

Implementing an IBLC in an agroindustry in the grain-milling sector in Sweden

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www.agroinlog-h2020.eu



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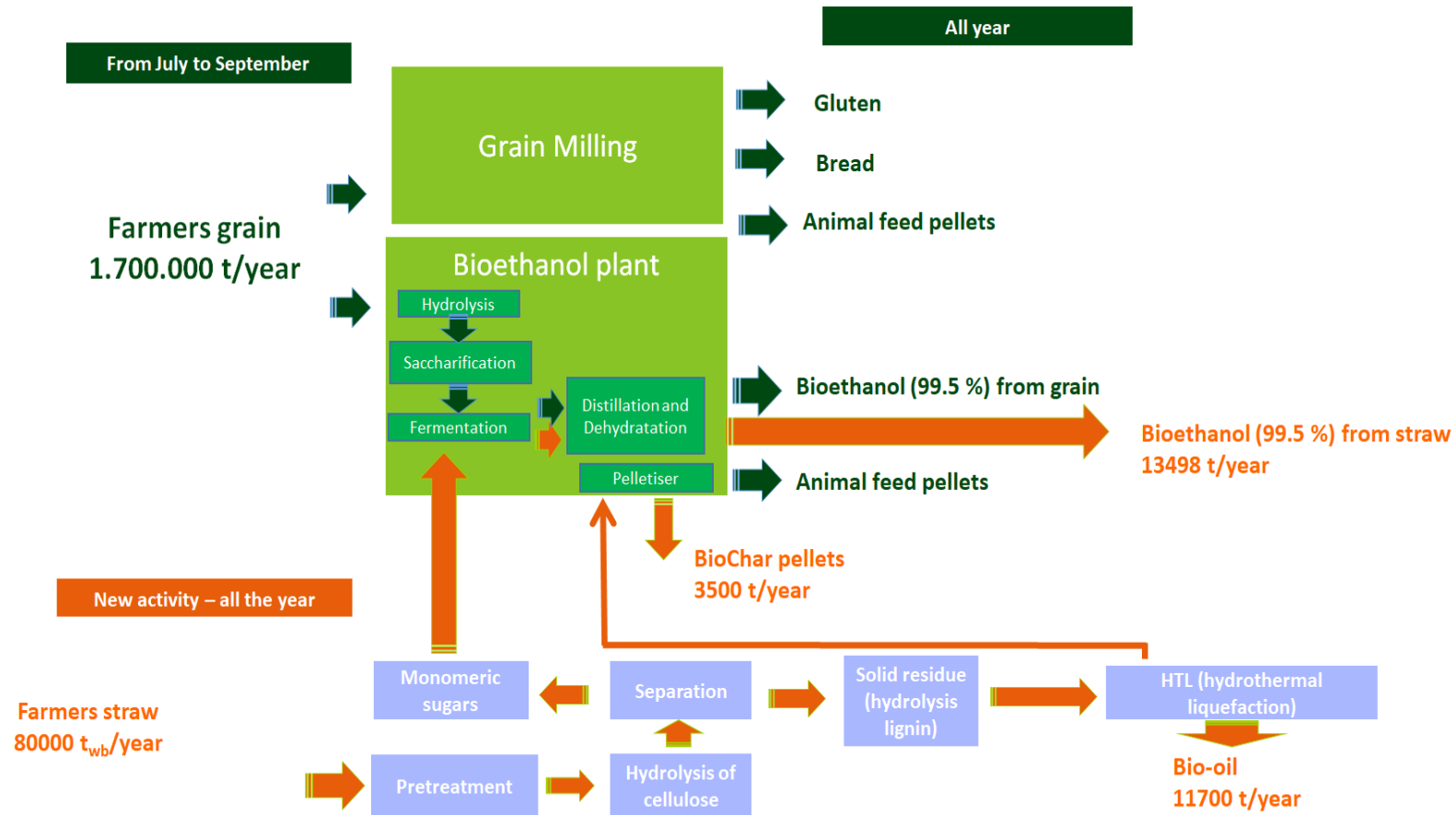


Lantmännen

- Lantmännen – Swedish cooperative, owned by 20,000 farmers.
- 10,000 employees
- Turnover: 4 billion € (2019)



The studied demo – integrating production of advanced biofuels in a 1G biorefinery

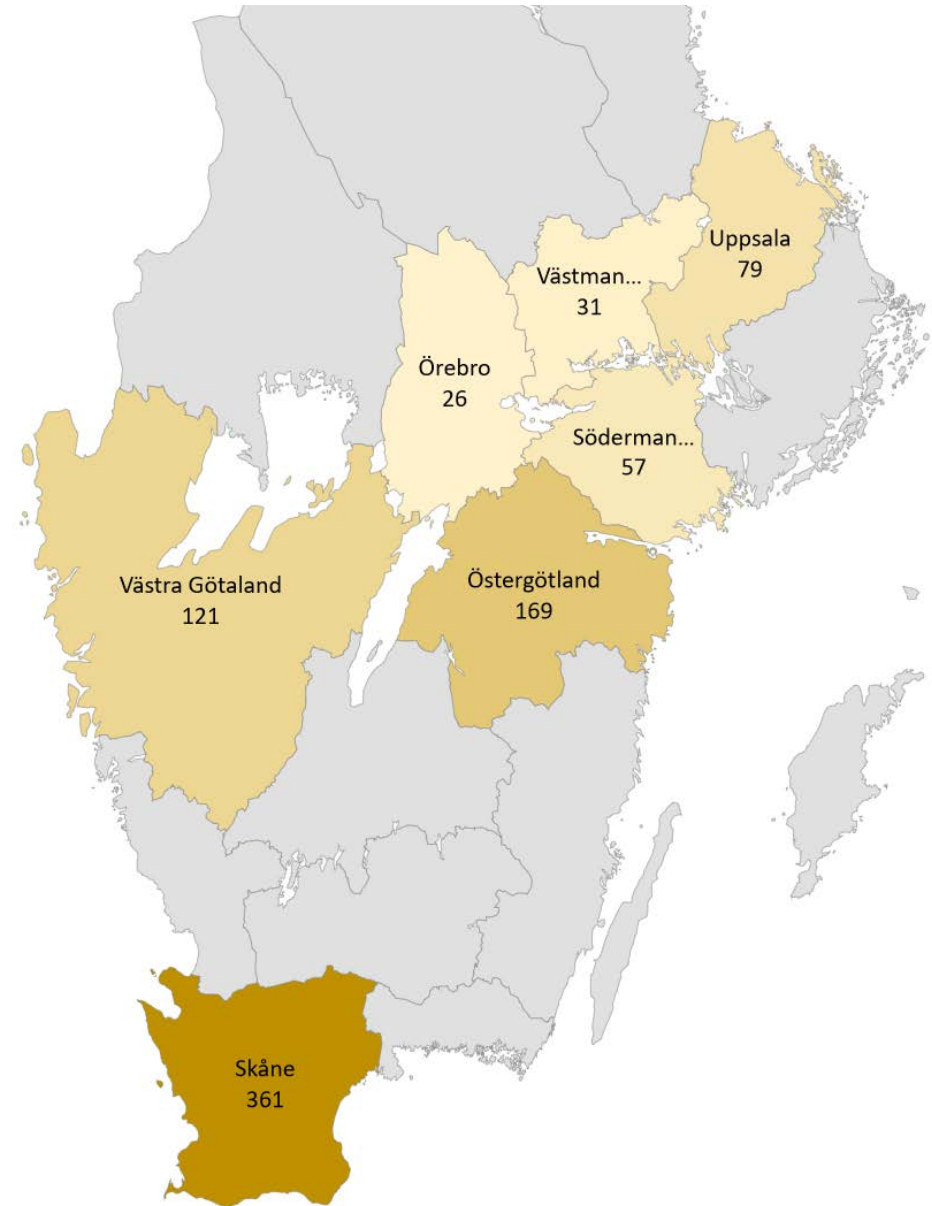


- 80,000 tonnes winter wheat straw to Lantmännen Agroetanol in Norrköping based on:
 1. Supply from surroundings of Norrköping (3 counties)
 2. Supply from another county in Sweden (Skåne)

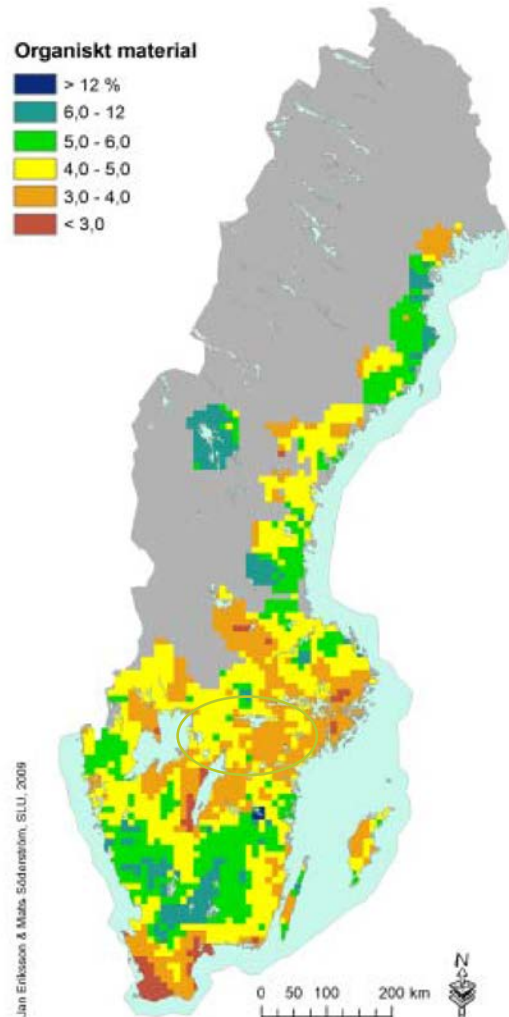
The background features a dark gray circle. A thick, lime green arc starts from the top right and curves around the bottom left, partially overlapping the gray circle. The text "Securing the raw material supply" is written in white, sans-serif font, centered horizontally within the gray circle.

Securing the raw material supply

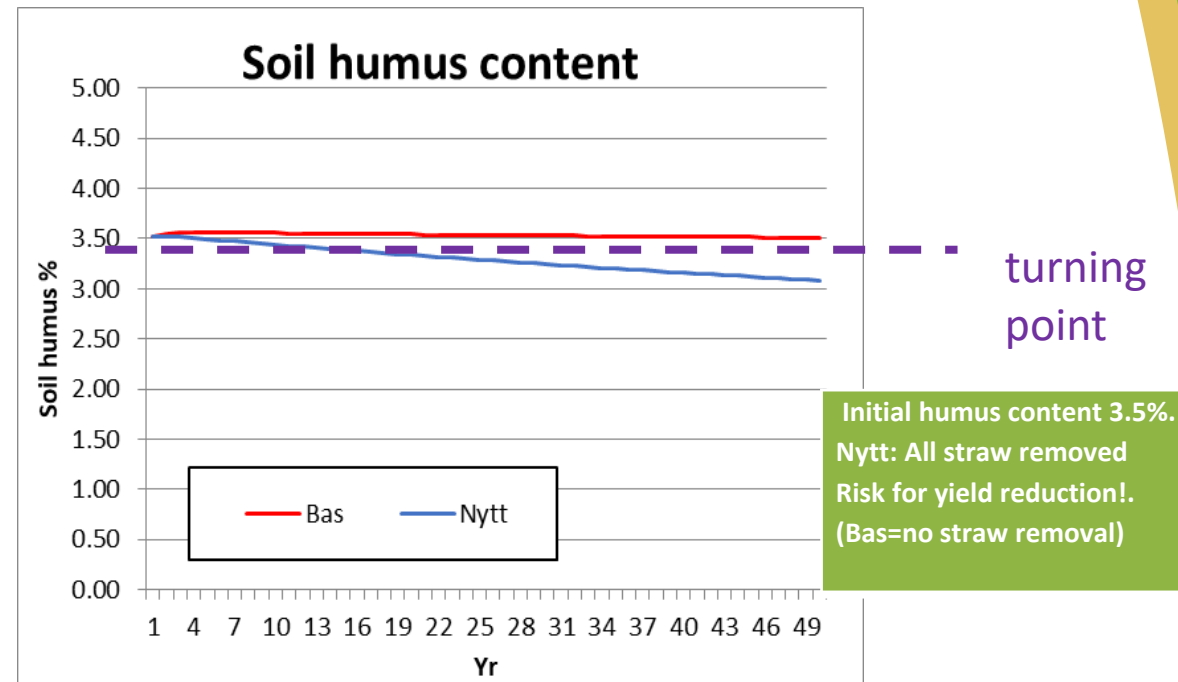
Winter wheat straw potential in Sweden



Sustainable straw supply



- Sustainable = no decrease in soil fertility, i.e. no negative effects on yield level in a 50- year perspective
- Used model “Odlingsperspektiv” based on field trials



Sustainable straw potential

Winter wheat straw annually available for removal

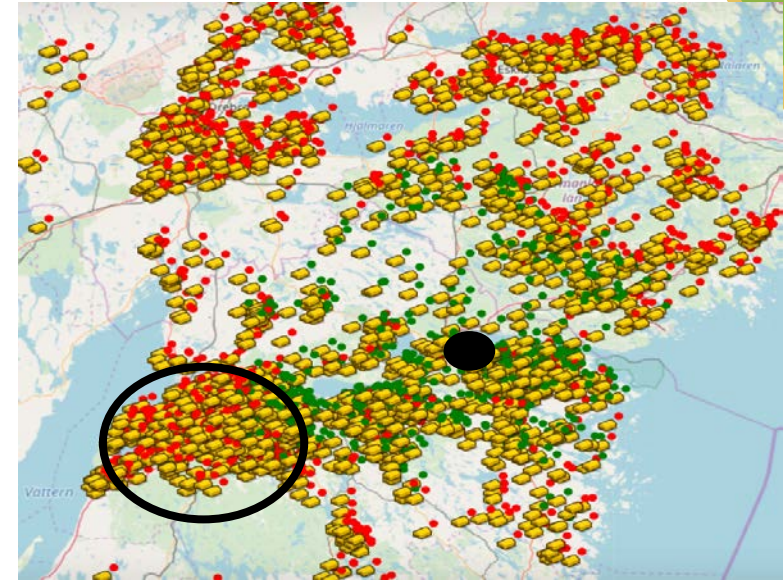
	Total straw resources	Resources at arable farms		Possible to take out	
County	tonnes ^A	% ^B	tonnes	% ^C	tonnes
Östergötland	196,465	70 %	137,525	100 % (+)	137,525
Södermanland	75,538	80 %	60,430	100 %	60,430
Örebro	39,037	80 %	31,230	100 % (+)	31,230
Total Norrköping area	311,040		229,186		229,186
Skåne	435,732	80 %	348,585	0 %	0

Compensations measures needed!

Modelling of the demo case supply chain

Assumptions

100% of the sustainable winter wheat straw on arable farms was available for ethanol production,
Straw used for feed and bedding in animal production was covered by the cereal production on animal farms



Compilation of results for the scenarios per selected farmer

Scenario	No. selected farmers	Maximum distance (km)	Supply cost (€/tonne)	Sold quantities per farmer (tonne)
0. Base	489	61	90.5	163
1. Drought	588	70	91.9	135
2. Unfavourable w.	645	74	93.3	123
3. Hub Vadstena	274	115	120	282

Harvesting trials

The background features a large, dark gray circle that occupies most of the frame. In the bottom-left corner, there is a lime green shape that curves upwards and to the right, partially overlapping the gray circle. A thin white line separates the green shape from the gray circle.

Three harvesting trials performed during the project

Aim of trial: Evaluate if total amount of harvested biomass can increase by incorporating chaff into the straw swath



Uppsala area

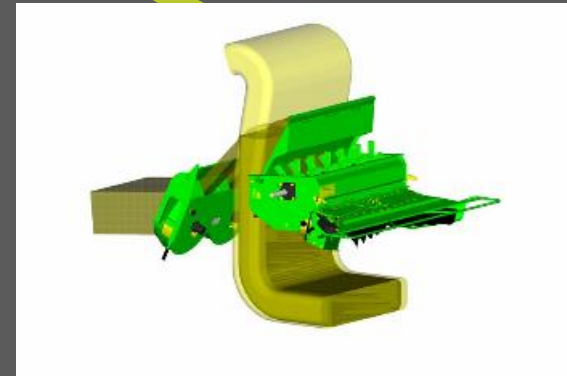
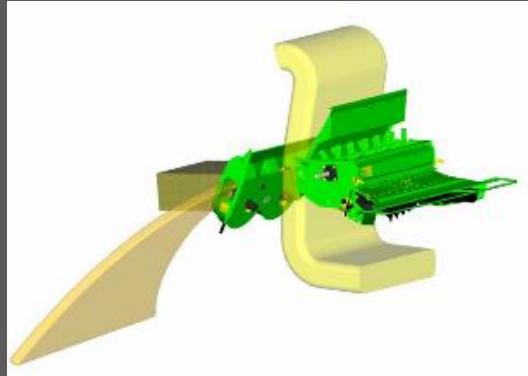
- ✓ Hybrid vs traditional harvester with and without chaff collection

Halland

- ✓ Traditional combine with Thierart technology

Combined harvest of straw and chaff

– Vansta, Uppsala 2017





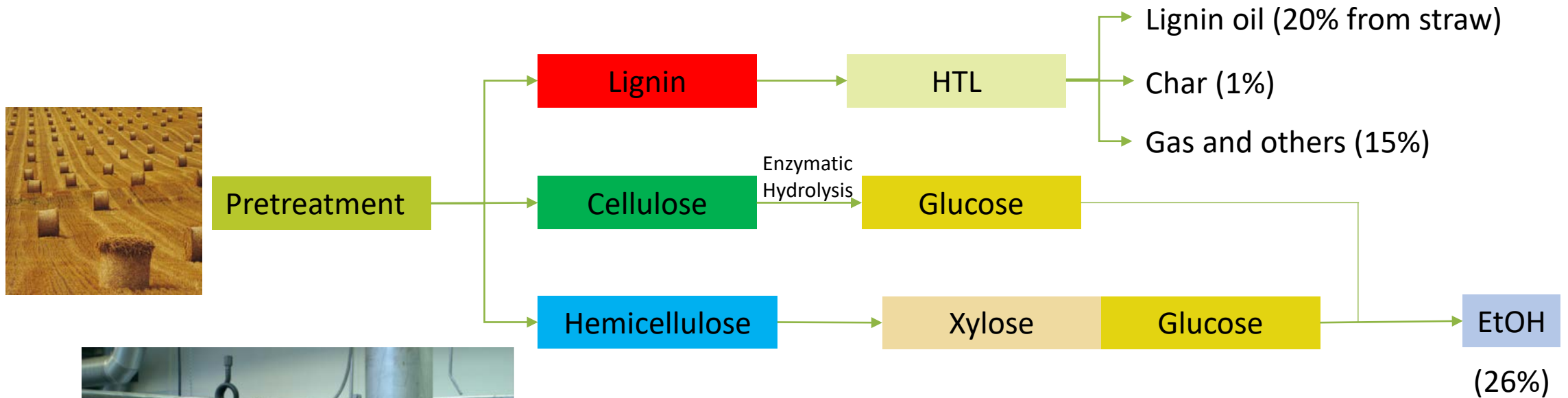
CREA-IT- Research Center for Engineering and Agro-Food Processing

Results of harvest trials

Straw and chaff recovery in bales				
	<u>kg DM (dry matter)/ha</u>		<u>Difference</u>	
Year	Control	Incorporated	kg DM/ha	%
2017	2,430	2,770	340	14.0
2019	4,773	4,899	126	2.6

Production of advanced biofuels

Overall process diagram

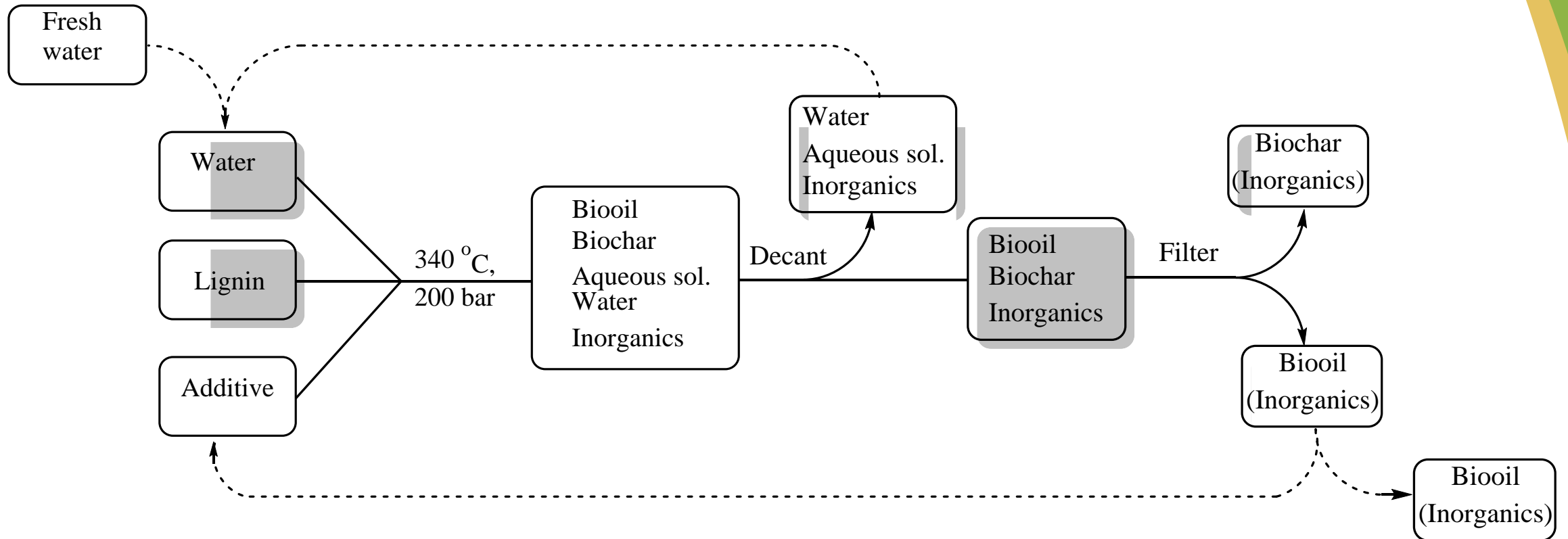


HTL

- Hydrothermal Liquefaction, biomass into biooil (biocrude)
- High temperature ($>300\text{ }^{\circ}\text{C}$) high pressure ($>150\text{ bar}$) near supercritical or even supercritical water conditions
- Performed in aqueous solution/slurry
- Short reaction times ($< 1\text{ hour}$)
- An HTL-pilot plant has been built during the project.



HTL Process: Strategy



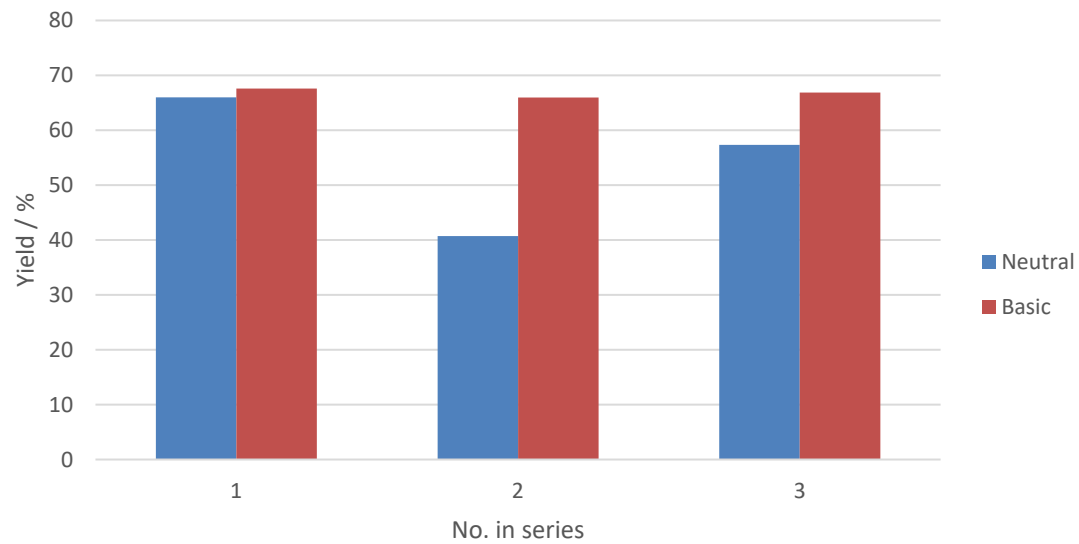
Operation of continuous HTL pilot

- Has been in operation for approx 100 runs
- Processes 0.5-1.5 l slurry per hour, selected examples below

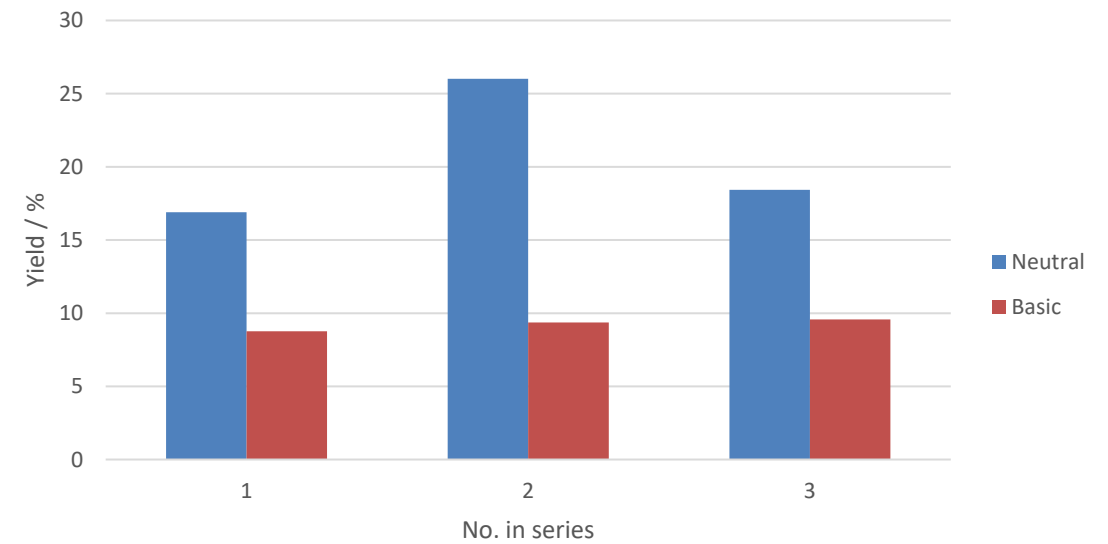
	V' ml·min ⁻¹	NaOH	UCO	collection h	Y (Char) %	Y(Oil) %	HHV MJ/kg	Ash g·L ⁻¹	TOC g·L ⁻¹
1	22.1	0	12%	2.45	16.9	66.0	35.0	3.7	16.7
2	20.38	0	12%	2.91	26.0	40.7	32.9	5.3	21.3
3	20.76	0	12%	2.92	18.4	57.3	36.2	6.2	27.0
4	24.47	2%	0%	2.43	14.8	39.0	29.2	33	22.3
5	24.41	2%	12%	2.68	8.8	67.6	36.1	27	24.4
6	25.22	2%	12%	2.83	9.4	66.0	34.0	39	37.4
7	24.49	2%	12%	3.05	9.6	66.9	34.4	45	41.9

Recycling produced biooil

Oil Yields



Char Yields



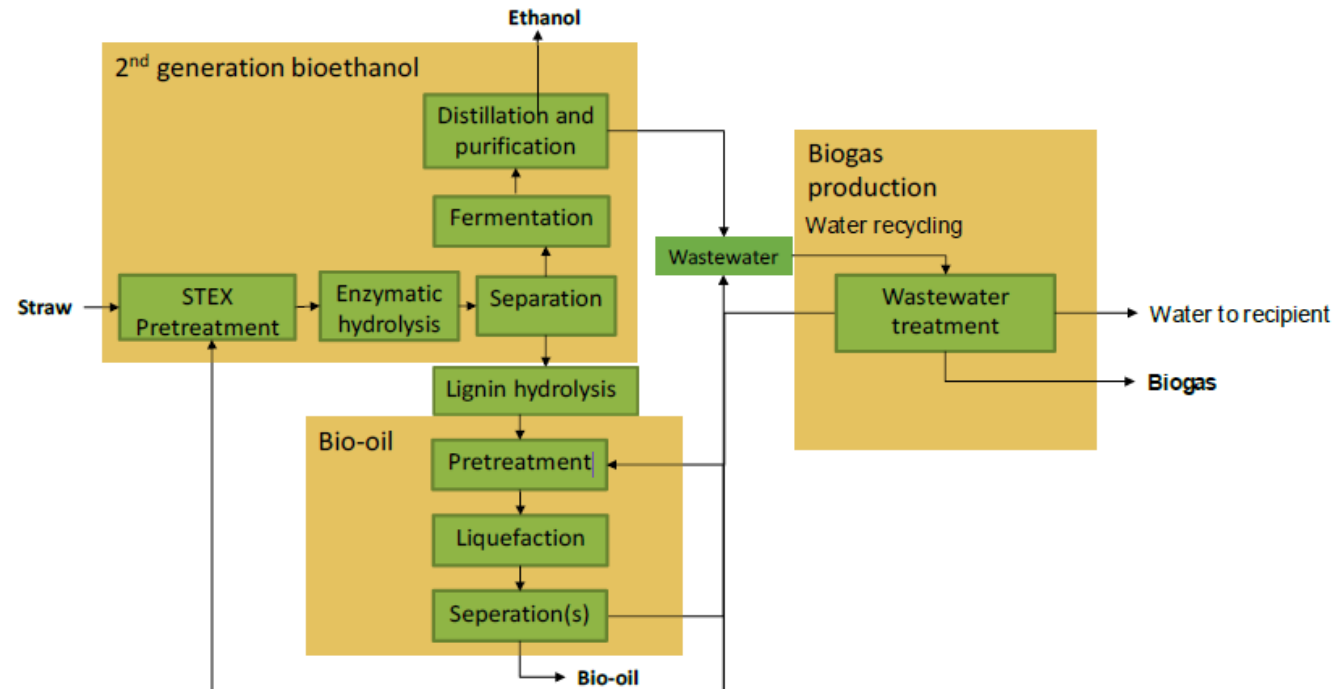
Potential applications for HTL-biooil

- Biooil
- Marine transport
 - Two types:
 - Heavy distillates fuels (mainly used for large vessels and longer distances)
 - Light distillates (mainly used for short distance, small-medium vessels)
- **Additive for asphalt**
 - Crude Biooil could improve asphalt properties and reducing paving cost
 - Crude Biooil is a renewable source that can be blended in bitumen
- Previous work indicates that bio-oil reduce the stiffness mixes
- Market price for Bitumen 355 EUR/ton (April 2019).
- Market potential in Europe 22 Mt/year

To sum up...

Business case findings

- ✓ Wasterwater treatment is needed → biogas production.
- ✓ Three bioproducts :
 - ✓ 2G bioethanol
 - ✓ HTL-biooil
 - ✓ Biogas
- ✓ Increased the value stream on lignin; from CHP to potential biofuel-oil.



Lessions learned

- Regarding straw potential and capacity to harvest and handle straw, it is possible to supply the Swedish demonstration case in Norrköping with 80,000 tonnes.
- Lantmännen has good IBLC preconditions to widen its current business model with production of second-generation ethanol.
- Lantmännen can produce ethanol from straw and has successfully learned to produce biooil with high yield from the lignin fraction remaining after ethanol production.
- There are a wide range of possible markets and applications for the biooil. For most applications, however, the biooil needs to be upgraded to some extent.