Coop Foundation – Work Package 2.1

Report – Background to Typha & Harvesting



Executive Summary

This agglomoration of data outlines the use of Typha within agriculture as part of the SEAD Artists output for subsequent use in harvesting and as potential feedstock for cattle, alongside other potential uses such as a fuel stock.

Typha itself is not homogeneous and can be found across many different topographies and climates across Europe (upon which this report focuses on). It therefore results in a variety of constitutent components, each one with different characteristics, which esults in a number of outputs from Typha such as the stalks, leaves, flowers and rhizomes.

We also address at a high level the current approaches to taken to Typha harvesting – noting that this will be covered in the next Work Package in more detail and finally review current approaches used by small groups in Europe for extant cattle feeding such as within silage or hay.

The really interesting area for future research that we allude to here could be in the use of Typha as a biofuel, noting the climate change requirements for aviation and the monies being provided to this sector, which could enable new commercial opportunities for farming and a sustainable commercial approach to this exciting area.

Contents

Introduction to Typha 3
Common locations: 3
Main Uses: 3
Typha variants across Europe: 4
Typha latifolia 4
Typha angustifolia 4
Typha domingensis 4
Typha x glauca 5
Composition of Typha Latifolia: 6
Harvesting Typha: 7
Leaves 7
Flower Spikes 8
Rhizomes 8
Stalks 9
Typha as a Cattle Feedstock 10
Nutritional value 10
Contents in Cattail 10
Cattle feeding with Typha 11
Silage 11
Hay 12
Grazing 12
Considerations when feeding cattle with Typha 13
Low protein 13
High Silica and Lignin 13
Possible contaminants 14
Mould and rot risk 15
Typha as a potential BioFuel 16
Advantages 16
Biofuel Variants 16
Biogas 16
Bioethanol 17
Biomass briquettes 18
Direct combustion 20

Introduction to Typha

Typha is a genus of wetland plants known as cattails or bulrushes and are typically found in marshes, ponds and the edges of lakes and streams.

Common locations:

- Ponds and Lakes: edges of still or slow-moving water.
- Rivers and streams: in calm backwaters and floodplains
- Marshes and Fens: wetland reserves, peat bogs and reedbeds.
- Ditches and Canals: along drainage ditches and canal banks.

Main Uses:

- Wildlife habitat: provides shelter and food for birds and aquatic animals.
- Crafts: weaving mats, baskets and insulation.
- Edible parts: young shoots, pollen and rhizomes are edible.
- Water filtration: helps in natural water purification by trapping sediments and absorbing pollutants.









Across Europe there are a few dominant types, which we introduce here before focusing on the dominant species in the United Kingdom.

Typha variants across Europe:

Typha latifolia

Broadleaf Cattail (throughout Europe)



- Wider leaves (10-20mm)
- No gap between male and females flower parts on the spike.
- Freshwater wetlands, ponds and slow-moving rivers.
- Highly invasive through rhizomes.
- Uses: edible parts, water filtration and crafting.

Typha angustifolia

Narrowleaf Cattail (Central and Southern Europe)

Narrower leaves (4-10mm)



- Distinct gap between male and female flowers on the spike.
- Prefers deeper water and slightly more saline conditions.
- Often grows alongside T. latifolia, sometimes hybridizing.
- Uses: similar to broadleaf cattail but also for erosion control.

Typha domingensis

Southern Cattail (Mediterranean: Spain, Italy and Greece)



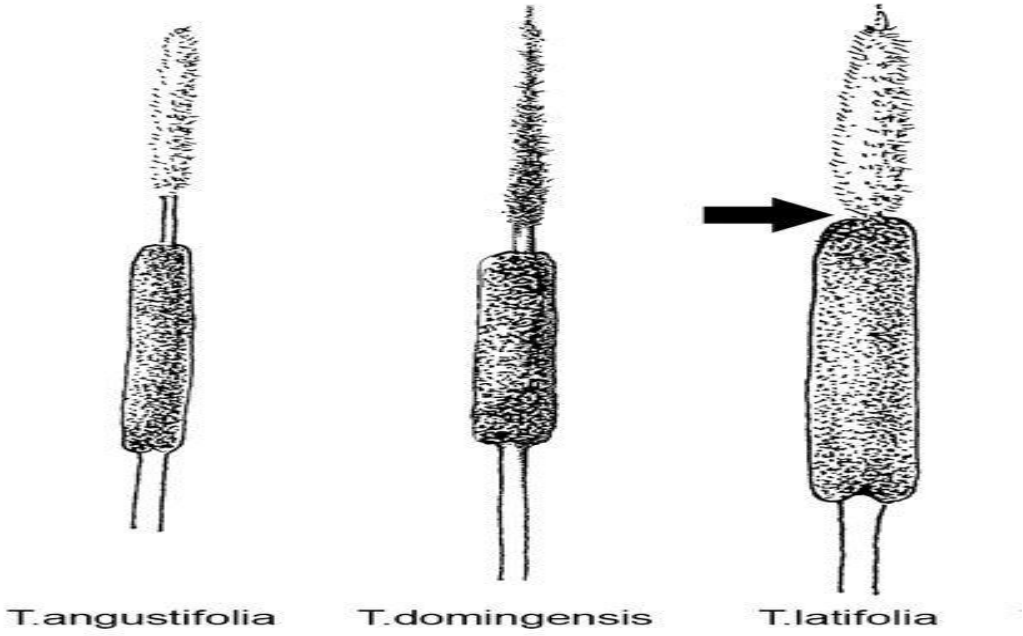
- Looks like T. angustifolia but prefers warmer climates.
- Brackish (salty) wetlands.
- More heat and drought tolerant.
- Uses: weaving mats and erosion control in arid wetlands.

Typha x glauca

Hybrid Cattail (Europe)

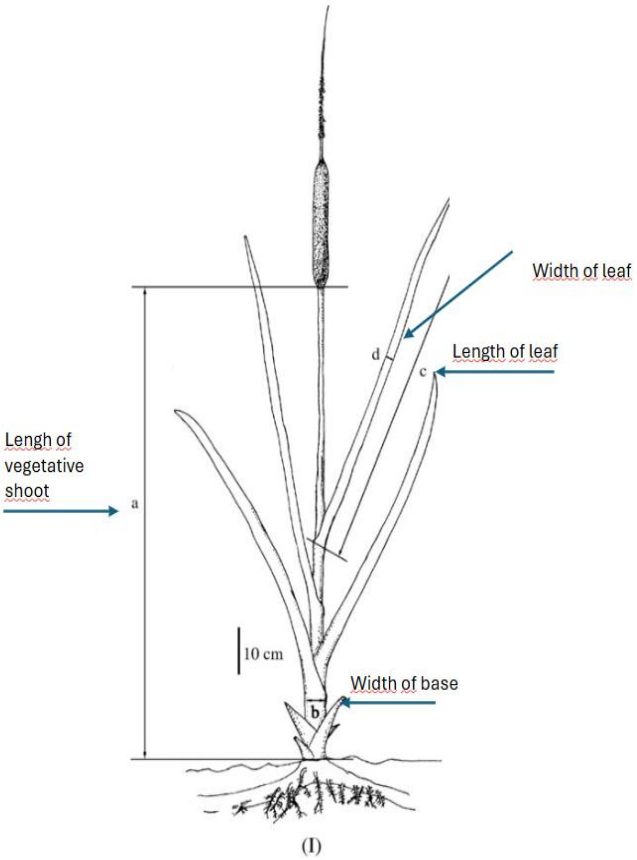


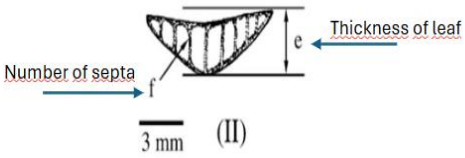
- T. latifolia x T. angustifolia.
- Intermediate traits between its parent species.
- More aggressive that either parent, forming dense monocultures.
- Lakes, ponds and disturbed wetlands.
- Uses: not widely used as it often outcompetes native plants.

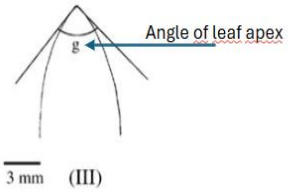


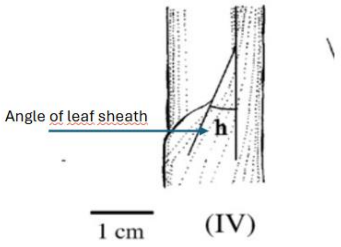
In summary there are 3 dominant Typha variants across Europe, but broadleaf cattail – latifolia is the primary one in the United Kingdom, and its component parts are expanded on below.

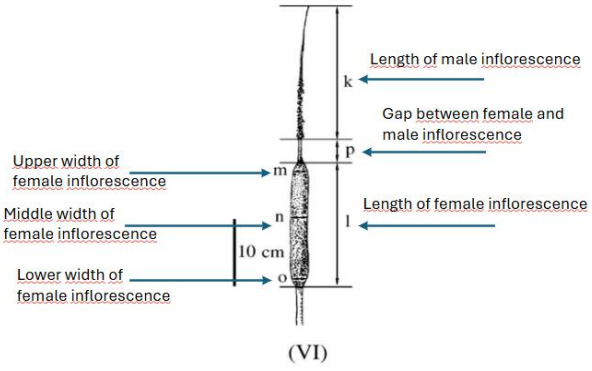
Composition of Typha Latifolia:

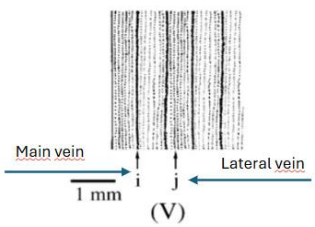


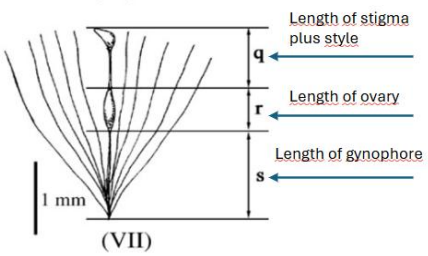












Harvesting Typha:

This will be documented and reviewed further in Work Package 2.2 which moves into the practicality of harvesting but in this segment, we cover the main means of harvesting the leaves, flowers, rhizomes and stalks.

Leaves *(For weaving and crafts)*

- Best time: late summer to early fall (before they dry out)
- Method: sharp knife or pruning shears (cut the long leaves near the base)
- Bundle them together and allow them to dry out if used for weaving.
- Harvesting Cattail Leaves (minute 2:20) via Canadian Bushcraft











Flower Spikes *(For food or pollen collection)*

- Best time:
  - Green flower spikes: late spring to early summer (for eating, similar to corn on the cob).
  - Brown mature spikes: summer to fall (for seeds or fibre).
  - Pollen: mid-summer (for flour substitute).
- Method:
  - Pull or cut off the green immature flower spike for cooking.
  - If collecting pollen, shake the brown flower head into a bag to collect the fine yellow dust.
  - Sharp scissors, shears, or a knife.
- Uses:
  - Young green spikes: edible (boil and eat like corn); pollen collection (flour substitute).
  - Mature brown spikes: fire tinder, stuffing material, seed collection.

Rhizomes *(For food or replanting)*

- Best time:
  - Fall to early spring (when starch content is highest): for flour, soups or roasting.
  - Year-round: for fibre, biofuel or medicine.
- Method:
  - Tools: Small spade, rake or hands.
  - Wade into shallow water and pull up the rhizomes (horizontal underground stems).
  - Wash thoroughly and peel off the outer layer before use.
  - Can be eaten raw, roasted or ground into flour.
  - Gloves, small shovel or digging stick and bucket or basket.



- Uses:
    - Food: starch extraction (can be dried, ground into flour), boiling or roasting like potatoes), raw (young shoots can be eaten fresh).
    - Industrial & craft: biofuel (fermented into ethanol), cordage (fibres can be used for rope and mats).
    - Medicinal: poultices (for treating wounds), tea (helps with digestive issues).

Stalks *(For making cordage or insulation)*

- Best time:
    - Spring – early summer: eating (young, tender inner stalks) and weaving (flexible stalks).
    - Late summer to fall: fibre, thatched roofing and fodder.
- Method:
    - Cut at the base, strip the outer layers and separate fibres for weaving or making rope.
    - Gloves, sharp knife or shears, basket or bag.
- Uses:
    - Food: edible core (mild, cucumber-like taste), raw in salads or cooked in soups and stir-fries, can be pickled or fermented.
    - Craft & Industrial: weaving (for baskets, mats and fencing), building material (in lightweight structures and insulation), papermaking (fibres processed into paper pulp).
    - Fodder & Bedding: dried stalks (livestock feed), soft, dry stalks (animal bedding).

Typha as a Cattle Feedstock

Within this segment we focus on the value of Cattail as a feedstock, noting that WP3.1 focuses on R&D Typha to Feed in more detail, this merely highlights areas of generic interest for the reader.

Nutritional value

- High Fibre (30-40% crude fibre) – useful as roughage but low in digestibility.
- Low protein (6-8% crude protein) – not enough for high milk yield or fast weight gain.
- Moderate energy – provides some carbohydrates but lower than grasses or legumes.
- Rich in minerals – contains potassium, calcium and magnesium but can be high in silica.
- Best used as a filler forage, not a complete feed.

Contents in Cattail

- 14.4% dry matter
- 8.70% crude protein
- 9.50% ash
- 3.50% ether extract
- 28.10% crude fibre
- 50.2% nitrogen free extract

Cattle feeding with Typha

Silage *(Best method)*

- https://youtu.be/ocyuPODD9sU?si=JiHEu5S5BxU02N6R
- Silage Making Process | How to make Silage for Cows / Goats | Cattle Feed Making Method
- Cut young green Typha shoots and leaves (before they mature and get too fibrous).
- Chop into small pieces.



- Mix with a higher-protein feed such as legumes, molasses or urea.





- Store in an airtight silage pit or a plastic wrap for at least 30 days.



Hay *(Dry forage)*

- Harvest before flowering (better digestibility).
- Dry well to avoid mould (can be done using a rotary drum dryer)
    - Clean Typha and ground or chop to uniform sizes to ensure even drying.
    - Feed into the rotary drum dryer through a conveyor or hopper.
    - The drum rotates, ensuring the feed is evenly distributed and expose to the drying air.
    - A heat source heats the air that flows through the drum, evaporating the moisture from the feed.
    - The airflow system ensures uniform distribution of hot air, maximizing contact with the feed for efficient drying.
    - The dried feed is discharged from the drum through an outlet, ready for packaging or further processing.
- Mix with alfalfa, clover or grain-based feeds for a balanced diet.



Grazing (Limited use)

- Best for swampy pasture areas.
- Rotate cattle to prevent overgrazing and ecosystem damage.

Considerations when feeding cattle with Typha

Low protein – needs supplementing with alfalfa, soybean meal or concentrates.

1. Ratios:
   i. 50-70% Dried Typha stalks.
   ii. 10-20% Legume hay (e.g., alfalfa, clover, or peanut hay)
   iii. 10-15% Grain or Energy source (e.g., corn, barley, molasses)
   iv. 2-5% Mineral Supplements (e.g., salt, calcium, phosphorus)

2. How to prepare:
   i. Chop dried Typha stalks into small pieces (2-5cm)
   ii. Mix with legume hay and grains for balanced nutrition.
   iii. Optional: add molasses to improve palatability.
   iv. Fermenting Typha stalks with silage-making techniques (adding lactobacillus bacteria) improves digestibility.

High Silica and Lignin – older plants are very tough and poorly digestible.

a) Young shoots (leaves and stems)
→ 1-3 months (spring-early summer)
→ high moistures y digestibility, rich in protein.

b) Mature stalks (leaves and stems)
→ Up to 6 months
→ can be used as roughage but low nutrients.

c) Flower spikes (green stage)
→ 3-5 months
→ nutritious, good palatability.

d) Rhizomes (roots)
→ 6-12 months
→ high starch but becomes fibrous as it ages.

e) Dried stalks and leaves (for silage and bedding)
→ 1+ years (dried and processed)
→ used as fibre supplement or bedding.

Possible contaminants – avoid plants growing in polluted water (heavy metals and toxins).

Although Typha is a hyperaccumulator plant and can tolerate and absorb heavy metals and pollutants from water, extreme contamination can hinder its growth.

See below a table of the maximum tolerance levels for pollutants.

- HEAVY METALS (mg/L or ppm)

Pollutant	**Max. tolerance for Typha**	**Effects on Growth**
Lead (Pb^{2+})	5-20 mg/L	Growth slows at >10 mg/L, toxicity at >20 mg/L.
Cadmium (Cd^{2+})	1-5 mg/L	Reduced biomass at >2 mg/L, lethal at >5 mg/L.
Zinc (Zn^{2+})	10-50 mg/L	Can tolerate up to 50 mg/L, but growth slows.
Copper (Cu^{2+})	5-15 mg/L	Toxic effects at >10 mg/L.
Chromium (Cr^{6+})	1-10 mg/L	Cr^{6+} is toxic, Typha struggles at >5 mg/l.
Nickel (Ni^{2+})	5-15 mg/L	Stunted growth at >10 mg/L.
Mercury (Hg^{2+})	0.1-1 mg/L	Highly toxic, >5 mg/L reduces survival.

- ORGANIC POLLUTANTS

Pollutant	**Max. tolerance for Typha**	**Effects on Growth**
Petroleum Hydrocarbons (Oil, Diesel, Gasoline)	Up to 500 mg/L.	Reduced oxygen, slows growth.
Pesticides (Atrazine, DDT, Glyphosate, etc.)	Up to 50 mg/L.	Root damage, but some tolerance.
Phenols	Up to 10 mg/L.	Above 10 mg/L is toxic.

- INDUSTRIAL WASTE AND SALINITY

Pollutant	**Max. tolerance for Typha**	**Effects on Growth**
Nitrate (NO_3^-)	>100 mg/L.	Thrives un eutrophic waters.
Ammonia (NH_3)	Up to 30 mg/L.	Excess causes toxicity.
Salinity (NaCl, TDS)	Up to 10 ppt (~1% salt)	Growth stops at >12 ppt.

Mould and rot risk – if improperly stored, Typha hay or silage can grow toxic moulds.

Tips for long-term storage and maintenance (here)

- Fresh storage (short-term)
  - Young stalks, leaves and rhizomes that are going to be used within 3-5 days)
  - Keep in shaded, cool area.
  - Store in plastic bags with ventilation holes to maintain moisture.
  - Refrigerate to extend freshness
  - Avoid stacking Typha too tightly.

- Dried hay (long-term)
  - Stalks and leaves used as roughage.
  - 6-12 months.
  - Sun-dry the small pieces for 3-5 days (moisture content <15%).
  - Store in bales or loose piles in a dry, well-ventilate shed.
  - Keep off the ground using pallets to prevent moisture absorption.
  - Avoid storing wet Typha as it can grow mould.
  - Avoid storing near flames as it is highly flammable.

- Fermented feed (Typha Silage)
  - Increases digestibility and nutritional value.
  - 6-24 months
  - Once mixed with molasses or urea, pack tightly into an airtight container and seal completely.
  - Ferment for 30-60 days before feeding.
  - Avoid excess moisture (>70% causes spoilage).
  - Avoid oxygen exposure (leads to mould growth).

- Storing rhizomes (high starch feed)
  - Best for energy-rich cattle feed.
  - 1-3 months (fresh) – store in a cool, dry place like potatoes.
  - 6-12 months (dried) – sun-dry and then grind into powder for mixing with other feeds.
  - Avoid high humidity (causes rot).
  - Store in sealed containers (preventing rodent access).

FEED TYPE	BEST STORAGE METHOD	SHELF LIFE
Fresh stalks and leaves	Cool, shaded area	3-5 days
Dried stalks and leaves (Hay)	Baled, stored dry	6-12 months
Silage (fermented feed)	Airtight container	6-24 months
Rhizomes (fresh)	Cool, dry storage	1-3 months
Rhizomes (dried and ground)	Sealed container	6-12 months

Typha as a potential BioFuel

In this final segment we conducted some further research into the potential of Typha as a potential biofuel, that could complement some of the cattle feeding.

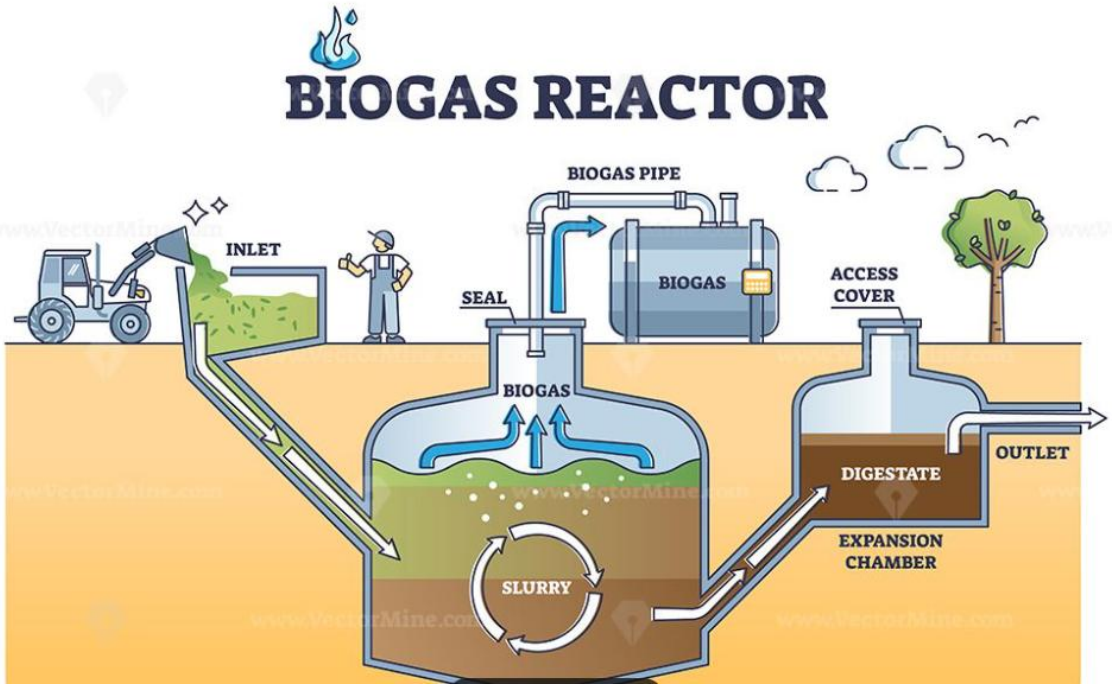
Advantages

- High Biomass Production: can grow densely and rapidly in wetlands.
- Carbon-Neutral: absorbs CO2 while growing, offsetting emissions when burned.
- Grows in Marginal Lands: doesn't compete with food crops.
- Assists in Water Purification: absorbs pollutants while growing, making it a dual-use plant.

Biofuel Variants

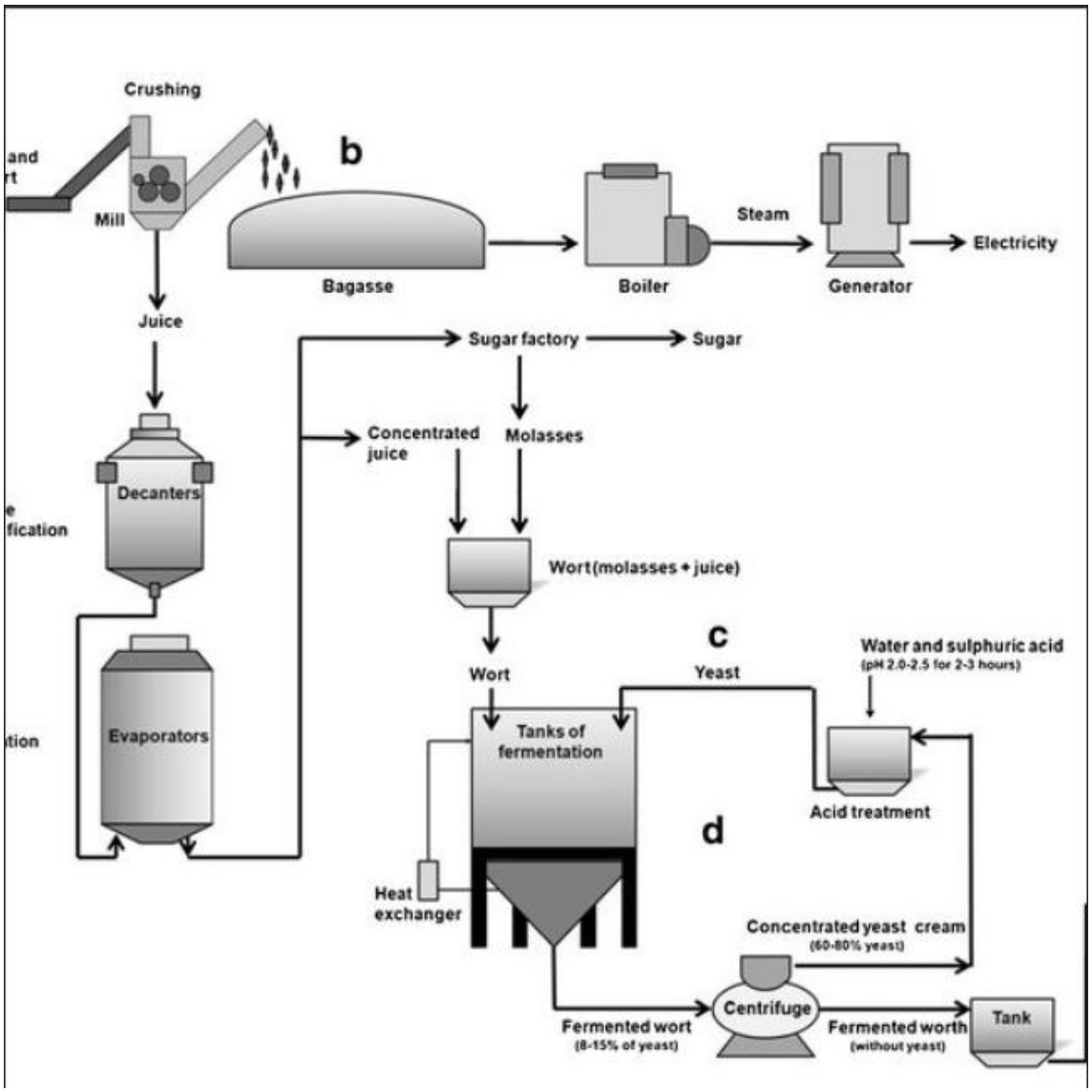
Biogas (Methane Production) https://youtu.be/3UafRz3QeO8

- Fermentation in anaerobic digesters → produces methane-rich biogas (cooking, heating or electricity)
- Typha has high lignin (Lignin | Definition, Function, Uses, & Facts | Britannica), so pre-treatment is needed for better gas yield.
- Process:
    - Harvest and chop: cut fresh Typha stalks and leaves into small pieces (5cm)
    - Pre-treat Typha biomass:
        - Soak in hot water or alkaline solution (e.g., NaOH) to break down tough fibres.
        - Add cow manure or another microbial inoculum to boost bacteria.
    - Anaerobic digestion:
        - Place biomass in a sealed digester (tank without oxygen)
        - Maintain a temperature of 35-55ºC for microbial breakdown.
    - Gas collection:
        - Production of methane (CH4) + CO2 over 15-30 days.
        - The resulting biogas van be burned as fuel or upgraded for use in gas engines.
    - Residue use: the leftover sludge is rich in nutrients and can be used as fertilizer.
- Yield: approx. 200-400 m3 of biogas per ton of dry biomass (depending on processing conditions).
- Easiest and most cost-effective for rural energy needs together with briquettes.
- Best for small-scale farms, rural energy and sustainable waste-to-energy systems.



Bioethanol (Liquid Fuel for Vehicles)

- The fermentable sugars and starch in Typha can be converted into bioethanol.
- Process:
    - Harvest and chop: collect young shoots and rhizomes (roots contain the most starch) and crush or grind to release starch.
    - Pre-treatment: break down fibrous material using enzymes or mild acid hydrolysis.
        - Use enzymes (cellulase, amylase) or mild acid hydrolysis (H_2SO_4, HCl)
        - Heat to 120-150ºC for 30-60 minutes.
    - Fermentation:
        - Yeast converts sugars into ethanol.
        - Keep at 30-35ºC for 24-72 hours.
    - Distillation and purification:
        - Heat fermented liquid to separate ethanol (78ºC boiling point)
        - Dehydrate ethanol for fuel-grade purity (approx. 95-99%)
- Best if blended with petrol or using in ethanol-based engines.
- Good for liquid fuel but needs advanced processing.
- Sustainable biofuel for transportation, especially in off-grid areas.
- Yield: approx. 250-400 litres per ton of dry biomass.
- Challenge: high fibre content requires effective pre-treatment to extract sugars efficiently.



Biomass briquettes (Solid Fuel)

https://youtu.be/HQfp-XIxNq0?si=V9Nkg5q27qESLFy0

- Typha stalks and leaves can be compressed into briquettes or pellets for burning in stoves, boilers and power plants.
- Process:
  - Harvest and dry:
    - Cut mature Typha stalks and leaves.
    - Sun-dry to 10-15% moisture content.
  - Grinding and mixing:
    - Grind into fine powder (1-3 mm particle size)
    - Mix with binder (e.g., sawdust, molasses, starch) for better compression.
  - Compression:

        - Use a briquette press (hydraulic, piston or screw type)
        - Apply high pressure (approx. 150 MPa) to form briquettes or pellets.
    - Cooling and storage:
        - Air-dry for 48 hours to harden.
        - Store in dry, ventilated space.
    - Burn as an alternative to wood or charcoal.
- Advantages:
    - Higher energy density than raw plant material.
    - Can replace firewood or coal in some applications.
- Energy output: approx. 15-18 MJ/kg (compared to wood at approx. 20 MJ/kg.
- Easiest and most cost-effective for rural energy needs together with biogas.
- High silica content can cause ash buildup in burners.





Direct combustion (Biomass energy)

- Can be burned directly in biomass power plants to generate heat and electricity.
- Process:
  - Harvest and dry:
    - Cut mature Typha stalks and leaves.
    - Dry to 15% moisture for optimal burning.
  - Shredding and pelletizing (optional):
    - Improves efficiency in biomass furnaces.
  - Combustion in boilers:
    - Burn in industrial biomass boilers to generate steam.
    - Use fluidized bed combustion to reduce ash buildup.
- Steam powers turbines to produce electricity.
- Challenges:
  - High ash and silica content can cause clinker formation in boilers.
  - Needs pre-treatment or mixing with other biomass sources.
- Works in large-scale biomass plants but needs proper handling
- High moisture content – needs drying before processing.
- High silica and ash content – can cause boiler fouling in combustion systems.
- Processing costs – requires pre-treatment (enzymes, heat or chemicals) for bioethanol production.
- Ecosystem impact – if overharvested, can affect wetland biodiversity.

