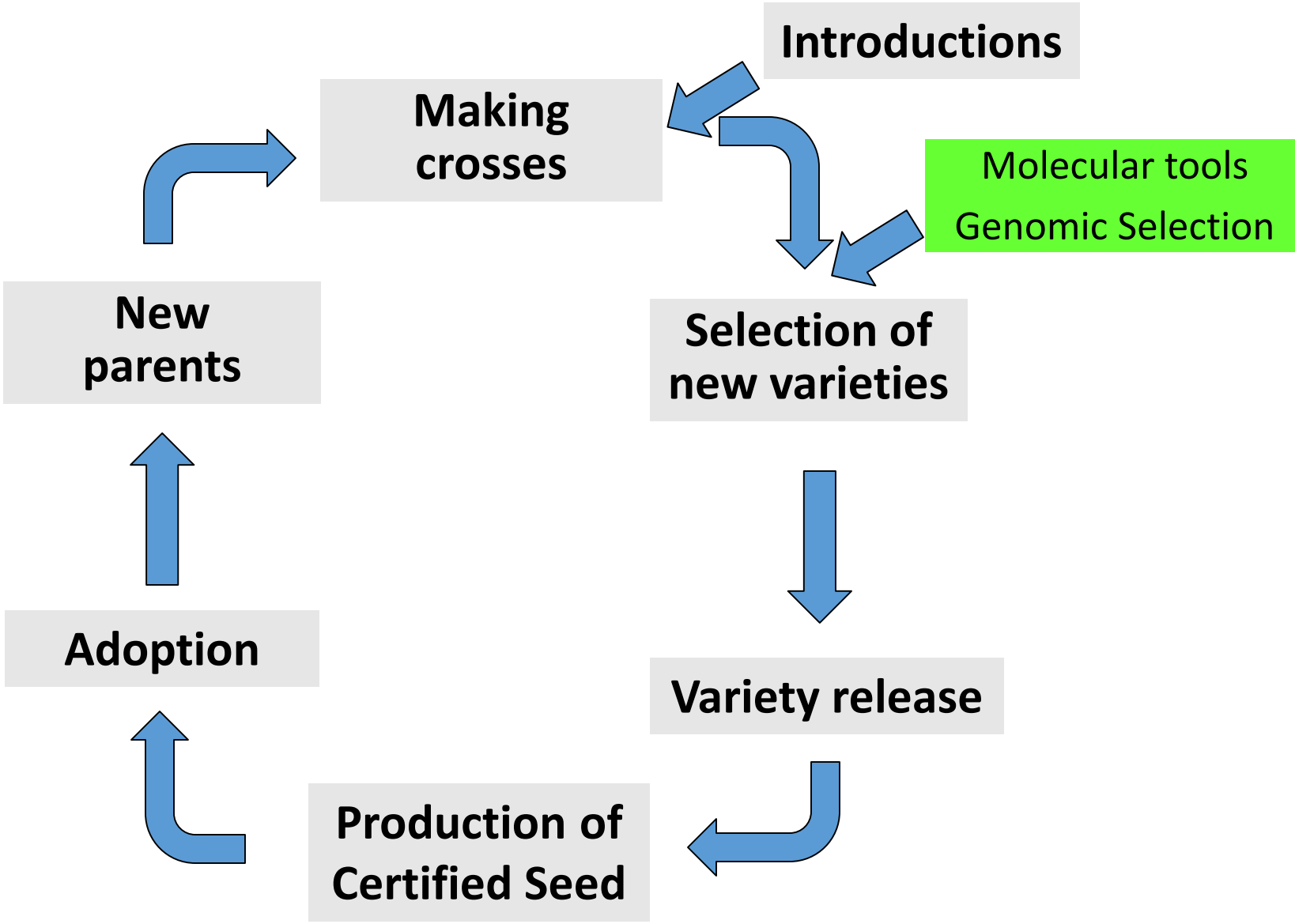
Participatory Plant Breeding and its challenges

S. Ceccarelli
(ceccarelli.Salvatore83@gmail.com)

Local solutions to global problems

What is Plant Breeding?

A Plant Breeding Program



Breeding Cycle – Main Stages

Seed production and distribution

Social targeting and

Selection in segregating populations

Molecular tools
Genomic Selection

Customer Profile

Breeding for whom?

Product Profile:

Breeding what type of variety?

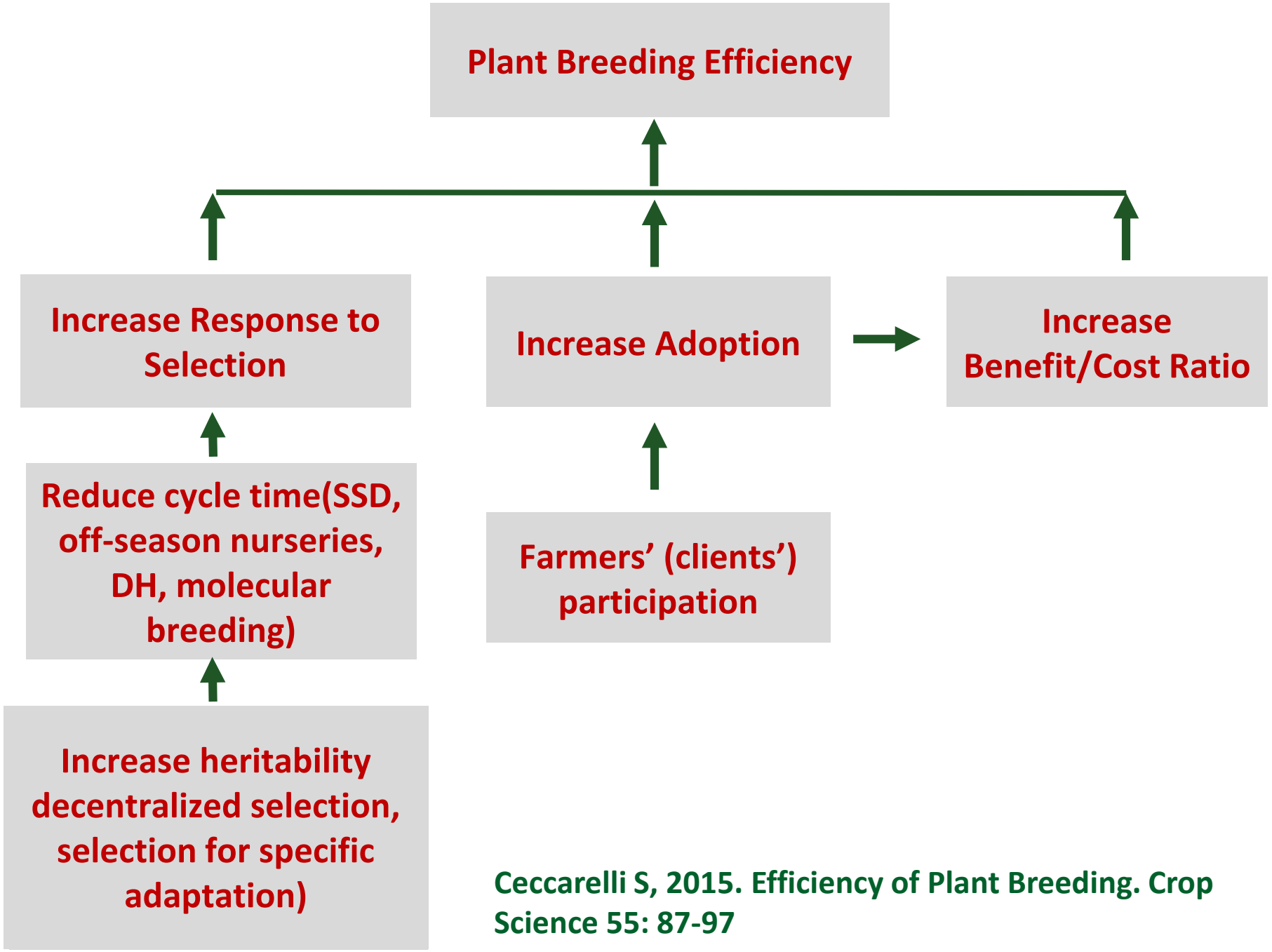
Breeding Efficiency

1. Number of varieties adopted/number of crosses made
1. No. of varieties released
2. Response to Selection = $(i\ \sigma_p\ h^2)/t$
3. Benefit/Cost Ratio
4. Increase in agro biodiversity

Genetic Gain

The breeder's equation

Why Participatory Plant Breeding?

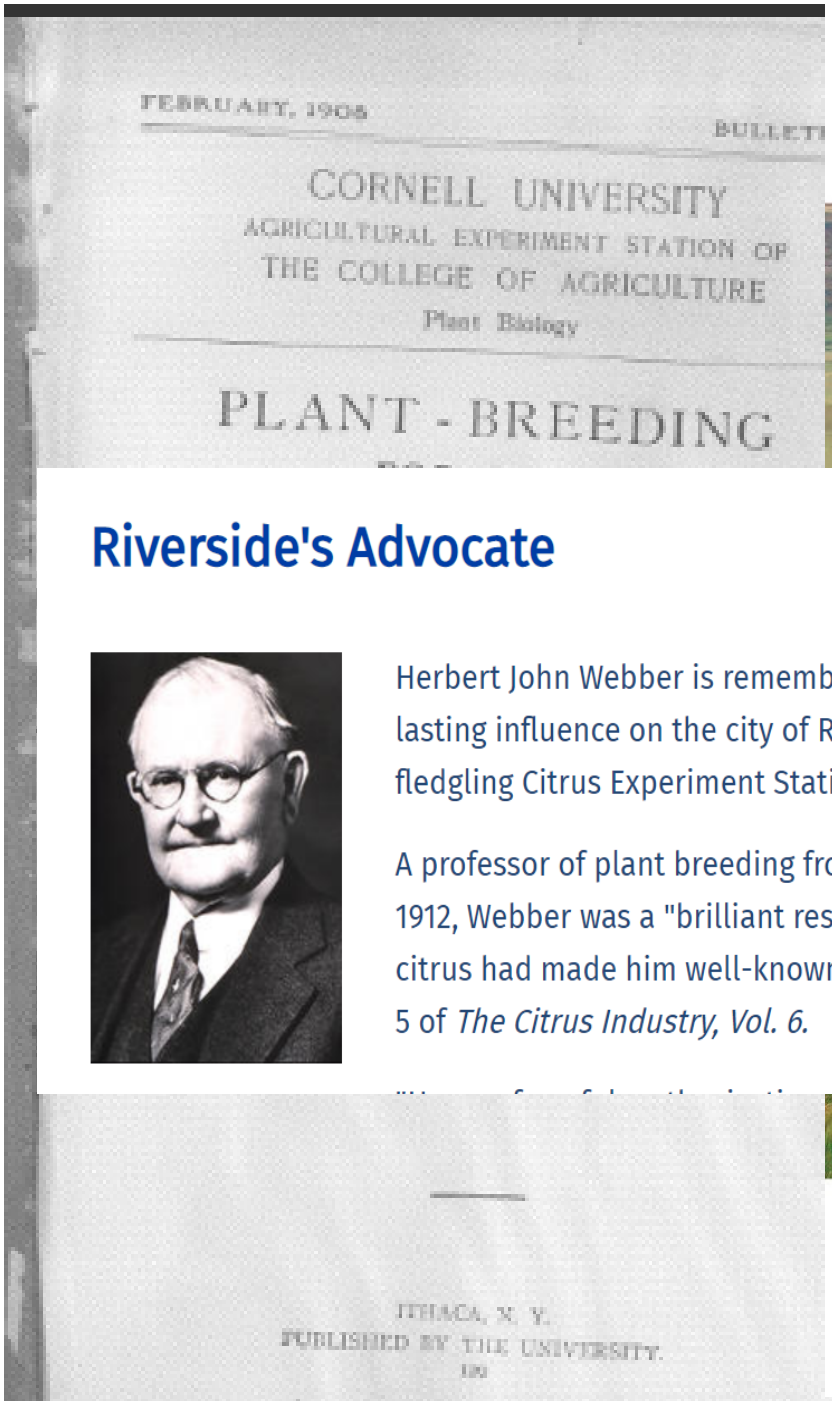


Ceccarelli S, 2015. Efficiency of Plant Breeding. Crop Science 55: 87-97

History of Participatory Plant Breeding (PPB)

Begins in the early eighties (Rhoades and Booth, 1982)

Rhoades RE and Booth RH (1982) Farmer-back-to-farmer: a model for generating acceptable agricultural technology. Agricultural Administration, 11: 127-137



ICARDA International Center for Agricultural Research in the Dry Areas

Plant breeding with farmers

No farmer, however, is so poor

Riverside's Advocate

Herbert John Webber is remembered for many contributions to science, education, and agriculture, but his lasting influence on the city of Riverside and the University of California comes from his insistence that the fledgling Citrus Experiment Station remain in the city.

A professor of plant breeding from Cornell University before joining the Experiment Station as director in 1912, Webber was a "brilliant research scientist" whose research for the U.S. Department of Agriculture on citrus had made him well-known to California growers, wrote Harry Lawton and Lewis G. Weathers in chapter 5 of *The Citrus Industry, Vol. 6.*

Solibam
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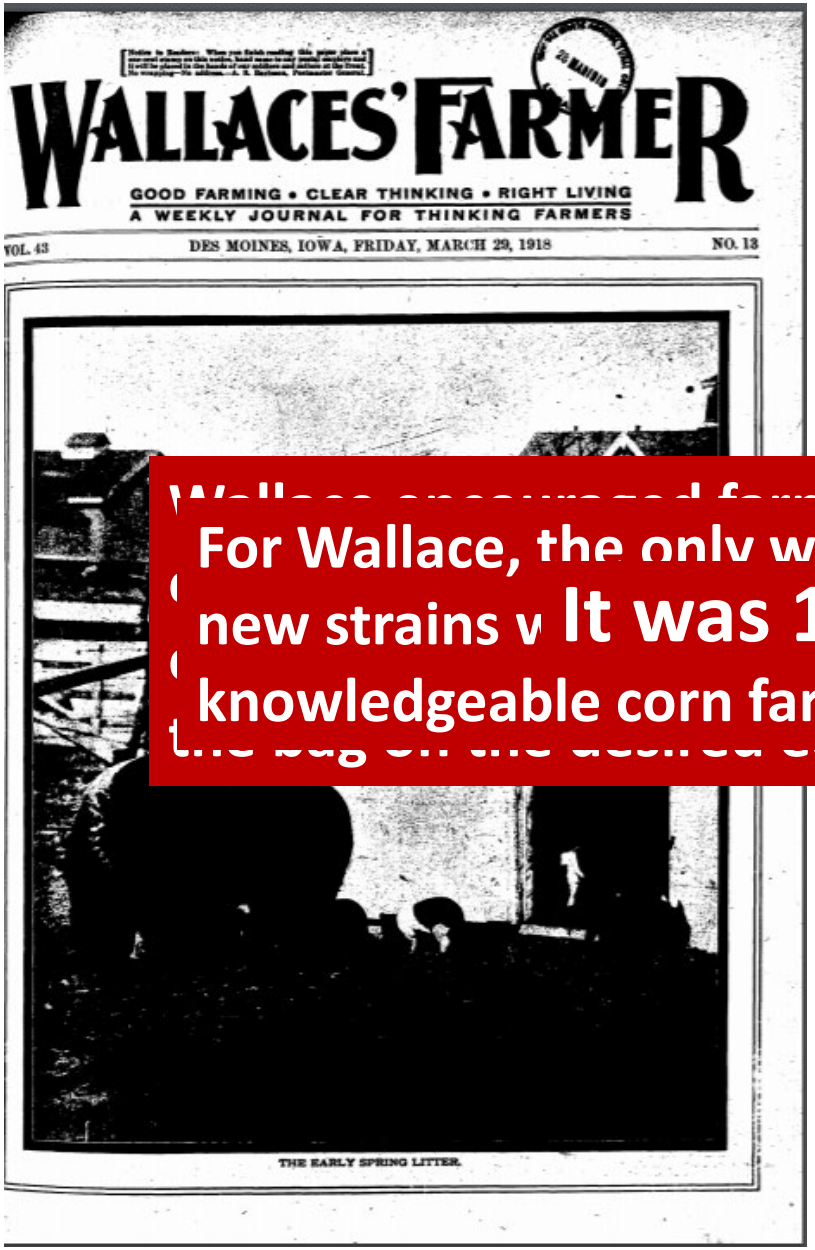
Support for research and production of this publication



WALLACES' FARMER

GOOD FARMING • CLEAR THINKING • RIGHT LIVING

A WEEKLY JOURNAL FOR THINKING FARMERS

VOL. 43 DES MOINES, IOWA, FRIDAY, MARCH 29, 1918 NO. 13

THE EARLY SPRING LITTER.

578 (14) WALLACES' FARMER March 29, 1918

Boys' Corner

Corn Breeding Plot

The Hog Contest

The Girls Can Do Their Share

Mak-a-Tractor $225

Here Are a Few Samples of the THOUSANDS of Answers:

Four Horses Work at One Horse's Cost

For Belt Power

For Heavy Hauling

Get These Two Free Books

THE E. C. STAUDE MFG. CO., 2011 W. University Ave., St. Paul, Minn.

For Wallace, the only way for breeders to discover new strains was pertise of the knowledgeable corn farmers themselves

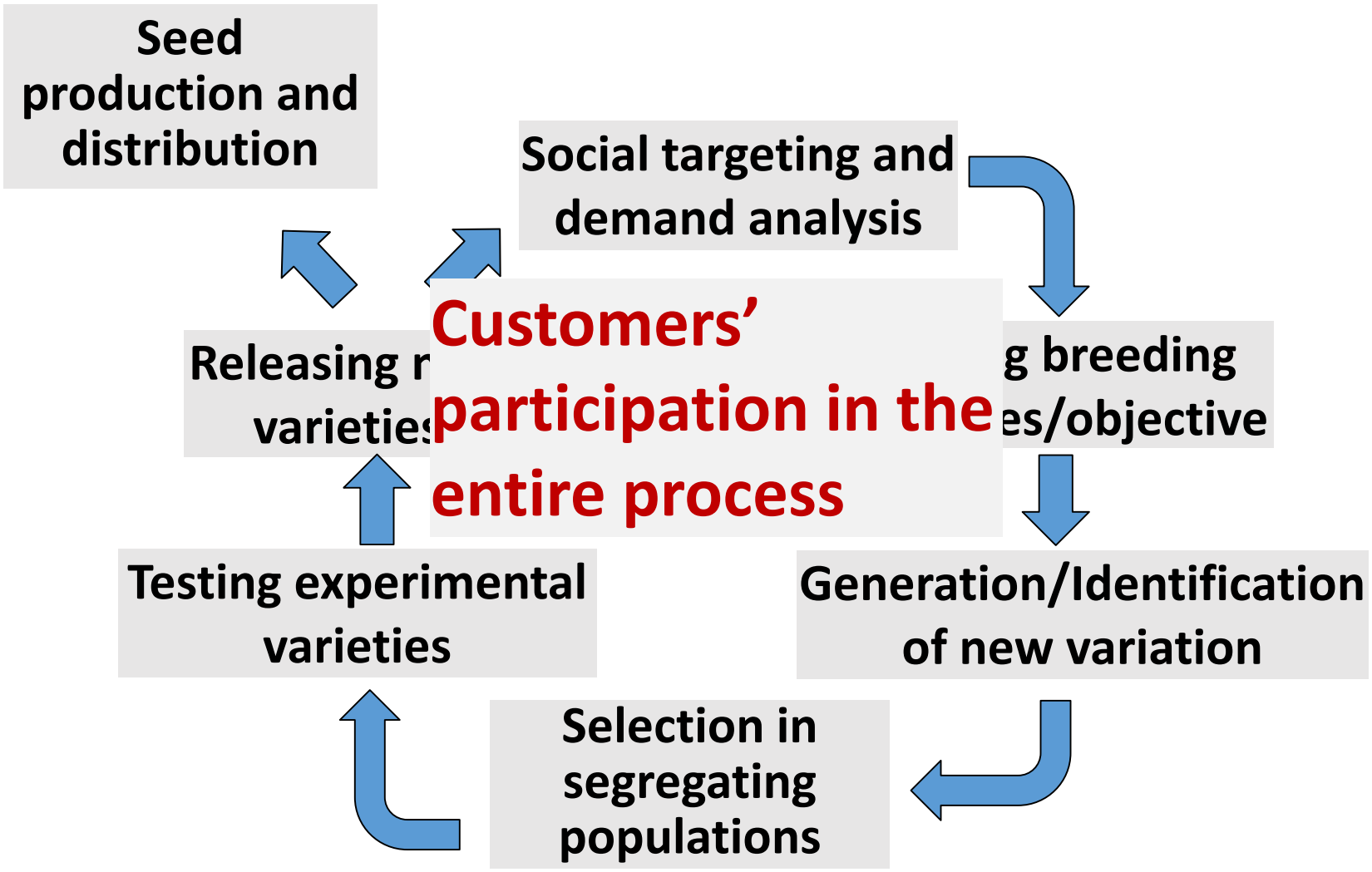
It was 1918

At the University of Illinois, reliance on farmers was to some extent a necessary evil. In their own breeding work, university researchers were hampered by a lack of fields for trials and literally "farmed out" their inbreds for crossing to farmers who volunteered for the task. This did not sit well with the commercial breeders, [redacted]s could not be relied on to maintain accurate records or keep the lines pure. At issue was the question of whether ordinary farmers were competent to manage the crossing of corn.

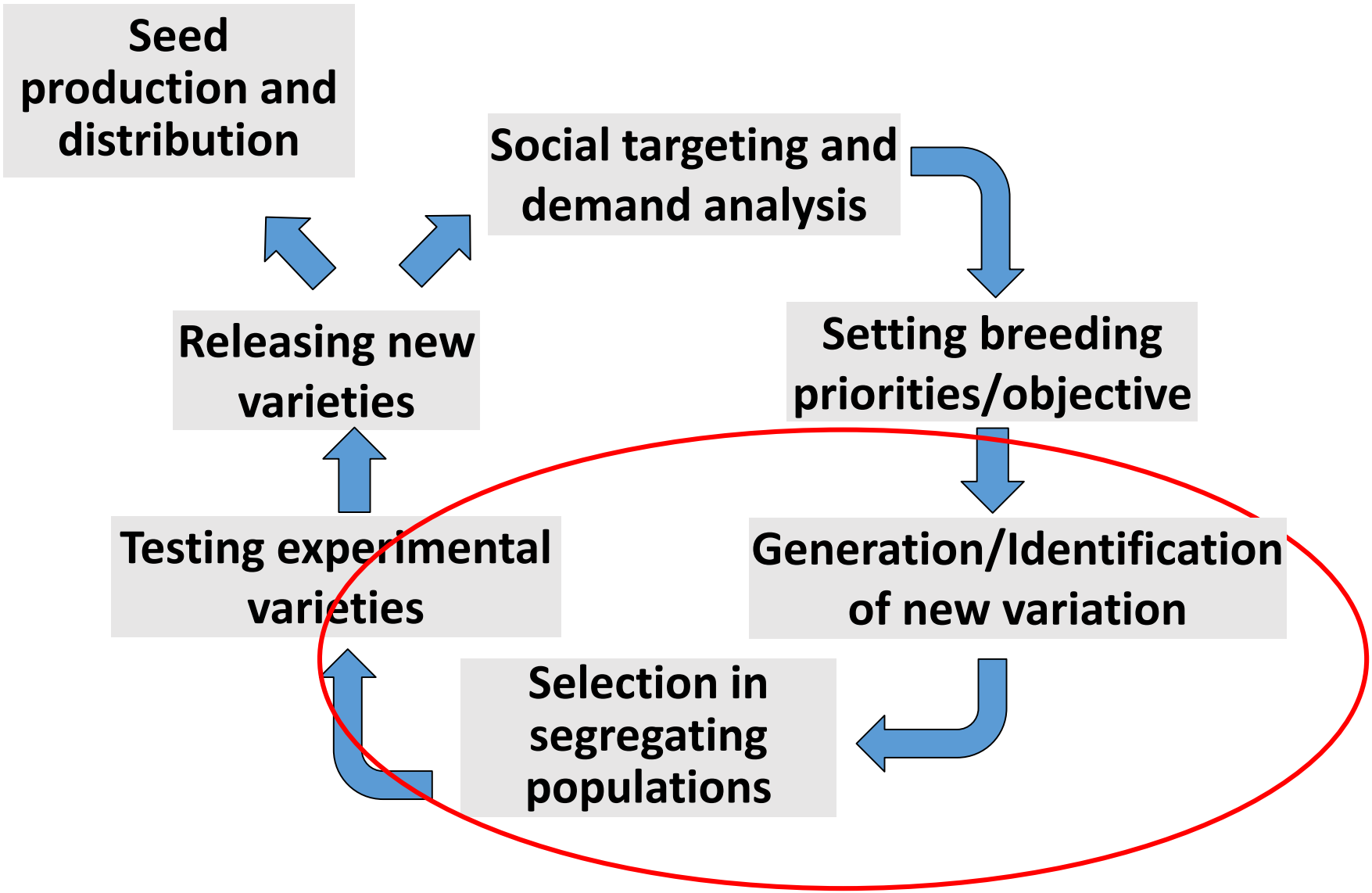
It was 1938

Twenty years earlier this was a task that Wallace had claimed "anyone" could do

Participatory Plant Breeding



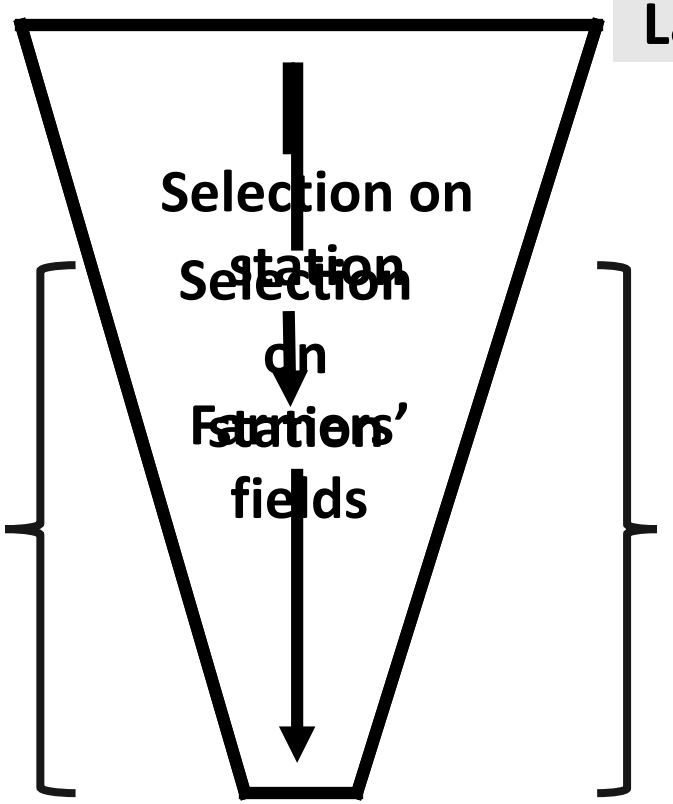
Breeding Cycle – Main Stages



Participatory Variety Selection (PVS)

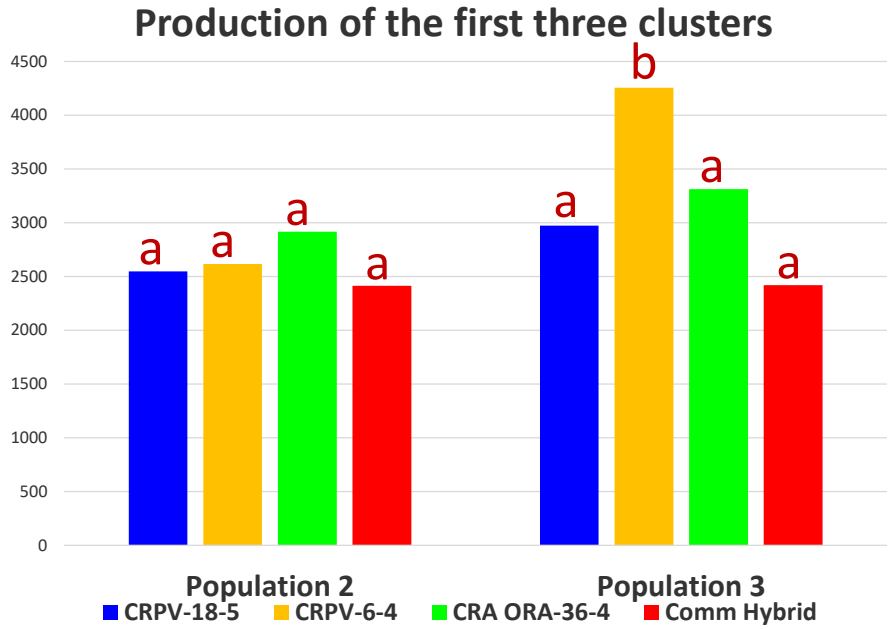
Clients' participation

Large genetic variability



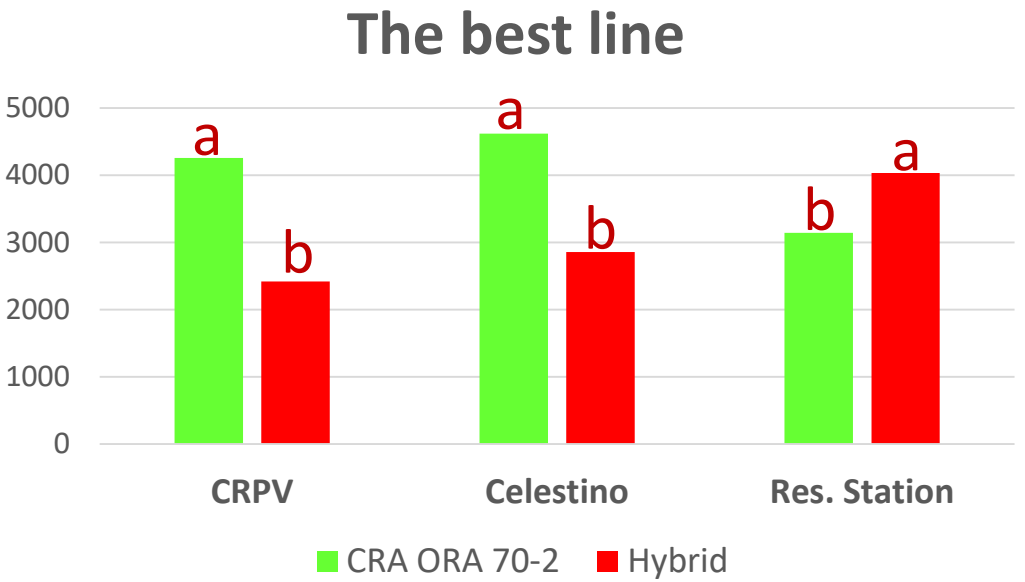
Clients' participation

Less and less genetic variability



PPB in tomato

Campanelli et al. 2015.
Participatory Tomato Breeding for Organic Conditions in Italy.
Euphytica 204 (1) 179-197



Selection moved from Research Station to Farmers' Fields

Decisions shared between breeder and farmers

1995: our beginning

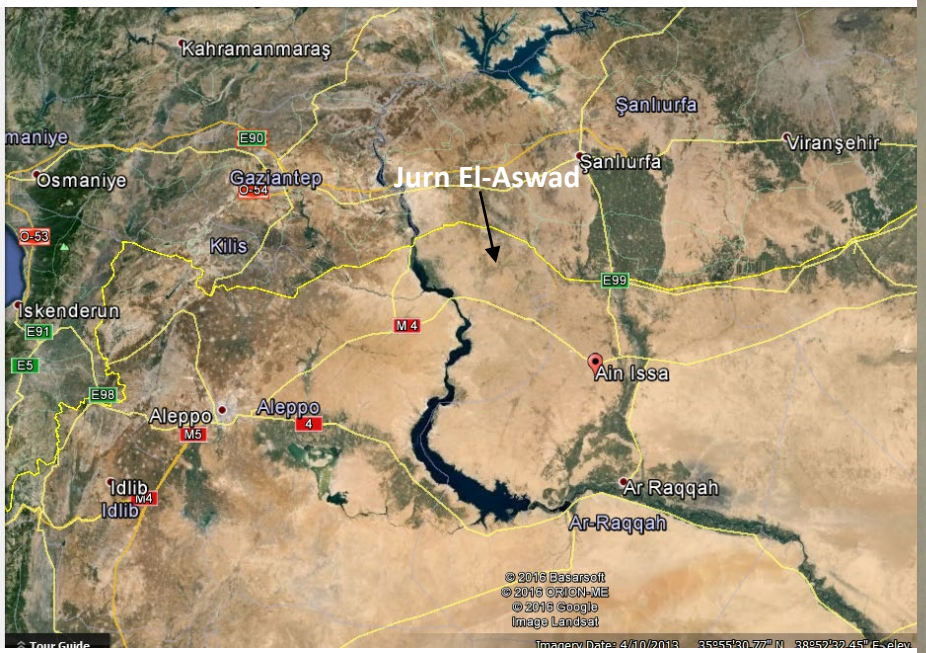
Participatory plant breeding

Proceedings of a workshop on participatory plant breeding
26-29 July 1995
Wageningen, The Netherlands

P. Eyzaguirre and M. Iwanaga, *editors*

of the main reasons for the failure of formal breeding to serve small, resource-poor farmers. Formal breeding has frequently adopted a negative interpretation of GE interaction. This has implied selection for broad adaptation, and consequently replacement of landraces with input-responsive cultivars ill-adapted to low-input and

1995 Jurn El-Aswad




1996

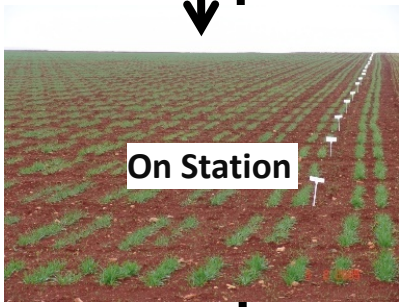

20 7 2005


12 6 2005

Farmers + Public Institution

Genetic Diversity

Genetic Diversity in farmers' fields

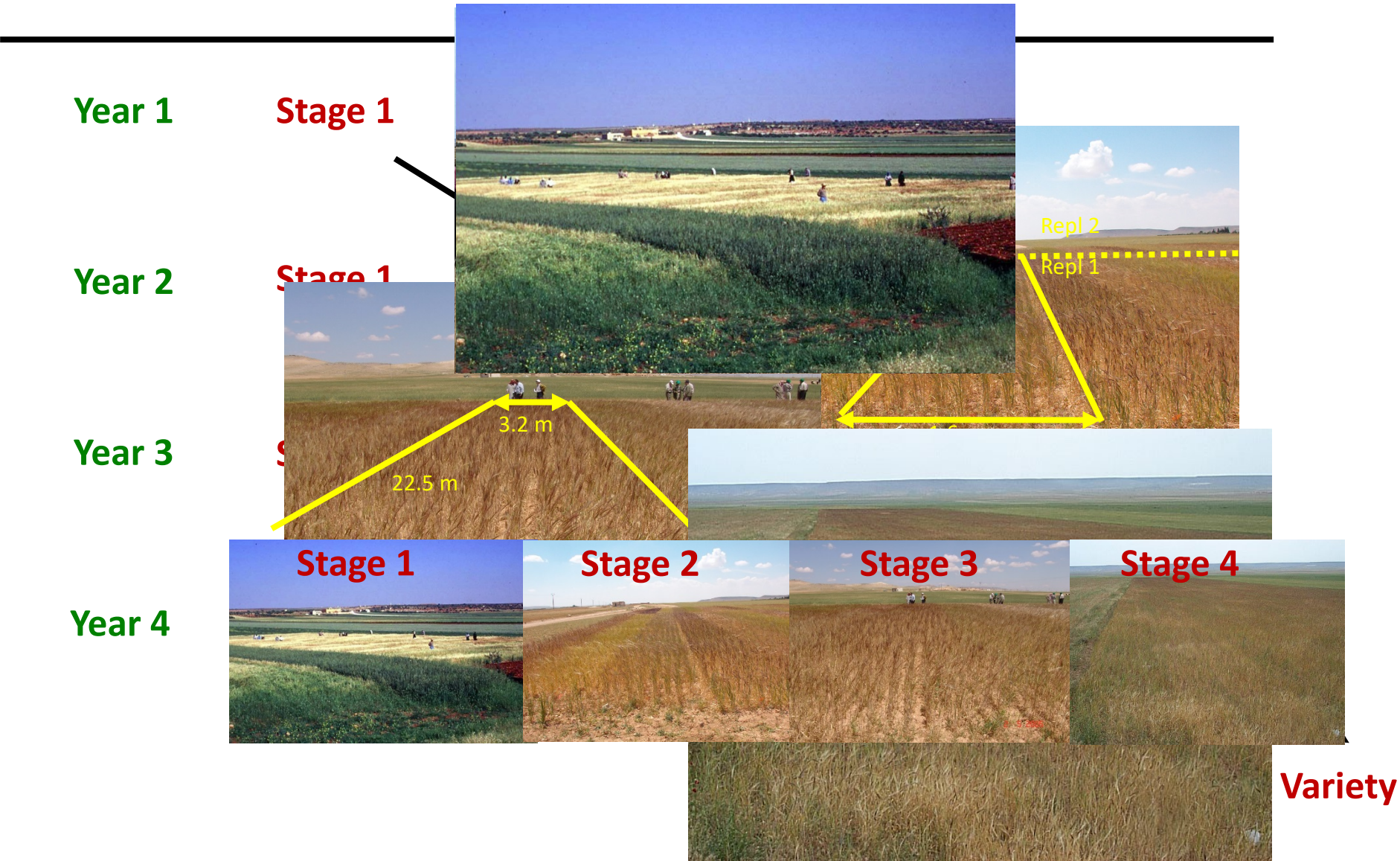


Selection in the field (men and women)

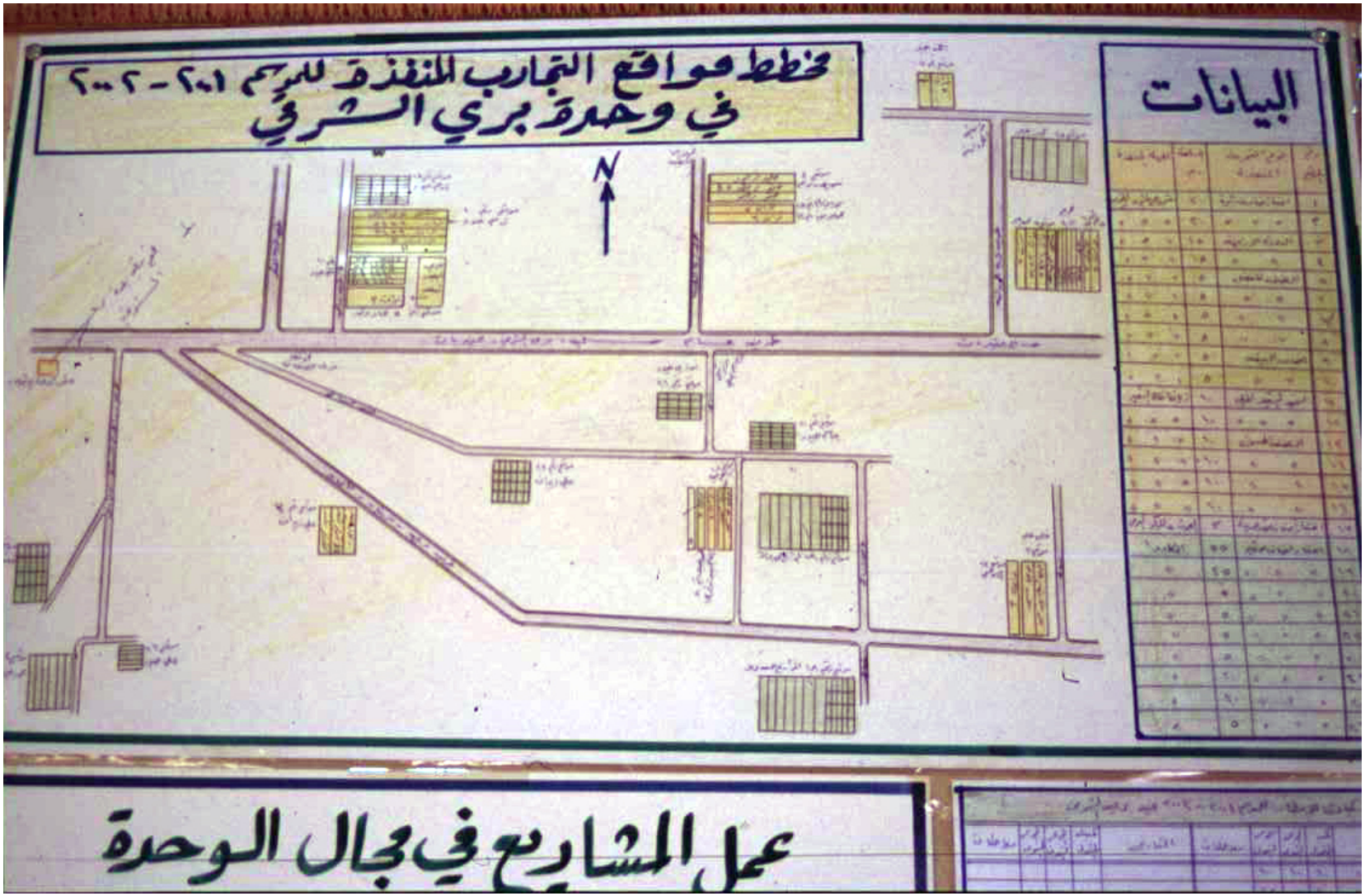
Seed production

New varieties

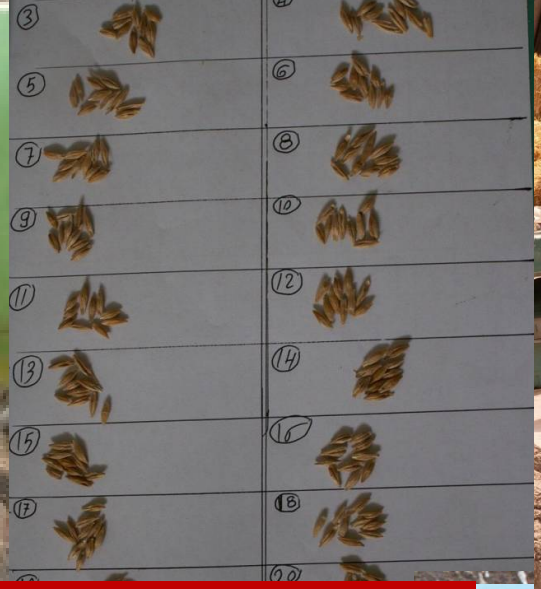
One Model of Participatory Plant Breeding Program (one village)



The village IS the research station



At each stage and in addition to the usual data collected in a breeding program, a group of farmers score all the plots



Data collection

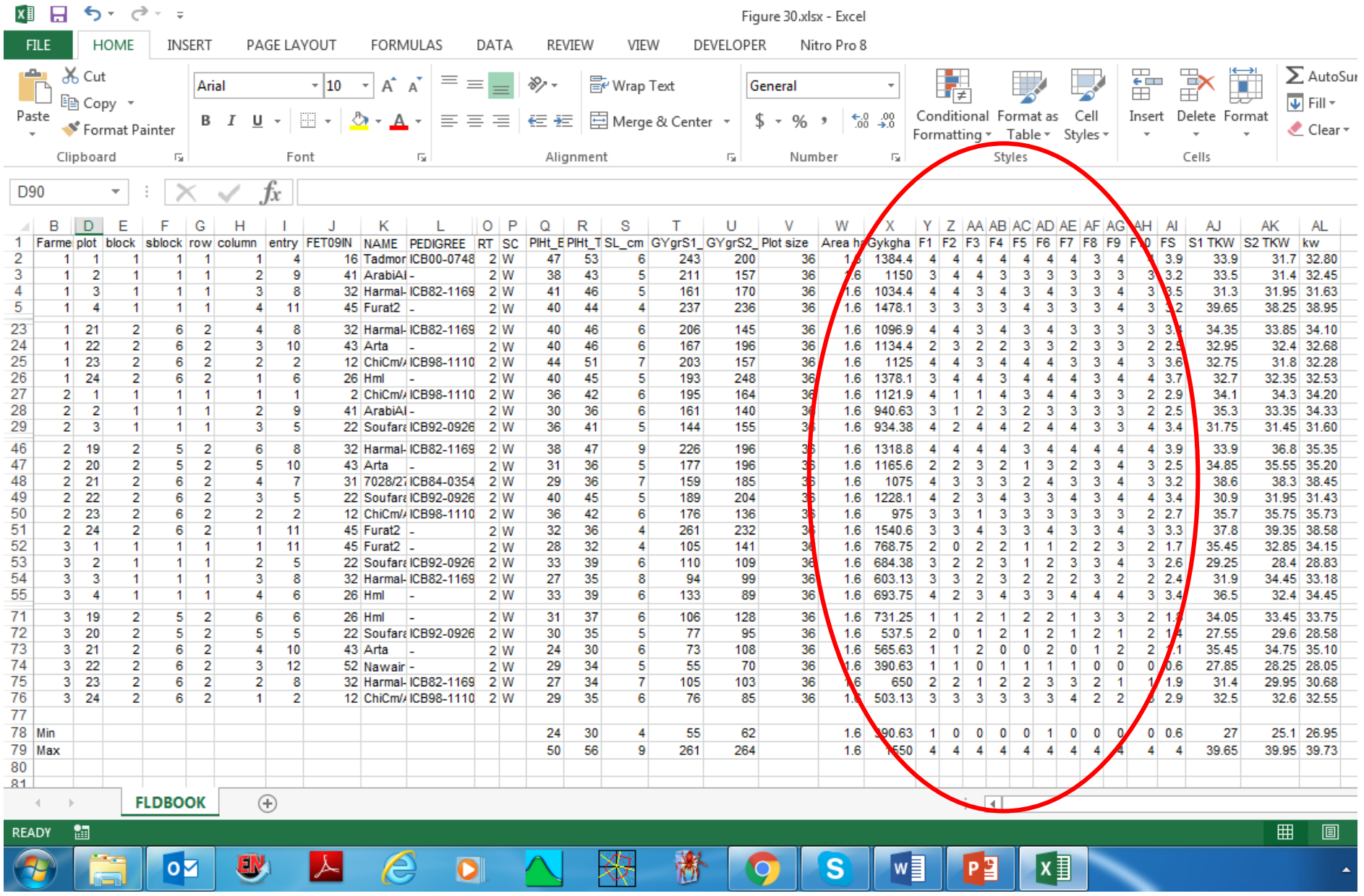


Figure 30.xlsx - Excel
FILE
HOME
INSERT
PAGE LAYOUT
FORMULAS
DATA
REVIEW
VIEW
DEVELOPER
Nitro Pro 8
Cut
Copy
Format Painter
Paste
Clipboard
Arial
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Font
Wrap Text
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Farme plot block sblock row column entry FET09IN NAME PEDIGREE RT SC PlHt_E PlHt_T SL_cm GYgrS1_ GYgrS2_ Plot size Area ha Gykgha F1 F2 F3 F4 F5 F6 F7 F8 F9 FS S1 TKW S2 TKW kw
1 1 1 1 1 1 4 16 Tadmor ICB00-0748 2 W 47 53 6 243 200 36 1384.4 4 4 4 4 4 4 4 3 4 3.9 33.9 31.7 32.80
2 1 2 1 1 2 9 41 ArabiAl - 2 W 38 43 5 211 157 36 1150 3 4 4 3 3 3 3 3 3 3.2 33.5 31.4 32.45
3 1 3 1 1 3 8 32 Harmal- ICB82-1169 2 W 41 46 5 161 170 36 1034.4 4 4 3 4 3 4 3 3 4 3.5 31.3 31.95 31.63
4 1 4 1 1 4 11 45 Furat2 - 2 W 40 44 4 237 236 36 1478.1 3 3 3 3 4 3 3 3 4 3 3.2 39.65 38.25 38.95
23 1 21 2 6 2 4 8 32 Harmal- ICB82-1169 2 W 40 46 6 206 145 36 1096.9 4 4 3 4 3 4 3 3 3 3.5 34.35 33.85 34.10
24 1 22 2 6 2 3 10 43 Arta - 2 W 40 46 6 167 196 36 1134.4 2 3 2 2 3 3 2 3 3 2 2.9 32.95 32.4 32.68
25 1 23 2 6 2 2 2 12 ChiCm/A ICB98-1110 2 W 44 51 7 203 157 36 1125 4 4 3 4 4 4 3 3 4 3 3.6 32.75 31.8 32.28
26 1 24 2 6 2 1 6 26 Hml - 2 W 40 45 5 193 248 36 1378.1 3 4 4 3 4 4 4 3 4 4 3.7 32.7 32.35 32.53
27 2 1 1 1 1 1 1 2 ChiCm/A ICB98-1110 2 W 36 42 6 195 164 36 1121.9 4 1 1 4 3 4 4 3 3 2 2.9 34.1 34.3 34.20
28 2 2 1 1 1 2 9 41 ArabiAl - 2 W 30 36 6 161 140 36 940.63 3 1 2 3 3 2 3 3 3 2 2.5 35.3 33.35 34.33
29 2 3 1 1 1 3 5 22 Soufara ICB92-0926 2 W 36 41 5 144 155 36 934.38 4 2 4 4 2 4 4 3 3 4 3.4 31.75 31.45 31.60
46 2 19 2 5 2 6 8 32 Harmal- ICB82-1169 2 W 38 47 9 226 196 36 1318.8 4 4 4 4 3 4 4 4 4 4 3.9 33.9 36.8 35.35
47 2 20 2 5 2 5 10 43 Arta - 2 W 31 36 5 177 196 36 1165.6 2 2 3 2 1 3 2 3 4 3 2.5 34.85 35.55 35.20
48 2 21 2 6 2 4 7 31 7028/27 ICB84-0354 2 W 29 36 7 159 185 36 1075 4 3 3 3 2 4 3 3 4 3 3.2 38.6 38.3 38.45
49 2 22 2 6 2 3 5 22 Soufara ICB92-0926 2 W 40 45 5 189 204 36 1228.1 4 2 3 4 3 3 4 3 4 4 3.4 30.9 31.95 31.43
50 2 23 2 6 2 2 2 12 ChiCm/A ICB98-1110 2 W 36 42 6 176 136 36 975 3 3 1 3 3 3 3 3 3 2 2.7 35.7 35.75 35.73
51 2 24 2 6 2 1 11 45 Furat2 - 2 W 32 36 4 261 232 36 1540.6 3 3 4 3 3 4 3 3 4 3 3.3 37.8 39.35 38.58
52 3 1 1 1 1 1 11 45 Furat2 - 2 W 28 32 4 105 141 36 768.75 2 0 2 2 1 1 2 2 3 2 1.7 35.45 32.85 34.15
53 3 2 1 1 1 2 5 22 Soufara ICB92-0926 2 W 33 39 6 110 109 36 684.38 3 2 2 3 1 2 3 3 4 3 2.6 29.25 28.4 28.83
54 3 3 1 1 1 3 8 32 Harmal- ICB82-1169 2 W 27 35 8 94 99 36 603.13 3 3 2 3 2 2 2 3 2 2 2.4 31.9 34.45 33.18
55 3 4 1 1 1 4 6 26 Hml - 2 W 33 39 6 133 89 36 693.75 4 2 3 4 3 3 4 4 4 3 3.4 36.5 32.4 34.45
71 3 19 2 5 2 6 6 26 Hml - 2 W 31 37 6 106 128 36 731.25 1 1 2 1 2 2 1 3 3 2 1.9 34.05 33.45 33.75
72 3 20 2 5 2 5 5 22 Soufara ICB92-0926 2 W 30 35 5 77 95 36 537.5 2 0 1 2 1 2 1 2 1 2 1.4 27.55 29.6 28.58
73 3 21 2 6 2 4 10 43 Arta - 2 W 24 30 6 73 108 36 565.63 1 1 2 0 0 2 0 1 2 2 2.1 35.45 34.75 35.10
74 3 22 2 6 2 3 12 52 Nawair - 2 W 29 34 5 55 70 36 390.63 1 1 0 1 1 1 1 0 0 0 0.6 27.85 28.25 28.05
75 3 23 2 6 2 2 8 32 Harmal- ICB82-1169 2 W 27 34 7 105 103 36 650 2 2 1 2 2 3 3 2 1 1 1.9 31.4 29.95 30.68
76 3 24 2 6 2 1 2 12 ChiCm/A ICB98-1110 2 W 29 35 6 76 85 36 503.13 3 3 3 3 3 3 4 2 2 3 2.9 32.5 32.6 32.55
78 Min 24 30 4 55 62 1.6 390.63 1 0 0 0 0 1 0 0 0 0 0.6 27 25.1 26.95
79 Max 50 56 9 261 264 1.6 1550 4 4 4 4 4 4 4 4 4 4 4 39.65 39.95 39.73
FLDBOOK
READY



After the statistical analysis of the trials, the final selection for the following stage is done in a joint meeting with farmers


GY

ام العمد - تجربة اولية - افضل ٢٠ صنف انتاجياً - ٢٠٠٩

المدخل	اسم الصنف	طول النبات سم	ترتيب طول النبات	طول السنبلة سم	ترتيب طول السنبلة	انتخاب المزارع	ترتيب انتخاب المزارع	وزن ١٠٠٠ حبة	ترتيب وزن ١٠٠ حبة	انتاج الحب كغ/هكتار	ترتيب انتاج الحب
٩٧	Clipper//WI٢٢٩١٣٢/WI٢٢٦٩/٣/SLB_١	٤٩,١٦	٧٤	٧,٩٥	٥٨	٣,٨١	١٠	٣٣,٢٣	٢٤	١٧٧٠	١
١٥٩	Harmal حرمل	٤٨,٧	٩١	٨,٣٢	٧	٣,٦٢	٥٩	٣٣,١٦	٣٧	١٧٢٤	٢
١٢٥	WI٢٢٩١/Furat ٢	٤٧,٧٢	١١٣	٧,٩٦	٥٣	٣,٦٢	٥٩	٣١,٨٢	٨٨	١٧٠٣	٣
١٥٠	Zanbaka/٥/Pyo/Cam//Avt/RM١٥٠٨/٣	٥٤,٠٦	٨	٨,٣٢	٧	٣,٣٥	١٠٦	٣٠,٦٩	١٣٠	١٦٩٣	٤
٣	WI٢٢٩١/٤/٧٠٢٨/٢٧٥٩/٣/٦٩-٨٢//Ds/A	٥٢,٨٦	١٥	٨,٣٢	٧	٣,٦٩	٤٥	٣٣,٧٦	٢٤	١٦٧٥	٥
١٢٧	Tadmor//ER/Apm/٢/H.spont.٤١-٣	٤٦,٢٤	١٣٦	٧,٦٩	١٠٤	٣,٧٣	٣٥	٣٢,٨٦	٤٩	١٦٥٩	٦
١٤	Clipper/Volla/٣/Arr/Esp//Alger/Ceres	٥٤,٣	٧	٨,٧٧	١	٣,٦٨	٤٧	٣٤,٤٦	١١	١٦٥٦	٧
١٠١	Clipper//WI٢٢٩١٣٢/WI٢٢٦٩/٥/Soufar	٤٨,٩٨	٨٤	٧,٩٥	٥٨	٣,٦٤	٥٤	٣٤,٩٢	٩	١٦٣٣	٨
١٢٧	Hml-٠٢/٥/Cq/Cm//Apm/٣/١٢٤١٠/٤/Gi	٥١,٠٩	٣٦	٨,٣٢	٧	٣,٨١	١٠	٣٠,٠٧	١٤٠	١٦٢٨	٩
١١٢	ArabiAbiad/Arar//H.spont.٤١-٥/Tadm	٥٢,٤٥	١٨	٨,٦٨	٣	٣,٧١	٣٧	٣٧,٢٤	١	١٦٢٧	١٠
٤٢	Arta/٣/Legia/LaurelS//Aleli	٤٧,٣١	١٢٠	٧,٦٩	١٠٤	٢,٩٧	١٤٠	٣٣,٠٣	٤٠	١٦٢٢	١١
٦٧	WI٢٢٩١/WI٢٢٦٩//WI٢١٩٨/Lignee ١٣١	٤٨,٠٤	١٠٩	٨,٢٣	٤٧	٣,٤٣	٩٢	٣١,٨٤	٨٦	١٦١٩	١٢
٥٤	ChiCm/An٥٧//Albert/٣/Alger/Ceres٣	٥٠,٠٨	٥٤	٨,٣٢	٧	٣,٧٤	٢٨	٣٣,٨٧	٢٢	١٦٠٩	١٣
٦١	ChiCm/An٥٧//Albert/٣/Alger/Ceres٣	٤٦,٠١	١٤٠	٧,٦٩	١٠٤	٣,٤٢	٩٣	٣٠,٩٥	١٢٣	١٦٠٨	١٤
١٢٢	Hml/٤/Arar/H.spont.١٩-١٥//Hml/٣/H.s	٤٩,٤٨	٦٨	٧,٩٥	٥٨	٣,٥٦	٧١	٣٢,٣٣	٦٩	١٦٠٧	١٥
٢٢	Moroc٩-٧٥//WI٢٢٩١/Cl-١٢٨٧/٢/H.sp	٥١,٧	٣٢	٨,٢٣	٤٧	٣,٨٦	٤	٣١,٢٥	١١٢	١٦٠٢	١٦
٨٦	Sara/٦/Moroc٩-٧٥/Hml-٠٢/٥/Clipper	٥١,٨	٣٠	٧,٩٥	٥٨	٣,٥٢	٧٨	٣١,١٩	١١٥	١٥٩٥	١٧
١٢١	Hml/٣/ArabiAbiad/Arar//H.spont.٤١-	٥٤,٥٢	٥	٨,٣٢	٧	٣,٨٢	٨	٣٦,٥٣	٢	١٥٩٢	١٨
٤٣	Arta/٣/Legia/Laurel'S//Aleli/٥/Roho/	٤١,٨٦	١٥٨	٧,١٥	١٥٥	٢,٨٦	١٤٧	٣٤,٢٩	١٣	١٥٩٠	١٩
٩٦	Clipper//WI٢٢٩١٣٢/WI٢٢٦٩/٣/SLB_	٤٨,٣٤	١٠٢	٧,٦٩	١٠٤	٣,٤٢	٩٣	٣١,٨٢	٨٨	١٥٨١	٢٠
١٥٢	فرات ١	٥٣,٠١	١٤	٦,٣٥	١٦٠	٢,٦٥	١٥٣	٢٩,٨٦	١٤٨	١٣٢٩	١٥٥
١٥٣	فرات ٢	٤٨,٣٤	١٠٢	٧,٩٥	٥٨	٢,٧٦	١٥٠	٣٣,٢٧	٣٣	١٥٤٠	٣٢
١٥٤	فرات ٣	٥٠,١٤	٥١	٨,٣٢	٧	٣,٦٠	٦٣	٣٤,٣٧	١٤	١٤٩٧	٥٩
١٥٥	عربي أسود	٤٧,٠٨	١٢٥	٧,٩٥	٥٨	٢,٦١	١٥٤	٣١,٦٥	٩٨	١٤٩٢	٦٢
١٥٦	نواعير ١	٤٥,٦٤	١٤٥	٧,٤٢	١٤٥	٢,٧٧	١٤٩	٣١,٦١	١٠٠	١٤٦٩	٧٧
١٥٧	عرطة	٤٥,٧١	١٤٣	٧,٩٥	٥٨	٣,٤٢	٩٣	٣٠,٩٣	١٢٤	١٥٧٣	٢٢
١٥٨	عربي أبيض	٤٧,٢٥	١٢٢	٧,٢١	١٤٩	٢,٨٦	١٤٧	٣٣,٢٠	٣١	١٤٥٩	٨٥
١٥٩	حرمل	٤٨,٧	٩١	٨,٣٢	٧	٣,٦٢	٥٩	٣٣,١٦	٣٧	١٧٢٤	٢
١٦٠	واسطة ١	٤٦,٨٨	١٣٠	٧,٩٥	٥٨	٣,٠٨	١٣٢	٣١,٨٢	٨٨	١٤٨٦	٦٣

- ٤٫١٠ أبيض
- حرمل
- عرطة
- ~~[illegible]~~
- نواعير ١
- فرات ٢

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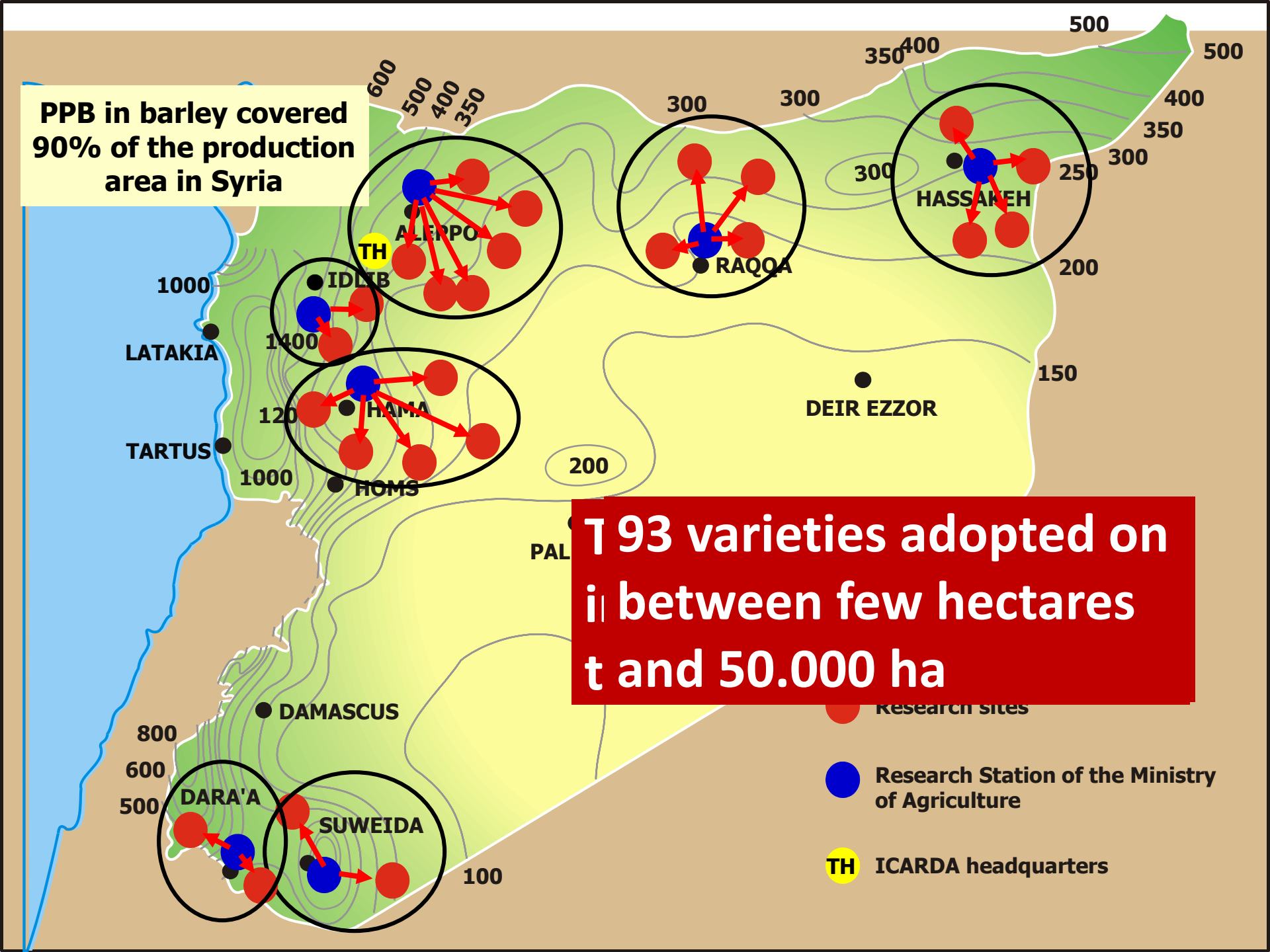
١٦

٢٢

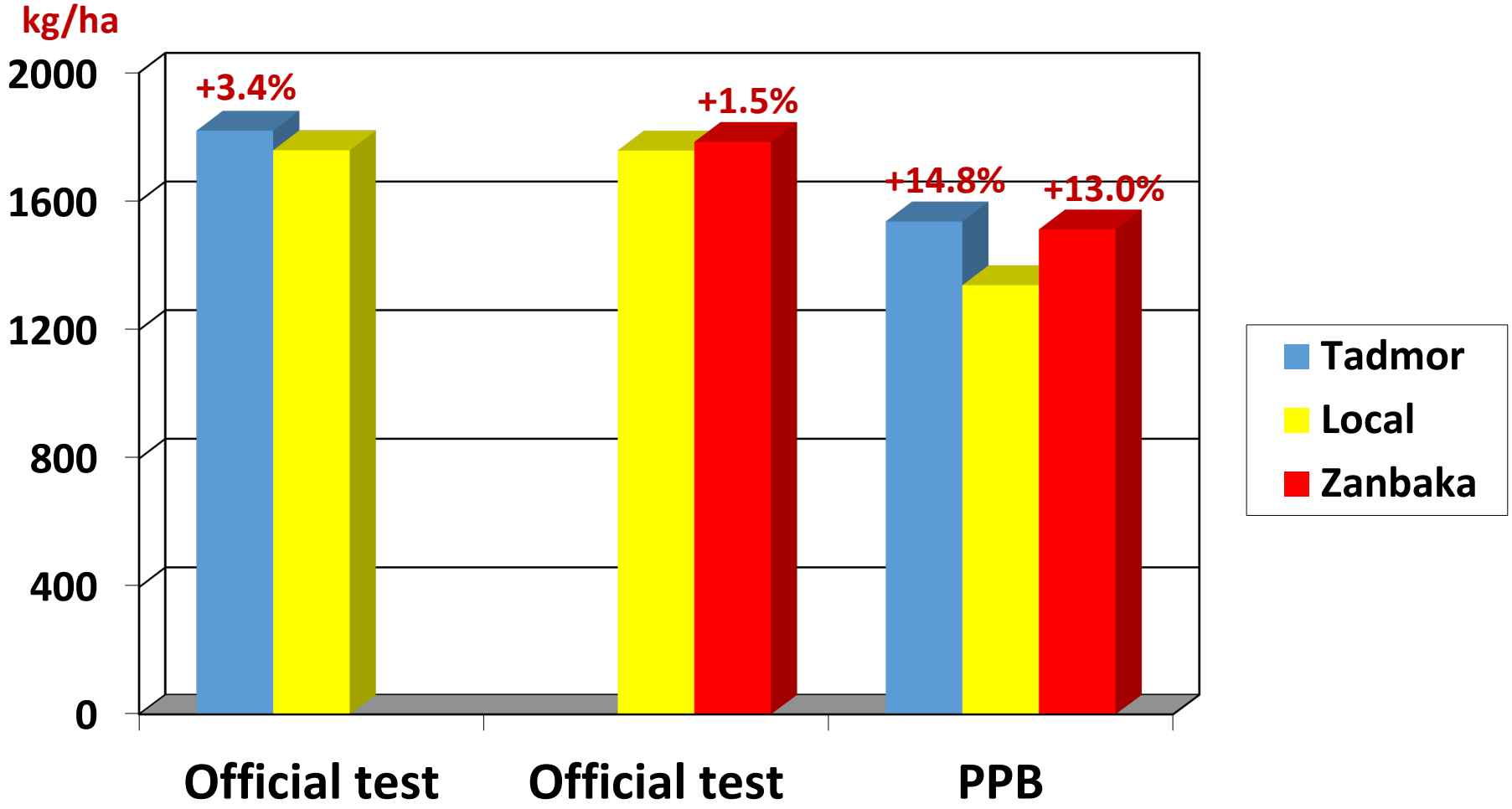
Precision and Relevance


6 5 2007


6 5 2007


PPB in barley covered 90% of the production area in Syria
93 varieties adopted on
between few hectares
and 50.000 ha
ALEPPO
IDLEB
HAMA
HOMS
RAQQA
HASSAKEH
DEIR EZZOR
LATAKIA
TARTUS
DAMASCUS
DARA'A
SUWEIDA
TH
Research sites
Research Station of the Ministry of Agriculture
ICARDA headquarters

Difference between official variety trials and PPB trials in Syria



Official tests: average of 26 trials in 4 years

PPB trials: average of 55 trials in 3 year

It is possible to do it here?

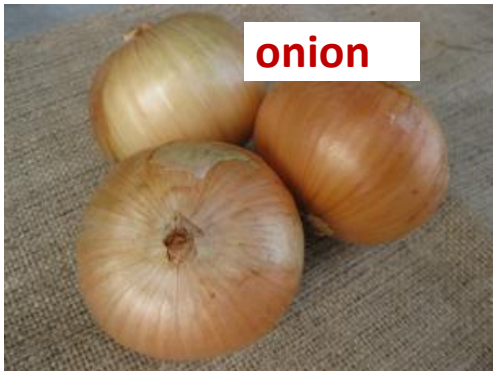
Rice in Bhutan


Iran

durum wheat

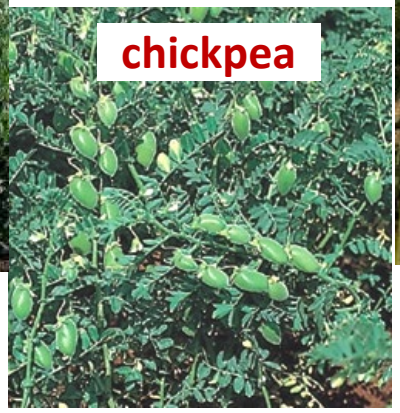

bread wheat


tomato


onion


faba bean


sorghum


chickpea


barley


bean


cowpea


lentil

Average grain yield (t/ha) of farmers' (FS) and breeder's selections (BS) in Syria

Loc.	Mean	FS	BS	prob
Ibbin	3.2	4.6***	4.0***	n.s.
Ebla	2.9	3.5*	3.2**	n.s.
Tel Brack	3.7	4.2	4.0*	n.s.
J. Aswad	1.4	2.0*	1.7**	n.s.
Bylounan	0.3	0.5*	0.3	n.s.
Al Bab	0.4	0.7***	0.5***	***
Melabya	0.7	0.9 ***	0.9***	n.s.
Bari Sharki	1.0	1.4*	1.1	n.s.
Suran	2.5	2.6	2.6	n.s.

Ceccarelli S, Grando S, et al. 2000. A Methodological Study on Participatory Barley Breeding. I. Selection Phase. Euphytica 111: 91-104.

On farm performance of bush bean varieties selected on station by farmers and breeders in Rwanda

	% of trials where selections out yielded the local	Yield increase (%)
Farmer Selection		
1989A	73 ns	3.9 ns
1989B	89 **	33.4 **
1990A	64 ns	12.9 ns
1990B	83 **	38.0 **
Breeder Selection		
1987A	51 ns	6.7 **
1988A	50 ns	2.6 ns
1988B	50 ns	7.6 **

Sperling et al. 1993. Rethinking the farmer's role in plant breeding: local bean experts and on-station selection in Rwanda. Experimental Agriculture 29: 509-519

Farmers Selection Criteria

Farmers are interested in a wider range of traits than commonly expected

Although yield is quoted as the most important criterion, they in fact select also for several other traits

Farmers' selection criteria vary with the environment

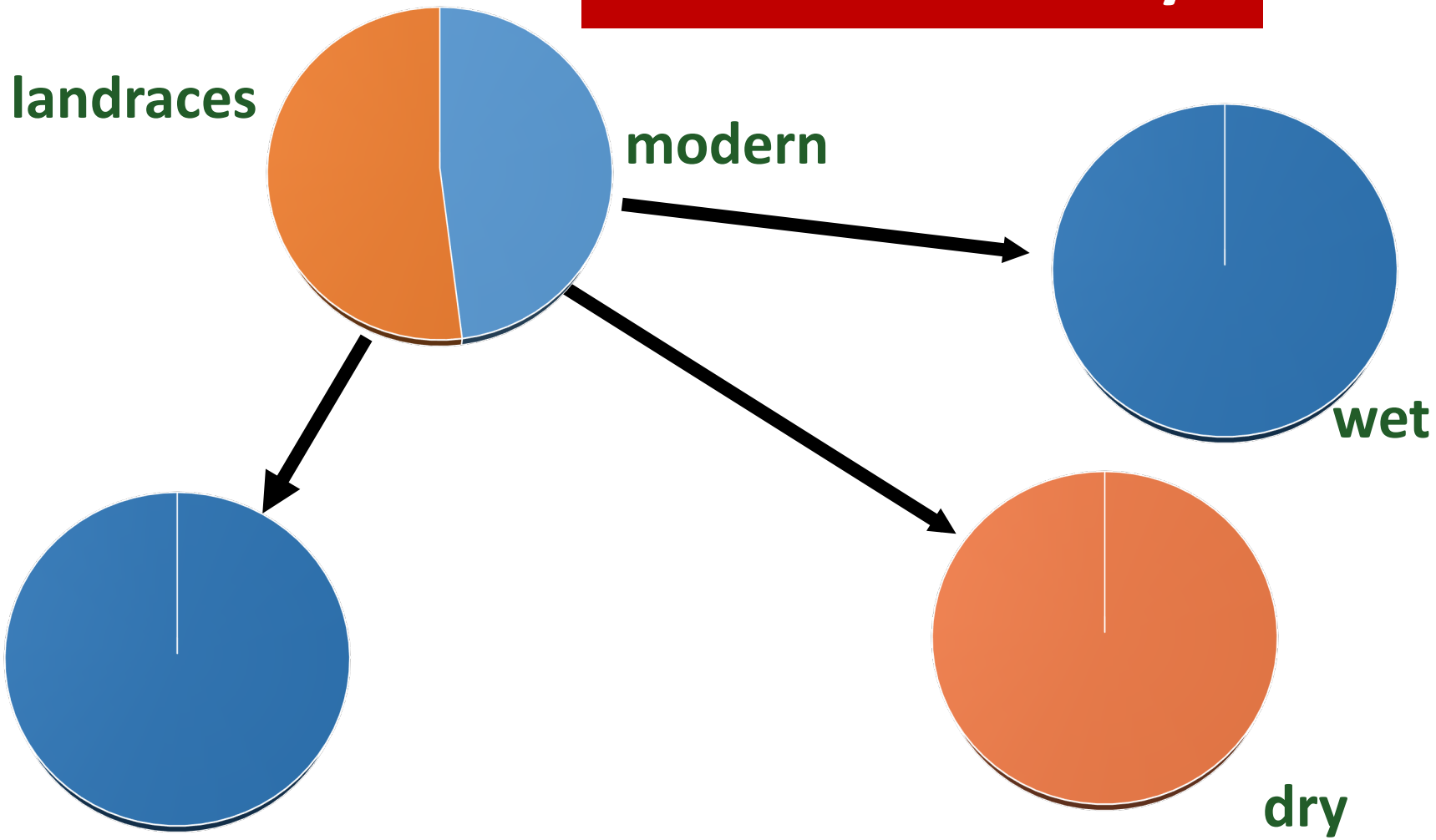
Tall or short? Plant height of barley lines selected by a breeder and a farmer in a research station (favorable environment) and in the farmer field in a dry area

Selected by	Selected at	
	Res. Station	Farmer's field
Farmer	71.1*	45.1***
Breeder	71.8*	42.8*
Pop. mean	77.5	39.6

*,*** Differences significant at P<0.05 and P<0.001, respectively

PPB and Diversity

PPB and diversity



PPB and *in situ* conservation

Through PPB several farmers are becoming aware of the value of landraces and more interested in their conservation

Participatory Plant Breeding

PPB is not a competition or a comparison of skills: it is merging two types of knowledge

PPB is not revolutionary. It recognizes that ultimately are the farmers who decide whether or not to grow a new variety

Participatory Plant Breeding

Fits crops to the physical and agronomic environments and to different uses

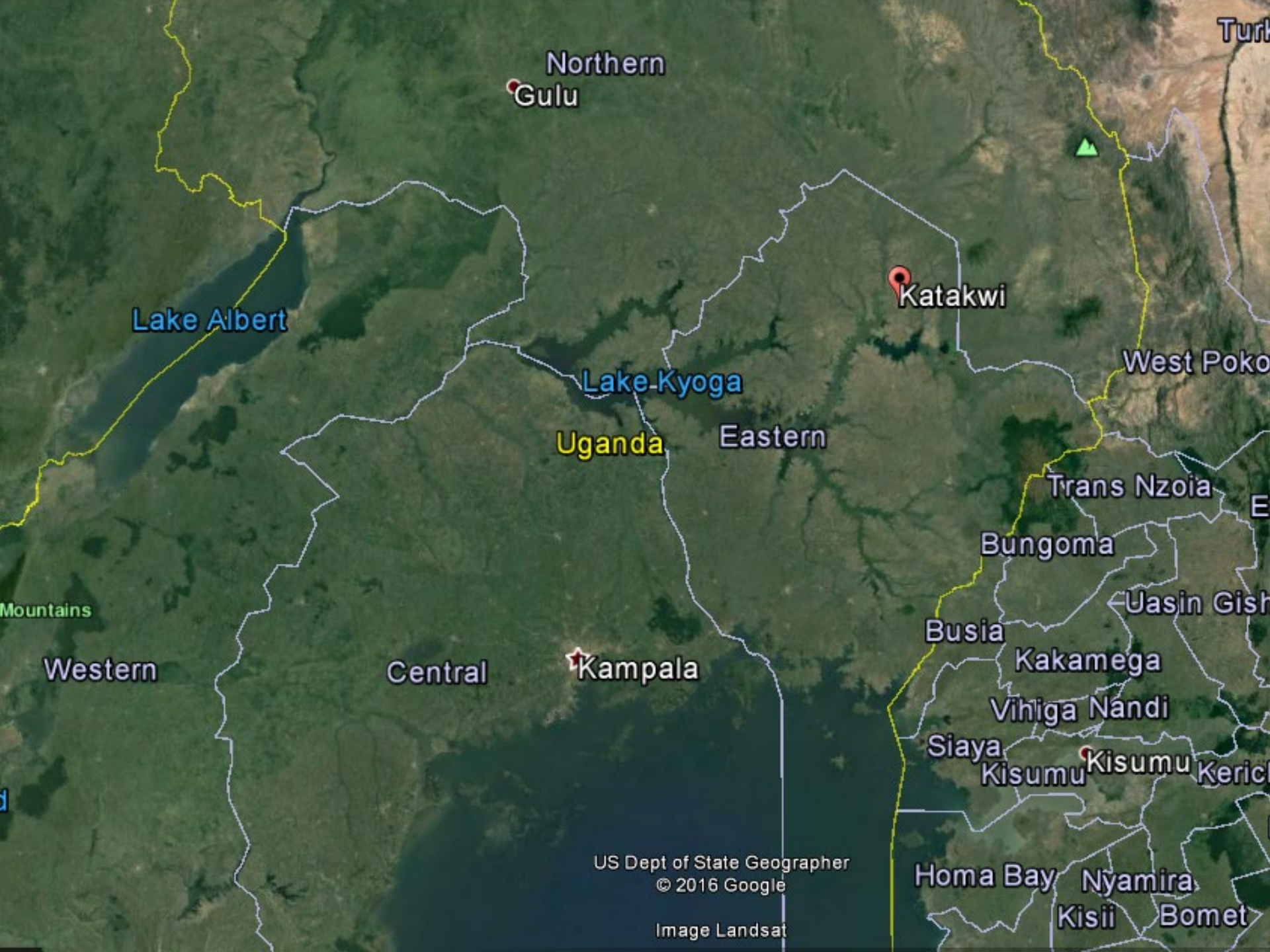
Adapts crops to evolving agronomic practices

It may be the only possible breeding for remote areas and minor crops

Women Participation

Seeds or Leaves?

The case of Cowpea in Uganda

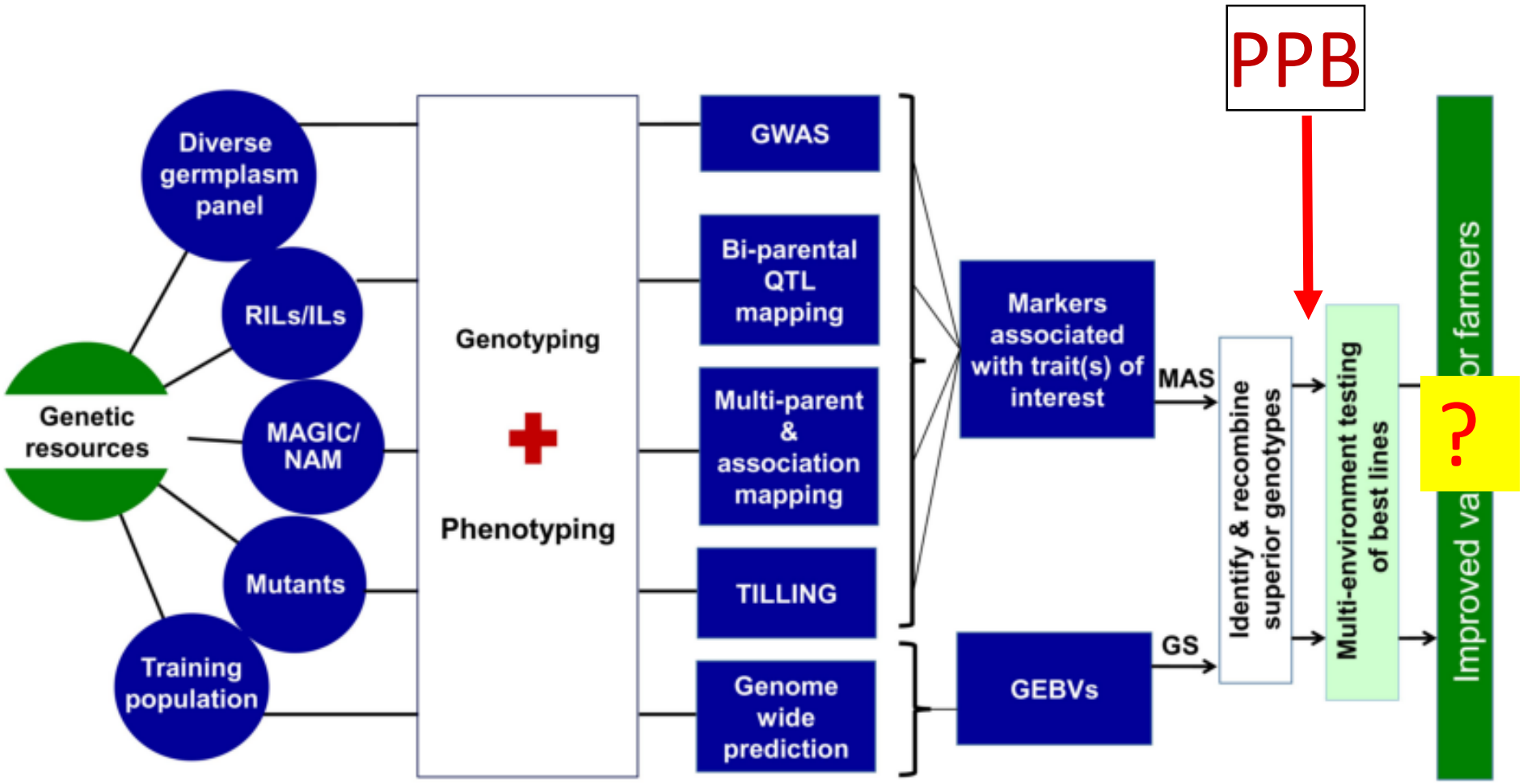

Northern
Gulu
Katakwi
Lake Albert
Lake Kyoga
West Poko
Uganda
Eastern
Trans Nzoia
Bungoma
Mountains
Uasin Gish
Busia
Western
Central
Kampala
Kakamega
Vihiga
Nandi
Siaya
Kisumu
Kisumu
US Dept of State Geographer
© 2016 Google
Homa Bay
Nyamira
Kisii
Bomet
Image Landsat

Design the trials together

Listen, listen, listen

Redesigning the trials

Genomic Assisted Breeding



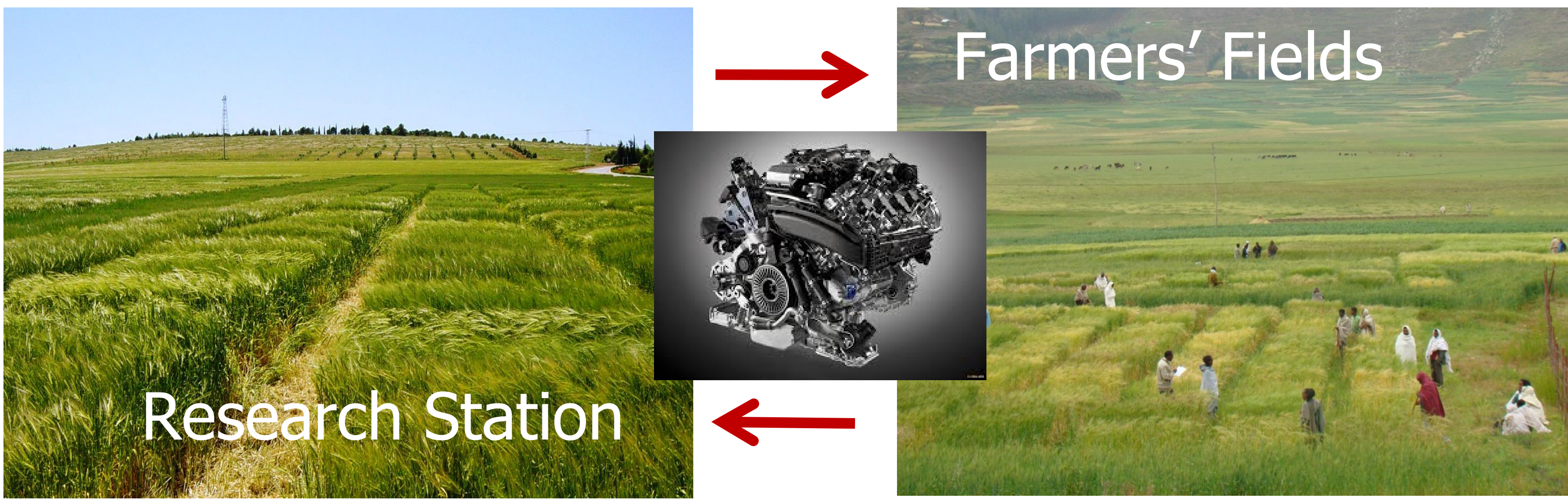
Varshney et al, 2014. Harvesting the Promising Fruits of Genomics: Applying Genome Sequencing Technologies to Crop Breeding. PLoS Biol 12(6)

Participatory Plant Breeding: the weakness of the model

The attitude of Institutions and researchers towards PPB is generally negative, unpredictable and mutable

Many scientists cannot accept, even if they do have proof of the contrary, that farmers can make selection

Farmers depend on external sources (usually the breeder) for the continuous flow of germplasm



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REVIEW

Participatory plant breeding: Who did it, who does it and where?

Salvatore Ceccarelli[1,*] and Stefania Grando[2]

[1]Consultant, Rete Semi Rurali, Scandicci 50018, Italy and [2]Independent Consultant, Ascoli Piceno 63100, Italy
*Corresponding author. Email: ceccarelli.salvatore83@gmail.com

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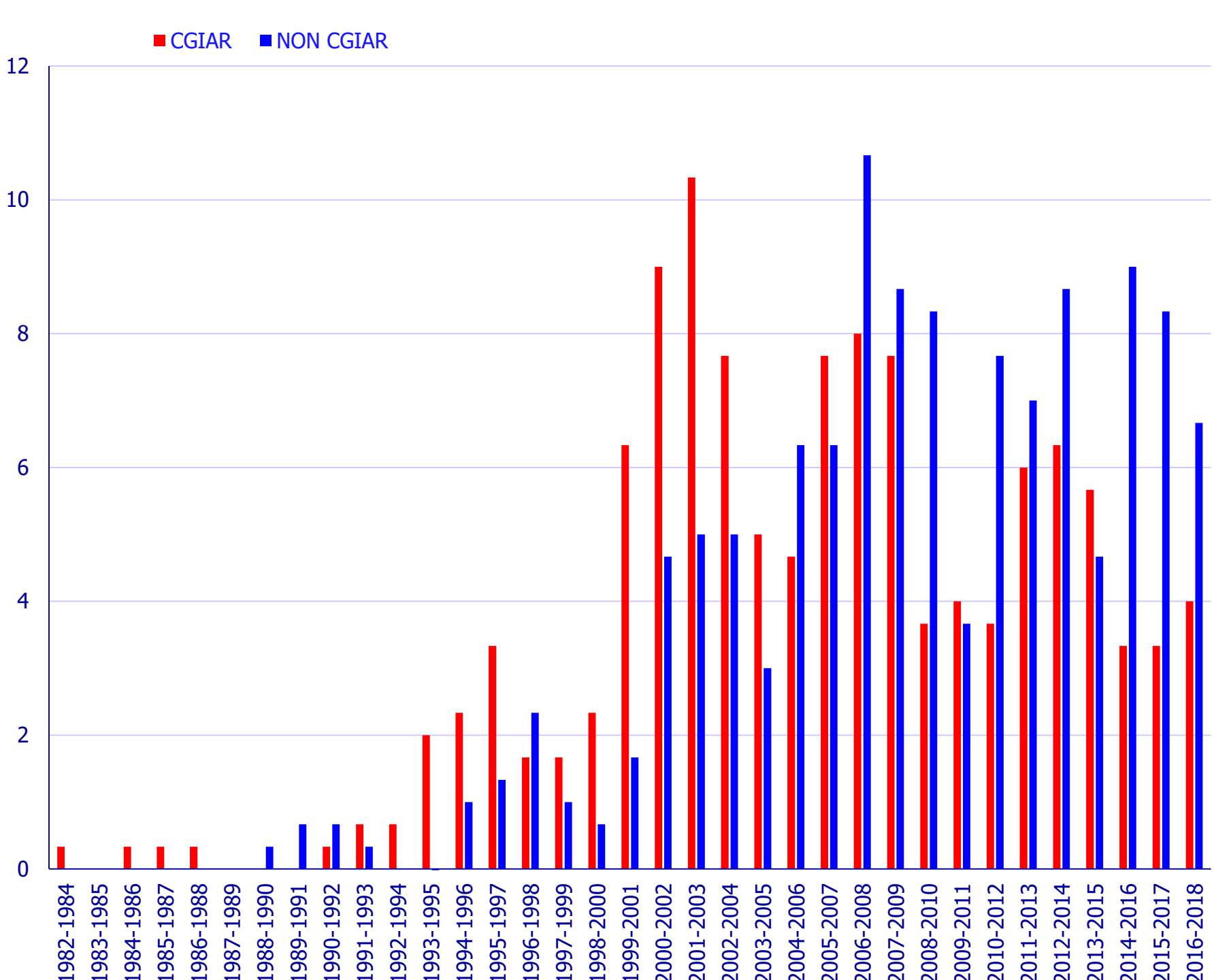
Abstract

The paper provides an overview of institutions, scientists, and practitioners involved over the years in the various ways in which participatory plant breeding (PPB) is implemented, with indication of the crops involved and the countries in which it took place, or is still taking place. This might help creating a better awareness of the scope (both geographical and crop wise) of the different methodologies as well as of their advantages, disadvantages, applicability, and limitations. Through a literature survey, we found 254 publications showing that over a period of 36 years participatory approaches in plant breeding have been used in 69 countries (10 developed and 59 developing) with 47 crops including self-pollinated, cross-pollinated, and vegetatively propagated crops, by several Institutions including CGIAR centers, universities, and NGOs. We argue that there are no obvious scientific or technical reasons limiting the use of PPB, and

69 countries have or have had PPB programs on 47 crops

Examples of varieties bred with participatory plant breeding and grown by farmers


CGIAR
NON CGIAR
12
10
8
6
4
2
0
1982-1984
1983-1985
1984-1986
1985-1987
1986-1988
1987-1989
1988-1990
1989-1991
1990-1992
1991-1993
1992-1994
1993-1995
1994-1996
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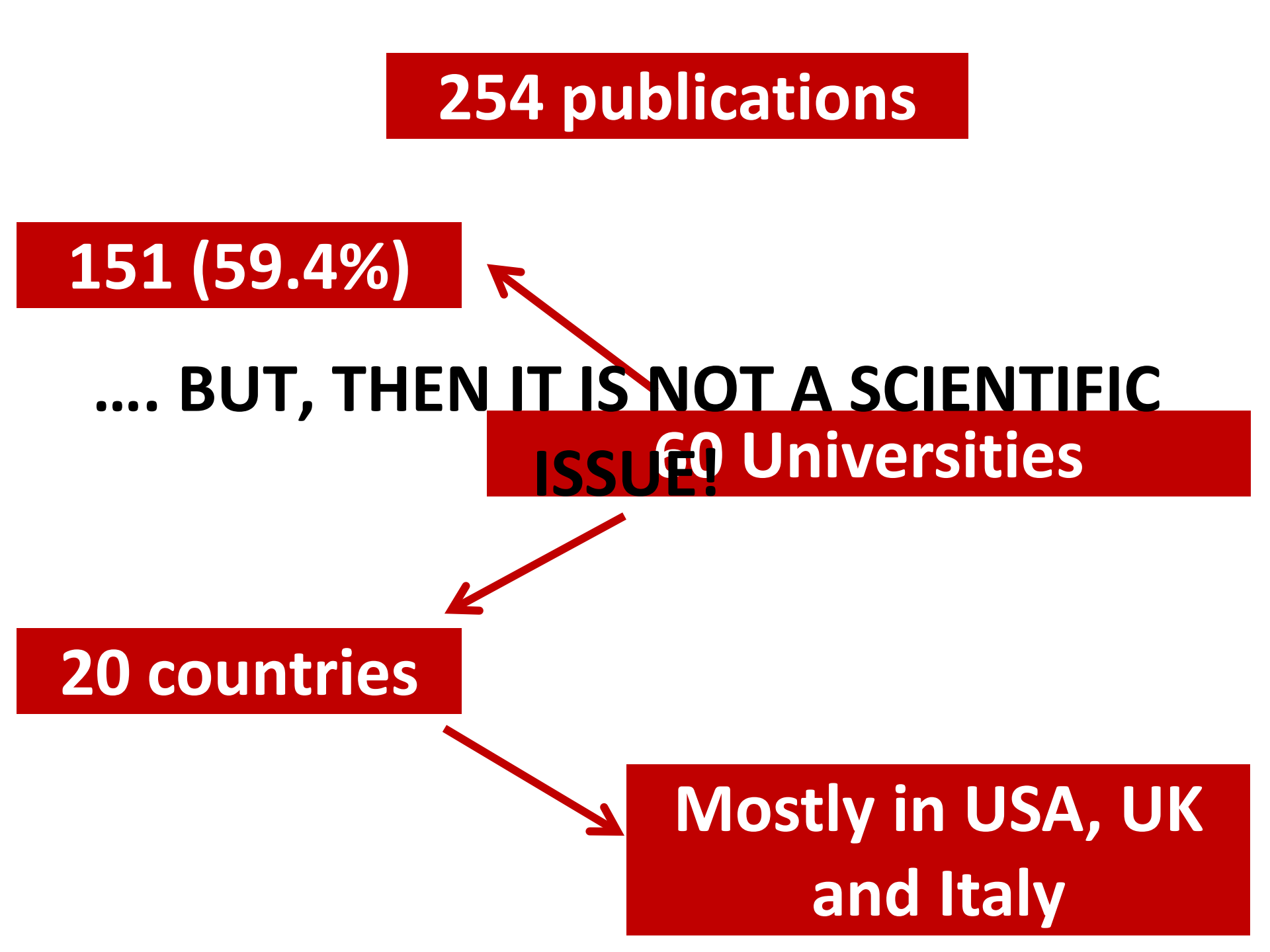
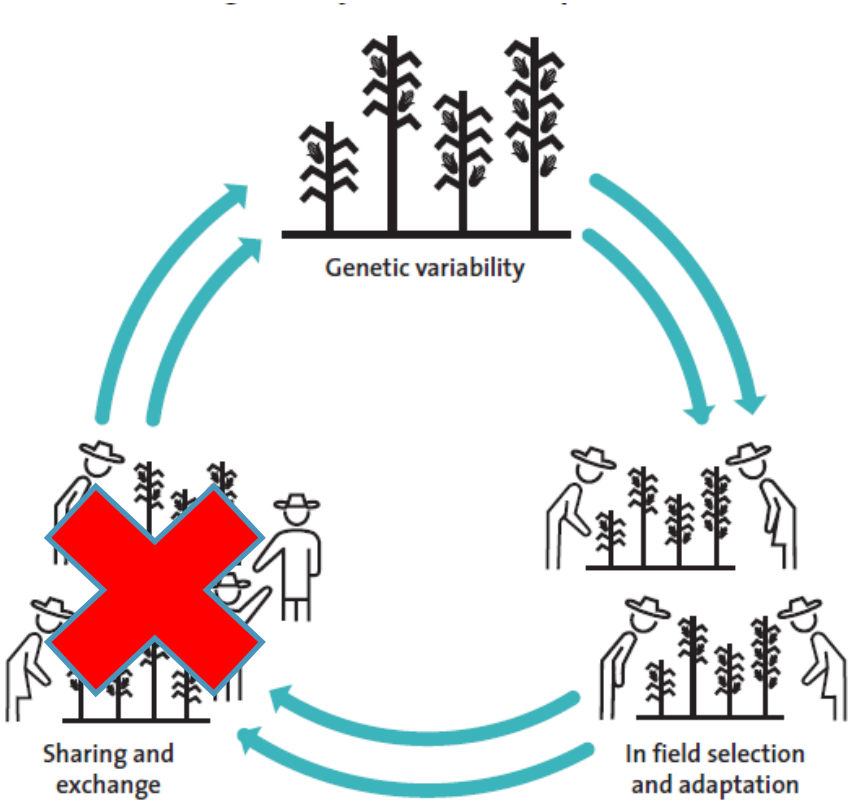
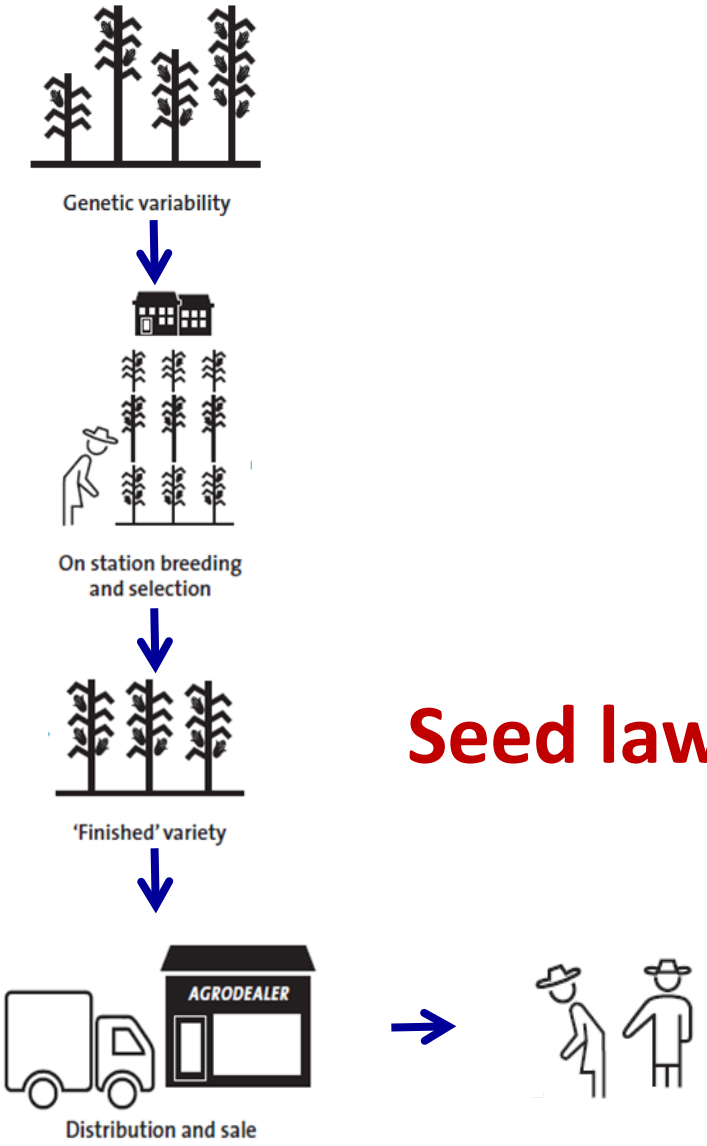
2015-2017
2016-2018


254 publications
151 (59.4%)
…. BUT, THEN IT IS NOT A SCIENTIFIC ISSUE!
60 Universities
20 countries
Mostly in USA, UK and Italy

From farmers → To Institutions/Corporations





Seed laws

Progressive corporate concentration of the seed market

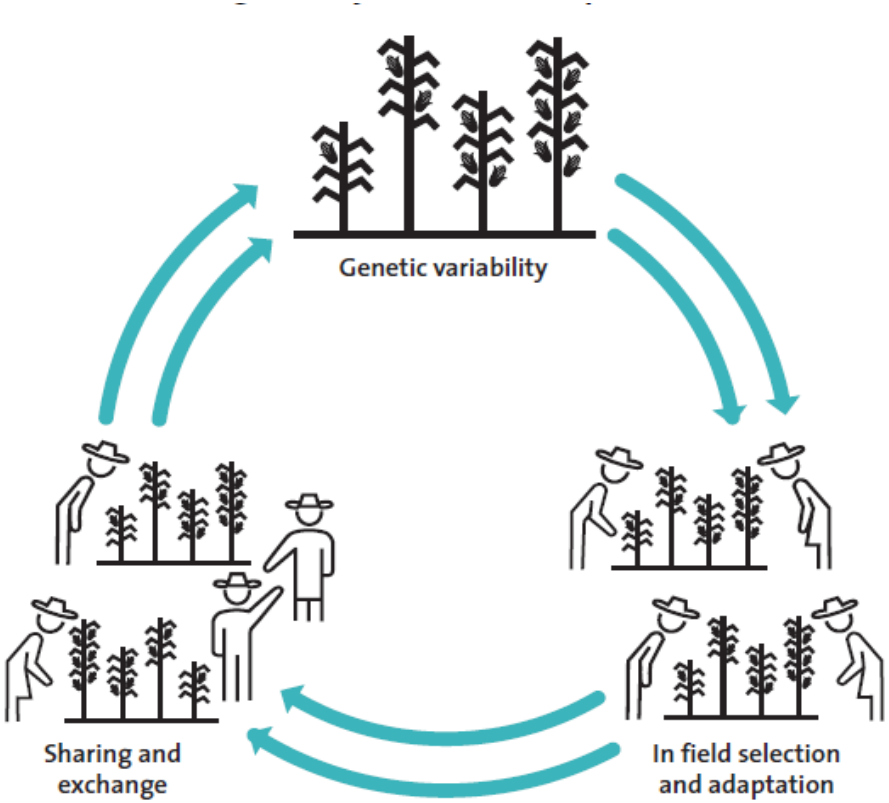
Kloppenburg J, 2010. Impeding Dispossession, Enabling Repossession: Biological Open Source and the Recovery of Seed Sovereignty. Journal of Agrarian Change, 10: 367–388

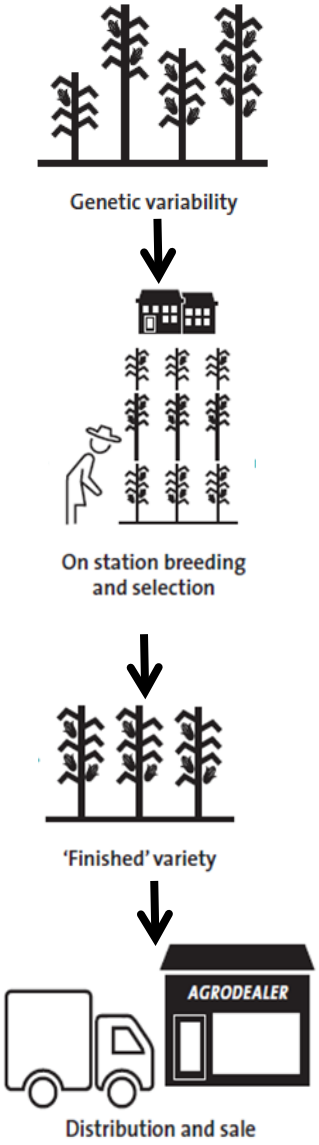
Participatory Plant Breeding From Dispossession

Kloppenburg J, 2010. Impeding Dispossession, Enabling Repossession: Biological Open Source and the Recovery of Seed Sovereignty. Journal of Agrarian Change, 10: 367–388

to Farmers

from Corporations/Institutions





Seed

Food

Chemicals

Power, Authority and Control

Deskilling

Evolutionary (participatory) plant breeding may offer a solution as in this case institutions are no longer indispensable


Thank you