High throughput plant phenotyping system for durum wheat breeding

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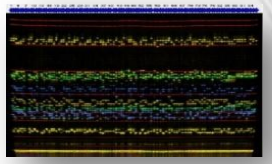
Cereal Research Centre for Cereal and industrial Crops



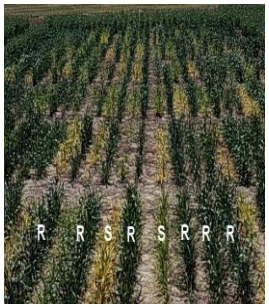
MISSION

The Center deals, with a multidisciplinary approach, in the supply chains of cereals and industrial crops for human, animal and non-food uses. It also guarantees the conservation and enhancement of biodiversity through the use of -omics sciences (i.e.genomics, metabolomics and phenomics)

Plant breeding methods

Traditional selection

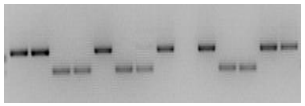
10-12 ANNI



Assisted selection (MAS)

4-6 ANNI

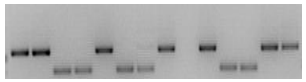
R R S S R S S R R S S R R

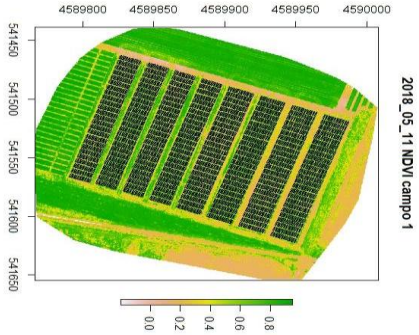


Assisted selection (MAS+HP)

4-6 ANNI

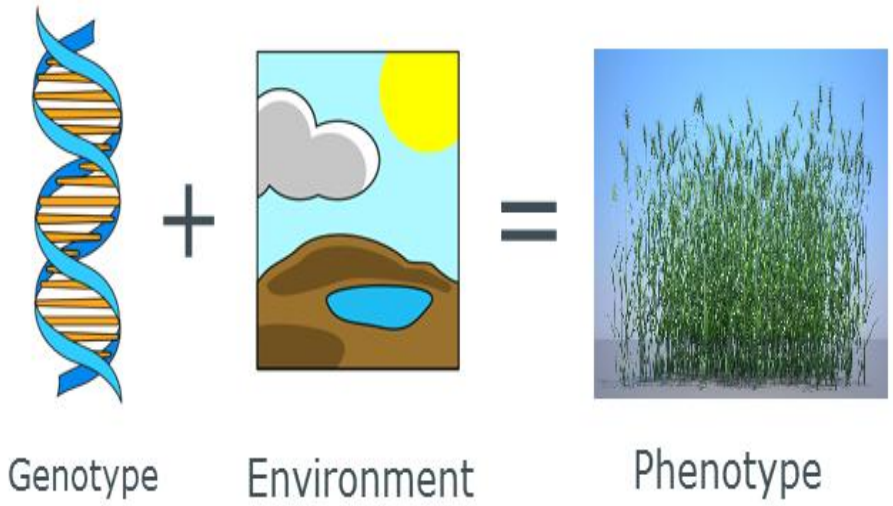
R R S S R S S R R S S R R





Phenotyping – the new bottleneck

Genomics is accelerating gene discovery
but how to establish gene function and development of new genotypes?



Phenotyping is important for

- functional analysis of specific genes
- forward and reverse genetic analyses
- production of new plants with beneficial characteristics

Characterization

- in different growth conditions
- of many different lines
  - mutant populations
  - mapping populations
  - breeding populations
  - germplasm collections

The Hight-throughput phenotyping system must be:

1. More efficient than the traditional visual or technological one (It should cost less, and must allow to reduce time and labor)

2. Accurate as the traditional one, with reduction of effects due to spatial variability, to gradients in the selection field, or to different operators;

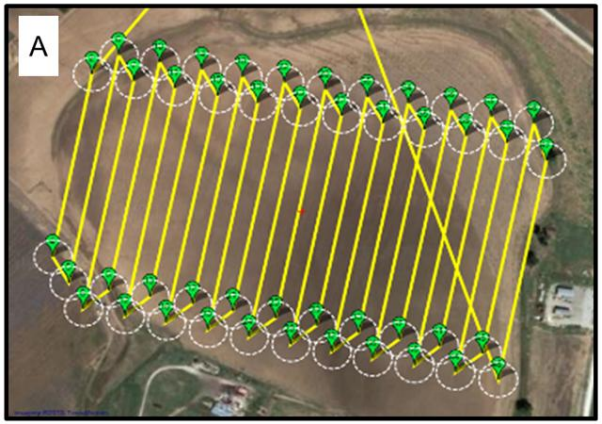
3. More informative, in the sense that it must allow to detect new phenotypic characters, even complex ones, or expression of physiological processes; characters that with traditional methods are difficult or impossible to evaluate.

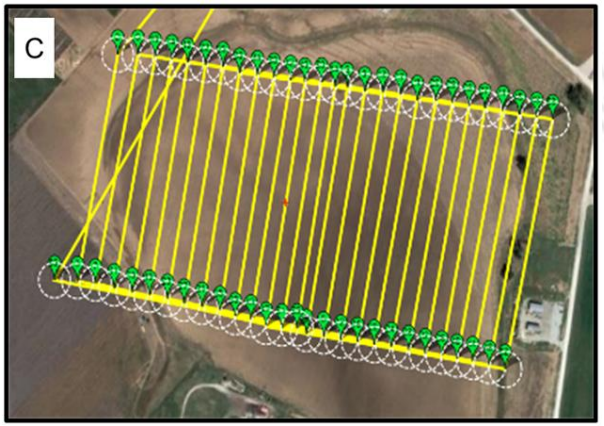
Use of drone to achieve a high-throughput phenotyping platforms

Traits of interest

Traits	Breeding generation when selection is conducted			
	All generations	F3	F4-F6	Advanced Breeding lines
Simple traits				
Diseases	visual	visual	visual	visual
Plant height	visual	visual	visual	visual
Heading date & Phenology	visual	visual	visual	visual
Soil coverage			visual	visual
Complex traits				
Yield			visual and instrumental	instrumental
Canopy temperature			instr.l (small plots)	instr.l (plots)
Stomatal conductance		instr.l (plants)	Instr.l (plants)	
Chlorophyll content		instr.l (plants)	instr.l (plants)	

Flight plan





Traits detected at CREA of Foggia

1° Focus

Traits	Breeding generation when selection to be conducted			
	All generations	F3	F4-F6	Advanced Breeding lines
Simple traits				
Diseases	Multispectral (NDVI), Thermal camera			
Plant height	Laser scan			
Heading date	RGB camera			
Soil coverage	RGB camera/NDVI			
Complex traits				
Yield	Multispectral (NDVI)			
Canopy temperature	Thermal camera			
Stomal conductance	Thermal camera			
Chlorophyll content	Multispectral (NDVI)			

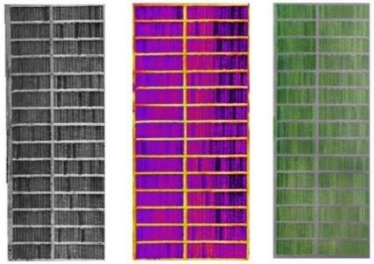
Soil coverage

High throughput is essential for phenotyping

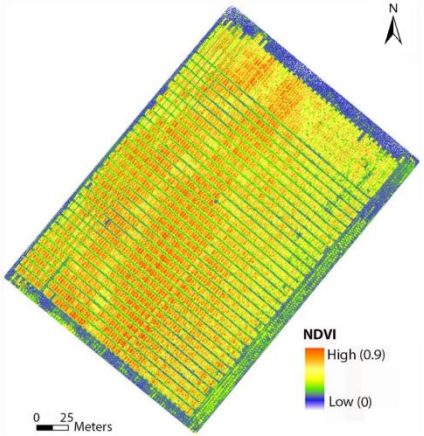
Visual score

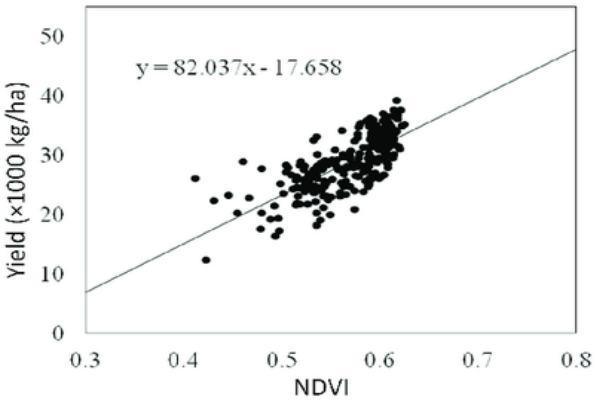
Hand-held camera

Drones with sensors

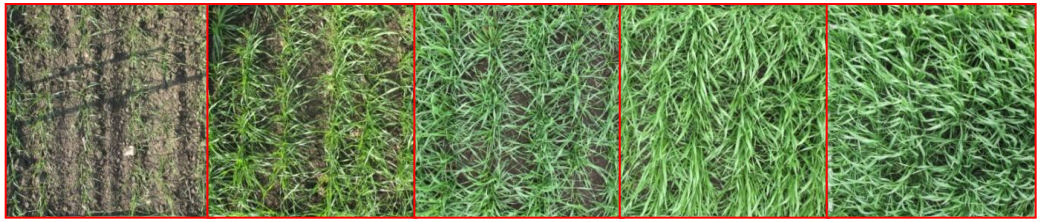


Parrot Bluegrass for NDVI analysis of 2000 plots of durum wheat(2h)





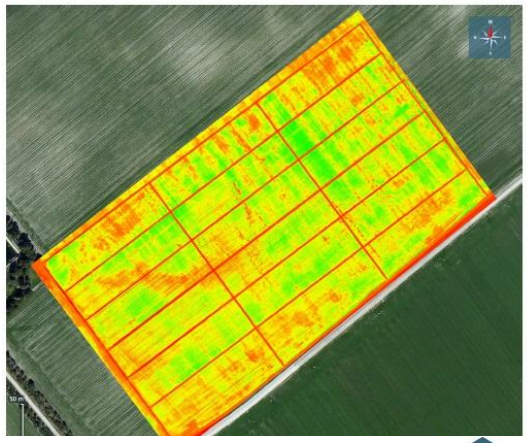
G1



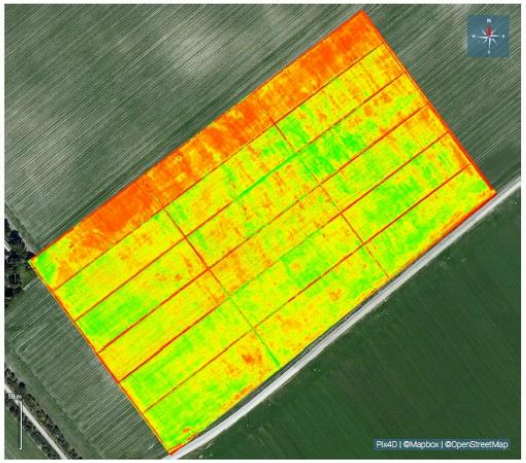
G2

Precision Agricolture #1

24/03/19



30/05/19



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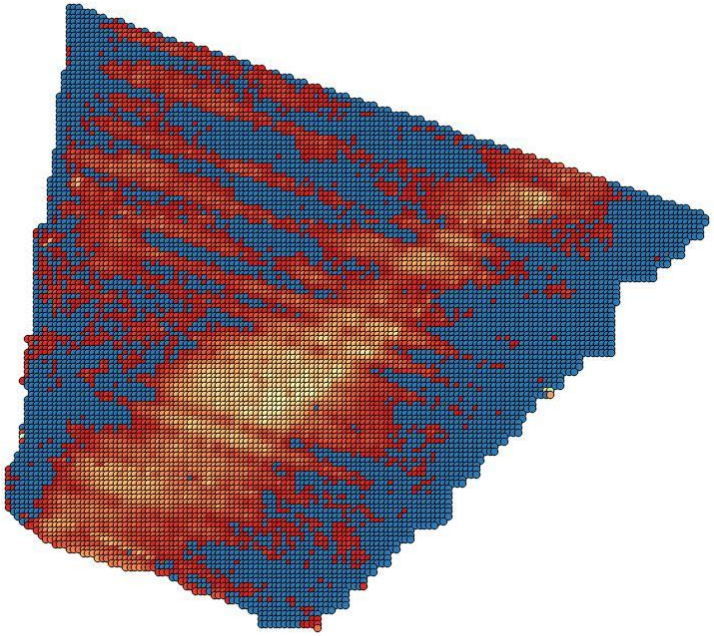
lavorazioni	Resa	Peso ettolitrico	Proteine
aratura	41,8	84,4	12,5
dracula	41,5	83,5	12,6
veloce	42,1	84,6	11,6
epoca semina	Resa	Peso ettolitrico	Proteine
novembre	41,5	85,0	11,3
dicembre	41,9	84,0	12,4
interfila semina	Resa	Peso ettolitrico	Proteine
conv15	41,9	84,5	12,0
conv30	42,0	83,7	12,5
seminbio	41,6	83,8	12,4
strigliatura	Resa	Peso ettolitrico	Proteine
no	42,3	84,5	12,1
si	41,3	83,8	12,4

12/06/19

Precision Agricolture #2



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