Establishment and Production of Willow

Our Experience in PEI

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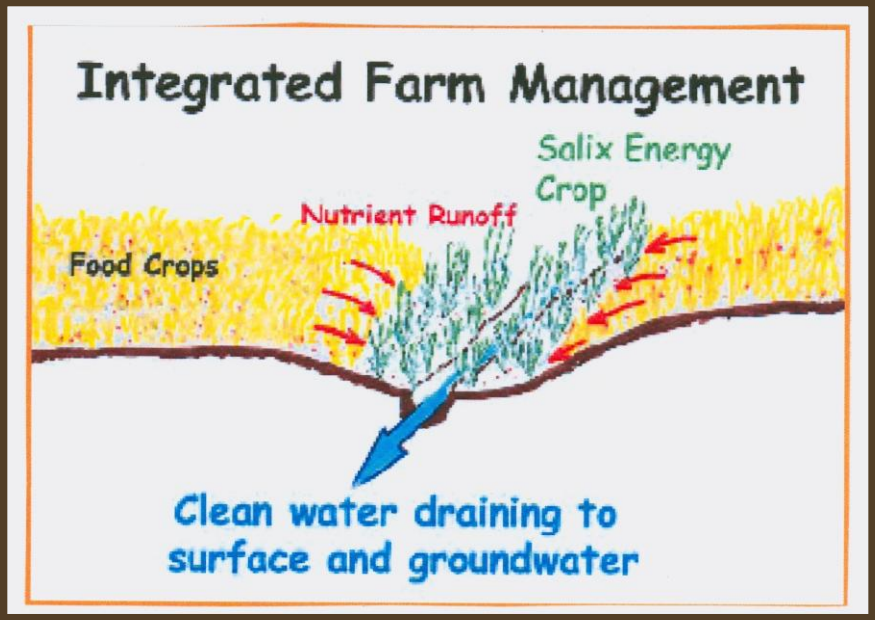
Canada

Overview

1. Why Willow ?
2. Which Willows ?
3. Soil Characteristics Best for Willows
4. PEI Demo Sites
5. Planting and Establishing Willows
6. Fertility, Management and Maintenance
7. Observations and Yield
8. Harvesting

Why Willow?

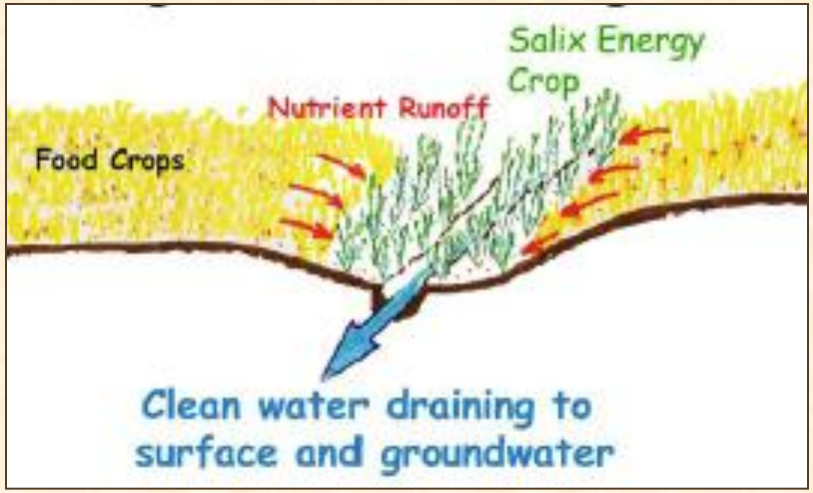
Produce Multiple Benefits



Incorporating willow biomass crops into riparian buffers produce clean water and renewable energy (Salix Maskiner 2000)

- Short rotation woody crops are unique:
  - **Produce environmental and rural development benefits in addition to bioenergy and/or bioproducts**
    - **Riparian buffer strips**
    - **Windbreaks and living snow fences**
    - **Nutrient and waste management systems**
    - **Enhance biodiversity**
    - **Phytoremediation**

Willows in Riparian Buffers



- **Native, perennial plant**
  - Non-invasive depending on species
- **Well adapted to riparian zones**
- **Rapid and extensive root development through the soil profile**
  - forms effective nutrient filter
  - stabilizes soil
- **Coppicing maintains plants in a juvenile state with high nutrient demand**
- **Growth begins in early spring**
  - Rapid site occupancy
  - Nutrient demand begins in early spring

Why Willow for Biomass?

Willow coppice

- Very high biomass production potential
- Heat value per dry ton is similar to other hardwoods
- Easily established with unrooted cuttings
- Re-sprouts vigorously after each harvest
- Many environmental and social benefits

Willow Fuel Characteristics	
Ash Content	1.65%
Calorific Value	19.6 GJ/DT

Energy Equivalent

1 tonne willow (3 bales)

≈

400 litres heating fuel

Why Willow?

Biomass Energy values

Species	Heat Value (GJ/Ton)	Yield (Tons/ha/yr)
Willow	16.1	11.3 – 16.8
Red Maple	16.1	1.1 – 2.3
Sugar maple	16.1	1.1 – 2.3
Beech	16.5	1.1 – 2.3

Ash content of various biomass materials

Biomass fuel used	Ash content
** Bark	5.0 to 8.0
** Woodchips with bark (forest)	1.0 to 2.5
** Woodchips without bark (industrial)	0.8 to 1.4
** Sawdust	0.5 to 1.1
** Straw and cereals	4.0 to 12
** Miscanthus	2.0 to 8.0
SRC Willows	1.65
Reed canary and switch grass	3.6

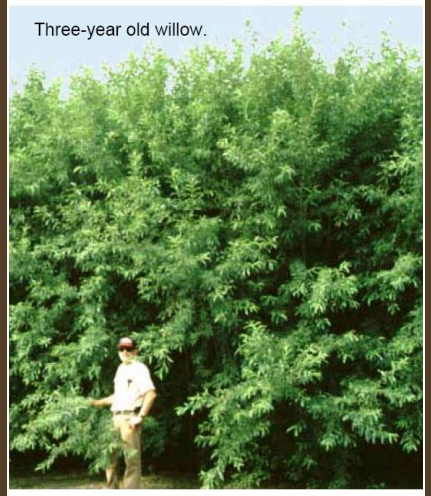
** Source: The handbook of biomass combustion and co-firing

The fuel quality of herbaceous species is much lower compared to wood, due to ash content, and high percentage of silica, potassium, and sodium. (slagging and fouling at high temperatures)

Biomass SRC Willow Production

- Sweden has 30 plus years of experience and 15,000 plus ha in production (Rosenqvist and Dawson 2005)
- Seven other European countries has a few hundred hectares each of SRC production
- SUNY-ESF researching since the mid 1980's. Over 500 ha in production
- Research being conducted in Quebec, Ontario, Saskatchewan, NS, NB and PEI

Which Willow?



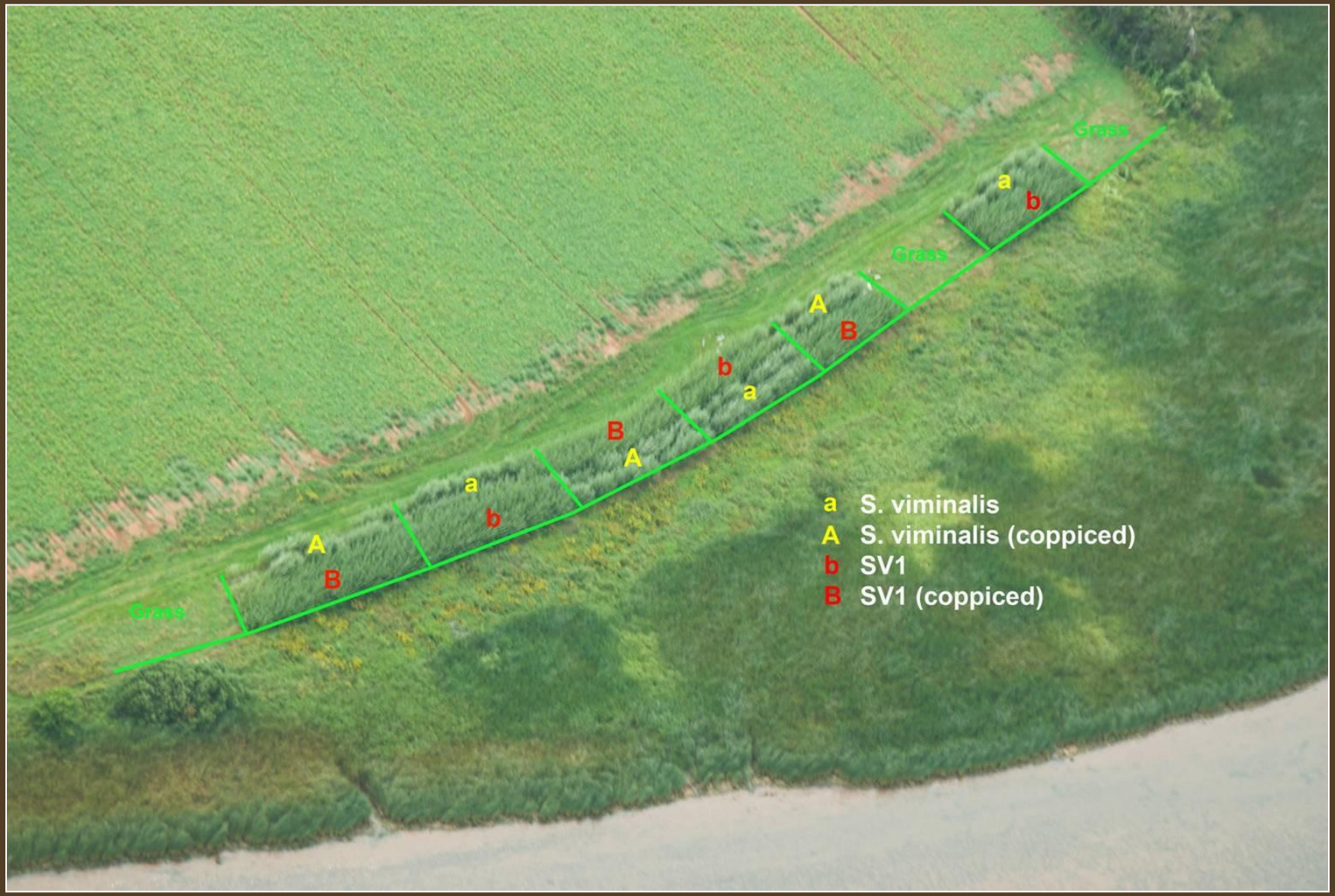
- Focus is on shrub type willows, not the more conspicuous tree willows
- Varieties selected are non-invasive (do not sucker or spread)
- High yielding species that respond to coppicing
- Common biomass willows such as SV1, viminalis, sx61, sx67 performed well here since 2006
- Variety trial at Meadowbank PEI also showed many other varieties that are promising for PEI growing conditions (2008)

Best soil characteristics for SRC Willows

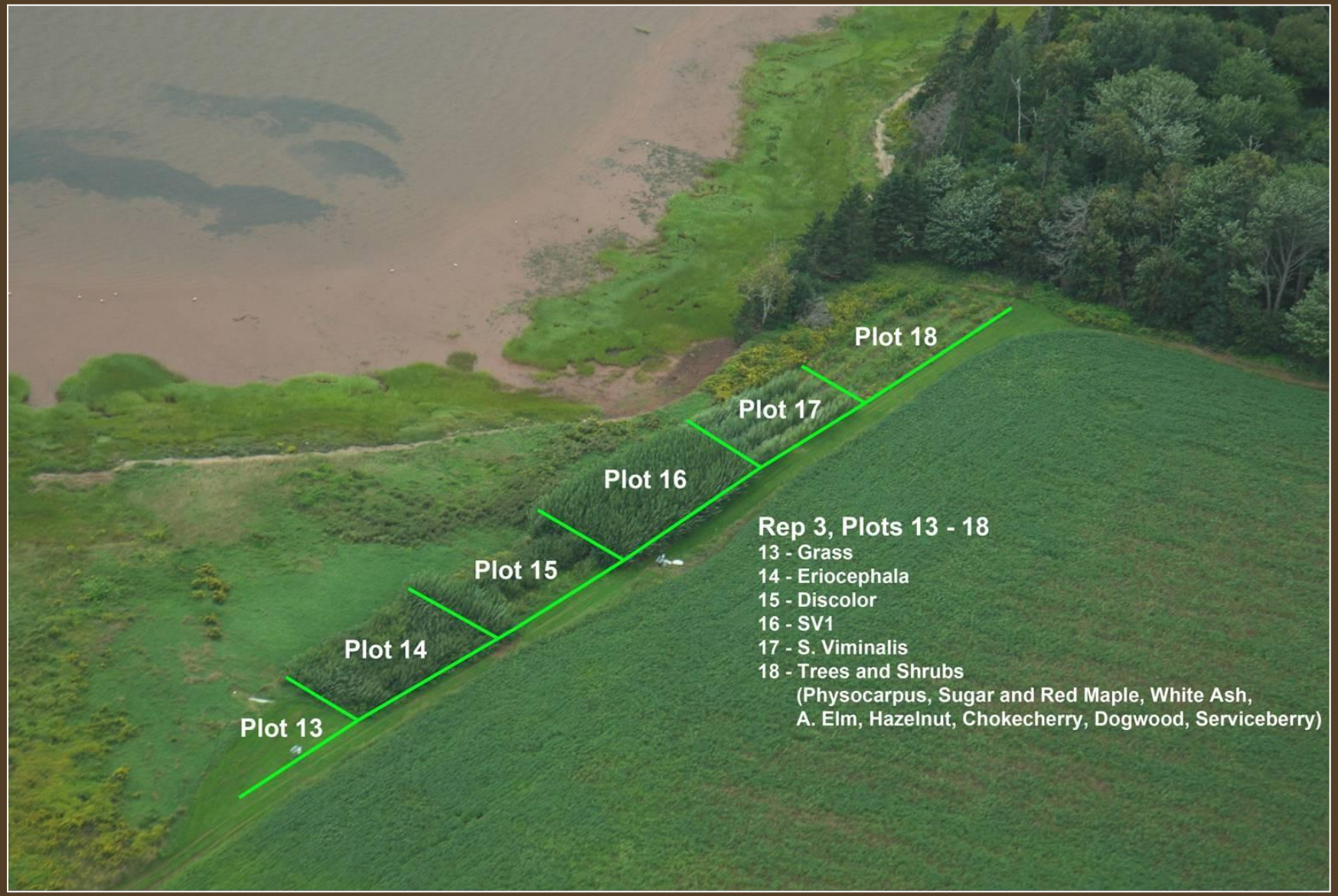
Soil Characteristic	Suitable	Unsuitable
Texture	Loams, sandy loams, clay loams, silt loams, and clay	Sandy, gravel, heavy clay with standing water
Structure	Well developed to single grain structure	Massive or lacking structure
Drainage	Imperfectly to moderately well drained	Standing water
pH	5.5 to 8.5	Below 5.5; above 8.5
Depth	46-cm or more	Less than 46-cm

PEI Willow Demo Sites

Year	Landscape Type	# of sites	Location/Cooperator	Size (ha)
2006	Riparian	4	Wilmot Valley – Willard Waugh and Sons; Meadowbank – Hans Wilting & Hans Hovingh	0.70
2008	Wet spot	1	Maple Plains – Troy Webster and BBEMA	0.5
2008	Riparian	1	Variety trail in Meadowbank – Hans Hovingh	0.3
2008	High slope (6 to 14%)	4	Shamrock – Martin Visser and Sons; Nine Mile Creek – Hans Wilting; and Lynwood Road – Hans Wilting	1.55
			Total	3.05



Willard Waugh and Sons Wilmot Valley



Hans Wilting - Meadowbank

Marginal lands

Maple Plains BBEMA Demonstration Site

Observations To Date

- High Mortality
- Low fertility/Low ph (approx. 4.9)
- Poor drainage/standing water
- Production on marginal lands > cost as inputs (lime, fertilizer) will be necessary

High slope site in Shamrock

Martin Visser and Sons Ltd.

Planting of willows on PEI

- Tillage is performed (30 to 35-cm of loose soil)
- Plastic mulch (1.2 meter wide) installed with a mulch applicator
- 25-cm Cuttings planted at various densities from 4,000 to 12,000 plants per ha
- Between willow rows seeded with 50/50 turf type perennial rye grass and meadow fescue


Plastic mulch applicator
Nine Mile Creek site - North

PEI Buffer Site Establishment

May 2006

Sept. 2007

June, 2006

Sept. 2008

Fertility requirements

- The riparian area sites had suitable nutrient supply – no application of nutrients was required
- The non-riparian sites did not produce as much biomass as its expected potential – fertility trials/ treatments were required
- SUNY-ESF recommends 100 units of N in year 2 only.
- Sites really low on phosphorous and potassium will also require amendments

Maintenance and Management of willows

- Grass was mowed several times in the first two years – weed control is absolutely critical in the first year – after that it will compete effectively over the entire life
- In fall of Year 1, the willows were coppiced to encourage increased multi-stem production

Fall coppicing of willows – Year 1 only

Year 1 Observations

- Cuttings generally sprout shoots within 2 weeks of planting
- Typically saw 95 to 100% survival rate, except some of the non-riparian sites had an issue with the quality and/or vigour of the cuttings with a higher mortality rate as a result

Further Observations

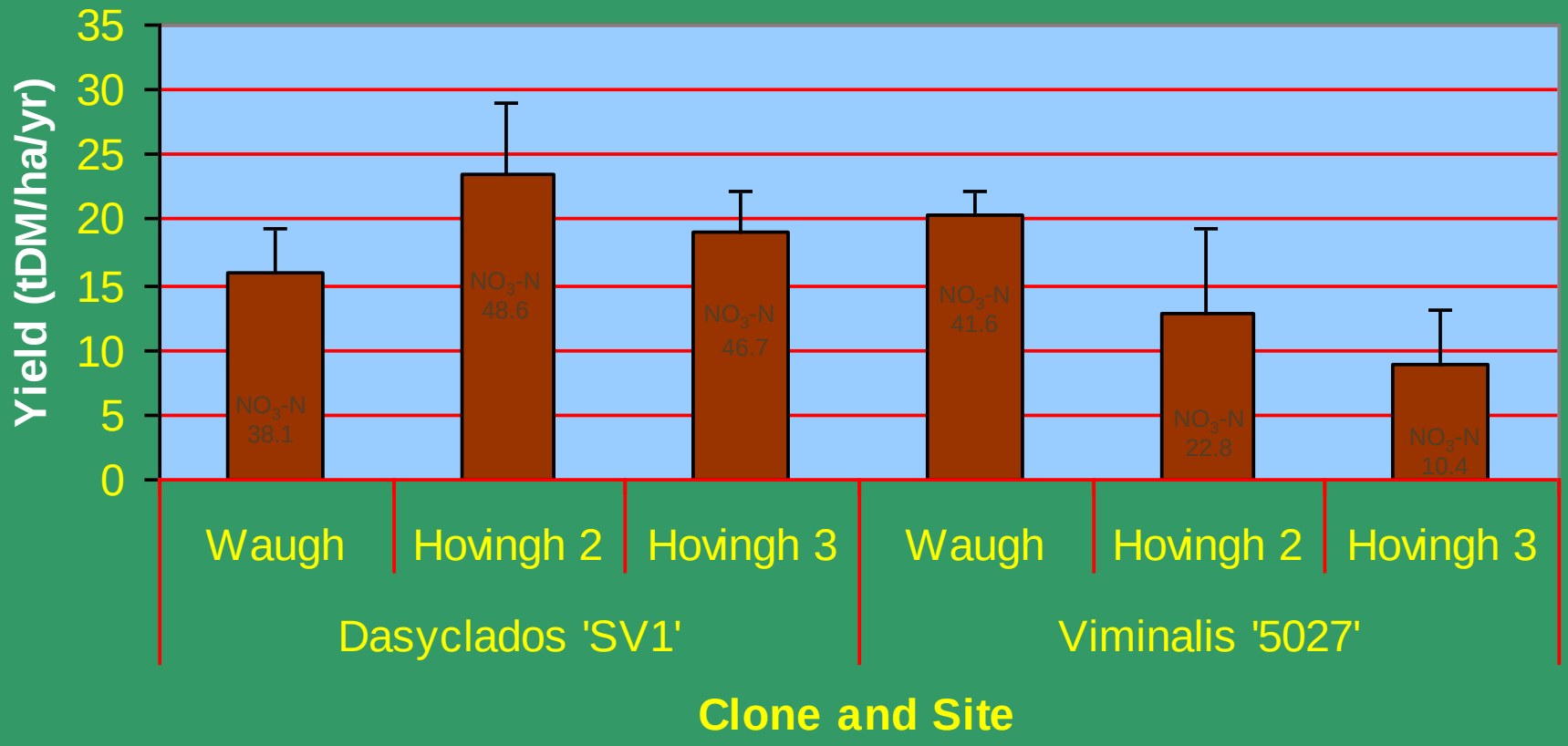
- Willow growth generally impressive .
- No evidence of serious pest or disease issues.
- Growth habit of native material a concern.
- Maintenance requirements in first year significant, i.e. weed control.
- Coppicing after Year 1 appears to improve biomass yield depending on clone

Harvested Plot

December 2009

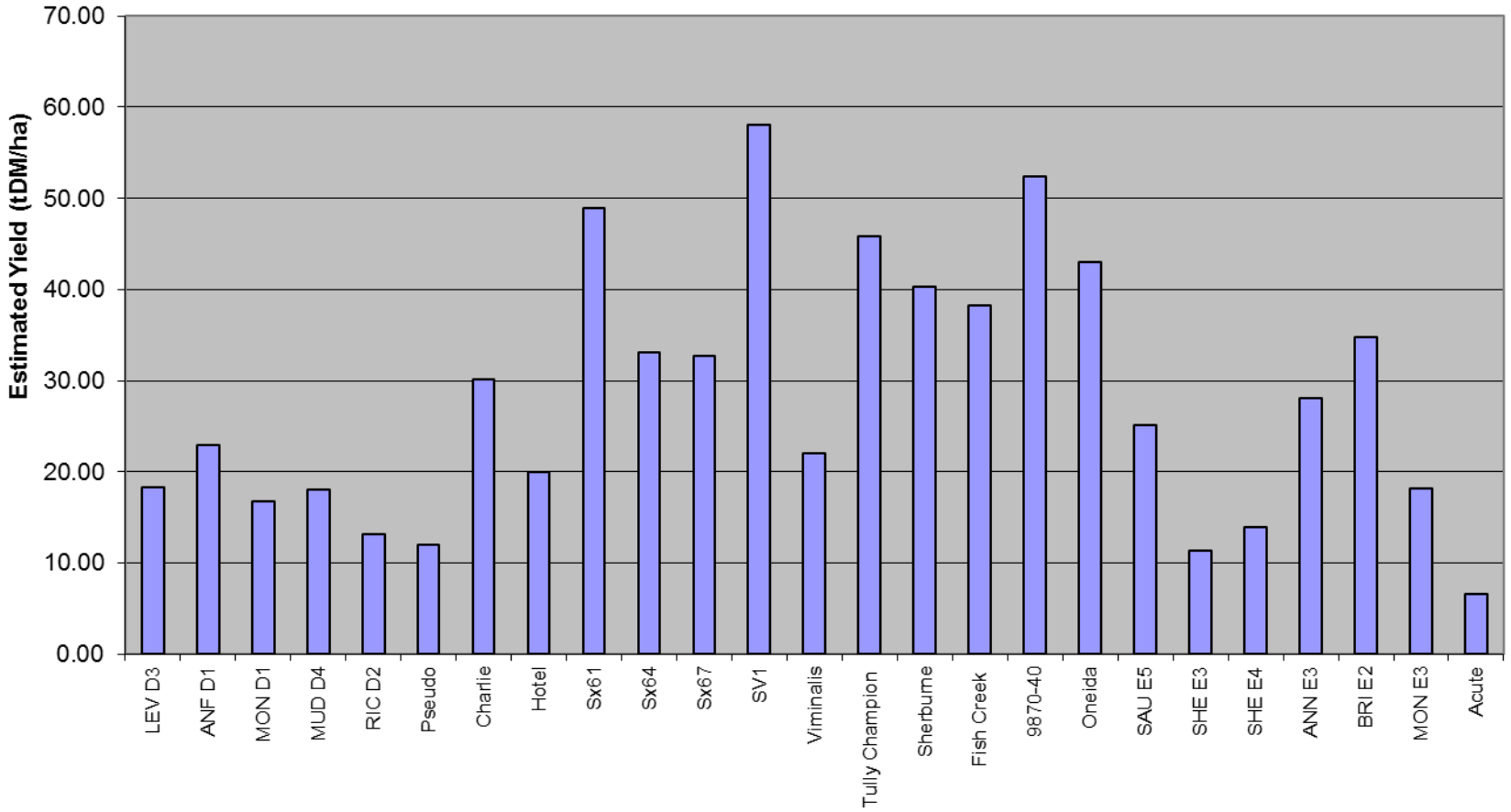
Non-Harvested and Harvested Plots
July 2010

Annual above-ground biomass yield at two sites



Biomass Production - Cycle 1 (2008-2011)

(Data courtesy AAFC-AESB Agroforestry Development Centre)



Harvesting

• PEI Soil and Crop Improvement Association received support from the PEI ADAPT Council and AAFC

• Objective was to explore and demonstrate farm scaled harvesting willow equipment for PEI –

•In 2009 Bruce McCallum of Ensight Consulting performed a literature review and was in contact with companies for possible demonstrations

•In 2010 AAFC STB purchased a JF 192 willow harvester from Denmark. Evaluation of equipment performed by Lowell Stevenson, a Forestry Consultant from Colville Road near New Haven

Evaluation of Farm Scaled Willow Harvesting Techniques for PEI

- Full report and fact sheet are both available on-line at www.peiscia.ca and click on Fact Sheets and Reports and then Agroforestry
- Fact sheet available today at booth display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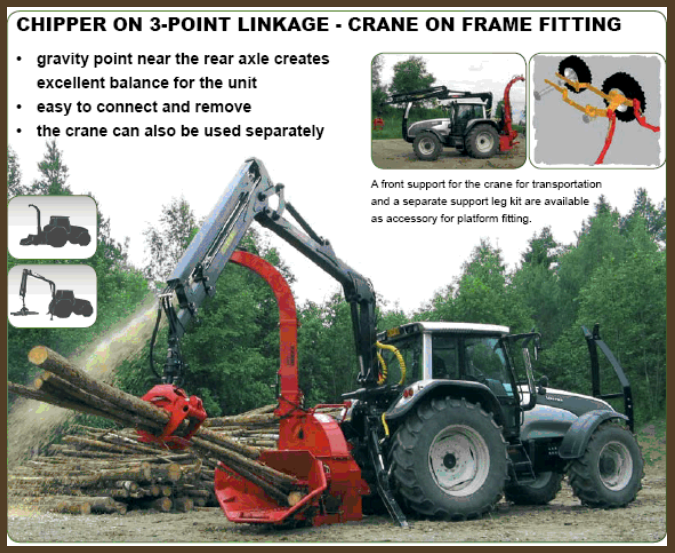
Bender – cut and chip harvester

Coppice Resource Limited header to fit CASE NEW HOLLAND FX SERIES forage harvester

Claas – cut and chip harvester

Ford New Holland Forage Harvester

Naarva Grip harvester



JF 192 harvester
Evaluated fall of 2011

Specifications of JF 192

- Procured in 2010 by AAFC; $ 35,000 (2010 $)
- Manufactured as a forage harvester in Brazil and modified into a willow harvester in Denmark by Ny Vraa Bioenergy
- Single row unit operates 2 to 5 km/hr; 0.5 ha/hr
- Operated by a 100 to 150 hp farm tractor with 3-pt hitch; 540 rpm PTO
- Designed to harvest multi stem willows with a maximum stem diameter of 5 to 6 cm

Evaluation results of JF 192

- Suitable size and price for PEI, especially for multi-farm ownership or custom work
- Processed stems up to 6 cms; best efficiency 3 to 4 cm diameter stems
- Wearing of coppice blades needs to be explored further – not experienced by Ny Vraa
- Willow stump shattering did occur but no negative effect on plant re-growth the year after
- Wood chip size/shape worked well in one furnace trial

Wear on coppice blades on JF 192

Stumps after harvesting with JF192

Willow re-growth August 2012

Site harvested December 2011 with JF 192

High slope site Lynwood Road
Hans Wilting farm

Additional products from Ny Vraa

JF Z200 Hydro E

JF 292 Available fall 2013

JF 192 is still available

Thank you!

Questions?