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VARIETIES AND POPULATIONS

FOR ON-FARM PARTICIPATORY PLANT BREEDING

AT FIRST GLANCE

Farmers involved in on-farm Participatory Plant Breeding (PPB) use various types of populations / varieties to diversify their agricultural strategies and their products. Populations' type varies according to farmers' breeding objectives and to the crop's mating system.

Embedding crop diversity and networking for local high quality food systems

Crop diversity for on-farm Participatory Plant Breeding (PPB)

Crop diversity is required to support more resilient and sustainable agricultural practices and diversified food systems. Developing PPB approaches together with farmers is a good way to increase diversity in the fields and plates. To carry out on-farm PPB, farmers use and develop various types of varieties depending on their breeding objectives and on the crop mating system. Usually they aim at developing varieties with a certain level of diversity, i.e. population-varieties, which are suited to their specific environmental conditions, farming practices and marketing objectives. We describe here different kinds of those populations-varieties.

i) Pure line varieties are composed of highly homozygous plants that are almost all **genetically identical**. It is the main variety type currently marketed for self-pollinated crops. They can be reproduced unchanged on-farm by farmers, but their potential for evolution and for response to selection is very low. For out-crossing crops, **F1 hybrids** are often marketed. They are obtained by crossing two pure lines and therefore all plants are genetically identical and highly heterozygous. Due to segregation of genes in the progeny, F1 cannot be maintained unchanged by farmers.

ii) Landraces and old varieties: Landraces are **genetically heterogeneous populations** locally adapted through on-farm management. However, if they have been maintained *ex situ*, their diversity might be drastically reduced (small size of populations). Old varieties have usually been developed through mass selection within landraces or after crosses by breeders before the 50's. They maintain some internal diversity. Since both are reproduced under their natural mating system, self-pollinated landraces are mostly composed of related inbred individuals, while out-crossing landraces consist in heterozygous plants. They can be reproduced on-farm with a specific attention to limit genetic drift by growing populations of sufficiently large size. Their great interest relies in their adaptation potential to low input or agroecological conditions and in their quality. *Example in DIVERSIFOOD: Tomato (ITAB, RSP).*

iii) Mixtures of landraces or old varieties: While harbouring many interesting traits, landraces and old varieties might be too far from farmers' expectations to be grown individually.

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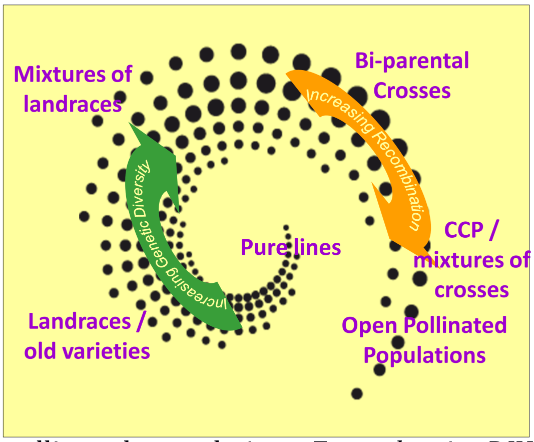

To this end, favourable traits from different origins might be combined by **mixing a set of selected landraces**, or old varieties, to design a "blend" with the expected morphological, adaptive and quality traits. However, interactions among plants (competition vs complementarity or synergy) from different varieties are not predictable. It might be necessary to manage the mixture by applying mass selection during several generations. Mixing self-pollinated populations will lead to limited recombination among plants while mixing out-crossing populations will allow the creation of a new broad-based open pollinated population. *Examples in DIVERSIFOOD: Buckwheat, Bread wheat (INRA), Durum wheat (RSR).*

iv) Bi-parental crosses: Crossing two parents (landraces, old or recent varieties) allows to combine their characteristics through **recombination of their genomes**. The more distant the parents, the more the progeny is diversified. Mass selection within the cross progeny may be applied to select new phenotypes or to frame the outline of the variability. Crossing plants of self-pollinated species is feasible on-farm by farmers, although it is time consuming and requires dedicated skills. *Examples in DIVERSIFOOD: Bread wheat (INRA & RSP), Carrots (PSR).*

v) Composite Cross Populations (CCP) / Mixtures of crosses: CCP consist in **crossing several parents** (any type of varieties) two by two during one or several consecutive generations. The more crossings, the more recombinations and possibilities for new genotypes to be generated. In case of a small number of parents, all crosses among all parents can be made (n*(n-1)/2 crosses with n parents), while if a larger set of parents is to be crossed, only n/2 crosses can be made, followed by crosses among the descendants for a certain number of generations. The objective is that all parents have contributed equally to the population and with a maximum of recombination among them. This approach is used in self-pollinated crops and requires patient hand crossing work. In case of out-crossing species, plants will randomly mate if mixed and there is no need to limit to particular crosses. This will lead to a new broad-based open-pollinated population (see below). Mass selection in further generations may allow to frame the CCP or to detect particular new phenotypes of interest. *Examples in DIVERSIFOOD: Buckwheat, Bread wheat (INRA), Lupin (FiBL), Bread wheat (ORC).*

vi) Open-pollinated population: In an out-crossing population (see above), plants are **highly heterozygous** if within-population genetic diversity is sufficient, i.e. population size is sufficient (at least several thousands) and selection is not too strong. *Example in DIVERSIFOOD: Maize (ITQB & IPC).*

Suggested readings

Rivière P, Goldringer I, Berthellot J-F, Galic N, Pin S, De Kochko P & JC Dawson (2015) Response to farmer mass selection in early generation progeny of bread wheat landrace crosses. ***Renewable Agriculture and Food Systems*** 30(2): 190-201. DOI:10.1017/S1742170513000343

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Dawson JC, Serpolay E, Giuliano S, Schermann N, Galic N, Chable V & I Goldringer (2012) Multi-trait evolution of farmer varieties of bread wheat after cultivation in contrasting organic farming systems in Europe. **Genetica** 140:1–17. DOI 10.1007/s10709-012-9646-9