Optimized Fuels for Sustainable Transport

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Responsible:	SYNCOM F&E Beratung GmbH
Authors:	Simon Kühner
Contact:	s.kuehner@syn-com.com
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Publishable Summary

This deliverable D7.1 is an outline of the Deliverable 7.2 ‘Socio-economic effects of large scale plantations’ due in M36. Socio-economy describes the relation of economic activities and societal processes. The respective task 7.3 of the OPTFUEL project studies the individual constraints of farmers with regard to the broadly described economic feasibility of short rotation coppice (SRC) plantations. Interviews will be performed in three regions for comparison: The first two surround Schwedt, the site selected for the first large BtL plant and have moderate (Western Pomerania) to relatively high (Brandenburg) SRC experience. The third region is around Bremen and serves as kind of reference (low SRC activity).

Among the results will be a recommendation

- for a convincing lay-out of demonstration plantations to show the general performance of SRC
- which type of farm is most interested in SRC production
- and what kind of contract is most asked for

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Preface

This assessment assigned to SYNCOM will be carried out by Simon Kühner. Simon holds a PhD in Biochemistry and was involved in the assessment of biomass potential and BtL economics in the FP6 project RENEW but is also a sideline farmer. He will be supported by a working group around Marek Bury, Agronomist of the University of Szczecin.

SYNCOM is a small R&D consulting company not involved in SRC production, trade or use beyond the research carried out in cooperative projects like OPTFUEL. In this project 200 ha of SRC plantations are/will be established in Workpackage 1. This is done independently of SYNCOM's socio-economic assessment. SYNCOM is not connected to CHOREN Biomass or other enterprises in the SRC business with regard to contracting of area or farmers. The only aim is to identify possibilities to enable or speed up the broader introduction of SRC plantations. If an interviewed farmer wishes to further explore his SRC possibilities, SYNCOM will establish the contact to CHOREN Biomass on the farmers request.

Introduction

Coppicing is a very old technique to harvest wood for energetic purposes or as construction material. If cut near the ground many tree species like willow, poplar, hazel, beech, ash, alder or oak will regenerate via shoots from the stool. When the intended diameter is reached after several years of growth the tree is cut again. This keeps the tree young and some stools with a diameter of more than 9 m are thought to have been continuously coppiced for centuries. So coppicing combines security of supply with little effort for cutting and eventually chopping of the comparatively thin stems. This is of importance especially in pre-industrial times: There is evidence of a causeway build with coppiced logs through marshland in Somerset (UK) 5800 years ago. In the 15th century coppicing for the production of charcoal was strictly regulated. The rotation time was 16 years except for a certain number of trees left growing for timber. This safeguarded the permanent supply of energy to the iron industry.

The rise of the fossil fuels coal, oil and gas let to the decline of the forest area in general and this management system in particular until the 1970ies with i) the oil crisis, ii) first indicators of environmental impacts of the mechanised, pesticide and fertilizer based modern agriculture iii) economic problems due steady increasing productivity and iv) social distortions in rural areas. One measure of the response initiated by the European Community and several countries was the afforestation of agricultural land and studies for the establishment of short rotation coppice plantations[1].

[1] The studied SRC or Agro-Forestry systems were mostly based on willow and poplar and rotations between 3 and 20 years. Systems with longer rotations of 8 to 20 years are considered short rotation forestry in contrast to conventional forestry starting at about 60 years.

Regulatory Background

Relevant regulations with respect to the short rotation coppice production on agricultural land are integrated in the Common Agricultural Policy, which includes the EU system of agricultural subsidies. The agricultural sector is the only really common market in the EC, and national individuality is either anchored in the regulations or needs to be approved.

Subsidies and incentives for EC-farmers date back to the post WWII time when many countries had to import large amounts of agricultural products to feed the people. Consequently, the aim of the 1963 established ‘Common Agricultural Policy’ (CAP) was to increase the food production to self sufficiency and the productivity to release workforce from the primary sector urgently needed for the industrial uptake. This was achieved within about 15 years by three measures:

- Guaranteed minimum prices (intervention price): If the price for a commodity dropped below a certain level, the states bought and stockpiled it to shorten its supply. This artificially raised the price again.
- Imports were blocked by tariffs and volume limits. Only amounts and products which could not be produced by domestic farmers were allowed to be imported
- Production volumes of some products like sugar and later milk was limited inside the EC by quotas.

Although the aims were achieved the payment of incentives continued as farmers depended heavily on it by that time. This had severe effects on the budget and on the world trade as the overproduction was exported using price incentives. In 1992 the CAP was reformed by several means:

- Gradual reduction of intervention prices. The gap between internal and world market prices was reduced.
- Afforestation aids were paid. One million hectare of agricultural land was converted until 1999.
- Farmers had to take 15% of their land out of production (set aside-obligation, step-wise reduction to zero in 2008)
- Agri-environmental regulations were introduced to reduce fertilizer and pesticide input.
- 5% of the budget were used for to diversify the economic basis of rural communities with rural development measures
- Direct payments to compensate to income losses. These were coupled to the production volumes of the last years under the condition of ongoing production

The reduced intervention price lead to a strong reduction in export subsidies, first due to the smaller gap between the internal and the world market price and second due to reduced exports as the then cheap cereals were used as animal fodder. Agriculture was less profitable and producers tried to compensate reduced margins per ton by a further increase in productivity. Afforestation and set-aside obligation was performed on the least productive land and the total production was only slightly reduced. Rural Development Programmes (RDP, German ELER) led to an increase in competitiveness and innovation of agriculture, sustainable land management and to improve social and economic viability of rural communities. For the individual RDPs, building blocks can be chosen from a catalogue of measures are adapted individually and then approved by the Commission. The support for the establishment of SRC plantations is possible under Measure 121, Article 26 ‘Modernisation of agricultural holdings’. The aid intensity is 50% of the eligible costs and may go up to 60% for young farmers in handicapped areas and 75% in outermost regions[i]. Fig 1 shows the geographical coverage of dedicated programmes, 5 of which mention area targets of 50.000 ha (Hungary), 47.500 ha (England), 30.000 (Sweden), 3.500 (Lithuania) or 800 ha (Slowakia). More regions as e.g. Saxony, Brandenburg or Lower Saxony might support SRC establishing enterprises under this measure individually and with usually less attractive conditions.

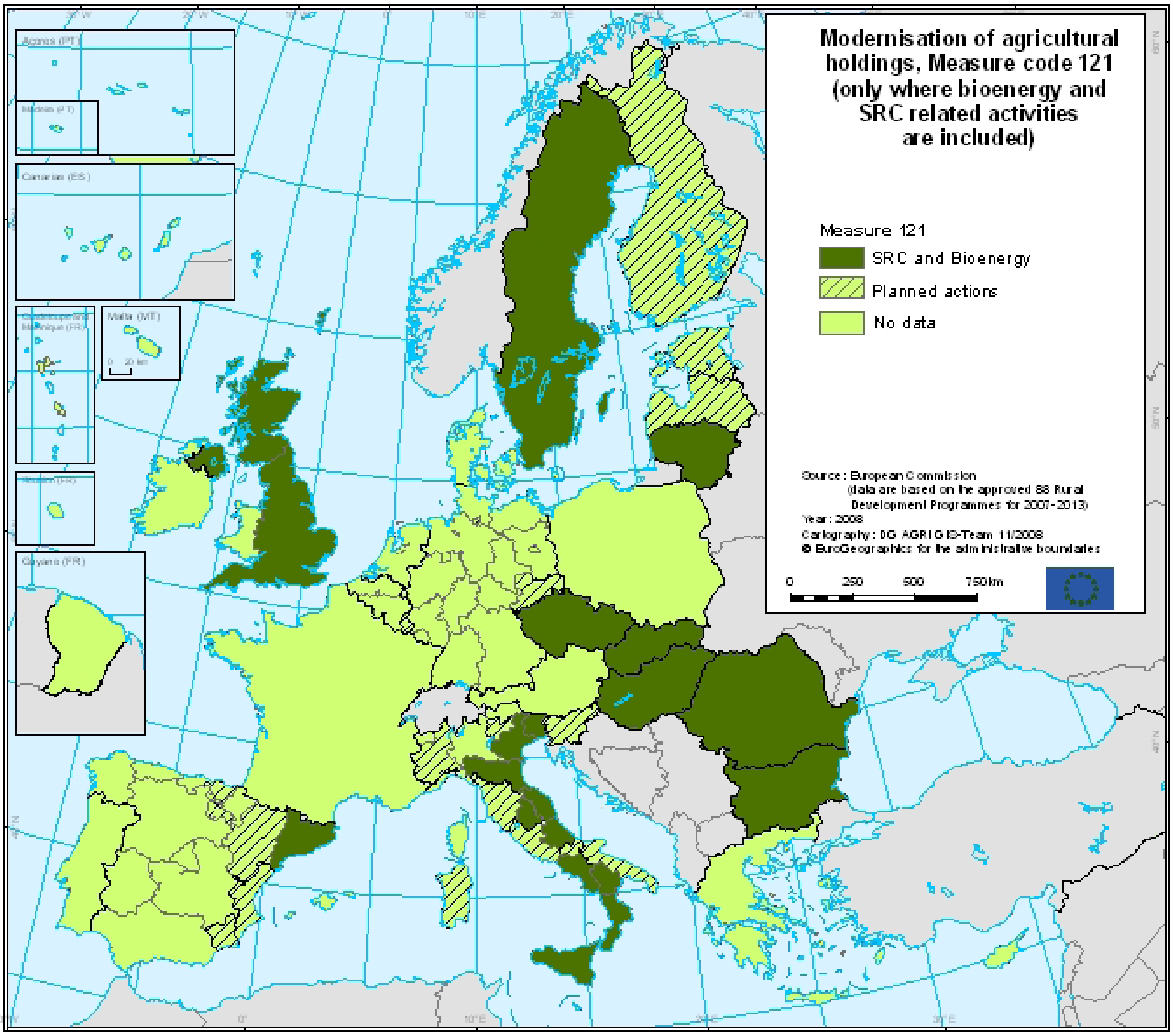

Figure 1: Geographical coverage Rural Development Programmes supporting the establishment of SRC plantations as of 2008.

In 2003 the mid-term review of the CAP reform introduced 3 mayor transitions:

- Decoupling of payments from amount of production to holding or area-specific payments
- Cross compliance to environmental requirements
- Obligatory modulation

Uncoupled direct payments were calculated by adding up the various premia for the production of certain amounts of crops and animals paid to the individual agricultural holding in the reference year. The sum was divided by the farmed area assigning a certain allowance for subsidy to each hectare, these certificates are tradable. This scheme is implemented in many member states, in some it is modified by a regional averaging of a part of the reference payments. This is the case in Germany where there are two different rates, one for permanent grassland and one for all other land. For example in Lower Saxony, the permanent grassland premium is typically between 100 and 250 €/ha and the cropland premium between 260 and

600 €/ha. These two premia are certificates tradeable within Lower Saxony which need to be activated with the respective area of pasture or cropland. In UK and Germany, these 'mixed' certificates with a premium of enterprise-individual highs will be averaged within the regions, resulting in case of Lower Saxony in an amount of approx 350 €/ha land in 2013. In 2008 it was clarified that land cropped with SRC is eligible for direct payments. Applicable tree species, the maximum duration of a rotation and the difference to regular forestry is individually regulated in the member states.

The term **Cross compliance** refers to the compliance to certain ethical standards of animal rearing, protection of landscape, soil, water and air and security of feed and food. Of special importance for SRC production is the preservation of permanent grassland which may not decrease by more than 5% in relation to the 2005 area. As SRC are considered crops and accordingly do not belong to this 'permanent grassland', availability of area might be affected, as e.g. in Schleswig-Holstein and Mecklenburg-Vorpommern this threshold is exceeded. Non-compliance leads to the reduction of direct payments.

Modulation describes the reduction of the direct payments e.g. in 2007 by 5 % to support measures of the second pillar 'rural development'.

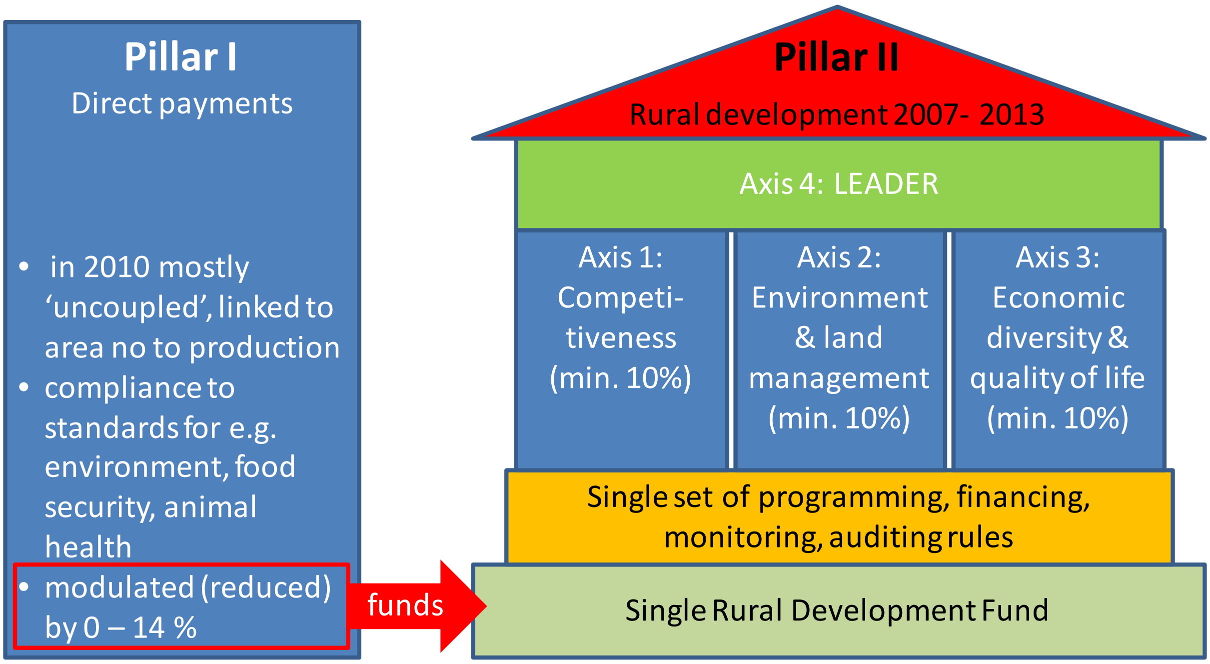

Figure 2: Overview on CAP measures. In 2008 the budget was 49.9 billion € of which 78% was used for direct payments, 10 % for market measures and 12% for rural development.

Between 2003 and 2009 the production of energy crops was allowed on set-aside land and to further support the biofuel directive aiming at 5.75% biofuels in the market, an **energy crop premium** of 45€/ha was introduced. It had a target of 1.5 million hectare energy crops on non-set aside land in EU15, which was increased in 2006 to 2 million hectars and all member states. Eligible was the production of crops like maize, grain, beet, rape, sunflower and SRC if supply contracts with bioenergy end-users or processors like biogas-, ethanol-, biodiesel- or pellet- plants were presented.

The mid-term 'Health Check' of the current CAP reform programme was performed in 2008/9. An important outcome was to increase the modulation (reduce the direct payments) to an amount of 10 %. For beneficiaries receiving more than 300.000 € per year the direct payments will be further modulated (i.e. reduced) by another 4 % to support the rural development programmes. These measures will be effective from 2014 on. It is not yet decided if the step-wise inclusion of the new member states to that system will be done cost-neutral (effective reduction of payments to current receivers) or with an adapted budget.

The outlook for the future is a further liberalisation of the agricultural market and the increased contribution of CAP payments to the benefit of ‘common goods’ like biodiversity, climate protection and clean air and water. Agriculture can provide solutions for the future, given its direct relationship with the earth and living things, according to a report of Stephan Le Foll (2010[ii]) EC-Parliament's rapporteur in agriculture and climate change. A new CAP is therefore needed to take account of the impact of global warming and to mitigate climate change. A new CAP, as ‘manager of the bio-sphere’, would guarantee the transition to a new model of production and ecologically, economically and socially efficient agriculture. Three ways seem possible: Limiting agricultural greenhouse gas (GHG) emissions, promoting carbon storage in the soil and producing sustainable and renewable energies, says Mr Le Foll's draft report.

Farmers experienced in the past a high dependency on political regulations which limited to some extend the economic freedom and gave rise to sometimes rapidly changing market environments and respectively income. Bioenergy production with SRC plantations of 20+ years lifetime might be perceived as possibility to increase entrepreneurship or as obstacle with regard to the rapidly changing system of incentives.

SRC country cases

Sweden

Sweden started to discover in the late 70ties in a series of research projects and trials the advantages of willow SRC plantations as important alternative crop for the production of wood fuel on farmland. However, plantations in large scale were first established from 1991 on due to generous establishment grants of 1200 ECU/ha plus 480 ECU/ha for fencing and planting on set aside land. These belong to several measures with the declared aim to remove 500.000 ha agricultural area from price-regulated food production to smooth the effects of the new deregulated agricultural policy. Also the taxes on fossil energies were increased considerably in 1991. However, the offered subsidies were only interesting due to an established logistic system and existing buyers for wood chips from forest residues. This allowed the integration of the SRC wood chips with similar characteristics and led to the establishment of plantations in an order of 17000 ha in 1996. As the subsidies were reduced later and yield expectations were not always met, the area reduced to about 15000 ha in 2008.

The willows used in energy forestry belong to the sub-species *Salix*, which are generally bushy in nature and grow to 5-7 m in height and have numerous shoots. After usual seed bed preparation, willow is planted as stem cuttings measuring 18-20 cm in length. The application of a pre-emergence herbicide is recommended and as weed control is important in the first year mechanical cultivation or selective herbicides might be later required. After the first growing season the plants are between 1 and 3 m high and will out-compete weed in the next season. A willow plantation is assumed to remain productive for at least 25-30 years and during its lifetime, the plantation may be harvested six to ten times, in cycles of 3-4 years. This makes it less demanding with regard to work force (~3 h/ha*a) than conventional crops (average 15 h/ha*a). The average yield level for one rotation was 17.5 tonnes dry mass per hectare from sites in central Sweden up to 21 t_{DM}/ha from sites in southern Sweden. Most plantations are grown for 4-5 years before harvest, so the annual yield levels are between 4-5 t_{DM}/ha*year. However, in plantations, which are fertilised and largely weed free, it is possible to produce more than 10 t_{DM}/ha annually. More recent plantings have included new varieties, which are harvested at shorter intervals of 3-4 years. This is because the bred varieties are much more productive than the older clones.

More than 60 % of the SRC production is located in central-eastern Sweden with a share of more than 1.5% of the arable land used for SRC in the Örebro county. Willow is mostly grown on larger crop farms on fields for set aside or wheat production (Rosenqvist et al 2000). These lay in regions with a potential for grain yields being average (region central) or high (region south) where the high demand for wood chips may not be sourced from forests. Willow growers are more often in the age of 50 to 65 years than non-willow growers. The reason for this might be that i) larger farms might better be able to compensate for the loss of income until the first harvest; ii) a change of production is easier on crop farms compared to dairy or cattle farms and iii) older farmers might prefer to reduce their work load.

The economy of willow plantations and returns for growers has been improved due to multi-functionality, by using sewage sludge as fertilizer. Sludge application is not permitted on food crops and disposal in landfill sites is very costly for municipalities. A number of municipalities have ventured into agreements whereby their sewage sludge is used on harvested willow plantations. Often this joint initiative also involves the buy back of wood chips for the municipal heating plant. Örebro and Västerås are the two largest cities supplying sludge to willow plantations. Most new plantings incorporate a specific contract for sludge application. During 2002 about 50% of the harvested plantations were fertilized by sludge.

The two farmer cooperative owned companies Lantmännen and SL Energy manage most of the plantations and initiated a lot of developments with regard to planting machinery leading to cost reductions by a factor of 2 within a few years and to harvesting machinery capable of chipping 60 to 70 tons per hour. A cost effective solution are special cutting heads for field harvesters, used for grass and maize silage in summer and autumn increasing their runtime per year. Lantmännen estimates the capacity of a harvester with about 500 ha per year under Swedish conditions, determined by the time the soil is frozen, field size and distance and biomass stock per hectare. Lantmännen has the long term objective of increasing the area of willow grown in Sweden to between 200,000-300,000 hectares in the next decades.

United Kingdom

In the UK/England the Farm Wood Fuel and Energy Project running from 1991 to 1997 was undertaken as commercial demonstration of 50 hectares of short rotation coppice (mostly poplar), established on six farms in southern England.
Key outcomes were

- Planting density from 6700 to 10,000 lead to an average yield of 7 t_{DM}/ha*year, with high performing fields at 11 tonnes and problem fields with 2 t_{DM}/ha*year due to rabbits or unsuitable soil
- Establishment costs were in the order of £1350 and SRC has the potential to be competitive with fossil fuels
- Winter conditions in the UK are unsuitable for most harvesting equipment trialled
- Both harvesting and chip storage need to be re-examined.

On base of these results, the Government offered a band for energy crops under the Non-Fossil Fuel Obligation (NFFO), which was the main stimulus for the development of renewable energy systems until 2000. In five successive rounds 8 to 20 year contracts allowing premium prices decreasing from 7.51 to 2.71 £-pence per kWh were awarded. The aim was to level the ground for expensive, emerging technologies and worked perfect for wind energy systems. The 8 MWe ARBRE power plant, the only project for SRC wood chips, received funding from this scheme but went into receivership in the commissioning phase. The 1500 ha SRC of a farmer cooperative in North Yorkshire which were contracted to supply the never-opened ARBRE plant are now supplied to co-fire the 4000 MW pulverised coal power plant in Drax. Drax gained experience with biomass from 2003 on plans to start a large-scale (~370 MW) co-firing in late 2nd half of 2010[iii] and intends to erect a further 900 MW in 3 dedicated biomass plants in this decade.

In 2002 the NFFO was replaced by the Renewables Obligation Credit (ROC) system, which required the producers to include a certain share of electricity from renewable sources rising from 3 to 15.4 % in 2015. If a producer had fewer certificates than required a payment needs to be made to the buy-out fund. This fund started with 30 £/MWh in 2003 and is in 2010 at 37 £/MWh (ie 3 to 4 pence per kWh). Added to the costs of ~ 2 pence per kWh generated from fossil fuel in 2003, electricity from renewable sources would be competitive below approximately 0.05 £/kWh. However, power from SRC is in the order of 0.06 to 0.07 £/kWh (Bullard 2003)[iv]. This requires extremely low biomass prices, and excluded a stimulation from the demand side at that time.

In April 2009 this deficit was partly overcome by a ‘banding’ of the ROC system reflecting different degrees of innovation and sustainability of production systems. Biomass or SRC relevant systems are shown in table 2 together with a reference from a competing sector.

Table 2: Renewable electricity generation systems banded for their degree of innovation and sustainability receive different credits per MWh of power.

Fuel / electricity generation system	**ROC granted**
Biomass co-firing, sewage gas	0.5
Energy crops co-firing; Biomass co-firing in CHP; on-shore wind	1
Energy crops co-firing in CHP; Dedicated biomass; off-shore wind	1.5
Dedicated energy crops; dedicated biomass CHP; dedicated energy crops CHP, anaerobic digestion (biogas); solar photovoltaic	2

However, SRC contributes to rural development as production and processing is diversified beyond the non-food sector. Accordingly, the Energy Crop Scheme (ECS) was launched under the England Rural Development Programme in 2000 implementing Regulation No. 1257/1999. It offered £1,000 for SRC on arable land and £1,600 for SRC on pasture land not eligible in the Arable Area Payment Scheme, covering in both cases approximately 50% of the establishment costs. The programme target were 16,700 ha new plantations.

The DEFRA (Department for Environment, Food and Rural Affairs) backs up interested farmers with very detailed information on SRC: What fields might be good sites, how to complete the subsidy application form, seed bed preparation, clone selection and planting, management, harvest… However, the mid-term review revealed that only 415 ha (or 2 %) of the targeted area were planted in 2003 and 4,425 ha in 2006, respectively, but applications for over 8,600 ha to be planted in 2007 and 2008 were approved before the scheme closed (Defra 2008)[v]. The average yield was approximately 10 t_{DM}/ha*a, 7 to 9 tonnes in the first harvest followed by increasing yields of up to 15 tonnes per year in successive harvests.

The target of the current 2007 to 2013 ECS programme under the new Rural Development Regulation (EC)1698/2005 is 47,500 ha SRC with the offer to cover 40% of the establishment costs. As the acceptance is weak the European Commission is sought to approve for 50% subsidy to establishment costs. The governments biomass strategy suggests that up to 350,000 ha of bioenergy crops might be grown by 2020.

An issue of increased importance for the public in England compared to other countries is birdlife and landscape conservation. These issues were extensively studied and some recommendations were formulated. Ground cover encourages the presence of some invertebrates, which in turn leads to an increase in the number of small mammals and birds found (Cunningham et al, 2004 & 2006)[vi]. High numbers of bird species are also found throughout the year and over the 3-year harvest cycle. Species of high conservation value regularly hold territories in SRC during the breeding season. Rotational harvesting, i.e. maintaining several different age classes within one area of coppice, provides the optimum sustained habitat. However, large continuous plantings of SRC that reduce the mix of previous land-uses will quickly reduce the biodiversity benefits. Hence current best practice if planting large areas of energy crops, is to plant a patchwork of fields interspersed with conventional arable or grass crops. This would also conserve the current landscape pattern. Headlands and rides necessary for the harvesting operations provide further habitat opportunities for a wide range of plants and animals, for example, 14 species of butterfly have been recorded on SRC headlands and butterflies of many families were more abundant in SRC plantations than on conventionally cropped fields (Haughton et al 2009)[vii]. Many of the species that use the habitats associated with SRC (i.e. hedges, scrub and woodland) will predate pest species. One of the birds commonly associated with SRC, the willow warbler, is one of the most important consumers of defoliating invertebrates. Therefore, any management practice that enhances the conservation potential of the crop is likely to prove valuable for pest management.

Italy

The 20 regions of Italy have individual plans, Veneto offered under Regulation 1257/1999 an expense based system with eligible costs for establishment amounting up to 5,000 €/ha plus management costs of 600 €/year for 5 years and income compensation for 20 years amounting to 185 or 725€/ha*year depending on the contribution of the agricultural income lower or higher, respectively, than 25% of the total income. However, agricultural plantations are restricted to an area of 1 ha maximum. Plantations for biomass purpose (rotation <15 years) between 1 and 10 ha are considered as forestry but the same rates are applicable. Planting density of poplar should be 250 to 400 trees/ha and for black locust (robinia) between 1000 and 4000.

The possibilities of SRC plantations supported by so favourable grant schemes and support by a dedicated National Research Centre for SRC www.ivalsa.cnr.it/ivalsae.htm were well perceived. In the last years farmers mostly located in the Po valley have planted over 5000 ha poplar SRC. Similar to Sweden, farmers are assisted all along the process from filing the grant request to harvesting and selling the product by SRC companies. These are usually connected to a nursery, organise the planting and usually buy the SRC on stock for 18 to 20 € per tonne harvesting mass. Due to high growth rates of up to 16 t_{DM}/ha*year (average 10 t_{DM}/ha*year, first harvest excluded) one- and two-year rotation systems based on poplar (6 – 10000 plants/ha) are usually preferred in order to allow a forager based harvest (Spinelli 2008)[viii]. An alternative is a 5 to 6 year rotation with 1300 to 3000 cuttings/ha). Well managed fields on good sites can reach or exceed a yield of 30 tonnes green biomass per hectare and year. With 18-20 €/green tonne, the establishment grant and cropping costs being only a fraction of those incurred with traditional food crops, this production is profitable for the farmer. As non-treated wood from waste management is nearly to 100 % used, heat and power plants in less forested regions like the Po valley increasingly rely on SRC wood chips. Rationally organised harvesting and transport by the SRC companies allows a profitable operation within the maximum price of 45 to 55€ per green tonne free plant gate in 2009. According to the CNR further improvements in poplar breeding and harvesting technology are assumed.

Poland

Biomass is recognized as being the most important and promising renewable energy source for Poland. The Government’s strategic objective is to increase the share of renewable energy sources in Poland's primary energy balance to 7.5% in 2010 and to 14% in 2020. However, in 2006 an area of only 6683 ha was cropped with willow. This includes 5326 ha SRC for bioenergetic utilisation for which 495 farmers received the 45 €/ha energy plant premium.

The polish Ecofund foundation offered 1000 PLN (in 2007 ca. 275 €) establishment subsidy. Yield levels of well managed plantations on average soils are between 9 and 11 t_{DM}/ha*year with a range of 4 to 5 t on sandy, marginal sites up to 25 t on highly fertile research plots (Stolarski 2008)[ix]. It was estimated that an area of 569,000 ha has a groundwater table within 2 m below surface, receives more than 550 mm precipitation and is outside of protected areas and thus is suitable for high productivity SRC cultivation. This is interesting as by ministerial decree the percentage of biomass from forestry (to which SRC belongs to) should increase from 5% in 2008 to 60 % in 2014. To not affect current use and sustainability of forestry this would require an additional area of 660000 ha SRC plantations. On the other side there is an EU budget of 524 mio € for renewable energy system for 2007 to 2013.

Hungary

Hungary is another country with ambitious aims under the Rural Development Regulation seeking to establish 50,000 ha of SRC with a establishment subsidy of 40%. In 2009 there were a 1600 ha SRC registered and applications for further 4600 ha were received. Used plants were poplar on 47% of the land followed by willow (44%) and robinia (5%).

Germany

R&D projects on SRC started in Germany from 1976 on and focussed on growth properties (12 – 15 t_{DM}/ha*a) and area availability (0.4 to 0.6 mio ha) (Makeschin 1989)[x]; improvement of planting material; carbon sequestration in soils under SRC plantations; economy of SRC plantations (Cluster: Fast-growing trees); and poplar SRC for cellulose production leading to some 100 ha of mostly poplar SRC plantations.

Beside biomass production multifunctional properties of agroforestry were studied: For recultivation of mining dumps robinia, poplar and willow were planted partly in an alley cropping systems as wind break for other crops. The Welzow dump SRC test site is characterised by a very low pH (down to 2.5), very low water retention and nearly any soil C_{org}. However, establishment success of the robinia is in the order of 85% and productivity averaged 3 t_{DM}/ha*a over the first 4 years. These plantations are now enlarged to 170 ha. On the Jänschwalde dump, robinia even reached up to 9 t_{DM}/ha*a in a 7 ha research alley cropping plot, clearly out-competing poplar and willow under these extreme conditions.

With regard to GHG emissions of agricultural areas it was found out that poplar as used in SRC plantations shows a very reduced level of nitrous oxide emissions (figure 2). Nitrous oxide arises from soil and fertiliser nitrogen turnover and usually contributes to a high level of total GHG emissions (Teepe 1999[xi], NABU 2008[xii]).

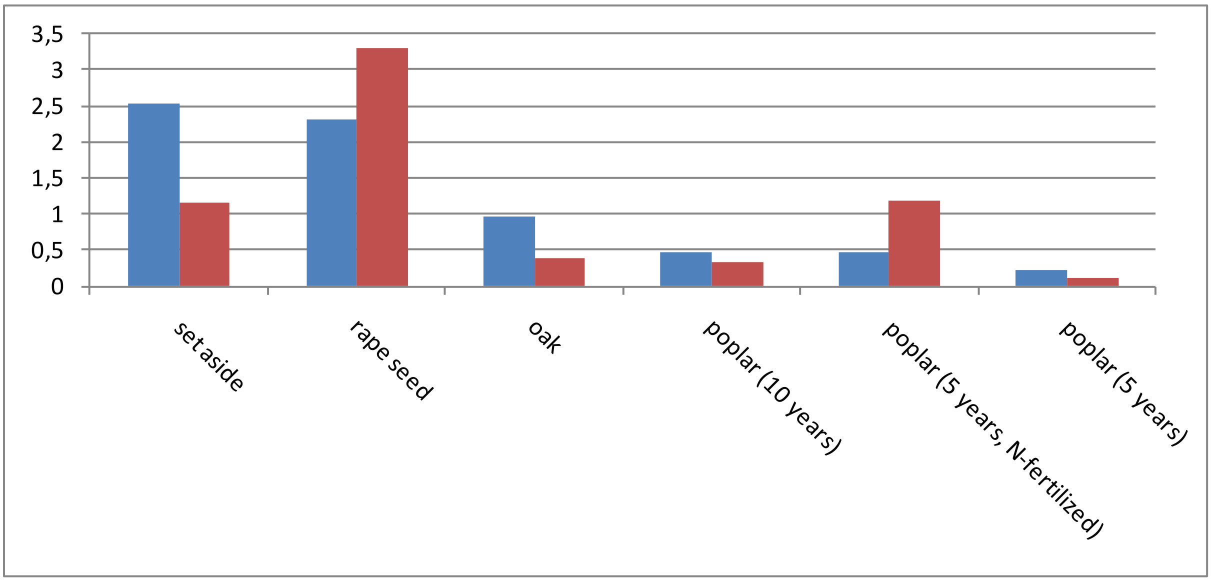

Figure 3 Nitrous oxide emissions (blue bar) [kg N_2O-N/ha*a] (Teepe 1999) and total GHG emissions (red bar) [tonnes CO_2/ha*a] (NABU 2008)

Recently, the DENDROM project running from 6-2005 to 7-2008 set a benchmark as fully integrated wood biomass project. By modelling, it related wood demand of nature conservation, timber, boards, pulp&paper and energetic use to the development of the different segments of forest resources on base of volumes on stock, forest age and use opportunities on the one side and the potential of SRC on arable land in the model region Brandenburg on the other. SRC was covered on the level of i) agricultural holdings with the development and demonstration of economic and environmentally sustainable production and management systems; ii) the region with an interaction of SRC and other land uses; and iii) national/international frame conditions and perspectives relevant for SRC, agriculture and forestry in a joint effort of scientists from forestry, agriculture, economy, ecology, engineering and social science. It turned out that production and demand for wood currently diverge with increasing tendency due to an increased demand for low quality wood (segments industry wood and forest residues) while the forest management system increasingly considering ecological issues tends to increase the offer of the high quality segment (even and thick logs). This tendency improves the economic base for agro forestry over the demand side. The project characterised two different agro-climatic conditions ´for favourable SRC production:

First, land of low fertility (sandy, soil bonity of 30) and limited water availability (480 mm precipitation, no ground water connection) typically cropped with rye and allowing not in every year economic operation. This is in Brandenburg a dominant type of arable land. Here poplar or willow -once established- would profit from the low susceptibility of perennial plants with regard to ‘wrong’ conditions like spring draught and the low input regarding labour, fuel, fertilizer and herbicide demand of annual crops. Typical yields for well managed plantations would be in the order of 8 to 12 t_{DM}/ha*a depending on species, planting density and water availability.

The second site type is characterised by connection to groundwater allowing yields of up to 20 t_{DM}/ha*a with poplar. Here, annual crops are outcompeted due to the very high productivity, a phenomenon which increases with decreasing soil fertility. Generally, DENDROM confirmed that the classic soil quality system is not applicable for SRC production. The highest relevance has water availability. Comparatively moderate amounts of fertilizer will stimulate the productivity of willow but poplar does hardly respond at all if cultivated on usual arable land.

The economic calculation was based on average costs for field preparations, planting, management, harvest and on the revenue for the wood chips as determined in DENDROM or comparable projects or taken from databases. Then, the SRC cropping system was compared to conventional crops. The result was that -depending on different frame conditions like price for food crops, straw and wood chips, energy, fertilizer and labour- SRC were competitive on 51 to 86% of the arable land of Brandenburg, that is an area of 550,000 to 915,000 ha. Excluded was most (95%) of the permanent grassland (due to cross compliance of direct payments), arable land in protected areas (GSG, LSG, NSG), land for organic production and water margins. On some sites SRC are competitive at a price level of about 40 €/t_{DM} free plantation[xiii], at 60 to 90 €/t_{DM} the production will considerably increase in Brandenburg.

Further on it was found out that there is an area of nearly 100.000 ha where SRC plantations would have a multifunctional purpose with regard to prevention of erosion. Assumed was planting of double rows on 3 and, respectively, 12 % of the area strongly (144,000) or extremely (292,000 ha) threatened by wind erosion and on 100 % of the water erosion threatened area (38,000 ha).

Although there were many research and demonstration projects covering the full spectrum of SRC only 1173 ha existed in 2008. This is probably due to a lack of an easily accessible establishment subsidy. Brandenburg and Saxony offer establishment grants between 25 and 45% of the costs under the investment aid programme, however, there are several restrictions and obligations[xiv].

Table 3: Various information on costs and return of SRC in Germany.

Costs [€]	Description	Reference
1800 – 3000 504 - 791	Full costs 1st year: Seed bed preparation, planting willow 13000/ha or poplar 8000-10000/ha, weed control. Amount of coverage	Leßmann, Kudlich, Horstmann, Fleßner (2009) [xv]
2000 68	Full costs 1st year: Seed bed preparation, planting willow 14000/ha or poplar 7000/ha, weed control (2xmech. & 2x chem.). Full costs post harvest per t_{DM} @ 10 t/$_{DM}$/ha*a	A. Möndel (2008) LRA Konstanz [xvi]
132	Return per ha*year of SRC on a good site in Saxony-Anhalt, compared to 188€/ha for usual agriculture and -68€ for fallow in 2009.	R. Richter (2009) LLFG Sachsen-Anhalt [xvii]
239 79	Return per ha or Full costs per t_{DM} on a average site in Saxony. being comparable to conventional crops assuming set-aside premium (392€/ha), drying to 20% moisture and price 66 €/t_{DM} for chips. With normal direct payments price need be 90€/t_{DM} to be comparable.	SMUL (2004) Sachsen [xviii]
62 - 98 170 – 438	Full costs per $t_{DM;}$ Return including premia on different soil qualities in Brandenburg at 75 €/t_{DM}.	LVLF Brandenburg 2008 [xix]

There is also support from the energy consumer side: The market incentive programme offers funding for heating systems with a rated power of 5 to 100 kW based on wood chips (1000€, flat rate) or pellets (36€/kW but at least 1000€) boosting the market enormously. Another mean is the renewable-electricity feed in tariff the rates of which are shown in the table 2 for 2010. The 'renewable bonus' is added to the base fee if forest wood or SRC are used. At plants with a rated power between 0.5 and 5 MW_{el} this bonus is differentiated, forest wood receives 2.48 and SRC 3.96 €-ct. Further boni may be added for advanced technologies (gasification, ORC, straw-firing) or for CHP operation.

Table 4: Feed in tariff for solid biomass-based (heat- and) power generation. For plants starting operation later than 2010 a yearly degression of 1 % applies.

Rated power	Base fee [€/100]	Renewable-bonus [€/100]	Technology bonus [€/100]	CHP bonus [€/100]
<150 kW_{el}	11.55	+5.94	+1.98	+2.97
<500 kW_{el}	9.09	+5.94	+1.98	+2.97
<5 MW_{el}	8.17	+2.48; SRC: +3.96	+1.98	+2.97
<20 MW_{el}	7.71 (only CHP)	-	-	+2.97

However, the combination of these measures (together with the economic competitiveness of SRC plantations) seem to have at least some effect as e.g. Volkswagen Kraftwerk announced to have its CHP in Emden partly fuelled with SRC, German Pellet and CHOREN Biomass cooperate in the establishment of up to 1000 ha SRC plantations for the production of wood pellets in the coming years and the power producer RWE enters the market with a target of 10.000 ha SRC in the next 4 years.

Objectives

The objective of task 7.3 is to find out the socio-economic constraints still interfering with broad introduction of short rotation coppice plantations.

Since the late 90ties SRC are increasingly known to be a profitable energy crop which is not negatively affected by measures of the Common Agricultural Policy (CAP) but except for Sweden first commercial plantations emerge just recently and SRC are still far away from being an important crop. This led us to study factors beyond the mere economic profit per hectare of SRC in this task of the OPTFUEL project to speed up implementation of SRC .

Core objectives are:

- What mean is necessary to demonstrate the general performance of SRC?
- Which type of farm is most interested in SRC production?
- What kind of contract is asked for?

Approach

The approach is to ask farmers for their knowledge on and attitude towards SRC and to learn what conditions need to be fulfilled in their individual case prior the decision to grow SRC on a portion of their land.

Personnel interviews allow in contrast to questionnaires by mail or telephone to better introduce the OPTFUEL project, the task 7.3 ‘socio-economic assessment’ and its rational. They are convenient for the farmer and secure a high success rate. The interview guideline method is more open than a questionnaire to be completed in writing by the farmer and secures proper formulation and perception of the questions. Further on it enables to address individual questions and details of the farm enterprise to individually get to the ground of the SRC-problem, to learn on the general conditions of the farm and to prevent objections concerning the reason for the questions: Again, this socio-economic assessment is purely research and the results will help actors in the SRC business to better address farmers.

Geographical layout

The geographical layout of the study focuses on the regions Brandenburg (NE Germany), Western Pomerania (Zachodniopomorski, NW Poland) and the area around Bremen (NW-Germany). The first two regions are surrounding Schwedt, the site where the erection of the world’s first industrial sized BtL plant with a demand of 1 million tons dry mass of wood is planned. For this BtL plant the feedstock will be sourced from demolition wood, forest wood and SRC. Assuming a SRC contribution of one quarter would require an area in the order of roughly 25,000 ha. However, both regions also belong to the greater area of Berlin, where several projects for wood based heat and power plants are running and more are announced. The third area around Bremen will serve as a kind of reference. This is important as the three regions should also represent different levels of SRC activities and awareness:

Brandenburg was subject of several national and federal projects and thoroughly studied in the DENDROM project, which was recently completed. In order to avoid redundancy a workshop was organised in June 2009 with professor Murach of the University of Applied Science Eberswalde, the coordinator of the DENDROM project and some other project partners. It turned out that really a lot has happened in the last years: Legal issues were cleared, a series of research plantations established, growth properties of willow and poplar depending on the availability of water in the growth season determined; the economics of SRC plantations calculated; areas where SRC perform economically better than conventional crops were identified; and even logistic concepts were developed. On the other hand an attempt to assess the socio-economics via a questionnaire was unsuccessful as only 2 of 70 addressed farmers replied. Accordingly, Prof. Murach recommended to not try to perform research questionnaires, as “virtually every farmer in Brandenburg was already contacted” with this regard. Taking this into account only enterprises which were in contract negotiations with CHOREN Biomass to set up demonstration plantations but declined in the last moment will be contacted to figure out their reasons.

In Poland the traditional cultivation of willow to yield shoots for braiding never completely stopped and there have always been some plantations also in **Western Pomerania**. Concerning SRC for bioenergy there are first commercial plantations on 330 ha in 2006 and a cross border network for the promotion of renewable energy is developing between the universities of Szczecin and Eberswalde. Many farmers have heard of CHORENs plans for a BtL plant in Schwedt. A meeting was organised with members of the chair of agronomy and forestry of the University of Szczecin to understand the specific constraints of this region and to discuss cooperation for this socio-economic assessment. It turned out that due to the BtL plans, farmers might be a bit reluctant concerning the scientific aims and might fear that something should be ‘sold’ to them. This problem might be overcome in a close cooperation to respected, local authorities as from the agricultural faculty in Szczecin, which served many enterprises of the region in the education of their staff. However, four different farm sizes will be studied, <25 ha; 25 – 50 ha; 50 – 300 ha and >300 ha to cover the whole range.

The third study area is situated around the city of **Bremen**. Farmers know SRC from diverse publications and have seen respective equipment on fairs. In 2008 a total of 250 ha SRC was registered in Lower Saxony with centres in Emsland and around Soltau/Uelzen. Recently, plans for the establishment of SRC plantations in the order of several 100 ha in Emsland were announced, but there are no plans for large scale installations. Additionally some fields are planted with Miscanthus. Accordingly, the region around Bremen allows finding out a comparatively unbiased, ‘native’ attitude of farmers for SRC plantations and will serve as a reference for the comparison with the first two regions. Here, the interview guideline and questions were developed and optimized at various occasions with farmers. As last step before the start of the interviews the assessment and questionnaire will be discussed with the Landvolk Niedersachsen, the local branch of the German farmer association (DBV).

Time schedule

The time schedule foresees that the interviews will be performed between December 09 and December 2010, in times where most farmers have a reduced workload and time to think beyond usual issues.

Then, the results of the interviews will be embedded in a general description of the agriculture in the regions, an estimated potential for SRC production and an outlook on the further development of the agriculture based on the interviews and on expert knowledge. The last point will involve experts of the universities Szczecin and Eberswalde, from the Landvolk and the Landwirtschaftskammer Lower Saxony (public body for enterprises in agriculture and forestry).

A preliminary final version of D7.2 will be available mid of 2011.

Farmer interview guideline

At the first contact and again at the interview it will be made clear, that the intention is not to ‘sell anything’ or to persuade the farmer to do something but only having an interview to find out the opinion of the farmer on SRC for a scientific purpose in the EU project OPTFUEL. Accordingly, it will be mentioned that the interviewer works for SYNCOM, a small consulting enterprise not contracted to organise land for customers or to engage in agricultural production. The farmer may terminate the interview at any time. The responses will not be connected to personnel or business information of any kind. The results of the interview will be anonymised prior to publication. During the interviews SRC production will be introduced to the farmer depending on the level of knowledge and interest.

Introduction:
In Germany 500.000 ha shall be cropped with short rotation coppice plantations for bioenergy generation according to governmental aims - that is nearly 5% of the total crop land. SRC are trees like willow or poplar harvested every 3-8 years for 20 years and longer. SRC are studied since decades in agricultural research stations and are expected to be competitive on considerable land portions. However, only on some 1000 ha SRC are currently established in Germany. I’d like to find out in this study (to which this interview with you will contribute) three objectives:

- What mean is necessary to demonstrate the general performance of SRC?
- Which type of farm is most interested in SRC production?
- What kind of production or supply contract may be asked for?

Questions: Hypothesis in green

- Can you (the farmer) imagine the production of crops for a non-nutritional purpose, like maize/corn, rape seed or cereals for bioenergy production? To find out the farmer’s opinion to the food/fuel debate.
- Can you imagine to assign one bioenergy crop for 20 to 25 years to a field? To find out the influence of annual crop rotations.
- Which knowledge or experience do you have with perennial cultures like Miscanthus, willow or poplar? Only flops or also positive examples? Do the descriptions in the response agree to the experiences of the interviewer? Most known are mishaps. Short comment on the flops and introduction to SRC cultivation and common perils.
- If negative examples are outweighing, How should demonstration plantations have to look like to dispel doubts? Typically, a demonstration site would be between 2 and 10 ha large and planted with up to 20 willow and poplar clones of different performance. Some of which are known to perform very well others less. On a commercial plantation a mixture of well performing species would be used. Is this comprehensible or would a test site with high grown plants next to a complete loss would leave a bad feeling? How should a convincing demo-plantation look like?
- Could you principally imagine to grow SRC?
- Please briefly characterize your enterprise, like organisational type, cultivated area (own/leased), soil quality, crop land /pasture, employees (education/age), machinery, subcontracting. Farm characteristics to find out a relation to SRC-attitude; as older Swedish wheat-farmers, or older Spanish farmers requesting afforestation aids.
- What is the focus of production? As above
- Are there currently areas which are less important or not really suitable for the focus of production? E.g. due to distance, weather caused crop failures, restrictions due to

erosion control (water, wind), water protection, environmental protection, shift of production, intensification or reduction of enterprise size? To find out if multi-functionality of plantations would apply, or if there are other advantageous conditions for SRC, which would be the most profitable sites.

- What development do you expect for the future? Implications for SRC-production? Expected development of farm/CAP/market and respective reaction of farmer
- Will the age distribution of the personnel become a problem? Are recruitment problems expected? SRC have a work requirement of <3 h/ha*a (compared to 15 h/ha*a for cereal crops) most of which is for planting or in the first year – partial retirement or time for an additional occupation
- Coming to the production of SRC:
    - SRC plantations need a relatively limited effort averaged over the ~20 lifetime. Seedbed preparation, planting, crop protection (regular weed control in the 1st year, if necessary spraying/chopping) occasional pest control, harvesting every 3 to 4 years in the winter, followed by fertilisation. → Most work occurs in the first year → crop with moderate cash flow at limited input of work and capital
    - Robustness: Once established, plants depend far less of the ‚right' amount and timing of precipitation and temperature
    - Security: Wood chips for energy are an emerging market with limited price volatility and possibility for long-term contracts, reverse correlation to energy price (low effort for fertilizer and fuel) lead to reliable cash flow of WELL established plantations (else very reliable losses) Key characteristics of the SRC production, might be positioned earlier in case a farmer raises the issue earlier.
- Which of these aspects might be most interesting? To find out most interesting aspects
- Assumed you can principally imagine growing SRC and would have available suitable land – which approach would you follow? Absolutely hypothetical! Might allow SRC-companies to better address farmers/comparison with farm characteristics
    - i) Full responsibility for the production and marketing following self education in training course, seminar, books or internet information;
    - ii) Contracting of an independent SRC expert, who recommends species, planting lay out, seedbed preparation crop protection measures etc.;
    - iii) Contracting of SRC specialist to establish the complete SRC plantation with specialized machinery and selected clones on farmers account, the farmer only prepares the seedbed, does crop protection, fertilisation and assists in the harvest.
    - iv) Cooperation with specialized SRC company. Establishment cost and plantation management is financed by SRC company. The income from wood chips yield is split between the farmer and the SRC company based on a contractual set share;
    - v) Land lease to SRC company → limited risk, no participation on potentially rising wood chips prices
- What prerequisites further to the contact to a SRC company, training courses or info material would you require prior to SRC production? To find out further prerequisites
    - A long term supply agreement?
    - What kind of political framework conditions are expected?
- In which order should the profitability per hectare be? To find out at which point a farmer would start SRC production – depending on soil quality, field size, multifunctionality
- In case of long-term supply contracts, should there be a price reference to other crops (wheat), energy (e.g. oil, electricity or maize for biogas), CO_2, inflation, or something else? To find out references

Proposed outline of D7.2

Introduction; description of agriculture in the study regions (using published data)

- Climate
- Soils
- Products
- Farms: acreage, (own/leased), organisational type (Family, cooperative, private, public, …), employees (age/education), typical production if different from average [e.g. 70% of milk production on farms of <25 ha; 80% of cereal production on farms >500 ha]
- Frame conditions: Political aims and support (subventions) for agriculture, market for products, environmental issues

Estimation of potential for SRC-production

- SRC-productivity (t_{TM}/ha*a) depending of soil fertility and precipitation/ground water
- Map of areas allowing profitable SRC-production setting different price ranges for SRC wood chips in comparison to annual crops.
- Types of annual crops eventually substituted by SRC
- Brandenburg: Review of DENDROM results and other published data;
- Other regions: Analyses in analogy to DENDROM

Interview results and discussion

- Analysis of interviews
- Description of expected development of political framework
- Long term perspectives of farmers and agricultural experts regarding crop market, size and organisation of farm enterprises

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