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# Training in organic breeding

Module 2: Phenomics: approaches and tools for genetic resources and breeding material characterization

## Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

Author: Pedro Mendes Moreira **(PUC-ESAC, PT)**



Co-funded by the European Union

Funded by the European Union, the Swiss State Secretariat for Education, Research and Innovation (SERI) and UK Research and Innovation (UKRI).

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# CONTEXT: Training in LIVESEEDING project

https://liveseeding.eu/trainings-summer-school/

| Training Packages & Summer School | Info & Materials | Upcoming Sessions | Target Groups |
|---|---|---|---|
| Organic plant breeding | More info | Register here | breeders, researchers, students |
| Organic cultivar testing | More info | Register here | farmers, breeders, examination and certification offices, researchers, national/regional authorities, citizens/consumers |
| High-quality organic seed production | More info | Register here | farmers, seed producers and multipliers, seed savers, breeders, examination and certification offices, researchers |
| Regulatory and policy aspects of the organic seed market and organic seed databases | More info | Register here | farmers, seed producers and multipliers, seed traders, seed savers, breeders, examination and certification offices, expert groups, national/regional authorities, actors of long value chains, actors of local value chains, private and public procurement bodies/officers |
| Entrepreneurship in the organic seeds and breeding sector | More info | Register here | farmers, seed producers and multipliers, seed traders, actors of long value chains, actors of local value chains, private and public procurement bodies/officers |
| Embedding organic seed and cultivated diversity in city food policies | More info | Register here | farmers, seed producers, seed savers, researchers, national/regional authorities, private and public procurement bodies/officers, citizens/consumers, media, students |
| Summer School | More info | Register here | |

# Training in organic breeding organized in 5 Modules

1. **Module 1** - Plant Genetic Resources (PGRs): collection, conservation and exchange to support the increase of agrobiodiversity in farming systems
2. **Module 2 - Phenomics: approaches and tools for genetic resources and breeding material characterisation - FEBRUARY 3rd 2025, 9:00 to 17:30 CET**
3. **Module 3** - Breeding methods fundamentals - FEBRUARY 13th 2025, 9:00 to 18:00 CET
4. **Module 4** - Development and application of molecular methods in organic breeding - MARCH 4th 2025, 9:00 to 18:00 CET
5. **Module 5** - Organic heterogeneous material (OHM) design and development - MARCH 7th 2025, 9:00 to 18:00 CET

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## February 3rd 2025 - 9:00 to 17:30 CET

**Unit 2.1: Main descriptors used worldwide in characterizing plant genetic resources**

- 9:00-10:30 - UPV (Adrian Rodríguez-Burruezo)

- 10:30-11:00 Break

**Unit 2.2: Intro to ShineMas: a web tool dedicated to Seed Lots History, Phenotyping and Cultural Practices**[1]

- 11:00-12:30 - INRAe (Yannick de Oliveira, Isabelle Goldringer)

- 12:30-14:00 Lunch Break

**Unit 2.3: Guidelines and examples of good practices in data management**

- 14:00-15:30 - INRAe (Yannick de Oliveira, Isabelle Goldringer)

- 15:30-16:00 Break

**Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming**

- 16:00-17:30 - IPC (Pedro Mendes Moreira)

1 - An extra practical session to use the tool with own data is scheduled for FEB 10th (9-12h)

# T1.4 Training in Organic Breeding

## Module 2 – Phenomics: approaches and tools for genetic resources and breeding material characterization

### Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

**Pedro Mendes-Moreira**

Polytechnic University of Coimbra

Agriculture School of Coimbra

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Co-funded by the European Union

Funded by the European Union, the Swiss State Secretariat for Education, Research and Innovation (SERI) and UK Research and Innovation (UKRI). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or REA, nor SERI or UKRI.

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# Module 2 – Phenomics: approaches and tools for genetic resources and breeding material characterization

## Planned for today

DYNAMIC MIXTURE OF:

1. *Presentation about main topics on* Methods for **phenotyping** and selection of **agronomic traits** of interest in organic farming*: utility, types, examples of descriptors, management of data, knowledge, additional material (50 min)*
2. Fast quiz (about 10 min) ***
3. Debate, Wrap up & Proposed homework (about 10-15 min) ***
4. QUESTIONS: THROUGH THE CHAT (Petra Jelincic will manage)

*** = IMPORTANT for CERTIFICATES (ALL THE UNITS!!!!)

LiveSeeding SEND TO BOTH: adrodbur@doctor.upv.es petra.jelincic@ips-konzalting.hr

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# Module 2 – Phenomics: approaches and tools for genetic resources and breeding material characterization

Where are the plant traits?

In U2.1 you have already contacted with the descriptors from BIOVERSITY, however… **Do all the traits have the same importance?... Never forget the phenology!**

Why we do not take all the data, described in the descriptors during all phases of a plant breeding program? More traits measured are needed for registration phase.

**P= G + E + S + G x E x S…**

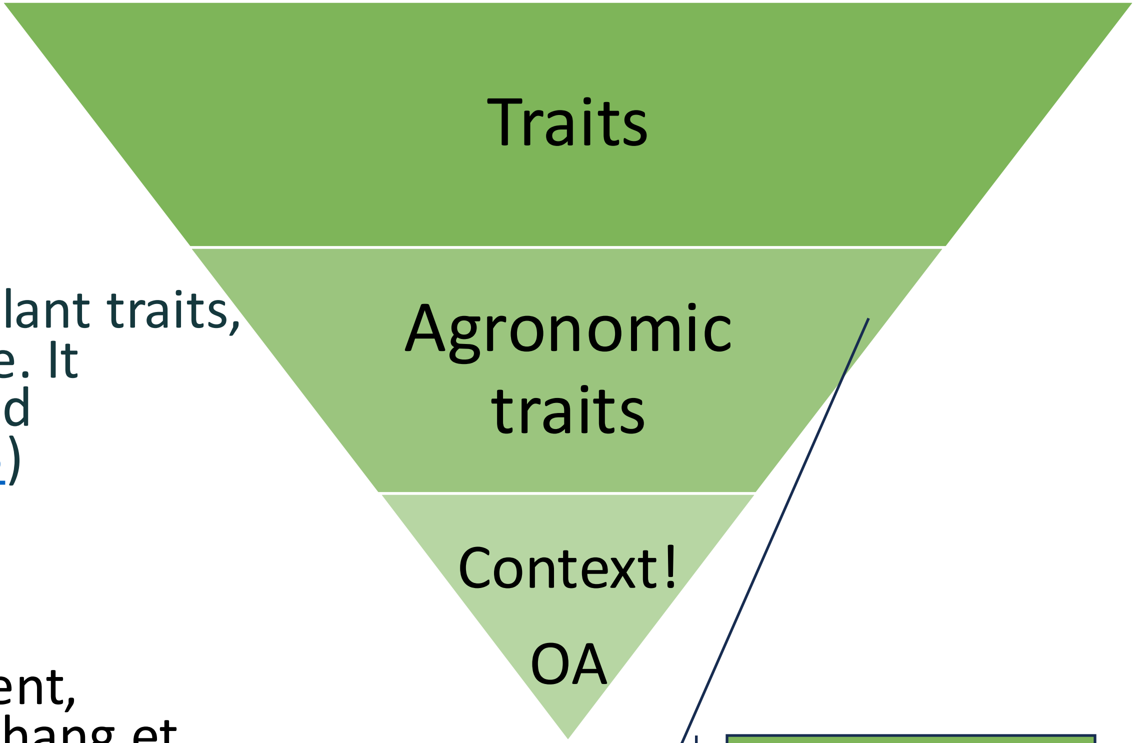
Traits(n) x Plants/Plot x Plot x Locations x Managing Systems

Cost to measure

How can we be more effective with our resources?

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

Unit 2.4: Methods for **phenotyping** and selection of **agronomic traits** of interest in organic farming




**What is phenotyping?**

Plant phenotyping, the quantitative description of plant traits, is crucial for plant breeding and precision agriculture. It involves characterizing anatomical, physiological, and biochemical properties of plants (Walter et al., 2015)

**What are Agronomic traits?**

Agronomic traits are key targets for crop improvement, encompassing yield, quality, and stress resistance (Zhang et al., 2021)… And what about Organic…

**But why we care about Agronomic Traits for Organic?**

**We need non neutral traits!**

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**But why we care about Agronomic Traits for Organic?**

Conventional varieties often **lack traits essential for organic production**!

Traditional breeding in high-input environments has led to:

- traits with negative **side-effects** in organic settings, like reduced disease resistance and lower nutrient-use efficiency (Bueren et al., 2011).

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

**But why we care about Agronomic Traits for Organic?**

Conventional varieties often lack traits essential for organic production!

- **Nutrient use efficiency from organic inputs,**
- **Weed competitiveness** (improving crop performance in organic systems and contributes to sustainable agriculture
- **Pest and disease resistance** (Bueren et al., 2011; Rempelos et al., 2023).

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

**But why we care about Agronomic Traits for Organic?**

Conventional varieties often lack traits essential for organic production!

- **nutrient use efficiency from organic inputs**,
  - Can enhance soil health, microbial biomass, and carbon content, potentially improving NUE over time (Toda et al., 2023).
  - A function of improved cultivars, best management practices, soil health factors (Baligar et al., 2001).

# Unit 2.4: Methods for phenotyping and selection of agronomic traits  of interest in organic farming

**But why we care about Agronomic Traits for Organic?**

Conventional varieties often lack traits essential for organic production!

- **weed competitiveness** (improving crop performance in organic systems and contributes to sustainable agriculture practices),
  - key traits for cereals, include plant height, early vigor, tillering capacity, and early maturity (Mason et al., 2007)
  - heterozygosity levels in faba beans (Ghaouti et al., 2016)
  - For soybeans, a direct selection system using crop species mixtures as competitors has been developed to screen for weed-tolerant genotypes (Horneburg et al., 2017).
  - adaptation to specific environments, and PPB (Wolfe et al., 2008)
  - enhanced crop competitiveness on organic maize to sustain yield (Ryan et al., 2009).

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

**But why we care about Agronomic Traits for Organic?**

Conventional varieties often lack traits essential for organic production!

- **pest and disease resistance** (Bueren et al., 2011; Rempelos et al., 2023).
  - Organic management practices can enhance natural pest control by altering plant resistance to insects, mediated by rhizosphere microbial communities and salicylic acid accumulation (Blundell et al., 2020).
  - Arbuscular mycorrhizal fungi can induce plant disease resistance, suggesting their importance in organic plant breeding (Hohmann and Messmer, 2027) .

**But why we care about Agronomic Traits for Organic?**

- Organic breeding programs should focus on traits prioritized by farmers, processors, and consumers (Rempelos et al., 2023).

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

The correspondence between descriptors by BIOVERSITY and Breeders indicate a GAP!

Knowing that fact ECPGR EVA programs are trying to fill that GAP

In 2011 an attempt was made to indicate some important traits

**Solibam**

**Strategies for Organic and Low-input integrated Breeding and Management**

Grant agreement number: FP7- KBBE-245058

**Collaborative project (Large-scale integrating project)**

**SEVENTH FRAMEWORK PROGRAMME**

**Deliverable 1.5**

***Determination of traits most relevant for model species of cereals, grain legumes and vegetables***

**Due date:** M12

**Actual submission date:** March, 11th 2011

**Project start date:** March 1st, 2010 **Duration:** 54 months

**Workpackage concerned:** 1

**Concerned workpackage leader:** Véronique CHABLE

**Dissemination level:** PU

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

## 3 – Traits of Maize (*Zea mays* L.)

List of characters to be scored, from Pedro Mendes-Moreira:
Characterisation to be carried out according to a randomized block design with replications.
Data preferably to be collected on single plant basis (10-20 plants per genotype per each replicate) or per plot.

| Traits | Prescritive | | Codes | | Description |
|---|---|---|---|---|---|
| | Plot | Pl/Ears | | | |
| Days-to-silk, nº † | 1* | | Fi | days | The beginning of days to silk (from planting until 50% of the plants in the plot begin silk emergence. |
| Days-to-silk, nº † end | 1* | | Ff | days | The end of days-to silk (from planting until 50% of the plants in the plot begin and finish silk emergence. |
| Days-to-anthesis, nº † | 1* | | Mi | days | The beginning of days-to anthesis, i.e., from planting until 50% of the plants in the plot begin anthesis |
| Days-to-anthesis, nº † end | 1* | | Mf | days | The end of days-to anthesis (from planting until 50% of the plants in the plot end silk emergence |
| Height | 1 | | Ĥ | cm | Average plant height, from the stalk basis to the last leaf insertion before the tassel |
| Uniformity | 1 | | U | score | 1 - minimum uniformity and 9 - maximum; 1-5 to populations and 6-9 to inbreds. |
| aNgle-leaf | 1 | | N | score | Angle of the adaxial side of the leaf above the ear with the stalk (5=45º, <5 =<45º and >5 = >5=45ºC ) |
| Tassel | 1 | | T | score | Tassel branching. 1- absent tassel (Inbreeds and hybrids) 9- a much branched tassel (frequent in populations with abnormal fasciated ears). |
| Ear placement | 1 | | E | score | 5- indicates that the ear is located in the middle of the plant. |
| Root lodging % | 1 | | R | % | Percentage of plants leaning more than 30º from vertical |
| Stalk lodging % | 1 | | S | % | Percentage of plants broken at or below the primary ear node, related with the quality of the stalk and the stalk damage caused by some insect attack. |
| Yield | 1 | | Yield | Mg $ha^{-1}$ | Grain yield (Mg ha-1) 15% moisture, a1) hand harvest (Portugal), Grain yield = Ear weight x (Grain weight/Ear weight) five shelled ears are used for determination of this racio and for moisture content |

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# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

- What do we search for our program?
- What is our context?

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

**VASO 1.0 - Genesis reasons in 1984**

To solve the problems of small Portuguese farmers with limited land, dense population, and an inadequate productivist model, where big corporations have little interest in this market.

**To respect local culture promoting the selection and breeding of genetic resources increasing the yield, maintaining the quality.**
**To keep germplasm evolving with time!**

**The Majority of the germplasm that I work with is used for human consumption**

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

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REVIEW article

Front. Nutr., 07 January 2022
Sec. Nutrition and Food Science Technology
Volume 8 - 2021 | https://doi.org/10.3389/fnut.2021.683399

## Traditional Foods From Maize (*Zea mays* L.) in Europe

Pedro Revilla[1*] Mara Lisa Alves[2] Violeta Andelković[3] Carlotta Balconi[4]
Isabel Dinis[5] Pedro Mendes-Moreira[5] Rita Redaelli[4] Jose Ignacio Ruiz de Galarreta[6]
Maria Carlota Vaz Patto[2] Sladana Žilić[7] Rosa Ana Malvar[1]

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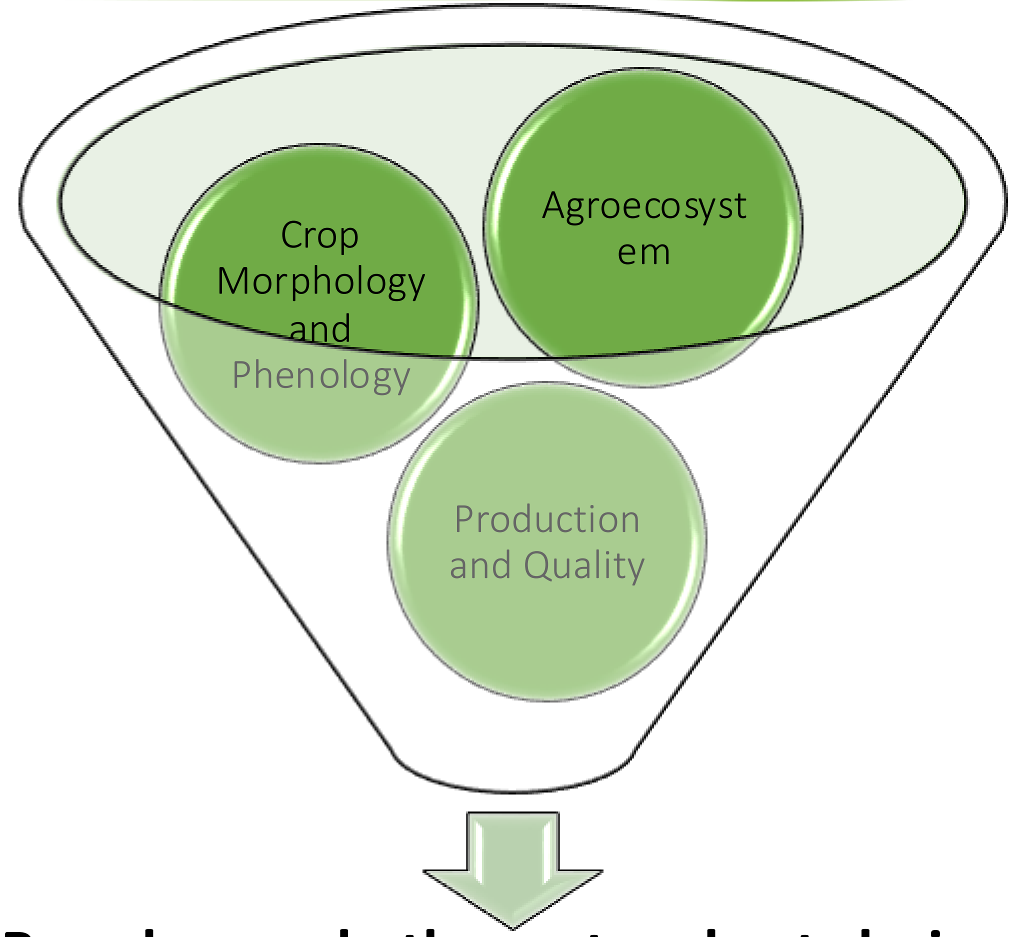
# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming




**Breeders and other actors best choices**
(This ilustrate part of the GAP information needed by breeders

Yield maintaining quality?

Desirable stand?

Pest and diseases?

Can we know more about our populations flowering behavior?

…

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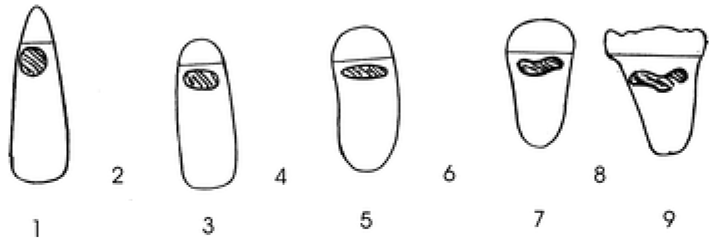
**Neutral marker**

What germplasm are you working in?

Do you have fasciation?




If your germplasm do not have fasciation your result will be always "1" so it is a neutral marker. But for us! You need to know what are your matherials and what you want from them! Case they have

# Unit 2.4: Methods for phenotyping and selection of agronomic traits  of interest in organic farming

**Broad diversity? Prebreeding Work**

**The HUNTERS** (**H**ight, **U**niformity, a**N**gle, **T**assel, **E**ar, **R**oot lodging and **S**talk lodging) analysis was developed as a method of evaluation

1–9 scale (1: very low, 2: very low to low, 3: low, 4: low to intermedium, 5: intermedium, 6: intermedium to high, 7: high, 8: high to very high and 9: very high) defining an average value per plot (Vaz Patto et al., 2007; Mendes Moreira et al., 2008)

H: Plant high (m) from the stalk basis to the last leaf insertion before the tassel.

U: Uniformity, complementary to diversity, where 1 is the minimum of uniformity and 9 the maximum. In general 1–4 applies to populations and 5–9 to inbreeds.

N: Angle of the adaxial side of the leaf above the ear with the stalk. <5 - angles inferior to 45º and >5, angles higher than 45 . Five = 45 angle.

T: Tassel branching. One - almost absent tassel common in inbreeds and hybrids, and 9 a very branched tassel, frequent in populations with abnormal fasciated ears.

E: Ear location. Five indicates that the ear is located in the middle of the plant.

R: Root lodging. It indicates the percentage of lodged plants and is related with the quality of the root system.

S: Stalk lodging. Percentage of broken plants. Is normally related with the quality of the stalk and the stalk damage caused by some insect attack.

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

Yes! We can easily connect this traits with SEEEDLINKED

# Unit 2.4

(A) - Immediately **before the pollen shedding**, detasseling all the undesirable plants (pest and disease susceptible, weakest and plants that do not fit the desirable ideotype);

(B) - **Before harvest**, besides selecting for the best ear size, the plants are foot kicked at their base (first visible internodes) to evaluate their root and stalk quality. Indirect measurement evaluation for pest and disease tolerance. If the plant breaks, it is eliminated. select prolific plants;

(C) - **At the storage** facilities, after harvest, selection is performed (normal and prolific ears) for ear length, kernel-row number, prolificacy, and the elimination of damaged/diseased ears. The selected ears are shelled and mixed together to form the next generation seed. The farmer selection pressure ranged from 1 to 5%

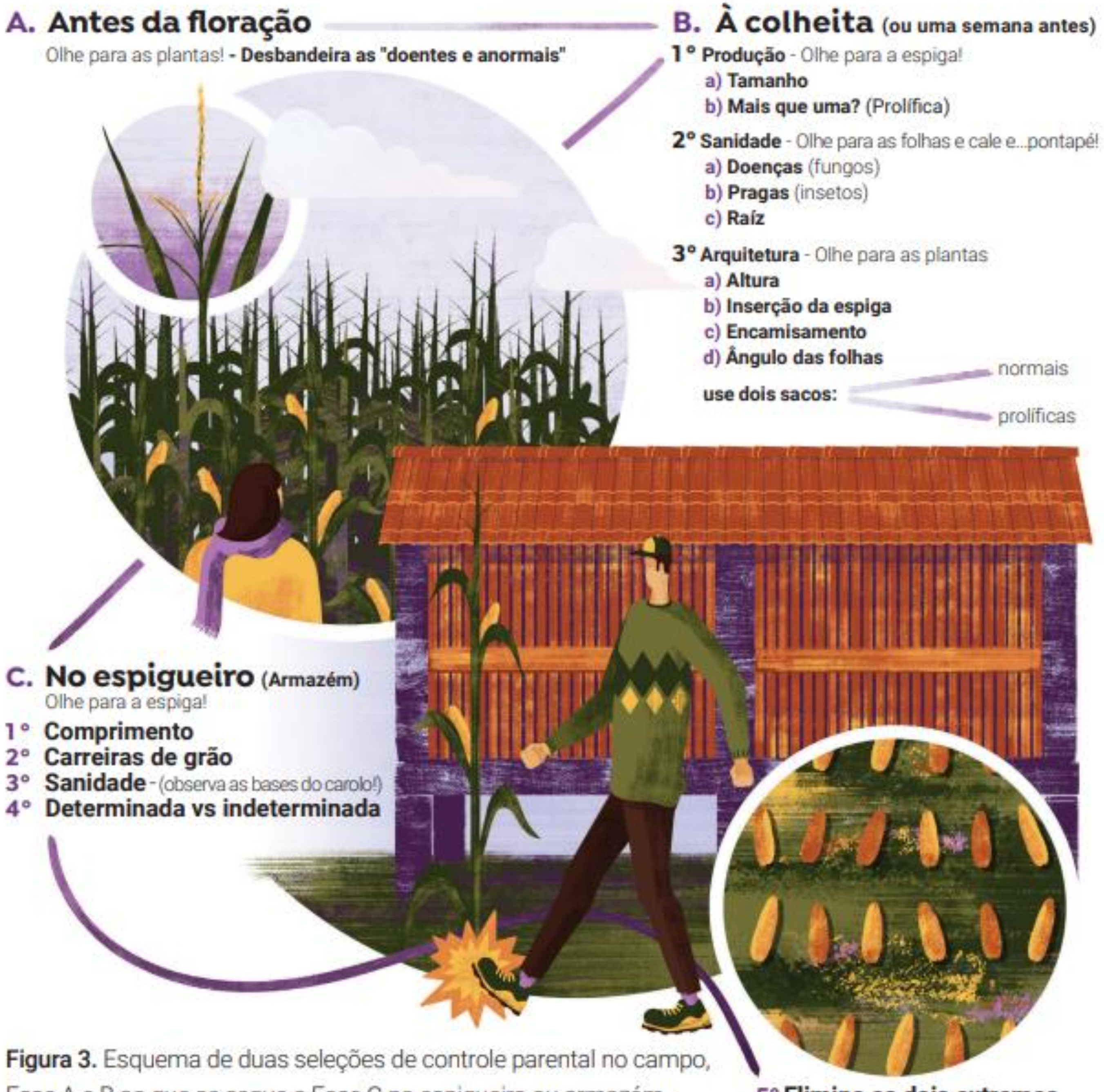
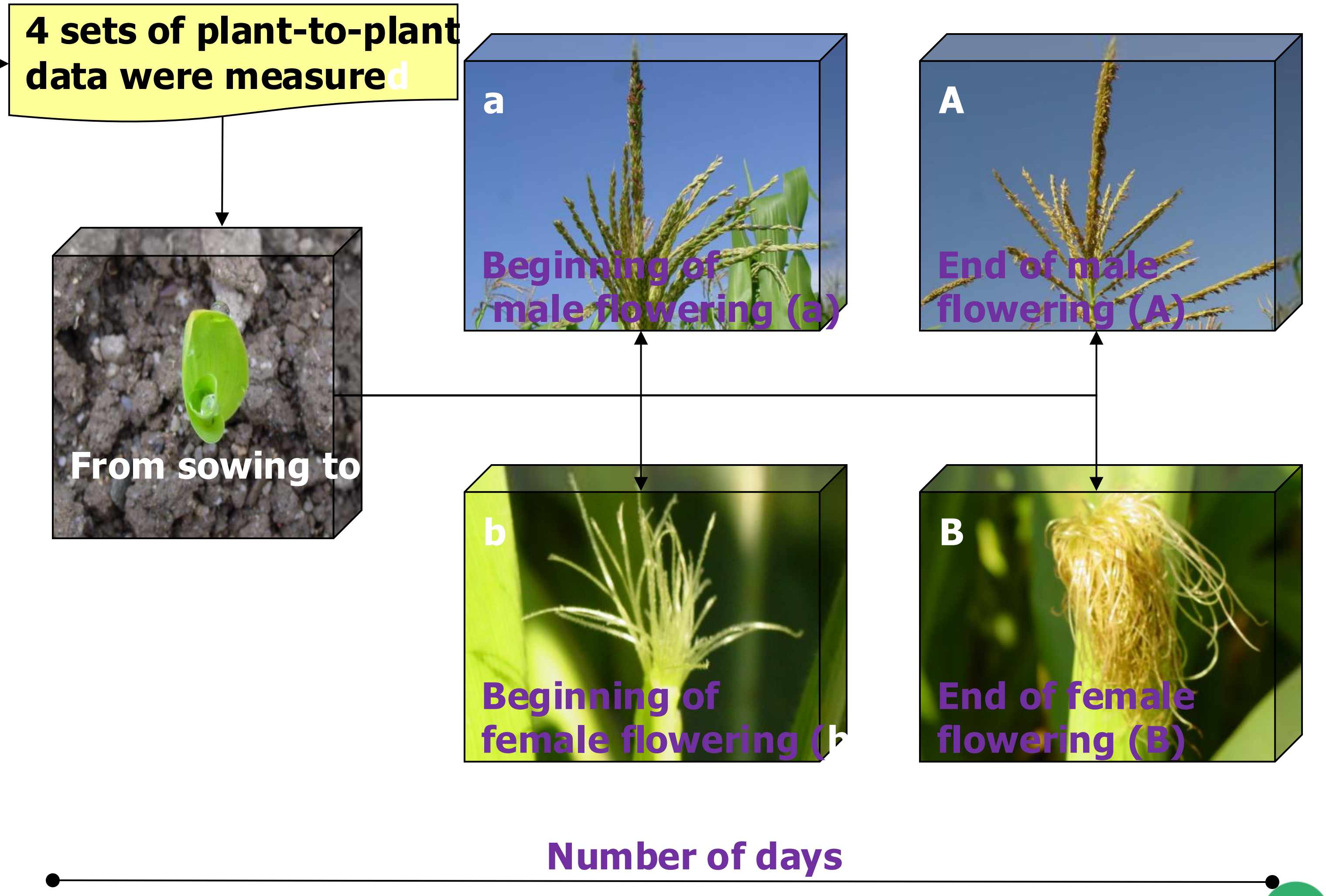



**Figura 3.** Esquema de duas seleções de controle parental no campo, Fase A e B ao que se segue a Fase C no espigueiro ou armazém.

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

**826 plants – VA Lousada**




The theoretical reasoning employed consists in **assuming** that all the **polinization occures only under gravity influence**, so that when maize plant has the hypothesis of flowering overlapping, this selfing probability will have a direct effect on the inbreeding depression.

This method enables the knowledge of a population concerning the relative amount of theoretical allogamy versus autogamy.

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

$OI = \frac{(B-b)+(A-a)-|B-A|-|b-a|}{2(B-b)}$

$$OI = \frac{(B-b)+(A-a)-|B-A|-|b-a|}{2(B-b)}$$

The number of days from planting, to the beginning (a) or end (A) of male flowering; or to the beginning (b) or end (B) of female flowering.

Evaluation of the overlapping index (OI) conditions:

OI is limited to 1 (100 %)

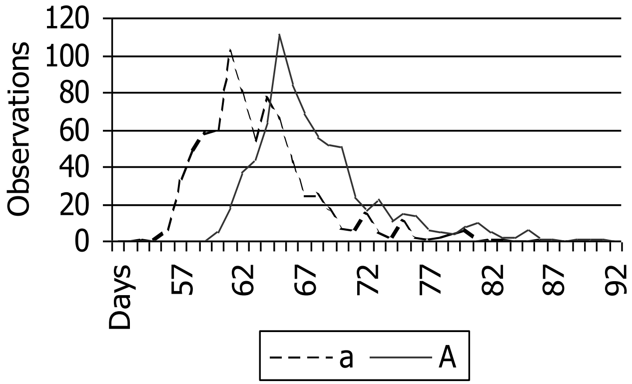
OI is either positive (some overlapping) or negative (overlapping does not occur).

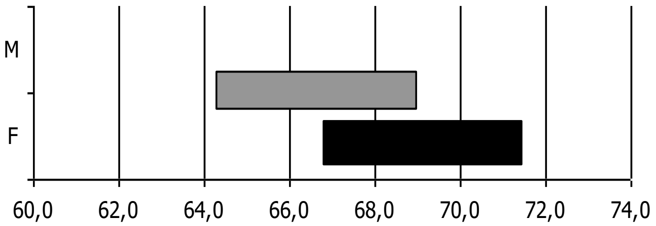
Maize breeders always look for high functional allogamy, so the selection for negative values of OI is pursued.

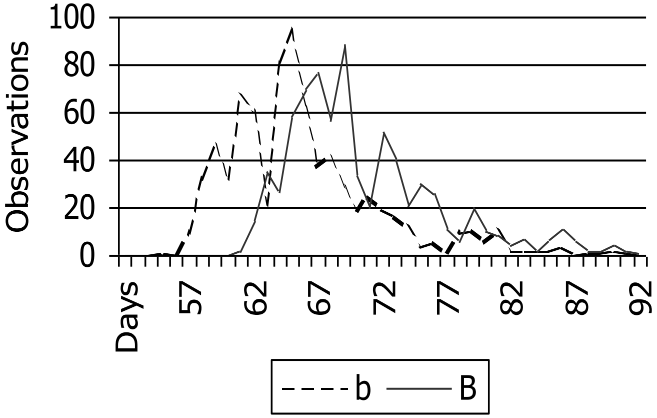
The proposed evaluation method can be conducted in only one year time, based on 13 possible overlapping types (T1-T13) (Figure 1).

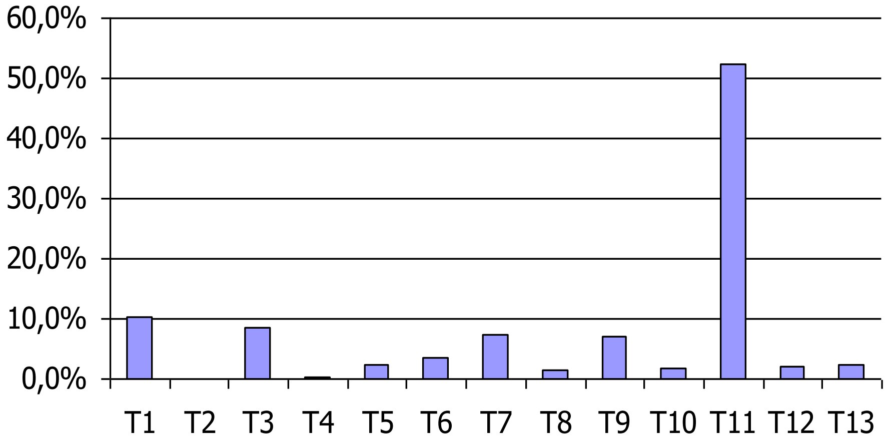
Moreira, P. M., & Pêgo, S. (2003)

| OI | | Obs. | % |
|---|---|---|---|
| OI<0 | a A | | |
| T1 | b B | 76 | 10,33 |
| | a A | | |
| T2 | b B | 1 | 0,14 |
| OI=0 | a A | | |
| T3 | b B | 62 | 8,42 |
| | a A | | |
| T4 | b B | 2 | 0,27 |
| OI=1 | a A | | |
| T5 | b B | 17 | 2,31 |
| | a A | | |
| T6 | b B | 27 | 3,67 |
| | a A | | |
| T7 | b B | 55 | 7,47 |
| | a A | | |
| T8 | b B | 11 | 1,49 |
| 0<OI<1 | a A | | |
| T9 | b B | 53 | 7,20 |
| | a A | | |
| T10 | b B | 14 | 1,90 |
| | a A | | |
| T11 | b B | 385 | 52,31 |
| | a A | | |
| T12 | b B | 16 | 2,17 |
| | a A | | |
| T13 | b B | 17 | 2,31 |
| Total | | 736 | 100 |




- Verdial de Aperrela:
  - ~19 % of no overlapping (OI <= 0, complete allogamy); ~15 % of complete overlapping (OI = 1, possible selfings all along the ear); ~66 % of partial overlapping (0 < OI < 1, possible selfings in specific parts of the ear).
- The population is represented in more than 50 % of the cases by partial overlapping of the type T11 (52.3 %). Even in this case (T11), our results show that 46.3 % of the kernels could have been selfed, while 53.7 % are hybrids.

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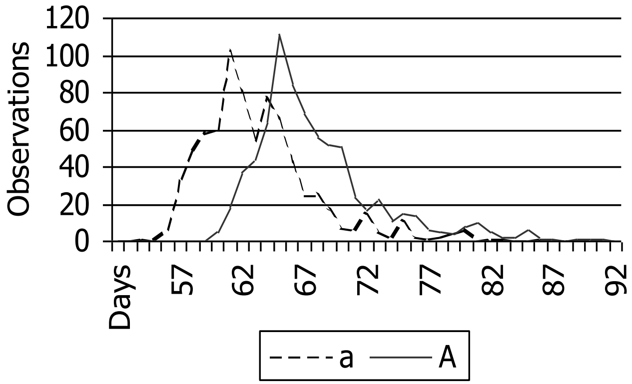
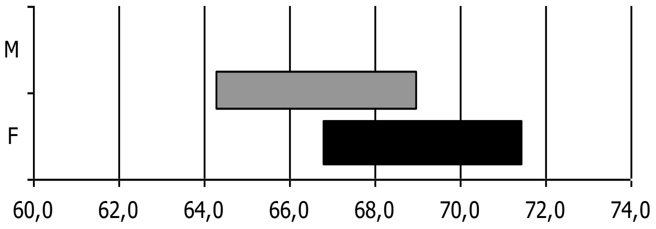
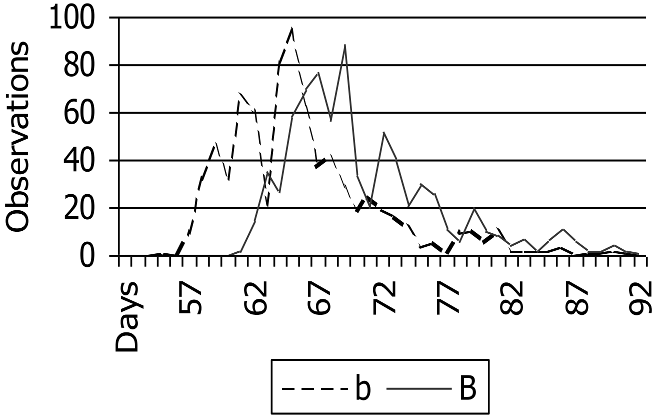
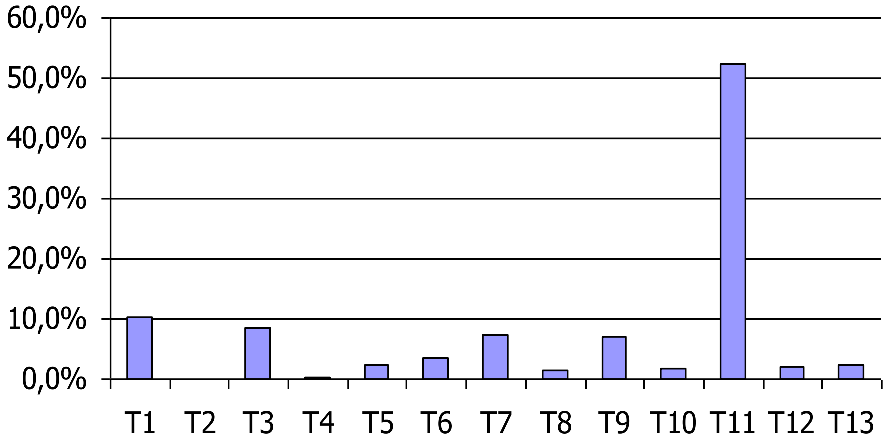
| OI | | Obs. | % |
|---|---|---|---|
| OI<0 | a A | | |
| T1 | b B | 76 | 10,33 |
| | a A | | |
| T2 | b B | 1 | 0,14 |
| OI=0 | a A | | |
| T3 | b B | 62 | 8,42 |
| | a A | | |
| T4 | b B | 2 | 0,27 |
| OI=1 | a A | | |
| T5 | b B | 17 | 2,31 |
| | a A | | |
| T6 | b B | 27 | 3,67 |
| | a A | | |
| T7 | b B | 55 | 7,47 |
| | a A | | |
| T8 | b B | 11 | 1,49 |
| 0<OI<1 | a A | | |
| T9 | b B | 53 | 7,20 |
| | a A | | |
| T10 | b B | 14 | 1,90 |
| | a A | | |
| T11 | b B | 385 | 52,31 |
| | a A | | |
| T12 | b B | 16 | 2,17 |
| | a A | | |
| T13 | b B | 17 | 2,31 |
| Total | | 736 | 100 |



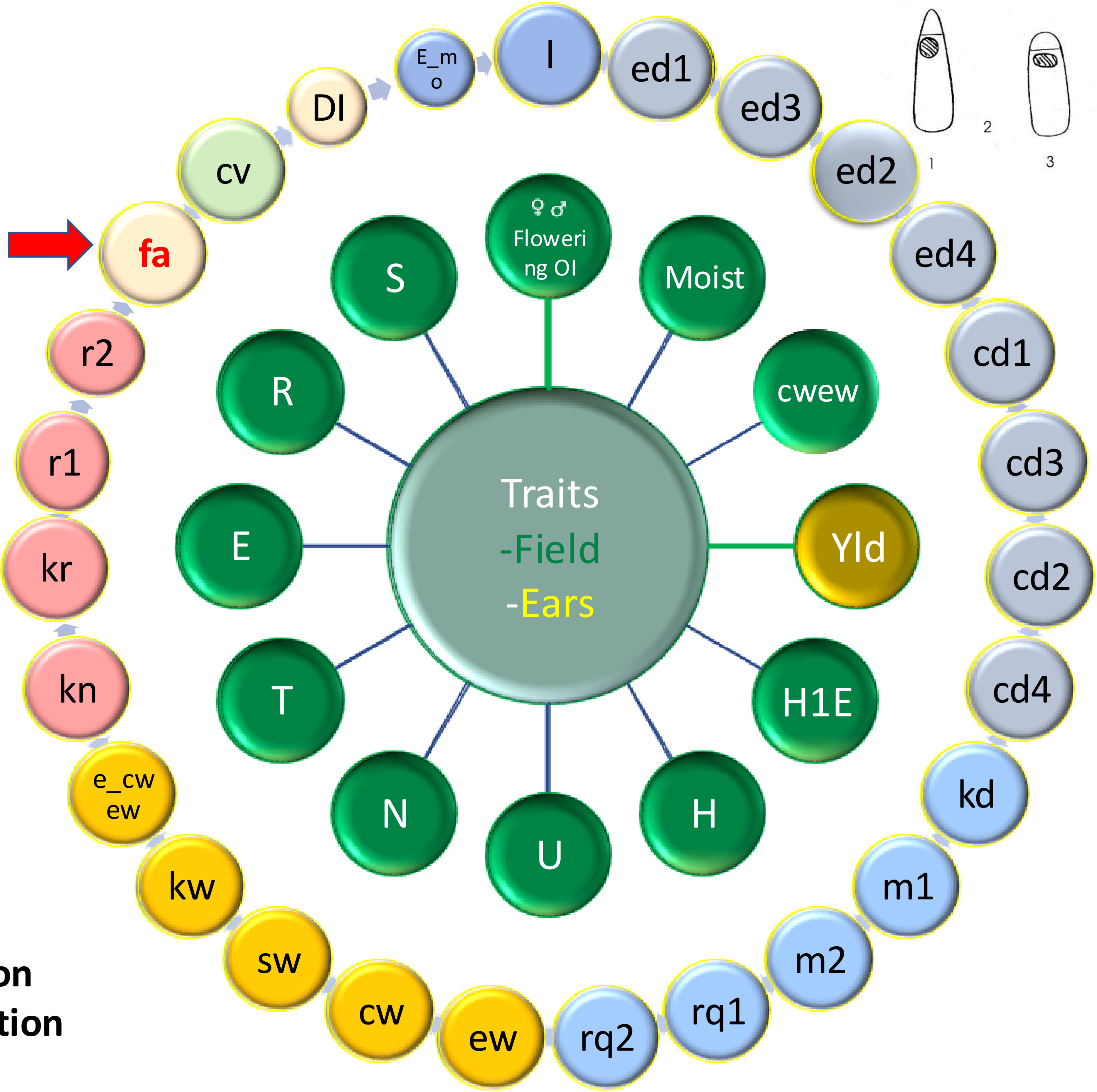



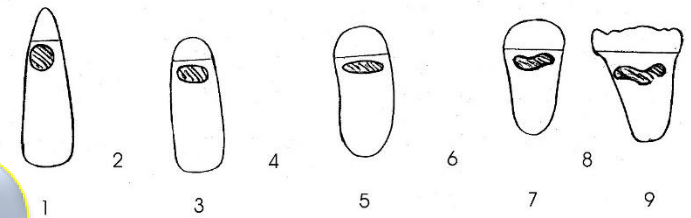




- An unexpected amount of complete allogamy (OI = 19.16 %) constitutes a selection potential for increasing allogamy at the expenses of possible autogamy.
- Figures 4 and 5 present some **differentiated peak**s, showing that this **population is not well recombined** and suggest it to be composed by at least three sub-populations which almost do not overlap. This represents a potential for both recombination and further genetic diversity implementation.

# Trials – What environments to use
# G + E + S + GxExS




**Traits used for population characterization**

**Statistical Analyses**

- **Correlations**
- **ANOVA**

# Example 2
# Trial in Organic and Conventional

| Rank Cal | Organic - Caldeirão | | Rank V | Conventional - Vagem | | Rank diferences |
|---|---|---|---|---|---|---|
| 1 | VA C0S0 19 - (Regadio Lousada | 4313,74 | 19 | VA C0S0 19 - (Regadio Lousada | 6450,77 | 18 |
| 2 | 2501 - (11-2019 Caldeirão 2019 | 4252,3 | 21 | 2501 - (11-2019 Caldeirão 2019 | 6344,97 | 19 |
| 3 | Bulk-Azores 2 - (110-2019 Cald | 4248,98 | 11 | Bulk-Azores 2 - (110-2019 Cald | 7308,47 | 8 |
| 4 | 2516 - (23-2019 Caldeirão 2019 | 4235,95 | 30 | 2516 - (23-2019 Caldeirão 2019 | 5675,8 | 26 |
| 5 | 2527 - (Caldeirão 2018) | 4195,12 | 35 | 2527 - (Caldeirão 2018) | 5575,57 | 30 |
| 6 | 2499 - (9-2019 Caldeirão 2019) | 4127,95 | 5 | 2499 - (9-2019 Caldeirão 2019) | 7961,27 | -1 |

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

**What are the resources that you have?**

Selecting for drought tolerance/resistance based on yield is a complicated task due to the complex nature of the trait and its low heritability . The task becomes particularly complex for participatory breeding approaches in which selection tools are to be applied directly by farmers.

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Open Access Article

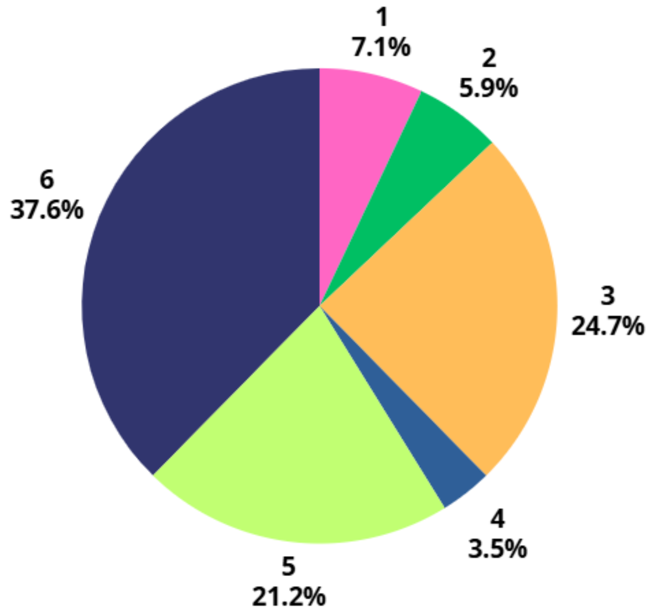
**Maize Open-Pollinated Populations Physiological Improvement: Validating Tools for Drought Response Participatory Selection**

by Susana T. Leitão [1], Emanuel Ferreira [2], M. Catarina Bicho [1,3], Mara L. Alves [1], Duarte Pintado [2], Daniela Santos [2], Pedro Mendes-Moreira [2], Susana S. Araújo [1], J. Miguel Costa [4] and Maria Carlota Vaz Patto [1,*]

# Evaluation


https://www.facebook.com/ESAC.IPC/videos/420973937771190

# Mister Tomate


Resultados da Escola da Agrária

Do we have the same results?
https://www.facebook.com/ESAC.IPC/videos/420973937771190

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# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

## PPB – from the farmer to the statistical tools - MARS, RF, CART

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ELSEVIER

Field Crops Research

Volume 161, May 2014, Pages 75-86

# Is ear value an effective indicator for maize yield evaluation?

Pedro M.R. Mendes-Moreira [a h i], João Mendes-Moreira [b c], António Fernandes [d], Eugénio Andrade [e], Arnel R. Hallauer [f], Silas E. Pêgo [g i], M.C. Vaz Patto [h i]

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https://doi.org/10.1016/j.fcr.2014.02.015



## Highlights

- A set of maize traits that could help farmers on selection for yield was identified.
- A new ear value formula that better estimates the yield potential was obtained.
- A new instance ranking measure to be used for evaluating ear ranks is proposed.
- A new method to be used in participatory research and pre-breeding is proposed.

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

(EV formula) was defined as:

$$EV = \frac{0.6 \times KW + 0.2 \times L + 0.15 \times R + 0.05 \times KN}{4} \quad (1)$$

*KW* stands for kernel weight (grams) at 15% moisture, *L* for ear length (centimeters), *R* for kernel row number and *KN* for total number of kernels.

Not forgeting to feed local iniciatives that can help on PPB recognition

“Best Ear of Sousa Valley competition” can provide adequate measurements, indicate best traits for selection and prediction


$$EVA = \text{mlr.varsEV} = -7.030877 + 0.031605 \times KW + 0.387825 \times L + 0.337015 \times R12 - 0.008875 \times KN \quad (13 \text{ and } 14)$$

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**Table 1**
Maize populations' characterization: kernel type, number of instances per population, origin and references.

| Population | Kernel type | Data[a] | Origin | Area/plot, ears/plot | References |
|---|---|---|---|---|---|
| Nutica | Yellow dent | 18 | Synthetic Pt (80% USA germplasm) | 9.6 $m^2$; 20 ears/plot | Moreira (2006) |
| Fandango | Yellow dent | 157 | Synthetic Pt (80% USA germplasm) | 9.6 $m^2$; 20 ears/plot | Mendes-Moreira et al. (2009) |
| Pigarro | White flint | 305 | Populations, Pt | 9.6 $m^2$; 20 ears/plot | Mendes-Moreira et al. (2008) |

[a] The number of instances per population corresponds to the product of selection cycles (for 'Pigarro' and 'Fandango'), years, locations with three reps, with exclusion of instances that not have the complete set of traits.

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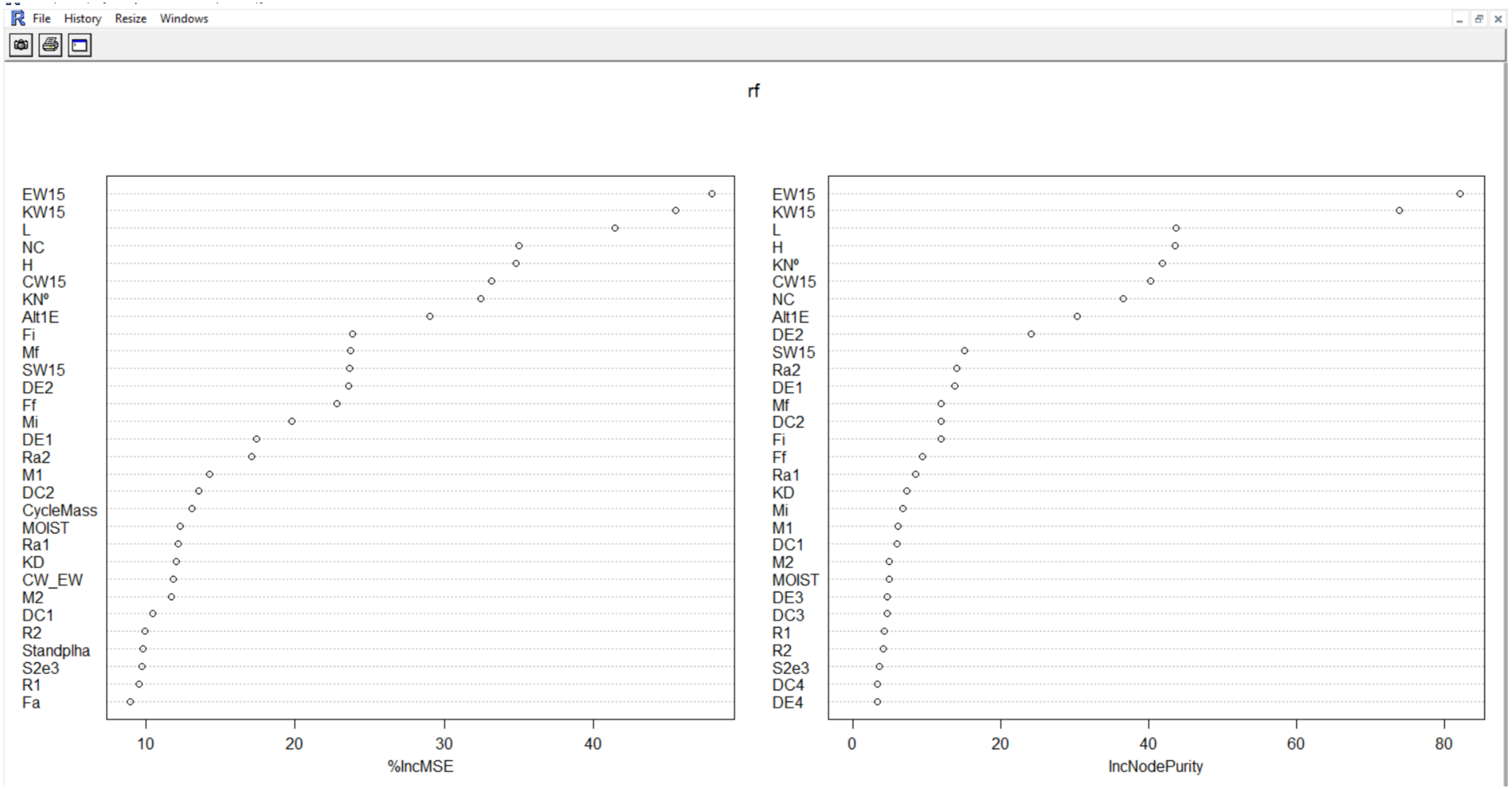
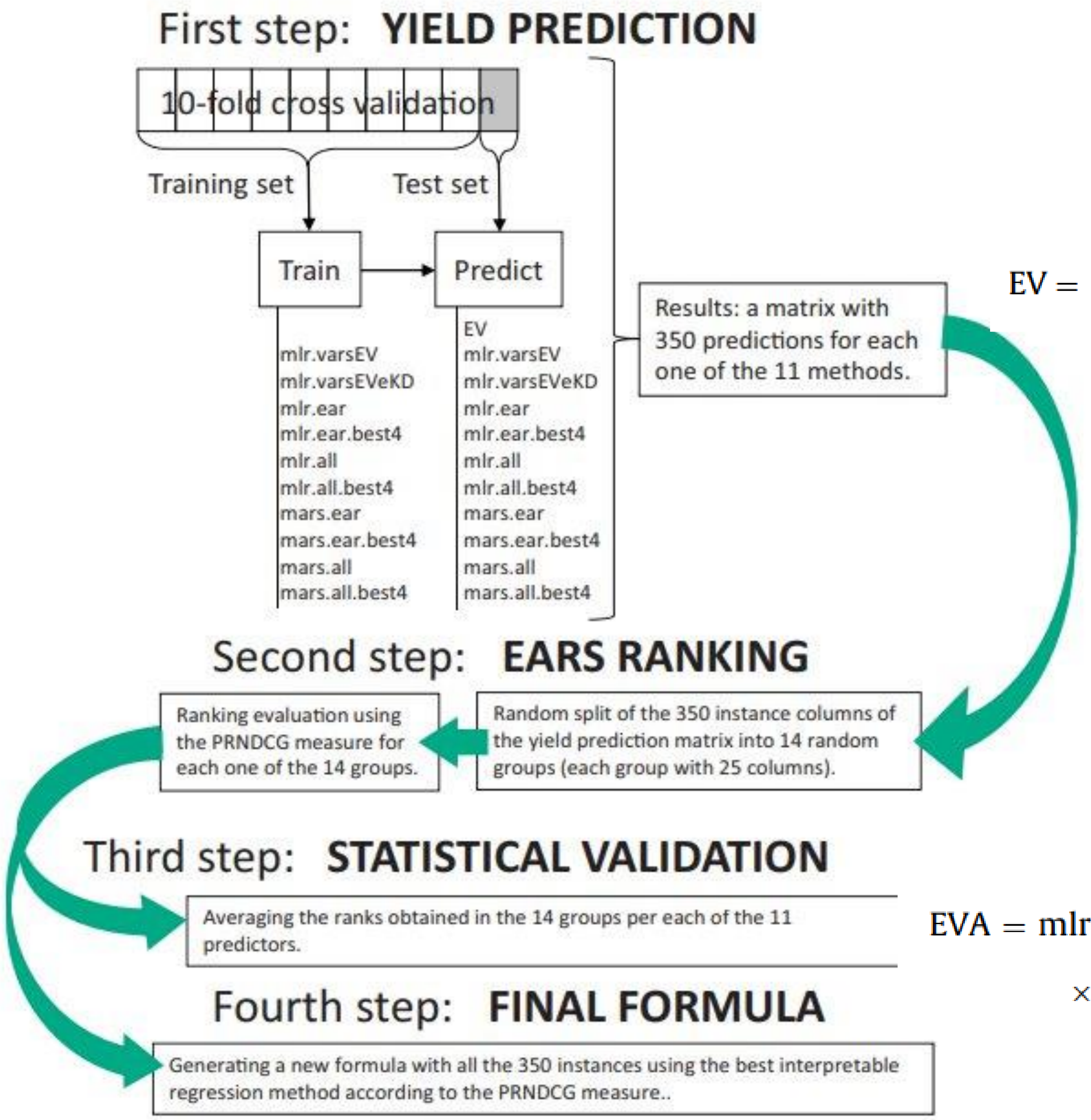
# PPB – from the farmer to the statistical tools




Searching for tools to help on the selection




$$EV = \frac{0.6 \times KW + 0.2 \times L + 0.15 \times R + 0.05 \times KN}{4} \quad (1)$$

$$EVA = \text{mlr.varsEV} = -7.030877 + 0.031605 \times KW + 0.387825 \times L + 0.337015 \times R12 - 0.008875 \times KN \quad (13 \text{ and } 14)$$

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

## Agronomic traits of interest in organic. Why?

- ❑*LIMITATION: there are many descriptors, but better to work with those which best encompass the diversity present on a crop and its relatives (comprehensive & discriminating ability)*
- ❑*Characterization with the many descriptors of a crop variety is not enough, search for the traits that respond to agronomic questions, search for better correlations with complex traits such as yield*
- ❑*Essential to better fit the varieties to organic environment (NUE, Weed competitiveness, pest and disease resistance) and focus on traits prioritized by farmers, processors, and consumers (Rempelos et al., 2023).*
- ❑*Check the level of diversity you have*
- ❑*Comparison to other and same accessions in other locations and actors (E + S and GXEXS)*

# Unit 2.4: Methods for phenotyping and selection of agronomic traits of interest in organic farming

PRACTICAL EXERCISES:

1. Guided visit to Overlap Index Maize

   + example with excel compiled data

1. Guided visit to Maize results

   + example of PUC-ESAC results with own data

SAME, but short, with seedlinked page?

# Seedlinked Trials Results

**Maize trial_Ensaio Milho:** https://app.seedlinked.com/trial/analytics/guest/MjA0Nw==

**Tomato degustation trial_Ensaio Tomate degustação:** **https://app.seedlinked.com/trial/analytics/guest/MjYxMg==**

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## DEBATE

- *Revise the quiz in common*
- *Own previous experiences*
- *Other questions and doubts*

# WRAP UP

- *What we have learned today?*
- *Proposed homework: study case, consider a crop that you are working and identify the five top traits that you would use in a breeding programe*

*Send to :*

*pmm@esac.pt and petra.jelincic@ips-konzalting.hr*

*By next Monday 10th february*

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Escola Superior Agrária
Politécnico de Coimbra

# Additional available materials


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# Further readings

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ORIGINAL RESEARCH article

Front. Plant Sci., 22 December 2017
Sec. Plant Breeding
Volume 8 - 2017 | https://doi.org/10.3389/fpls.2017.02203

## Setting Up Decision-Making Tools toward a Quality-Oriented Participatory Maize Breeding Program

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...e of Excellence for Biodiversity and Molecular Plant Breeding (CoE CroP-BioDiv), Zagreb, Croatia

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UK Research and Innovation

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Thanks for your attention!

# Query Unit 2.4 - Methods for phenotyping and selection of agronomic traits of interest in organic farming

**Tomato Evaluation - Choose your perfect tomato acording the shape and collourhttps://www.facebook.com/ESAC.IPC/videos/420973937771190**

R: This question allowed to indicate that according to the group we can have different responses

**In a breeding Program, you should measure all your accession with all the traits indicated by Bioversity**

No – You should choose what are the most important traits to deal with

**Are there any differences between Agronomic traits used for conventional and for organic?**

Yes, for example, we are interested in measure competition or allelopathy between crop and weeds, which is not important in conventional where herbicides are applied

**Nitrogen Use Efficiency (NUE) can be considered a simple trait.**

No, because NUE comprises two main components: nitrogen uptake and utilization efficiency, each involving numerous physiological processes and biochemical pathways

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# Quiz U2.4 + homework

Consider the file "Degustação de Tomate - LIVESEEDING- ESAC 2024". What was the accession with higher acidity.Tomato degustation trial_Ensaio Tomate degustação:

https://app.seedlinked.com/trial/analytics/guest/MjYxMg==

R:631

How many overlapping index cases exist for maize ?https://esacpt-my.sharepoint.com/:x:/g/personal/pmm_esac_pt/EbmeGIzGoKtGntb12adEWiMBKcRyL8KJk7-M1K_irL_a-g?e=4sdzCS

R:13

**Proposed homework:**

Study case, consider a crop that you are working and identify the five top traits that you would use in a breeding programe for organic.

R: open question depending on the chosen crop