Cost reduction and efficiency improvement of Short Rotation Coppice (CREFF)
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Cost reduction and efficiency improvement of Short Rotation Coppice (CREFF)

on small field sizes and under unfavorable site conditions by focusing on high product quality and a product-oriented cooperative value chain

Present geopolitical and environmental world context:
- Rarefaction of fossil fuels
- Needs to reduce CO₂ emissions

Promotion of renewable energy
- Biomass
- Short Rotation Coppice (SRC)

Up to recently, slow development in Europe due to non-competitive profits as compared to non-energetic cultures
- Expensive plant material
- Plant breeding and optimization of species-site matching needed
- High harvest and transport costs

Necessity to reduce production and supply costs

At present, research results available for:
- medium to good sites
- for large field sizes

Such conditions rarely found in many regions of Central Europe:
- Good sites rare and expensive and used for demanding annual crops
  - SRC on less favorable sites in terms of soil quality and forms (small stripes along creeks or forests)
- Average sizes of fields and farms much smaller than in UK and south-Sweden
  - SRC in small field sizes, at scattered locations and on unfavorable sites
### Introduction

- **WP1. Plantation management**
- **WP2. Harvest and logistics**
- **WP3. Conditioning of material**
- **WP4. Economic evaluation**
- **WP5. Business concepts**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>Problem</td>
<td>Objectives</td>
<td>Organization</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **At present, research results available for:**
  - Medium to good sites
  - For large field sizes
- **Such conditions rarely found in many regions of Central Europe:**
  - **Good sites** rare and expensive and used for demanding annual crops
  - **Small fields along creeks or forests**
- **Average sizes of fields and farms** much smaller than in UK and south-Sweden

- **SRC in small field sizes, at scattered locations and on unfavorable sites**

- **To promote the use of biomass from SRC, optimized SRC value chains for unfavorable conditions have to be found**

### Approach

- **Initialization of intensive and early cooperation between producers and consumers**
- **Concentration of the SRC-production inside these co-operations to the requirements of industrial consumers**
- **Based on the known value chain structures, streamlining of all major processes like the production, harvest and logistics, and conditioning of SRC-products**
- **Design of improved local SRC value chains with help of real pilot co-operations of producer and consumer**
- **Evaluation of economic and socio-economic aspects of improved local SRC value chain scenarios**
### Introduction

#### WP1: Plantation management

**Results**

General results:
- Development of strategies allowing a major cost reduction and a higher efficiency even for areas in Central Europe characterized by less favorable conditions for SRC-production.
- Implementation of the results in the course of the project through the establishment of pilot cooperatives of SRC-producers and industrial consumers (show-cases for new efficient strategies fostering a wider implementation of SRC).

#### WP2: Harvest and logistics

- **Quality products controlled by:**
  - SPECIES / SPECIES / SPECIES (INRA)
  - SPECIES / SPECIES / SPECIES (FVA)
  - SPECIES / SPECIES / SPECIES (HFR)

#### WP3: Conditioning of material

- **Quality products controlled by:**
  - SPECIES / SPECIES / SPECIES (INRA)
  - SPECIES / SPECIES / SPECIES (HFR)
  - SPECIES / SPECIES / SPECIES (Stora Enso, Veolia, Schellinger)

#### WP4: Economic evaluation

- **Economic analyses of value chains:**
  - SPECIES / SPECIES / SPECIES (IER)

#### WP5: Business concepts

- **New business concepts:**
  - SPECIES / SPECIES / SPECIES (INRA / UNIQUE)

**Initial approach:**

1. **State of the art**

   SRC, a particular forest ecosystem

   - Little biomass accumulation
   - Regular young wood exportations, without residuals, implying a rapid soil depletion
   - Necessity to optimize and to sustain biomass production while preserving soil richness

2. **Problem**

   SRC, a particular forest ecosystem

   Site conditions
   - **Adequate / optimized matching**
     - Reduction of input needs
     - Reduction of associated costs
2. Problem

Production

Carbon cycle

Optimization

Irrigation

Nitrogen cycle

Water cycle

Fertilization

Phytosanitary treatment

Irrigation

Water input

Cutting frequency

Density

N input

Rotation lengths

Cutting calendar

Plant material

Management

Management

2. Problem

Production

Carbon cycle

Optimization

Irrigation

Nitrogen cycle

Water cycle

Fertilization

Phytosanitary treatment

Irrigation

Water input

Cutting frequency

Density

N input

Rotation lengths

Cutting calendar

Plant material

Management

Management

3. Objectives

Exploration of the triangular relationships among productivity, WUE and NUE for varying:

1- Site conditions
2- Plantation management modalities
3- Nature and age of the planted material

NUE

WUE

4. Material and methods

Tree dimensions (stem circumference / height)

Biomass production (extrapolation)

Nutrient-use efficiency

Biomass production / Nutrient content

Water-use efficiency

Biomass production / Water consumption

Estimation of the wood/leaf contents in N, P, K, Ca, Mg by elemental analysis

Estimation via the wood/leaf content in carbon 13 by mass spectrometry
4. Material and methods

- Potential species:
  - Poplar - *Populus*
  - Willow - *Salix*
  - Black locust - *Robinia*
  - Alder - *Alnus*

- Potential sites:
  - Germany
  - France
  - Austria

WP2: Improvement of harvesting systems and transport logistic related to specific site conditions

Results

- Quality products controlled by improved processes for storage and drying
- Reducing costs by controlling economic impacts of improved technology in the value chain

Initial approach:
- Overcome implementation problems with the help of producer-consumer cooperations
- Establish cooperation and/or producer associations

Wood & energy industry
- *IER*
- *HFR*
- *INRA*
- *Stora Enso*, Veolia, *Schellinger*

WP2: Improvement of harvesting systems and transport logistic related to specific site conditions

- Economic analyses of value chains are necessary to identify and map the potential savings of improved technology in the value chain

Research structure:

- Farmer
- Plantation management
- Quality products
- Wood & energy industry
- Economic analyses of value chains
- Improved harvesting systems and transport logistic

WP2: Improvement of harvesting systems and transport logistic related to specific site conditions

Introduction

1. Problem

SRC is often uneconomical!

- Costs have to be reduced!
- Harvesting & Transport can cause < 90% of total SRC costs

- especially on small field sizes, steep and wet areas
- Full-mechanised harvesting is often not possible or uneconomical
- Semi-mechanised or feller-buncher harvesting are often not cost-efficient enough so far and need to be improved
- Scattered SRCs of a small field size need to be included in an effective logistic system to reach an economical SRC management

WP1: Plantation management

WP2: Harvest and logistics

WP3: Conditioning of material

WP4: Economic evaluation

WP5: Business concepts

Results

WP4: Economic evaluation

Economic costs have to be reduced!

WP1: Plantation management

WP2: Harvest and logistics

WP3: Conditioning of material

WP5: Business concepts

Costs have to be reduced!

WP2: Harvest and logistics

WP3: Conditioning of material

WP4: Economic evaluation

WP5: Business concepts

WP2: Harvest and logistics

WP3: Conditioning of material

WP4: Economic evaluation

WP5: Business concepts

Small scale harvesting systems so far

- Especially with harvesting and logistics of SRC products on small size fields and with longer rotation periods (> 5 years)
- Tests up to now mainly for forage harvesters; only few for semi-mechanised and motor-manual methods (Burger and Scholz 2004, Textor and Wilwerding 2003)
- Little experience with logistics for combined harvesting of several small scale plots.


### 3. Objectives

“Development of improved and economically viable SRC harvesting and logistic systems which are adapted to the particular site conditions” (focus on small field sizes and unfavorable site conditions)

<table>
<thead>
<tr>
<th>Improved Harvest &amp; Logistic systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>small performance enhancement</td>
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<tr>
<td>product quality improvement</td>
</tr>
<tr>
<td>steep cost reduction scattered</td>
</tr>
</tbody>
</table>

### 4.1 Material and methods (1)

The three commonly used harvesting systems (forage harvester, feller-buncher, motor-manual) will be analyzed under different site conditions (steep, wet, small field size, etc.) on 50 SRC-plantations in Germany, Austria and France.

Their capacity and production cost will be analyzed using time-studies: the quality of the wood chips will be compared and analyzed in the laboratory.

### 4.2 Material and methods (2)

Different means of transport of the SRC wood to its processing place will be analyzed under different circumstances (distance, reloading points, field storage, etc.)

New efficient logistic models will be developed using the results of all WP and with a focus on widely scattered small size SRCs.

<table>
<thead>
<tr>
<th>WP3: Value added conditioning of SRC raw material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research structure:</td>
</tr>
<tr>
<td>Economic analyses of value chains (WP1)</td>
</tr>
<tr>
<td>Harvest &amp; management</td>
</tr>
<tr>
<td>Wood &amp; Energy Industry (schell, Veolia, Stora Enso)</td>
</tr>
</tbody>
</table>

### WP3: Value added conditioning of SRC raw material

- **Farmer**
- **Harvest & Transport**
- **Conditioning of wood quality**
- **Wood & Energy Industry**

Initial approach:

- Establish cooperation and/or producer associations.
1. Problem

Raw material from SRC often shows different properties in comparison to traditional wooden material, for instance:
- higher percentage of bark
- higher content of minerals

Aspects:
- very cost sensitive material
- quality parameters for different applications (e.g. pellet, pulp) are characterised and defined insufficient
- technical instructions are not existing (SRC material)
- losses of quality while raw material storing
- standardized conditioning methods must be developed for … storage / dimensioning / drying … of wood chips

2. State of the art

- insufficient information on quality issues regarding utilisation in the energy sector or as fibrous raw material
- quality aspects are often excluded in the price formation process
- still unsatisfactory conditions for the storage of wood chips from SRC
- previous simulations could not simulate all the relevant conditions of storage
- inhomogeneous raw material because of the small SRCs


3. Objectives

- identify and characterise conditioning technologies and processes, which increase the product quality in terms of different utilisation paths (energy-, pulp- and wood-industry)

Decision Support System
Technical Instructions

- simulation of storage:
  - different raw material qualities and storage possibilities under different material and climate conditions

4.1 Material and methods

- tagging and systematise properties and quality parameters characterising important end product requirements
- developing a set of standardized evaluation methods for key parameters
- design of a device to simulate the behaviour of wood chips under different conditioning scenarios
4.2 Material and methods

- identifying and developing best practise methods of storage, dimensioning and drying wood chips
- detection of technical and economical constraints for productive and efficient technologies
- describing productivity and cost efficiency of different technologies
- compilation of a decision support model for storing and conditioning measures
- design of technical instructions (Quality Management System) with cost efficient assessment methods
- industrial experience
- research background
- inquiries
- pilot studies at installations of the industrial partners

WP1: Plantation management

WP2: Harvest and logistics

WP3: Conditioning of material

WP4: Economic evaluation

WP5: Business concepts

Results

WP4: Economic and socio-economic evaluation of SRC-value chain

Research structure:

1. Problem

- For an optimization of the supply chain for wood from SRC the different parts of the chain (production, provision and conditioning) have to be connected
- The costs of wood supply chains based on sites with non favorable site conditions (slope, quality, water and nutrition supply) is not well known
### 2. State of the art

- A few studies and examinations about cost of parts or the process chain like the production (planting, management) or the provision (harvesting) exist.
- No overall and comprehensive information about product oriented wood supply chains for CHP.
- The aspect of product orientation as well as the aspect of non favorable field location and sizes cannot be found in the chain analysis.

### 3. Objectives

- The determination and the assessment of the costs of different options of wood production in short rotation coppice (SRC) and the development of market and prices of energy wood.
- The analysis of the effects of area characteristics (location, area size a. o.) and other factors (work intensity, amount of pestizides, transport distance) on the feasibility of SRC.
- The assessment of additional economic (added values through by-products) and socio-economic benefits (employment effects) of the most important value chains and frame conditions.
- The estimation of mid-term developments and the cost optimization potentials connected to these developments.
- Definition of optimized production and provision chains with respect to costs and ecological aspects (GHG-emissions).

### 4. Material and methods

Based on input from the WP1 – 3 about process chain related cost categories like machine hours and material flows (fertilizer, pesticides etc.):

- Definition and characterization of typical products (bundles or chips, high or low moisture content, etc.) and systems.
- Cost balance of the different production and provision systems.
- Emission balances and related environmental costs.
- Balance of employment effects and other macroeconomic aspects (added values).
- Definition of optimum production and provision systems with respect to the costs and ecological aspects.

### WP5: New business concepts for successful implementation of a consumer-oriented wood-fuel value chain from SRC

- SRC-producing Farmers
- New business concepts
- Economic evaluation of value chains
- Wood & energy industry

**Economic evaluation of value chains**

1. SRC producing Farmers
2. Farmers around industry plants
3. Farmers offering access to SRC plantations
4. Wood & energy industry
5. Stakeholders involved in using SRC products

**New business concepts**

- Establishment of producer-consumer co-operations

**Wood & energy industry**

- Stora Enso, Schellinger GESA, CREED, UPME, Stracel
### 1. Problem

- In many areas of central and western Europe the SRC-production is still in its infancy and a very “exotic” topic for farmers – explicitly in our main study area (South-West Germany and North-East of France).
- Biomass from SRC often seems not known or not accepted by woodfuel consumers or the wood industry.
- Even in the past two years with rising prices for wood and growing demand for wood, there are obvious many constraints and problems for farmers to invest in SRC.

### 2. State of the art

- Lack of “implementation oriented” research along the supply- and value-chain with a focus on the implementation problems.
- Lack of research with a ”case-study approach“:
  - Meaning working with main stakeholders = SRC producer-consumer groups
  - trying to work-out optimal business concepts in close cooperation.
- Results from field-research are rare (i.e. Dendrom, Agrowood*) and missing for the specific conditions in our study-area (South-West Germany & North-east France).


### 3. Objectives

1. Identify reasons, why farmers do not invest in SRC production.
   - Hypothesis is:
     - The low level of implementation of SRC production is caused by
       - lack of knowledge amongst farmers, politicians, and other stakeholders,
       - lack of knowledge about SRC products (wood-chips / industrial wood) at industrial consumers,
       - undeveloped markets and unclear quality criteria for the final products,
       - unclear legislative framework for SRC production.
     - This complex - beside technical problems faced by WP1-WP3 - leads to low efficiency of SRC value chains and high production costs and
     - it ends in a unfavourable profitability level compared to competing agricultural products.

2. Test one potential approach to overcome the constraints.
   - Hypothesis is:
     - Regional co-operations between producers & consumers can lead to optimised business concepts and more efficient supply- and value-chains.

### 4. Material and methods (1)

- Initiate 3 “pilot co-operations” and implement case studies of co-operations between
  
  **Producer (Farmers) <-> Consumer (Bioenergy, Pellet plants, Particle board - or Pulp industry)**

- Initiate, moderate and guide an implementation-process, where partners name, define and discuss
  - SRC products (quality, quantity) ➔ link to WP3 Conditioning
  - Costs and price-restrictions ➔ link to WP4 Economic evaluation
  - Implementation problems for farmers (political, market-, economical-)
  - Procurement problems for consumers ➔ link to WP 2 Harvest & Logistics.
The “pilot co-operations” will serve as a communication forum for the detection & eradication of production-related, institutional, social, and environmental constraints, development of locally adapted business concepts and SRC value chains, knowledge transfer.

Methods:
- Workshops and interviews to analyse the situation and to conceptualize and define solutions.
- Economic model calculations (link to WP4 Economy) to evaluate, which constraints and barriers are relevant to restrict successful implementation.
- Examination of the operational decisive behaviour of the farmers and the wood-fuel industry.

Strategies to overcome the problem of unfavorable conditions = small field sizes at scattered locations on unfavorable sites by:
- Improvement of efficiency via a straight consumer-oriented quality production (WP3)
- Definition of an optimal, locally adopted production system for farmers (WP1)
- Co-operation for better information and optimized business models between producers and consumers (WP5) leading to
  - consumer-oriented production systems among producers,
  - improved harvesting techniques and establishment of efficient logistic systems between partners (WP5).

⇒ Overall cost reduction for the SRC-production (WP4)