



**Pushing boundaries in
brewing by using 100%
alternative cereals**



Pushing boundaries in brewing by using 100% alternative cereals



- TETRA-project: HBC.2023.0064
- 1/12/2023 – 30/11/2025
- Funding:
92.5% VLAIO & 7.5% supervisory group



MaltLess kick-off meeting

Jan 26, 2023

13.00 – Welcoming

13.05 – Introduction of the VLAIO TETRA-program

13.15 – Introduction of the research team and supervisory group

13.30 – Introduction of the MaltLess project

13.45 – Contents of the work packages

14.25 – Feedback & take-home message

14.30 – Networking moment



Vlaanderen
is ondernemen

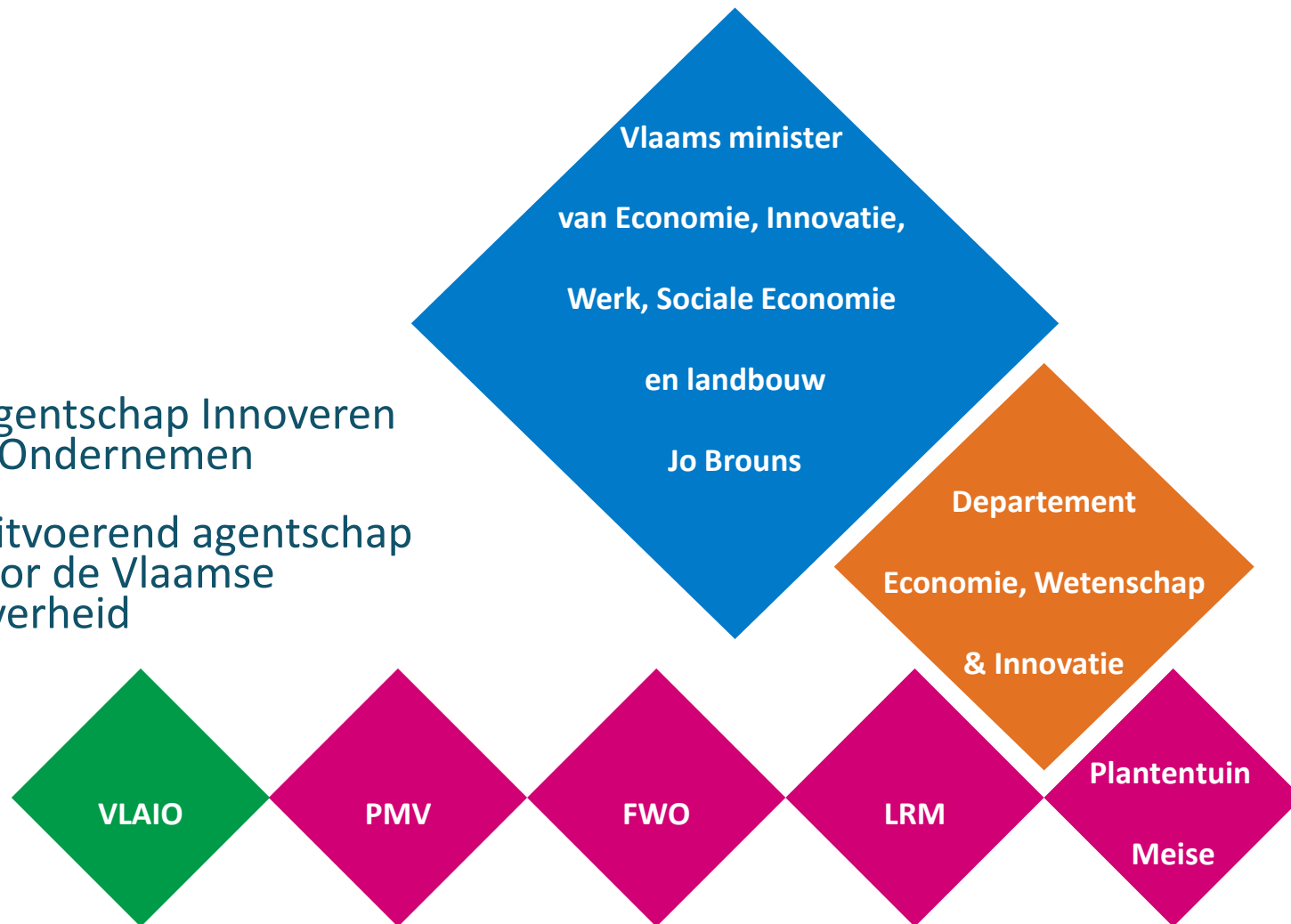
TETRA

- tetra@vlaio.be
- marianne.claessens@vlaio.be

**AGENTSCHAP
INNOVEREN & ONDERNEMEN**

Wie zijn we?

- ▶ Agentschap Innoveren & Ondernemen
- ▶ Uitvoerend agentschap voor de Vlaamse Overheid





TETRA-programma

Programma voor

- **praktijkgericht onderzoek**

door

- **hogescholen**
 - **geïntegreerde opleidingen in de universiteiten**
 - Onderzoeksgroepen en -organisaties (EU-definitie!)
 - grote onderaannemer(s): samen max 10% begroting
- voor
- **ruime doelgroep Vlaamse, pref. niet-R&D intensieve ondernemingen & social profit organisaties**
 - **kennis stroomt door naar het onderwijs**

} minstens
2/3 begroting



Doel TETRA-project

- Stimuleren van **kennisoverdracht**
- **Brugfunctie** tussen **nieuwe technologie** of **recent afgewerkt onderzoek** en **concrete toepassings-mogelijkheden**
- **Vertaling en transfer** van **bestaande kennis**
 - Projectresultaten **op korte termijn** na afloop van het project bruikbaar zodat de doelgroep **sneller en efficiënter kan innoveren**
 - Projectresultaten geven aanleiding tot **economische (en maatschappelijke) voordelen bij de doelgroep**
 - **Meerwaarde voor de studenten**

Rol begeleidingsgroep





Begeleidingsgroep

- Ondernemingen en social profit organisaties, **representatief voor de brede doelgroep** en alle organisaties (collectieve centra, federaties, leveranciers, klanten, ...incl. overheid) **relevant voor de brede uitrol** van de resultaten op het einde v/h project
- Leden geloven in het belang van de projectresultaten en ondersteunen het project met woord en daad (reeds van bij de voorbereiding)
- **Cofinancieren samen 7,5% (excl. Overheid, HS of Univ!)**
 - Invulling cofinanciering $\approx$ maat voor betrokkenheid doelgroep
- **Goede interactie met de doelgroepbedrijven is essentieel**
 - vóór, tijdens ($\pm$ om 6 m) en na het project
 - **project opvolgen, bijsturen, klankbord voor valorisatie**



Reglement van orde

- Regelt rol en werking gebruikersgroep
- Verduidelijkt **de rechten en plichten van de leden**
- **Te ondertekenen door alle leden**
- Leden die een bijdrage leveren in de cofinanciering
 - **engagement betaling**



Bevraging leden gebruikersgroep

- **Feedback** gevraagd van **aanwezige leden**
 - ✓ Nog steeds **relevant** voor uw onderneming?
 - ✓ Hoe scoort u het **projectverloop** en behaalde projectresultaten?
 - ✓ Hoe tevreden bent u over de **ruimte voor interactie en sturing**?
 - ✓ Hoe tevreden bent u met de **behandelde punten** in de gebruikersgroep?
 - ✓ Zijn er (mogelijke) **toepassingen van concrete, bruikbare resultaten bij uw eigen onderneming** (of uw ledenbedrijven) op korte termijn?
- **Doel:** garantie overeenkomst tussen verwachtingen van de gebruikersgroep en voortgang project (in kader van doelstellingen)
- Feedback wordt besproken in volgende meeting

Deze Feedback kan bekomen worden via een enquête, uitgestuurd door de uitvoerders.

Vragen ?



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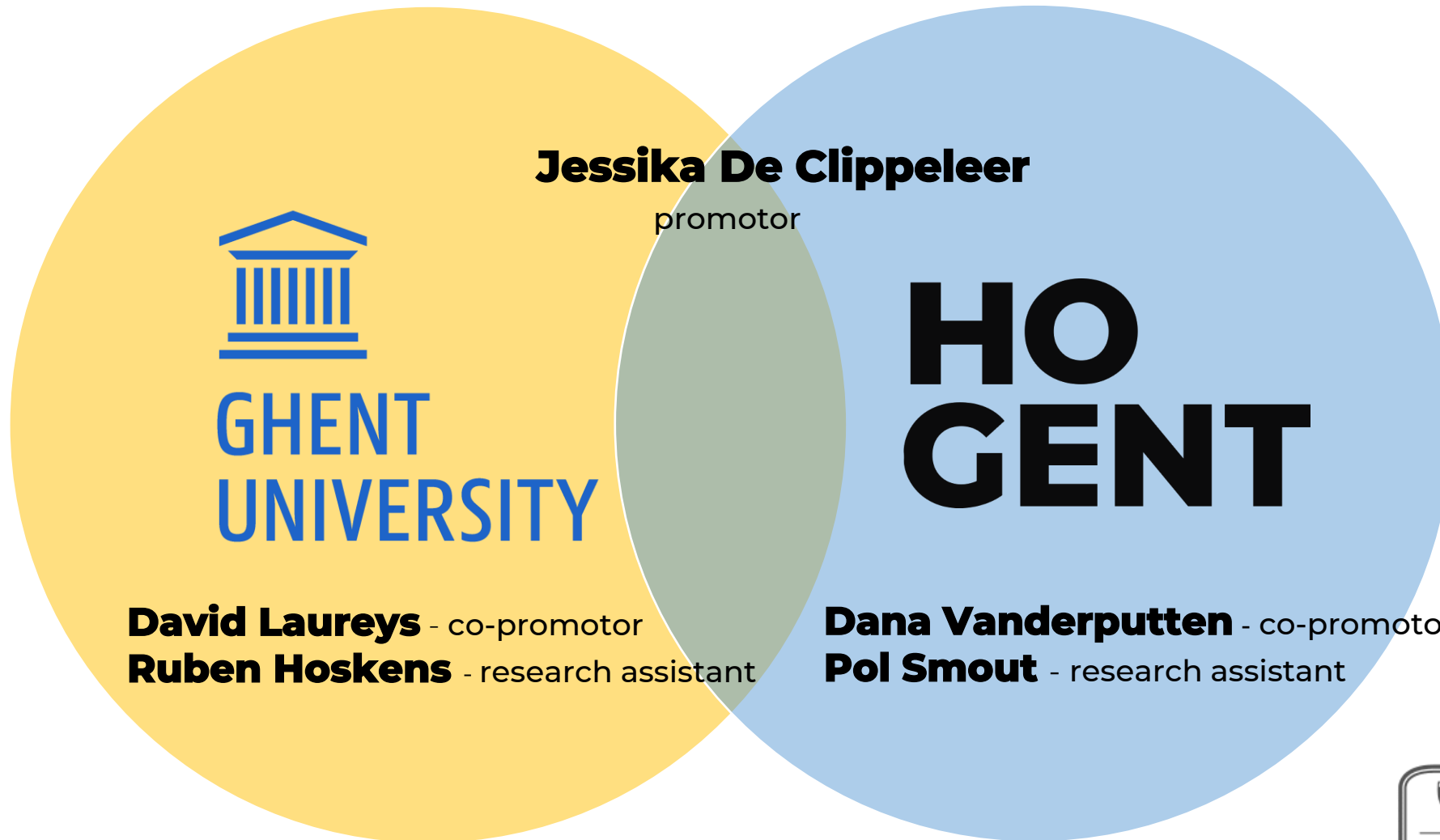
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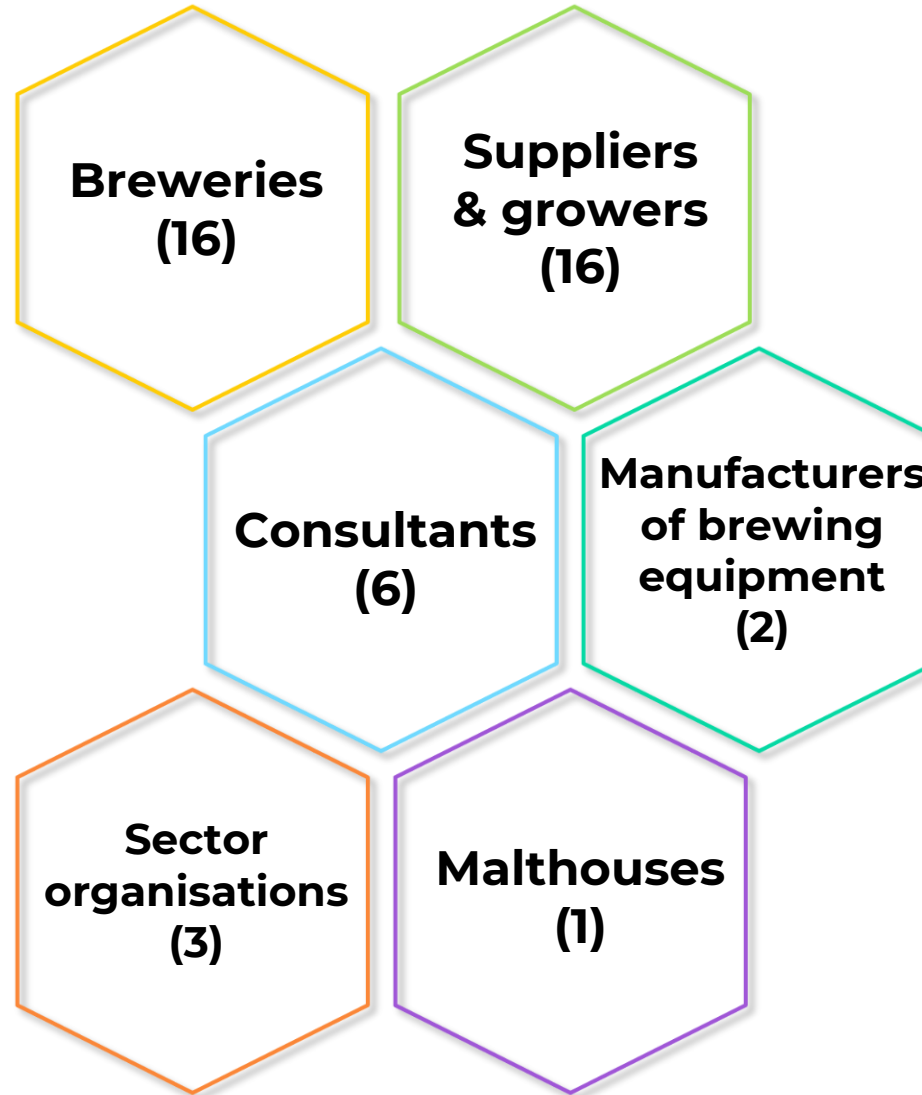
14.25 – Feedback & take-home message

14.30 – Networking moment

Research team



Supervisory Group







novonesis



Suppliers
& growers
(16)



BOERDERIJ BIJLSMA

OERGRAAN (EENKOORN, EMMER, SPELT), AARDAPPELEN, PIOENROZEN EN MEER



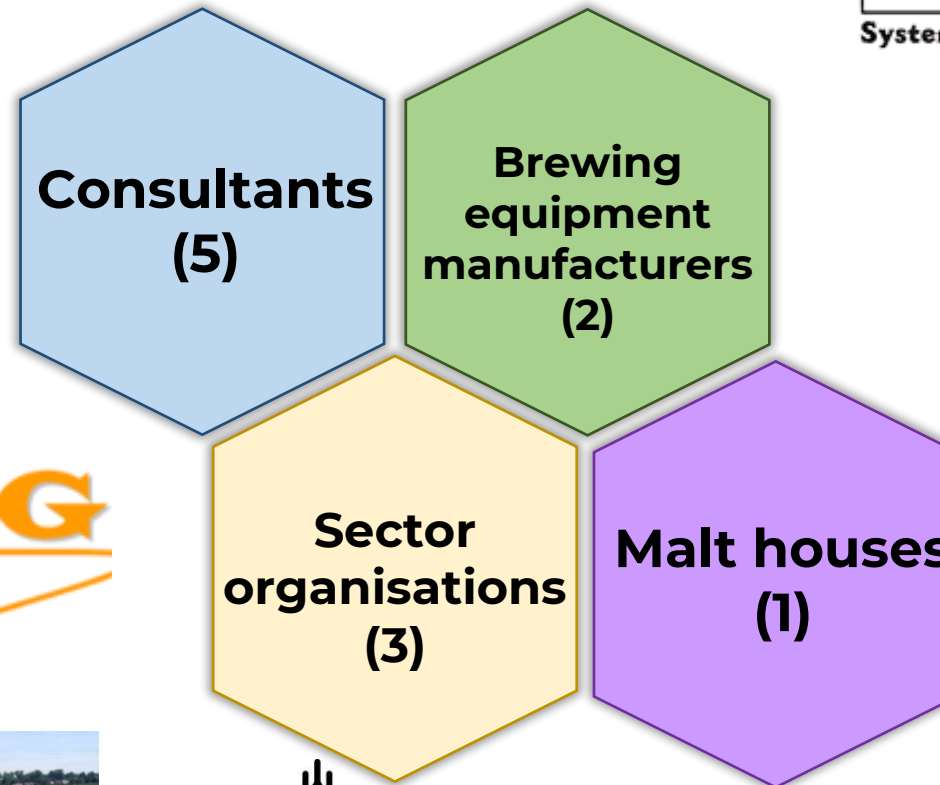
Maatschap
de Milliano-Meijer

ANV Groene Oogst

vivagran



- Jozef Maes Brewconsulting GCV
- QiBD (Quality in Brewing and Distilling)
- Belgian Fine Technology International (BFTI)
- Brew-Art bv
- KALANA bvba
- B.C.B. BV



**Proefhoeve Bottelare
(UGent/HOGENT)**



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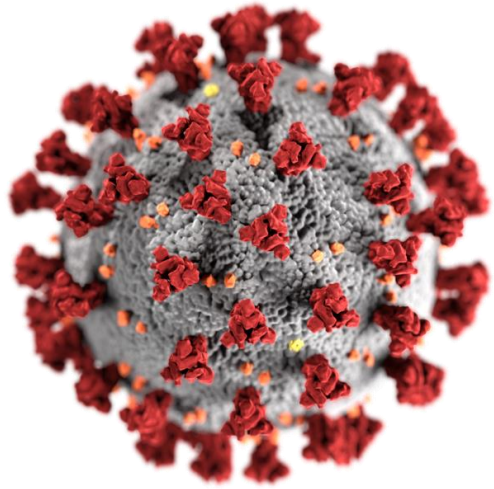
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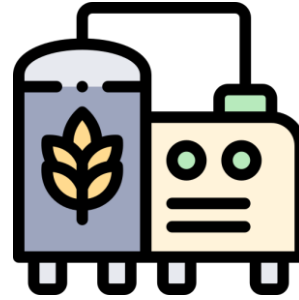
14.30 – Networking Moment

Sector trends



Consumer demands

- Healthy lifestyle
- New products
- Durability



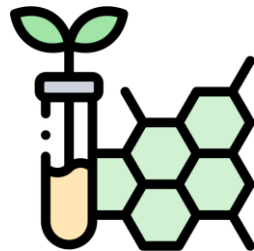
Breweries

- Need for innovation & diversification
- High prices for energy & resources
- Reduction in malt quality & quantity
- Strive for controllable brewing process & stable beer quality
- Ecological ambitions



Biotech sector

- Efficient enzyme production
- Wide range of brewing-related enzymes



Ecological ambitions

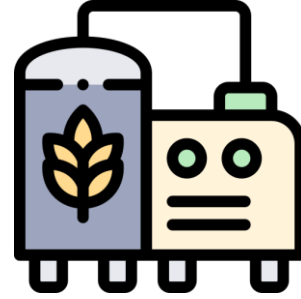
- Efficient use of resources (water, energy, starch ...)
- Short chain production

Overall objective

To provide the entire brewing sector with knowledge to tackle the challenges of **brewing with 100% unmalted alternative cereals**, aiming to introduce both alcoholic and non-alcoholic high-quality **beer-like fermented cereal drinks** to the market.



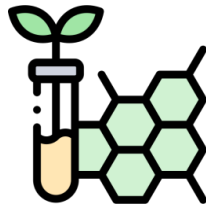
- New experiences
- Products with new functionalities (e.g. gluten-free beers)
- Durable & ecological products



- Diversification & innovation
- Less resource & energy costs
- Resource flexibility
- Controllable brewing process & beer quality
- More ecological brewing process



- New applications for enzymes



- Saving of water & energy
- More efficient use of starch in cereals
- Short chain production with local cereals

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WP 1 State of the art

Brewing with 10 unmalted alternative cereals

WP 1.1

Market trends
Legislation
Scientific Literature

WP 1.2

Characterisation of 10 raw cereals

Insight into challenges of brewing with 100% unmalted cereals

WP 2 Laboratory-scale wort production

WP 2.1

Wort optimisation for alcoholic

WP 2.2

Wort optimisation for NABLAB

6 best cereals

4 best cereals

WP 3 Wort production on 20 L scale and fermentation

WP 3.1

Evaluation of wort production

WP 3.2

Analytical & sensory evaluation

3 + 3 best cereals (alc./NABLAB)

WP 4 Scale-up to 5 hL scale

WP 4.1

Production on 5 hL scale

WP 4.2

Analytical & sensory evaluation

WP 5 Scale-up to industrial scale

WP 5.1

Production on industrial scale

WP 5.2

Analytical & sensory evaluation

WP 6 Coordination, reporting, services en dissemination

Intended milestones

WP 1 State of the art

- **M1** Insight into trends and legislation around beer-like fermented cereal drinks
- **M2** Insight into state of the art of brewing with 100% unmalted cereals & exogenous enzymes

WP 2 Laboratory-scale wort production

- **M3** Insight into brewing potential of 100% unmalted cereals with enzyme blends
- **M4** Parameters for alcoholic wort production
- **M5** Parameters for NABLAB wort production
- **M6** Insight into impact of commercial enzymes on wort production & composition

WP 3 Wort production on 20 L scale & fermentation

- **M7** Insight into brewtechnical potential of 100% unmalted alternative cereals
- **M8** Insight into sensory, physicochemical and functional properties
- **M9** Selection of 3+3 cereals for production of alcoholic/NABLAB drinks on pilot scale

WP 4 Scale-up to 5 hL scale

- **M10** Validation of knowledge from smaller scales
- **M11** Insight into physicochemical, microbiological and flavour stability of drinks

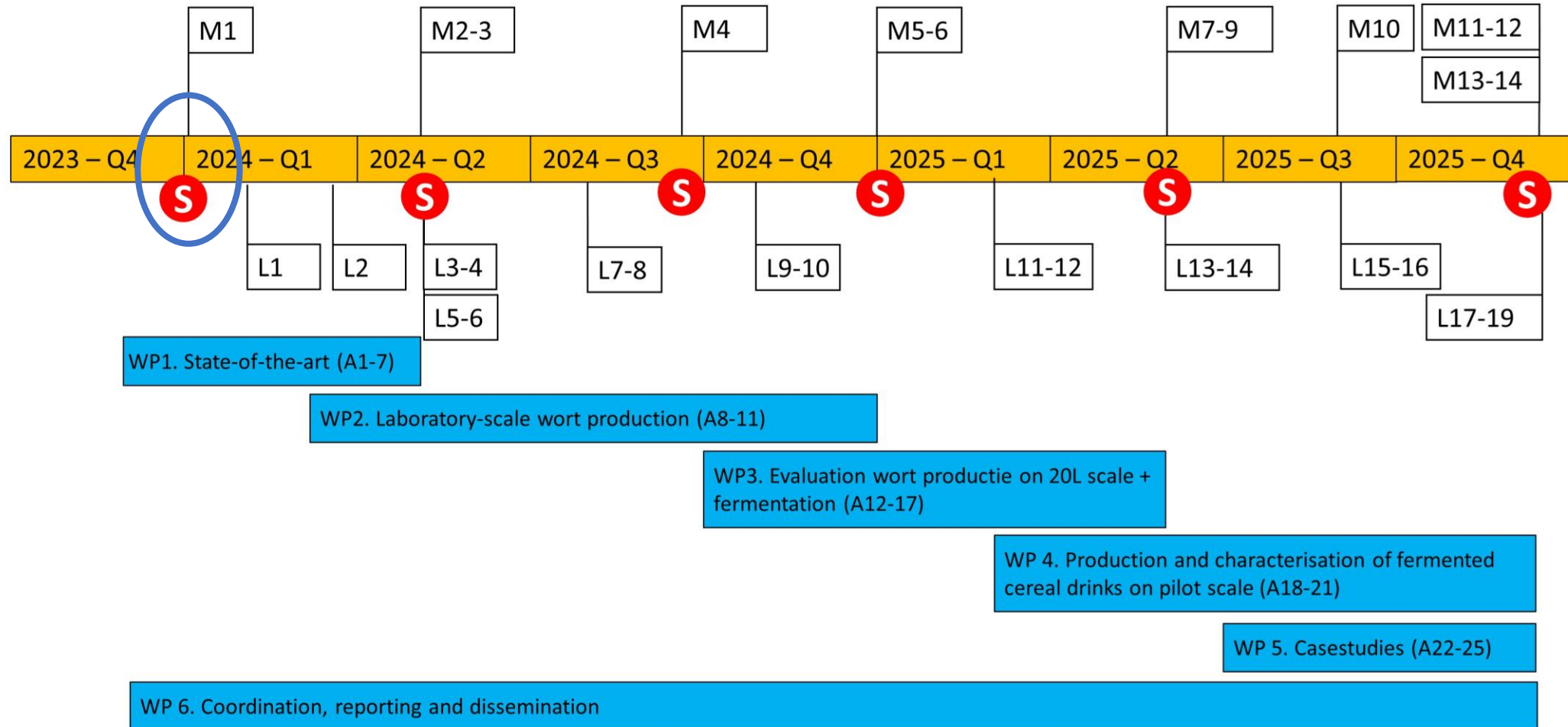
WP 5 Scale-up to industrial scale

- **M12** Insight into potential (technical, analytical, sensorical, gastronomical, consumer-acceptance) of unmalted cereals for production of beer-like drinks

WP 6 Coordination, reporting, services and dissemination

- **M13** Wide dissemination of results
- **M14** Implementation of results in the industry

Timeline



WP 1 State of the art

beer-like fermented cereal drinks,
usage of 100% unmalted cereals and
exogenous enzymes



WP 1 State of the art

- **WP 1.1** Beer-like fermented cereal drinks – trends, production & legislation
- **WP 1.2** Characterisation of raw cereals

WP 1 State of the art

- **WP 1.1** Beer-like fermented cereal drinks – trends, production & legislation
- **WP 1.2** Characterisation of raw cereals

WP 1.1 State of the art

- Market trends
- International legislation
- Scientific literature:
 - Usage of 100% unmalted cereals
 - Current exogenous enzymes
 - Selected cereals: khorasan, buckwheat, sorghum, triticale, tritordeum, rye, oats, einkorn, teff & barley

Survey



Feedback?



? Market trends

? Selected products

**We are open to using products from members of the
supervisory group!**

? Cereals (khorasan, buckwheat, sorghum, triticale, tritordeum, rye, oats,
einkorn, teff & barley)

? Exogenous enzymes

? Final selection in
coordination with
respective companies



Product	Producer	Enzymatic activity
Ondea® Pro	Novozymes	pullulanase, α-amylase, cellulase, endo-1,4-xylanase, protease (neutral), lipase
Ceremix®Flex	Novozymes	maltogeen amylase, pullulanase en α-amylase
Brewers Compass®	DSM	endo-1,4-glucanase, α-amylase, protease (neutral)
Glucoamylase 400	Lallemand	γ-Amylase
Glucanase Premier	Lallemand	Beta-glucanase, xylanase

WP 1 State of the art

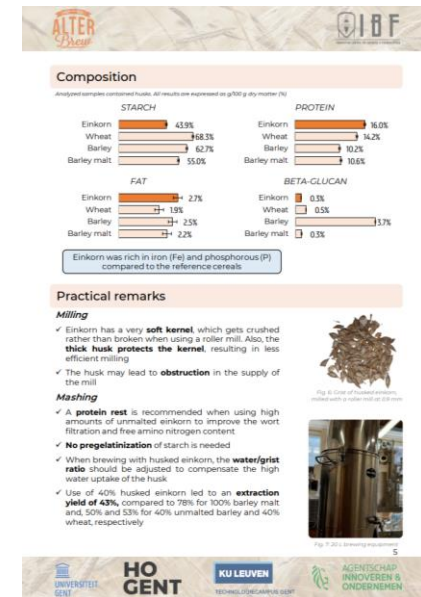
- **WP 1.1** Beer-like fermented cereal drinks – trends, production & legislation
- **WP 1.2** Characterisation of raw cereals

WP 1 State of the art

- **WP 1.1** Beer-like fermented cereal drinks – trends, production & legislation
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WP 1.2 Characterisation of raw cereals

- TETRA AlterBrew: knowledge surrounding khorasan, buckwheat, sorghum, tritordeum, einkorn & teff
- TETRA NABLAB: oats & rye
- New: triticale



WP 1.2 Characterisation of raw cereals

- Milling properties
- Thousand kernel weight
- Kernel size
- **Gelatinisation temperature** (Rheometer)
- **Enzymatic activity** (Ceralpha, Betamyl-3)
- **Composition** (EBC methods)
 - Starch, metals, proteins, fats, arabinoxylans, β -glucans, α -amylases, β -amylases



Feedback?



Deliverables WP 1

L1-L2	Selected alternative cereals and brewing enzymes
L3	Database with relevant information on brewing with selected alternative cereals & brewing enzymes
L4	Review-paper on brewing with 100% unmalted cereals



WP 2 Laboratory-scale wort production

based on 100% unmalted cereals with
exogenous enzymes



WP 2 Laboratory-scale wort production

- WP 2.1 Wort optimisation for alcoholic drinks



Maximalisation of extraction efficiency and filterability

- WP 2.2 Wort optimisation for NABLAB



Minimalisation of fermentable sugars and
maximalisation of filterability

WP 2 Laboratory-scale wort production

- **WP 2.1 Wort optimisation for alcoholic drinks**



Maximalisation of extraction efficiency and filterability

- WP 2.2 Wort optimisation for NABLAB



Minimalisation of fermentable sugars and maximalisation of filterability

WP 2.1 Wort optimisation for alcoholic drinks

1

Commercial enzyme blends + unmalted cereals

Milling & mashing as recommended (often for barley)



2

Wort characterisation



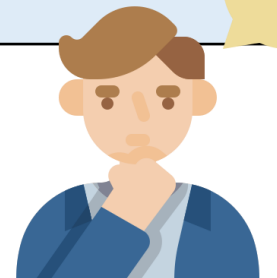
WP1 + enzyme manufacturers



- Targeted selection of additional enzymes
- For cereals with high T_{gel} and insufficient starch breakdown:
 - Thermostable amylases + modified mashing scheme
 - Enzymes that directly target ungelatinized starch



Maximalisation of extraction efficiency and filterability



WP 2.1 Wort characterisation

Mostly EBC methods

- FAN
- Amino acids (HPLC-PDA)
- Fermentable sugars & dextrins (HPAEC-PAD)
- Soluble nitrogen
- Soluble HMW proteins (Bradford)
- β -glucans
- Extract
- pH
- Colour
- Viscosity
- Filtration speed

Filtration at 78°C to better approximate industrial practice



WP 2 Laboratory-scale wort production

- WP 2.1 Wort optimisation for alcoholic drinks



Maximalisation of extraction efficiency and filterability

- **WP 2.2 Wort optimisation for NABLAB**



Minimalisation of fermentable sugars and
maximalisation of filterability

WP 2.2 Strategy for NABLAB wort optimisation

- From TETRA NABLAB: big negative influence of >60% malt:



- Uncontrollable presence of hydrolytic enzymes
- Uncontrollable presence of fermentable sugars
- Few broken down fibers and proteins



- Ideal NABLAB situation:



- Controllable enzymatic activity
- Minimize fermentable sugars
- Maximize molecular weight compounds

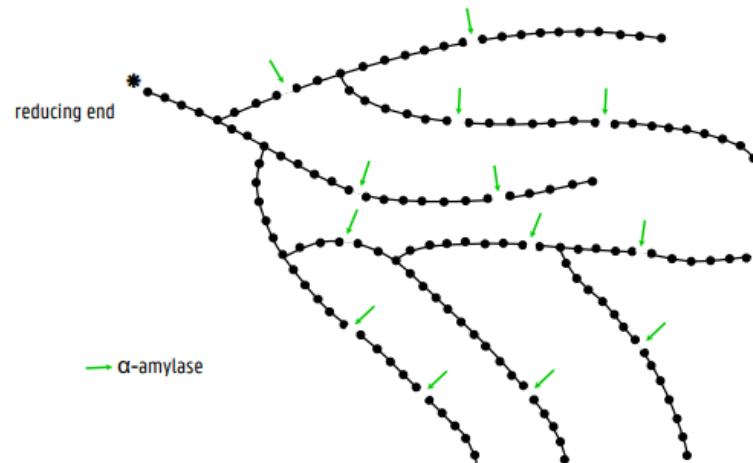
→ Minimize alcohol production
→ Avoid excessive sweetness

→ Contribute to 'body'

WP 2.2 Strategy for NABLAB wort optimisation

α -amylases:

- Endo-hydrolases:
Degrade starch at random locations into (limit) dextrins and fermentable sugars
- Starch liquefaction & declined viscosity
- T_{opt} : 72°C

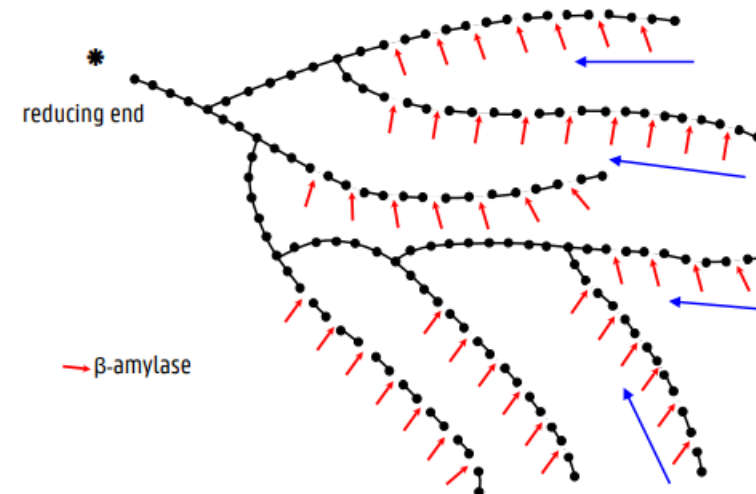


Enables



β -amylases:

- Exo-hydrolases:
Release maltose from non-reducing end starch/dextrins
- Production of fermentable sugars
- T_{opt} : 62°C



WP 2.2 Strategy for NABLAB wort optimisation

α -amylases:

- Endo-hydrolases:
Degrade starch at random locations into (limit) dextrins and fermentable sugars
- Starch liquefaction & declined viscosity
- T_{opt} : 72°C

Enables



β -amylases:

- Exo-hydrolases:
Release maltose from non-reducing end starch/dextrins
- Production of fermentable sugars
- T_{opt} : 62°C

Keep sufficient



Minimize



WP 2.2 NABLAB wort optimisation in MaltLess



- Unmalted alternative cereals:
 - LOW: α -/ β -amylases activity, fermentable sugars
 - HIGH: HMW fibers & proteins
- For each cereal: **Starting point = Mashing schemes from WP2.1 (alcoholic)**

1 Usage of thermostable exogenous α -amylases

- No exogenous β -amylases
- Adapted mashing scheme: amyolytic step at $>72^{\circ}\text{C}$  **Endogenous β -amylases inactive**
- Sufficient breakdown of starch into dextrins, minimize maltose formation

2 Gradually decrease concentration and/or exposure time exogenous α -amylases

- Determine effect on filtration time & wort composition (viscosity, extract efficiency, fermentability)

3 Usage of additional exogenous enzymes for fiber and/or protein degradation (proteases and/or hemicellulases)



WP 2.2 Wort characterisation

Mostly EBC methods

- FAN
- Amino acids (HPLC-PDA)
- Fermentable sugars & dextrins (HPAEC-PAD)
- Soluble nitrogen
- Soluble HMW proteins (Bradford)
- β -glucans
- Extract
- pH
- Colour
- Viscosity
- Filtration speed

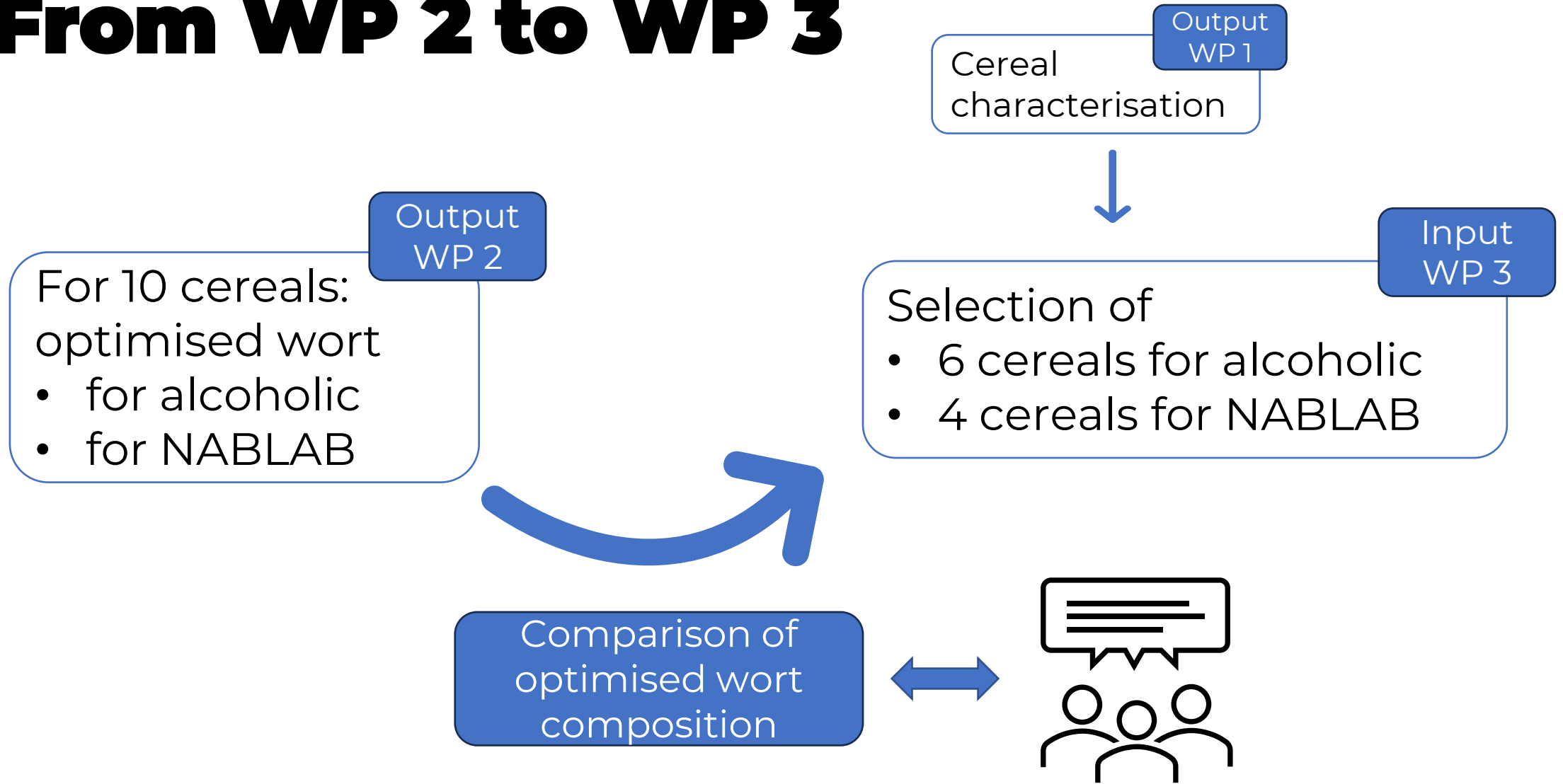


Deliverables WP 2

L5-L6	Characterised wort produced with 100% unmalted cereals and commercial enzyme blends
L7-L8	Characterised wort with optimised enzyme addition for alcoholic beer-like fermented drinks
L9-L10	Characterised wort with optimised enzyme addition for non-/low-alcoholic beer-like fermented drinks



From WP 2 to WP 3



**WP 3 Evaluation of
wort production
on a 20 L scale &
fermentation of the
optimised wort**



WP 3 Evaluation of wort production on a 20 L scale and fermentation of the optimised wort

- WP 3.1 Evaluation of wort production on 20 L scale
- WP 3.2 Fermentation with analytical & sensorial characterisation of fermented cereal drinks

WP 3 Evaluation of wort production on a 20 L scale and fermentation of the optimised wort

- **WP 3.1 Evaluation of wort production on 20 L scale**
- WP 3.2 Fermentation with analytical & sensorial characterisation of fermented cereal drinks

WP 3.1 Evaluation of wort production on 20 L scale

1. Produce wort on 20 L scale in duplicate

- Validate optimized conditions (<WP 2) for alcoholic/NABLAB drinks
- If needed: adjust (e.g. increase enzyme addition, add rice husks ...)
- Usage of neutral hop & yeast to keep the flavour of the alternative cereals intact

2. Characterise wort (and compare with WP 2)

- | | |
|-------------------|------------------------|
| ▪ Filtration time | ▪ Amino acids |
| ▪ Extract | ▪ Fermentable sugars |
| ▪ pH | ▪ Dextrins |
| ▪ Colour | ▪ Soluble nitrogen |
| ▪ Viscosity | ▪ Soluble HMW proteins |
| ▪ FAN | ▪ β -glucans |



WP 3 Evaluation of wort production on a 20 L scale and fermentation of the optimised wort

- **WP 3.1 Evaluation of wort production on 20 L scale**
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WP 3 Evaluation of wort production on a 20 L scale and fermentation of the optimised wort

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- **WP 3.2 Fermentation with analytical & sensorial characterisation of fermented cereal drinks**

WP 3.2 Fermentation of the optimised wort

- Fermentation of wort to obtain experimental fermented cereal drinks
 - **We are open to using products of supervisory group members !**
 - For alcoholic drinks: neutral yeast
 - For NABLAB: alternative yeast
- Unfiltered carbonation & filling (to see effects on beer turbidity), for NABLAB: pasteurization



WP 3.2 Analytical characterisation

- Standard: extract, pH, colour, FAN, soluble HMW proteins, fermentable sugars & dextrins, bitterness
- **Physicochemical:** viscosity, foam stability, turbidity
- **Functional properties (!):** minerals, vitamins, antioxidant power, nutritional value, gluten, amino acids, polyphenols
- **Flavour stability**



WP 3.2 Analytical characterisation

100% Unmalted alternative cereals could secure stable foam & beer haze



- **Physicochemical:** viscosity, foam stability, turbidity
- **Functional properties (!):** minerals, vitamins, antioxidant power, nutritional value, gluten, amino acids, polyphenols



Alternative cereals have potential for unique marketability:

- Healthy beer-like drinks (e.g. NABLAB high in minerals)
- Gluten-free beer
- ...



WP 3.2 Sensory characterisation

- Internal tasting panel (UGent/HOGENT)
- Supervisory group



Data from analytical characterisation



**Selection of most promising cereals for WP 4
(3 Alcoholic + 3 NABLAB)**



Deliverables WP 3

L11-L12	Bottled alcoholic drinks based on 100% unmalted cereals & an optimised mashing process and their characteristics
L13-14	Bottled non-/low-alcoholic drinks based on 100% unmalted cereals & an optimised mashing process and their characteristics
L17	Characteristics of aged alcoholic and non-/low-alcoholic bottled drinks



WP 4 Evaluation of the production process on a pilot scale (5 hL)



WP 4 Scale-up to pilot

For 3 + 3 most promising cereals:

- **WP 4.1** Production of alcoholic and NABLAB beer-like fermented cereal drinks on pilot scale (5 hL)
- **WP 4.2** Analytical and sensory characterization of fresh and aged pilot drinks
 - Standard analyses, physicochemical properties, functional properties, flavour stability
 - Sensory analysis (internal + supervisory group)

L15-L16

Bottled pilot drinks based on 100% unmalted cereals with characteristics of fresh and aged drinks



WP 5
**Implementation and
evaluation of
project results in
industrial practice**



WP 5 Scale-up to industrial scale

- **WP 5.1** Production on industrial scale
 - **Collaboration with supervisory group members**
 - Freedom as to what cereal(s), hopping, yeast ...
 - Goal: 3 different drinks, different equipment
 - Guidance by IBF members
- **WP 5.2** Evaluation of the commercial drinks
 - Analytical and sensory analysis
 - By IBF & supervisory group, but also by **consumer acceptance test** (100-250 persons) and **zythologist**

L18-L19

Bottled casestudy beer-like fermented cereal drinks with their characteristics and gastronomic potential



WP 6 Coordination, reporting, services and dissemination



WP 6 Coordination, reporting, services and dissemination

- **Three project meetings / year** with supervisory group
- Organisation of relevant **activities**:
 - Visits to trial fields
 - Sensory evaluation sessions
 - Brewery visits with best practices
- **Summary reports** for supervisory group
- Individual **visits & advice** for breweries
- Academic dissemination (congresses, publications, educational practice ...)
- Communication towards the industry (online, IBF symposium ...)



WP 1 State of the art

Brewing with 10 unmalted alternative cereals

WP 1.1

Market trends
Legislation
Scientific Literature

WP 1.2

Characterisation of 10 raw cereals

Insight into challenges of brewing with 100% unmalted cereals

WP 2 Laboratory-scale wort production

WP 2.1

Wort optimisation for alcoholic

WP 2.2

Wort optimisation for NABLAB

6 best cereals

4 best cereals

WP 3 Wort production on 20 L scale and fermentation

WP 3.1

Evaluation of wort production

WP 3.2

Analytical & sensory evaluation

3 + 3 best cereals (alc./NABLAB)

WP 4 Scale-up to 5 hL scale

WP 4.1

Production on 5hL scale

WP 4.2

Analytical & sensory evaluation

WP 5 Scale-up to industrial scale

WP 5.1

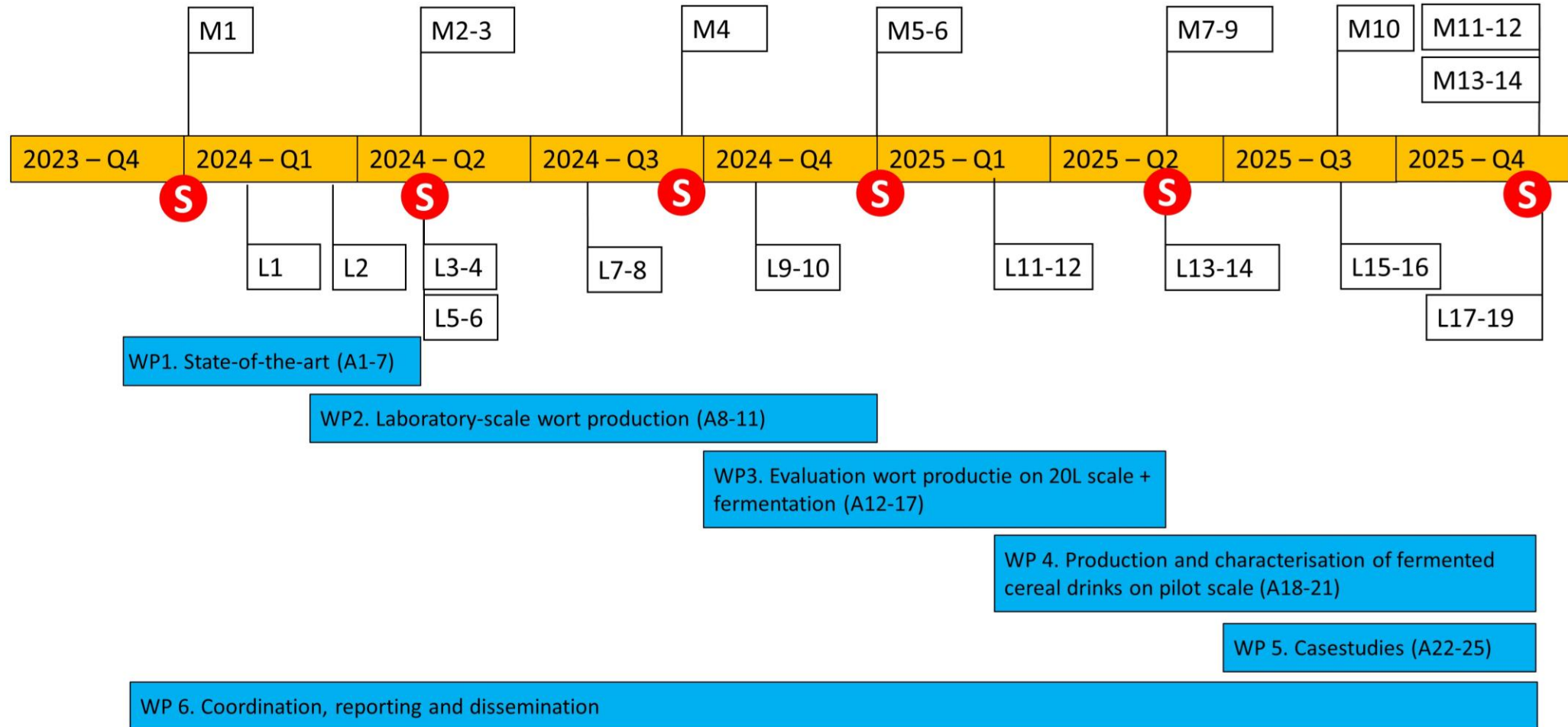
Production on industrial scale

WP 5.2

Analytical & sensory evaluation

WP 6 Coordination, reporting, services en dissemination

Timeline





Malt
Less

MaltLess kick-off meeting

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- 14.25 – Feedback & take-home message**
- 14.30 – Networking moment

Questions, remarks and feedback



To Do

- Next meeting: June, 14th (morning)
- Answer our satisfaction survey:





Contact Information

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