Circular nutrient management: transforming phosphorus and nitrogen in farm slurry to stable commercial fertilisers

Innovate UK Project No: 10130299

Innovate UK

MASTEK AGRI MACHINERY & INNOVATION
Engineering for A Greener Future!

Merigan

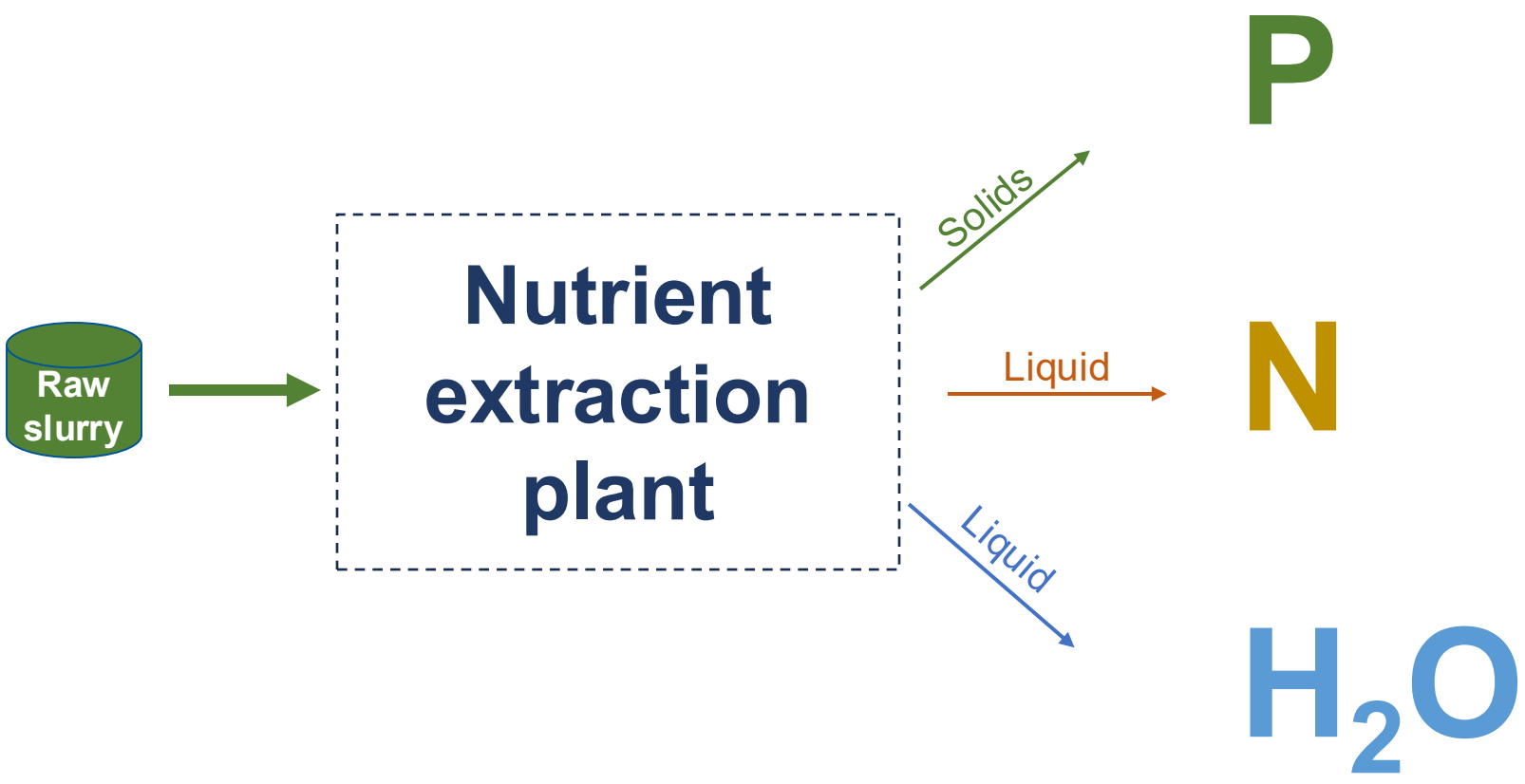
elentecBio

STOIC OPTIONS

School of Sustainable Food and Farming

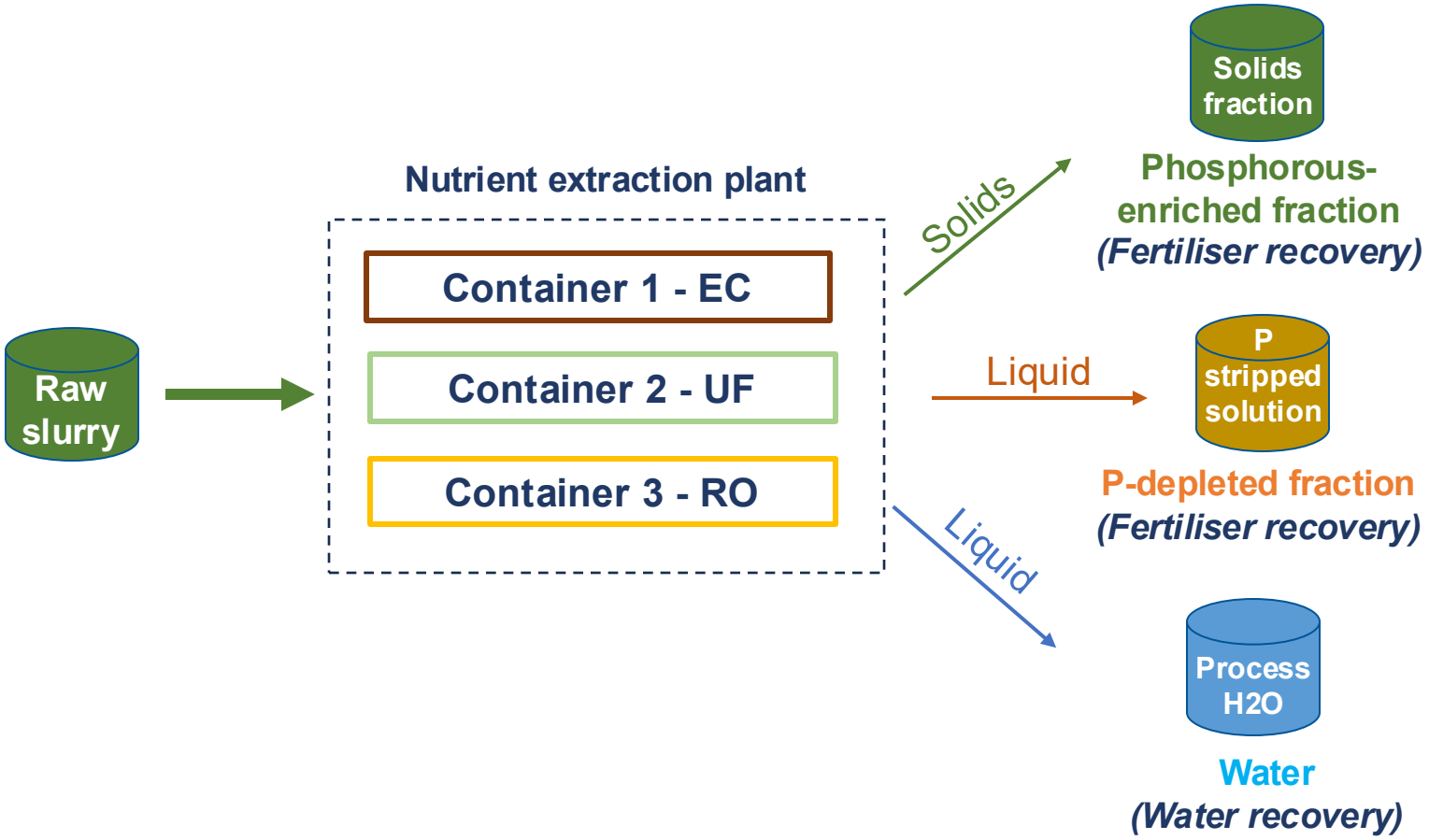
Harper Adams University

Outline Process diagram



Innovate UK
MASTEK AGRI MACHINERY & INNOVATION
Merigan
elentecBio
STOIC OPTIONS
School of Sustainable Food and Farming
Harper Adams University

Outline Process diagram



Sludge-like fertilizer product for growers

Export all or some off farm

Liquid fertilizer products for farmers

Essentially P-free liquid fertiliser for use on high P-index fields

Water for safe discharge or site reuse

Mineral content substantially reduced

Innovate UK

MASTEK AGRI MACHINERY & INNOVATION

Merigan

elentecBio

STOIC OPTIONS

School of Sustainable Food and Farming

Harper Adams University

Outline Process diagram



Innovate UK

MASTEK AGRI MACHINERY & INNOVATION Engineering for A Greener Future!

Merigan

elentecBio

STOIC OPTIONS

School of Sustainable Food and Farming

Harper Adams University

Outline Process diagram







Innovate UK

MASTEK AGRI MACHINERY & INNOVATION Engineering for A Greener Future!

Merigan

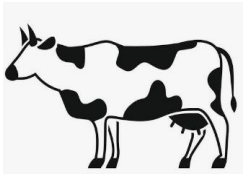
elentecBio

STOIC OPTIONS

School of Sustainable Food and Farming

Harper Adams University

Standard Practice

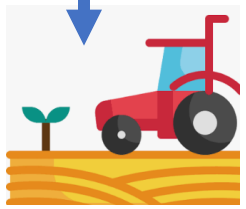




NPK (1.99-0.56-2.25)

High P index fields cannot fully valorise £3.97/m^3 slurry

X



If slurry cannot be spread then either slurry is exported off-farm or dairy production is halted / curtailed

Alternatively – implement nutrient recycling to enable dairy production AND valorise excess nutrient AND recover water

UKRI Innovate

MASTEK AGRI MACHINERY & INNOVATION Engineering for A Greener Future!

Merigan

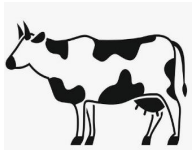
elentecBio

STOIC OPTIONS

School of Sustainable Food and Farming

Harper Adams University

Nutrient recovery practice and estimates of value per m^3 slurry treated





Slurry Separation then EC plant

Off farm export or on farm use £2.89 shreds (2.37-0.62-1.08) plus fine shreds [41.9% total, estimate only]

Solids

Solids fraction

(3.03-1.24-2.31)
20.44% total

Phosphorous-enriched fraction
(Fertiliser recovery)

Off farm export to valorise £1.20/m^3 slurry

Liquid

P stripped solution

(1.25-0.01-3.61)
15.33% total

P-depleted fraction
(Fertiliser recovery)

On farm use to valorise £0.47/m^3 slurry

Liquid

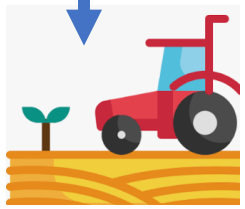
Process H2O

(0.07-0.0003-0.15)
15.33% total
Cost of H_2O = £4/m^3

Water
(Water recovery)

On farm use of water to valorise £0.61/m^3 slurry

X



NPK (1.99-0.56-2.25)

High P index fields cannot fully valorise £3.97/m^3 slurry

UKRI Innovate

MASTEK AGRI MACHINERY & INNOVATION

Merigan

elentecBio

STOIC OPTIONS

School of Sustainable Food and Farming

Harper Adams University

Costs

- **CAPEX**
  - Investment for 400-cow unit ca. £500k for unit with nominal 3m^3/h flow

- **OPEX**
  - Running costs result from:
    - Power consumption (10-20kW)
      - Energy to operate equipment (e.g. pumps)
    - O&M
      - Electrode replacement (iron dosing consumable)
      - Regular servicing of hardware (e.g. pumps, filters)

Next steps

- **Continue operation at site to continue growth of dataset:**
  - to inform developing regulatory approach (use of fractions and water)
  - to refine Business Model
  - to test process robustness

- **What next**
  - Demonstration on other sites (Fundraising)
  - Partnering to develop optimal processing of P-rich fraction for export

Preliminary Italian ryegrass glasshouse trial

Four treatments replicated four times:

- **Separated slurry**
- **P-rich** (slurry fraction following processing with the EC technology
- **NP-fertilisers** (Nitram, NH_4NO_3, 34.5%N ; Triple Superphosphate, 45% P_2O_5)
- **Water** control

Treatments applied once at the max recommended rate (DM yield of 9-12 t ha^{-1}, soil P index 1)

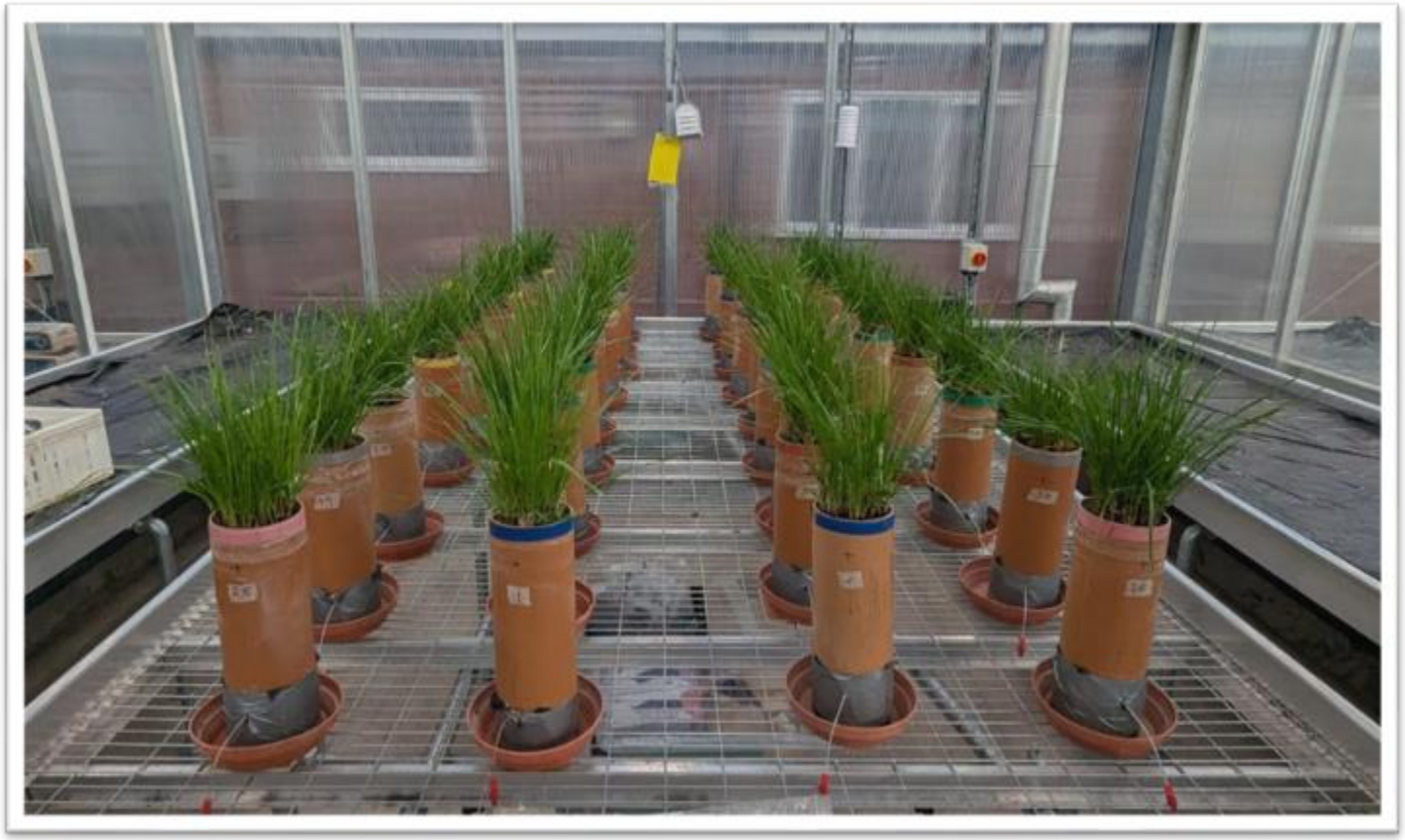
- Nitrogen at 250 kg N ha^{-1}
- Phosphorus at 50 kg P ha^{-1}

Current glasshouse trials – Italian ryegrass (IRG)

IRG (*Lolium multiflorum)* sowing rate of 35 kg ha^{-1}, managed in a 4-cut system

Clay soil: P index 1; SNS index 1

Treatments: Separated slurry; P-rich; P-poor concentrated; P-poor liquid NP-fertilisers; Water control



	1st appl. kg ha^{-1}	2nd appl. kg ha^{-1}	3rd appl. kg ha^{-1}	4th appl. kg ha^{-1}
Target N	130	110	70	30
Target P	70	25	15	10

UKRI Innovate UK
MASTEK AGRI MACHINERY & INNOVATION
Merigan
elentecBio
STOIC OPTIONS
School of Sustainable Food and Farming
Harper Adams University

Current glasshouse trials – Spring wheat (SW)



SW (*Triticum aestivum var.* Mulika, UKFM Group 1), late sowing rate @ 400 seeds/m2

Clay soil: P index 1; SNS index 1

Treatments: Separated slurry; P-rich; P-poor concentrated; P-poor liquid NP-fertilisers; Water control

Target N 180 kg ha^{-1}; Target P 80 kg ha^{-1}

UKRI Innovate UK
MASTEK AGRI MACHINERY & INNOVATION
Merigan
elentecBio
STOIC OPTIONS
School of Sustainable Food and Farming
Harper Adams University