Training course outline

MODULE 3

Breeding methods fundamentals

Task 1.4 - WP1

TRAINERS (or responsible partner): ***UPV(lead), IPC, KIS, INRAE***

SECTION 1: Info on the module for *trainees*

Identity card and case study data

Below you'll find all the information you need to produce one or more learning activities: the training objective and the pedagogical modality chosen (face-to-face, virtual classroom, self-study), parameters that form the framework of your exercise, a list of learning activities and a list of pedagogical resources from which you can draw (but you're free to invent new ones) to design your learning activity.

1. TRAINING THEMATIC- Background (Maximum 500 words)

Plant breeding methods encompass a range of strategies to achieve the improvement of plant varieties and populations. From the initial stage of starting from suitable genetic variation (fundamental for breeder´s success) to the different methodologies used in building a new improved variety. Having a good perspective on the main issues on breeding methods is essential for an efficient breeding work and a good response to selection. The availability of sources of variation to provide response to our breeding objectives is the first step. To achieve that, breeders can perform preliminary screenings or generate new variation through different methods. Then to choose and develop suitable breeding methodologies (or combinations of them) is also a key issue, as it must adapt the kind of traits we want to improve, the reproductive system of the species managed and/or the kind of variety or population we have as target. Moreover, there are many parameters which support and help breeders´ decision during the process and must be considered (e.g. correlations, heritability, combining ability). Finally, and particularly in the frame of organic breeding, a participatory approach has been gained attention in the last years. Participatory breeding enables a more efficient selection of lines by considering the opinion of the most relevant socioeconomic actors of the value chain (e.g. breeders, scientists, farmers, citizenship, retailers). In this module (Module 3 within T1.4 in LIVESEEDING), the targeted trainees will learn about the most relevant particularities, methodologies and strategies related and aimed at organic breeding.

2. TRAINING STAKES AND OBJECTIVES

Describe here the training stakes for this audience and the general training goal to achieve at the end of the training

Training stakes and the general training goal for the target audience you have chosen

1. The training course aims to:
Main methodologies for breeding in organic systems

2. Structure of the module and training
This module 3 is divided into four units.
- Generation of new diversity
- Common methods and strategies in organic breeding.
- Calculation and evaluation of key breeding parameters
- Fundamentals in participatory plant breeding

3. At the end of the training, the trainee will be able to:

- Know the opportunities to have genetic variation to start the breeding process
- Know the most relevant parameters used by breeders to support their work and selections
- Get a better understanding about breeding strategies in the context of organic systems, including participatory approaches

3. STRUCTURE OF THE TRAINING MODULE

Insert a summary table showing the module structure, units, and their duration.

MODULE #3 – Breeding methods fundamentals	6.5 hours
Unit one: *Generation of new diversity*	1.5 hours
Unit two: *Common methods and strategies in organic breeding*	2 hours
Unit three: *Calculation and evaluation of key breeding parameters*	1.5 hours
Unit four: *Fundamentals in Participatory Plant Breeding*	1.5 hours

4. TARGET AUDIENCE

Training is only effective if it is designed for a given audience and related to the problematic work situations for that given audience. A training activity may therefore differ depending on whether it is aimed at an advisor from a small seed company or a network of seed producers.

Check the target audience(s) (preferably one type of audience, possibly 2)

x Farmers' seed (networks) □ Contract seed producers x Handcraft small-scale seed enterprises □ Large scale / □ Multinational seed companies

Precise the target audience

1. Organic farmers (wide range, particular interest for farmers committed with agroecology, preservation of landraces and starting in breeding their own varieties)
2. Students (mainly University students, both undergraduate or MSc in Plant Breeding; but also open to others like High School degrees on agroecology)
3. Organic breeders

Specify the target audience, its level of expertise (experts, beginners, intermediates) and whether the training concerns vegetable seeds or cereal seeds.

Check the "pre-requisite" level of the trainees

□ Beginner X Intermediate □ Expert

Check the type of seeds concerned by the training

x Vegetables seed x Cereals

5. MODALITIES

□ virtual classroom / x face-to-face classroom (mainly online) / □ self-paced-training

6. EVALUATION METHODS

x Quiz / □ Presentation of a case study / x *add the method (homework: search info online)*

7. MATERIAL AVAILABLE FOR BUILDING THE LEARNING ACTIVITY(IES)

The learning resources for this topic are mainly books or scientific reports of reference on this issue. Some of them through online links or online available videocasts. This will complement your learning with more details. We encourage you to read these works to improve your understanding on breeding methodologies in the context of organic systems They will be provided and mentioned during the main presentation. As some examples:

- G. Acquaah. 2020. Principles of Plant Genetics and Breeding. 3rd edition. Book. Wiley, West Sussex, UK.
- H. C. Brookfield, Helen Parsons, Muriel Brookfield. 2003. Agrodiversity: Learning from farmers across the world. Book. United Nations University Press, New York, USA. 343 p.
- Ceccarelli, S., & Grando, S. (2020). Participatory plant breeding: Who did it, who does it and where? Experimental Agriculture, 56(1), 1–11. doi:10.1017/S0014479719000127.
- CERTRA. Desenvolvimento de Cadeias de Valor de Cereais Traditionais para una Alimentaçao Sustentável en Portugal. https://esa.ipb.pt/certra/divulgacao.html
- Cubero-Salmerón, JI. 2013. Introducción a la Mejora Genética Vegetal. 3a edición. Libro completo. ISBN 978-84-8476-655-1. Ediciones Mundi-Prensa, Madrid, España. 602 p.
- DINAVERSITY project. https://dynaversity.eu/2020/04/04/cereal-reinassance-in-the-field-documentary/
- https://dirros.openscience.si/IzpisGradiva.php?id=21310&lang=slv, dCOBISS, DOI: 10.3389/fpls.2024.1523745.
- Lammerts van Bueren ET & Myers J (editors). 2012. Organic crop breeding. Book. Wiley, West Sussex, UK. 312 p.

- Mendes-Moreira, P. M. M., Patto, M. V., Mota, M., Moreira, J. P. C. L. M., Santos, J. P. N., Santos, J. P. P., ... & Pego, S. E. (2009). "Fandango": long term adaptation of exotic germplasm to a Portuguese on-farm-conservation and breeding project. Maydica 54(2):269-28.
- Mendes-Moreira, P. M., Mendes-Moreira, J., Fernandes, A., Andrade, E., Hallauer, A. R., Pêgo, S. E., & Vaz Patto, M. (2014). Is ear value an effective indicator for maize yield evaluation? Field Crops Research, 161, 75-86. doi:10.1016/j.fcr.2014.02.015
- Mendes-Moreira, P., Satovic, Z., Mendes-Moreira, J., Santos, J. P., Nina Santos, J. P., Pego, S., & Vaz Patto, M. C. (2017). Maize participatory breeding in Portugal: Comparison of farmer's and breeder's on-farm selection. Plant breeding, 136(6), 861-871.
- Messmer, M, Wilbois, KP, Baier, C, Schäfer, F, Arncken, C, Drexler, D & Hildermann, I. 2015. Plant Breeding Techniques: An assessment for organic farming. ISBN 978-3-03736-286-0. FiBL, Switzerland. 48 p.
- Pipan, B.; Sinkovič, L.; Pipan, B. Multi-Elemental Composition, Nutrients and Total Phenolics in Seeds of Phaseolus vulgaris L. Breeding Material. J. Elem. 2021, 26, 613–623. 10.5601/jelem.2021.26.2.2143
- Plestenjak, E., Meglič, V., Sinkovič, L., Likar, M., Regvar, M., & Pipan, B. 2024. Nodulation performance and agronomic traits of European common bean (Phaseolus vulgaris L.) genetic resources. Acta Agriculturae Scandinavica, Section B — Soil & Plant Science, 74(1). https://doi.org/10.1080/09064710.2024.2392507
- Plestenjak, E., NEei, Mohamed, Sinkovič, L, Meglič, V., & Pipan, B. 2024. Genomic insights into genetic diversity and seed coat color change in common bean composite populations. Frontiers in plant science. 2024, vol. 15, [art. no.] 1523745. ISSN 1664-462X. https://www.frontiersin.org/journals/plant-science/articles/10.3389/fpls.2024.1523745/full#h7
- Rey, F, Flipon E (Eds.); P. Riviere, F. Rey, I. Goldringer (auts), 2021. Selecting the appropriate methodology for organic on-farm cultivar trials: a technical guide for researchers and facilitators. LIVESEED project.
- Serpolay, E, Nuijten, E, Rossi, A, Chable, V. 2018. Toolkit to foster multi-actor research on agrobiodiversity. Diversifood Project https://diversifood.eu/wp-content/uploads/2017/09/toolkit_multi_actor_research_BAT_web2.pdf
- Sinkovič, L., Tavakoli Hasanaklou, H., Neji, M., Plestenjak, E., Dolničar, P., Meglič, V., & Pipan, B. (2024). Combining multi-criteria decision analysis with agro-morphological-biochemical-molecular traits of interest for use in breeding in promising common bean breeding lines (Phaseolus vulgaris L.). Cogent Food & Agriculture, 11(1). https://doi.org/10.1080/23311932.2024.2439551
- Vaz-Patto, MC, Moreira, PM, Carvalho, V & Pego S. (2007). Collecting maize (Zea mays L. convar. mays) with potential technological ability for bread making in Portugal. Genetic Resources and Crop Evolution, 54, 1555-1563.

8. TRAINING TECHNIQUES

Check one or several learning activities you have chosen to develop

Expositive methods – which emphasize the 'absorption' of new Information. The learner need to listen, read, observe.	x Presentation: organized information on a specific topic x Demonstration of how a task can be performed x Worked examples with comment and explicit reference to the theory x Case studies real, significant cases related to the topic □ other + with survey and feedback
Application methods – which emphasize the active processes that learners use to perform procedural and principle-based tasks and build new knowledge	□ Demonstration and practice of a gesture or procedure □ Analysis and diagnosis of a "virtual" case study (described in writing, audio or video recording) x Guided search for resources and production of a summary □ Role-playing or simulation x Project: apply the principles and concepts learned in your own environment
Collaborative methods – which emphasize the social dimension of learning and engage learners in sharing knowledge and performing tasks in a collaborative way.	x Guided online discussions (chat, forum, video or audio conference): debate, exchanges □ Collaborative work: application methods involving group collaboration (longer, more complex tasks) x Tutoring or even peer assessment: pairing up, for example, to assess each other's work/production.

SECTION 2: Info on the module for trainers

2.1 THE DURATION OF THE PLANNED ACTIVITY, ITS VARIOUS STAGES AND TIMING

Describe the duration, stages, and timing of the activities in each unit

Unit 1 1) Sharing of instructions about the session, and main concepts to be learned – 5-10 min, 2) Main presentation from the trainer, description of useful materials - 45 min, 3) Evaluation of trainees 1 questions relative to issues exposed during presentations (Quiz, 10 min in total; response provided by e.mail to the trainer) 4) plenary explanation of PGRs repositories in Genebanks (15 min) 5) Conclusions, follow-up and prospects (what have we learnt today?, 5 min). 6) Evaluation of trainees 2 (individual homework performed individually during the next week, work provided to the trainer by e.mail)

Unit 2 1) Sharing of instructions about the session, and main concepts to be learned – 5-10 min, 2) Main presentation from the trainers, description of useful materials (available online) - 75 min, 3) Evaluation of trainees 1, using questions relative to issues exposed during presentations (Quiz, 10 min in total; response provided by e.mail to the trainer) 4) plenary discussion on pre-breeding procedures, strategies and selection of parents/populations (15 min) 5) Conclusions, follow-up and prospects (what have we learnt today?, 5-10 min). 6) Evaluation of trainees 2 (individual homework, performed individually during the next week and provided to the trainers by e-mail)

Unit 3 1) Sharing of instructions about the session, and main concepts to be learned – 5 min, 2) Main presentation from the trainer, description of useful materials (available online) - 60 min, 3) Evaluation of trainees 1 questions relative to issues exposed during presentations (Quiz, 10 min in total; response provided by e.mail to the trainer) 4) plenary discussion of main differences and complementarities among key breeding parameters (10 min) 5) Conclusions, follow-up and prospects (what have we learnt today?, 5 min). 6) Evaluation of trainees 2 (individual homework, community seed bank activities and cooperative conservation projects/networks worldwide (successful examples), performed individually during the next week, work provided to the trainer by e.mail)

Unit 4 1) Sharing of instructions about the session, and main concepts to be learned – 5-10 min, 2) Main presentation from the trainers, main concepts in participatory plant breeding, description of useful materials and papers (available online) - 50 min, 3) Evaluation of trainees 1 questions relative to issues exposed during presentations (Quiz, 10 min in total; response provided by e.mail to the trainer) 4) plenary discussion of main differences and complementarities among key breeding parameters (10 min) 5) Conclusions, follow-up and prospects (what have we learnt

today?, 5-10 min). 6) Evaluation of trainees 2: individual homework, find a PPB project from your location/area and characterise the chosen project in brief paragraph (performed individually during the next week, work provided to the trainer by e.mail)

INSTRUCTIONS

Describe the instructions you're going to give trainees for carrying out the activity. Ideally, write down these instructions

The structure of each unit will be shortly explained in the first 5-10 min.
In summary, be ready:
i) to follow online presentation
ii) take notes of main issues treated
as iii) there will be a short quiz for evaluation
iv) put your questions on the chat and
v) finally, you will be also evaluated through a home work (during the next week), based on a practical work related to the topics given in the corresponding unit.

MATERIALS

Describe the materials provided for trainees to carry out the activity (resources, Internet links, etc.) and specify how they will use the resources, and describe the link between the resources and the activity

UNIT 1 – During the presentation, several materials and online resources will be shared with the trainees. Works or papers as examples of generation new diversity, as well as books will be mentioned and listed in the presentation. These works (mostly available online) will be provided to the trainees to widen the info of the own presentations, as complementary information. Examples:

• H. C. Brookfield, Helen Parsons, Muriel Brookfield. 2003. Agrodiversity: Learning from farmers across the world. Book. United Nations University Press, New York, USA. 343 p.

• M. Messmer, K.P. Wilbois, C. Baier, F. Schäfer, C. Arncken, D. Drexler and I. Hildermann 2015. Plant Breeding Techniques: An assessment for organic farming. ISBN 978-3-03736-286-0. FiBL, Switzerland. 48 p.

• Vaz Patto, M. C., Moreira, P. M., Carvalho, V., & Pego, S. (2007). Collecting maize (Zea mays L. convar. mays) with potential technological ability for bread making in Portugal. Genetic Resources and Crop Evolution, 54, 1555-1563.

UNIT 2 - During the presentation, aimed at main breeding strategies, based on maize and beans as examples, several works and papers available online will be shared with the trainees. Other relevant resources will be shared in a list on the presentation to widen the info on breeding strategies, as complementary information for the students. Examples:

• E.T. Lammerts van Bueren and J. Myers (editors). 2012. Organic crop breeding. Book. Wiley, West Sussex, UK. 312 p.

• Mendes-Moreira, P. M. M., Patto, M. V., Mota, M., Moreira, J. P. C. L. M., Santos, J. P. N., Santos, J. P. P., ... & Pego, S. E. (2009). "Fandango": long term adaptation of exotic germplasm to a Portuguese on-farm-conservation and breeding project. Maydica 54(2):269-28

• Mendes-Moreira, P., Satovic, Z., Mendes-Moreira, J., Santos, J. P., Nina Santos, J. P., Pego, S., & Vaz Patto, M. C. (2017). Maize participatory breeding in Portugal: Comparison of farmer's and breeder's on-farm selection. Plant breeding, 136(6), 861-871.

• F. Rey, E. Flipon (Eds.); P. Riviere, F. Rey, I. Goldringer (auts), 2021. Selecting the appropriate methodology for organic on-farm cultivar trials: a technical guide for researchers and facilitators. LIVESEED project

•PLESTENJAK, Eva, NEJI, Mohamed, SINKOVIČ, Lovro, MEGLIČ, Vladimir, PIPAN, Barbara. Genomic insights into genetic diversity and seed coat color change in common bean composite populations. Frontiers in plant science. 2024, vol. 15, [art. no.] 1523745. ISSN 1664-462X. https://www.frontiersin.org/journals/plant-science/articles/10.3389/fpls.2024.1523745/full#h7, https://dirros.openscience.si/IzpisGradiva.php?id=21310&lang=slv, dCOBISS, DOI: 10.3389/fpls.2024.1523745.

• Pipan, B.; Sinkovič, L.; Pipan, B. Multi-Elemental Composition, Nutrients and Total Phenolics in Seeds of Phaseolus vulgaris L. Breeding Material. J. Elem. 2021, 26, 613–623. 10.5601/jelem.2021.26.2.2143

UNIT 3 – During the presentation, aimed at main breeding parameters, several works and papers available online will be shared with the trainees. Other relevant resources will be shared to widen the info on the estimation of breeding parameters, as complementary information for the students. Some examples:

• J.I. Cubero-Salmerón. 2013. Introducción a la Mejora Genética Vegetal. 3a edición. Libro completo. ISBN 978-84-8476-655-1. Ediciones Mundi-Prensa, Madrid, España. 602 p.

• G. Acquaah. 2020. Principles of Plant Genetics and Breeding. 3rd edition. Book. Wiley, West Sussex, UK.

• Plestenjak, E., Meglič, V., Sinkovič, L., Likar, M., Regvar, M., & Pipan, B. (2024). Nodulation performance and agronomic traits of European common bean (Phaseolus vulgaris L.) genetic resources. Acta Agriculturae Scandinavica, Section B — Soil & Plant Science, 74(1). https://doi.org/10.1080/09064710.2024.2392507

• Sinkovič, L., Tavakoli Hasanaklou, H., Neji, M., Plestenjak, E., Dolničar, P., Meglič, V., & Pipan, B. (2024). Combining multi-criteria decision analysis with agro-morphological-biochemical-molecular traits of interest for use in breeding in promising common bean breeding lines (Phaseolus vulgaris L.). Cogent Food & Agriculture, 11(1). https://doi.org/10.1080/23311932.2024.2439551

•PLESTENJAK, Eva, NEJI, Mohamed, SINKOVIČ, Lovro, MEGLIČ, Vladimir, PIPAN, Barbara. Genomic insights into genetic diversity and seed coat color change in common bean composite populations. Frontiers in plant science. 2024, vol. 15, [art. no.] 1523745. ISSN 1664-462X. https://www.frontiersin.org/journals/plant-science/articles/10.3389/fpls.2024.1523745/full#h7, https://dirros.openscience.si/IzpisGradiva.php?id=21310&lang=slv, dCOBISS, DOI: 10.3389/fpls.2024.1523745.

UNIT 4 – During the presentation, aimed at participatory breeding, several works and papers available online, links will be shared with the trainees. Other relevant resources will be shared to widen the info on participatory approaches, as complementary information for the students. Some examples:

- Ceccarelli, S., & Grando, S. (2020). Participatory plant breeding: Who did it, who does it and where? Experimental Agriculture, 56(1), 1–11. doi:10.1017/S0014479719000127.
- CERTRA. Desenvolvimento de Cadeias de Valor de Cereais Traditionais para una Alimentaçao Sustentável en Portugal. https://esa.ipb.pt/certra/divulgacao.html
- DINAVERSITY project. https://dynaversity.eu/2020/04/04/cereal-reinassance-in-the-field-documentary/
- https://dirros.openscience.si/IzpisGradiva.php?id=21310&lang=slv, dCOBISS, DOI: 10.3389/fpls.2024.1523745.
- Mendes-Moreira, P. M. M., Patto, M. V., Mota, M., Moreira, J. P. C. L. M., Santos, J. P. N., Santos, J. P. P., ... & Pego, S. E. (2009). "Fandango": long term adaptation of exotic germplasm to a Portuguese on-farm-conservation and breeding project. Maydica 54(2):269-28.
- Mendes-Moreira, P. M., Mendes-Moreira, J., Fernandes, A., Andrade, E., Hallauer, A. R., Pêgo, S. E., & Vaz Patto, M. (2014). Is ear value an effective indicator for maize yield evaluation? Field Crops Research, 161, 75-86. doi:10.1016/j.fcr.2014.02.015
- Mendes-Moreira, P., Satovic, Z., Mendes-Moreira, J., Santos, J. P., Nina Santos, J. P., Pego, S., & Vaz Patto, M. C. (2017). Maize participatory breeding in Portugal: Comparison of farmer's and breeder's on-farm selection. Plant breeding, 136(6), 861-871.
- Rey, F, Flipon E (Eds.); P. Riviere, F. Rey, I. Goldringer (auts), 2021. Selecting the appropriate methodology for organic on-farm cultivar trials: a technical guide for researchers and facilitators. LIVESEED project.
- Serpolay, E, Nuijten, E, Rossi, A, Chable, V. 2018. Toolkit to foster multi-actor research on agrobiodiversity. Diversifood Project https://diversifood.eu/wp-content/uploads/2017/09/toolkit_multi_actor_research_BAT_web2.pdf

PLANNED INTERACTION BETWEEN TRAINEES AND/OR WITH THE TRAINER

Describe it and specify in particular if it's remote (virtual class, self-training) the support used (chat tool, collaborative writing document, collaborative whiteboard, survey, etc.).

The four units: Remote virtual class (synchronous, through TEAMS or similar platforms), chat tool for questions during presentation (questions not replied during the virtual online class will be replied later in a document, which will be shared to the mail list of trainees)

EVALUATION

Describe how you are going to assess what you have learned. Please note that the skills assessed must relate to the training objective you have formulated. If it's a quiz, true/false, MCQ, etc., write down the questions you might ask.

The four units: fast quiz (about 10 min) during the lesson + individual homework (during the week after the lesson, provided to the trainer once finished for evaluation)