Decentralized Participatory Plant Breeding as a response to variability in the target environments.
1. Definitions

2. Why participatory plant breeding?

3. What is participatory plant breeding?
   Breeding methods, selection by farmers, seed productions, farmers' skills, women selection, cost of participatory plant breeding, institutionalization and scaling up, new varieties

4. Conclusions
Decentralized-participatory breeding

Selection done jointly by farmers and professional breeders

On Farm

Centralized breeding

Selection done by professional breeders

On station

Decentralized breeding

Centralized-participatory breeding

Selection done jointly by farmers and professional breeders

On Farm

Decentralized-participatory breeding

On station
Plant breeding has not been very successful in stressful environments.

For crops grown in marginal environments, research stations are not good selection environments. This is largely due to genotype x environment interactions effects.

On station yield trials, crosses of segregating populations are conducted. On farm yield trials follow.
Biplot of grain yield of thirty barley genotypes grown in six locations in Morocco.

\[ G \times E = 84.9\% \]

Component 1 (33.43%)

Component 1 (21.42%)

Research stations

\[ 12 \text{ E3} \]

\[ 1 \quad 6 \quad 8 \quad 4 \]

\[ 16 \quad 9 \quad 5 \quad 7 \quad 11 \quad 14 \quad 17 \quad 15 \quad 20 \quad 13 \quad 18 \quad 19 \quad 22 \quad 24 \]

\[ 0.05 \quad 0.375 \quad 0.7 \]

\[ -0.275 \]

\[ 0.7 \]

\[ -0.6 \]

\[ -0.275 \]
Biplot of grain yield of twenty five barley genotypes grown in six locations in Tunisia

G x E = 63.3%
Grain yield (% of the check) on station of the best five entries at Senafe (Eritrea)

Entries

- **Res. Station**
- **Senafe**
PPB Trials 1997: 208 entries, 2 Research Stations, 9 Farmers fields

Rainfall data 1997
A fundamental issue in plant breeding

Selection Environments ➔ Target Environments
Few selection environments for several target environments
Decentralized Breeding

Creation of Variability

N. Africa (Morocco, Algeria, Tunisia) (Libya, Egypt)

Lebanon

Eritrea

Yemen

Far East (China, India, Korea)

Latin America (Colombia, Peru, Ecuador, Bolivia)

Iraq: Irrigated Rainfed

Central Asia, Iran Turkey

Jordan

Ethiopia

NARS
Decentralization may not be enough

In International breeding programs, decentralization often transfers selection from one breeding station to another.

At National level, decentralized selection addresses target environments identified on the basis of repeatable genotype x locations interactions without including farmer preferences.
Why Decentralized - Participatory Plant Breeding?

An alternative way to address the multitude of physical and socio-economic target environments in which the participation of farmer in the early stages of selection is expected to increase the speed of producing specifically adapted cultivars and to improve adoption rate.
What is Participatory Plant Breeding?

Farmers (users) are involved in the development of varieties and not only in their testing.

This implies that the opinion of farmers counts as much as the opinion of the scientists.
What Participatory Plant Breeding is not?

Participatory plant breeding is not only talking to farmers

Participatory plant breeding is not a different science
A centralized-non participatory plant breeding program

A decentralized-participatory plant breeding program

On station yield trials

Segregating populations

Crosses

On farm yield trials

On farm yield trials

Segregating populations

Crosses
A three steps process

Exploratory phase  
1997-1999

Methodology development  
2000-2003

Institutionalization and scaling up  
2003-2005
Exploratory phase
(1997-1999)

Objectives

• Build human relationships (building the team)
• Understand farmers’ preferences
• Measure farmers’ selection efficiency
• Develop scoring methodology
• Enhance farmers’ skills
Exploratory phase
(1997-1999)

Talking to farmers

........ but listening is more important
Participatory Barley Breeding In Syria 1996-1999

Locations
1- Taftanaz
2- Ebla
3- Tel Brak
4- Jurn El-Aswad
5- Baylonan
6- Al-Bab
7- Melabya
8- Bari Sharki
9- Sauran
10- Breda
11- Tel Hadya
Outputs the first phase

- Increased farmers' awareness of plant breeding
- Demonstration that farmers' selection is at least as efficient as breeder's selection
- Demonstration that farmers' can handle large number of lines/populations
- New selection criteria, depending on environment
- Speed of adoption increased
- Quantity and quality of requests increased
- Requests to extend PPB to other crops
- Dissemination of PPB to other NARS (Tunisia, Morocco, Eritrea, Jordan, Egypt, Yemen)
- Move from linear to cyclic processes
- Decentralization (the example of Morocco)
- New varieties start spreading during the project

Objectives

- Implementation of the breeding plan
- Experimental designs and statistical analysis
- Farmers’ selection methodology refined
- Seed production
The General Model

Adoption
Release (?)

Crosses
F1
F2 bulks

TE_1
3 cycles of selection

TE_2
3 cycles of selection

TE_3
3 cycles of selection

TE_4
3 cycles of selection

TE_5
3 cycles of selection

TE_6
3 cycles of selection
The Farmer yield trials

Crosses
F1
F2 bulks

On Station

Farmer Initial Trial (FIT)

Farmer Advanced Trials (FAT)

Farmer Initial Trial (FIT)

Farmer Advanced Trials (FAT)

Farmer Elite Trials (FET)

On Farm

No. of trials per village

1-2

4-8

3-8

Back to formal breeding for crosses

Adoption Release (?)
A village as a research station
FIT (Farmer Initial Trials), 179 entries, small plots
FAT (Farmer Advanced Trials): 10-25 entries, large plots
Farmer Advanced Trial (FAT)

FAT (two replications) within the same village share the same entries.

Each farmer may plant the FAT in a different rotation, or with a different seed rate, or on a different soil type, may use fertilizer (or apply a different amount of fertilizer).

Farmers rely greatly on the information about the management of the trial during the selection process.

At an early stage of the breeding program the lines are already characterized for their response to environmental or agronomic factors.
Nematodes

One FAT has revealed a suitable site to screen for nematode resistance.
FET at Jurn Aswad (270 mm)
Large scale trials: 3-4 entries on 0.1-1.0 ha

From crosses to 0.5 ha in seven years
Participatory Barley Breeding In Syria (2000-2003)

- **FIT 378 Entries plots of 12 m²**
- **FAT 169 Entries plots of 144 m²**
- **FET 72 Entries plots of 0.3-1.5 ha**

Locations:
- 2- Mardabsi
- 3- Tel Brak
- 4- Jurn El-Aswad
- 5- Baylonan
- 6- Al-Bab
- 7- Melabya
- 8- Bari Sharki
- 9- Sauran
- 10- El Mghirat
- 11- El Raheb
- 12- Sardah
A two-step selection process

Visual Selection + Quantitative Information
All the available information is shared
Data Analysis

**REML** (specific GENSTAT programs for spatial analysis written by the Biometrics Unit at ICARDA)

- missing data
- unbalanced data set
- Best Linear Unbiased Predictors (BLUPs)
- Heritability $\pm$ s.e.
Data Analysis

G x E Interactions (Gebei, GGEbiplot)

Similarity analysis (dice coefficient, Euclidean distance)
Large Genotype x Location Interactions in stress environments also at micro-level

Genotype x Farmers’ Fields Interactions in Syria

Mardabsi (grain yield = 4.4 t/ha)

Bylounan (grain yield = 1.3 t/ha)
Seed production

Developing village-based seed production
Farmers’ skills

Reports and Presentations

إحالة إلى المزارع
 تقديم الحاج صالح
Do women make a difference?
Dendrogram based on cluster analysis of farmers, women and breeder selections in barley at Rabba (Jordan), 2002.
Women Selection in Yemen

Breeder

Male Farmers

Female Farmers (I)

Female Farmers (G)

Euclidean Distance
COST OF PPB

When the number of sites is the same, the total cost of trial management in PPB is in most cases lower than in the centralized breeding.
Evolution of on-station and on-farm yield testing
Institutionalization and scaling up
(2003-2005)

Objectives

• Transfer the process to the National Program
• Expanding to more provinces and more villages within the existing provinces
Workshop with GCSAR, GOSM, Extension Directorate and farmers

Participation of GCSAR and Extension staff in all activities

Training courses on data analysis

From 11 to 28 villages
Participatory Barley Breeding in Syria 2003

Locations
2 - Mardabsi
3 - Tel Brak
4 - Jurn El-Aswad
5 - Baylonan
6 - Al-Bab
7 - Melabya
8 - Bari Sharki
9 - Sauran
10 - El Mghirat
11 - El Raheb
12 - Sardah
Lentil and barley advanced trials at Al-Ashmour (Yemen, 2700 m asl). Two replications (each on a different terrace) with large plots.
The diffusion of Zanbaka in some of the dry areas of Syria (150-250 mm annual rainfall)
Most farmers plant Zanbaka on a small area.
Lines selected and multiplied by farmers in the north-west coast of Egypt (100-150 mm annual rainfall). Plot size 0.2-.25 ha, seed rate 60 kg/ha.
Conclusions

Farmers’ selection is effective, and this allows to address a larger number of target environments than in decentralized non-participatory breeding.

New varieties are spreading in areas where centralized non-participatory breeding had no impact.

Large effect on diversity.

PPB projects have a large effect on farmer empowerment even if this is not explicit in the design of the projects.
Conclusions

The methodology is continuously evolving, also as a consequence of farmers’ improved skills.

PPB methods can be very different, even with the same crop, depending on current farmers’ practices (example of Eritrea, Nepal).

PPB projects have to be developed primarily with the Institutions responsible for plant breeding.

The cost to the Institution (s) and to the farmers is not necessarily higher.
Acknowledgements

The work presented here was only possible because of the support of:

BMZ
IDRC
OPEC Fund
The Government of Italy
The Government of Denmark
The System Wide Program for Participatory Research and Gender Analysis
Thank you