Practical and economic issues relating to coppicing and short rotation crops
“International experiences and options for NZ”

Ian Nicholas,
Scientist, Bioenergy project
Scion, Rotorua, New Zealand
(Associate Task Leader
IEA Bioenergy Task 30
Short Rotation Crops)

Acknowledgements

- Eddie Johansson, Sweden
- Larry Abrahamson and Tim Volk, USA
- Gillian Alker, UK
- Kevin Snowdon, Gerard Horgan, N.Z.
- Richard Harper, Australia
- Laercio Couto, Brazil
- Brent Apthorp N.Z.
Outline

- Short Rotation Crops
- International SRC
- Issues for SRC
- International barriers
- Case studies
- Economic considerations
- New Zealand context
- Conclusion

Definition. “Short Rotation Crops”

“Short Rotation Crops” means woody crops such as willows, poplars, Robinia and Eucalyptus with coppicing abilities as well as lignocellulosic crops such as reed canary grass and Miscanthus.
Residues to Revenues 2005

Welcome...

to the IEA Bioenergy Short Rotation Crops for Bioenergy Systems Task 30 website

The work of IEA Bioenergy is carried out through a series of Tasks, each having a defined work programme. Each participating country pays a modest financial contribution toward administrative requirements, shares the costs of managing the Tasks, and provides in-kind contributions to fund participation of national personnel in the Tasks. The scope of the work undertaken within IEA Bioenergy is shown in its website (www.ieabioenergy.com).

IEA Bioenergy provides opportunities for:

- Researchers - to exchange information on recent developments in R&D through networking, meetings and/or workshops; to provide opportunities for collaborative R&D;
- Industry - to be informed of new projects; to work together to develop handbooks or models; to offer early participation of industrial partners in R&D work.

Newsletter

No. 2, April, 2003

Short Rotation Crops

Task 30 Short Rotation Crops for Bioenergy Systems

Editorial

Yes the newsletter is still going...I had hoped to get another one out last year but didn’t make it. The Annual meeting was a great meeting and very interesting. Not only for the material presented, but for the field days and the interactions with Task 31 participants. The pre and post conference tours were a fascinating insight into the Brazilian sugar and eucalyptus industries.
International SRC

- Sweden: willow (17,000 ha)
- United Kingdom: willow (1,500 ha)
- United States: willow, eucalypt, switchgrass, poplar
- Brazil: eucalypt (2.2 million ha)
- Canada: poplar
- Australia: mallee eucalypts, eucalypt
- New Zealand: eucalypt, acacia, willow

SRC Issues

- Barriers
- Markets
- Economics
- Harvesting costs
- Environmental benefits
- Resource control
NZ and International SRC Barriers

- Technical
- Economic
- Socio/political

Technical SRC barriers

- Unfamiliar fuel barriers
- Unfamiliar crop barriers
- Underdeveloped technologies
  - Conversion
  - Harvesting
Non technical barriers

- Research and development
- Policy
- Market
- Communication
- Public acceptance

Non technical barriers to

- Fuel production
- Supply Chain
- Conversion technologies
Case Studies

- Enköping (Sweden)
- Narrogin (Australia)
- Syracuse (United States)
- Lake Taupo (New Zealand)
- Charcoal production (Brazil)
Enköping District heating plant
Case Study 2
Narrogin (Australia)
Salinity is a major issue in Australia, estimated 14 million ha could be at risk by 2050.
Causes of salinity

Residues to Revenues 2005
Mallee eucalypt plantings

Narrogin (Western Australia) Demonstration Plant
Commissioning September 2005
IWP - Process Integration

Harvest → Leaf → Chip

Distillation → Combustion → Boiler - Turbine → Heat → Carbonization

Oil → Electricity

Credit: Shelley Liddelow (SEDA)

Phase farming
Background-USA

- Worldwide demand for energy will continue to grow at an exponential rate
- Supplies of oil will peak early this century
- Concern about national energy security
- Increasing concern about environmental impacts related to the use of fossil fuels
- SUNY-ESF, designated as the SUNY Center for Sustainable and Renewable Energy for NY
Regional Development

- Long history of short-rotation woody crops research at SUNY-ESF
- Research on willow begins in mid 1980s
- **Salix Consortium** formed in 1993 to facilitate the commercialization of willow biomass crops
  - Over 20 different organizations involved
    - Industry, University, State, Federal, Farm

SUNY-ESF research station in Tully, NY. Site of original willow biomass trials in the US.

Current Status

- About 200 hectares of willow biomass crops in New York
- Small trials and demos have been located throughout the Northeastern US
  - from Delaware to Minnesota
  - and Quebec to North Carolina
- Numerous other trials and demos using willow for agroforestry and phytoremediation applications

Location of willow demonstration and research locations in New York state.
Potential Markets-USA

- Bioenergy:
  - Co-firing with coal
  - Small and large scale gasification
  - Combined heat and power systems
  - Ethanol production – Biorefinery
- Bioproducts
  - commodity chemicals
  - specialty chemicals
  - polymers, composites, plastics
- Pulp & paper
- Specialty and niche plantings

Bioenergy Benefits

(Adapted from Mann and Spath, 1997 and Heller et al., 2003)
Residues to Revenues 2005

Willow coppice-SUNY

Willow sprouts
Willow riparian planting

Willow phytoremediation
Case Study 4
Lake Taupo (New Zealand)
Background

Lake Taupo water quality declining over time attributed to land use; settlement and agriculture

Recreation and tourism protection
Emphasis on land use change from pasture to trees in economic framework

**Lake Taupo options**

- Willow crop
  - Seen as most economic and cheapest to grow and harvest to produce economic land crop for:
    - Ethanol
    - Biopolymers
- Eucalypt
  - Seen as too expensive to establish and harvest

- **Trials underway(with SFF support)**
  - 2005, 8 ha, willow, eucalypt and poplar
Willow demonstration planting

Willow demonstration planting-2ha
8 ha willow research trials (3 sites)
Case Study 5
Charcoal production (Brazil)

Brazil statistics (000ha)

- State eucalypt pine
- MG 1080 100
- SP 574 202
- BA 213 238
- ES 152 -
- RS 116 137
- PR 67 605

2202 1282

New Zealand 30 1770

Australia 600 1200

Residues to Revenues 2005
Charcoal truck

Charcoal for sale at garage (govt. certified)
Charcoal furnaces

Charcoal logs for processing
Final loading into chamber

Combustion
CAF
Brazilian multiple product company (Minas Gerais)

- Establish eucalypts 4,000 ha/yr
- Charcoal
- Lumber
- Poles

Eucalypt plantation (CAF)
Rejected planting

Minimum cultivation establishment
Residues to Revenues 2005

Post harvest

Two man harvest team
Case Study 6
Bay of Plenty Effluent project (New Zealand)
Sub surface irrigation of primary effluent

**Old technology**

**New technology**

**Project outline**

- Established March 2000
- Three irrigation treatments (commenced March 2001)
  - operational rate
  - Control (no treatment)
  - 1.5 operational rate
- **Two tree spacings**
  - Biomass
  - Pulp
- Monitoring 2000-2004
- Project completed June 2004
Age 2 years

Age 3 years
Age 4 years

Biomass age trends

Residues to Revenues 2005
Summary- at age 4 years

- Irrigation increased growth-marginal
- Closest spacing carried highest volume
- Wide spacing had largest diameter
- No visible interaction between pipe and roots
- No ground water effects
Selection of New Zealand Biomass studies (MAI>20 ODT)

MAI ODT (tonnes/ha/yr)

Pine (6)
Eucalypt (12)
Poplar (1)
Willow (1)
Acacia (2)

Genus (data points >20)
### SRC Economic Comments

### Syracuse Willow Economics ($US)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Current Yield ($ green ton⁻¹)</th>
<th>Increased Yield ($ green ton⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case **</td>
<td>27.96 ($3.00 MMBtu⁻¹)</td>
<td>24.32 ($2.60 MMBtu⁻¹)</td>
</tr>
</tbody>
</table>

- Average delivered coal cost is $1.50 - 2.00 MMBtu⁻¹.

(Tharakan et al. 2005)
Willow and Eucalypt comparison

**Eucalypt**
- Growing cost = $45/ODT
- Delivered cost (bc) = $94/ODT
- Delivered cost (1/2) = $70/ODT

**Willow**
- Growing cost = $38/ODT
- Delivered cost (1/4) = $51/ODT
- Delivered cost (1/2) = $63/ODT
Growing costs of Eucalypt SRC in New Zealand

Range of sensitivity in response, some easier to control than others.

- Growing crop
  - yields
  - wood density
- Project management
  - land price
  - seedling cost
  - establishment cost
  - interest rate

Source: Nicholas, 2003

Environmental services SRC can provide

- Land treatment
- Low nitrate land use
- Phytoremediation
- Riparian buffers
Overcoming NZ barriers to SRC for bioenergy

- Markets
- Harvesting costs
- Economics
- Land bank

Conclusion

Practical and economic issues relating to coppicing and short rotation crops

"International experiences and options for NZ"

- SRC has a role in New Zealand based on:
- Strength of environmental services to provide for specialist markets.
- Need for bioenergy resource buffers.
- Complementing forest residues as a market and economic alternative.
- Future markets will provide niche markets with market pull, not resource push.