

Jerusalem artichoke as a platform for inulin, ethanol and feed production in Canada

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Biology of Jerusalem artichoke



- Native to North America from the Composite family
- Forms tubers
- Deep root system
- Annual/Perennial



Why Jerusalem artichoke?

- ❑ Not a designated food crop
- ❑ High biomass yield of soluble sugars
- ❑ Low input and production cost
- ❑ Adapted to marginal lands
- ❑ Perennial crop

ARC Research:

Agronomic studies



June 12

- ✓ Cultivation practices (seeding, harvesting)
- ✓ Fertilization (mineral vs. organic)
- ✓ Soil requirements
- ✓ Post-harvest storage



Sep. 9

JA Cultivation

Planting



Hilling



Digging



Similar to potato production
with slight or no modification of
farm machinery





ARC Research:

New cultivar development

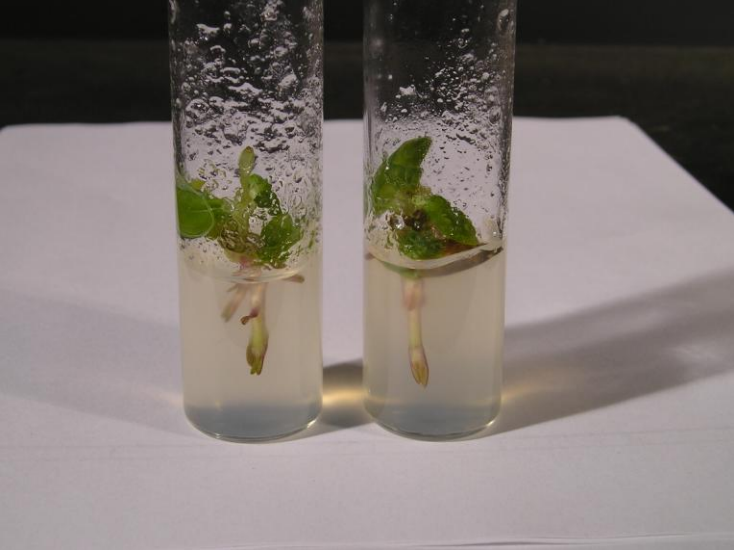
Cultivar evaluation:

- 42 genotypes in our collection

New varieties:

- Exclusive rights to two cultivars in North America
- Mutation breeding to increase sugars in stems
- Transformation and genetic engineering





ARC Research:

Production of seeding material

- **In-vitro propagation**
 - Identification and optimization of general and cultivar specific growth conditions:
 - media composition (carbohydrates, hormones)
 - temperature
 - light regimes
 - size of the primary explants

Minituber production



Tubers generated using tissue culture approach are being tested in field



Yields (t/ha) of JA tubers in Vegreville

Cultivar	Potential	Achieved
Albik	24-34	18-26
SW	22-30	22-24
Rubik	23-31	18-22





Yield of stems (t/ha) at Myrnam

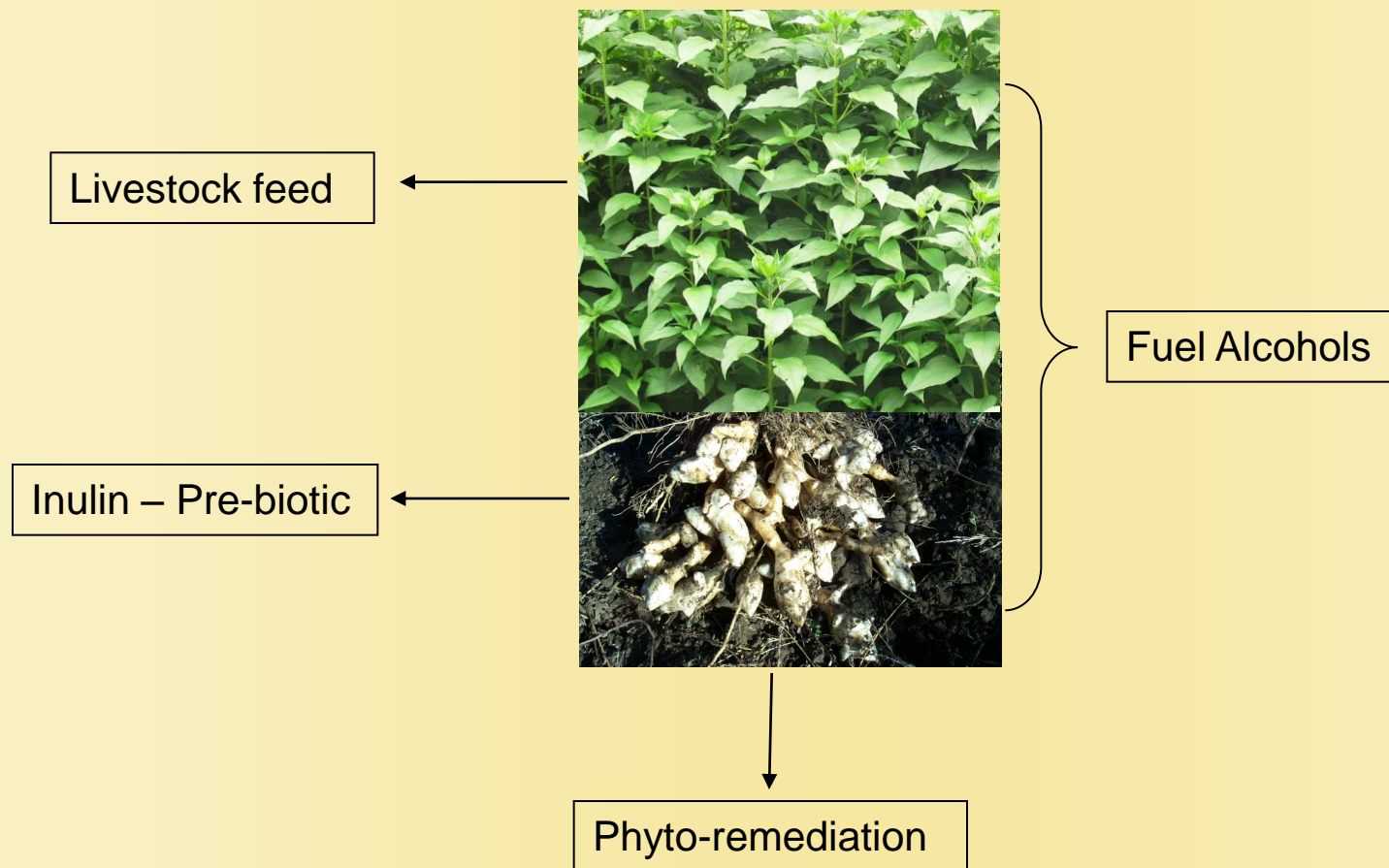
Cultivar	Fresh	Dry
OL	120	30
SW	48	15

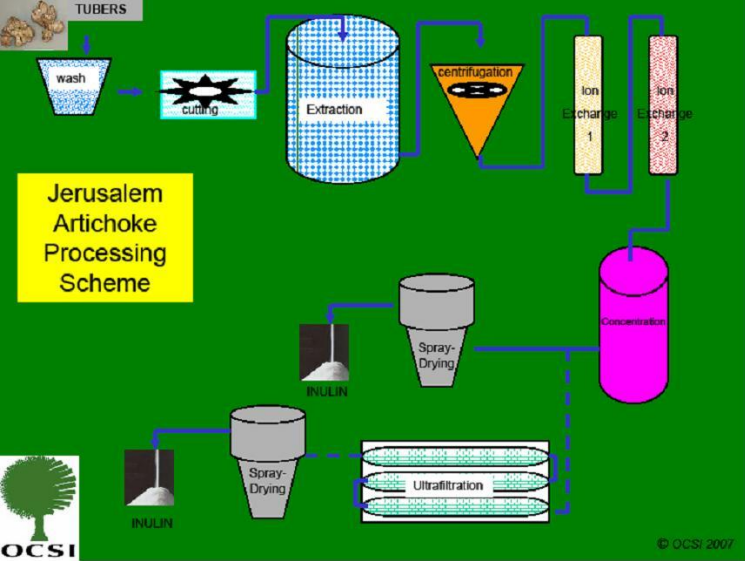


JA – A multi-product crop



The Many Paths of JA

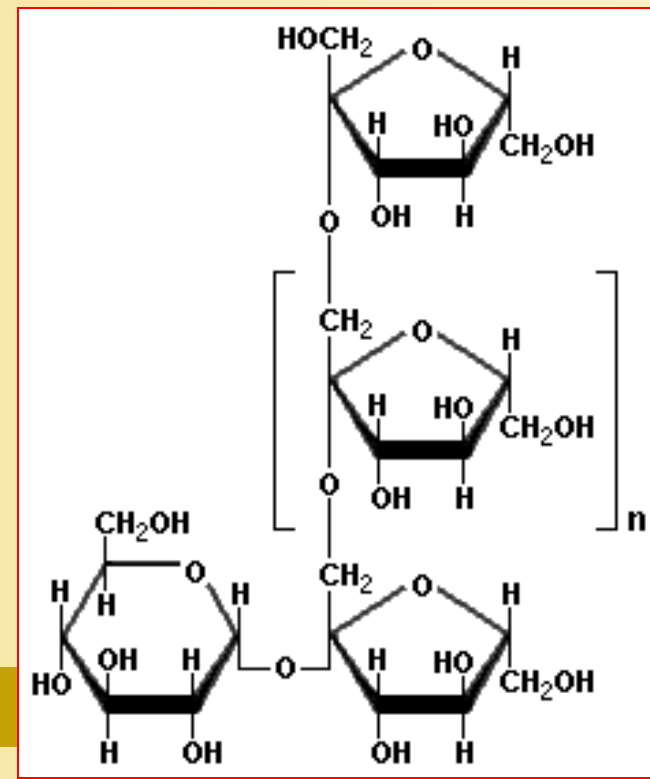




ARC Research:

JA inulin extraction and purification

1. Inulin as functional food health promoting & disease preventing properties
2. Naturally-occurring storage carbohydrate containing non-digestible fructooligosaccharides (FOS).
3. Degree of polymerization (DP) of the inulin chain indicates the amount of fructose molecules attached to glucose moiety.
4. The bond between fructose units in inulin is a β -(2 \rightarrow 1) glycosidic linkage.



Health benefits of inulin

- Helps in weight management (soluble fibre)
- Anti-microbial properties
- Reduced risk of cardiovascular diseases (lipid metabolism)
- Anti-carcinogenic properties
- Reduced risk of osteoporosis
- Lowers blood sugar in Type II diabetics

Food products containing inulin



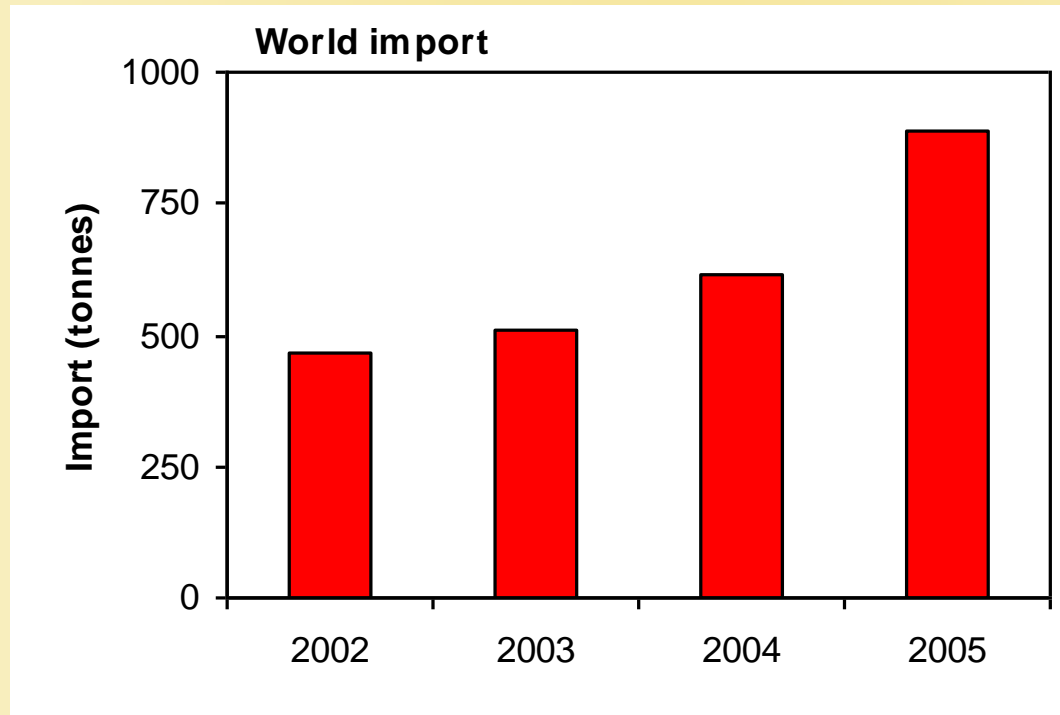
- Yogurt
- Power bars
- Beverages
- Breakfast cereals
- Butter
- Candies
- Chocolate
- Ice cream
- Diabetics sugar

In supplements



Also in animal feed

Inulin market

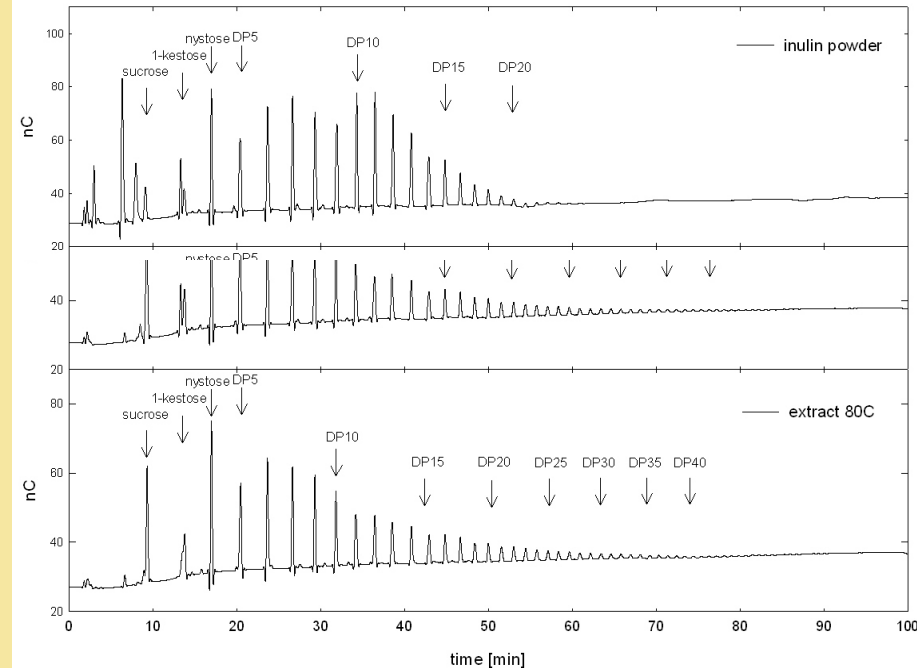


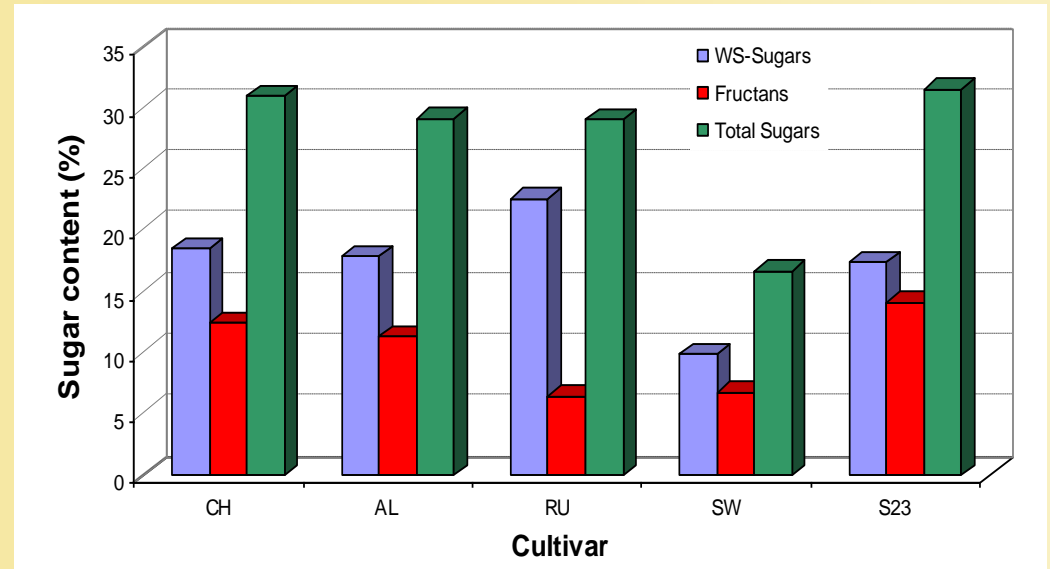
N. America – 2003 market value \$ 500 M,
projected \$2.6 B by 2010

Quality of ARC's JA inulin



- JA inulin is chemically identical to commercial chicory inulin.
- Our test results suggests that JA inulin exhibit a comparable biological function to chicory inulin





Water extractable carbohydrates in stems of JA

- Fresh and dry stems are rich in sugars
- Easily fermentable to fuel alcohols
- Above ground biomass are good forage for livestock



Comparison of average ethanol yield from different crops

Crop	(L/ha)
Jart stalks (Alberta)	3400
Jart stalks + tubers	5000
Corn (Canada)	3100
Wheat (Canada)	1500
Barley (Canada)	800
Sugar beets (USA)	4000
Sugar cane (USA)	5000

JA as livestock feed

Feeding value and forage quality characteristics of Jerusalem artichoke tops and tubers and other selected forages

Forage	Dry matter	Total digestible nutrients	Digestible protein	Crude protein	Crude fibre
	%				
Jerusalem artichoke tops	27	67	3	5	18
Jerusalem artichoke tubers	21	78	6	10	4
Alfalfa, full bloom	91	53	10	14	35
Smooth brome, post bloom	94	46	2	6	33
Corn silage	29	70	5	8	22
Beet pulp	91	75	5	10	21

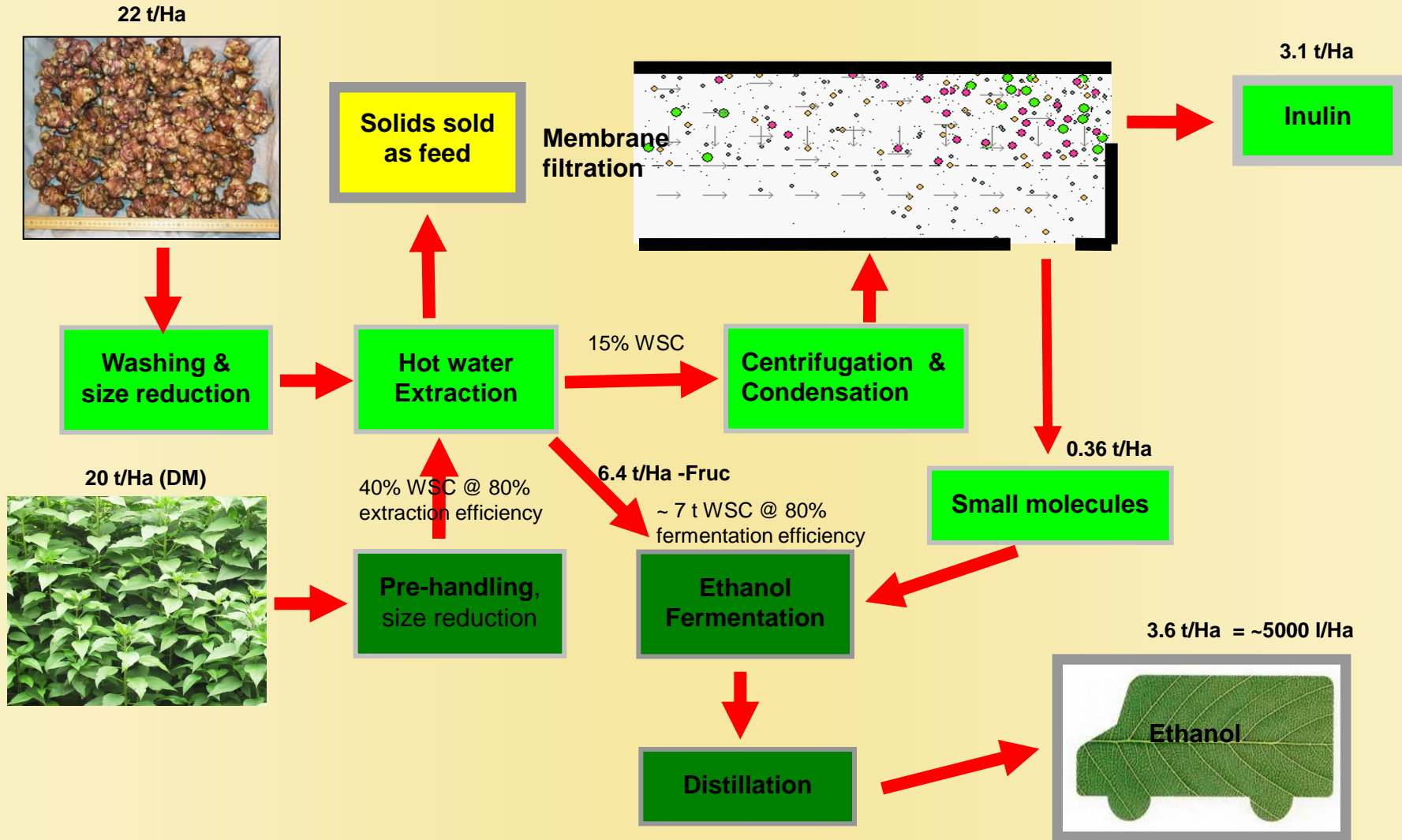
JA is similar to corn silage in feed value

(Source: Cosgrove et al. - www.hort.purdue.edu/newcrop/afcm/jerusart.html)

JA Biorefinery concept

- Whole crop utilization – zero waste concept
- Increase economics and profitability
- Improve the value derived per hectare
- Stimulate economic activities in rural communities
- Enhance sustainability

JA Biorefinery - Inulin, fuels and feed



Next steps

- Pilot-scale demonstration of plant biorefining process
- Improve process efficiencies & economics
- Study scale up potential
- Make products for 1st commercial sale

Scale-up production estimates

- Pilot plant – 1,000 tonnes tubers
capacity (requires ~ 40 Ha, 150 tonnes of inulin, 240 tonnes WSC
– ~150,000 liters ethanol)
- Pilot plant – 10,000 tonnes tuber
capacity (requires 400 Ha, 1500 tonnes of inulin, 2400 tonnes
WSC, 1.5 million liters of ethanol)
- Small commercial plant 50,000 tonnes
tuber capacity (requires 2000 Ha, 7500 tonnes of inulin,
12,000 tonnes of wsc, 7.5 million liters of ethanol)

- ❖ Our economic and market analysis shows a positive NPV for stand alone or a co-located inulin facility suggesting that capital investments in an inulin production plant in Alberta will be a profitable venture.
- ❖ We estimate 5 years Internal Rate of Return (IRR) to range from 10 to 30% and payback period of 4 to 5 years depending on plant location and value of by-products.
- ❖ We are interested in partnering with those interested in JA bio-refining business in Alberta Canada.

Acknowledgements

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THANK YOU

