Pre-breeding to build capacity for more effective use of plant genetic resources for food and agriculture

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DETAILED CURRICULUM OUTLINE
for an e-learning course[1]
(Version 01.07.2009)

Based on the outcomes of a Consultative Workshop

7-8 May, 2009
Bioversity International, Maccarese
Rome, Italy

Organized by

The Food and Agriculture Organization of the United Nations
(GIPB and KCE)
and
Bioversity International

[1] Detailed curriculum outline prepared by Jonathan Robinson, Consultant to Bioversity International, with assistance from KCE (FAO) and participants in the Consultative Workshop. This document assembled by the Task Force for the course development "Pre-breeding to build capacity for more effective use of plant genetic resources for food and agriculture" (GIPB/FAO and Bioversity International).

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Pre-breeding to build capacity for more effective use of plant genetic resources for food and agriculture

1. Background

Enhanced crop productivity underlies development in many countries, through the combination of genetic improvement and better management practices that ultimately provide improved nutritional status and/or generate greater income for growers and consumers. Effective genetic improvement relies on an appropriate genetic base, technical expertise, and enabling policy and institutional environments.

The decision to develop an e-learning course in pre-breeding evolved out of needs perceived by both Bioversity International and GIPB/FAO to improve the capacity of institutions and scientists to better access and utilize the genebanks of our crop genetic resources. While both organizations have successfully trained scientists in plant breeding and genetic resources management, there was a perceived need to improve the effectiveness of the efforts by reaching more people more effectively. E-learning courses can fulfill this need.

The FAO Knowledge Exchange and Capacity Building Division has been developing e-learning materials for FAO Member States in various technical areas within its core mandate. FAO has collaborated with external partners since 2001 to develop and deliver a series of extensive self-paced e-learning courses as part of its efforts to: i) build awareness and understanding; ii) provide on-the-job training for technical staff; iii) make available tools, methodologies, guidelines and learning materials; and iv) support face-to-face training and other capacity building activities. The courses use state-of-the-art technologies to create an interactive, self-paced learning environment while meeting the needs of low bandwidth users and those working on older systems. The curricula are delivered free of charge on CD and over the World Wide Web.

2. Goal Statement

To enable genebank curators and plant breeders, both in public and private sectors, and especially in developing countries, to further develop their knowledge and skills in order to collaboratively increase the use of genebank materials in breeding programmes for the sustainable benefit of society and the environment.

3. Consultative Workshop

A workshop was held with invited experts at Bioversity International headquarters in Rome from 7-8 May 2009. The specific purpose of the workshop was to identify the scope of content to be covered in the distance learning curriculum. To accomplish this, the workshop covered three tasks:

1) Review of the various audience groups to which the course will be;
2) Identification of the job tasks that they must perform to carry out their work;

3) Analyze each task to understand the required skills and knowledge to perform it.

This set of tasks, knowledge and skills forms the content of the curriculum. The instructional designer will use the task analyses developed during the workshop to organize the content into a logical course structure, which is divided into units and lessons. Applying a task-oriented approach to address job-related learning needs greatly enhances the development of a curriculum that satisfies the learning needs of different audiences in different contexts.

Two working groups met independently for the purpose of discussing these tasks, and brought ideas together in plenary sessions. One working group discussed the primary audience of genebank curators in national and international genebanks, and the other working group covered the other primary audience of plant breeders in national and international agriculture research institutions and in private crop improvement companies

The working groups reviewed and updated the set of *tasks* central to pre-breeding activities within the target audience, reviewed the list of *knowledge* required for carrying out each task, updated the list of *resources* which will assist the further writing of the lessons, and identified *potential authors* and *peer reviewers*.

At the conclusion of the workshop, the facilitator outlined the next steps in the process. With the task analysis from the workshop, the curriculum coordinator worked with the Instructional Designer and Information Management Specialist of FAO/KCEF, and with the task force of Bioversity and GIPB, to develop the detailed curriculum outline and identify content providers for each learning unit. Content providers will be contracted, and this content developed into the e-learning modules through the standard procedures of KCEF. The modules will be peer-reviewed and pilot-tested in the field before final public release, scheduled for early to mid-2010. The organizers hope and expect that all the workshop participants will continue their involvement in the process through to the completion of the process.

4. Target Audience

Primary audience:

- Genebank curators
- Plant breeders (practicing and in training) working in National and International Agricultural Research Institutions and in private crop improvement companies

Secondary audience:

- Undergraduate, MSc and PhD graduates working in crop science and plant breeding
- Extension specialists, technicians, etc
- BS, MSc and PhD students in crop science and plant breeding
- University lecturers working in universities' faculties of crop science and similar faculties

5. Structure of this Document

In order to assist authors in formulating and developing learning content, the curriculum outline provides details and guidance for each lesson as follows:

Lesson learning objectives describe the knowledge and skills that the learners will have acquired by the end of the lesson.

Guidelines and suggestions for authors that help define the scope of the lesson.

Scope notes for each **learning step**, which provide advice to authors on the information to include, the topics and concepts to be developed in detail.

Resource pointers for each lesson, which provide additional sources of information that might be useful to both content authors and the learners.

Notes regarding sources of information:

- The sources may be relevant across various lessons, even if only cited once. Authors should scan the resources for all of the lessons to check for any of relevance to their specific tasks.
- Most of these sources were given during the consultative workshop, and may not be complete or entirely accurate in every detail. Authors should do the appropriate investigation to get the original sources.

6. Detailed Curriculum Outline

UNIT 1: INTRODUCTION TO PRE-BREEDING

Lesson 1.1: Definition and scope of pre-breeding

Learning objectives

At the end of this lesson, learners should be able to:

- provide a definition of pre-breeding;
- explain the usefulness and scope of pre-breeding;
- describe the context in which pre-breeding is carried out; and
- identify the situations to which pre-breeding is best applied.

Guidelines for the author

This lesson defines pre-breeding and describes its relationship to full-scale breeding. The aim of this lesson is to describe the potential of pre-breeding to make optimal use of the benefits represented by PGR. It also introduces the criteria to define when pre-preeding is an advisable option, by presenting examples of applications of pre-breeding to particular problems.

Learning steps	Scope notes for the author

What is pre-breeding?	Explain the specific nature of current and future problems in food production with reference to sub-optimal use of the PGR held in the world's genebanks. Indicate how the linkages between genebank curators and plant breeders might be strengthened through increased investment in pre-breeding. Provide a definition of pre-breeding and explain carefully how it fits into the crop improvement continuum.
The need for multi-disciplinarity and communication	Stress the importance of multi-disciplinarity in crop improvement in general, and pre-breeding in particular, and the need for continuous constructive communication among all the principal actors to ensure that all available expertise is brought to the task.
Pre-breeding in context	Pre-breeding is conducted to serve particular ends and depends on various differing circumstances: it is not an academic exercise. The nature of the circumstances should be fully explained so that pre-breeding can be seen in context.
Problems addressed through pre-breeding	Demonstrate, using examples, the circumstances under which pre-breeding can be usefully applied as well as the limitations of pre-breeding. Learners should also become aware of alternatives to pre-breeding that might be implemented to address problems, particularly application of improved crop management.

Resources

Ortiz, R. 2002. Germplasm enhancement to sustain genetic gains in crop improvement. In Engels, J.M.M, V. Ramanatha Rao, A.H.D. Brown & M. Jackson (eds.) *Managing Plant Genetic Diversity.* IPGRI, Rome, Italy – CAB International, Wallingford, UK. pp. 275-290

Ortiz, R. & K.N. Watanabe. 2004. Genetics contributions to breeding polyploid crops. *Recent Research Developments in Genetics & Breeding* 1, 269-286

Tanksley, S.D. & McCouch, S. 1997. Seed Banks and Molecular Maps: Unlocking Genetic Potential from the Wild. *Science* 277:1063-1066.

Anonymous, *Genetic Vulnerability of Major Crops* (National Academy of Sciences, Washington, DC, 1972)

D. L. Plunknett *et al*., *Gene Banks and the World's Food* (Princeton Univ. Press, Princeton, NJ, 1987).

Lesson 1.2: Basic concepts for pre-breeding

Learning objectives

At the end of this lesson, learners should be able to:

- identify the biological information necessary to set up a successful pre-breeding programme; and
- know where to look to get relevant information.

Guidelines for the author

This lesson is a refresher course for those with a background in plant biology and genetics. It should introduce basic concepts and make reference to existing resources (tutorials, courses, books).

Learning steps	**Scope notes for the author**
Essential plant biology	Provide some basic biological information so that the learner becomes aware of the major differences among breeding systems and the effects that these have on the way a pre-breeding programme is conducted. Provide an account of the breeding systems of the major crops, illustrating how some of their most important traits have been managed in breeding programmes.
Phenotype, genotype and environment	Describe the principles of how plant phenotype is determined by its genes and the environment, and their interaction, and how this impacts crop improvement.
Basic genetics	Provide definitions and examples of the inheritance of traits controlled by major genes with respect to improvement of a range of crops (Mendelian genetics), and by minor genes with respect to crop improvement of a range of crops (quantitative genetics). Provide a concise account of molecular aspects of genetics in plants with reference to a range of crops.
Sources of useful information	Describe the types of information that might be used to set up and manage a pre-breeding programme, and indicate the places where such information can be found. Limitations of the information and information sources should also be addressed.

Resources

Crossa, J., J. Burgueño, S. Dreisigacker, M. Vargas, S. Herrera, M. Lillemo, R.P. Singh, R. Trethowan, J. Franco, M. Warburton, M. Reynolds, J.H. Crouch & R. Ortiz. 2007. Association analysis of historical bread wheat germplasm using additive genetic covariance of relatives and population structure. *Genetics* 177, 1889-1913

Dwivedi, S.L., J.H. Crouch, D. Mackill, Y. Xu, M.W. Blair, M. Ragot, H.D. Upadhyaya & R. Ortiz. 2007. Molecularization of public sector crop breeding: progress, problems and prospects. *Advances in Agronomy* 95, 163-318

Ortiz, R. 1995. *Musa* genetics. In Gowen, S. (ed.). *Bananas & Plantains.* Chapman & Hall, London, UK. pp. 84-109

Ortiz, R. & S.J. Peloquin. 1994. Use of 24 chromosome potatoes (diploids and dihaploids) for genetical analysis. In Bradshaw, J.E. & G.R. Mackay (eds.). *Potato Genetics.* CAB International, Wallingford, UK. pp. 133-153

McCouch, S. *et al.*, 2007. Through the genetic bottleneck: *O. rupipogon* as a source of trait-enhancing alleles for *O. sativa*. *Euphytica* 154:317-339.

J.J. Valkoun 2001. Wheat pre-breeding using wild progenitors. Euphytica 119: 17-23.

Warburton ML, Crossa J, Franco J, et al. 2006. Bringing wild relatives back into the family: recovering genetic diversity in CIMMYT improved wheat germplasm Euphytica 149:289-301.

Byrne *et al.,* 2008. Genetic analysis of pod and seed resistance to pea weevil in a *Pisum sativum* x *P. fulvum* interspecific cross *Australian Journal of Agricultural Research* 59: 854-862.

Knights, E. *et al.*, 2008. Resistance to *Phytophthora medicaginis* Hansen and Maxwell in wild *Cicer* species and its use in breeding root rot resistant chickpea (*Cicer arietinum* L.). *Australian Journal of Agricultural Research* 59:383-387**.**

UNIT 2: GENEBANK MANAGEMENT RELEVANT TO PRE-BREEDING

Lesson 2.1: Introduction to genebanks

Learning objectives

At the end of this lesson, learners should be able to:

- explain the role of genebanks; and
- understand essentials of genebank management.

Guidelines for the author

This lesson represents a concise account of what it takes to make and manage a genebank. The aim of this lesson is to provide an outline of genebank operations with particular respect to pre-breeding. It is therefore essential that the need for linking genebank operations with pre-breeding is emphasized and problems are addressed. Examples should be provided wherever possible so that the learner is fully aware of requirements and options. Use should be made of information contained in the State of the World's PGRFA report.

Learning steps	**Scope notes for the author**
What are genebanks?	Provide a concise account of the purpose of genebanks and their role in strengthening food security and sustainable agricultural production. Describe the various types of genebank that are used to conserve PGR, including those associated with molecular biology such as tissue culture and gene libraries. Provide an indication of the relative importance of the various types of genebank.
How are collecting missions planned and carried out?	Explain a little of the history of plant collecting and the methods used to plan and carry out collecting missions. Ensure that there is discussion of major gaps in collections, particularly regarding minor crops and crop wild relatives.
How are genebanks managed?	The processes of day-to-day management should be summarized, including maintenance of collections, viability testing, regeneration, safety duplication and data management. Crop germplasm networks should also be referred to.

Resources

Ortiz, R. 2002. No just seed repositories: a more pro-active role for gene banks. *Gene*

Conserve 1, 21-24. http://www.geneconserve.pro.br/artigo_6.htm

Broadening the Genetic Base of Crop Production. 2001. (eds. Cooper, Spillane and Hodgkin) CABI Publishing.

IRRI Genetic Resources Center – SMTA rights and obligations, http://www.irri.org/grc/GRCHome/..%5Crequests%5Cobligations.htm

Committee on Genetic Resources for Food and Agriculture-FAO, http://www.fao.org/ag/cgrfa/

F. Engelman and Engels, 2002

Rao et al. (2006). Seed handling in genebanks: self-learning module.

Knowledge base of best practices in genebank management (SGRP)

Van Hintum – core collections (Bioversity technical bulletin)

Best practices guidelines on transgenes (on SGRP Knowledge Base)

Crop-Specific Regeneration Guidelines (SGRP)

Engels and Visser, A Guide to Effective Germplasm Management (IPGRI Handbook for genebanks no. 6)

MSTRAT (Isabelle Goldringer)

PowerCore (RDA-Korea-Bioversity)

FIGS (Mackey and Street)(PNAS)

Lesson 2.2: Characterization and evaluation of genebank materials

Learning objectives

At the end of this lesson, learners should be able to:

- explain what characterization and evaluation are and why they are crucial to the success of pre-breeding;
- describe the range of methods available for characterizing and evaluating genebank material; and
- understand the importance of documenting genebank accessions.

Guidelines for the author

Please refer to pre-breeding requirements.

Learning steps	Scope notes for the author
Why are germplasm characterization and evaluation important?	Provide examples of the usefulness of characterization and evaluation data and explain why their absence limits plant breeding capacity. Outline the current state of characterization and evaluation with reference to important germplasm collections.

Methods for characterizing and evaluating genebank material.	Illustrate the main available methods for characterizing and evaluating genebank material with reference to pre-breeding requirements.
Documentation	Illustrate the importance of documenting genebank accessions.

Resources

Ortiz, R. 1997. Morphological variation in *Musa* germplasm. *Genetic Resources & Crop Evolution* 44, 393-404

Ortiz, R., J. Crossa, J. Franco, R. Sevilla & J. Burgueño. 2008. Classification of Peruvian highland maize races with plant traits. *Genetic Resources and Crop Evolution* 55:151-162

Ortiz, R., R. Sevilla, G. Alvarado & J. Crossa. 2008. Numerical classification of related Peruvian highland maize races using internal ear traits. *Genetic Resources and Crop Evolution* 55, 1055-1064

Ortiz, R., R. Sevilla & J. Crossa. 2008. Minimum resources for phenotyping morphological traits of maize (*Zea mays* L.) genetic resources. *Plant Genetic Resources Characterization and Utilization* 6, 195-200

Linking Genetic Resources and Geography: Emerging Strategies for Conserving and Using Crop Biodiversity. 1999. (eds. S. Greene and L. Guarino) CSSA Special Publication #27

Bioversity International Law and Policy training module

IRRI training module on material transfer aspects (available on Internet)

Knowledge base of best practices for genebank management (SGRP) (includes protocols for wild and breeding materials)

IUCN Guide to Understanding the Intl Treaty (G. Moore)

UNIT 3: PRE-BREEDING PROJECT MANAGEMENT

Lesson 3.1: Planning a pre-breeding project

Learning objectives

At the end of this lesson, learners should be able to:

- identify the elements of a project plan for pre-breeding; and
- understand the importance of adopting a participatory approach throughout the project.

Guidelines for the author

This lesson explains why it is necessary to plan ahead in a pre-breeding programme. It covers the range of issues that need to be considered before embarking on a pre-breeding programme, stressing the importance of adopting a participatory approach.

Learning steps	Scope notes for the author

Setting the aims	Stress that the success or failure of a pre-breeding programme depends heavily on planning. Encourage setting realistic aims for the project to maximize the chances of success.
Identifying suitable germplasm	Describe the importance of knowing what germplasm to look for and where to look for it in order to be able to embark on a pre-breeding programme.
Resource requirements	Describe all the resources that need to be available for a pre-breeding programme to be successful.
Data systems	Stress the importance of designing the data handling system before the project gets underway so that data can be collected, stored and analyzed as the project progresses. Illustrate the dangers of not being able to use data effectively due to poor planning.
Monitoring and evaluation	Explain why a monitoring and evaluation plan is important to keep the pre-breeding project on track, and how this can save resources if it is well designed.
Markets	Explain that pre-breeding is carried out for a specific purpose and that the clients for the pre-breeding products have to be identified in advance.
Adopting a participatory approach	Stress the merits of joint approaches to problems, citing examples of regional and international cooperation that have been successfully employed to address important issues in crop improvement. Illustrate the potential role of farmers and consumers in pre-breeding programmes and the contribution of indigenous knowledge to germplasm management.

Resources

Ortiz, R., H.J. Braun, J. Crossa, J.H. Crouch, G. Davenport, J. Dixon, S. Dreisigacker, E. Duveiller, Z. He, J. Huerta, A.K. Joshi, M. Kishii, P. Kosina, Y. Manes, M. Mezzalama, A. Morgounov, J. Murakami, J. Nicol, G. Ortiz-Ferrara, J.I. Ortiz-Monasterio, T.S. Payne, R.J. Peña, M.P. Reynolds, K.D. Sayre, R.C. Sharma, R.P. Singh, J. Wang, M. Warburton, H. Wu & M. Iwanaga. 2008. Wheat genetic resources enhancement by the International Maize and Wheat Improvement Center (CIMMYT). *Genetic Resources and Crop Evolution* 55, 1095-1140

Ortiz, R., D. Vuylsteke, R.S.B. Ferris, J.U. Okoro, A. N' Guessan, O. B. Hemeng, D.K. Yeboah, K. Afreh-Nuamah, E.K.S. Ahiekpor, E. Foure, B.A. Adelaja, M. Ayodele, O.B. Arene, F.E.O. Ikiediugwu, A.N. Agbor, A.N. Nwogu, E. Okoro, G. Kayode, I.K. Ipinmoye, S. Akele & A. Lawrence. 1997. Developing new plantain varieties for Africa. *Plant Varieties & Seeds* 10, 39-57

Watanabe, K., M. Orrillo, M. Iwanaga, R. Ortiz, R. Freyre & S. Perez. 1994. Diploid potato germplasm derived from wild and land race genetic resources. *American Potato Journal* 71, 599-604

Pre-breeding: a link between genetic resources and maize breeding. 2000. Nass and Paterniani, Scientia Agricola 57: No. 3.

Wheat pre-breeding using wild progenitors. 2001. J.J. Valkoun. Euphytica 119: 17-23.

Broadening the Genetic Base of Crop Production. 2001. (eds. Cooper, Spillane and Hodgkin) CABI Publishing.

Genetic Resources, Chromosome Engineering and Crop Improvement. 2005. (eds. R.J. Singh and P. Jauhar) Volume 1. Grain Legumes. Taylor and Francis Group (CRC Title).

Genetic Resources, Chromosome Engineering and Crop Improvement. 2005. (eds. R.J. Singh and P. Jauhar) Volume 2. Cereals. Taylor and Francis Group (CRC Title).

Lesson 3.2: Managing and assessing a pre-breeding project

Learning objectives

At the end of this lesson, learners should be able to:

- identify what is required to keep a pre-breeding project running;
- understand the importance of having contingency plans to face unforeseen events; and
- describe the process of monitoring and evaluation of a pre-breeding project.

Guidelines for the author

This lesson addresses the day-to-day management of a pre-breeding programme. The lesson will take a very practical approach and illustrate issues by providing examples and posing key questions. There will be a focus on fault-fixing to reduce the chances of catastrophic failure. This lesson completes the management process by explaining the importance of documenting outputs from the pre-breeding programme, assessing outcomes and using this information in future planning exercises.

Learning steps	Scope notes for the author
Day-to-day management	Explain the importance of following the original project plan to ensure that day-to-day management does not become onerous, while remaining flexible in order to be able to adapt the project to changing circumstances.
Contingency plans	Not everything will go according to plan. Explain what can happen to upset plans, referring to problems in the field, greenhouse and laboratory etc. Discuss the importance of having contingency plans so that the impacts of unforeseen events are minimized and that the project is not put in jeopardy or has to be terminated when something unexpected occurs.
Monitoring and evaluation	Illustrate aspects of project monitoring and evaluation that are relevant to pre-breeding using documented examples. Include the concepts of indicators, the necessity of reference to other pre-breeding experiences and the costs and benefits associated with various pre-breeding options.

Resources

Bioversity International Law and Policy training module

IRRI training module on material transfer aspects (available on Internet)

Knowledge base of best practices for genebank management (SGRP) (includes protocols for

wild and breeding materials)

IUCN Guide to Understanding the Intl Treaty (G. Moore)

UNIT 4: CREATING AND MANAGING VARIATION

Lesson 4.1: Principles and methods of parental selection

Learning objectives

At the end of this lesson, learners should be able to:

- understand the importance of parental selection in a pre-breeding programme; and
- describe the main methods for making parental selection based on phenotype and genotype information.

Guidelines for the author

This lesson lays the groundwork for making a practical start on a pre-breeding programme and should therefore carefully explain why parental selection is important and how it can be done effectively based on various types and sources of data and information.

Learning steps	Scope notes for the author
Choosing the parents	Guide the learner through the considerations that have to be made in selecting parents for a pre-breeding programme with reference to various crops and traits. Explain the need for characterization and evaluation data in making choices.
Tools and methods	Provide a summary of the tools and methods that can be employed in making parental selection more efficient and effective. Describe phenotypic and genotypic screening methods with reference to some important traits in various crops, including those for resistance to biotic and abiotic stresses, quality characteristics etc. Mention should be made of creating variation with mutagens, providing examples of successful crop varieties.

Resources

Ortiz, R., W.W. Wagoire, O. Stølen, G. Alvarado & J. Crossa. 2008. Combining ability and heterosis under pest epidemics in a broad-based global wheat breeding population. *Plant Breeding* 127, 222-227

Ortiz, R., S.J. Peloquin, R. Freyre & M. Iwanaga. 1991. Efficiency of 4*x* x 2*x* breeding scheme in potato for multitrait selection and progeny testing. *Theoretical and Applied Genetics* 82, 602-608

Tenkouano, A., J.H. Crouch, H.K. Crouch, D. Vuylsteke & **Rodomiro Ortiz**. 1999. A comparison of DNA marker and pedigree methods for genetic analysis in plantain and banana (*Musa* spp.) clones. I. Estimation of genetic relationships. II. Predicting hybrid performance.

Theoretical and Applied Genetics 98, 62-68; 69-75

Lesson 4.2: Transferring traits from non-adapted materials

Learning objectives

At the end of this lesson, learners should be able to:

- understand the genepool concept;
- understand all the fundamental issues concerned with managing non-adapted germplasm;
- appreciate the difficulties associated with trait transfer from within the species, from different species, from different genera and from outside the immediate genepools;
- describe the principal methods and technologies employed in transferring a range of traits from non-adapted materials into better adapted material.

Guidelines for the author

This lesson will describe the issues associated with transferring traits from non-adapted germplasm sources to materials that can be more easily handled by plant breeders in a conventional breeding programme, or that can find a direct market. Examples should be provided of traits, crops and transfer methods. Account should be taken of wide crossing, embryo rescue, protoplast fusion, electroporation, genetic engineering and all other methods and tools used in trait transfer from non-adapted materials.

Learning steps	Scope notes for the author
Introduction to genepool concept	Introduce the concept of primary, secondary and tertiary genepools to the learners through examples. Explain how some gene sequences are common across widely divergent species and that there is considerable synteny among other species of related genera.
Barriers to crossing	Explain the nature and extent of the various barriers to crossing/trait transfer that occur and can frustrate efforts to pre-breed. Emphasize how the problems increase the more distant the parents are and how some species are naturally difficult to breed.
Methods and technologies to assist in trait transfer	Provide introductory accounts to all the principal methods and technologies associated with bridging the barriers to trait transfer, including standard and modern ones.

Resources

Dwivedi, S.L., H.T. Stalker, M.W. Blair, D. Bertioli, H.D. Upadhyaya, S. Nielen & R. Ortiz. 2008. Enhancing crop gene pools with beneficial traits using wild relatives. *Plant Breeding Reviews* 30, 179-230

Ortiz, R. 1998. Potato breeding via ploidy manipulations. *Plant Breeding Reviews* 16, 15-86

Peloquin, S.J. & R. Ortiz. 1992. Techniques for introgressing unadapted germplasm to breeding populations. In Stalker, H.T. & J.P. Murphy (eds.). *Plant Breeding in the 1990s.*

CAB International, Wallingford, UK. pp. 485-507

Wheat pre-breeding using wild progenitors. 2001. J.J. Valkoun. Euphytica 119: 17-23.

Lesson 4.3: Managing segregating populations

Learning objectives

At the end of this lesson, learners should be able to:

- apply the general principles of managing segregating populations generated from parental crossing;
- understand how the segregating populations are managed according to the particular type of crop; and
- identify the various methods used to maintain the desired trait in the population and remove unwanted traits.

Guidelines for the author

This lesson covers management of germplasm following successful transfer of traits from non-adapted material. Through use of examples of crops and traits the learners will be shown how segregating populations are handled and how the desired traits are maintained in future generations of crossing and selection. The lesson will address management of material in the field, greenhouse and laboratory for the various methods of trait transfer used and for particular crops and traits.

Learning steps	Scope notes for the author
What are segregating populations?	Explain what segregating populations are in terms of various types of gene action and the types of trait that might be of interest in a pre-breeding programme. Explain how traits are maintained in a population and how they can be lost unless particular procedures are adopted (e.g. selection under stress pressure to be able to recognize resistance).
What methods are available to improve the segregating material?	Describe in brief the methods available for maintaining desired traits while removing unwanted traits that are transferred from non-adapted material. Explain why in some cases a pure line might be the wanted outcome of trait transfer and in other cases an improved population might be sought.

Resources

Cambridge and Martin Wolfe (check with Isabelle Goldringer)

Knowledge base of best practices of genebank management (SGRP)

Louise Sperling (various publications)

ICIS, IRIS platforms (IRRI and CIMMYT)

Painting et al. (1995) Guidebook for genetic resources documentation

Lesson 4.4: Identifying genes of interests

Learning objectives

At the end of this lesson, learners should be able to:

- understand how genes of interest can be identified and tracked using a variety of methods and technologies.

Guidelines for the author

This lesson concentrates on identification of genes and their expression as traits. This lesson will go further than Lesson 1.2 by explaining the technologies and methods that can be used to investigate genes and traits. In addition to established methods of screening for gene expression, it will be necessary to describe, *inter alia*, using examples, marker-assisted selection, gene tagging, QTL analysis and other relatively advanced tools used by plant breeders with particular reference to pre-breeding. Application of cytogenetics, including FISH and GISH, as well as genomics should also be addressed.

Learning steps	**Scope notes for the author**
Selecting genes	Explain that selection can be based on phenotypic expression of genes and/or on the genotype itself.
Methods to track traits and genes	Illustrate the variety of methods available to track traits and genes.

Resources

Dwivedi, S.L., J.H. Crouch, H.D. Upadhyaya, M. Blair, R. Serraj, J. Balaji, H.K. Buhariwalla & R. Ortiz. 2005. Using genomics to exploit grain legume biodiversity in plant breeding. *Plant Breeding Reviews* 26, 171-357

UNIT 5: DISTRIBUTION, USE AND REGULATORY ISSUES

Lesson 5.1: Distribution and use of pre-breeding products

Learning objectives

At the end of this lesson, learners should be able to:

- decide the best way to get their pre-breeding products to the markets and clients; and
- understand how the use of the products might change according to changing needs.

Guidelines for the author

This lesson addresses issues of how pre-breeding products are made use of either in full-scale breeding programmes or directly by society/industry etc.

Learning steps	Scope notes for the author
Do not forget the end user	Stress the need to consider the client and market for the pre-breeding product prior to and throughout the pre-breeding process. Pre-breeding represents substantial investment and its products have to be useful.
Be aware of the changing needs of society and industry	Emphasize that markets and client needs are not static and attention must be paid to changes that could affect whether a pre-breeding product remains useful. Illustrate this with examples of products that are destined for commerce and others that are developed to enter a breeding programme.

Resources

Bioversity International Law and Policy training module

IRRI training module on material transfer aspects (available on Internet)

IUCN Guide to Understanding the Intl Treaty (G. Moore)

IRRI Genetic Resources Center – SMTA rights and obligations, http://www.irri.org/grc/GRCHome/..%5Crequests%5Cobligations.htm

Committee on Genetic Resources for Food and Agriculture-FAO, http://www.fao.org/ag/cgrfa/

Managing Global Genetic Resources: Agricultural Crop Issues and Policies. 1993. Committee on Managing Global Genetic Resources: Agricultural Imperatives. National Academy Press.

Bioversity Policy and Law Training Module

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Lesson 5.2: Regulatory issues

Learning objectives

At the end of this lesson, learners should be able to:

- identify the range of regulatory issues and international legislation that affect establishment and success of a pre-breeding programme.

Guidelines for the author

This lesson discusses the range of legal instruments that can affect pre-breeding programmes and the movement of germplasm across national boundaries.

It also concentrates on IPR as related to germplasm use and sale, and to associated information.

Learning steps	Scope notes for the author
Which international legislation affects pre-breeding?	Introduce the major treaties, bodies etc. that affect pre-breeding through germplasm collection, use and exchange.
Which other legislation can affect pre-breeding?	Outline other regional, national, local policy issues that have an effect on the range of activities that contribute to pre-breeding.
What are IPR?	Explain all the various forms of IP that are likely to be of interest to plant breeders and germplasm managers, including those that relate to generation and dissemination of information in addition to those that concern collection and use of PGR.
How do IPR affect pre- breeding?	Explain how and why a pre-breeding programme needs to take heed of IP issues to maximize the benefits that can accrue from it and ensure that legal issues do not restrict progress in the project.

Resources

Fowler, C., G. Hawtin, R. Ortiz, M. Iwanaga & J. Engels. 2004. The question of derivatives: promoting use and ensuring availability of plant genetic resources. *Journal of World Intellectual Property* 7, 641-663

Bioversity International Law and Policy training module

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