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THE COSTS AND BENEFITS OF WILLOW (SALIX) IN SHORT ROTATION FOR NICHE ENERGY MARKETS IN THE NETHERLANDS

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TABLE OF CONTENTS

SUMMARY

This study gives an estimation of the costs and benefits of willows (Salix) in short rotation for energy niche markets in the Netherlands. The study is based on literature, present research and experience of willow growers.

The average direct costs of the crop are 89 ecu (DFL 190,-) ovendry ton (odt) material (marge 66-140 ecu).
In competition with other crops the average energy cost price of this crop at the farmgate is 143 ecu/odt. With fallow land subsidies and other subsidies and in some specific regions this calculated cost price can going down to average 56 ecu/odt. As feedstock for an electricity plant this price is just a little bit higher (17 %) as the price of natural gas. For local heating systems (consumer prices) the feedstock price can concur.

This study also gives sensibility analysis of energy crop prices with several subsidies, other yields and a marge of the costs. Also a comparison of this study with other simular studies is given.

1. OBJECTIVE

This study gives an estimation of the costs and benefits of willows (salix) in short rotation for energy niche markets in the Netherlands. The study is based on literature, present research and experience of willow growers.

The collected information is used in a case study in the Concerted Action "Development of a Standard Methodology for Integrating Non-Food Crop Production in Rural Areas with Niche Energy Markets" in the AIR Programme of the European Union (EU).

2. INTRODUCTION

Willows in short rotation is a new crop. The cultivation is as follows: in the first year cuttings in high densities are planted in the soil. For example 16.000 cutting/ha. The distance in the rows between the cuttings is for example 50-60 cm, distance between two rows 75 cm and 150 cm. The branches are harvested each 2, 3 or 4 years with a harvesting machine (comparable with a maize harvester). The stub is growing again new branches sprout and the proces continues again. After for example 24 years and 8 times harvesting grubbing up could be necessary (the stub will become too big for the machinery). The branches can be used for energy purposes (electricity plants or local heating systems).

At the moment there is not much experience with willows in short rotation as an energy crop in the Netherlands.

Since last year field experiments have been carried out in the Flevopolder (Minderhoudhoeve, Dronten) of "Stichting Bos en Hout" with 1 willow species (Salix Alba) and 8 poplar species. The total experimental field is 2.2 ha.

Since April this year there is also an experimental field at the IMAG-DLO Research Station (Oostwaardhoeve in Slootdorp) in the northwest of the Netherlands. This experimental field covers 12 ha (10 ha Salix, species ORM and RAPP and 2 ha poplar). The density of the willows is 16,000 cutting/ha. The distance between the cuttings in the rows are about 56 centimetre and between the rows 75 centimetre and 1.5 metre.

The intention on these plantations is to harvest the branches each three or four years (at the same way like maize). The branches will be used for energy production. The stump is growing out again.

In the Netherlands and Belgium a few professional willow growers have practical experience with willows in high densities for other purposes. The density of willows in these plantations are high compared to a "normal" energy crop. In this plantations the densities are 40,000 till 135,000 cuttings per ha. The willows are used for water management works, fences, baskets, etc. The willows are cut every year or every two years.

In other surrounding countries (Germany, Denmark, England) more experiments with willows as energy crop are carried out.

Sweden has the most experience with willows as energy crop. At the moment there are 1,000 farmers with 10,000 hectare of Salix production in short rotations. In this study information from the field trials and large scale implementation in Sweden is also used.

3. COSTS

First we will deal in this paragraph with the costs of this energy willow crop. In the next chapter the benefits and net result will be considered.

In this pragmatic scenario is assumed that the total area of willows in short rotation within an energy production region is about 10,000 ha. With this area there are benefits of scale (price of cutting, plantmachine and harvesting machinery). In this chapter no subsidies and set aside regulations are assumed.

3.1 Estimated average costs

The costs can be divided in establishment, harvesting, annual management and grubbing up costs. Table 1 presents the most realistic esimation of costs at this moment. Research in the future and more experiments are necessary to make these costs more definitive.
In table 1 each type of costs is briefly discussed.

Establishment Costs:

Field preparation:

It is very important to have a good and clean field in autumn before planting. With a good preparation there will be a better condition for the cuttings and less weed in the planting year (information Sweden and the professional willow growers in the Netherlands and Belgium). The costs of spraying, ploughing and harrowing are average costs of a contractor.

Cuttings:

Assumed is a plantation of 16,000 cuttings/ha. This is the same number as in the experimental field in Slootdorp (in Sweden : 18,000 cuttings, in England 10,000). In normal market circumstances with enough hectares of willows and enough support of cuttings a marketprice can be about 0.05 ecu/cutting. This price is simular to cuttings at other plantations (nurseries, berries, etc).

Planting:

The planting costs in Sweden are at the moment 175 ecu /ha. With enough hectares the planting costs in the Netherlands will be simular.

Starting with a plantation it is assumed that no special plant equipment is developed. Plant machinery can be hired from other farmers (cabbagr, leek, nursery). Estimation of the costs of hiring machines from other farmers is based on figures from the Research Station for Arable Farming (PAGV) "Kwantitatieve Informatie 1993/1994". The total number of hours needed for planting 1 ha is 16 hours (experimental field, Slootdorp). This agrees with the planting hours of the professional willow growers in the Netherlands and Belgium (starting from the same number of cuttings; they use more cuttings/ha).
The hours for the tractor driver (4 hours/ha) cost 16 ecu/hour. For the other hours on the planting machine 9 ecu/hour is paid. The hourly wages of 16 ecu are the gross hourly wages (including social securities and taxes)

TABLE 1. AVERAGE ESTIMATION OF THE COSTS OF A WILLOW (SALIX) PLANTATION IN SHORT ROTATION

		What is included?	✓	Comments/Source of data
Establishment Costs (EC)	ecu/ha 1525	Soil preparation	V	260 60 Spraying weeds in autumn before ploughing 200 ploughing and harrowing
		Seeds/Cuttings	V	750 16000 cuttings/ha (0,05 ecu/cutting; estimated market price in normal market circumstances)
		Planting	V	175 Swedish planting costs (1994)
		Fertilising as part of establishment		First year probably no fertilizer required; depends on the field
		Spraying as part of establishment	V	250 50 ecu for weed control chemical 125 ecu for weed control mech./handwork 75 ecu for disease chemical
		Fencing		No fencing. The costs of fencing are probably more than the damage.
		Irrigation system installation		Probably too expensive.
		Cutting-back	V	40 Ca. 5% losses 800 cuttings
		Replanting	V	50 5 hours.
Harvesting Costs (HC)	ecu/ha/harvest 630	Harvesting	V	400 Machinery costs direct chipping; estimated for a multiple use of a maize-harvesting machine.
		Storage	V	50 Estimate for polythenecovers or hiring containers.
		Fertilising after each harvesting operation	V	120 100 fertilizers 20 machinery hours
		Spraying after each harvesting operation	V	60 40 chemicals 20 machinery + hours
		Other operations		
Annual Management Costs (MC)	ecu/ha/y 655	Fertilising every year		0 Not yet considered, research is necessary
		Spraying every year	V	70 35 chemicals 35 machinery costs + hours
		Annual irrigation costs		Not considered.
		Land rent and building costs	V	565 240 Average land rent, incl. water conservancy taxes 325 Building costs, average arable farm
		Overheads	V	20 Administration and control
Grubbing-up Costs (GC)	ecu/ha 600	Grubbing-up	V	600 Heavy ploughing, harrowing and spraying.

Source: FORMAT : EU-AIR CONCERTED ACTION
RESULTS: INTEGRATING RESULTS OF EXPERIMENTAL FIELDS IN SWEDEN AND THE NETHERLANDS AND EXPERIENCE OF PROFESSIONAL WILLOW GROWERS IN SWEDEN, BELGIUM AND THE NETHERLANDS

of full-time workers in agriculture (wages according to the collective labour agreement). The other hourly wages are less (12 hours, 9 ecu/hour; accepted hourly wages for temporary work).
The best time to plant seems to be March provided that the soil is dry enough.

Fertilising as part of establishment:

The first year probably no fertilizer is required. It depends on the field. In Sweden the farmers use no fertilizer in the first year either.

Spraying as part of establishment:

After planting in spring weed control is necessary. It seems best to use chemical spraying (simazin) once, one or two weeks after planting (experience professional willow growers). Later in the first season for weed control it is necessary to spray local chemical between the rows and mechanical by hand in the rows. On average once treament of chemical spraying is necessary for diseases in the willows (information professional willow growers).
In Sweden weed control is also used. The disease in the willow plantation are accepted in Sweden. Probably in the Netherlands there are more diseases in the plantations; caused by warmer climate in the growing season.

Fencing:

The costs of fencing are probably larger than possible damage (information of "Slootdorp" and professional willow growers). In areas close to forests fencing seems to be necessary.

Installation Irrigation System:

Probably too expensive. An average there is enough rain in the growing season.

Cutting back:

About 5% losses is normal. This comes down to 800 cuttings, with a price of 0.05 ecu/cutting.

Replanting:

About 5 hours of replanting is assumed. Replanting can be done in winter time by hand in non-expensive hours.

Harvesting Costs

Harvesting:

Regarding machinery costs it is assumed that these equal those of a maize harvesting machine (Bosma, 1994). The same machines with another cutting mechanism can be used.

Storage:

Some storage facilities are necessary before transport.

Fertilizing after each harvesting operation:

Swedish farmers and professional willow growers in the Netherlands and Belgium use fertilizers after harvesting. The kind of fertilizer depends on the soil. In Sweden they use 40 kg P, 130 K and 60 kg N after the harvest (Source: G. van der Meijden, apprenticeshipreport: Harvesting Techniques and Logistics for Short Rotation Energy Forestry in Sweden). Also in the economic calculation in Sweden of H. Rosenquist fertilization is used.

Spraying after each harvesting operation:

Weed control is necessary after the harvest, just before the new growing season.

Annual Management Costs

Fertilizing every year:

Not yet considered. Research is necessary. In Sweden they use N every year.

Spraying every year:

Spraying once for diseases in the plantation seems to be necessary.

Land rent and building costs:

The land rent in the Netherlands averages 240 ecu/ha (including water conservancy taxes). One third of the land is rented. Two thirds of the land is own property. The real costs of own property are higher. The amount of 240 ecu/ha can be assumed to be equal to an estimation for own property farmers, since these farmers do not make an exact account and land has also other values.
The building costs of an average arable farm in the Netherlands are 325 ecu/ha.

Overheads:

For administration and control 20 ecu/ha is taken into account.

Grubbing Up Costs

The real costs of 1 hectare grubbing up are about 600 ecu per hectare. This is heavy harrowing, spraying and ploughing (information: professional willow growers: 16 hours of 37 ecu).

Using the costs in table 1 and calculating with a farmers interest rate (Fr) of 7 % and a project life (T) of 24 years presents table 2 the annualised production costs. The annualised production costs are 994 ecu/ha/year. With an annualised yield of 11.2 odt/ha/y means this an energy crop cost price at the farmgate of 89 ecu/oven dry ton.

TABLE 2. ANNUALISED PRODUCTION COSTS OF A WILLOW PLANTATION IN SHORT ROTATION (PROJECT LIFE 24 YEARS)

Variable	Variable name	Value		Comments/Source of data
Harvest interval	Ti	3	y	Research is necessary for the best harvest interval.
Annualised Establishment Costs	AEC	132,96	ecu/ha/y	EC x Fr x (1 + Fr)^T / [(1+Fr)^T - 1]
Annualised Harvesting Costs	AHC	195,96	ecu/ha/y	HC x Fr / [(1+Fr)^Ti - 1]
Annual Management Costs	AMC	655,00	ecu/ha/y	MC
Annualised Grubbing-up Costs	AGC	10,31	ecu/ha/y	GC x Fr / [(1 + Fr)^T -1]
Annualised Production Costs	PC	994,24	ecu/ha/y	AEC + AHC + AMC + AGC

3.2 Calculations with variation in costs

In paragraph 3.1 the estimated average calculation of the energy crop price (without subsidies) at the farm gate is reflected.

Because there are a lot of uncertainties at the moment this paragraph reflects the variation in costs (also without subsidies). More research is necessary to make clear the exact cost and profits.

Table 3 (Establishment Costs), table 4 (Harvesting Costs) and table 5 (Annual Management and Grubbing Up Costs) reflect a margin in the various costs. Some comment on these costs will be given as well.

TABLE 3, 4 and 5. ESTIMATION OF THE MINIMUM, AVERAGE AND MAXIMUM COSTS OF A WILLOW PLANTATION IN SHORT ROTATION. Costs in ECU/HA (1 ECU= DFl 2,14; sept '94)

TABLE 3. ESTABLISHMENT COSTS (ECU/HA)

	Minimum Costs	Minimum Comments	Average Costs	Maximum Costs	Maximum Comments
Soil preparation	110	only ploughing and light soil; no spraying	260	340	heavy soils
Seeds/Cuttings	560	0,035 ecu/cutting	750	1600	0,1 ecu/cutting
Planting	175	planting costs in Sweden (1994)	175	400	heavy soil, not so big area
Fertilizer as part of establishment	0		0	150	fertilizer required; poor soil
Spraying as part of establishment/ weed control	50	a relatively clean field; once chemical weed control	250	350	much weed and disease control necessary
Fencing	0		0	650	much damage; fencing necessary
Installation of irrigation system	0		0	0	Probably too expensive
Cutting back	0	losses accepted	40	200	Ca. 20 % losses
Replanting	0		50	200	Ca. 20 hours
Total	895		1525	3890	

TABLE 4. HARVESTING COSTS (ECU/HA)

	Minimum Costs	Minimum Comments	Average Costs	Maximum Costs	Maximum Comments
Harvesting	300	estimated min double use of a maize-harvesting machine	400	500	estimated max double use of a maize-harvesting machine
Storage	0	optimalized transport	50	100	more storage necessary
Fertilizing after each harvesting operation	0	rich soil; enough elements	120	160	poor soil
Spraying after each harvesting operation	0	clean field	60	120	much weed control necessary
Total	300		630	880	

TABLE 5. ANNUAL MANAGEMENTS AND GRUBBING UP COSTS:

	Minimum Costs	Minimum Comments	Average Costs	Maximum Costs	Maximum Comments
Fertilizing every year	0		0	130	100 chemicals (Swedish 30 hours (research recommandation)
Spraying every year	0	diseases accepted	70	140	two times spraying by plane or special equipment
Annual irrigation costs	0		0	0	not considered
Land rent and buiding costs	535	marginal land	565	625	good land
Overheads	20		20	40	
Total	555		655	935	
GRUBBING UP COSTS	450		600	900	

Table 6 presents the calculations of the energy prices at the farm gate in the several models (with variations in costs).

In table 6 you find that the costs of the energy crop price at the farm gate are average 89 ecu/oven dry ton (odt). In the minimum scenario this price is 66 ecu/odt and 140 ecu/odt in the maximum scenario.
Assumed in this scenarios is a average harvested yield of 12 odt/ha/year, a harvest interval of 3 years, a project life of 24 years and a discount rate of 7 % (market rate, october 1994).

TABLE 6. MARGES OF THE SEVERAL COSTS

	RANGE OF COSTS		
COSTS	LOW/ MINIMUM	AVERAGE	HIGH/ MAXIMUM
Establishment (ecu/ha)	895	1525	3890
Harvesting (ecu/ha/harv)	300	630	880
An. Management (ecu/ha/y)	555	655	935
Grubbing up (ecu/ha)	450	600	900
Annualised Establishment Costs (ecu/ha/y)	78	133	339
Annualised Harvesting Costs (ecu/ha/y)	93	196	274
Annual Management Costs (ecu/ha/y)	555	655	935
Annualised Grubbing up Costs (ecu/ha/y)	8	10	15
Annualised Production Costs (ecu/ha/y)	734	994	1563
Harvested Yield (odt/ha/harvest)	36	36	36
Annualised Yield (odt/ha/y)	11.2	11.2	11.2
Costs Energy Crop Price Farmgate (ecu/odt)	66	89	140

3.3 Comparison with other simular studies

This paragraph considers the differences between the calculation of willows in short rotations done in this study and two other simular calculations. The first comparison is the calculation of a poplar plantation in the NOVEM feasibility study (The Feasibility of Biomass Production for the Netherlands Energy Economy, NOVEM, 1992). The second is the Swedish economical evaluation of Salix.

3.3.1 Comparison willows with poplar in the Netherlands

In the NOVEM-study the Feasibility of Biomass Production for the Netherlands Energy Economy is calculated in B.6 the costs of a poplar cultivation in the Netherlands.

The poplar calculation gives a costprice of 66 ecu/oven dry ton material. This willow calculation gives a cost price of 89 ecu/odt. These two calculations are not comparable. There are a lot of differences between the two calculations:

The method of the poplar calculation is based on the principe that all costs are calculated on present value. The method used in this EU Concerted Action Methodology is based on annualised production costs.

The costs of establishment of a poplar plantation are higher in comparision with a willow plantation. Fences are considered in the poplar cultivation. No costs of replanting are considered in the calculation of poplar.

No building costs are considered in the poplar calculation.

The costs of fertilizer after the harvest in the poplar calculation are higher as in the willow calculation.

The harvesting costs in the poplar calculation are about the double of the harvesting costs of willows.

In the poplar calculation is assumed a production of 15 odt/ha/year. In the willow calculation is calculated with an average of 12 odt/ha/year.

The cost of removing stubs is in the poplar calculation four times more as in the willow calculation.

Making a comparable calculation between willows and poplar it is necessary to correct the poplar calculation with the yearly building costs of 327 ecu /ha/y and a production of average 12 odt/ha/y. This gives a energy crop cost price at farm gate of the poplar cultivation of 110 ecu/odt.
The average energy crop cost price of willows at farm gate is 89 ecu/odt.

So, a plantation of willows looks about 20 % cheaper as a plantation of poplar. Anyhow at the moment there are in both calculations uncertainties. There ia a margin. Further research and experience will be necessary.

3.3.2 Comparison willows in the Netherlands with willows in Sweden

The method of the Swedish calculation is also calculated in annualised costs (Rosenquist, H; enclosed as appendix).

The calculated energy cost price at farmer's gate in Sweden (without land and building costs and farmer's margin) is about 31 ecu/odt.
The simular calculated energy cost price at farmer's gate in the Netherlands, also calculated without land and building costs and farmer's margin is 38 ecu/odt.

The establishment costs in the Netherlands are higher than the Swedish. The planting costs are about the same. In the Netherlands soil preparation is assumed as a part of the establishment costs. In the Swedish study not.

In the Netherlands is spraying for diseases in the plantation a regular activity in opposition with Sweden.

The harvesting costs in both countries are about the same.

In Sweden is calculated with a harvest in the first 4 years of average 6 ton odt/year. In the next 20 years is calculated with a harvest of average 12 ton odt/year. Harvesting is each 4 years. In the Netherlands is assumed harvesting each 3 years.

The calculated grubbing up costs in the Netherlands are about 70 % higher as in Sweden.

In the Swedish calculation the calculated price is not at farmer's gate, but at gate of the conversion installation: In the Swedish calculations there are costs like transport and brokerage.

The Swedish calculation don't calculate with costs of land and buildings. Without land- and building costs and farmer's margin the totally costs of the willow cultivations in both countries are about the same.

4. BENEFITS, NET RESULT AND SUBSIDIES

The benefits of a willow crop are related to the yield of the willow plantation and the price of the chipped harvested material. Also subsidies and the use of set aside regulations are important. At the moment there are a lot of uncertainties. In this chapter is chosen for the most probable options.

Net result

The net result of the farmer is defined as: Output- All (payed + calculated) costs. In the regions in the Netherlands with the most potential for a willow crop (on arable farms), the gross margin must be 1170 ecu (about 2500 dutch guilders)/hectare/year. With this amount in some regions an energy crop can compete probably with a normal crop. A deduction of the cost of land and buildings (average 560 ecu per ha) means that the net result must be minimal about 610 ecu per ha to start a willow plantation. In some specific less favoured regions, most in the northeast of the country, the net result can be minimal about 480 ecu per ha.

Yield:

The yield per hectare of a willow plantation in normal circumstances can be estimated at 12 ton oven dry material (odt) per ha. Also in Sweden and England growers calculate with this same yield.
At the moment the yield of the existing willow plantations of the professional willow growers in the Netherlands is also about 12 odt/ha.
Potentially a production of 14-15 odt/ha might be possible (Nonhebel, 1994)

Harvest interval:

In Sweden the harvest interval is 4 years. In England growers calculate with a harvest interval of 3 years. In this calculation as well a harvest interval of 3 years is considered. Research is necessary for the best interval. Using a maize-harvesting machine probably the harvest of 3 years is the maximum.

Interest rate:

In the calculation a rate of 7% is used. This is the real interest rate at the moment. In the Netherlands about a fourth part of the farm property is paid with loans. Most farmers will be charged with a lower rate.

4.1 The energy crop price at farm gate without subsidies

Using our Methodology, the average costs of chapter 3, a yield of 12 odt/ha/y, annualised production costs of 994 ecu/ha/y and a desired net result of 610 ecu/ha can be calculated that the annual revenue required must be 1604 (994 + 610) ecu/ha/year. This means an energy crop price at the farm gate of 143 ecu/oven dry ton.
This is the price for willows in short rotation to compete with other crops. With this price no subsidies are necessary.

Table 7 gives the results of this calculation.

TABLE 7. CALCULATION OF ENERGY CROP PRICE AT THE FARM GATE

Variable	Variable name	Value		Comments/Source of data
Annual Revenue Required from Sale of Energy Crop	AR	1604,24	ecu/ha/y	PC + NM
Harvested yield	Y	36	odt/ha/harvest	Actual yield probably
Annualised yield	AY	11,20	odt/ha/y	Y x Fr / [(1+Fr)^Ti - 1] for a permanent crop Y for an annual crop
Energy Crop Price at the Farm Gate	FP	143,26	ecu/odt	AR/AY

4.2 Sensibility analysis energy crop prices (with subsidies, other yields, etc)

The quatitative assessment as presented in the previous sections contain a lot of uncertainties in the estimations. This paragraph gives an overview of the impacts on the calculation by the various assumptions.

In the previous calculations subsidies have not been taken into account.

This paragraph will give scenarios of energy crop prices at the farmer's gate with an other discount rate and other net result, odt/ha and subsidies.

Table 8 presents calculations with other rates, yields, fallow land subsidies, plant subsidies and special tax facilities.
Each calculation gives the energy price at farmgate and the price with the range of the costs that is given in chapter 3.

The first case in table 8 gives once more the results of the calculations of chapter 3.

In case 2 the interest rate is changed in 3 %. The most farmers don't calculate with the real interest rate (7 %); about a fourth part of the average farm property is paid with loans. An interest rate of 3 % looks more farmer's practice.

In case 3 the yield is lower: average 9 odt/ha/year.

In case 4 the expected yield is higher: average 15 odt/ha/year.

In case 5 there is a fallow land subsidy of 502 ecu/ha. In the Netherlands in 1993 (June) there was a total of 22,000 ha fallow land (14.000 ha "set aside EU rules"; amounts of 700-870 ecu/ha, contracts for 5 years (new contracts not available) and 8,000 ha "Mac Sharry EU rules"; amounts of 502 ecu/ha (clay) and 357 ecu/ha (sand). With this subsidy the energy crop price at farmer's gate can be average 92 ecu/odt. This is 30 % less as the simular price without this subsidy (133 ecu/odt).

TABLE 8. ENERGY PRICES WITH OTHER RATES, FARMER'S MARGIN AND ODT/HA

Case	Energy Price at Farmgate (ecu/odt) Low	Average	High	Interest Rate (%)	Subsidies (ecu/ha)	Desired Net Result (ecu/ha)	Odt/Ha/Year	
1	120	143	194	7	0	610	12	
2	114	133	179	3	0	610	12	
3	152	177	239	3	0	610	9	
4	91	106	143	3	0	610	15	
5	70	92	136	3	502	610	12	
6	66	87	131	3	560	610	12	
7	59	80	124	3	560 +	610	12	+ plant subsidy
8	47	68	112	3	700 +	610	12	+ plant subsidy
9	36	57	101	3	700 +	480	12	+ plant subsidy
10	35	56	99	3	700 +	480	12	+ plant and other subsidies

In case 6 there is a subsidy of 560 ecu/ha/y. This is the same amount for temporary forest in the Netherlands.

In case 7 the subsidy of 560 ecu/ha/y is valid. Also there is a plant subsidy of 1400 ecu (3,000 guilders). This amount is about the same what farmers get for forestry plantations at this moment.

In case 8 there is a subsidy of 700 ecu/ha/y. This is the same amount farmers receive if they change their land (<50 ha) to permanent forest. Also there is a plant subsidy of 1400 ecu.

Case 9: in some specific regions in the north of the Netherlands the net result could be about 480 ecu/ha. In this model there is also an annually subsidy and a plant subsidy like in 8.

Case 10: at the moment in the Netherlands there is a general investment tax reduction for small investments. This is 18% for investments between 1,449 and 24,766 ecu). An investment of for example 10,000 ecu's gives a reduction of taxes of 10,000 x .18 x .36 = 648 ecu's. This reduction is only given in the first year. In this case this tax reduction is used. Also case 9 is operative.

Further reduction of taxes and specific rules for investments can reduce the energy prices at the farm gate.
For example: At the moment there is a swift tax depreciation of environmental investments. When this can be applied to a willow plantation investment it can reduce the farm gate energy price.
Another example could be the (water)conservancy taxes of agricultural land (average in the Netherlands about 45 ecu/ha/y). The land owner and user pays 100%. A tenant pays 50%, when the owner requires this. Forestry land has an average conservancy tax of 16 ecu/ha/y. The question for this tax is: Is a willow plantation an agricultural or forestry activity? Is this the case, the willow grower can ask the conservancy for a lower tax.

4.3 Possibilities for willows for electricity or other heating systems

Looking at table 8 the lowest farm gate energy prices will be 35 ecu/odt (oven dry ton material). The average low price (with the average costs) will be 56 ecu/odt. The price of 56 ecu/odt is almost simular to the farmer's price in Sweden (61 ecu/odt, at gate factory).

A price of 56 ecu/odt at the farm gate (with about 5 ecu/odt transport gives a price of about 61 ecu/odt at the gate of a conversion system) may offer possibilities for an energy crop of willows in some specific regions in the country.

Assumed that willows have the same combustionvalue as poplar (18.5 Giga Joule per ton oven dry material) then the price of the energy input can be calculated.
A price at the gate factory of 61 ecu (DFL 130,-)/odt means for example an cost of the energy input of 3.3 ecu (DFL 7,-)/Giga Joule.

In comparison with the input prices of other fuels for electricity at the moment a price of 3.3 ecu/GJ is just a little bit higher. At the moment the price of coal is about 2.1 ecu/GJ and of natural gas about 2.8 ecu/GJ. At the moment the prices are historical seen very low. When there comes a little higher price level or an CO_2 tax on the fossil fuels the use of willow as a fuel can compete with other fuels.

An advantage of chips of willows as fuel for an electricity plant is that you can burn it together with coal.

For local heating systems the chipped willows maybe can compete with other fuels because the consumer's price of the other fuels are much higher then the prices for big consumers or factories. Either, the conversion systems could be more expensive. Research on this points looks necessary.

5. CONCLUSIONS AND DISCUSSION

This report gives the most probably costs of a willow plantation in short densities in the Netherlands.
At the moment there is less experience with this crop. That's why also in this study is given a variation in these costs.

The average direct costs of the crop are 89 ecu (DFL 190,-)/ovendry ton material.

The calculated mimimum costs of this crop are about 66 ecu (DFL 141,-)/odt and the calculated maximum costs are about 140 ecu (DFL 300,-)/odt.

In competition with other crops it is assumed that the net result of this crop must be about 610 ecu/ha. With this desired net result and the direct costs of this crop the average energy cost price of this crop at the farmgate is 143 ecu (DFL 306,-)/odt.

Together with fallow land subsidies, plant subsidies and other subsidies the calculated cost price at farm gate can going down to average 56 (f 120,-) ecu/odt. So, the minimum price can be calculated at 35 ecu (f 75,-) and the maximum at 99 ecu (f 212,-)/odt.

Calculating with the average price level of 56 ecu (f 120,-)/odt at the farmgate and to use this chipped material in a heating system or as feedstock for an electricity plant this price is just a little bit higher (17 % respectively 55 %) as the price of natural gas or coal. Calculating with the low price level of 35 ecu/odt at farm gate it is even cheaper to use willows as energy feedstock.

Nevertheless at the moment there are a lot of uncertainties around this energy crop.
Further experience and research is necessary to optimalize this crop. (yield, fertilizer, spraying, havesting system). We can learn a lot of the experience with this crop in Sweden.

Also more insight is required in the feasibility at farmer's level: At what net result they will start a plantation and in which regions and under which conditions. Further research on these points is necessary.

At the moment there are a lot of advantages of introducing an energy crop: It can give new activities in some regions, the out of country payments of oil and coal can stay in the country, a better diversification of energy inputs (less risk), environmental advantages and CO_2 reductions.

Also it is economical better to start a plantation with a fallow land subsidy than only to receive a fallow land subsidy like now happens.

Starting an energy crop there must be a willingness to change a use of fossil fuels into non fossil fuels. The communitity and also for example the electricity companies can make it possible that there come energy crops.

In the beginning producing is maybe more expensive as fossil fuel, but once you have done experience and knowledge with energy crops and conversion of it. Diversification of fuels can be important in the future (less risk).

Further conditions to start an energy crop is a good cooperation between farmers, government (set aside rules and contracts) and conversion companies.

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APPENDIX

THE ECONOMICAL CALCULATIONS FOR GROWING SALIX IN SWEDEN; DATA 1993;
H. ROSENQUIST

	Rate of interest		6 %		*(real rate)*	
Income	*unit*	*number*	*price*	*SEK/ha*	*factor*	*SEK/ha,yr*
Chips yr 4	ton DM	25	540	13500	0,063	852
Chips yr 8, 12, 16, 20, 24	ton DM	48	540	25920	0,165	4 289
Establishment support	st	0	10000	0	0,075	0
Sum of income						*5 141*
Individual costs 1						
Planning, adm, training.,yr1	hour	5	120	600	0,075	45
Weed control che yr 0	l	4	150	600	0,080	48
Planting	times	1	8500	8500	0,075	639
Weed control che yr 1	l	3,5	129	451,5	0,075	34
Weed control mec yr 1	yr	0,7	800	560	0,075	42
Cut back	times	1	343	343	0,075	26
Weedcontrol che yr 2	l	1	129	129	0,071	9
Weedcontrol mec yr 2	times	2	350	700	0,071	50
Fertilizer N28 yr 2,3..24	kg	215	1,5	322,5	0,925	298
Fertilizer PK 7:25 yr 5,9..21	kg	500	1,93	965	0,197	190
High-fertilizing yr 3,4,7,8 osv	times	1	313	313	0,471	147
Harvest yr 4	times	1	3665	3665	0,063	231
Harvest yr 8,12,16,20,24	times	1	5663	5663	0,165	937
Transport yr 4	ton DM	25	78	1950	0,063	123
Transport yr 8,12,16,20,24	ton DM	48	78	3744	0,165	620
Brokerage, yr 4		13500	0,08	1080	0,063	68
Brokerage yr 8,12 osv		25920	0,08	2073,6	0,165	343
Supervision, adm., yr 1,2,..24		1	120	120	1,000	120
Closing down yr 24	times	1	3000	3000	0,020	59
Sum of individual costs 1						*4 030*
Net result 1	*Income - costs 1*					*1 112*
Individual costs 2						
Stump pulling, yr 0	hour	1	450	450	0,080	36
Soil tillage yr 1	hour	0,6	440	264	0,075	20
Rolling, yr 1	hour	0,3	350	105	0,075	8
Spraying, yr 0	times	1	103	103	0,080	8
Spraying, yr 1	times	1	103	103	0,075	8
Spraying, yr 2	times	1	103	103	0,071	7
Fertilizing, yr 2,5,6,9..21,22	times	1	83	83	0,454	38
Fertilizing PK, yr 5,9...21	times	1	83	83	0,197	16
Sum of costs 2						*141*
Net result 2	**Income - individual costs**					**971**