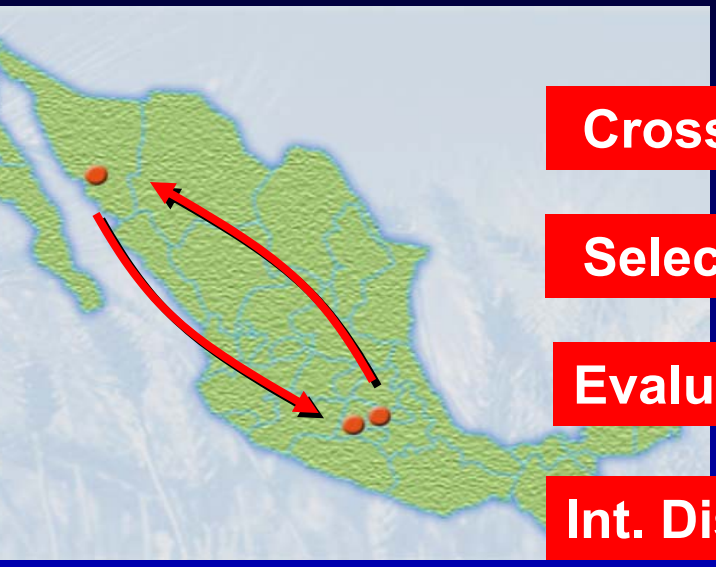
A practical perspective on the application of molecular breeding software

Hans-Joachim Braun

CIMMYT

General breeding scheme



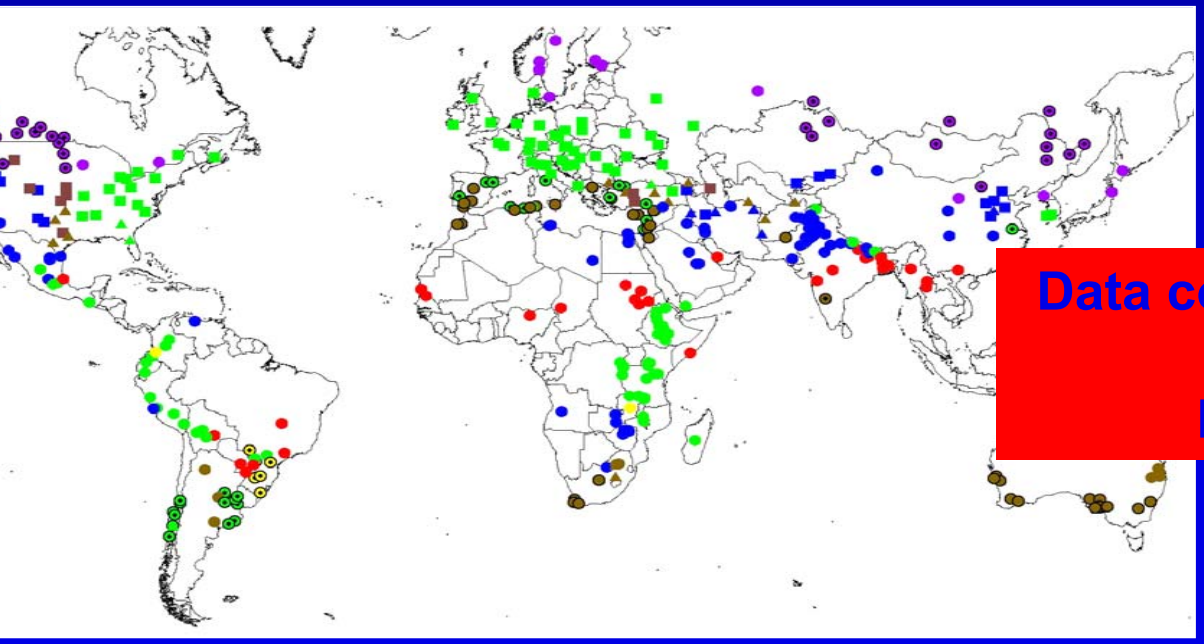
Crossing

Selection

Evaluation

Int. Distribution

5 years / 2 crops year



Data collection & interpretation of worldwide
Multi-location testing

Product of Trait Performance
makes a Variety
and not the sum

- Grain Yield x Abiotic Stress Tolerance x Disease Resistance x Quality
- If any component is 0 = susceptible, low quality, wrong grain color
- **Farmers will not grow the variety**

Q	Grade Data			Non-Grade Data				Semolina Data									Agronomic		
1*	Test Weigh	Yellow Berry	Black Point	Grain Protein		Grain Ash	1000 GW	SDS WMeal	Flour	Flour Color	Extraction Total	Sem.	Protein Semolina		Alveogram W	P/L	Color Sem.	Grain Yield Cd. Obregon		
	Kg/hl	%	%	2% m	Dry M	%	gr	ml	ml	Min b	%	%	2% m	Dry M	10 $^{-4}$ J	P/L	Min b	Altar = 100% Avg = before 20		
	> 82	< 5	< 5	> 13	> 14.7	< 1.6	> 50	> 8.5	> 10.5	> 21	> 65	> 54	> 11.5	> 13.8	> 280	> 1.5	> 26	Avg	2001	200
	83.4	0.5	0.8	13.0	14.8	1.6	45.8	8.0	9.6	21	70	58	11.3	13.6	365	2.3	24.5			
	83.1	0.7	1.3	12.1	13.8	1.5	47.0	8.8	9.5	21	69	57	10.7	12.9	320	2.3	24.2			
	81.9	0.2	1.0	12.9	14.7	1.5	48.6	9.7	10.3	20	68	55	11.2	13.5	298	2.0	23.7			
	82.7	0.3	1.4	12.7	14.4	1.5	46.9	8.0	9.3	18	70	57	11.4	13.6	292	2.4	22.6			
	82.0	0.1	1.4	13.6	15.4	1.5	46.2	8.6	9.8	21	70	55	12.0	14.4	433	2.1	24.3			
	82.0	0.3	0.9	13.1	14.9	1.6	44.4	8.4	10.1	22	68	55	11.5	13.8	314	1.8	25.8			
	76.9	0.1	1.3	13.3	15.1	1.6	43.7	9.5	11.0	24	67	53	11.2	13.5	586	2.0	29.0			
	82.8	0.0	1.2	13.9	15.7	1.7	49.7	10.0	11.5	23	74	56	12.3	14.5	376	2.1	28.4	103	94	
	81.8	0.8	0.9	14.0	15.9	1.8	42.1	9.0	10.0	20	69	56	11.6	14.0	294	2.2	23.7	111	110	
4	82.6	1.6	0.9	12.7	14.6	1.6	50.0	8.0	9.5	21	66	56	11.2	13.4	334	3.0	25.8	106	110	90
1	84.0	0.0	0.4	12.5	14.2	1.5	46.4	10.0	8.5	21	73	59	11.8	13.5	428	2.2	26.5	106	110	10
4	82.2	0.2	0.6	13.4	15.2	1.5	47.6	11.0	11.5	21	69	57	11.8	14.1	361	2.2	26.7	109	101	11
	84.4	0.2	2.3	12.8	14.6	1.6	47.5	8.0	9.5	22	71	57	11.1	13.4	291	2.2	25.1	98	95	11
	82.8	0.2	0.9	13.0	14.7	1.7	51.8	4.0	4.0	22	66	57	11.1	13.3	173	4.5	27.9	99	96	10
2	82.4	0.7	0.8	13.5	15.3	1.7	50.5	5.0	4.5	23	62	55	11.4	13.7	243	4.3	28.7	99	96	10
2	81.8	0.0	1.1	13.8	15.7	1.5	49.4	10.0	11.0	24	72	54	11.6	13.9	418	1.9	29.4	102	99	11
	81.6	0.4	0.2	13.0	14.8	1.5	49.1	10.0	10.5	21	66	57	11.5	13.8	333	2.2	25.7	98	98	10
	84.2	2.7	2.8	12.0	13.6	1.6	57.2	9.0	10.0	20	69	55	10.6	12.7	234	1.9	24.1	103	94	10
1	84.0	0.0	1.2	13.1	14.9	1.5	48.9	9.0	12.0	24	71	56	11.5	13.8	366	1.9	27.0	108	97	10
1	81.0	0.2	0.5	13.5	15.3	1.8	44.2	9.5	10.5	23	65	56	11.9	14.2	318	2.2	28.4	113	99	92
1	84.4	0.0	1.9	12.6	14.3	1.5	45.1	11.0	11.5	24	70	56	11.1	13.3	333	2.5	27.2	97	95	95
1	83.8	0.2	0.6	12.3	13.9	1.5	44.8	11.0	12.5	25	68	54	10.8	13.0	514	2.2	28.9	104	98	10
1	82.6	0.0	0.0	11.6	13.2	1.6	42.3	10.0	12.5	24	70	57	10.6	12.7	592	2.1	27.6	103	104	10
4	82.4	0.2	0.3	12.5	14.2	1.5	45.1	10.5	13.5	23	69	57	11.2	13.4	340	2.9	26.6	103	97	99
4	82.0	1.0	0.6	12.6	14.3	1.6	43.7	10.5	10.5	22	70	55	11.4	13.7	266	1.4	26.9	97		10
3	82.4	6.4	1.2	11.8	13.4	1.5	36.0	9.5	10.5	25	71	58	10.5	12.6	494	2.8	28.0	98	96	10
1	84.4	1.8	1.7	12.1	13.8	1.5	44.4	10.5	13.0	25	69	56	10.7	12.9	390	2.2	28.4	98	92	10
1	83.6	0.4	4.2	12.2	13.9	1.5	48.4	9.0	11.0	24	71	54	10.6	12.7	334	1.6	26.9	117	115	11
1	82.4	0.5	3.8	11.9	13.5	1.5	40.4	9.0	11.5	25	70	55	11.0	13.3	409	1.2	27.6	104	102	95
	78.4	0.0	1.3	14.9	17.0	1.8	45.2	14.0	15.5	20	67	55	13.0	15.6	444	1.7	24.3	110	109	11
1	84.0	0.3	7.5	12.2	13.8	1.4	40.2	8.5	11.5	24	68	56	10.8	13.0	550	2.4	26.4	109	107	10
1	83.2	0.4	1.6	11.9	13.5	1.5	41.4	10.0	12.0	24	74	55	11.1	13.4	445	2.0	27.6	104	107	97
3	82.4	0.3	5.1	13.0	14.7	1.6	48.6	8.0	11.5	23	71	55	10.8	13.0	517	2.5	26.0	105	88	96
	83.0	2.6	0.2	13.5	15.3	1.3	58.0	6.5	10.0	23	69	58	11.8	14.2	242	1.7	24.8	106	116	11
1	84.0	3.8	2.1	12.0	13.6	1.4	48.6	8.5	8.5	23	70	57	10.3	12.4	347	2.6	26.3	108	107	11
3	82.8	1.0	0.2	12.3	14.0	1.6	43.4	9.0	10.5	24	69	58	10.6	12.8	595	2.2	26.8	114	114	10
1	80.6	0.8	4.7	12.6	14.3	1.6	45.7	10.0	13.0	25	69	58	11.5	13.9	604	2.0	27.5	109	107	98
2	81.6	0.8	0.4	12.7	14.4	1.7	45.9	8.0	9.0	25	71	56	11.5	13.8	235	1.7	30.0	108		12
1	84.0	0.0	1.5	13.3	15.2	1.5	42.3	12.0	14.5	24	67	54	11.7	14.1	556	1.9	26.6	105	95	10

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ed Lines
/AJAIA_3/3/MINIMUS/C
/AJAIA_3/3/MINIMUS/C
_7/CHEN_1//YAV_10/AU
IA//MEMO_1/YAV79
O_8//SORA/2*PLATA_12
ALTAR 84/3/HUI/POC//B
PRIMADUR//HAI-OU_17/
_10/LIRO_3
/LOTUS_4//SOMBRA_2
_17/PLATA_2//LIRO_3
/3/AJAIA_12/F3LOCAL(
LBOR_1//KITTI_1
_6/FOCHA_1
14/ANADE_1//KITTI_1
14/ANADE_1//KITTI_1
_3/RISSA//SOOTY_9/RA
RK MI83-84 375/NIGRIS_
RK MI83-84 503/LOTUS_

MH76A.722//YAV/3/ALTA
CHEN_1/TEZ/3/TANTLC
_10/6/MQUE/4/USDA573
_10/6/MQUE/4/USDA573
_3/GREEN_22
_3/PHAX_1//TILO_1/LO
_3/PHAX_1//TILO_1/LO
_3/PHAX_1//TILO_1/LO
_4/INTER_8
_4/INTER_8
*PLATA_12//SOMAT_3
*PLATA_12//SRN_3/NIC
95/3/D67.3/RABI//CRA/4
3/CASCA_1//SILVER_2

lity Index - Dr. J. Pena

1 Overall very good quality (Grain, pigment and strength)
2 Good, high in yellow color and acceptable grain and strength
3 Good, high strength and acceptable grain and yellow color
4 Acceptable grain attributes and acceptable color and strength

Why do we need tools in breeding?

- Selection efficiency increases if all data –biological and molecular - can be used to decide
  - Which crosses to make? Parental selection
  - Which type of cross: Single, three-way, double, backcross,
  - Which selection method? Pedigree, bulk, modified bulk, selected bulk

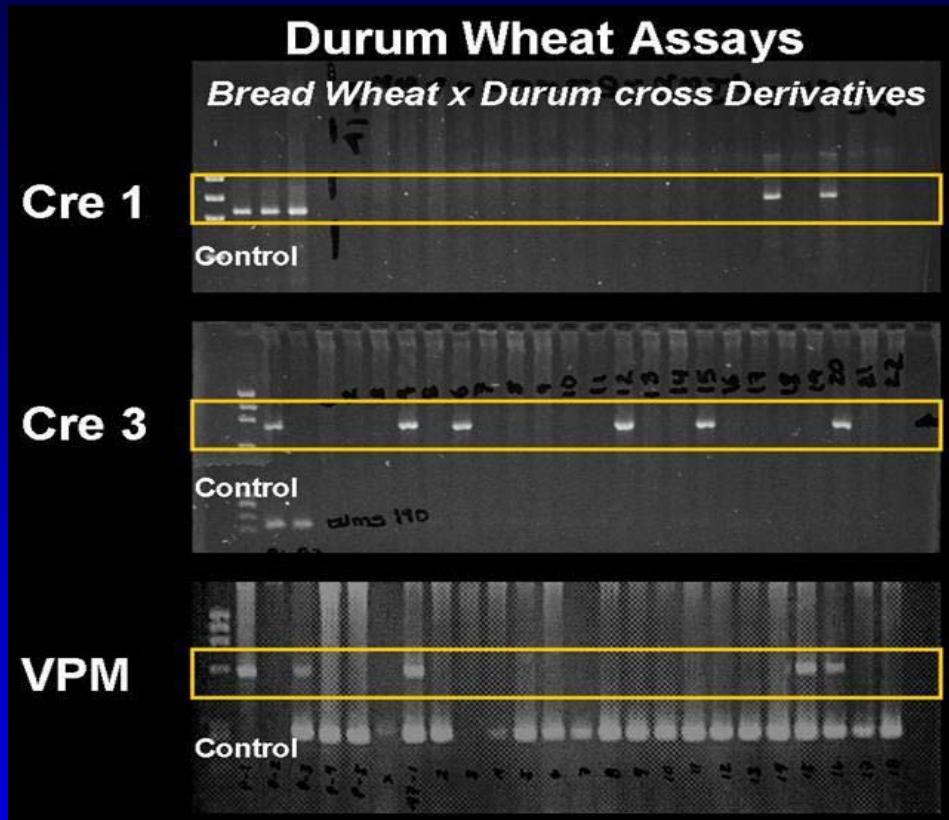
Why do we need tools in breeding?

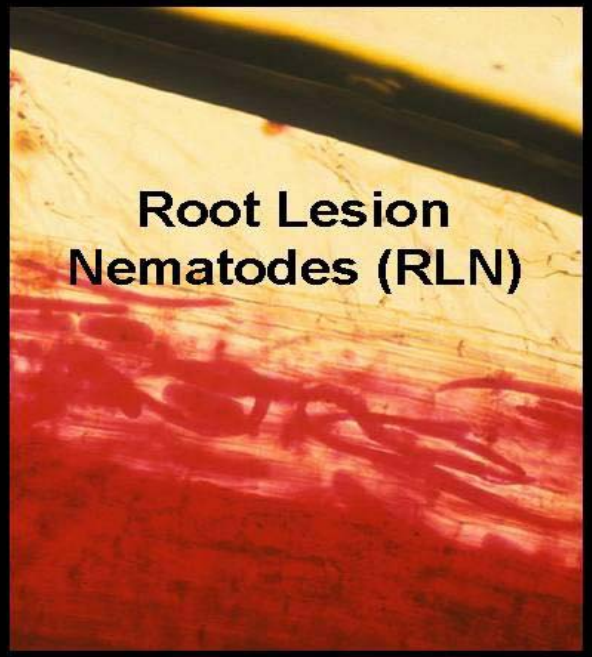
- Increased selection efficiency
- Large amount of gene and molecular information available from Genomics research
- Linking available biological and molecular data and breeders' requirements
- How to access data that they are "knowledge" to be used in a breeding program

New challenges, new tools

Drought tolerance through better root health

Use of molecular markers





Molecular markers routinely applied in wheat breeding to incorporate resistance to low heritability traits e.g. CCN and RLN nematodes

CIMMYT ®
W.H. Pfeiffer

QuCim Application

Comparison of two breeding strategies:

Modified pedigree (MODPED)

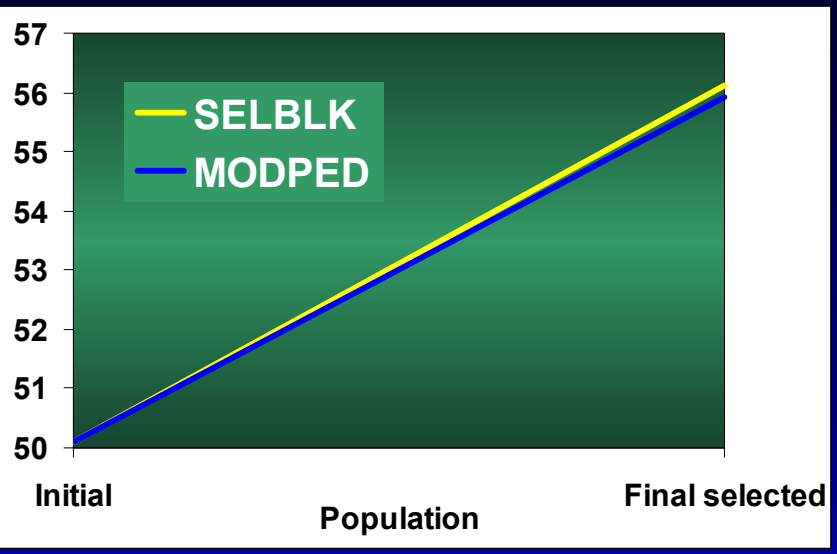
vs

Selected bulk (SELBLK)

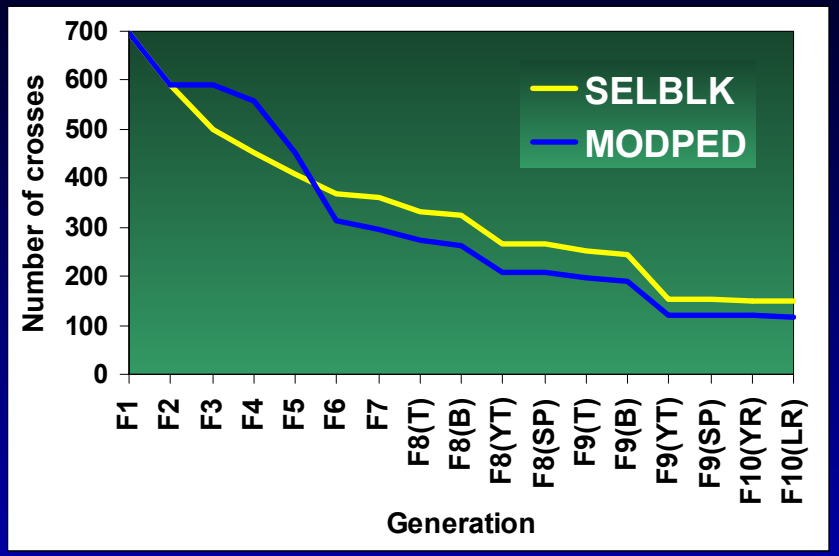
Criteria for comparing breeding methods

- Genetic gain, measured by the change in mean genotypic value in the population before and afte selection
- Genetic diversity in final selected population, measured by the number of crosses retained
- Economics, measured by
  - Number of plants in a breeding cycle: how much land will be used?
  - Number of families in a breeding cycle: how much time and labor will be spent in preparing seed bags?

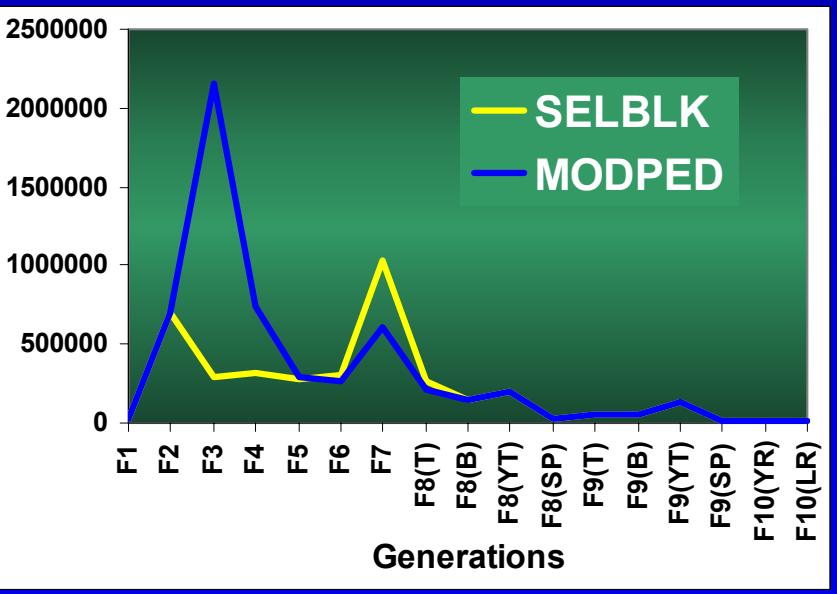
enetic gain in yield from SELBLK is 3.3% higher than MODPED



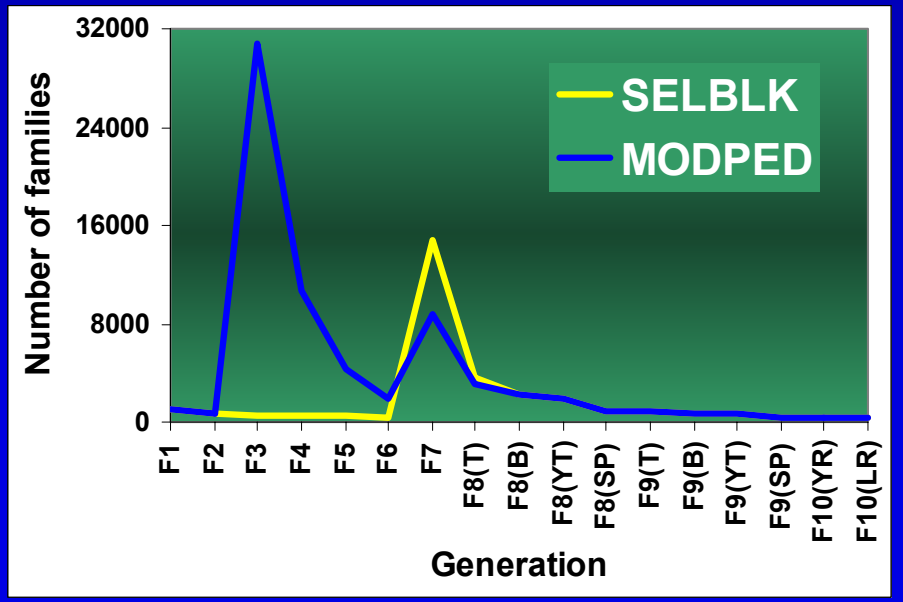
SELBLK retained 25% more crosse in the final selected population



SELBLK required 1/3 less land from F1 to F8 than MODPED



SELBLK produced 40% less familie to be planted from F1 to F8



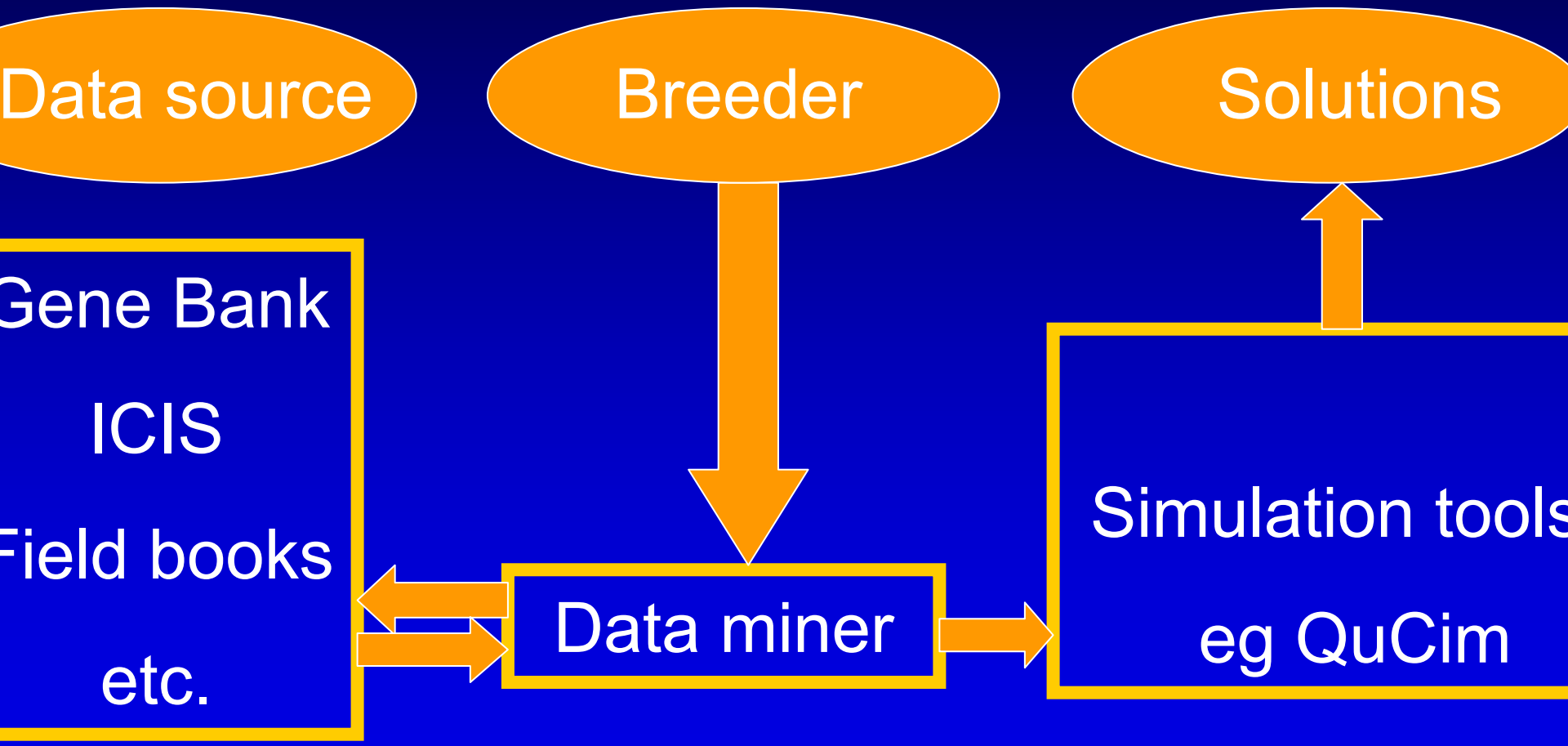
High Fe and Zn grain concentration

- Zn: 10 genes; 5 explaining more than 10%; cost / marker 1$
  Fe: 7 genes; 4 explain more than 10% cost / marker 1 $

- Optimum crossing and selection method considering costs for MAS
- Crossing: F2- derived, BC1, BC2 BC3

- Selection: Phenotype followed by grain analysis
  Phenotype followed by MAS
  Phenotype followed by grain analysis and MAS
- Correlation Fe : Zn 0.5

An integrated decision-supported system for breeding




Thank You