

Integrated Protein and Feedstock Recovery from Fermentation Process Co-products

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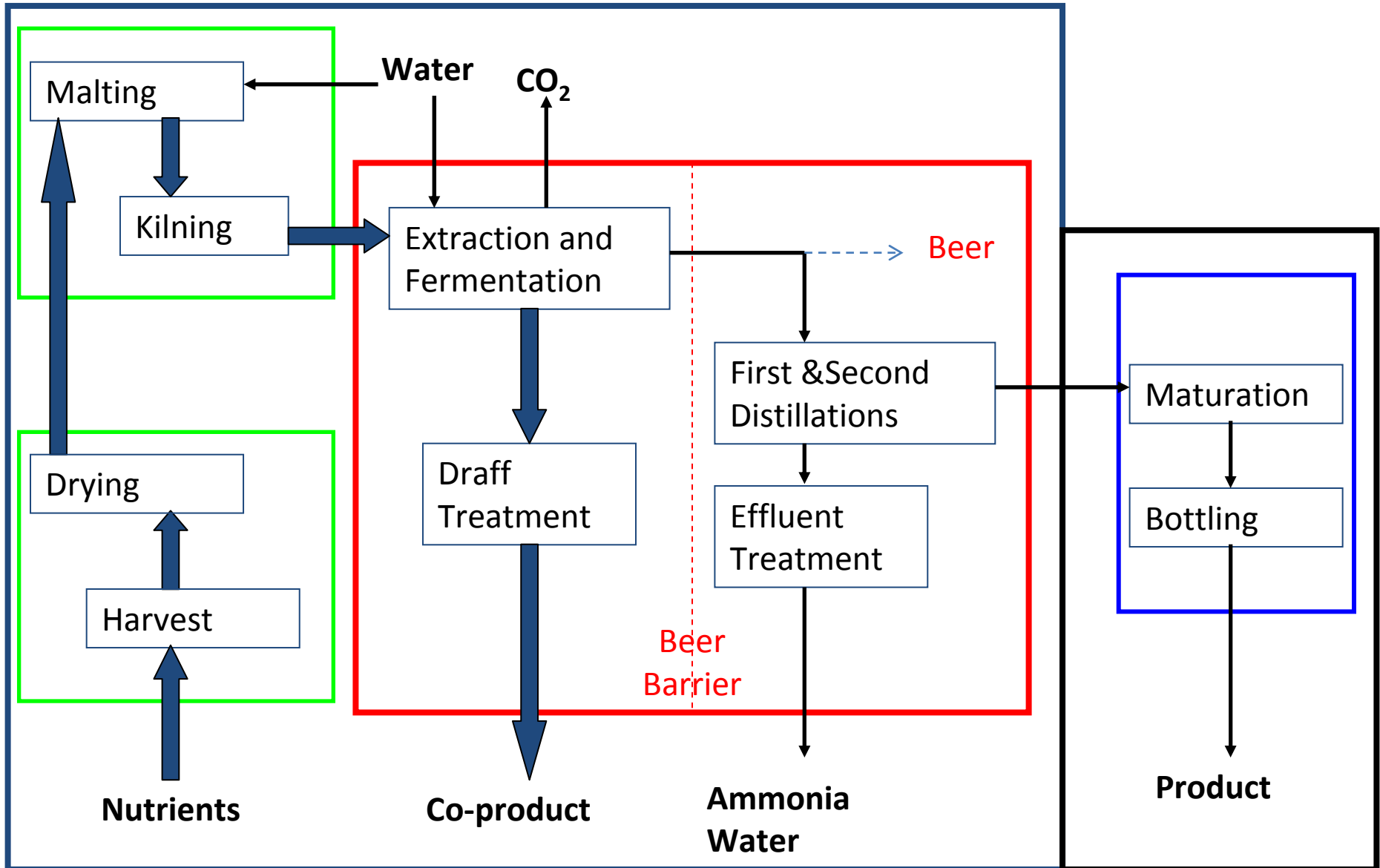


International Synergies
industrial ecology solutions

Knowledge
Transfer
Network

Environmental
Sustainability

Scope & Boundaries



Co-Products from Beer and Whisky

- Draff: grain solids left after starch and enzyme extraction
- Dregg: solids from wort boiling in beer production, denatured protein
- Spent Yeast: post fermentation, may be combined with draff if all-in fermentation
- Chilled screenings: precipitated solids after chilling mostly in lager process
- Pot ale: residues from first distillation in Malt whisky, yeast debris, protein, unfermented carbohydrates
- Spent Wash: pot ale equivalent from grain distilling, may contain
- Carbon dioxide

Product, Feedstock or Fuel

- Products:
 - Direct competition with established entities
 - Established Specifications
 - ‘Tail wagging donkey’
- Feedstock:
 - Fit in with established product chain
 - Simpler specifications
- Fuel:
 - Fall-back position

Established Products and Feedstocks

- Tannins – cider and wine
- Animal foods – DDGS
 - energy intensive
 - low value, competitive, decreasing market
- Plant protection – eg slug repellent
 - small, niche market
- Pharmaceutical Auxiliaries – maleates
 - very pure, low tonnage
- Lactic Acid – food additive, plastics
- Gases and solvents – secondary bacterial fermentation
 - Methane
 - Butanol and higher alcohols
 - Dehydration to alkenes -> alkylation, polymerisation -> gasoline, kerosene, diesel, rubber
 - Acetone
 - CO₂

Protein: Problem or Product

- In pot ale or spent wash:
 - Fouls heat exchangers
 - Generates ammonia in treatment
 - Aquatic toxicity
 - Generates H_2S in treatment
 - Contaminates methane
- In draff
 - In combustion yields SO_2 and NO_x
- As a Product
 - Significant value if quality is right

Limitations

Legal Definition of Scotch Whisky:

- Produced at a distillery in **Scotland**
- From only water, yeast and malted barley and other cereals (the grain **the whole grain** and nothing but the grain)
- Matured in an excise warehouse in **Scotland** in oak casks for at least **3 years**
- **No additives** other than spirit caramel
- **“Traditional”** methods
- Single malts *must* be bottled in Scotland from 2012

**Tampering with a malt whisky is
like painting a moustache on the
Mona Lisa**



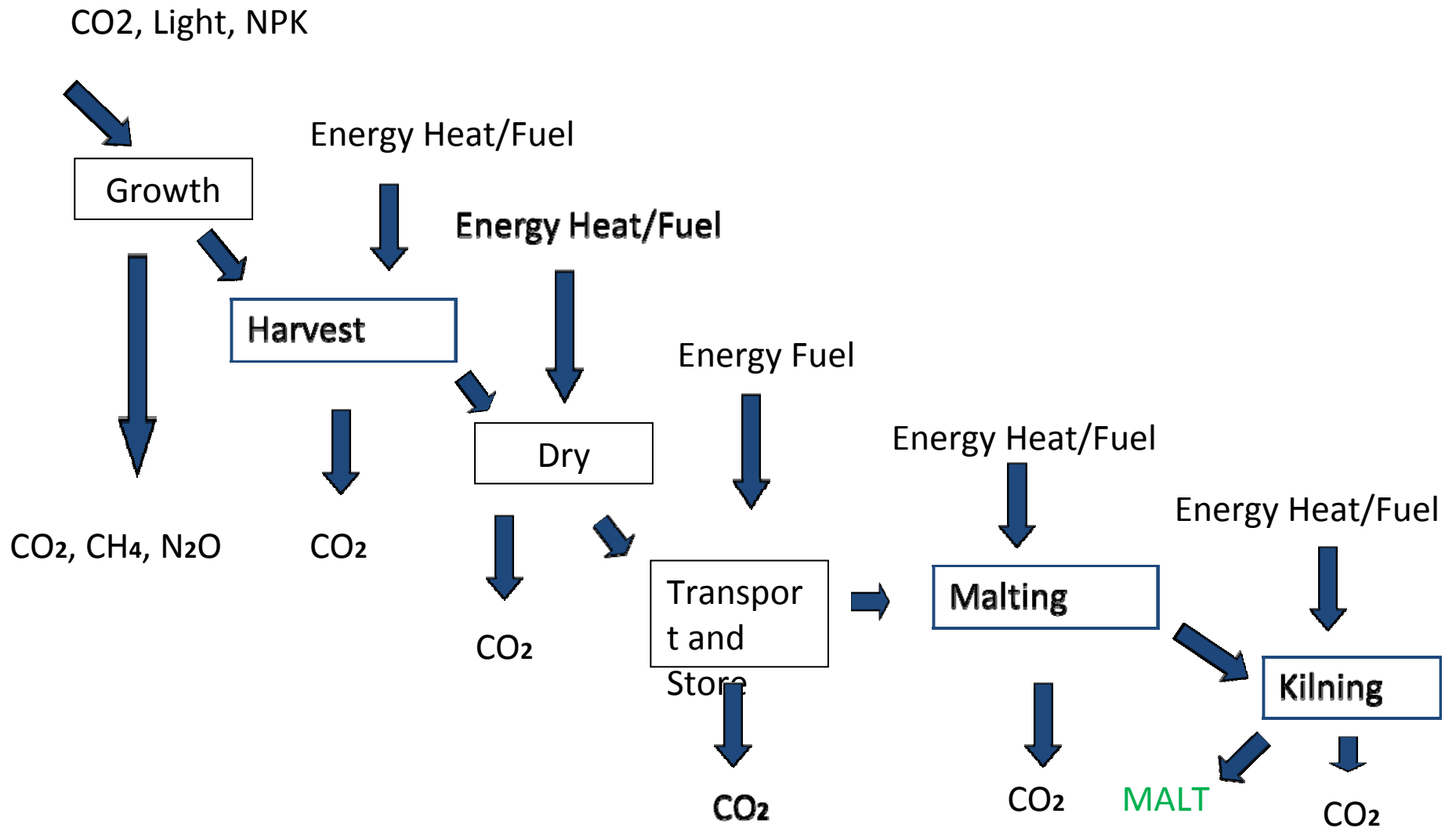
Two Options

1. Make changes that do not affect the qualitiesu of the whisky

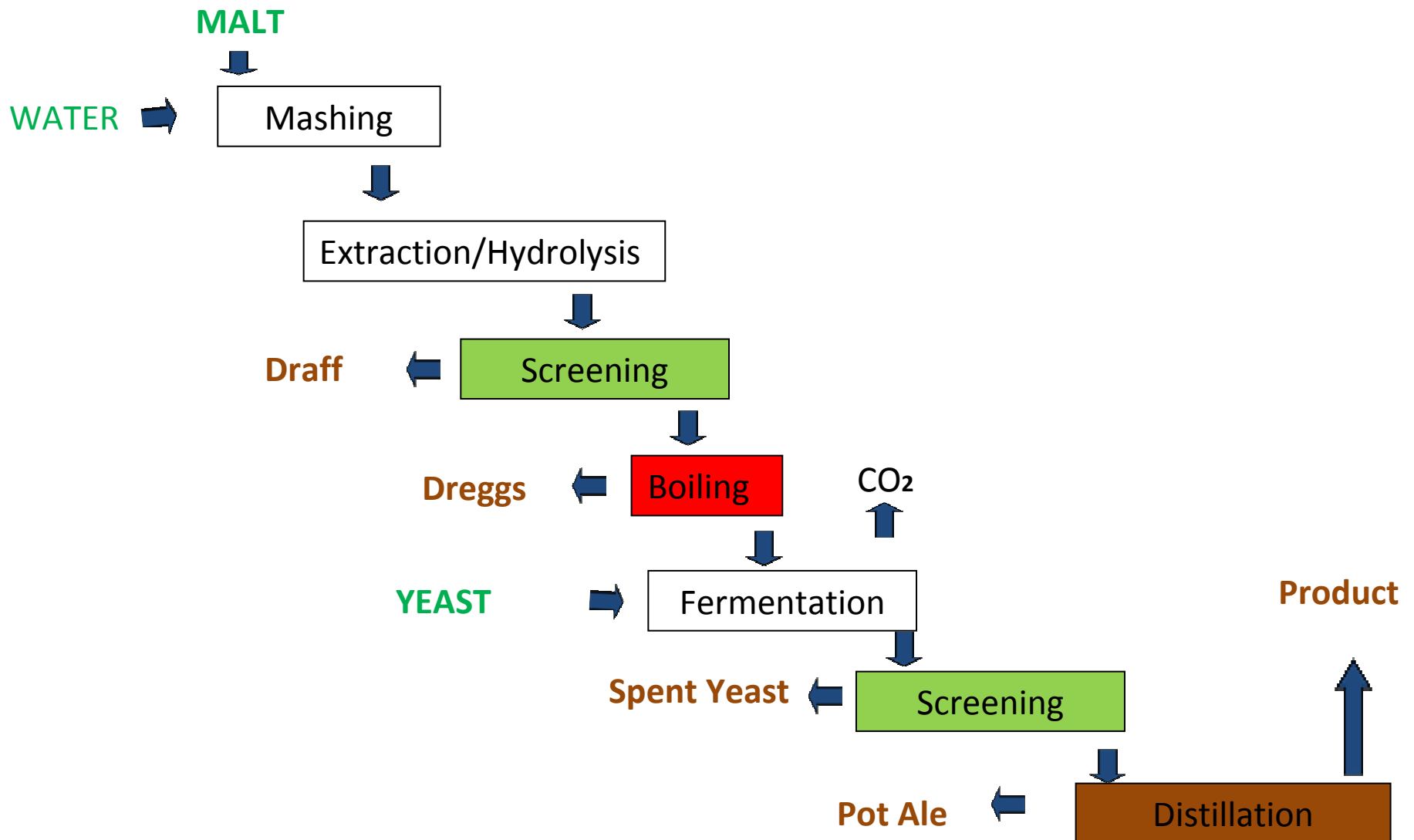
2. Design a distillery for a new malt

Evaluate suitable technologies for each.

Malting Process



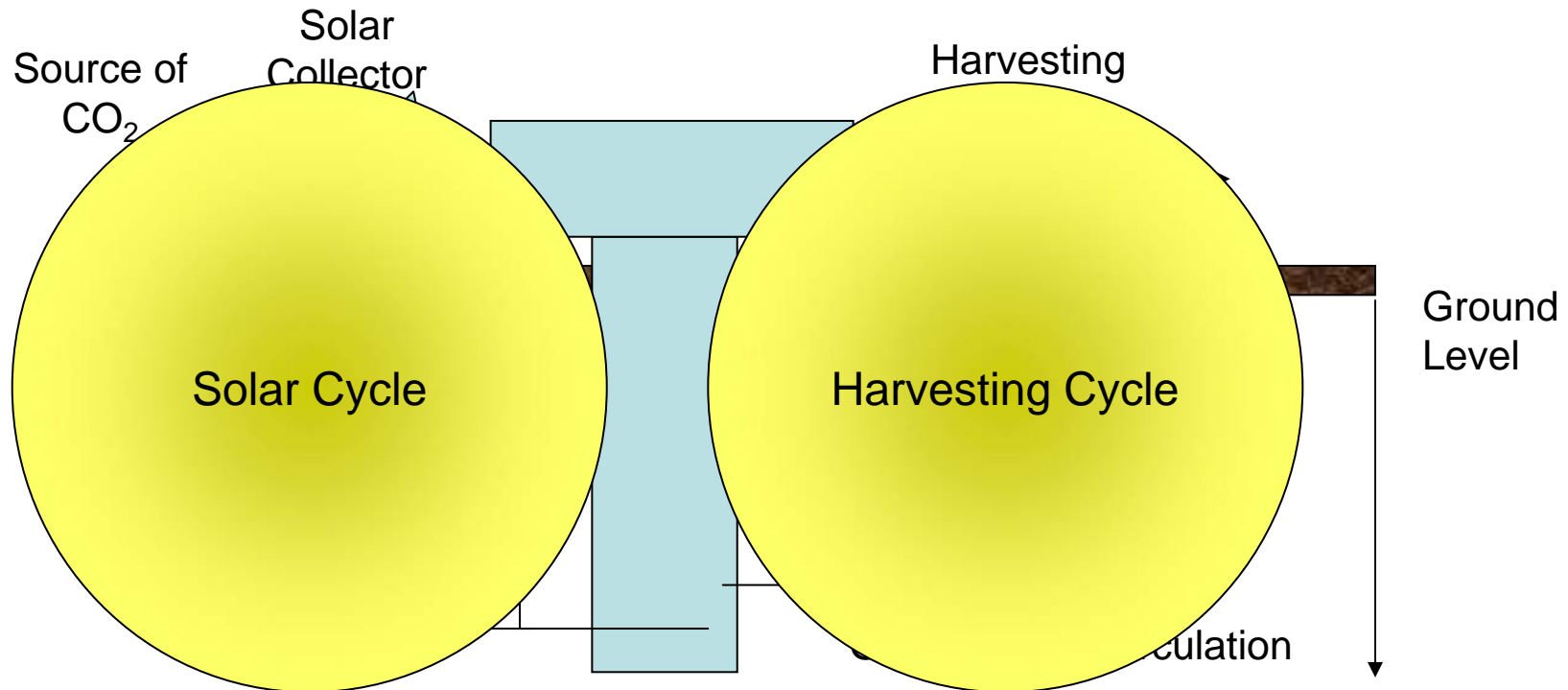
Fermentation and Distillation



% (dry)	Wheat USDA 2010	Barley USDA 2010	Maize USDA 2010	Fishmeal FAO 2009	Soybean USDA 2010
Protein	11.9	13.8	10.5	72.2	39.9
Oil/fat	2.2	2.5	5.2	10.0	21.9
Carbohydrate	84.2	81.1	82.9	0.0	33.0
Fibre	14.2	19.1	8.1	0.0	10.2
Ash	1.7	2.5	1.3	17.8	5.2
Fat + Oil	14.2	16.3	15.7	82.2	61.7
Soluble Carbohydrate	70.0	62.0	74.8	0.0	22.8
Typical Price 2009-10 £/te	160	100	130	1100	300
Protein £/te	1340	725	1239	1523	752
Protein+ oil £/te	1129	612	826	1338	486

Hydroloop Algae-Photo-Bioreactor

- Hydrostatic loop reactor for algae production
- Key features are the solar collection unit and the reactor design



- Selecting the appropriate cyanobacteria for the feed and biomass end use.
- Residence time for given sunlight availability

Glen Close: the Sustainable Distillery



Acknowledgements

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- SWRI
- SWA
- NB Distillery, Cameron Bridge, Glenkinchie, Glen Turret
- ICBD
- IBD
- NISP and ISL
- Environmental Sustainability KTN
- SFC
- AB Agri, Heineken, Helius, Stratocirrus, Veolia