

**GIFS** | GLOBAL INSTITUTE FOR FOOD SECURITY  
POTASHCORP - A FOUNDING PARTNER

## Digital Agriculture and Global Food Security:

Opportunities for UK-Canada collaboration



January 18<sup>th</sup> 2016  
Maurice Moloney Exec. Director and CEO

**UNIVERSITY OF SASKATCHEWAN** | Government of Saskatchewan



## The world is digitized



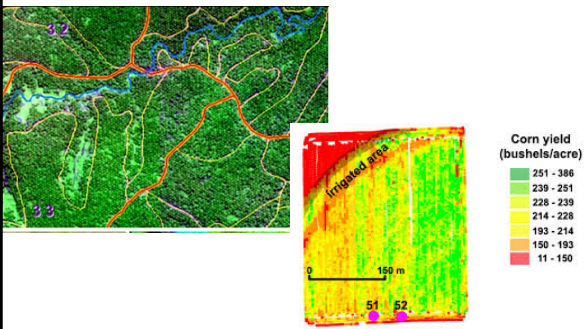

**GIFS** | GLOBAL INSTITUTE FOR FOOD SECURITY  
POTASHCORP - A FOUNDING PARTNER

## And the world of agriculture is no exception




**GIFS** | GLOBAL INSTITUTE FOR FOOD SECURITY  
POTASHCORP - A FOUNDING PARTNER

## The sources of data multiply annually

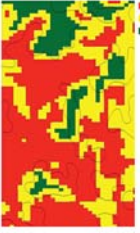


**GIFS** | GLOBAL INSTITUTE FOR FOOD SECURITY  
POTASHCORP - A FOUNDING PARTNER

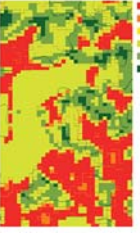
**Soil Type**



**Normalized Yield**



**FieldScripts<sup>®</sup>**




There is evidence that high-precision data can lead to improvements of up to 20% return per hectare

**FieldScripts**

**GIFS** | GLOBAL INSTITUTE FOR FOOD SECURITY  
POTASHCORP - A FOUNDING PARTNER

## This requires diverse and overlapping data sets



## And a wide variety of data acquisition systems

**GIFS** | GLOBAL INSTITUTE FOR FOOD SECURITY  
POTASHCORP - A FOUNDING PARTNER

It will be critical to measure the value proposition



=\$/£ ?



GLOBAL INSTITUTE  
FOR FOOD SECURITY

POTASHCORP - A FOUNDING PARTNER

Field automation: robotization and autonomous vehicles



GLOBAL INSTITUTE  
FOR FOOD SECURITY

POTASHCORP - A FOUNDING PARTNER



GLOBAL INSTITUTE  
FOR FOOD SECURITY

POTASHCORP - A FOUNDING PARTNER

Lettuce thinning by robot

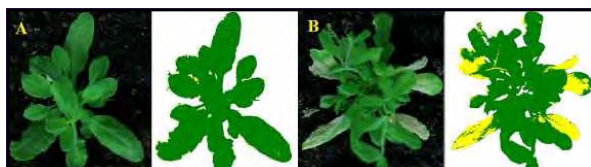


**Blue River Technology's LettuceBot**  
Thins a field in the same time as 20 workers



GLOBAL INSTITUTE  
FOR FOOD SECURITY

POTASHCORP - A FOUNDING PARTNER



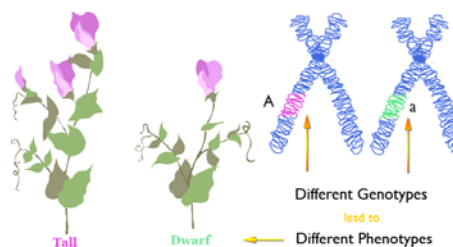
A major challenge is digital phenotyping



GLOBAL INSTITUTE  
FOR FOOD SECURITY

POTASHCORP - A FOUNDING PARTNER

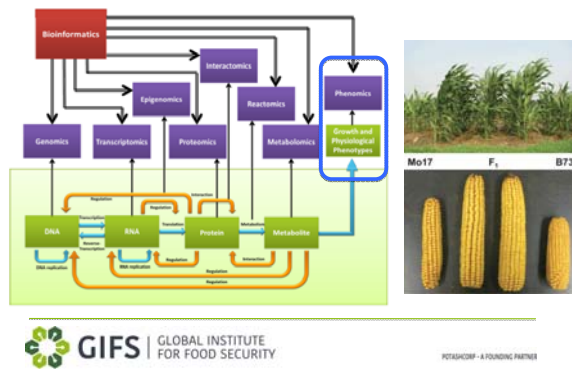
**Computer science and plant breeding:**  
How does a Genotype specify a Phenotype?



GLOBAL INSTITUTE  
FOR FOOD SECURITY

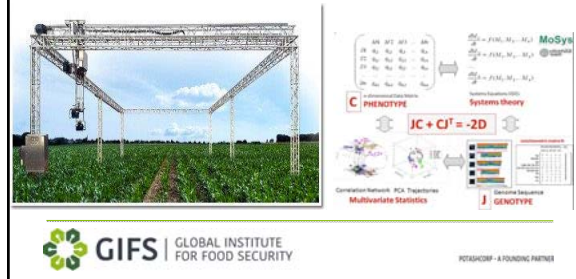
POTASHCORP - A FOUNDING PARTNER

## Plant Breeding is still an analog to digital process

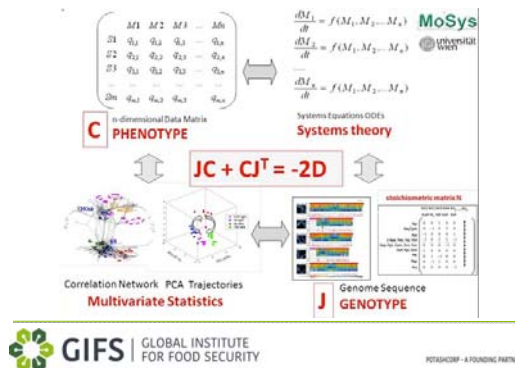


## The need: digitizing the phenotype

The digitization of plant phenotypes into a unified data platform would allow association genetics to be applied on a massive scale essentially by machine-machine interrogation.

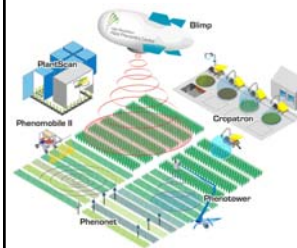


## Digital Representations of Plant Phenotypes



## Capitalizing on the Genomics revolution

We need to integrate genotype and phenotype, but what is missing?  
Imaging plants from macro-to-micro scale and creating ordered data sets

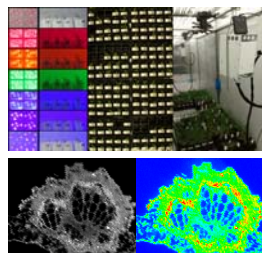
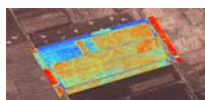


The challenges associated with this are threefold:

- Image acquisition
- Image digitization
- Database assembly and organization

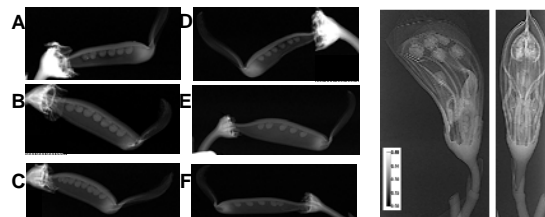
## Approaches to digital imaging of Plants

- Phytotron and Field-based imaging and phenotyping
- X-ray confocal microscopy
- IR, soft X-ray, hard x-ray imaging
- Radioisotope imaging (Cyclotron)
- Neutron whole plant imaging
- Wakefield laser microscopy
- MALDI-2D Mass Spec imaging

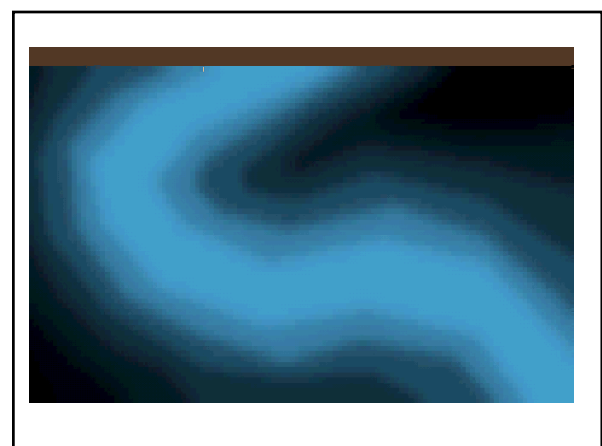
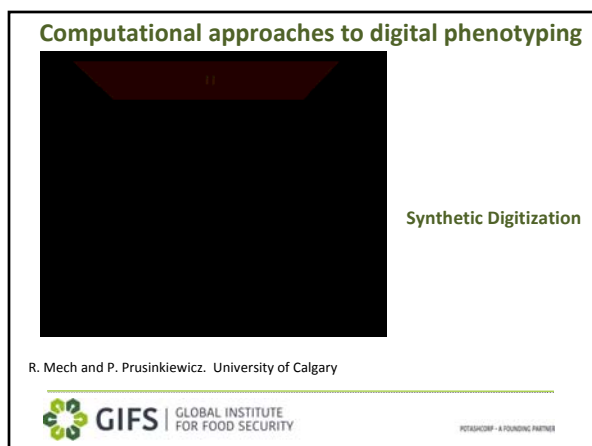
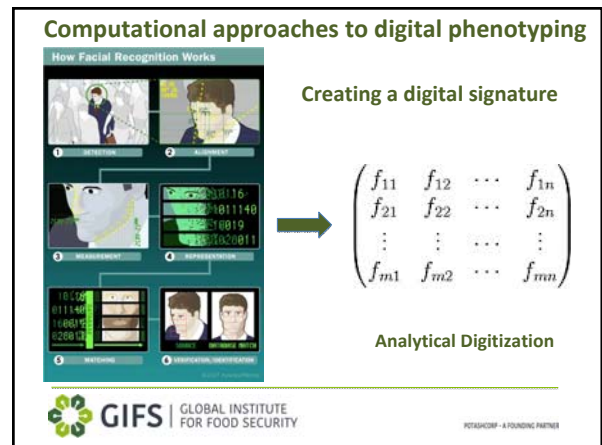
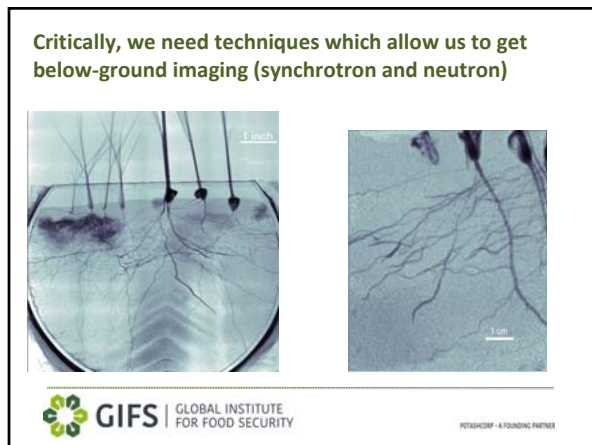
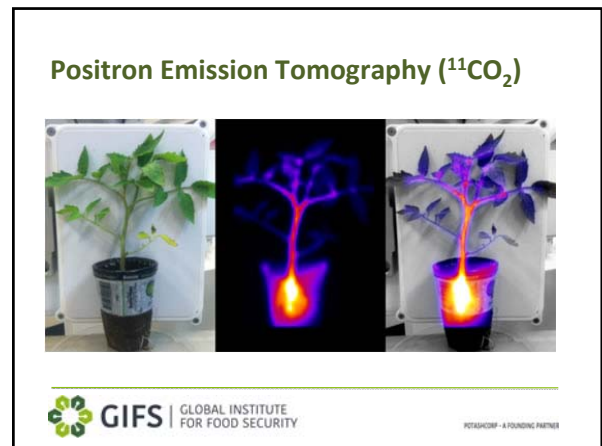
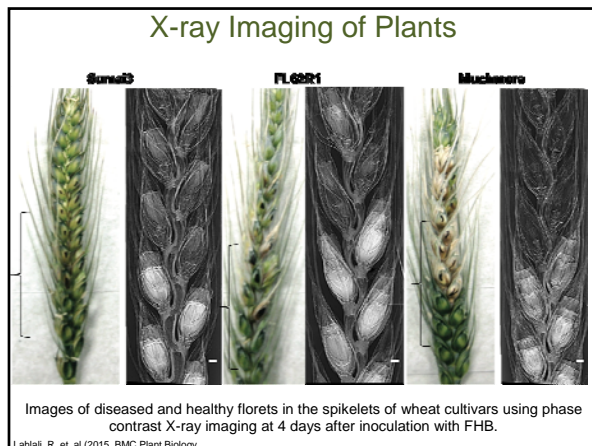


## The critical role of advanced imaging technologies

- Digital imaging creates data that can be analysed computationally
- Advanced imaging techniques allow us to assess the whole plant not just above-ground structures

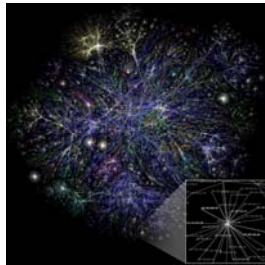






## Collaborative Phenotype Data Management

- Shared research data infrastructure that integrates genotype, phenotype and microbial information with environmental and agronomic information
- This will require peta-byte storage capacity initially for raw data



**GIFS** | GLOBAL INSTITUTE  
FOR FOOD SECURITY

POTASHCORP - A FOUNDING PARTNER

## Distributed High-Performance Computing

- Scalable statistical analysis enabled by distributed computing, compilers, networks, and performance evaluation



This will require dataprocessing speeds that are more typical of governments, not researchers, but if Moore's Law continues to operate, this will happen



**GIFS** | GLOBAL INSTITUTE  
FOR FOOD SECURITY

POTASHCORP - A FOUNDING PARTNER



## Opportunities for UK-Canada collaboration in Digital Agriculture



### Arable crops:

Wheat, Barley, Canola/oilseed rape, oats

### Horticultural:

Potatoes, berry fruits, tree fruits, veg. crops

### Dairy and livestock:

Grassland, protein crops  
Livestock monitoring and phenotyping

### Technologies

Robotization  
Precision seeding and fertilization  
Alternative weeding  
Soil sensors (nutrients, water, pH)  
Image analysis (genetics, pathologies, pests)  
Animal feeding, milk yield, health



**GIFS** | GLOBAL INSTITUTE  
FOR FOOD SECURITY

POTASHCORP - A FOUNDING PARTNER