



## Molecular techniques to map farmer and breeder preferences - an innovative approach towards participatory plant breeding

### For more information about the 'Seeds for Needs' initiative, see:

- Factsheet 1  
*A participatory approach for landrace evaluation*
- Factsheet 2  
*The crowdsourcing approach*
- Factsheet 3  
*Strengthening the informal seed system through community seedbanks*
- Factsheet 4  
*Diversity in durum wheat landraces to tackle drought*
- Factsheet 6  
*Improving Ethiopian durum wheat landraces through breeding*

Assessing the genetic variability of crops is required to identify and develop cultivars (cultivated varieties) suitable for specific growing conditions and specific economic, social and environmental needs. Modern breeding relies on the identification of DNA regions that control complex traits of agronomic interest, such as resistance to drought, yield and plant height. Once those are identified, molecular tools can be applied to enhance the selection process and speed up the development of new varieties. The identification of such regions, called association mapping, is based on integrating molecular data with extensive phenotypic data (i.e. the observable characteristics of a crop).

In our study, farmers, breeders and molecular biologists worked as a team to characterize a broad collection of Ethiopian traditional varieties (landraces) of durum wheat. Farmers were not just recipients of the breeding process outcomes, but were a key resource in enabling its success.

The first step in our research was to characterize 373 landraces and 27 improved varieties from the Ethiopian Biodiversity Institute in Addis Ababa, using 'next-generation sequencing' techniques. These varieties were then evaluated in field experiments in two locations, Gere Gera and Hagereselam, over a 2-year period by researchers and farmers. Data on eight agronomic and morphological traits (including flowering components, yield components and plant structure) were collected. Data on these eight traits was complemented by information provided by farmers on four additional traits – earliness, spike quality, tillering capacity and 'overall' appreciation of the landrace<sup>1</sup> (see Fig. 2). We are now able to map in the genome not only the traits recorded by scientists, but also the traits identified by farmers.

<sup>1</sup> See Factsheet 1 for explanation



## Our progress

- Analysis of the molecular data shows remarkable genetic diversity in the landraces. In particular, a Principal Component Analysis (PCA) shows that improved varieties cluster together (an index of reduced variability), and are genetically very different from the vast majority of landraces. This indicates that Ethiopian germplasm has contributed very little to the genetic composition of the improved varieties (Fig. 1). The analysis also shows that Ethiopian landraces are very rich in diversity,

which can provide an enormous contribution to wheat improvement.

- Fig. 3 shows and compares the positions in the genome of specific traits linked to tillering capacity and farmer preferences. On chromosome 5B, we were able to identify a specific segment of the genome that is linked to traits desired by both breeders and farmers. We can now use this information to take into account farmer preferences for advanced breeding.

## Looking ahead

The initiative shows how involving farming communities can contribute to scientific knowledge and potentially to breeding programmes. Our approach, which is able to map farmers' preferred traits in the genome, can serve as the basis for marker-assisted participatory breeding, linking breeders' and farmers' goals. At the same time, the large genetic diversity of Ethiopian landraces is an important global resource for breeding.

**Fig. 2 - Farmers, with the support of scientists, evaluate varieties in the field.**





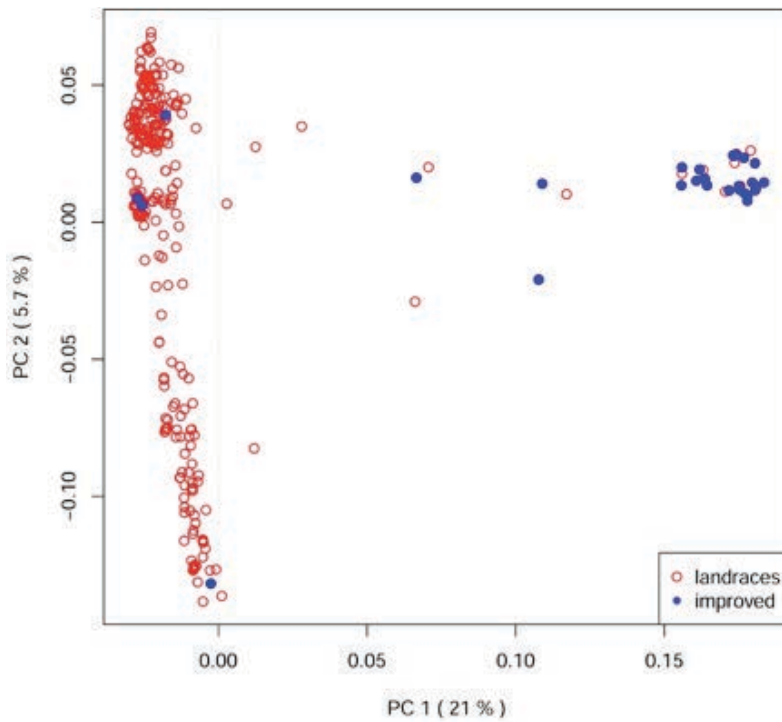


Fig. 1 - Principal Component Analysis (PCA) of Ethiopian durum wheat genetic diversity. The blue dots represent improved lines released for cultivation in Ethiopia over the past 20 years, the red dots represent the Ethiopian landraces. The distance between the dots is a proxy for genetic diversity. The Ethiopian landraces show much more diversity than the improved lines.

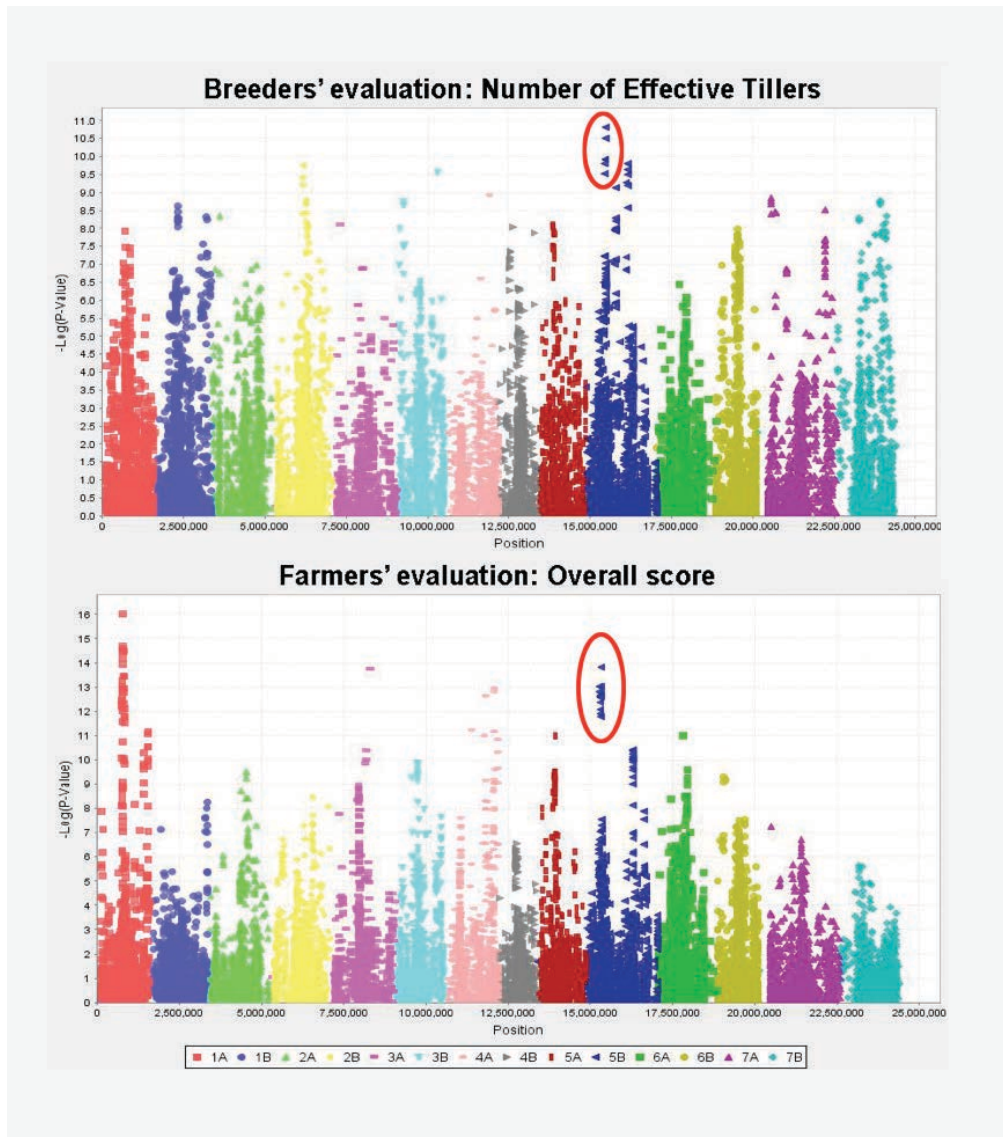




Fig. 3 - This chart, also known as a 'Manhattan plot', shows association mapping of the landraces in our study. Different colors depict wheat chromosomes, and each square indicates a molecular marker whose position in the genome is known. The red circle highlights a set of markers responsible for the number of tillers (identified by scientists) and farmers' 'overall' appreciation. As the chart shows, the same area in the genome is linked to both traits, making it a good candidate to be used in the breeding process. It also shows that farmers' appreciation is partly determined by the number of effective tillers per plant. If plants are screened for the right variant (allele) at this position in the genome, the production of improved landraces could be significantly faster.



Cover Photo: Farmers harvesting wheat in project site, Ethiopia  
Credit: Bioversity International/E.Dullo



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