We have
1001 reasons
to invest in sorghum

GRAIN QUALITY

GLOBAL APPROACH TO INTEGRATE NEW TARGETS IN BREEDING WORK

Sorghum ID
SORGHUM A KEY TO BUILD OUR FUTURE

SEEDS FROM EUROPE

CAMPAIN FINANCED WITH AID FROM THE EUROPEAN UNION

ENJOY
IT'S FROM
EUROPE

We have 1001 reasons to invest in sorghum

Joël ALCOUFFE

Sorghum breeding coordinator
RAGT2n

We have 1001 reasons to invest in sorghum

Sorghum plays a significant role in human food especially in regions with challenging climates and lower incomes

Even if in Europe grain sorghum production is mainly dedicated to feed, uses in human food are emerging.

In both cases, grain quality qualification and improvement are important for the value chain.

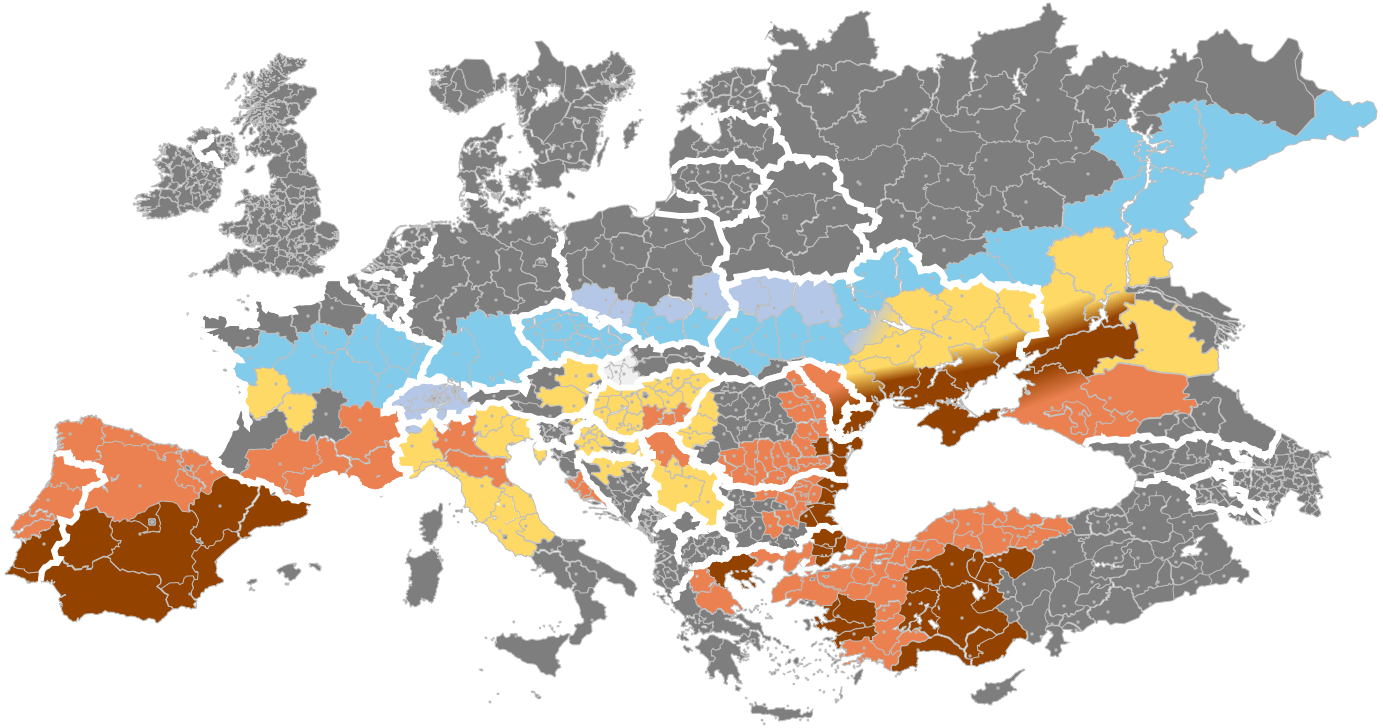
NITROSORG project is an example of collaborative work which addressed the objective to develop tools to be implemented in breeding strategies

Remind main GRAIN breeding targets

- **EARLINESS**
- **YIELD**

- **PLANT ARCHITECTURE**

- **STABILITY ACROSS ENVIRONMENTS**
  - Lodging resistance
  - Drought tolerance
  - Temperatures
  - Stay Green
  - Diseases (stem, foliar)



- **GRAIN**
  - COLOR
  - TANIN
  - **Grain content & quality**

NITROSORG

JAN 2022 – JUNE 2025

Total project amount: 243 343 €

(without public salaries)

CASDAR Grant (Public founding) : 192 562€

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RÉPUBLIQUE FRANÇAISE

MINISTÈRE DE L'AGRICULTURE ET DE L'ALIMENTATION

AVEC LA CONTRIBUTION FINANCIÈRE DU COMPTE D'AFFECTATION SPÉCIALE DÉVELOPPEMENT AGRICOLE ET RURAL

NitroSorg

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UE

PEAT

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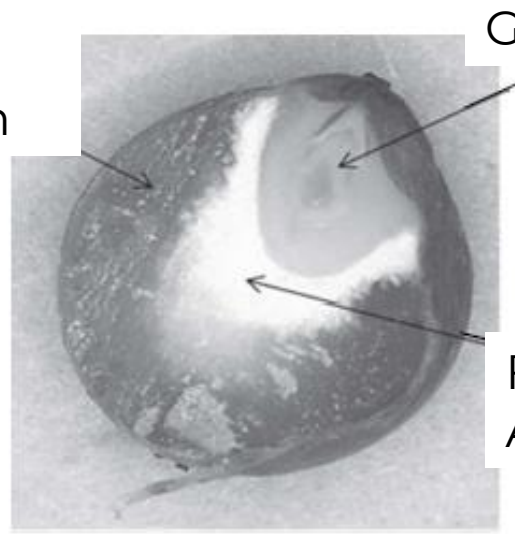
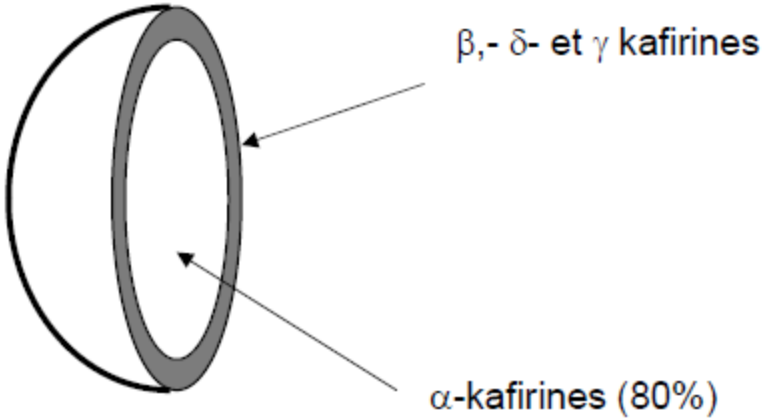
Context: sorghum GRAIN

Main features

- **80% STARCH & PROTEINS** located in albumen > genetic variability <
- **STARCH**: mainly AMYLOSE & AMYLOPECTIN in pellet form
- **KAFIRINS:** main sorghum proteins, storage proteins





Corps protéique du grain de Sorgho

Context: sorghum GRAIN

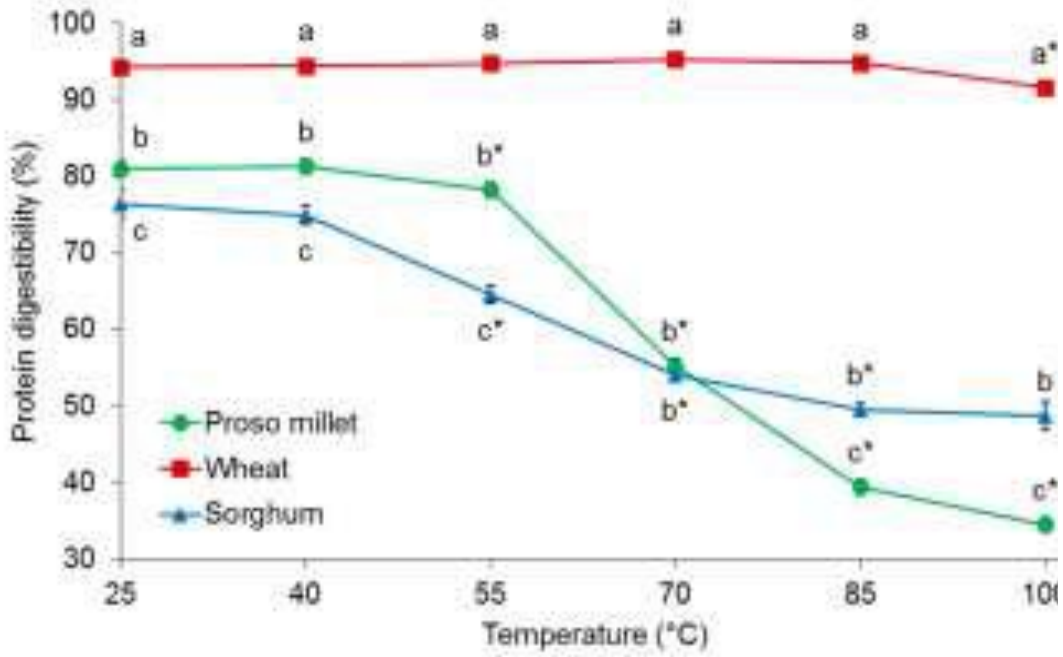
Low digestibility

- **Interactions between proteins and other grains componants**

  tanins, starch, cell wall

- **Kafirin storage form in albumen**

- **Development of disulfide bridges during grain formation and baking**



Gulati et al., 2017

Limit for food – digestibility decrease after baking

Criterias not yet targeted

NITROSORG OBJECTIVES

Develop **PHENOTYPING TOOLS** & GENOMIC+ PHENOMIC **PREDICTION MODELS**

DELIVER TO BREEDERS PARTNERS phenotyping & prediction tools for targeted criterias

Characterize current commercial varieties offer and variability available in breeding programs (protein content, digestibility, vitrosity, tanin content, starch)

Characterize « world » diversity trough a selected panel to look for **relevant sources**

Better understanding of biochemical factors impacting **protein digestibility**

VALIDATE these factors in poultry feeding: define an ideotype

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PROJECT ORGANIZATION

We have 1001 reasons to invest in sorghum

WP1

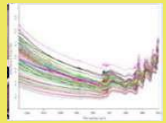
Genetic PANELS

- Commercial offer
- Breeders ressources
- World diversity

WP2

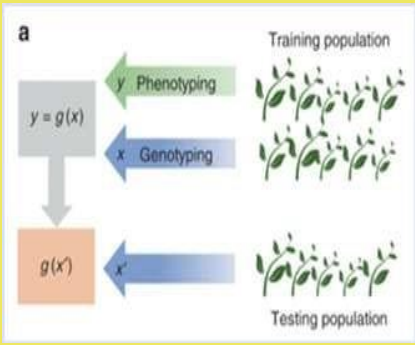
PHENOTYPING

SPIR measures
Grain + leaves



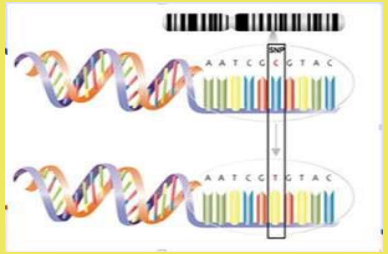
Protein content & digestibility estimation (chemical + NIRS)

PHENOMIC PREDICTION



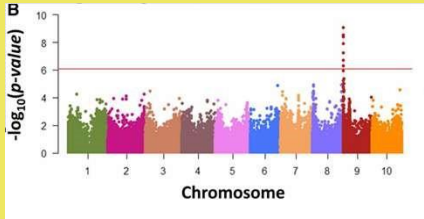
improve performances predictions

GENOTYPING



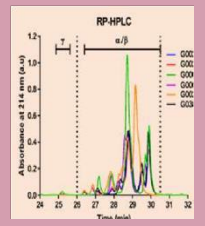
GENOMIC PREDICTION

GWAS



WP3 IDEOTYPES DEFINITION

Test 5 varieties + CORN check



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ENJOY IT'S FROM EUROPE

TOOLS DEVELOPMENT

DATA SET NIRS & Biochemicals

2018-2023

1500 samples – 4 programs, 6 sites

WEST AFRICA

Improve productivity, resiliency & insure food security

2021-2024

3200 samples 3 sites **FRANCE**

Improve grain quality & adapation for poultry feed

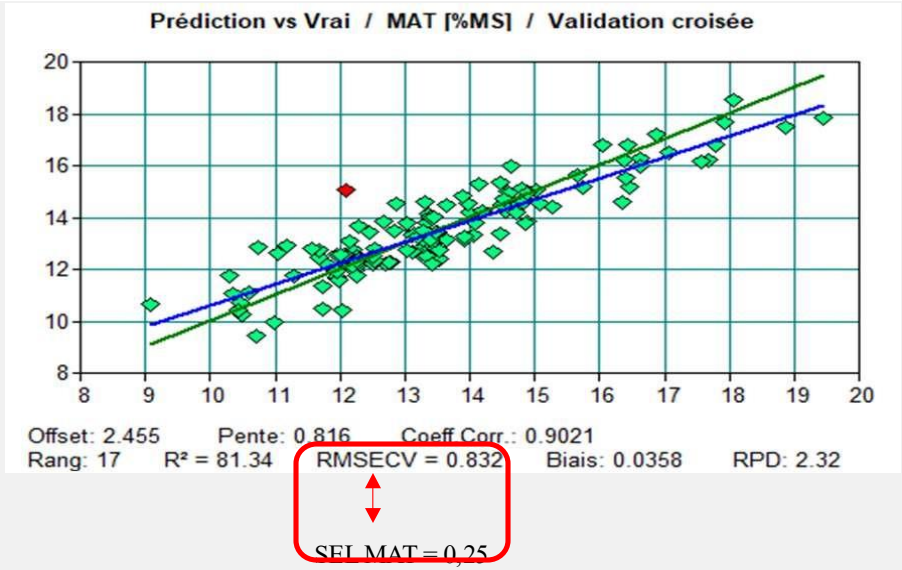
NIRS: Bruker-TANGO = all samples

REFERENCE DATAS

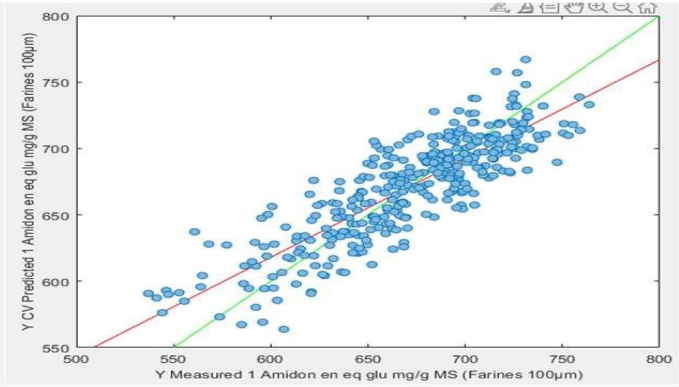
- STARCH: enzymatic method (420 samples)
- PROTEINS: Kjeldahl method (240 samples)

BIOCH& SPIR SELMET lab

NIRS CALIBRATION



WHOLE GRAIN



Labo	Calibration (Cross Validation - 353 ech)					Validation (59 échantillons)			
SEL	Prétraitement	Nb LV	SECV	CV biais	R^2CV	SEP	Pred biais	R^2Pred	RPD
21.17	1050-2535 nm SNV D1 pol2 15pts MeanCenter	9	23.4	-0.13	0.726	23.67	1.5	0.732	1.89

OK FOR PROTEINS

OK FOR STARCH

Laurent BONNAL

Armel SOTILLO Mathilde SINGER

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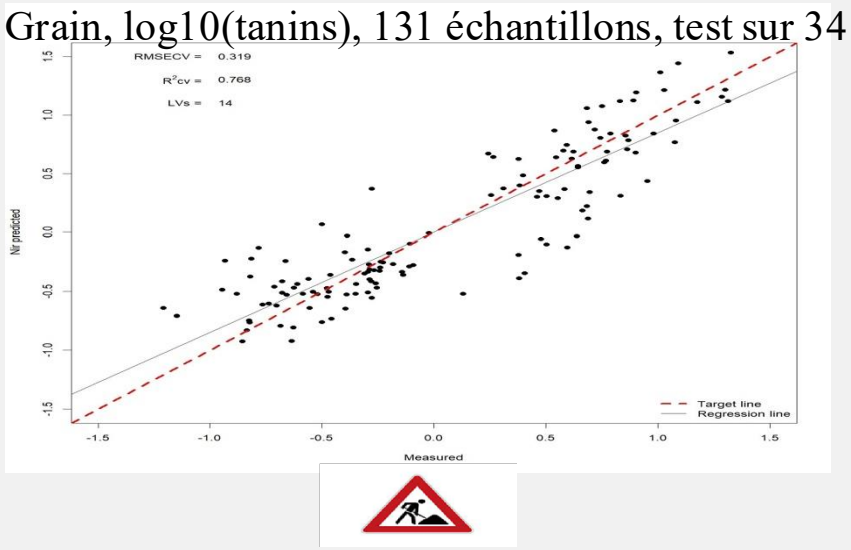
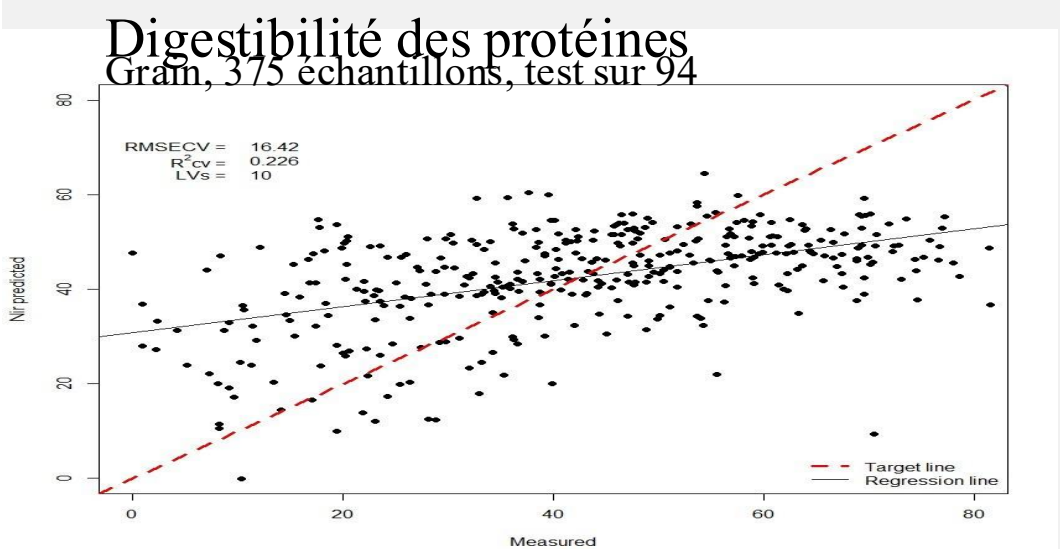
NIRS CALIBRATION

WHOLE GRAIN





TANIN

PROTEIN DIGESTIBILITY ?

Gilles CHAIX

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GENETIC DIVERSITY AVAILABLE

WORLD DIVERSITY PANEL

303 SELECTED GENOTYPES

Sources		Nombre de génotype	Sources
✓ Core Collection CIRAD (CCC)		30	Deu et al. 2006
✓ Reference Set GCP		73	Billot et al. 2013
✓ CCC + Ref Set		30	Billot et al. 2013 ; Deu et al. 2006
✓ Sorghum Association Panel (SAP)		119	Boatwright et al. 2021 ; Sukumaran et al., 2012 ; Cuevas et al., 2018 ; Luo et al., 2016
✓ Référence bibliographique	• Duressa et al., 2020	2	Duressa et al., 2020
	• Kardes et al., 2021	24	Kardes et al., 2021
	• Yan et al., 2011	8	Yan et al., 2011
	• Axtell et al., 1981	13	Axtell et al., 1981
✓ Autres	• Collection ICRISAT	1	Hess et al., 2002
	• AG (MAGADJI3)	1	
	• Control (BF201)	1	
	• NITROSORG (Sorgho Bleu)	1	

Fabien de BELLIS

agAP INSTITUT
Amélioration génétique et adaptation des plantes méditerranéennes et tropicales

PRIVATE ELITE PANEL

60 INBRED LINES PER BREEDER

EUROSORGHO THE SORGHUM BREEDER

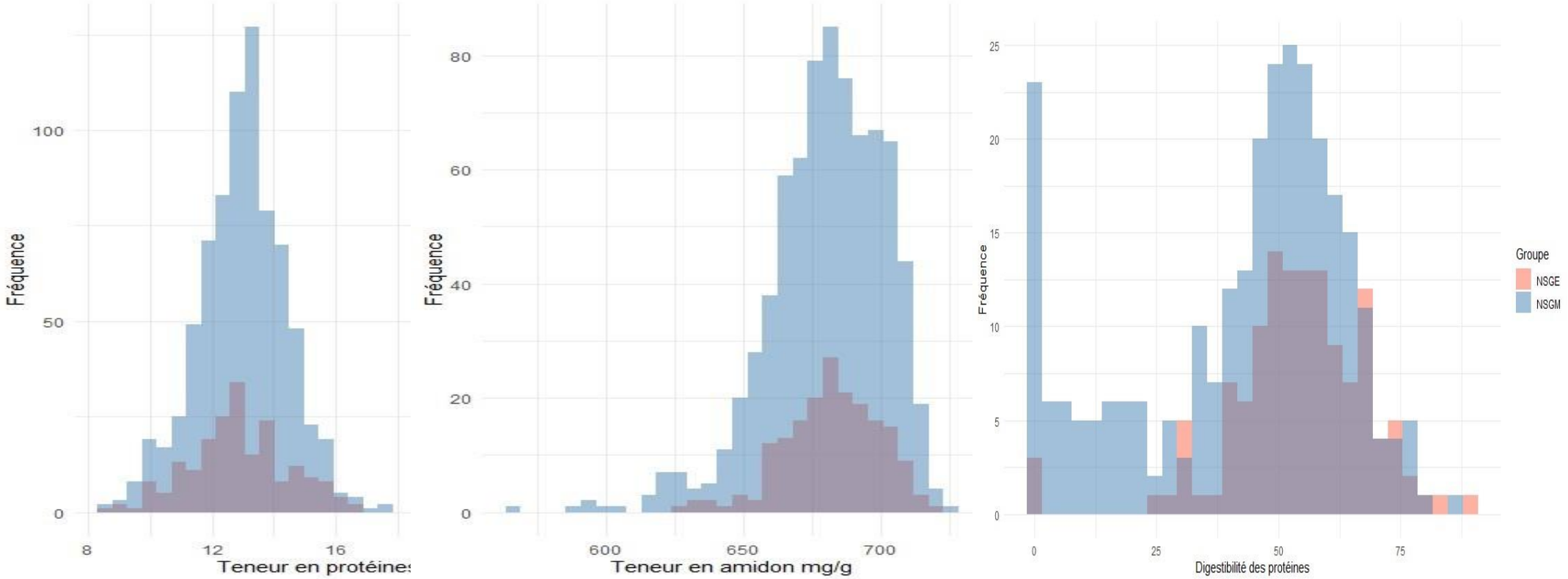
R·A·G·T 2n

Clothilde BOUBEE DE GRAMONT
Patrice JEANSON

Quentin DUPRAT
Joël ALCOUFFE

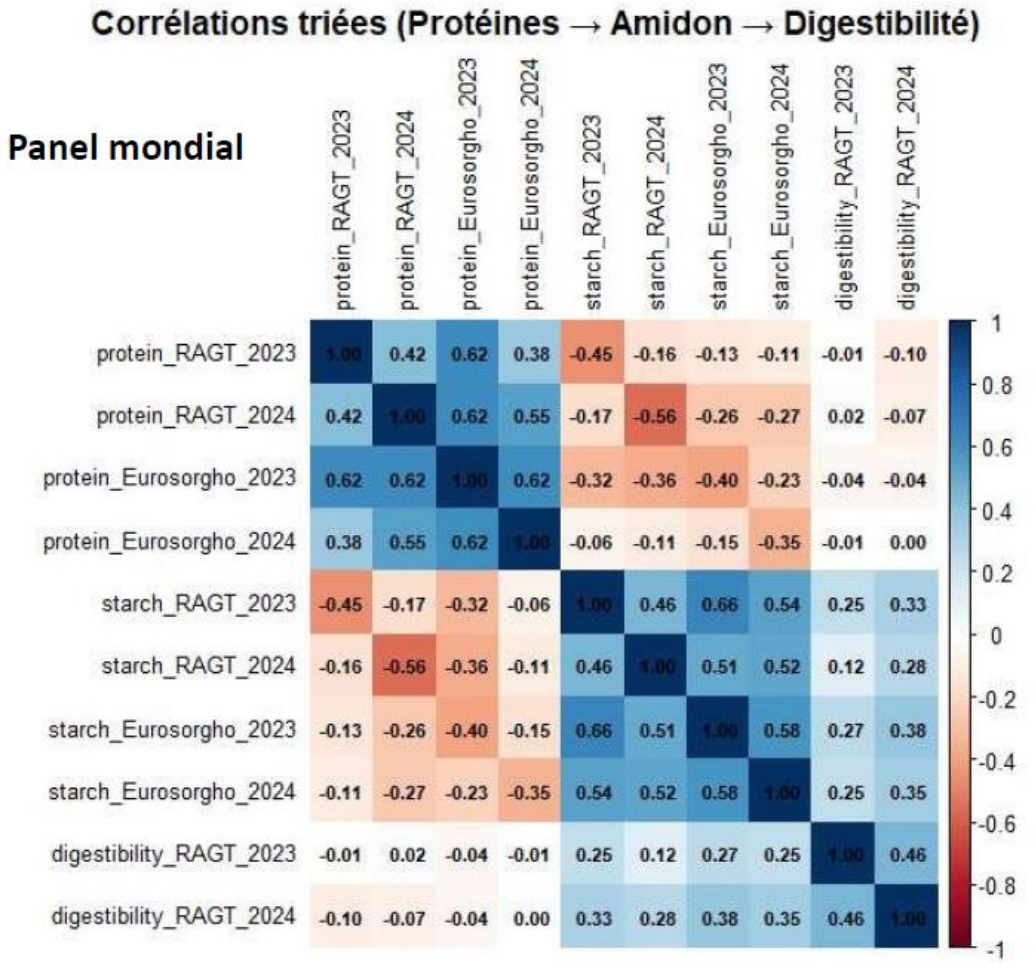
GENETIC DIVERSITY AVAILABLE

Variability 2024 datas



Protein content% **Starch content mg/g** **Protein digestibility%**

COMPARISONS ENVIRONMENT – TRAITS



Environment correlations

Proteins: 0,38 to 0,62

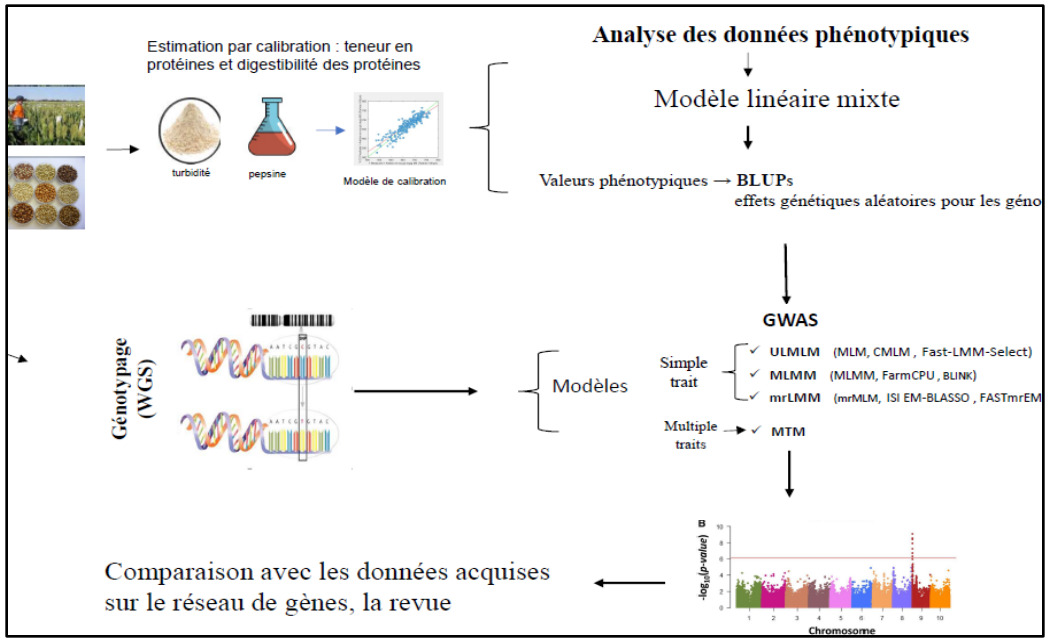
Starch: 0,46 to 0,66

Digestibility year correlation 0,46

Traits correlations

Proteins – Starch	**négative**
Digestibility – Proteins	**~ 0**
Digestibility- starch	**~ 0,25**

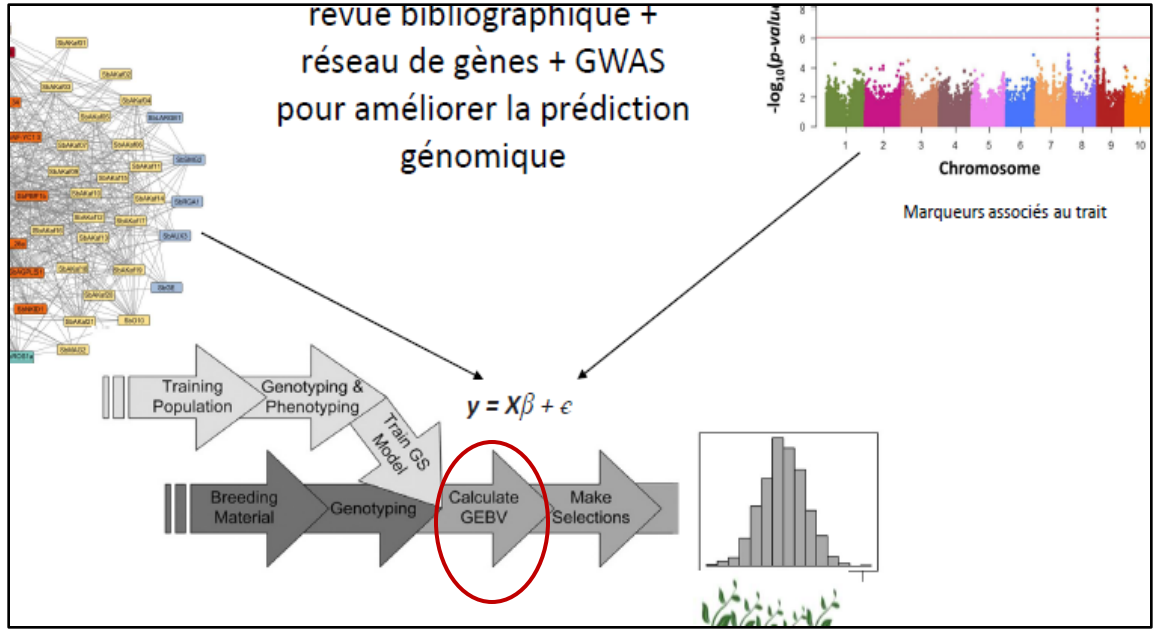
IN PROGRESS



GWAS – GENETIC DETERMINISM

PhD Mamadou SENE

agAP INSTITUT
Amélioration génétique et adaptation des plantes méditerranéennes et tropicales



PHENOMIC PREDICTIONS

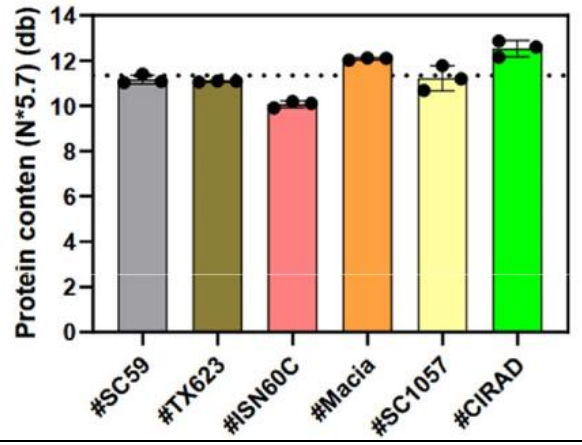
Genomic Estimated Breeding Value

5 VARIETIES DIGESTIBILITY ANALYSIS

IN VITRO ANALYSIS

	Prot	Dig
CIRAD001	+++	++
N60C	+	+
TX623	+	+++
SC59	+	-
Macia	++	+++

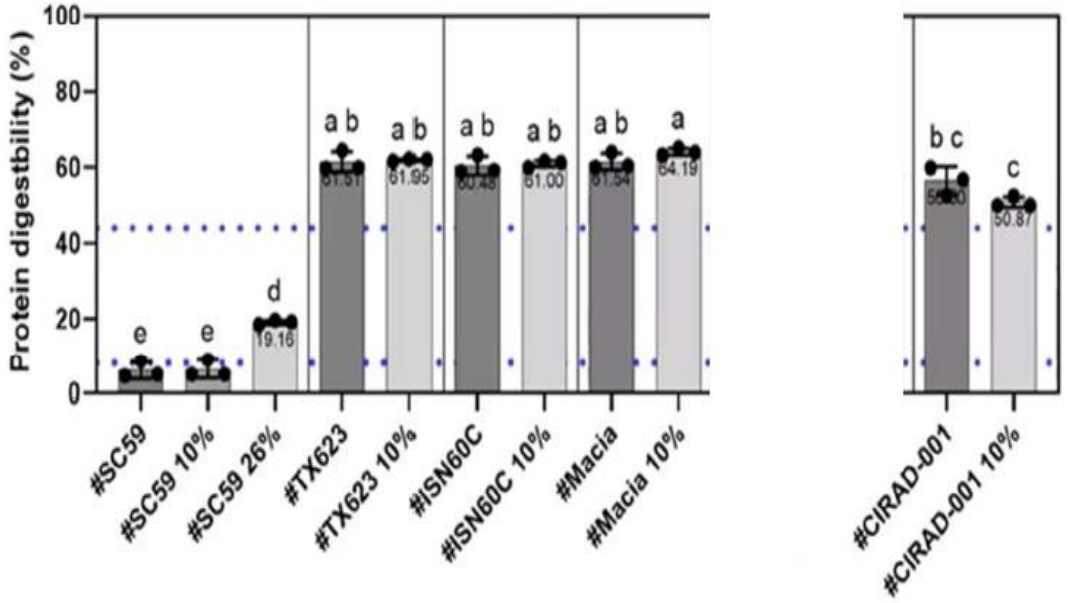
Selected at the beginning



Protein Digestibility

Hamza MAMERI

UMR iAte ingénierie des Agropolymères & technologies émergentes



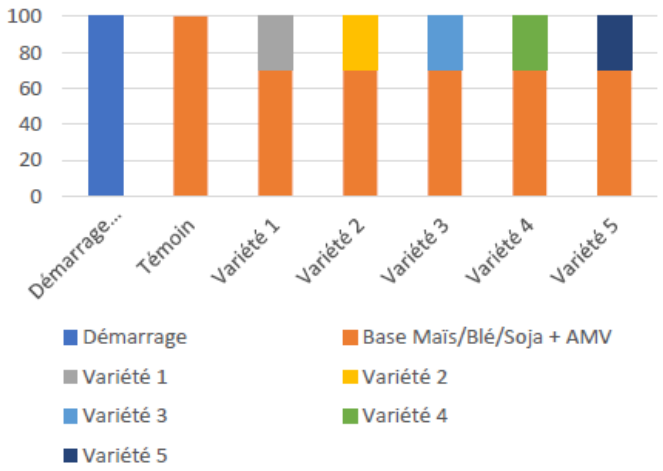
5 VARIETIES DIGESTIBILITY ANALYSIS

IN VIVO ANALYSIS

Characterize animals answer at 2 levels

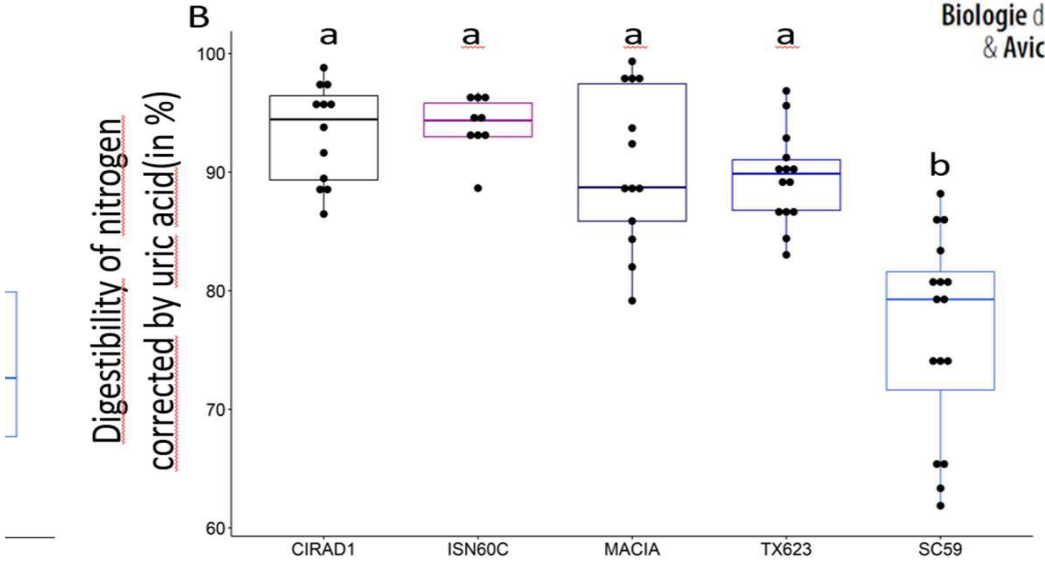
- **proteins:** nitrogen + amino acids
- **energy** (not finalized)

Comparisons of sorghum varieties by substitution in a check feed

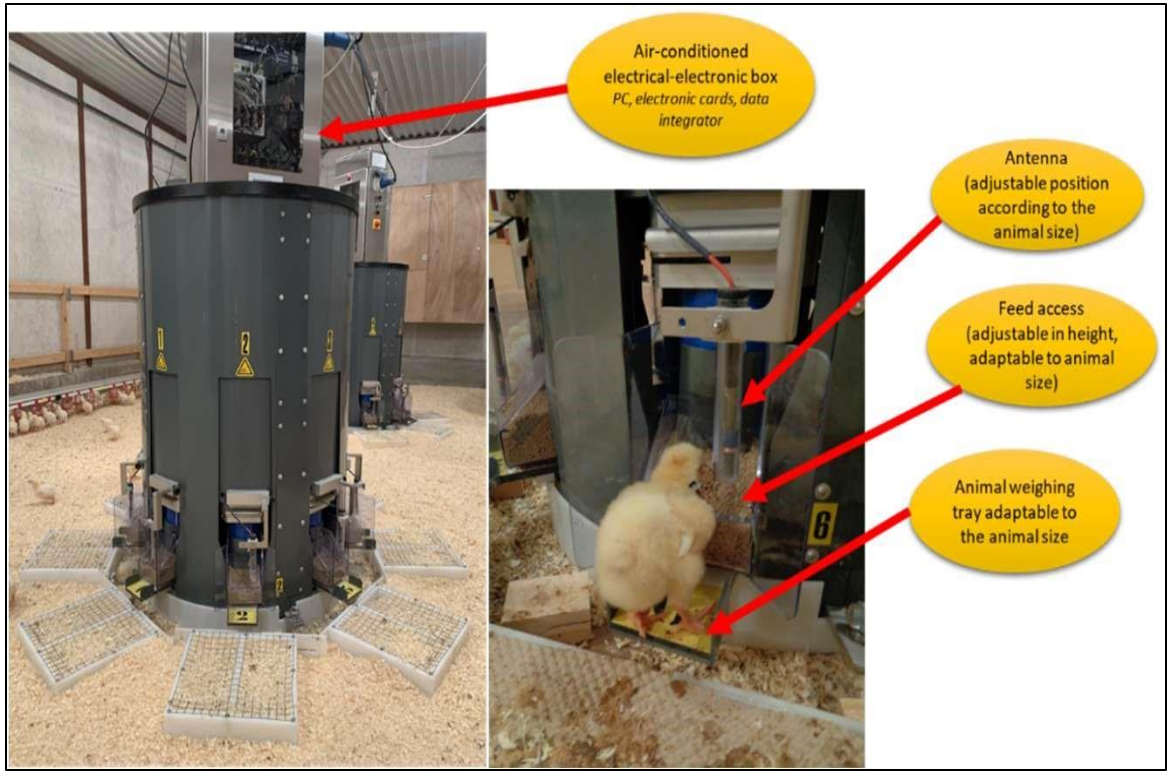


Flavie DEROUIN TOCHON

Few differences between genotypes, except tanin one



CHICKEN PERFORMANCE TRIAL



Eva PAMPOUILLE

ITAVI

10 Chickens ROSS308 mâles (fast growth)

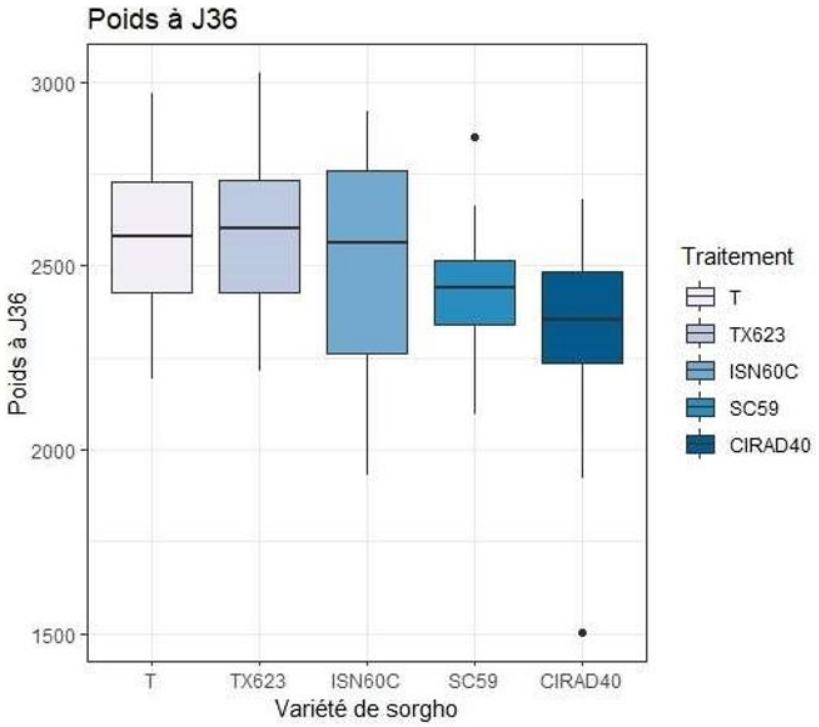
36 days

Daily performances analysis

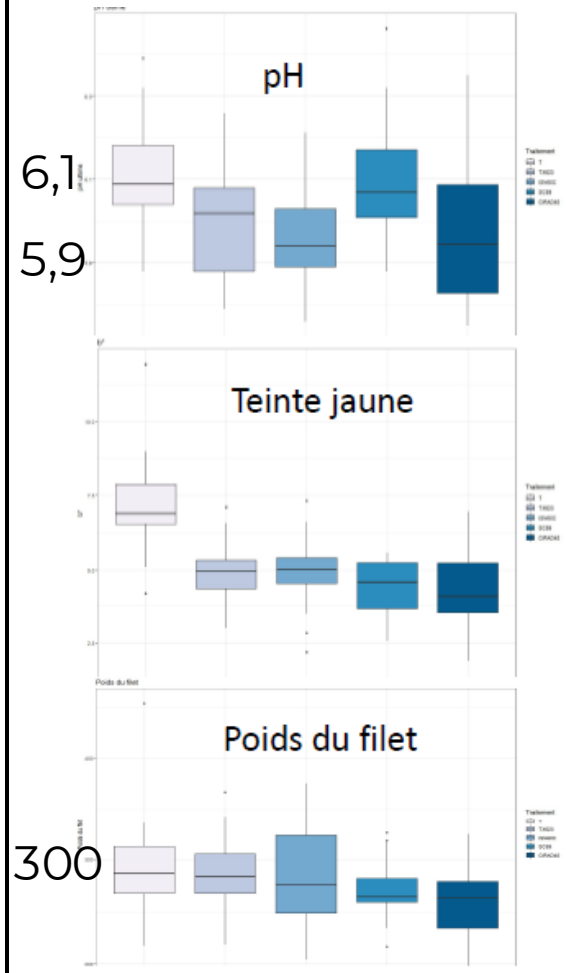
Statistic unit = chicken

TRIAL RESULTS

WEIGHT + 36 DAYS



QUALITY RESULTS



« ultimate pH »= meat quality indicator

5,7 < NORM < 6,1
pH<5,7 soft meal, water loses
pH > 6,1 darker meat, less juicy

Yellow tint... linked to corn content

Meat fillet weight

Conclusion

- global approach across on entire chain value
- hudge amount of datas cumulated
- not finalized: work in progress for analysis and valorization
- regrets on tested varieties (not enough contrasted)
- some tools yet in implementation step (NIRS equation)

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Thank You

köszönöm