TRACE-RICE

INTERNATIONAL CONFERENCE ON SUSTAINABLE FOODS
Achieving the Sustainable Development Goals

ESTIG/IPB BRAGANÇA, PT

July 24-25 2024

RFID

TRACING RICE AND VALORIZING SIDE STREAMS ALONG MEDITERRANEAN BLOCKCHAIN

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

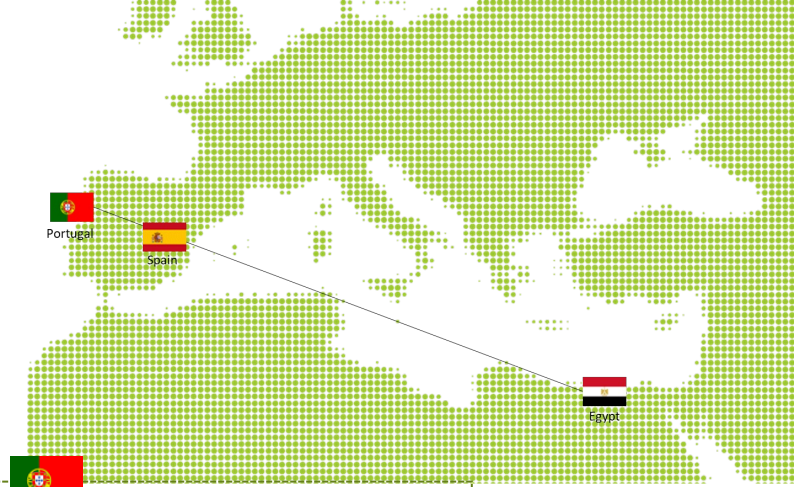Instituto Nacional de Investigação Agrária e Veterinária, I.P.
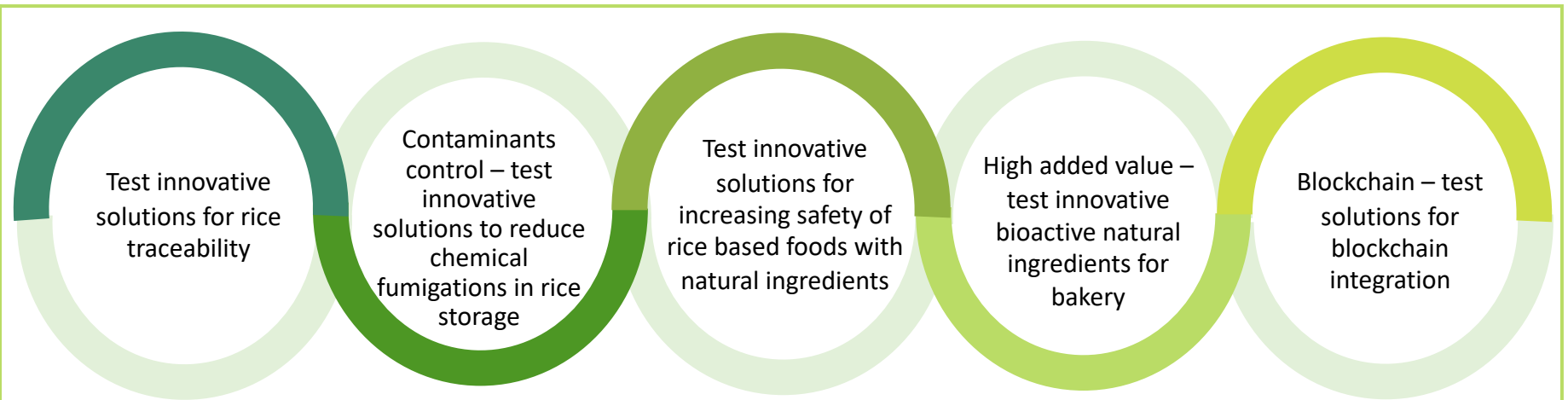iniav

Trace RicE

Adoption of tools for traceability, authenticity, contaminant mitigation and conversion of by-products to innovative rice base food produced in the Mediterranean.

From 2020 to 2024 brings together 10 partners from public and private sectors across the Mediterranean for delivering reliable and economic strategies to certify what is circulating in the European market.

Portugal
Spain
Egypt

iniav — Instituto Nacional de Investigação Agrária e Veterinária, I.P.
iBET — Instituto de Biologia Experimental e Tecnológica
ITQB NOVA DE LISBOA
CASA DO ARROZ
ernesto morgado desde 1925
MATER DYNAMICS
BGI
ALEXANDRIA UNIVERSITY

Grupo Desarrollo
iata — Instituto de Agroquímica y Tecnología de Alimentos

TRACE-RICE ambition is to strengthen the competitiveness of the Rice Mediterranean value chain supported by five main pillars:

Test innovative solutions for rice traceability

Contaminants control – test innovative solutions to reduce chemical fumigations in rice storage

Test innovative solutions for increasing safety of rice based foods with natural ingredients

High added value – test innovative bioactive natural ingredients for bakery

Blockchain – test solutions for blockchain integration

Overview of TRACE-RICE WPs

**WP1:** TEST SOLUTIONS FOR AUTHENTICITY, ORIGIN AND TRACEABILITY

- Identification of a collection of a subset of 22 target varieties
- DNA-based methods in rice certification
- Chemical and rheometric data related to the rice quality of target varieties
- Data management

WP2: TEST SOLUTIONS AND BEST PRACTICES TO REDUCE CHEMICALS

- Integrated mapping of existing solutions to prevent insect infestation, mycotoxin contamination, and pathogen development
- Catalogue of predictive models of microbial inactivation and growth

WP3: CIRCULAR ECONOMY APPLICATIONS IN RICE CULTIVATION AND NEW HIGH-ADDED VALUE PRODUCTS

- Market analysis of rice-based products and election of consumers targets
- Innovative rice based foods and beverages

WP5 EXPLOITATION AND REPLICABILITY

WP6 DISSEMINATION AND COMMUNICATION

WP1 TEST SOLUTIONS FOR AUTHENTICITY, ORIGIN AND TRACEABILITY

WP2 TEST SOLUTIONS AND BEST PRACTICES TO REDUCE CHEMICALS

WP3 CIRCULAR ECONOMY APPLICATIONS IN RICE CULTIVATION AND NEW HIGH-ADDED VALUE PRODUCTS

WP4 TEST SOLUTIONS FOR BLOCKCHAIN INTEGRATION AND DEVELOPMENT OF PREDICTIVE MODELS

WP7 PROJECT MANAGEMENT
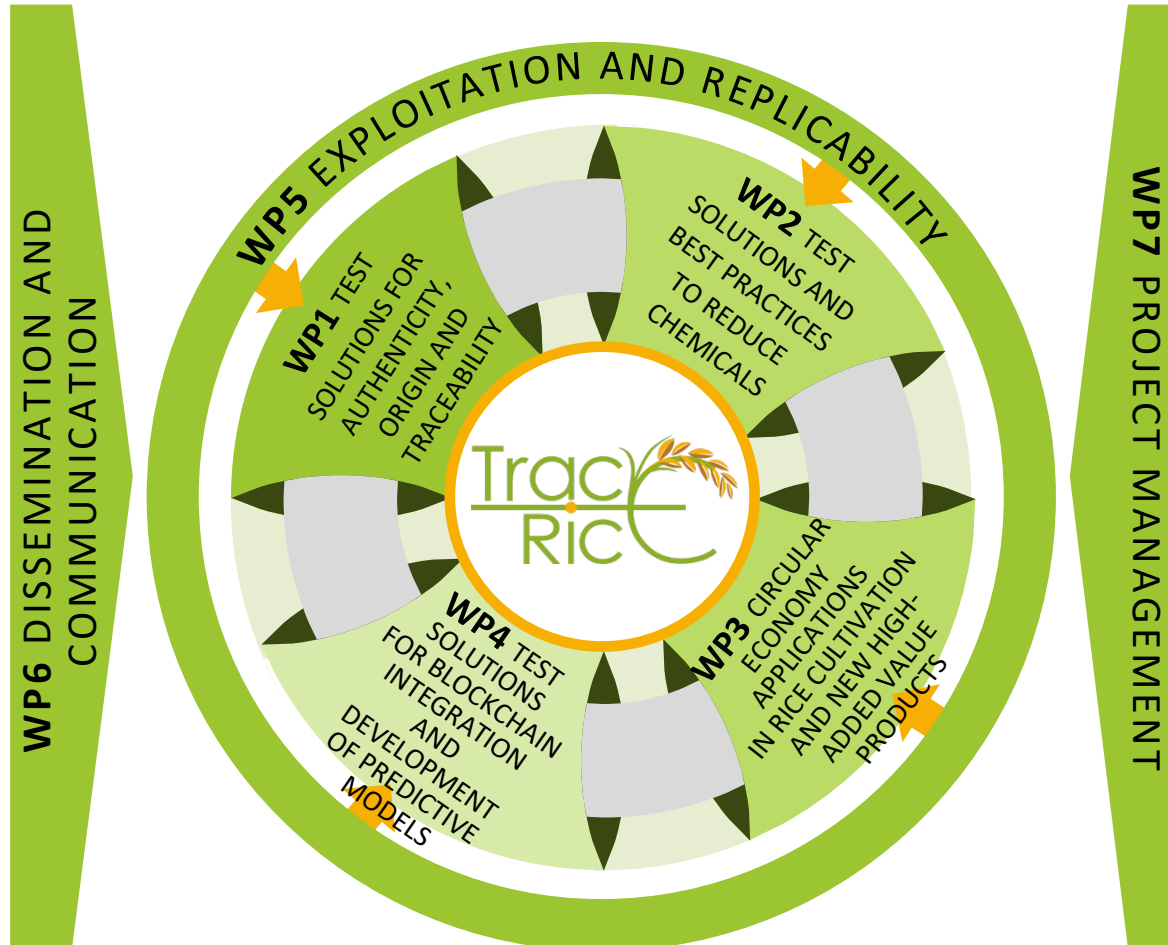
WP4: TEST SOLUTIONS FOR BLOCKCHAIN INTEGRATION AND DEVELOPMENT OF PREDICTIVE MODELS

- Pilot study for blockchain integration and development: definition of system architecture and case study variables
- Digital tool to generate rice field datasets and images: the related specifications and design guidelines were elaborated for further testing and upload to the web

WP6: DISSEMINATION AND COMMUNICATION

- website www.trace-rice.eu
- Social media (LinkedIn and Youtube channel)
- Flyers and posters in partner's languages
- Project presentation videos

WP7: PROJECT MANAGEMENT

- Project management handbook
- Quality assurance plan
- Data management plan

DNA-based methods in rice certification

20 SELECTED VARIETIES:

Seed germination in hydroponics in Yoshida medium

DNA isolated from leaves (CTAB method)

Seeds homogenized with CryoMill or coffee grinder

DNA isolated from seeds (CTAB method)

Arborio
Ulisse
Ronaldo
Ariete
Giza 181
Arelate
Caravela
Super Basmati
Maçarico
J. Sendra
Gageron
Manobi
Carnaroli
Elettra
Teti
CL-28
Giza 177
Albatros
Lusitano
Basmati type III

Whole-genome sequencing
(Illumina)

Bioinformatic analysis
of the 20 genomes
+2 previously sequenced:
Bomba and Puntal

Identification of polymorphisms
and design of a functional
detection method

DNA-based methods in rice certification

WP1

Whole-genome sequencing of 20 genotypes *(Illumina)*

+ Bomba & Puntal
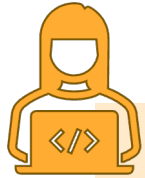
Bioinformatic analysis *(22 varieties)*

Design of an **efficient detection method**

Identification of **polymorphisms**
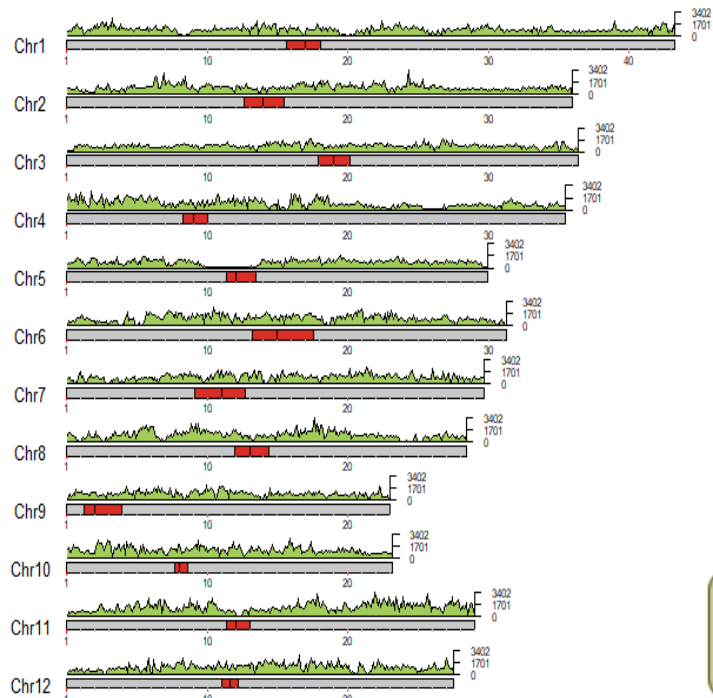
(GATK workflow for variants calling)

3,612,131 **SNPs**

1,217,118 **InDels**

>15 bps
52,174 InDels

6 primer pairs distinguish **all selected varieties**
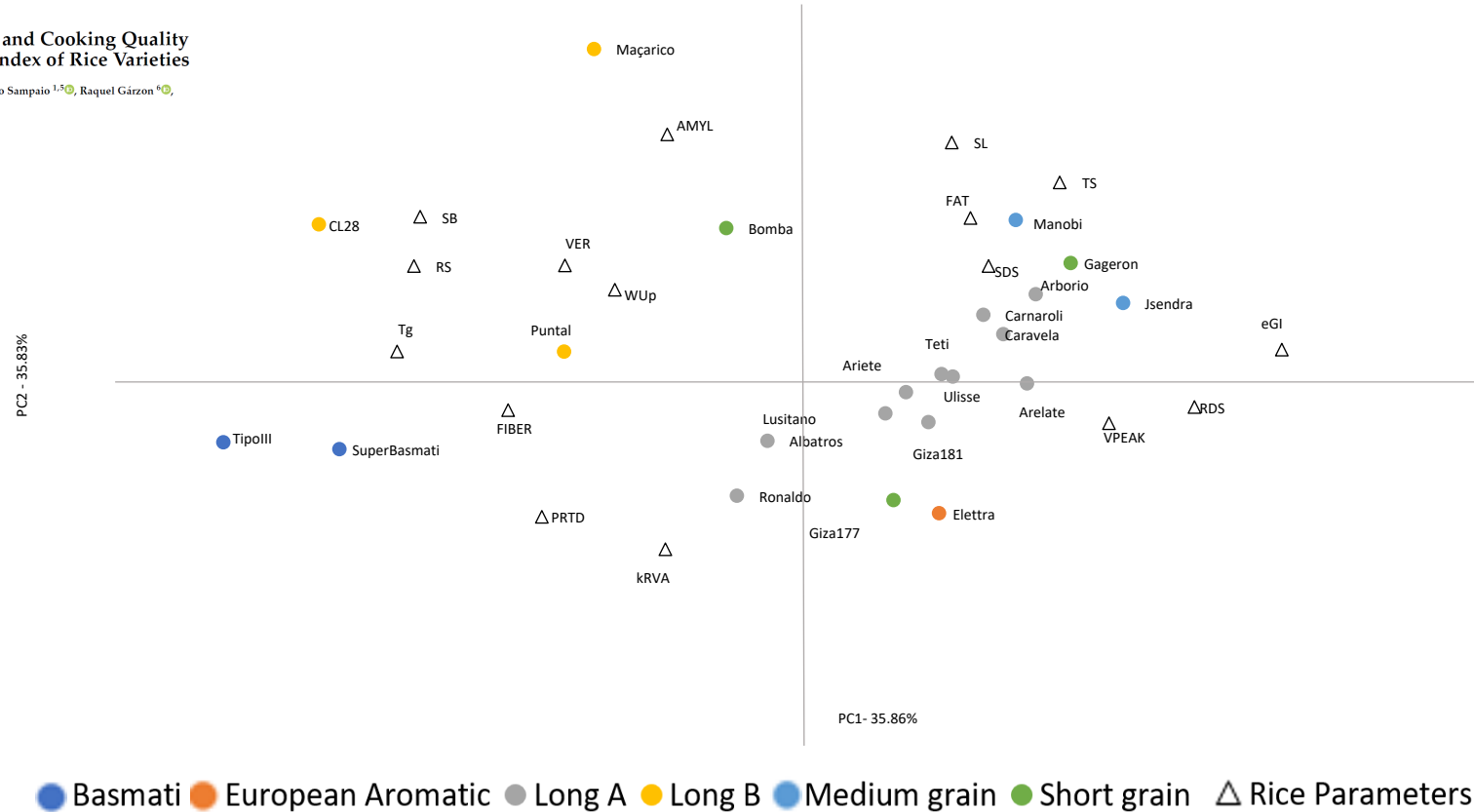- PCR reaction
- gel electrophoresis
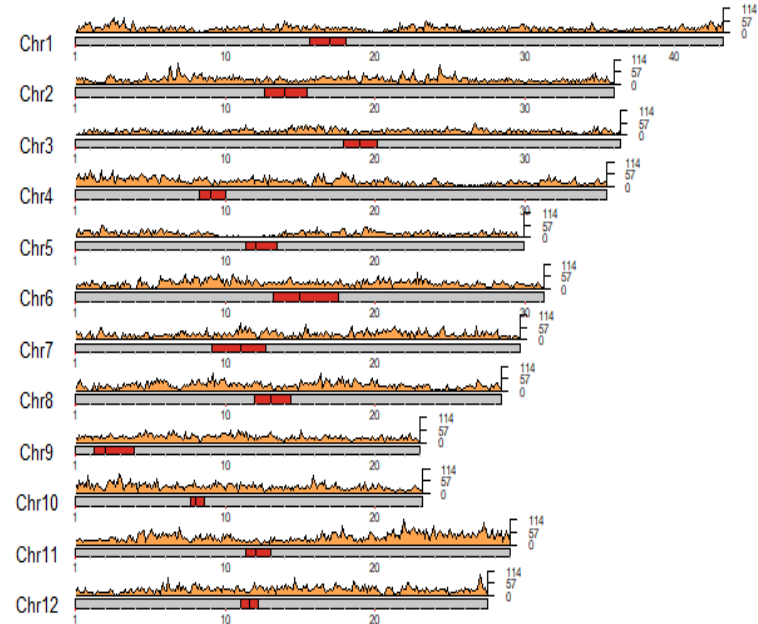
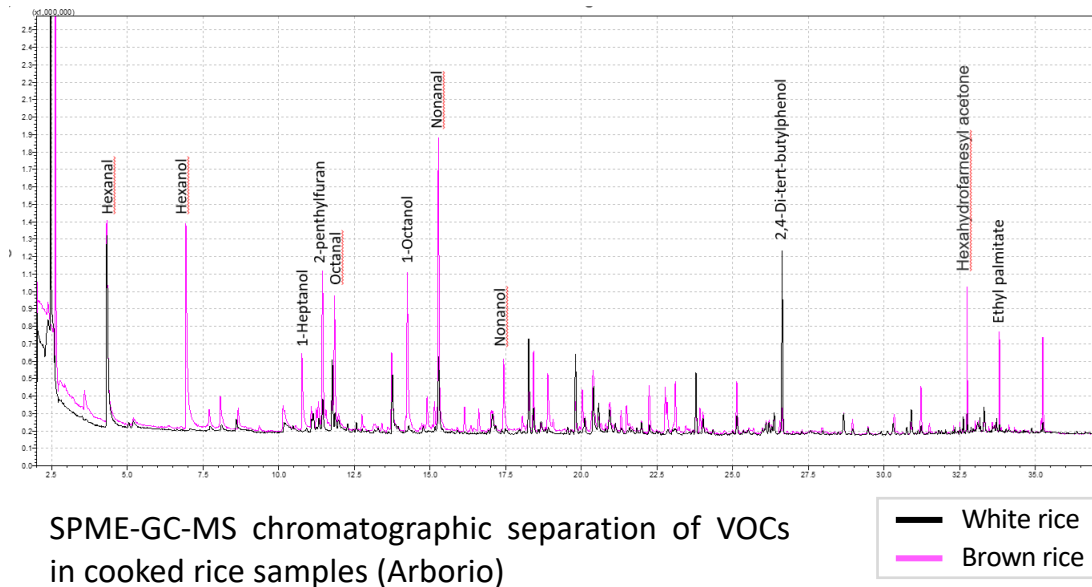# Chemical and rheometric data of rice quality

Rice varieties with lower eGI have lower digestion rates, lower RDS, higher RS contents and Tg, as well as a greater tendency to retrogradation (SB)

Chemical and rheometric data of rice quality

Characterization of volatiles- flavour/odour traits to identify those with stronger contribution

Characterization of compounds responsible for **sweet** and **bitter** taste (saponins, phenolic saponins, benzaldehyde, lipid deterioration products, phenolic compounds)

## Untargeted SPME-GC-MS characterization of volatile organic compounds (VOCs)

Optimized protocol to extract: **Free** phenolics, **Soluble conjugate** phenolics and **insoluble-bound** phenolics

## HPLC-DAD-ECD analysis of phenolic compounds

SPME-GC-MS chromatographic separation of VOCs in cooked rice samples (Arborio)

Quantitative and **qualitative differences** in **VOCs** allow distinguishing **white** and **brown** cooked rice samples
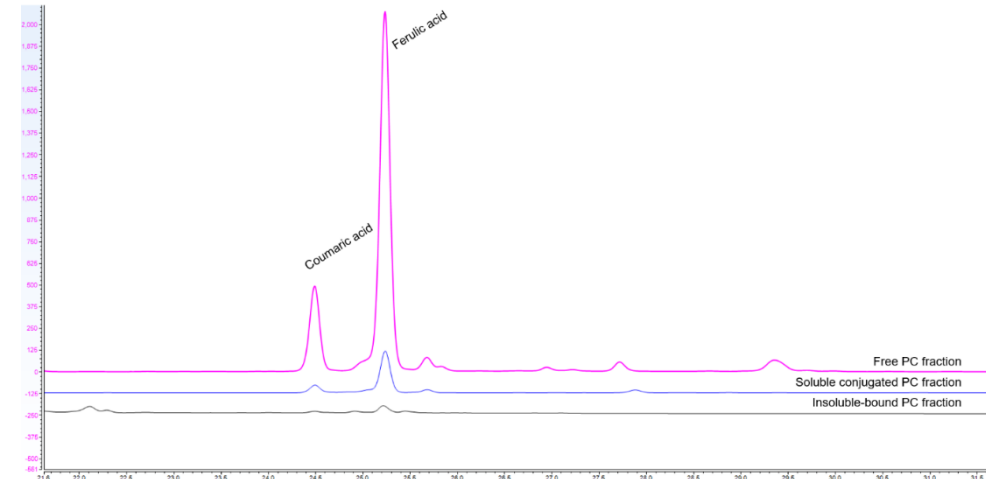
Chromatographic separation of p-coumaric and ferulic acid (320 nm) of the diferent phenolics compounds (PC) fractions from rice bran test sample

Chemical and rheometric data of rice quality

WP1

Spectral data to build models for the prediction of different **parameters related to rice quality, safety and authenticity**

Collection of spectral data using Fourier-transform infrared spectroscopy (FTIR) and near-infrared spectroscopy (NIR)
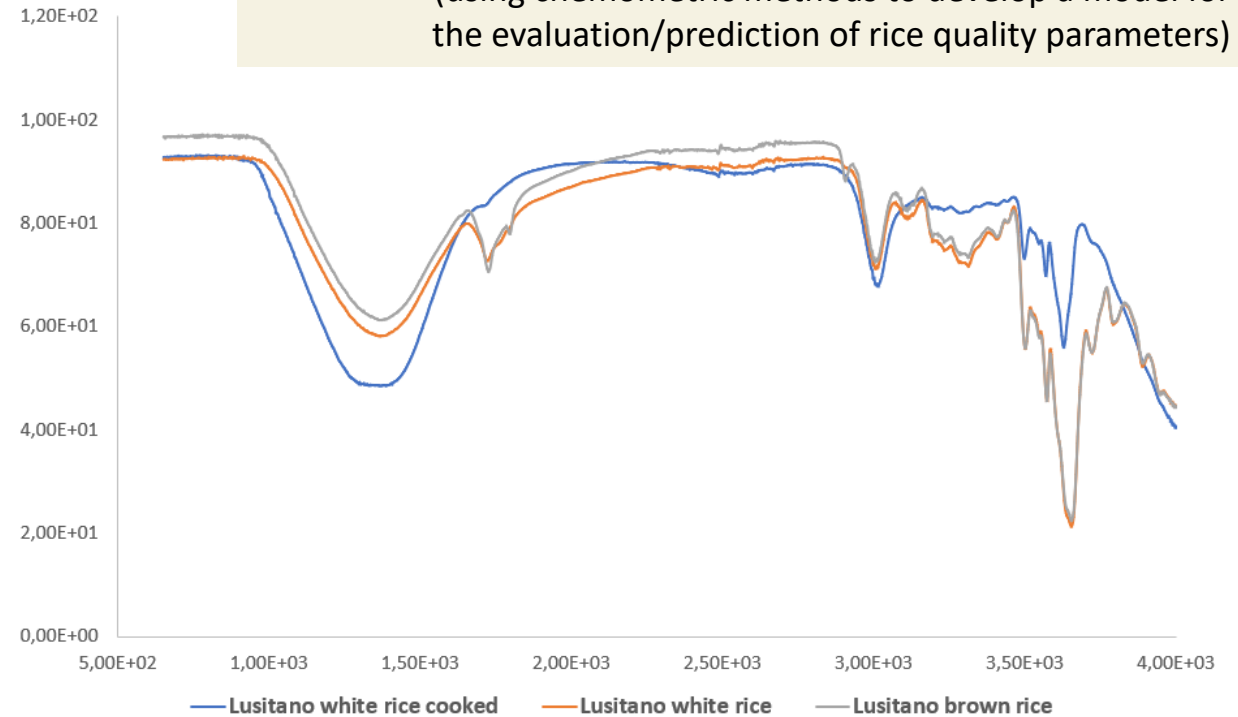
FTIR spectral data from raw rice flour
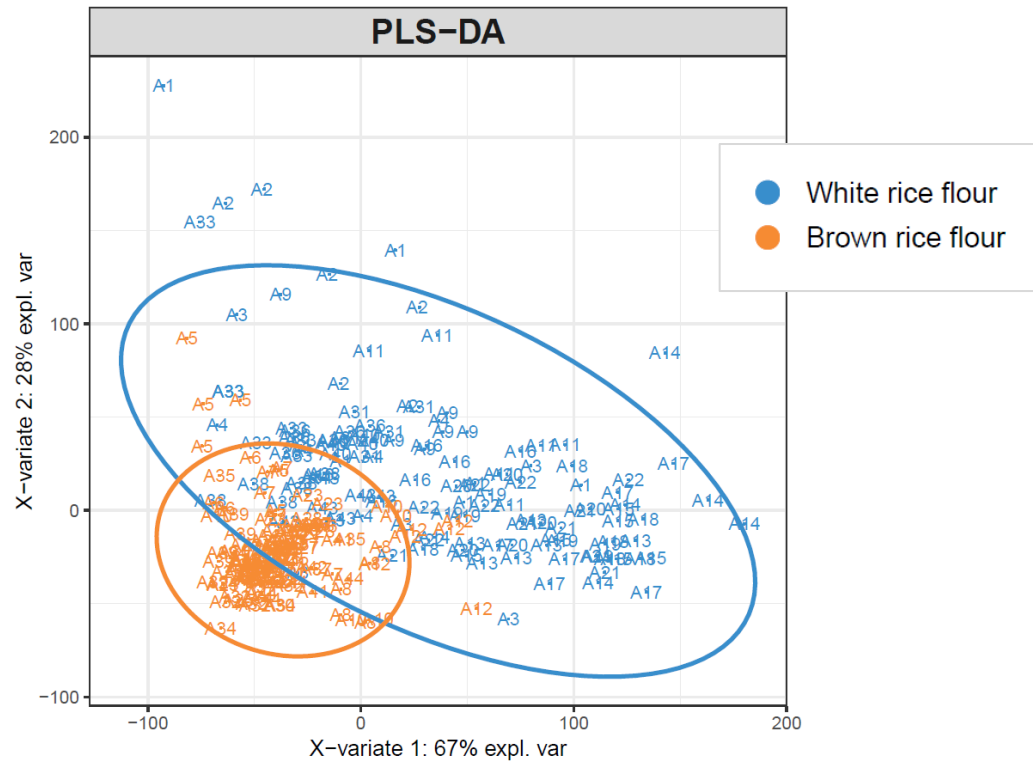
PLS-DA of 22 varieties of white and brown rice flour samples

Data processing currently ongoing

(using chemometric methods to develop a model for the evaluation/prediction of rice quality parameters)

FTIR absorption spectra of "Lusitano" rice samples

Data Management

BioData.pt

All the samples => annotated following the best practices and using the **MIAPPE checklist**

(the Portuguese node of ELIXIR)

Liinks to **ELIXIR** => *following* **MIAPPE standards**

Minimum information about Plant Phenotyping Experiments (all metadata)
(Good practices in Data Management)

PHENO (BrAPI end point)

BrAPI (Breeding API – Application Program Interface)

Effort to enable **interoperability** among plant breeding databases

- ➢ **European varieties** annotated following the **EU Plant Variety** database
- ➢ **Observed trait** (e.g., amylose content) annotated following the Rice specific **Crop Ontology** and **Gramene** databases
- ➢ **Data linked to a Universal Unique Identifier (UUID)** team member / institution, geolocation fingerprint (GFP), Unique Event Identifier (UEI) / submitted characterization dataset, and a timestamp.
- ➢ **Build predictive generation models => Assess rice authenticity using machine learning strategies** (eg: random forest => effective method for classification of gene analysis and metabolomics - already applied for identification of rice seed varieties).
- ➢ **Digital platform for data uploading and processing** (cross-sharable database for producers, auditors and end-consumers).

Solutions & best practices to reduce chemicals

Integrated mapping of existing solutions to prevent:

(i) insect infestation

(ii) mycotoxin contamination

(iii) pathogen development

foods — MDPI

Review

Advances in environmentally friendly techniques and circular economy approaches for insect infestation management in stored rice grains

Inês Gonçalves de Sousa [1,2], Jorge Oliveira[3], António Mexia[2,4], Graça Barros[4], Carina Almeida[1], Carla Brazinha[5], Anna Vega[4], Carla Brites[1,7*]

toxins

an Open Access Journal by MDPI

Mycotoxins Contamination in Rice: Analytical Methods, Occurrence and Detoxification Strategies

Ana Rita Santos; Filipa Carreiró; Andreia Freitas; Sílvia Barros; Carla Brites; Fernando Ramos; Ana Sanches Silva

Toxins 2022, Volume 14, Issue 9, 647

foods — MDPI

Review

Risk of *Bacillus cereus* in Relation to Rice and Derivatives

Dolores Rodrigo *, Cristina M. Rosell and Antonio Martinez

Test of the efficiency of physical and bio-based solutions for limiting insect contamination

Catalogue of predictive models of microbial inactivation and growth as function of processing and storage conditions
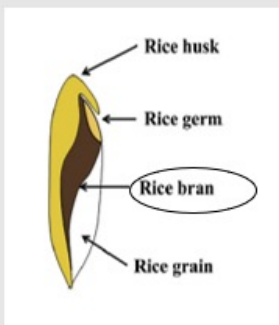
Circular economy applications and new high-added value products

Converting by-products to innovative natural ingredients
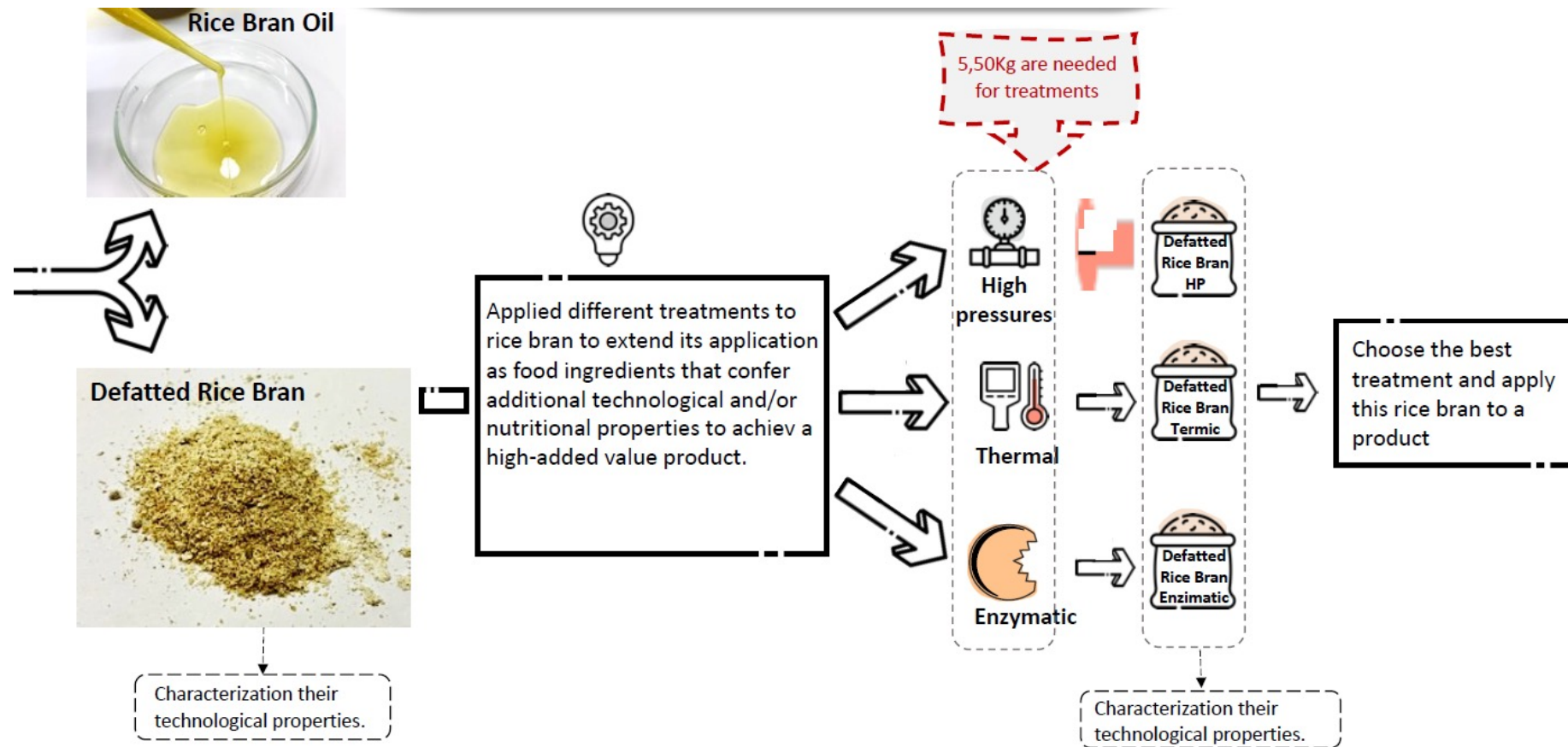
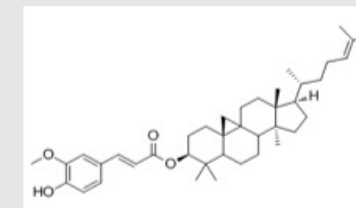# Circular economy applications and new high-added value products

Extraction of bran bioactive compounds

Extract rich in γ-oryzanol: anticarcinogenic, anti-inflammatory, antidiabetic and neuroprotective, which are mainly attributed to its antioxidant capacity

	SFE*	Soxhlet (hexane)	Soxhlet (ethanol)
Extraction yield (%)	17.3	18.0	24.9
γ-Oryzanol (mg/g$_{extract}$)	36.6	18.57	21.6
Antioxidant activity, ORAC (μmol TEAC/g$_{extract}$)	450 ± 48	480 ± 50	310 ± 10

Supercritical CO_2 extraction (SFE)

*Optimized SFE conditions:

Flow rate: 20 g/min

Extraction time: 180 min

Pressure: 500 bar

Temperature: 62 °C

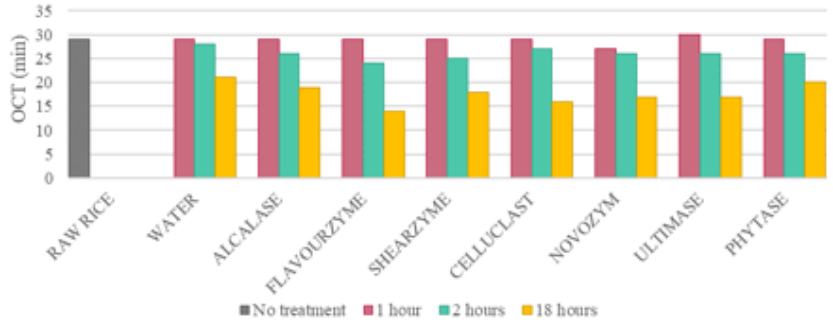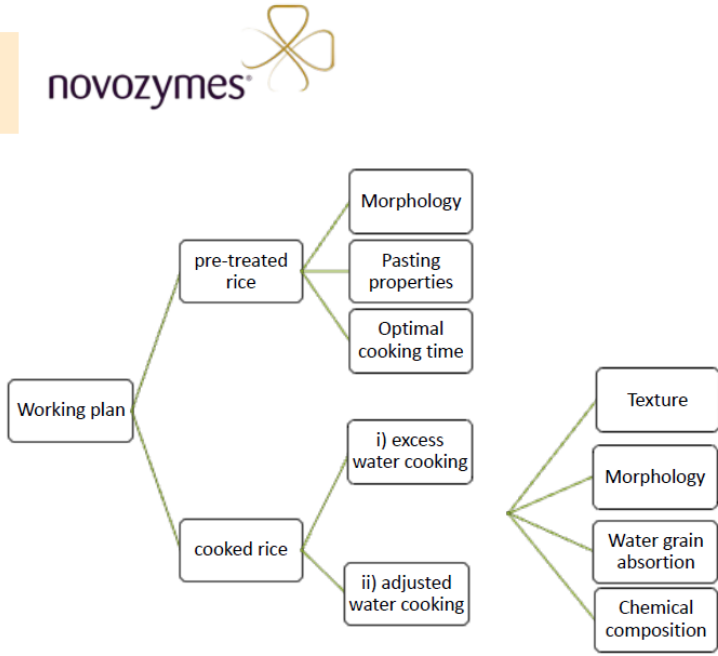**Comparative analysis of γ-Oryzanol profiles in the bran of exotic rice varieties**

Cristiana L. Pereira,[1,3] Manuela Lageiro,[1,2,3] Carla Brites[1,4]

Circular economy applications and new high-added value products

Increase the functionality of brown rice and their bioactive compounds by enzymatic treatments

Brown rice — ENZYMES — novozymes

PROTEASES
- Alcalase-Pro 1
- Flavourzyme-Pro 2

XYLANASE
- Shearzyme-Xyl 1
- Celluclast-Xyl 2
- Ultimase-Xyl 3
- Novozym-Xyl 4

PHYTASE
- Phytase-Phy

Working plan
- pre-treated rice
  - Morphology
  - Pasting properties
  - Optimal cooking time
- cooked rice
  - i) excess water cooking
  - ii) adjusted water cooking
    - Texture
    - Morphology
    - Water grain absortion
    - Chemical composition

OCT (min): RAW RICE, WATER, ALCALASE, FLAVOURZYME, SHEARZYME, CELLUCLAST, NOVOZYM, ULTIMASE, PHYTASE

■ No treatment ■ 1 hour ■ 2 hours ■ 18 hours

Decrease of cooking time with the enzymes treatments

Circular economy applications and new high-added value products

Rice-based products

https://issuu.com/graosbrasil/docs/granos142online

Market analysis of rice-based products and election of consumers targets

Different strategies were identified that are currently being tested to increase the functionality of rice and their bioactive compounds such as germination, fermentation, physical and enzymatic treatments

Developing innovative food and beverages

Bakery products enriched in fiber produced from rice bran

Gluten

Gluten FREE

Brown, white and germinated rice fermented products

Improved bakery products with the fiber fine fraction (<210 μm) to increase the 'invisible' fiber

Optimization of GABA and taste of fermented beverage

Circular economy applications and new high-added value products

Inovative Rice-based Foods
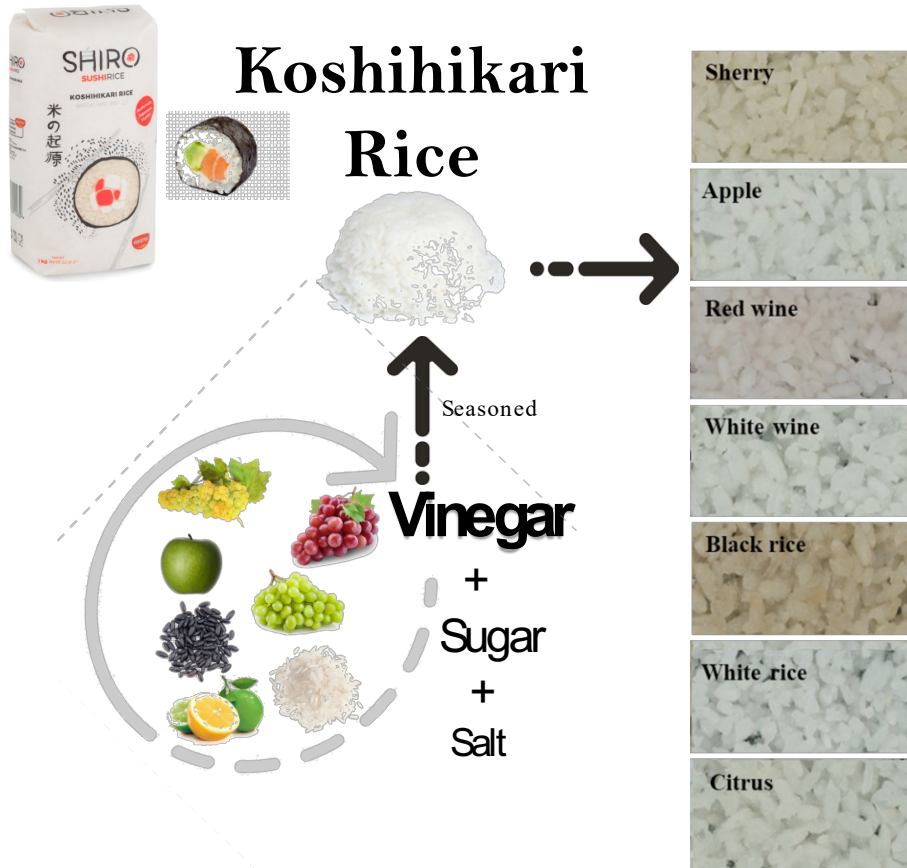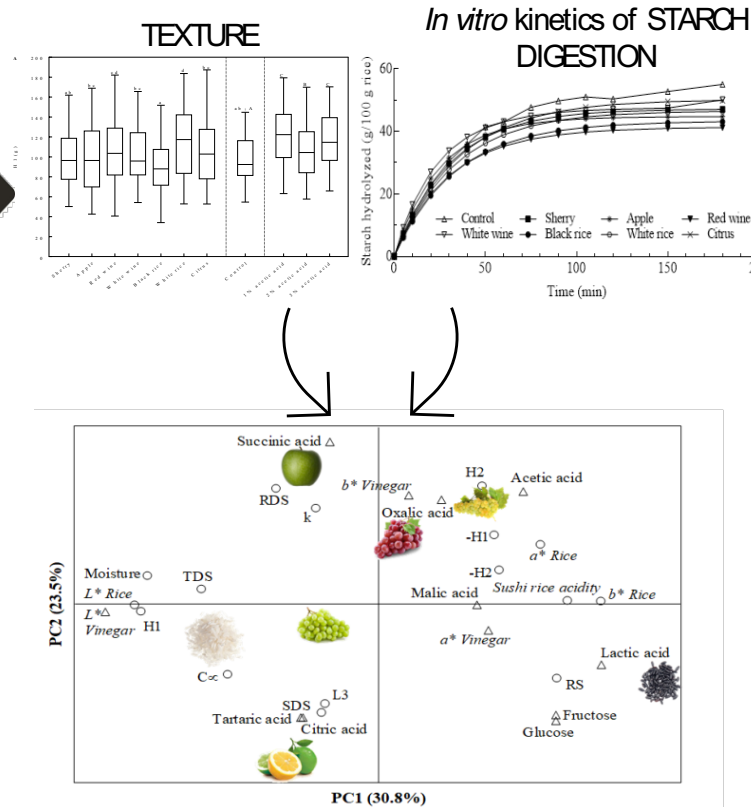
Seasoning impact on cooked rice quality: technological and nutritional implications for sushi

- Sherry vinegar produced the highest acidity and adhesiveness

- The acetic acid of the vinegar could prevent the complete digestion of complex carbohydrates
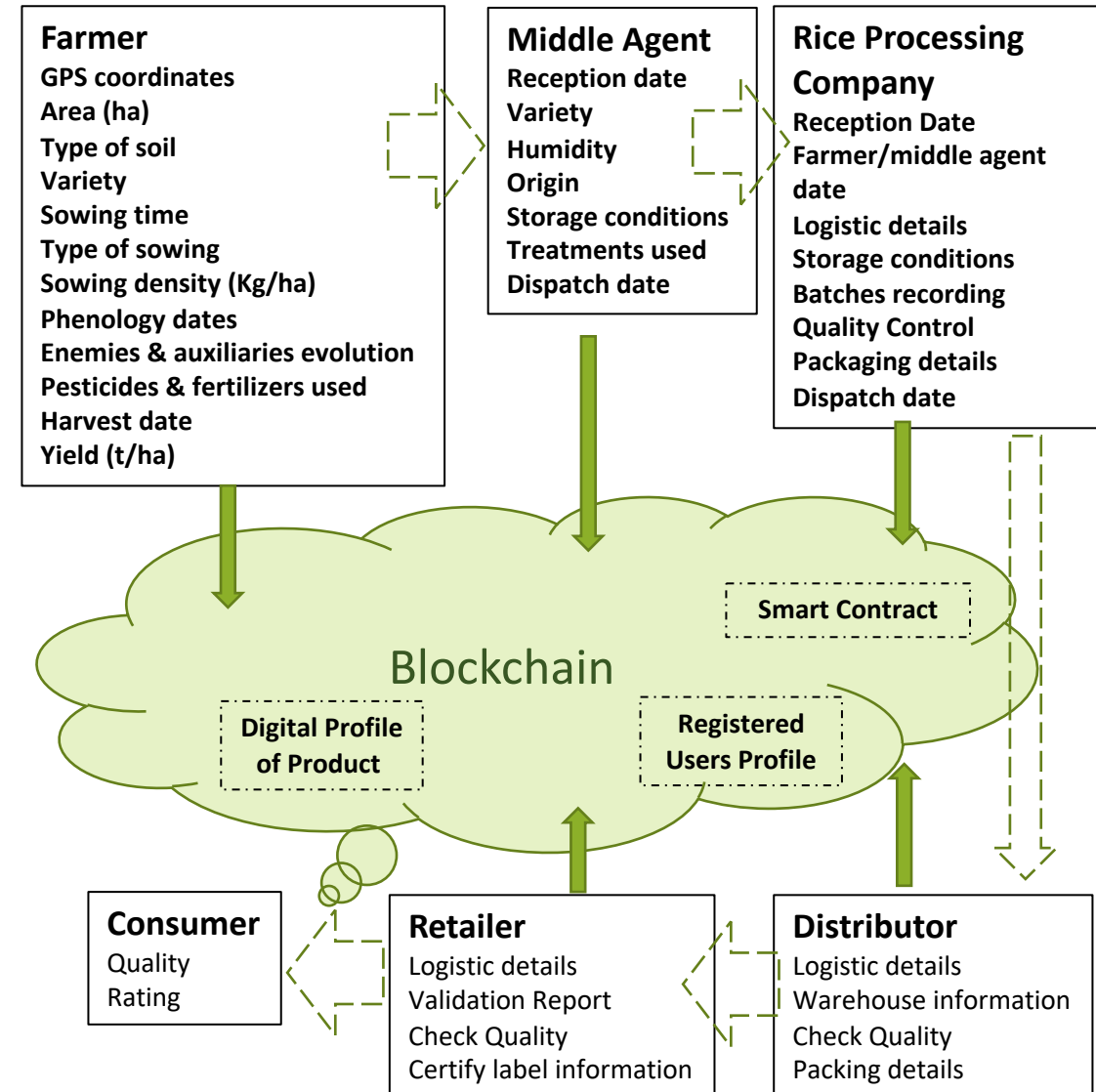
Solutions for blockchain integration

Several issues on the rice value chain:

- A lack of transparency and traceability leads to frauds, contractual breaches and insurance claims
- Documents need to be checked and matched manually
- Higher costs on traceability and control
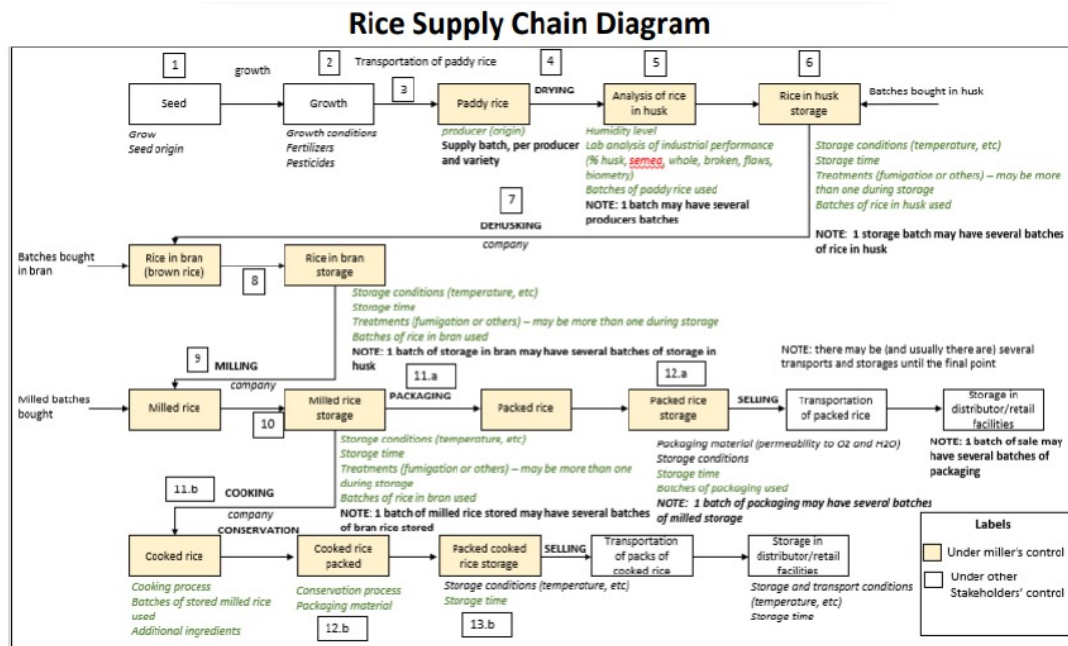
Solution:

Develop a software-as-a-service (SaaS) solution, supported on blockchain technology, that allows for rice products to be traced and tracked throughout the whole value chain

Farmer
GPS coordinates
Area (ha)
Type of soil
Variety
Sowing time
Type of sowing
Sowing density (Kg/ha)
Phenology dates
Enemies & auxiliaries evolution
Pesticides & fertilizers used
Harvest date
Yield (t/ha)

Middle Agent
Reception date
Variety
Humidity
Origin
Storage conditions
Treatments used
Dispatch date

Rice Processing Company
Reception Date
Farmer/middle agent date
Logistic details
Storage conditions
Batches recording
Quality Control
Packaging details
Dispatch date

Blockchain

Smart Contract

Digital Profile of Product

Registered Users Profile

Consumer
Quality
Rating

Retailer
Logistic details
Validation Report
Check Quality
Certify label information

Distributor
Logistic details
Warehouse information
Check Quality
Packing details

Solutions for blockchain integration

Definition of case study variables

Rice Supply Chain Diagram

Enhancing Rice Authenticity and Traceability Through a Digital Field Data Recording App

C. Gonçalves[1], J. Fernandes[1], C. Silva[2], C. Brites[1]*,

[1]INIAV, National Institute for Agriculture and Veterinary Research, Oeiras, Portugal

[2]Ribarroz, Cabeção, Portugal

*carla.brites@iniav.pt

Development of Esri ArcGIS Collector Mobile App for rice field data register in compliance with protect production guidelines

- to generate reports for the rice chain stakeholder's

- is a support tool with a critical role to play in the traceability and authenticity of rice

- with an multidisciplinary approach that incorporates operational research, geographic information systems and rice field specific analysis

- the model was build as a pilot case study of UNIARROZ/EM

Dissemination, communication and achievement indicators

22 ARTICLES

80 NEWS

34 DELIVERABLES

20 DELIVERABLES SUBMITTED

554 Followers | LinkedIn

29 POSTERS

13 KPIs

8 KPIs ACHIEVED

thank you!

Carla Brites

http://trace-rice.eu/