Training course outline

MODULE 5

Organic heterogeneous material (OHM) design and development

Task 1.4 - WP1

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

Organic Heterogeneous Materials appear as useful plant populations to contribute to a more diverse, dynamically adaptable and resilient farming system. These populations, while showing uniformity for many morphological traits (e.g. fruit size and appearance, plant development), also preserve a heterogeneous genetic background for other traits which could be useful for adaptation to a wide range of pedoclimatic conditions. Thus, they are of particular interest in the context of organic farming and low input farming, as well as to face the climate change.
A range of topics will be given in the different units, among others: examples of OHMs already obtained, procedures to start the initial populations (composite cross populations or dynamic mixtures), breeding strategies and tools for genomic tracking of their evolution, as well as fundamentals on population genetics to understand their evolution. The present module is aimed at training on the fundamentals of all these concepts.

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 issues related to Organic Heterogeneous Materials (OHMs) concepts, fundamentals and development. From basic knowledge and population genetics dynamics to their development and tracking.

2. Structure of the module and training
This module 5 is divided into four units:
- Composite Cross Populations: setting-up & selection
- Dynamic mixtures: setting-up & selection
- Fundamentals of populations genetics applied to OHM development and use
- Using genomics to track the evolution of heterogeneous organic materials

3. At the end of the training, the trainee will be able to:
- Learn how to develop OHMs
- Understand the fundamentals on how they evolve during their selection and development
- Learn how to track by genomic approaches the evolution of heterogeneous populations through generations

- Learn the main applications and opportunities of OHMs in organic farming

3. STRUCTURE OF THE TRAINING MODULE

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

MODULE #5 – Organic heterogeneous material (OHM) design and development	6.5 hours
Unit one: *Composite Cross Populations: setting-up & selection*	2 hours
Unit two: *Dynamic mixtures: setting-up & selection*	1.5 hour
Unit three: *Fundamentals of populations genetics applied to OHM development and use*	1.5 hour
Unit four: *Using genomics to track the evolution of heterogeneous organic materials*	1,5 hours

4. TARGET AUDIENCE

Target audience(s)

Students
Researchers
Breeders

Precise the target audience

Students: wide range, but minimum since University undergraduates on Agronomy, Biology, Biotechnology, to MSc in Plant Breeding and Biotechnology, PhD students

Researchers: early stage career researchers in agronomy and plant breeding

Breeders: and more specifically organic breeders who want to learn about and apply molecular markers in their breeding programmes

Check the "pre-requisite" level of the trainees

Intermediate

Check the type of crop concerned by the training

Vegetables
Cereals

5. MODALITIES

Online workshop

6. EVALUATION METHODS

Online quizzes and homework the week after the session

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

The learning resources for this topic require that you connect to the internet with your computer to follow the presentations, some videos, downloading online available papers to work with, online softwares, or making the requested homework later. Also, some scientific papers and online available info to widen the details about the topics given will be also mentioned and advised for future reading. They will be provided and mentioned during the main presentations.

Some examples:

For Unit 1:

- https://www.biodiversecarbonfarming.com/biodiverse-farming/composite-cross-populations/
- S. Brumlop, O. Weedon, W. Link, M.R. Finckh. 2019. Effective population size (Ne) of organically and conventionally grown composite cross winter wheat populations depending on generation. European Journal of Agronomy 109: 125922, https://doi.org/10.1016/j.eja.2019.125922
- Weedon, Odette D., Sarah Brumlop, Annette Haak, Jörg Peter Baresel, Anders Borgen, Thomas Döring, Isabelle Goldringer, Edith Lammerts van Bueren, Monika M. Messmer, Péter Mikó, and et al. 2023. "High Buffering Potential of Winter Wheat Composite Cross Populations to Rapidly Changing Environmental Conditions" Agronomy 13, no. 6: 1662. https://doi.org/10.3390/agronomy1306166
- Vollenweider C, Spieß H (2018) Composite cross populations: legal considerations and their value for plant breeding. In: Vereinigung der Pflanzenzüchter und Saatgutkaufleute Österreichs (Ed), 68. Jahrestagung 2017, 20-22 November, Raumberg-Gumpenstein, pp 49-50. BOKU-University of Natural Resources and Life Sciences, Vienna, Austria. ISBN-13: 978-3-900932-53-4

For unit 3:

- PopGen software. Online available resource to simulate the evolution of genes in the context of population genetics and micro-evolutionary forces (provided online through the Radford University server): https://sites.radford.edu/~rsheehy/Gen_flash/popgen/

For unit 4:

- Siddiqui, M.N., Schneider, M., Barbosa, M.B. et al. Natural selection under conventional and organic cropping systems affect root architecture in spring barley. Sci Rep 12, 20095 (2022). https://doi.org/10.1038/s41598-022-23298-3
- Schneider, M., Shrestha, A., Ballvora, A. et al. High-throughput estimation of allele frequencies using combined pooled-population sequencing and haplotype-based data processing. Plant Methods 18, 34 (2022). https://doi.org/10.1186/s13007-022-00852-8

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 needs to listen, read, observe.	x Presentation: organized information on a specific topic □ 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 + Survey and feedback
Application methods – which emphasize the active processes that learners use to perform procedural and principle-based tasks and build new knowledge	x 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 x 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 (UPV – Adrian Rodriguez-Burruezo; INRAe – Isabelle Goldringer)
1) Sharing instructions about the session, and main concepts to be learned – 5-10 min, 2) Main presentation from the trainer - 50 min, 3) individual work for trainees, based on a paper aimed at the development of one CCP design and development (30 min), 4) General revision of the work, discussion, questions from trainees (15 min), 5) Evaluation of trainees 1: questions relative to issues exposed during presentations (Quiz, 10 min in total; response provided by e.mail to the trainer) 6) Conclusions, follow-up and prospects (what have we learnt today?, 5 min).

Unit 2 (IPC – Pedro Mendes Moreira)
1) Sharing instructions about the session, and main concepts to be learned – 5-10 min, 2) Main presentation from the trainer, practical examples of mixtures, collaborative work with trainees based on examples, etc. - 55 min, 3) Evaluation of trainees 1: questions relative to issues exposed during presentation (Quiz, 10 min in total; response provided by e.mail to the trainer) 5) Conclusions, follow-up and prospects (what have we learnt today?, 10 min). 6) Evaluation of trainees 2 (proposal of individual homework, performed individually during the next week and provided to trainer by e.mail)

Unit 3 (UPV – Adrian Rodriguez-Burruezo; INRAe – Isabelle Goldringer)
1) Sharing instructions about the session, and main concepts to be learned – 5-10 min, 2) Main presentation, description of fundamentals on population genetics, effect of reproductive systems, sharing useful materials about populations genetics, etc. - 40 min, 3) Guided training using a PopGen online simulator (20 min) 4) Evaluation of trainees 1: questions relative to issues exposed during presentations (Quiz, 10 min in total; response provided by e.mail to the trainer) 5) Conclusions, follow-up and prospects (what have we learnt today?, 10 min). 6) Evaluation of trainees 2 (proposal of individual homework, based on trainees´ practising with PopGen simulator, performed individually during the next week and provided to trainer by e.mail)

Unit 4 (FiBL – Michael Schneider)
1) Sharing instructions about the session, and main concepts to be learned – 5-10 min, 2) Main presentation from the trainer, concepts of genomics, tutorial explaining main stages on genomic tracking (from DNA/RNA isolation to sequencing, SNPs detection, and), epigenetic variations, effect of the environment on population changes at genomic level, etc., practical examples, collaborative work with trainees based on examples, etc. - 55 min, 3) Evaluation of trainees 1:

questions relative to issues exposed during presentation (Quiz, 10 min in total; response provided by e.mail to the trainer) 5) Conclusions, follow-up and prospects (what have we learnt today?, 10 min). 6) Evaluation of trainees 2 (proposal of individual homework, performed individually during the next week and provided to trainer by e.mail)

INSTRUCTIONS

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

UNIT 1 – The structure of the unit will be shortly explained in the first 5 min.
In summary, be ready:
i) to follow online presentation
ii) take notes of main issues treated and participate on the general discussion of each part as there will be both:
iii) a work to be performed on 30 min and a short quiz for evaluation of the whole unit

UNIT 2 – The structure of the unit will be shortly explained in the first 5 min.
In summary, be ready:
i) to follow online presentation
ii) take notes of main issues treated and participate on the general discussion of each part as there will be both:
iii) a short quiz for evaluation of the whole unit and a homework

UNIT 3 - The structure of the unit will be shortly explained in the first 5 min.
In summary, be ready:
i) to follow online presentation in their two parts
ii) take notes of main issues treated and participate on general discussion as there will be both:
iii) a short quiz for evaluation of the whole unit and…
iv) finally, you will be also evaluated through a homework (during the next week). based on your own practice with the PopGen simulator. The work will consist of making a word file with screenshots of your own simulations (changing different options of micro-evolutionary forces) and explaining why the populations evolve as seen in the screenshots.

UNIT 4 – The structure of the unit will be shortly explained in the first 5 min.
In summary, be ready:
i) to follow online presentation
ii) take notes of main issues treated and participate on the general discussion

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 online available resources will be mentioned and shared with the trainees. These materials will be useful to widen the info provided for their knowledge and/or performing a requested work during the session. As an example, the Paper for the work during the session:

Weedon, Odette D., Sarah Brumlop, Annette Haak, Jörg Peter Baresel, Anders Borgen, Thomas Döring, Isabelle Goldringer, Edith Lammerts van Bueren, Monika M. Messmer, Péter Mikó, and et al. 2023. "High Buffering Potential of Winter Wheat Composite Cross Populations to Rapidly Changing Environmental Conditions". Agronomy 13(6): 1662. https://doi.org/10.3390/agronomy1306166

UNIT 2 – During the presentation, several online available resources will be mentioned and shared with the trainees. These materials include links to ongoing projects and study cases aimed at mixtures development and breeding towards OHMs, as well as some papers and scientific publications to illustrate the presentation and to provide further info.

UNIT 3 - During the presentation, several online available resources and other materials will be mentioned to the trainees. The main resource will be the online available "PopGen" server, provided by Radford University (https://sites.radford.edu/~rsheehy/Gen_flash/popgen/), which will be used both i) to understand the effect of the main micro-evolutionary forces (selection, genetic drift, mutation, migration) and ii) to perform a practical homework during the week after.

UNIT 4 – This unit is mainly theoretical, although based on practical examples and explanations of DNA and RNA extraction protocols, genotyping and bioinformatics procedures, etc. Schemes, images and examples of real experiments from the lecturer will be given during the presentation to illustrate the main issues on tracking genomic changes on plant populations during breeding or in response to specific pedoclimatic conditions. Also links to the publications used will be provided during the presentation for further learning. Examples:

Schneider, M., Shrestha, A., Ballvora, A. et al. High-throughput estimation of allele frequencies using combined pooled-population sequencing and haplotype-based data processing. Plant Methods 18, 34 (2022). https://doi.org/10.1186/s13007-022-00852-8

Siddiqui, M.N., Schneider, M., Barbosa, M.B. et al. Natural selection under conventional and organic cropping systems affect root architecture in spring barley. Sci Rep 12, 20095 (2022). https://doi.org/10.1038/s41598-022-23298-3

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), and some quizzes to be solved in about 10 min.

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.

Most units will include short quizzes or practical work (10-20 min, depending on the unit) during the lesson + individual homework in some units (during the week after the lesson, provided to the trainer by e.mail once finished for evaluation).