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Yam interplant variability: causes and consequences for breeding strategies

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11th 2018

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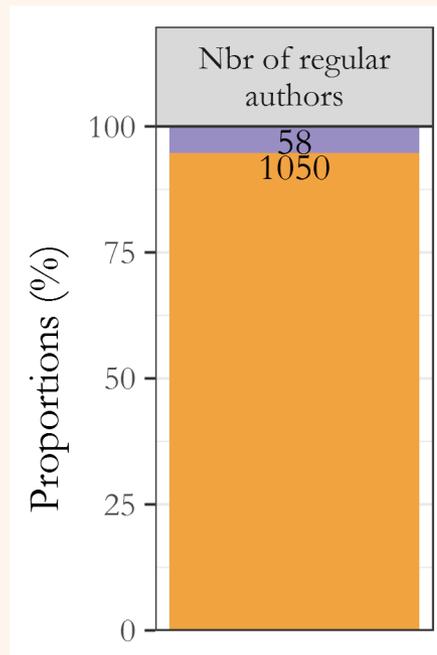


Why studying yam production?



Why studying yam production?

Neglected yet important!



Species:  Yams  Potato



Understanding yam interplant variability

A necessary prior



Yam interplant variability

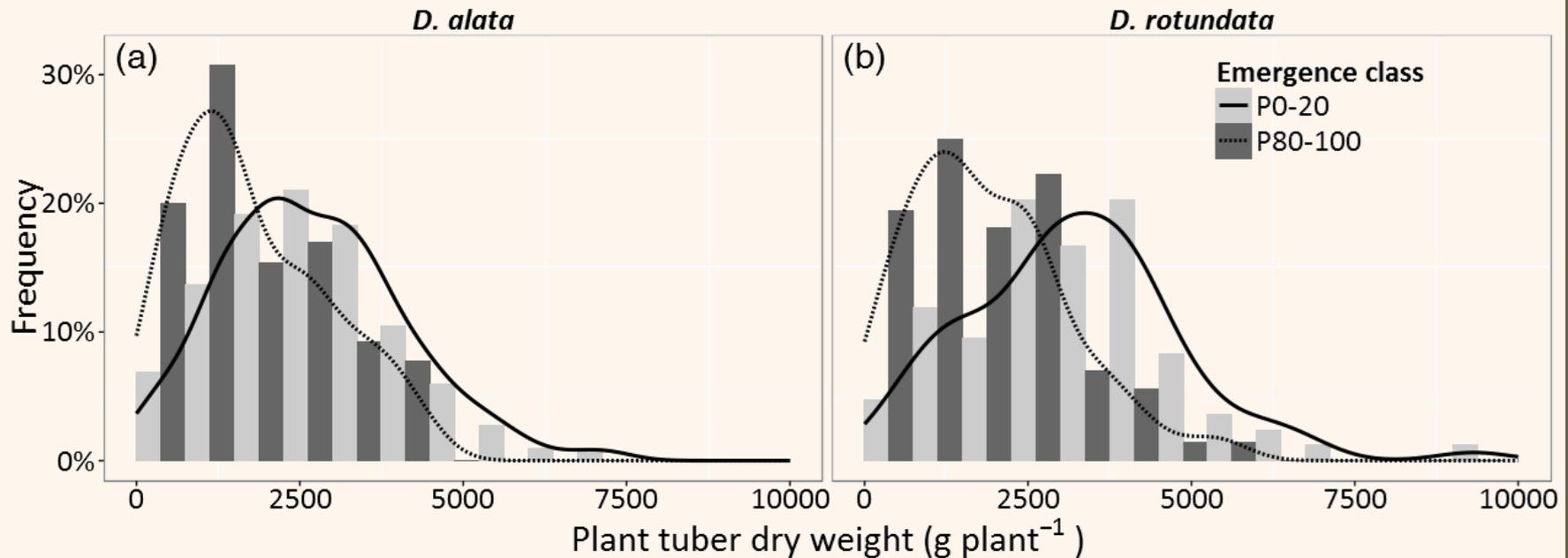
Framework

- RT team at Cirad : to contribute to implement sustainable yam-based cropping system through varietal innovation
- Major challenge: a huge interplant variability leading to insignificant results



Yam interplant variability

Quantification



- C.V. between 50 and 70% over five years experiments on *D. alata* and *D. rotundata*
- C.V. three time higher than other crops (e.g. potato)
- Variability was observed very early in the crop cycle (i.e. 30 days after emergence)
- Many variables can lead to this situation: Size and origin of seed-tuber, Age of seed-tuber, Nutrient content of seed-tuber...



Yam interplant variability

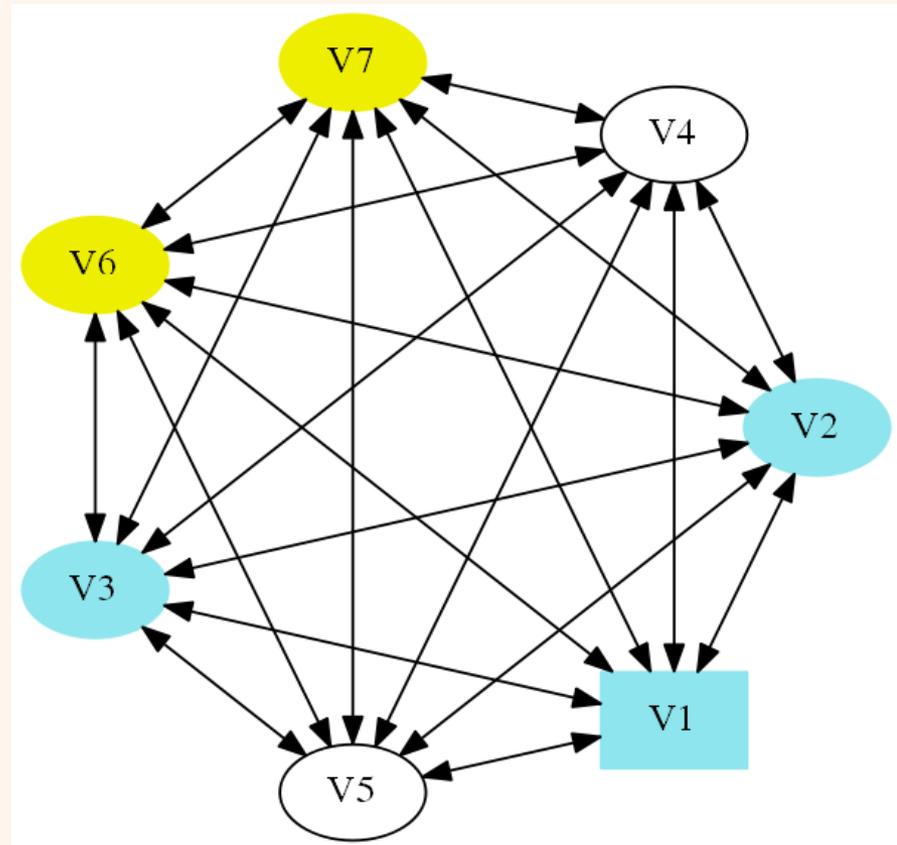
Causes

Complex => multivariate :

- Lot of explanatory variables
- Different type of variables (gaussian, binary, poisson...)

Neglected =>

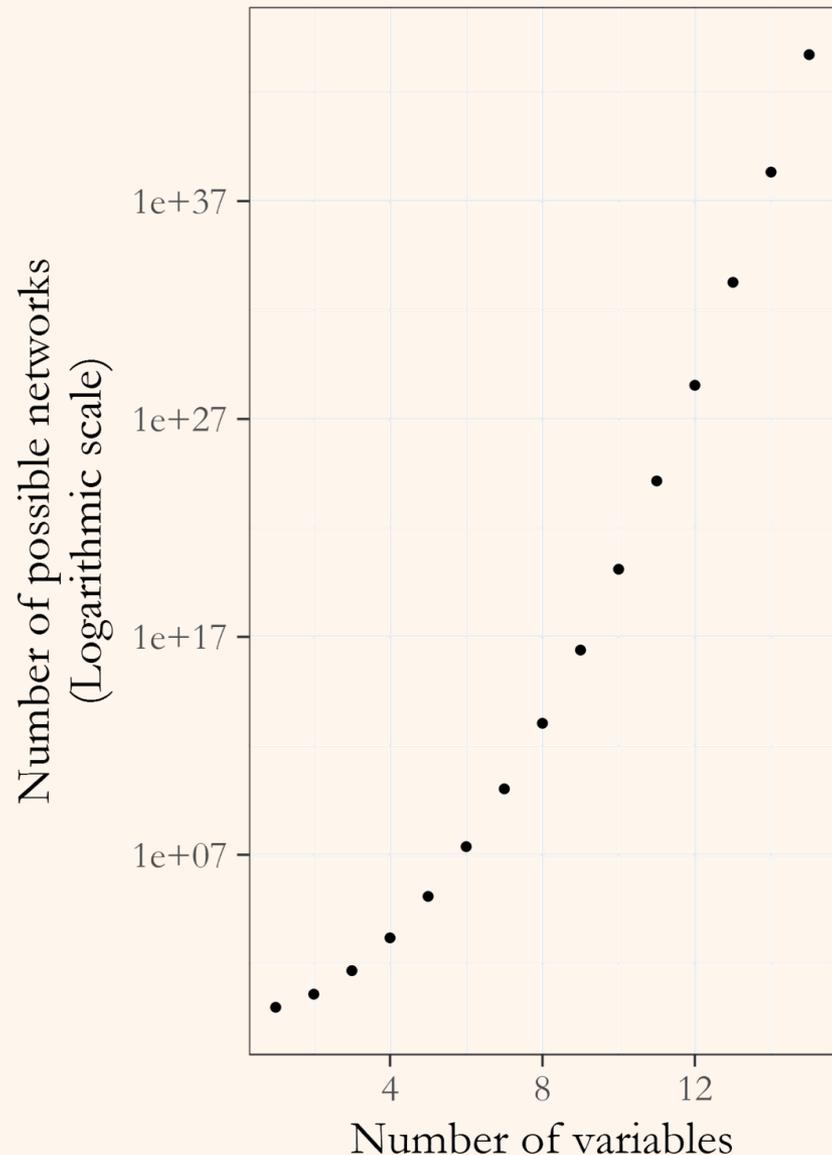
- No or very few knowledge available
- All variables are potentially dependent



Yam interplant variability

Causes

- Identifying the best structure supporting data
 - ⇒ Direct and indirect dependencies
 - ⇒ Vast search space
 - ⇒ Super-exponential in the number of nodes
- Quantifying dependence relationship between variables
 - ⇒ Additive Bayesian Networks

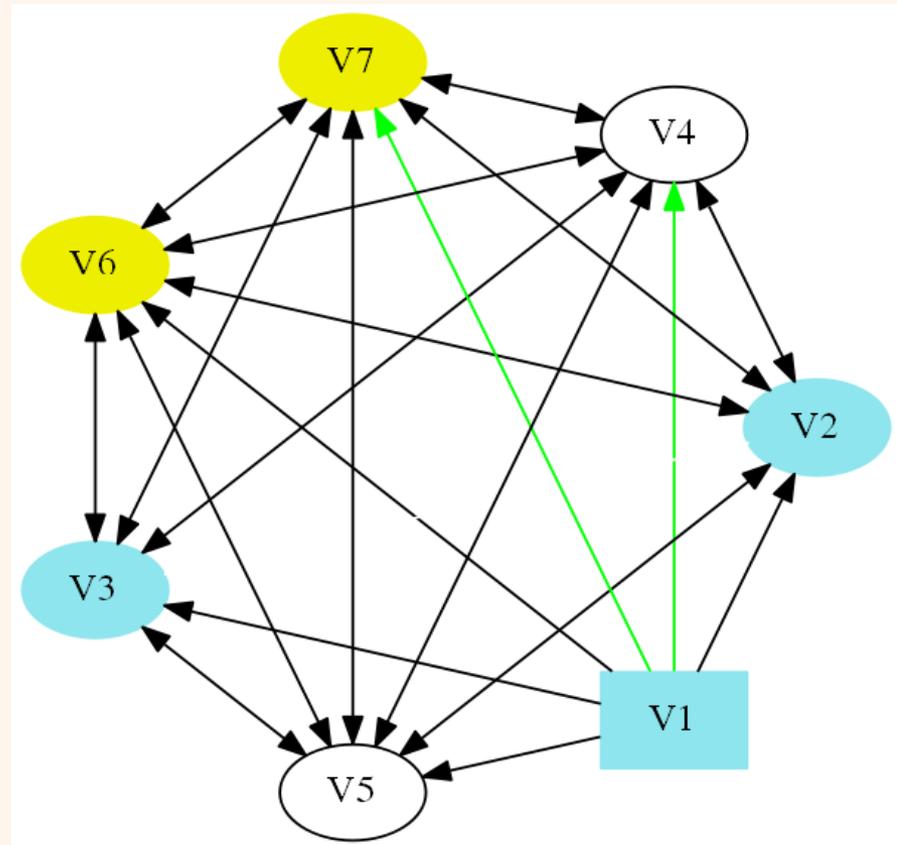


Yam interplant variability

Causes

Reducing search space

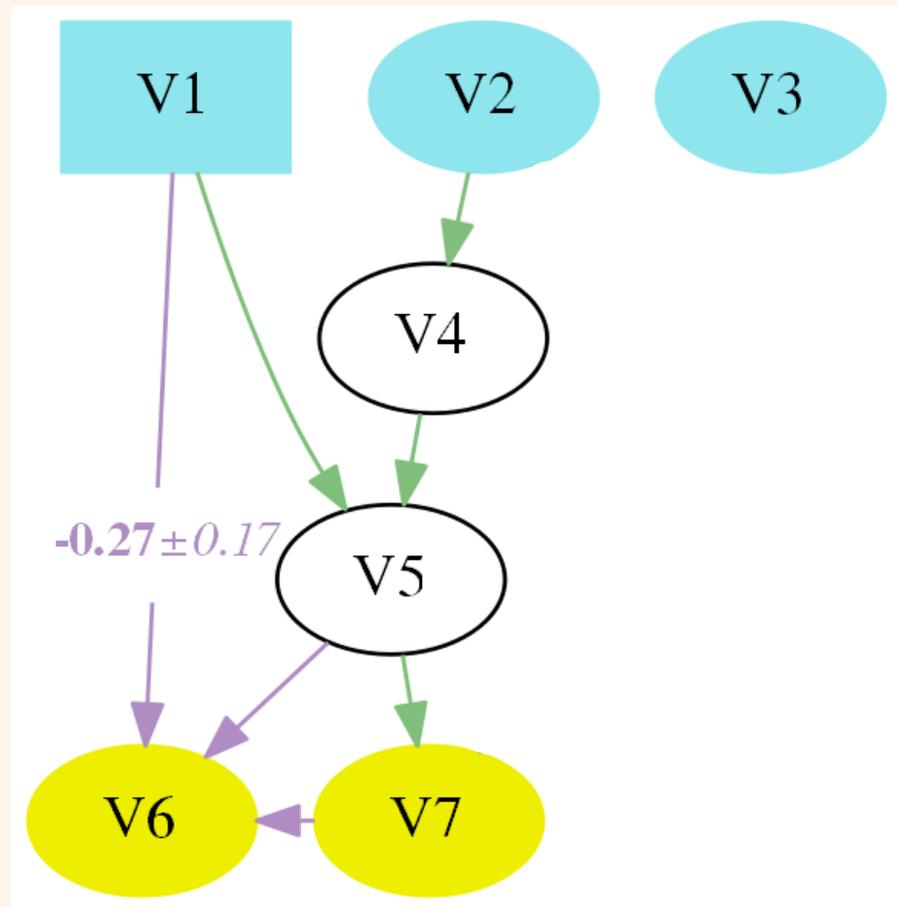
- Banning arcs depending on impossibilities
- Retain arcs based on littérature
- Impose an apriori complexity limit (max number of parents)



Yam interplant variability

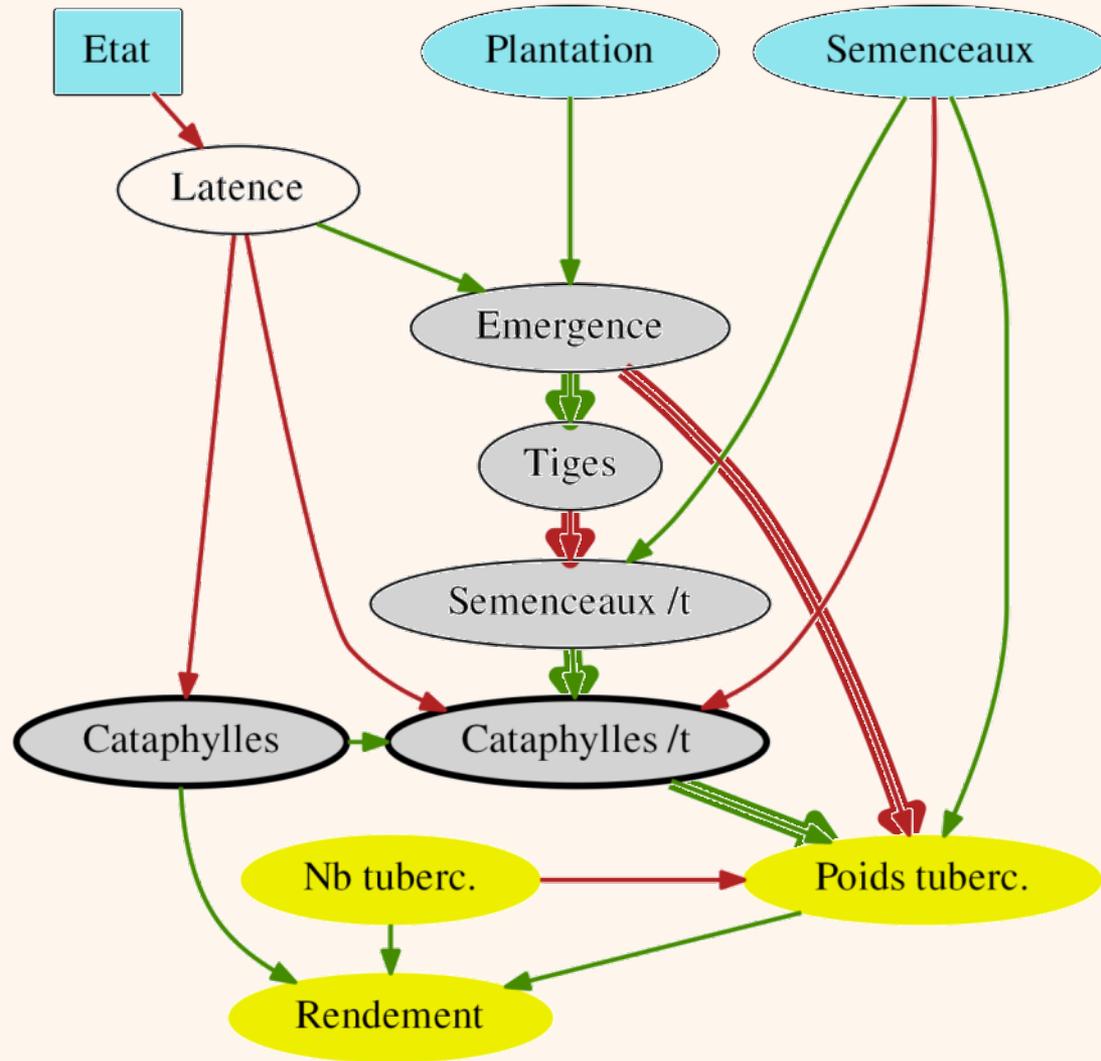
Causes

- Exact search (<22 variables) or heuristic searches
- Choose the model with the best goodness of fit
- Adjustment for overfitting with parametric bootstrapping (MCMC)
- Marginal posterior densities for each variable
- Mean effect size and 95% credible intervals



Yam interplant variability

Causes



- Importance of planting conditions
 - Seed-tuber state, planting date and seed-tuber size
- Leaf trait well correlated to yield
- Main importance of emergence date
 - Indirect effect
 - Direct effect

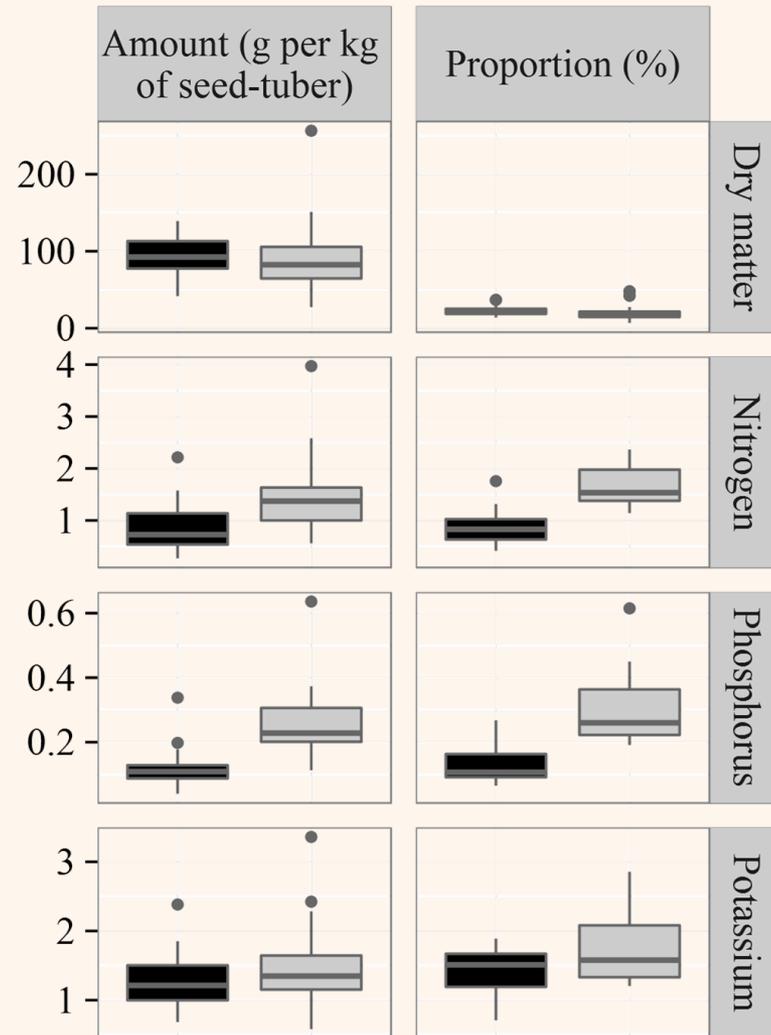


Yam interplant variability

Causes

Mainly explained by
heterogenous planting material

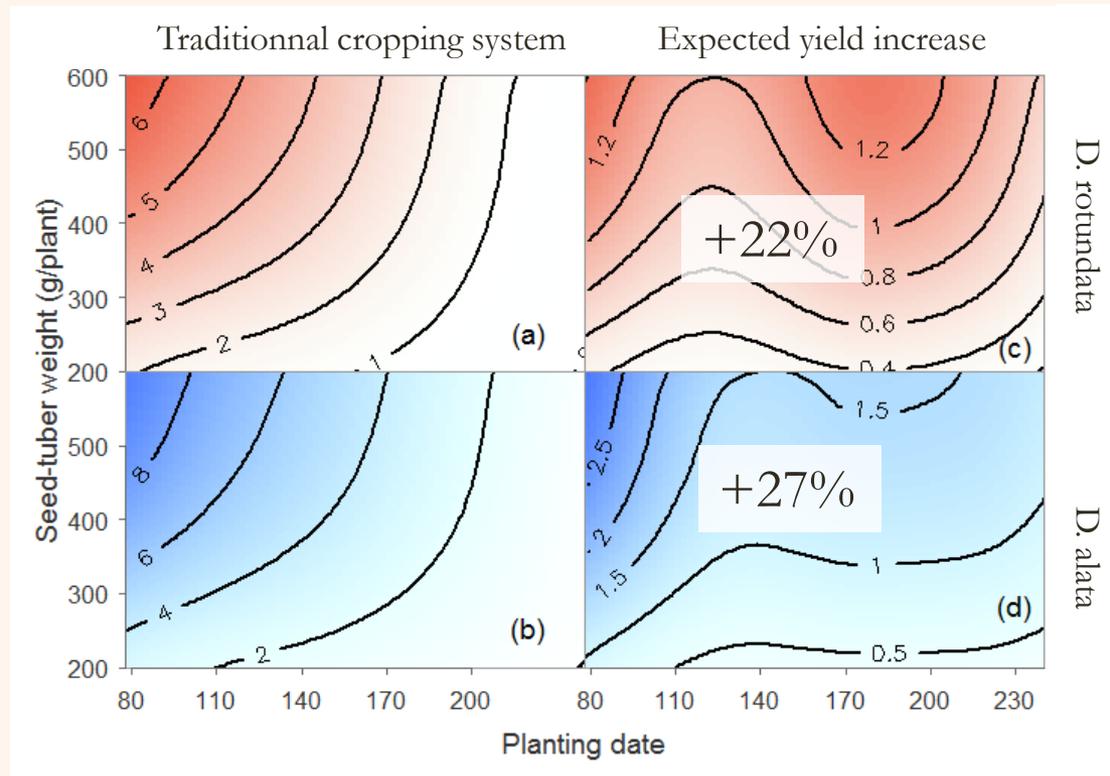
- Seed-tuber size
- Seed-tuber resources content
- Seed-tuber physiological age



Yam interplant variability

Consequences

- For farmers
 - Yield loss



Yam interplant variability

Consequences

- For farmers
 - Yield loss
 - Intensification
- For research
 - **Healthy** seeds system → **Quality** seeds system
 - Adapted follow up: **mean** yield → **cohort** observations
 - Recording individual emergence as a marker of interplant variability
 - Statistical methods: **ANOVA** → **multivariate** analysis
 - Adapted experimental unit: **individual** selection → **group** selection

We can now face other challenges, e.g. make up the huge gap between our genotyping and phenotyping capability

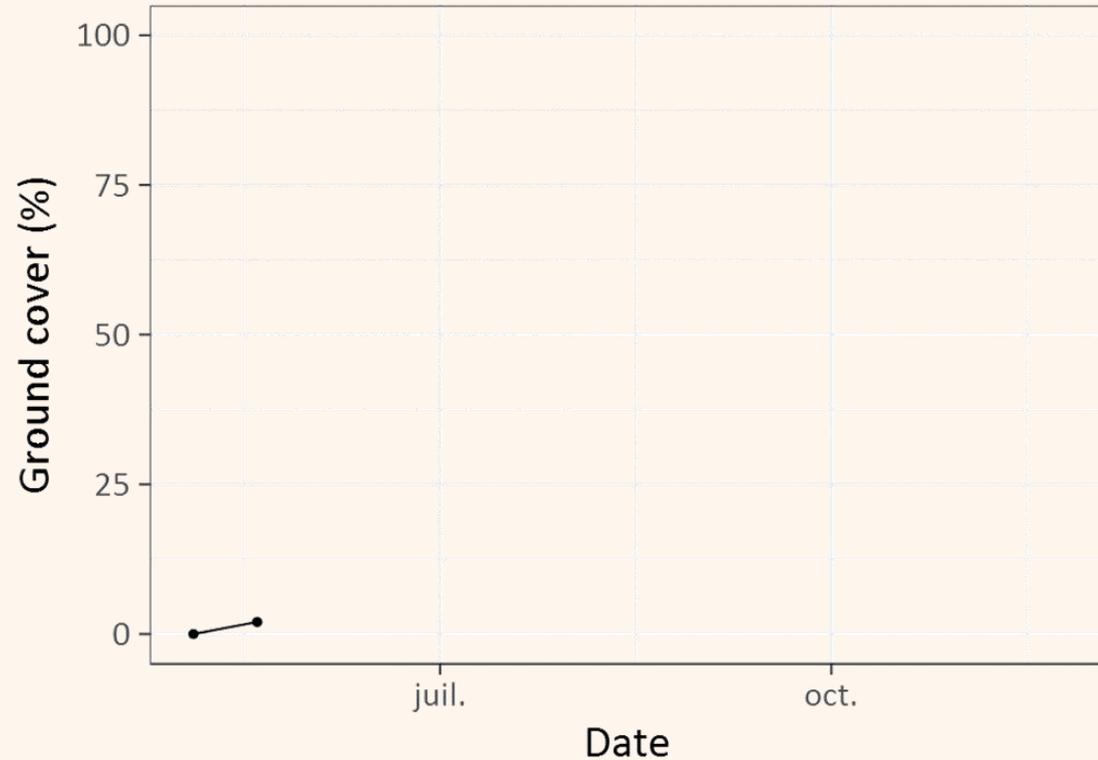
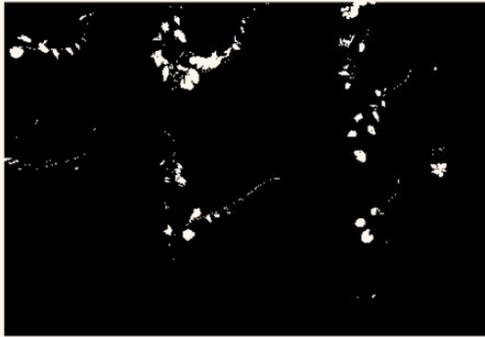


Developing phenotyping methods



Developping phenotyping methods

Ground cover dynamic



Weekly observations

⇒ Ground cover dynamic

⇒ Emergence dates, senescence rate and growth cycle length

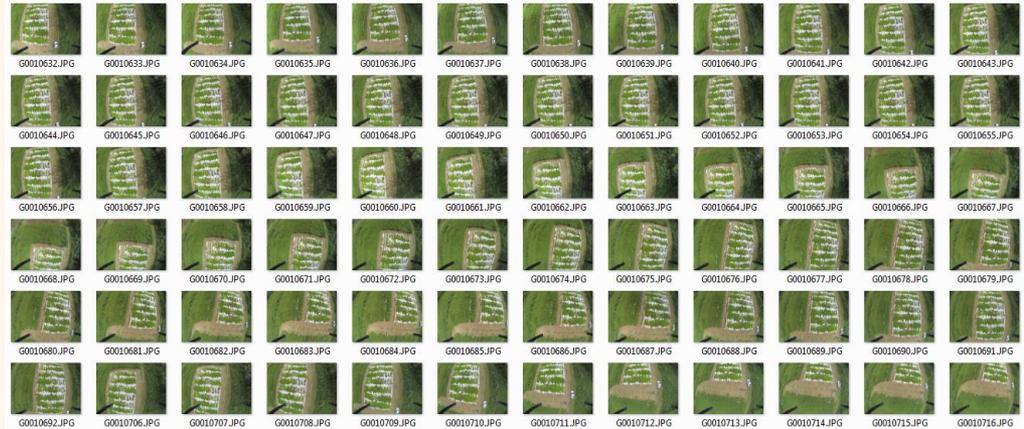
⇒ Diseases dynamics

⇒ Crop architecture (compacity...)

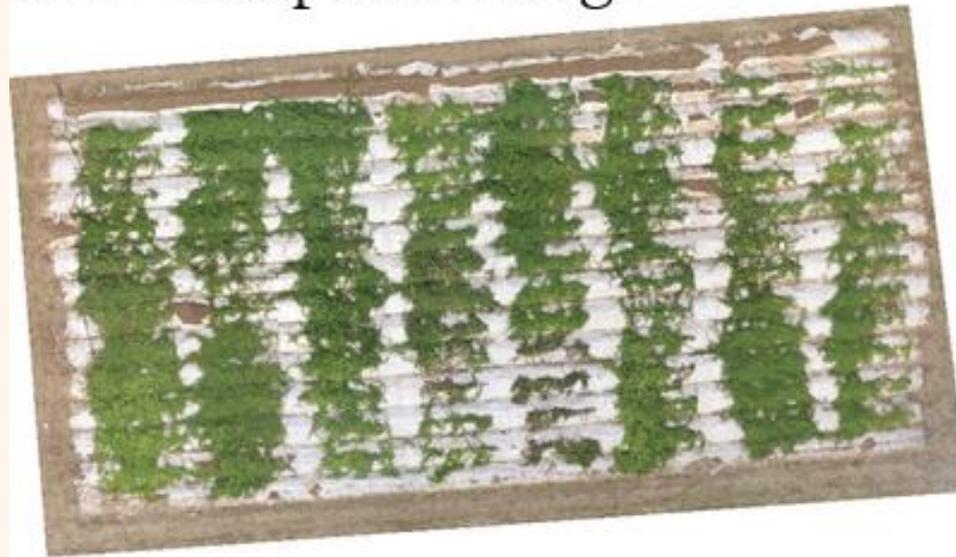


Devellopping phenotyping methods

Ground cover dynamic, nutritional status, stress

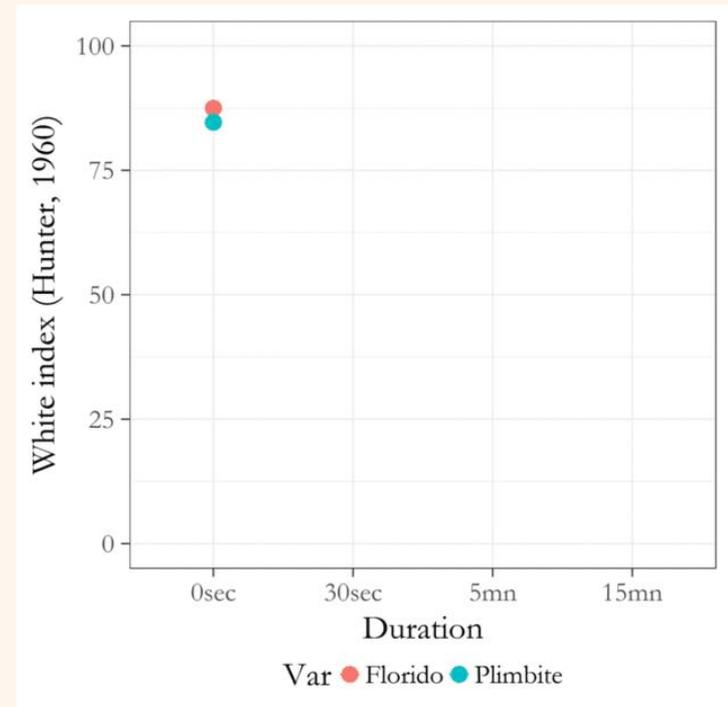


RGB composite image



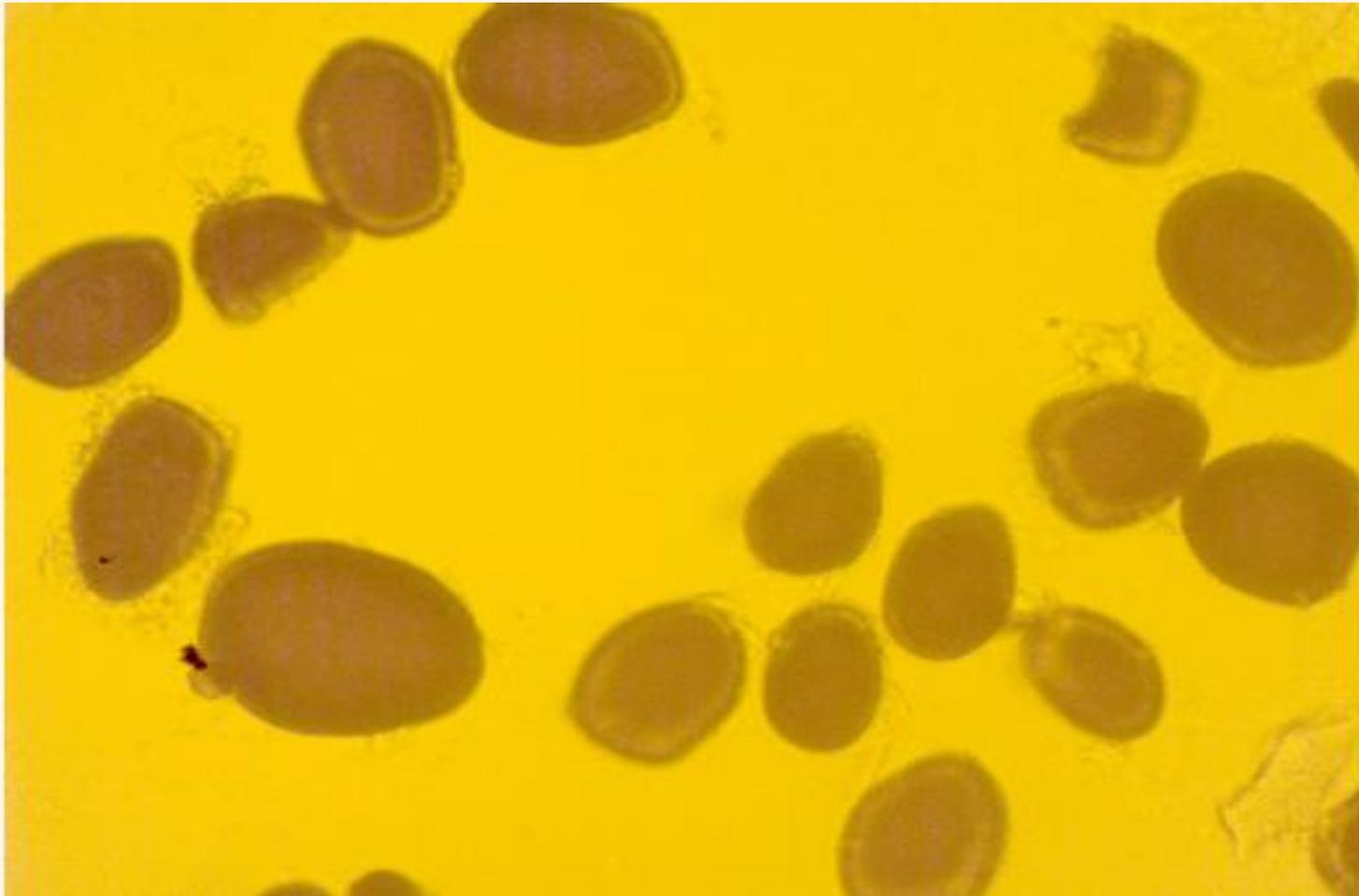
Develoopping phenotyping methods

Quality: color and browning



Developping phenotyping methods

Quality: starch grain size and shape

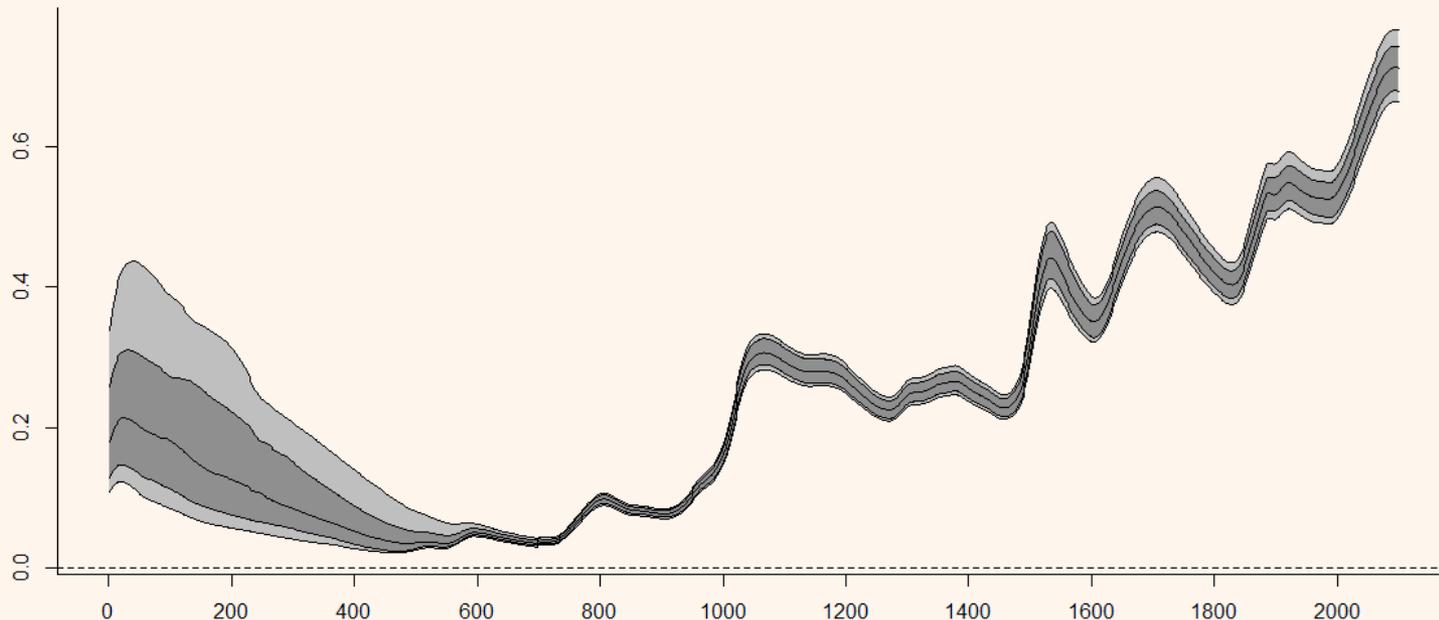


Developing phenotyping methods

Quality: tuber content and texture

NIRS and derived method (MIRS, colored NIRS...)

- **Pretreatment** (discrete wavelet transforms, derivatives and multiple scatter corrections)
- **Calibration sample** (Puchwein algorithm)
- **Training model** with model ensembling (neural network, multi-layer perceptron NN, gaussian process, support vector machine and partial least squares and principal component regression)



Conclusions and perspectives



Conclusions and perspectives

- Bayesian Network allow us to encompass system complexity (i.e. multivariate) quantitatively and qualitatively and is well suited while there is lack of knowledge
- Yam interplant variability if mainly driven by heterogenous planting material
- Measuring individual emergence date allow us to control the influence of interplant variability in our studies
- Based on these results we developed adapted HTP methods
- Some HTP methods are still under development
 - Stress, initiation of tuberization
 - NIRS/MIRS, amylose/amylopectine...
- GxE interactions and GWAS





Thanks

