differences of the trees are great. Indeed, the difference between ashes and pin oaks amounts here to 42 t/Ha, whereas the difference in the soil between these two stands only reaches 24 t/ha. So, in order to sequester C as much as possible, it is not only important to use fast growing species, but also species with a good quality litter, that directly increases the quantity and the quality of the soil humus. Ash is a tree species with a rich leave litter, contrary to pin oak, of which the leaves more difficulty decompose and the litter leads to a slow but obvious soil degradation.

It is to be expected, that the C-sequestration in the litter will change still strongly, especially with pin oak. The biomass and the C-content of the litter of the ash stand are presently very reduced, namely 2.5 t/ha. In a nearby ash stand in the old forest, the accumulated C amount in the litter reaches 4.1 t/ha. This value too is small in comparison to the 8.8 t/ha, as indicated by Nabuurs & Mooren (1994) for the litter layer of ash stands in the Netherlands. The pin oak nowadays contains 8.2 t carbon in the litter, whereas in a nearly pedunculate oak stand in an old forest the stock amounts to 35 t/ha. A substantial increase of the C-content in the litter of pin oak is expected.

The research proves, that the secund goal of the EU-directive 2080/92, i.e. the increase of the C-storage, can be realized. Therefore, however, it will be necessary to deal judiciously with the problems. Firstly, the rate of rise will depend considerably on the starting situation of the soils, which should be afforestated. Arable land, with little C in the soil, will give a faster and better result than pasture in which in a first phase of the afforestation the C-content can still diminish significantly. The choice of tree species too is of great importance ; species with a fast and great increase of biomass, with leave-litter that is favourable for a mull-humus and the development of a rich earthworm population and which provide products with a long life expectancy, are highly recommendable.

5. LITERATURE

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