Utkast 20240121

Vombssänkans willow- and poplar park (VPP) 2024.

Aimes:

---to improve the efficiency of carbon sinks in nature,

---to minimise the tendency towards overgrowth of lakes and seas.

Working hypotheses:

1. **Woody biomass is too valuable to be burned.**
2. **The fastest way to reduce carbon dioxide levels in the atmosphere is to plant lots of trees.**
3. **Tree planting in specially selected areas can prevent leakage from agriculture.**

A Photo Seminar, VI, 2024.

-Objectives: to assess and demonstrate the potential of trees to decarbonize the atmosphere and to prevent leakage of nitrate ions to streams and lakes.

by

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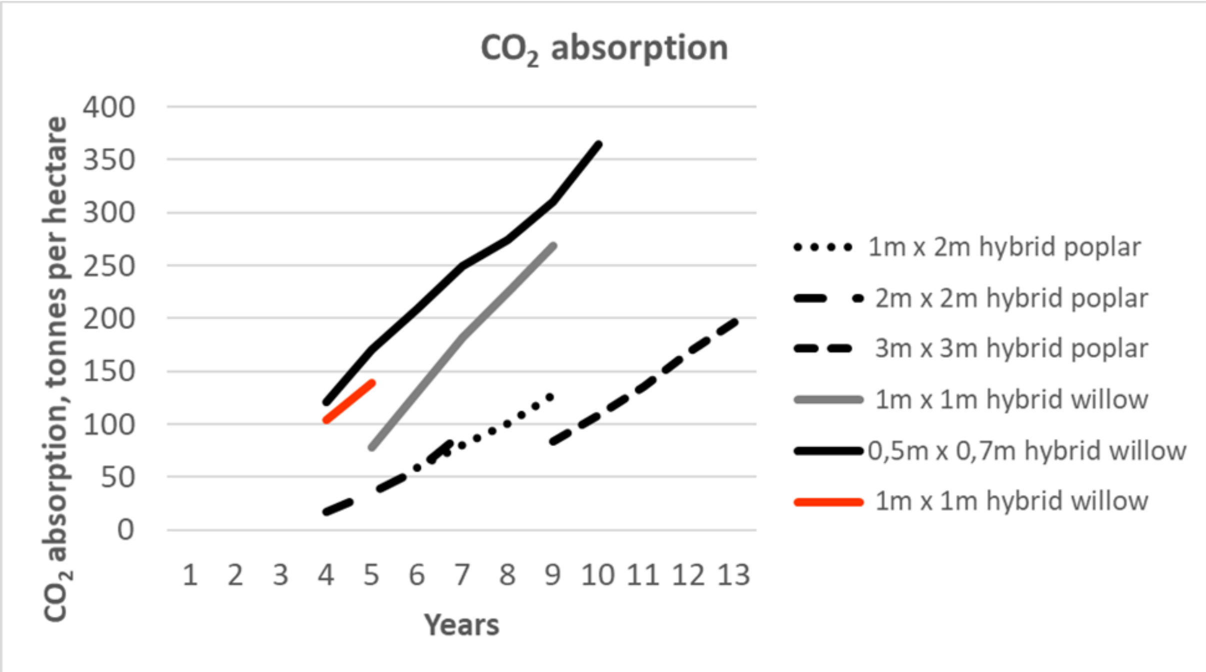
Welcome back !

Abstract.

Increased concentration of carbon dioxide in the atmosphere due to the use of fossil fuels is leading to the climate change. Single-stemmed willow and poplar trees are among the most efficient tree species for carbon dioxide absorption at Swedish conditions.



Willow and poplar plantations growing with good water and nutrient conditions absorb 20 – 30 tonnes/ha/yr of carbon dioxide from the atmosphere and 200 – 400 kg of nitrate ions/ha/yr from leaking agriculture fields (Table 6). Produced wood will be used for energy (electricity, hydrogen gas, alcohols, wood chips), paper, biochar (in Swedish: biokol), furniture, wall panels, textiles, fruit packaging.

Plantations.

A poplar plantation with long cuttings (3,5m).

Experimental field: Björkadammen.

Figure 1. Overview of a part of the Vombsjösänkan`s willow and poplar park (VPP). The area is called Björkadammen and consists of a fertile bog with pH 5.7 - 5.9. The ground water level is 0.5–1.0 m. Sommer frosts are frequently occuring. The other part of the park is called Ankedammen (Fig. 2) and is located 1 km to the south, just north of Bruksgården.

Experimental field: Ankedammen

Figure 2. Overview of that part of VPP that is known as Ankedammen. This part of the park is located on a soil dominated of fine sand with pH 6.2 and the groundwater level is at 4m. In this experimental area the Faculty of Forest Sciences, SLU, tests and determines the optimal production potential of fast-growing deciduous tree species through fertilization and irrigation treatments.

Figure 3a. One-year old plantation of poplar (Populus trichocarpa) with long cuttings, 3.5 m long, of 2 – 5 year old poplar shoots. Winter dormant cuttings are drilled 1m into the ground.

The design is 2 x 2m. Protective cylinders are made of cardboard. Note! no soil preparation.

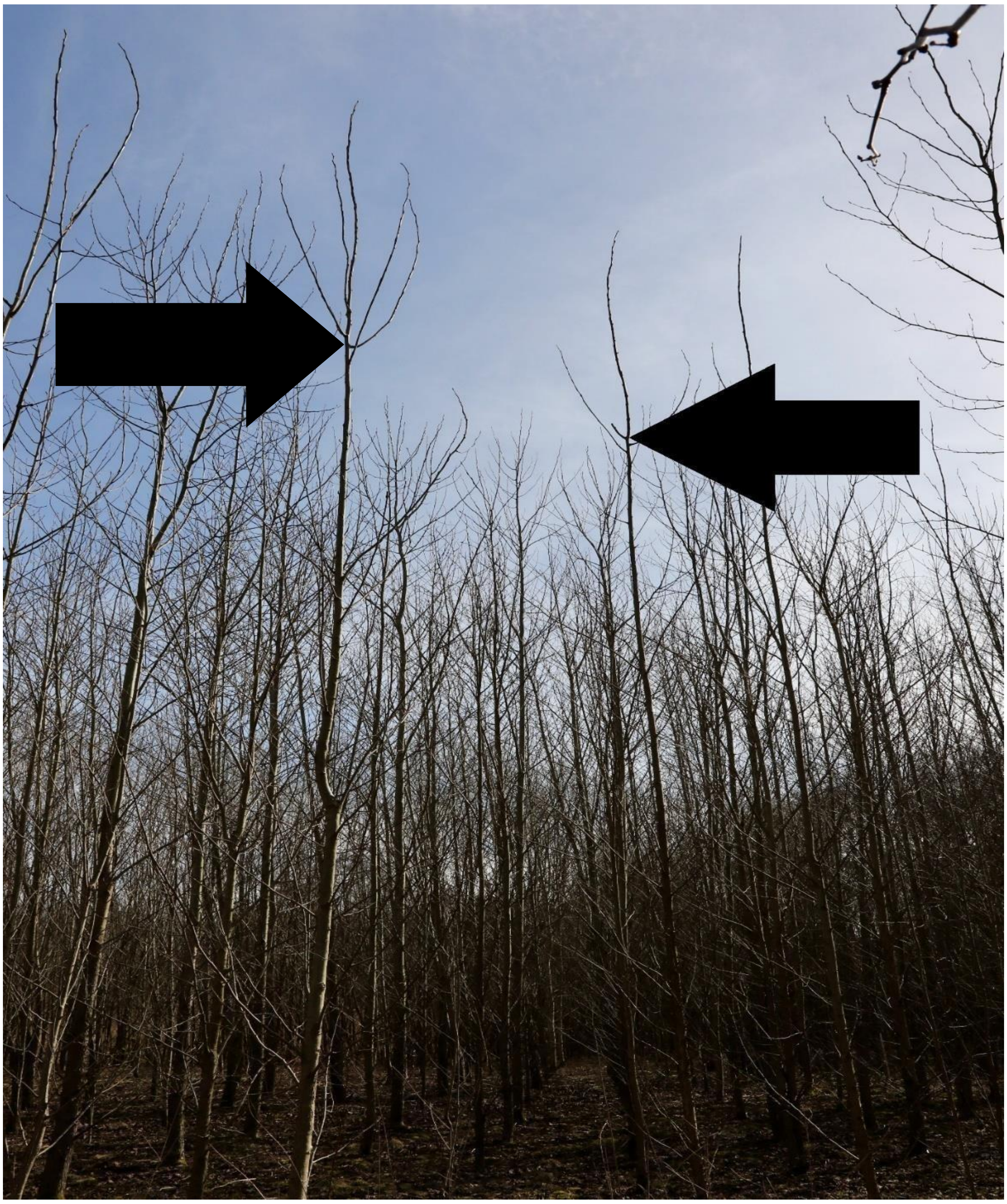


Figure 3b. Foreign poplar species were introduced to Sweden in the 1700s. Some particularly interesting, new clones were supplemented and tested in the 1930s-40s (for match stick production), and in the 1980s-90s (for energy purposes). Crossings within and between species have been carried out in Sweden and abroad. About a hundred new clones are tested at VPP. The results suggest a production potential of 25 – 35 m^3 sk/ha/year (0.8 – 1.2 kg/m^2 /yr). The arrows are showing where annual growth for the most recent year begins. (sk: means stem volum plus the volum of large branches).

Figure 4. Energy forest cultivation with new willow clones. A new planting pattern and longer rotation times gives almost a doubled woody biomass production. The photo shows a nine years old plantation of the clone Tora. Design: 0.5 x 0.7m. The shoots are 12 – 13 m high. Average production after a few years of establishment amounts to 2 kg TS/m^2/year.

Figure 5. The same type of cultivation as in the previous photo. Notice particularly the large number of shoots per unit area. This willow clone can thus be made: A. to grow densely without stems that outcompete each other, and B. to have the phenology to grow as single stemmed trees. It is these two characteristics, which we will exploit in the future and which are the cause of an almost doubled level of woody biomass production.

Figure 6a. The ability of some willow clones to grow as individual, straight- and single stemmed trees is being tested on VPP. The photo shows a nine-year old plantation with the clone ESO 77590. Cuttings length 1m, drilled 0.5m into the ground. Planting design 1 x 1m. *No soil preparation*. Presently the trees have an average diameter of 8 cm and are 13 m tall. Average biomass production amounts to 2 kg/m^2/year after a few years of establishment. The wood can be used, among other things, for pallets and for packaging for e.g. fruit. There may also be even more valuable woody products of this type of wood in the future. Large-scale cultivation of this kind of plantation absorbs 30 tons of carbon dioxide and up to 400 kg of nitrate ions per ha and year (Table 1). Concerning energy, for example 110 MWh of heat can be extracted from produced wood from one hectare of such plantations per year (see below). If there is enough water and nutrition, such cultivation in southern Sweden has a volume production potential of 300 – 400 m^{3}sk / ha/ 10 year.

Figure 6b. A forest harvester with a new crane tip and with a mounted and multitree handling head for small dimensions of trees. The unit has been developed at the Faculty of Forestry Sciences, SLU, Umeå, Sweden (Professor Tomas Nordfjell). The reach of the boom in both directions is 10 m. The harvester is suitable for the type of Komplementary forestry shown in Figure 6a (breast diameter 10 – 15cm). The harvester has a capacity of 30 – 40 trees per hour. With this type of harvester new ideas are born, some of them are tentative and some very speculative. But here it is necessary with thinking outside the box. Fencing of willow plantations with galvanized steel net is extremely expensive (Table 4), even if we use living fence posts (Figure 10). Within the research team we are discussing possibilities to cut willow trees at harvest 3 – 4m above ground. They have then a diameter of 15 to 20 cm and a hight of 20- 25 m. During such conditions the stem start to develop new shoots and branches next year only from the top of the stem, where red deer and moose do not reach them. During such conditions fencing will only be necessary during the first 5- 10 years. Then the fence can be moved to next willow plantation. A more realistic idea is perhaps to cut all the stems at the ground at harvest with exception of the stems at the uttermost lines around a plantation. Those stems should be cut 3 -4 m above ground. On these stems a net should be hanged the coming 5 - 10 years. In this latter case perhaps it is enough tp use cheap bio plastic net (from China?). To be sure that these fencing ideas really will work out small areas with wild life fodder ought to be planted in the neighbourhood. In this way we believe that we can get the animals not to turn down the still existing stems by their body by "walking" over the stems. This type of arrangement will be tested at VPP during the coming years. This type of harvester will be able to operate electrically in the future.

Figure 7. Many of the new willow clones are being tested on their ability to grow as individual, single-stemmed trees. The picture shows two lines with the clone Emma. The plantation is 5 years old. It was planted with 30 cm long cuttings and with a design of 0.5 x 0.85m. The planting was heavily thinned after three years. The shoots are currently 7m. Measurements are carried out of the stem diameter growth every month at VPP on the willow clone Tora. The results are showing that the diameter growth is starting slowly at the end of April (Figure 8b). The growth is reaching its optimum in June and July. It is slowing down in August and September and stop totally in October.

Figure 8a. A willow plantation with 12 new clones and with long cuttings, 3.5 m long, drilled 1m into the ground. *No soil preparation*. Design 1 x 1m. The planting was carried out in March 2020, the photo was taken in March 2022. At that time the best growing clones had a length of 6m and a diameter of 3.5cm. The planting is fenced.

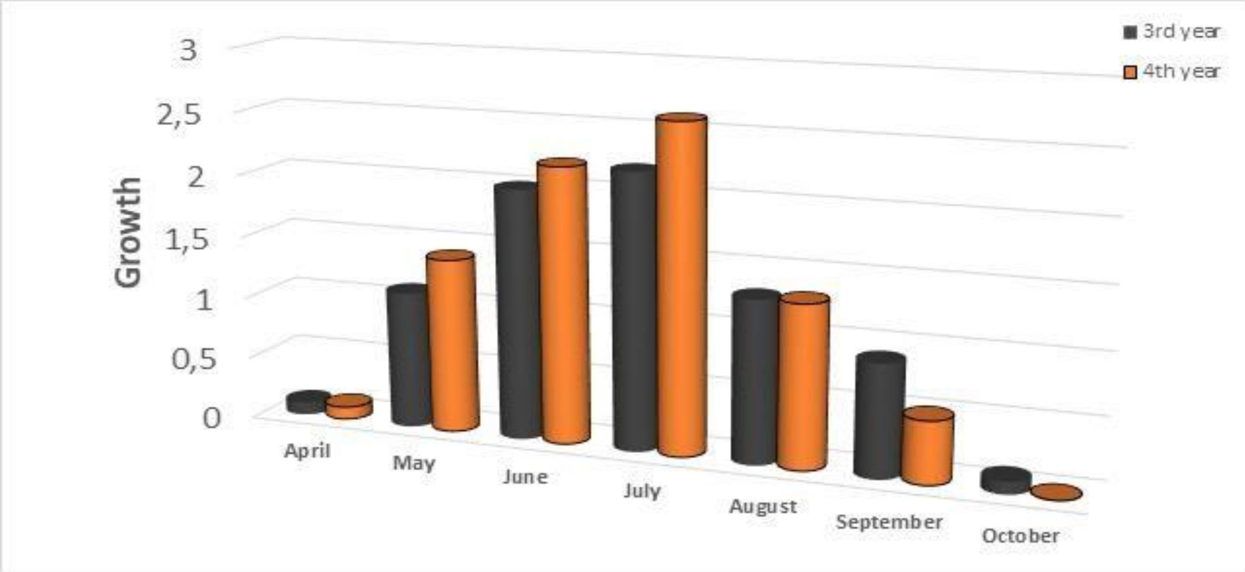


Figure 8b. Monthly diameter growth in mm during the third and fourth year of one of the willow clones in Figure 8a (Tora). The diameter growth started the last week of April, peaked in June and July and ended in the first week of October. This is the growing pattern for willows in the most southern part of Sweden. (for details see Table 5).

Current situation

In a try to get fast-growing, bushy, shribe-like willow hybrid clones to develop as single-stemmed, strait-growing trees 3,5 m long cuttings were planted with a design of 1 x 1m and no soil preparation (Figure 8a). Totally 240 long cuttings were planted. After 4 years of growth all cuttings except one were growing as single-stemmed, strait-growing trees. Only one cutting was developed as a double-toped tree. Similar test-plantations have earlier given the same results. It seems as we here are on our way to develop a new type of Short Rotation Forestry in Sweden. We call it SUPPLEMENTARY FORESTRY (in Swedish KOMPLETTERINGSSKOGSBRUK). This form of cultivation is a further development of the form of cultivation that was known as Energy Forestry. The fast-growing, deciduous tree species that are relevant here are willow and poplar.

Description of SUPPLEMENTERY FORESTRY.

In SUPPLEMENTARY FORESTRY a new form of plantations and alternative methods for cultivation and management have been developed. This means that we have succeeded in getting bushy, fast-growing, shrub-like willow clones to develop as single-stemmed, straight-growing trees. The advantages here is that some willow clones retain their very high growth potential even as individual trees. Besides of that the planting is carried out without soil preparation. Both willow and poplar clones are grown with very tight designs. For the willow, with its very light-permeable canopy, planting without soil preparation means that a large part of the biodiversity in these forests can be preserved. Both tree species are planted with cutting lengths varying between 1 and 3.5 m, depending on the risk of summer frosts. If there is enough with water and nutrients in the soil, the production potential of both willow and poplar plantations is 30 – 40 m^3/ha/year after a few years of establishment. These production potentials mean that each hectare of these types of crops absorbs 20 to 30 tonnes of carbon dioxide from the atmosphere each year and 100 kg of nitrogen as nitrate-nitrogen from the soil and ground water. In many places with high populations of moose and red deer this type of cultivation must be fenced.

Produced wood is intended to be used as raw material in the production of biofuels, pulp, biocol, textiles, and as carpentry material for simpler wood products such as fruit boxes or and pallets.

Figs. 9a and b. In a new plantation in 2022, the ability of the most promising "tree-forming" willow clones were tested to grow and develop in a highly weedy and grassy environment. The length of the cuttings is 1m. *No soil preparation*. Varying designs. The highest annual shoots are today, after one year´s growth, 3 m.

Figure 10. A living fence post (see the arrow) is the latest innovation at VPP. It has been shown that 4 -5 years old trunks of both willow and poplar stems can be used and made to grow further as fence posts, when fencing plantations with game-fence net. In this way, the impregnated posts, which often rot after 10 – 15 years, are avoided. In addition, biomass production is slightly increased, as these posts become new trees and are cut at each final felling 3m above ground. The cut-off posts will once again start to grow new shots. Such a fence is estimated to have a service life of 50 years.

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Figure 11. A fertilized and irrigated clone test of new poplar clones, not previously planted in Sweden. There were originally 129 different clones planted. Half were of the pure species P.trichocarpa, the other half was hybrids between this species and P.deltoides and vice versa. All hybrids were dead after 10 years due to root rot. This is probably due to the very poor soil they were growing on and that the utilized fertilization regime was not sufficient, mainly on the nitrogen side on this sandy soil.

Results

Wood biomass production, opportunities and requirements.

¤ The new willow and poplar clones show a production potential of up to 1.5 kg/m^2/year for poplar and 2.0 kg/m^2/year for willow in parcel experiments under favorable culture conditions.
¤ Crucial to the size of wood biomass production is the availability of nutrients and water and the grower's professional skills.

¤ For optimal production, optimal planting patterns are crucial.

¤ The planting design determines the time of felling and vice versa.

Table 1. Production, an overview.

A. old cultivation methods, old plant material (old clones)

B. new cultivation methods, new plant material (newly breeded clones) When calculating possible amounts of biofuels from produced woody biomass, preliminary values based on 1 m^3 aspen wood has been used in the case of poplar wood (see below). All corresponding results from the willow cultures have been multiplied with 1.25 because the dry density is 25% higher for the willow wood (poplar 0.33, willow 0.45 kg/dm^3). The same applies to carbon dioxide absorption and nitrate nitrogen uptake. When calculating carbon dioxide and nitrate nitrogen uptake, the starting point has been that all dry, woody biomass contains 50% carbon atoms and 0.5% nitrogen. All values are calculated on dry woody biomass. Some roundings have been taken. The sign # means not allowed upscaling #, only for discussion and comparison. All completely dry wood contains 18.5 – 19 MJ/kg or about 5 kWh/kg, all expressed in the energy form heat.

					poplar	willow
	A	B	A	B		
woody biomass prod. kg TS/m^2/yr	1	1,5	1	2		
woody biomass prod. tonTS/ha/yr	10	15	10	#20#		
woody biomass prod. m^3/ha/yr	30	45	22	#45#		
heat prod.MWh/ha/yr	60	90	60	#110#	el.	
prod. MWh/ha/yr	20	30	20	#40#		
hydrogen gas prod. MWh/ha/yr	13	20	12	#24#		
methanol prod. liter/ha/yr	9 000	13 500	8 300	#17 000#		
ethanol prod. liter/ha/yr	4 000	6 000	3 800	#8 500#		
carbon dioxide prod. ton/ha/yr	18	27	18	#36#		
nitrate nitrogen uptake kg N/ha/yr	50	75	50	#100#		

Table 2

Out of 1 m^3 *aspen wood* can be extracted (P.Börjesson 2022)
1900 kWh heat or
650 kWh electricity +1250 kWh heat in CHP prod. or
800 kWh of electricity or
300 liters of methanol or
135 liters of ethanol or
430 kWh of hydrogen

Comments on Table 1.
As shown here, very high production values were achieved on a number of parcel experiments. It can be assumed that corresponding levels of production will be repeated on cultivations on large areas. It is the availability of nutrients and water and, not least, the grower's professional skills that determine whether the entire growth potential of willow and poplar can be exploited on each land area. The experimental cultivations at VPP have shown the very high production potential of willow and poplar. There is something to work on here!

OBSERVANDUM:

1. **A counting example and a thought experiment is here discussed, (maybe a little out in the blue, right?!):**

The area of Swedish arable land in 1950 was 4 million hectares. Today it is about 2.8 million hectares. The disused part of our old arable land is to some extent planted with spruce. Other parts have become pasture, which over time have often been pre-bushed. These spruce forests on old arable land are today largely mature and often strongly insect-damaged (by spruce bark beetle). All this means that these spruce forests could usefully be felled. The overgrown arable land could be cleared up (see Figures 9a and b). If this happens and Sweden plants willow forests of new clones (see above) on exposed lands, the following could happen.
If, through these measures, we manage to collect 1 million hectares, and plant willows on these, these willows will absorb all the carbon dioxide that Sweden emits annually. But these conditions only apply, if electricity or hydrogen gas is produced from the wood, or if the wood is simply burned, so that the carbon dioxide can be easily and economically collected and pumped into porous rocks with dense rocky layers as a roof.

2. **Already in the second year after felling, these willow and poplar plantings are up to full growth due to heavy stump shoots formation.**
3. **It is quite right, as the debate says, that if some old fir trees are allowed to stand, they will store a great deal of carbon. Old spruce trees are still absorbing some carbon dioxide. But if we do not cut mature spruce trees, the wood shortage in Sweden and in the world will increases even more. In the future this may create additional incentives to increase fellings e.g. in the rainforests of Amazonas! This could mean that the more forest land we protect in the Nordic countries, the larger areas of the Amazon and other rainforests will be devastated.**
4. **If other methods are used to *reduce* carbon dioxide emissions in our society, willow and poplar plantings can really *remove* already emitted carbon dioxide from the atmosphere. The potential of both willow and poplar is enormous!**

5. **Cost estimations of a willow plantation in full scale in the upcoming climate transitions are currently almost an absurdity. Nevertheless, it is carried out here in order to at least get some ideas of the trends.**

Below are given (Table 3) some economic calculations of a willow forest, which looks like the one in
Figure 6a.

Conditions for calculations:

Area 1 ha, cutting length 1m, willow clone 77590, design 1 x 1m, no soil preparation, fenced, fencing costs 100 kr/m, the fence net is estimated to last at least 50 years, the planting fence posts are alive (of willow or poplar wood), harvest after 10, 20 or 50 years, NOTE: land and possibly maintenance costs are not included in the calculation. No planting grants are included. No compensation for capturing and storing carbon dioxide and nitrogen is included.

Table 3. Economy for willow plantations.

The economic calculations are carried out by Håkan Rosenqvist after obtained production data and stated price

PREREQUISITES: 1 hectare of cultivation.

harvest after	**10 years**	**20 years**	**25+25 years**	
volume	**350m^3,**	**700m^3,**	**875+875m ^{3}**	
investments				
planting, SEK	**100,000**	**100,000**	**100,00**	
fencing SEK	**40,000**	**40,000**	**40,000**	
harvest SEK	**100 / m^3 ,**	**100 / m ^{3,}**	**100 / m ^{3}**	
wood price SEK	**500/ m^3,**	**500 / m^3,**	**500 / m^3**	
real interest rate	**3 %**	**3%**	**3%**	
annuity factor	**0.1172**	**0.0672**	**0.0389**	
present value factor revenue	**0.7441**	**0.5537**	**0.4776**	**0,2281**

Table 4 RESULTS.

Annual hectare cost, SEK	**16,408**	**9,408**	**5,441**
Present value of revenue, SEK	**104,172**	**155,036**	**46,999**
Annual income, SEK	**12,209**	**10,418**	**10,418**
Annual net, SEK	**- 4,199**	**1,010**	**4 167**

Comments and thoughts of the results on Table 4:

The above economic calculations require special comments. They are done in order to have a starting point for serious, detailed discussions of the economy of using fast-growing trees in forestry and agriculture.

In a thorough economic evaluation, all costs and opportunities shall be assessed in detail. In the one for planting of willow treee the cost in the beginning is very high. This information is given to highlight the possibilities and the necessities of a serious discussing of possibilities to really reduce just the starting costs. A strict mechanisation of the planting technique with utilisation of tractor drills and GPS will considerably reduce the planting cost. The price of fencing and harvesting in the Table is at today's level and reducing the cost for fencing should have priority number one. Using net of bioplastic and living posts (Figure 10) will lower the prize. The cost for cuttings will be much lower

in a common introduction of willow plantation in a large scale in our country. The price of management is not included, because we do not know what it would consist of more than the usual supervision. The prize for wood is at a high international level and is also assumed to include possible subsidies of all kinds. Evan the cost for carbon dioxide emissions, the so called "emission trading scheme" (ETS) is included. The price for one ETS is currently 1000 SEK/ ton of carbon dioxide emitted. But how much of this sum will go to the growers?
Concerning the discussion of to days climate change, we might not forget, that if water and nutrients are available in the soil in sufficient quantities, a willow plantation, like the one that appears in Figure 6, takes up 20 - 30 tonnes of carbon dioxide per hectare and year from the atmosphere.

Table 5

VPP, location, climate and soil condition

Location: 8 km east of Veberöd, Skåne Sweden

Latitude: 55°40;55,66N Björkadammen---55°29; 55.65N Ankedammen
Longitudand: 13°37; 13.62E Björkadammen---13°36;13.60E---Ankedammen
Altitude: 20m asl, Börkadammen – 40m asl, Ankedammen
General characterization: old, cultivated Carex bog--pure sandy soil
Problems: summer frosts, voles, red deer, wild boars
Precipitation: 709 mm
Rainfall during the growing season: 426 mm.
Annual solar radiation: 1123 kWh/m^2
Solar radiation during growing season: 808 kWh/m^2
Lowest temperature in winter: -26.3°C
Mean temperature: May-August 14.2°C
Mean temperature of the year: 8.5°C
Temperature summa of the growing season: 1534 daydegree
Start of the growing season (>5°C) day no 103 (13/4)
End of the growing season (<5°C) day no 317 (13/11)
Length of the growing season (>5°C-<5°C): 216
Size of the plantation: 3 ha---1 ha
Soil type: In one area Carex mire dominates, in the other area sand dominates Bed rock: limestone pH:
5,7-5,9---6,2

Organic content: very high---very low
Level of ground water: 0.5-1 ---4m
Earlier crops: grass---potatoes, raw
Production level: very low
Planting preparation: none
Species: h-willow clones, new h-poplar from BC,---new h-poplar clones
Length of the cuttings: 0,3 – 3,5 m---0,2-0,3 m
Planting method: machine drill---by hand
Time for planting: 1993-2022---1990-207
Design: varying---varying
Thinning: 2021---2005,2007,2009
Fencing: total and net cylinders---total
Survival: > 95%
Weed management: none
Fertilisation: none---fertigation
Irrigation: none---fertigation
Damage: red deer, stem rot different insects leaf rust,
--- stem rot, insects
Optimum production: 2 $kg/m^2/yr$--- 4 $kg/m^2/yr$

Sidoplantewringar I
södra Svertige, Skåne,
och nästan i
Mellansverige, Uppland

Side plantations in southern Sweden, in Skåne, Småland, and Upland.

Torup, outside Malmö, h-aspen, 27 years old plantation, standing volume 807 m^{3}sk/ha

OBSERVANDUM:

1. h-aspen cannot be planted with cuttings.

2. After clearcutting and thinnig great many root suckers are developing.

Lilla Fagerhult. A 21-year-old willow tree, planted in the Southern Swedish Highlands in Lilla Fagerhult, 270m above sea level, latitude 57° N. In a clone test of new poplar clones (P. trichocarpa), a willow clone has also been tested, namely ESO 77590. It can, as it seems, be made to grow like single-stemmed trees. Willow trees are planted in three rows, inserted into the poplar clone test with initially 10 willow plants in each row. The area consists of old arable land with pH 6.2, the annual average rainfall is 593 mm, the design was initially 2 x 2m. In 2008, the plantation was thinned by removing half of the trees. The average diameter of the 16 remaining willow trees was 16 cm and the average height was 26m.

Sätuna, outside Uppsala, OP 42, 31 years old plantation, standing volume 805 m^{3}sk/ha.

OBSERVANDUM:

1. After clear-cutting and thinning, only stump shoots were developing, but only on up to 10 years old tree stumps.

Table 6.

CO2-absorption,
tonnes/ha

Poplar Poplar Poplar Willow Willow
Willow m x m 1 x 2 2 x 2 3 x 3 1 x 1
0,5 x 0,7 1 x 1 Cuttings/ha 5000 2500 1100
10000 28500 10000 size 900m2 600 m2
1400m2 50m2 400m2 100m2 mix mix
mix Eso77590 Tora Tora
length,cutting 3,5m 3,5m 3,5m 1m 1m 3,5m
Age Fig.6a Fig. 4,5

4		**17**			**121**	**104**
5		**35**		**78**	**170**	**139**
6	**59**	**56**		**130**	**209**	
7	**80**	**91**		**182**	**249**	
8	**101**			**225**	**274**	
9	**128**		**84**	**269**	**311**	
10			**108**		**365**	
11			**136**			
12			**168**			
13			**196**			

Comments to Table 6

1. **The above given hectare-results are received by an upscaling of square meter- results from parcel plantations, which size are given in the head of the Table**
2. **All edge effects are excluded.**
3. **Carbon accumulation in the root system is not included, because of known difficulties with root investigations and size determinations. However, it may be postulated that the biomass in the coars root system (diameter >1cm) is 30-50% of the woody biomass above ground. Furthermore, there are evidence that the life span of fine roots**

(diameter <1cm) is estimated to be 5-10 year and 2-3 weeks for root hairs (diameter <1mm). (Överkurs): It is a common knowledge that deciduous forests have a higher albedo (reflexion of sunshine) than i.e. spruce forests. That means that the temperature sum is lower in deciduous forests than in i.e. spruce forests. Furthermore, that might mean that the temperature sum is higher in a spruce forest than in a deciduous forest. This may indicate a higher rate of both the heterotrophic and the autotrophic respiration in the soil of a spruce forest and by that higher emission of carbon dioxide. But this fact has small influence of here given results. The reason for this is that the heterotrophic respiration is always going on, may be a little bit slower in deciduous forests and that plus and minus exclude each other's in the autotrophic respiration because of strong variation in structure and in the root mass between different tree species.

4. Uptake of nitrogen from the soil (in the form of nitrate) can be estimate to be 1 % of the carbon accumulation in the woody biomass above ground and the same amount in the ro

Requirements and problems.

Once more it should very clearly be pointed out that the above given production results for willow and poplar cultivations have been achieved in plantations on land with good to very good water status and good nutrient conditions. Especially the requirement for good water conditions is important to emphasize. The nutrient conditions of the soil may possibly be remedied with fertilization of various kinds. So, for example, willow and poplar crops can be used in areas with large pig and poultry farms to get rid of the manure. In addition, conditions in southern Sweden today are such that the annual nitrogen deposition amounts to 20 kgN/ha/year.

But good water conditions must be present. Irrigation can never be an alternative. On the other hand, willow plantations, but not poplar crops, can be grown on very wet and even on waterlogged areas.

New plantings and shrub-shaped plantations of willow and poplar are popular game feed for moose and red deer. If these two tree species are developed into single-stemmed trees, red deer and moose "tear off" the bark of the trunks. If there are strong populations of moose and red deer in the area, the trees must be protected in some way. Total fencing of plantations with wildlife fence net is expensive. So is the method of protecting each individual tree trunk with a protective cylinder of some kind (Figure 3a). Many different

materials have been tested so far, but none have worked satisfactorily. The cylinders have either been too bad or too expensive. New innovations are called for here.

Previous shrub-shaped willow plantations and older poplar plantings have been damaged by various insects and fungi. The biggest problem so far has been root and stem rot in poplar. But it occurs only on weak soils. Leaf rust fungi such as Melampsora and Massonina attack both tree species on all types of soil. To solve these problems, resistance research must be deployed. Various insect infestations have previously been observed, but only to a minor extent.

But the most important requirement, and also the biggest problem with introduction of a new form of cultivation in forestry and agriculture is the skill of the growers. When introducing the cultivation of fast-growing deciduous trees a very high level of biological knowledge and general professional skills of the growers are complete crucial for a successful cultivation.

Now it is time for the society, politicians and authorities to notify trees capacity 1. to accumulate energy, 2. to decarbonize the atmosphere and 3. to decrease the leakage of nitrate ions from agriculture land to the Baltic see. The faster the trees are growing, the more efficient are all these three mentioned "processes".

----"yes, that`s the way it is!"

More about this in a book in Swedish by Lars Christersson: "Kompletteringsskogsbruk---ett led i klimatomställningen", 3.dje omarbetade uppl, förlaget Boken, Örkelljunga. www.adlibris.com

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