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Participatory Agrobiodiversity implementation in Ethiopia: a success story

1. *Introduction*

Ethiopia is an agricultural society characterized by a high percentage of rural poor, high rates of subsistence agriculture and food insecurity. Although Ethiopia has cut by half the proportion of people who suffer from hunger in the past 15 years, 32% of the population is still undernourished (FAO, 2015).

Climate change is severely affecting production systems in the whole of Africa (Pachauri *et al*., 2014), with a predicted yield loss in all major cereals crops across the continent. Ethiopia is also being affected, in particular the tendency is an increase in temperature in all four seasons and changes in rainfall patterns (Conway & Schipper, 2011). Furthermore, in Ethiopia direction of changes in rainfall patterns is very difficult to predict (Conway & Schipper, 2011). One solution for long term adaptation, management of climate related risks (including increased unpredictability and uncertainties in the models) is to enhance the level of genetic diversity available to farmers, by introducing new traits into the production system. The Intergovernmental Panel on Climate Change (IPCC) recognizes that one of the key adaptive strategy for farmers in several parts of Africa is to shift to crop varieties that better suit the current climatic conditions (Yesuf et al. 2008), yet these better adapted varieties have to be identified and delivered quickly to the farmers.

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Wheat is a basic daily consumed food crop in Ethiopia, it is one of the officially announced strategic crops that contribute to food security and livelihood improvement of smallholder farmers in Ethiopia (EARO, 2000). In fact Ethiopia is still a net importer of wheat. Future gains in yield potential could be obtained by valuing the largely untapped sources of genetic diversity housed in collections of wheat landraces and of their wild relatives.

For those reasons we launched a research project to improve the food security of farmers in Ethiopia, whose medium-term objective is to contribute to the development of new genotypes in wheat to be used both as genetic material for gene discovery and fine mapping and as advanced pre-breeding germplasm for improving grain yield and yield stability. Since the research activity specifically focuses on the characterization and use of wheat landraces collected from different Ethiopian regions, our project is aimed at addressing some of the specificities of wheat cultivation in Ethiopia. The specific objectives of our project are: i) investigating the Ethiopian small farming system; ii) the identification and characterization of local wheat varieties obtained from the Ethiopian Biodiversity Institute (EBI) in Addis Abeba; iii) merging phenotypic and genotypic information with traditional farmers' knowledge.

2. *Materials and methods*

Household survey

The study was conducted in 24 villages in two locations in northern Ethiopia (in Tigray and Amhara regions). A survey was carried out in the spring of 2013 in the two locations. Twelve villages per location were chosen and 12 households per village were randomly selected, providing questionnaires which were collected from a total of 288 farmers. The questionnaire was organized in seven sections, as follows:

1. General information
2. Farmer interviewed
3. Demographic information, fields, products and activities
4. Incomes
5. Wheat varieties and seed distribution
6. Seed management
7. Climate change perception

Questionnaires were digitalized twice using *Census and Survey Processing System* (CSPro 5.0) software, by two different data entry persons. The main purpose of the double data entry in data cleaning was to reduce entering mistakes. Once digitalized, the questionnaires were exported and analyzed using *SPSS Statistics 20.0* software.

Germplasm characterization

In 2012 we sowed 373 wheat accessions obtained from the Ethiopian Biodiversity Institute (EBI) and collected from various regions in Ethiopia and 27 improved

varieties approved for cultivation by the Ethiopian ministry of agriculture. Those 400 genotypes were grown in two consecutive years in two differently characterized agro-ecological zones of Northern Ethiopia: Hagereselam (2,590 m a.s.l.), in the western part of the Tigray Region, and Geregera (2,890 m a.s.l.), in the eastern part of the Amhara Region. DNA was successfully extracted from all landraces and cultivars and genotyping was performed with the Illumina 90K SNP Wheat chip.

Plant variety selection

All the 400 varieties were evaluated in the two locations by 30 local farmers (15 males and 15 females) before harvest. Our work started with a focus group discussion with the farmers to identify and ranking the traits they use to evaluate wheat varieties and to investigate about their perception about climate change. *Earliness, tillering capacity, spike morphology* and *overall plot characteristics* were evaluated, giving a score from 1 to 5. More than 200,000 data points were collected and allowed to relate farmers' preference with agro-morphological measurements.

3. *Main results*

For each household questionnaire, a family unit indicator was calculated according to age of family head, education of the family head and numbers of family members. Three household classes were created based on the potential development of the family. In both locations the most numerous class was the middle one, representing sustainable family units. According to the questionnaires, the income of farmers interviewed in the Amhara Region comes especially from agricultural activities, whereas the income of farmers interviewed in the Tigray region comes also from other activities, such as off-farm employment, renting out farm machineries, animals and land or loan from bank or other formal institution.

Crop diversity was analyzed in the two locations; it is greater in villages around Geregera than in the ones around Hagreselam and in both locations crop diversity among farmers is bigger than crop diversity within farmers.

Data of diversity from Single Nucleotide Polymorphism (SNP) analysis clearly indicate that Ethiopian wheat landraces are very different from European and Mediterranean wheat accessions, and that most improved varieties are genetically similar whereas Ethiopian germplasm is more heterogeneous and scarcely used in plant breeding.

Results from plant variety selection indicate that *spike morphology* is the most relevant trait in farmers' evaluation of wheat variety. Correlation analysis among farmers' traits and agronomic data shows a significant correlation meaning that farmers, just observing a wheat variety, have a real perception of its agronomic characteristics.

Finally a ranking of new wheat varieties evaluated by the farmers was done and it was compared with the ranking of wheat varieties currently gown by the farmers. The best 50 new accessions of the ranking have scores greater than the ones of wheat varieties grown by the farmers indicating that the material we presented to the farmers is highly appreciated.

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