Agronomical dimension of Precision crop farming: how to combine knowledge and technology in the agriculture?

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Danish Farmers ABROAD
- på hjemmebane overalt ...

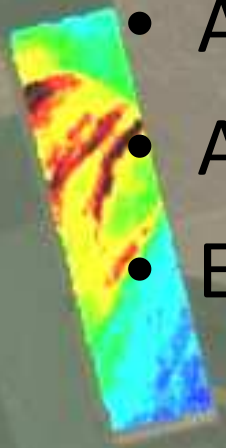
16.06.2016, Braedstrup, Denmark

Geocarta SA quick facts

- Company specialized in geophysical technologies
- Company founded in 2001, based in Paris
- Operates world wide (Europe, Africa, South America)
- Develops and owns geophysical technologies (hard & soft)
- Commodity plantation (SOSUCAM, SARIS), large cooperatives (Axereal, Terrena), international seed breeders (Limagrain, Monsanto), best vineyards in the world (Moet & Chandon, Cheval Blanc…)
- Ressearch (France: CNRS, INRA / Brazil: EMBRAPA, CTBE)
- Civil engineering (public and private actors)
- Arqueology (public and private actors)

Summary

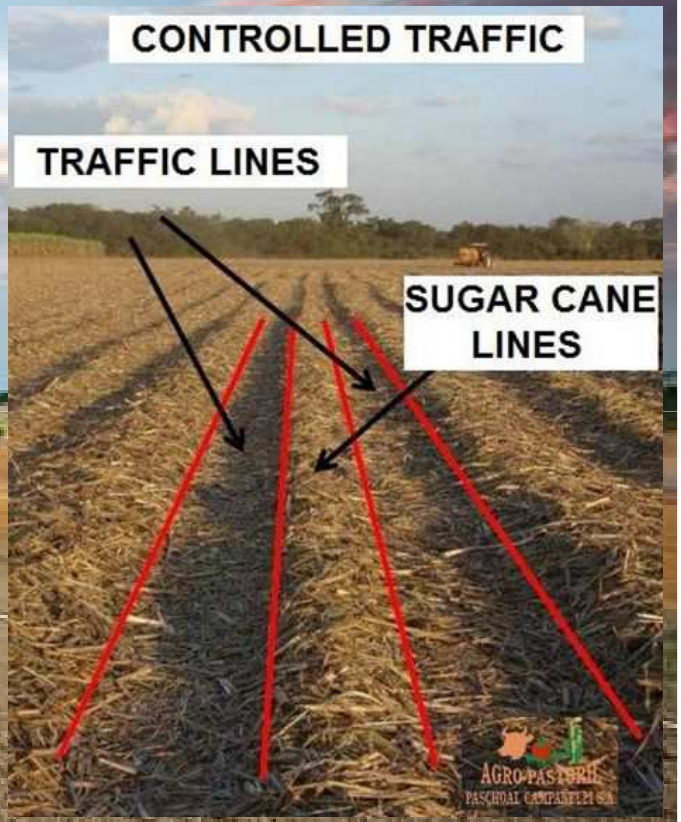
- What Precision Agriculture is NOT
- What Precision Agriculture IS
- Soil and Crop sensors
- Variable Rate Technologies (VRT)
- Application: Epis-Centre (France)
- Application: Sosucam (Cameroon)
- Economic study: Epis-Centre (France)



What Precision Agricultre is NOT ?

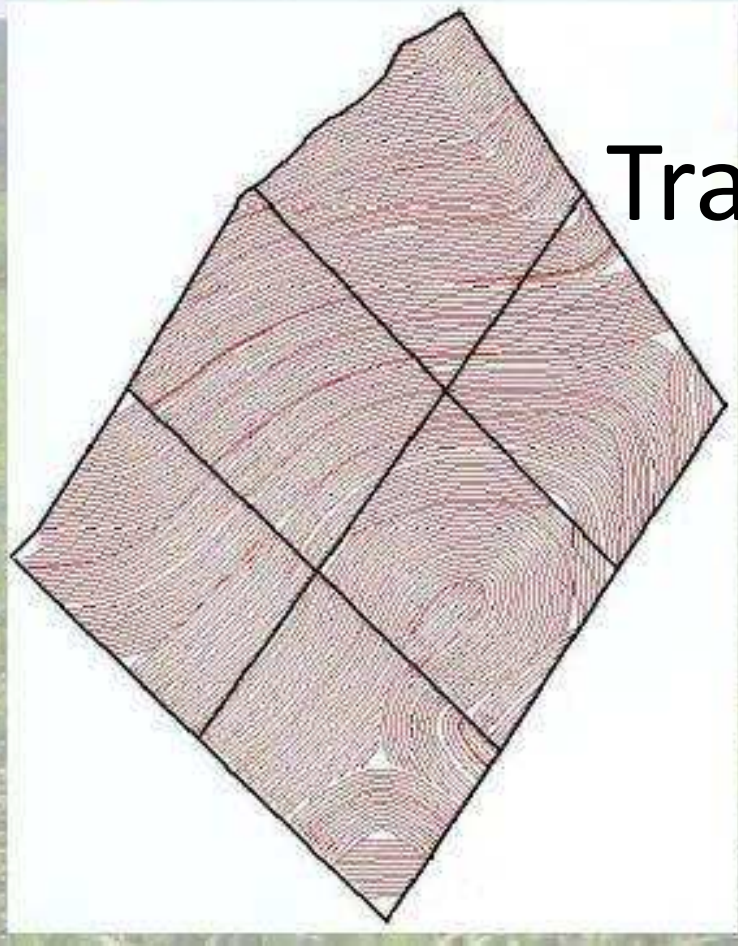
Precision Agriculture is not a technology, it is a strategy to adapt the production process to inter and intra-field variablity, but technology makes it possible

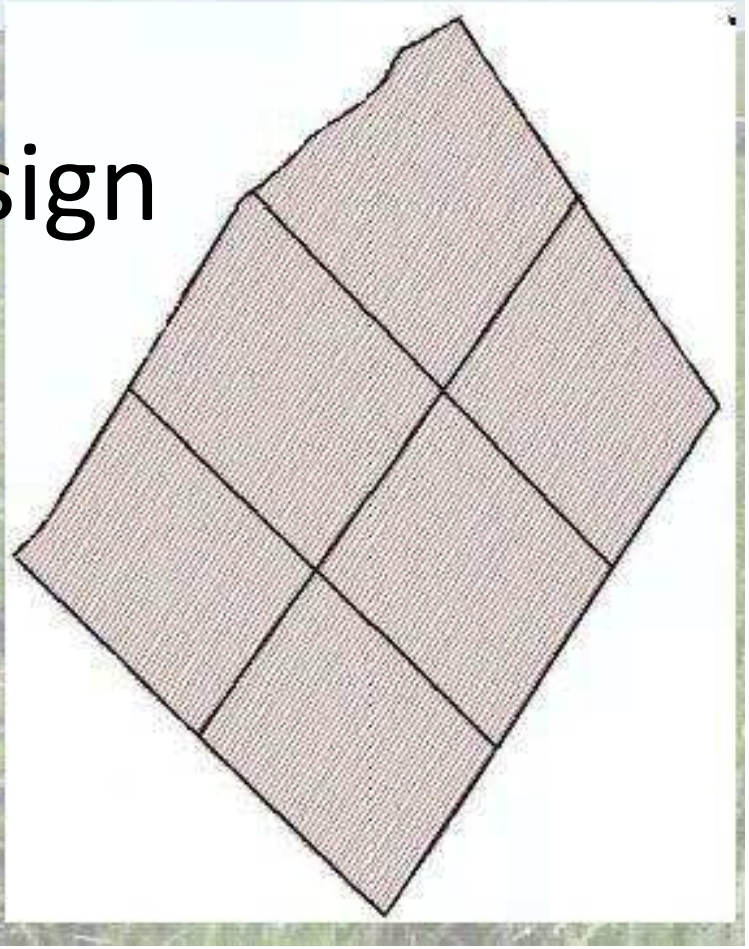
Navigating with precision (autopilot): straight lines, less compactation (planting, spraying, harvesting), tracing design



	Number of line	Average lenght of line (m)	Total linear meters	Maneuvers	Maneuver time 1 min / maneuver
Old Planting (1,40m)	1 728	370	639 360	1 728	29 hours
New Planting (1,50m)	626	1 080	676 080 (+5,7%)	626	10,5 hours (-18,5 hours)

Tracing design





Planting with precision: avoid overlap, regular singulation, deepness consistency

Spraying/Spreading with precision: avoid overlap

Acurate equipment meets acurate geopositioning

- Navigating with precision (autopilot): straight lines, less compactation (planting, spraying, harvesting), tracing design
- Planting with precision: avoid overlap, regular singulation, deepness consitency
- Spraying/Spreading with precision: avoid overlap

= improvment of conventional production process

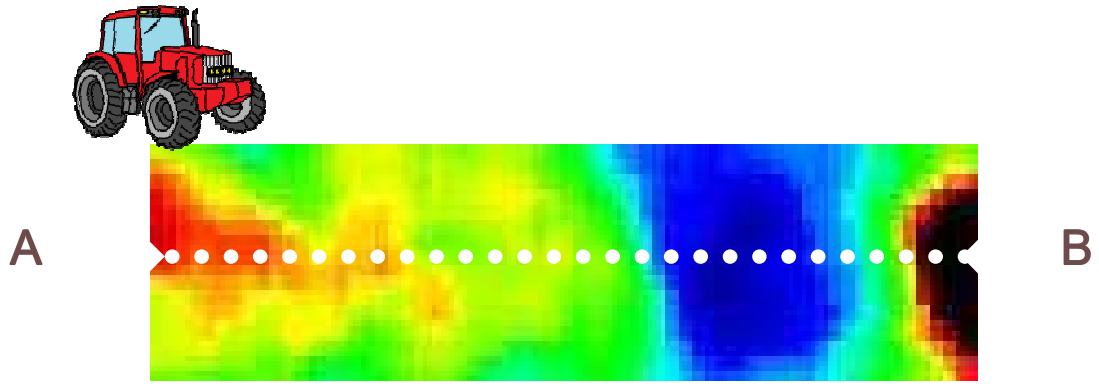
++ no site-specific knowledge (purely technical)

++ direct financial return

What Precision Agriculture IS ?

- Precision Agriculture is all about dealing with spatial variability of permanent and temporal factors
- Precision Agriculture is a site-specific crop managment

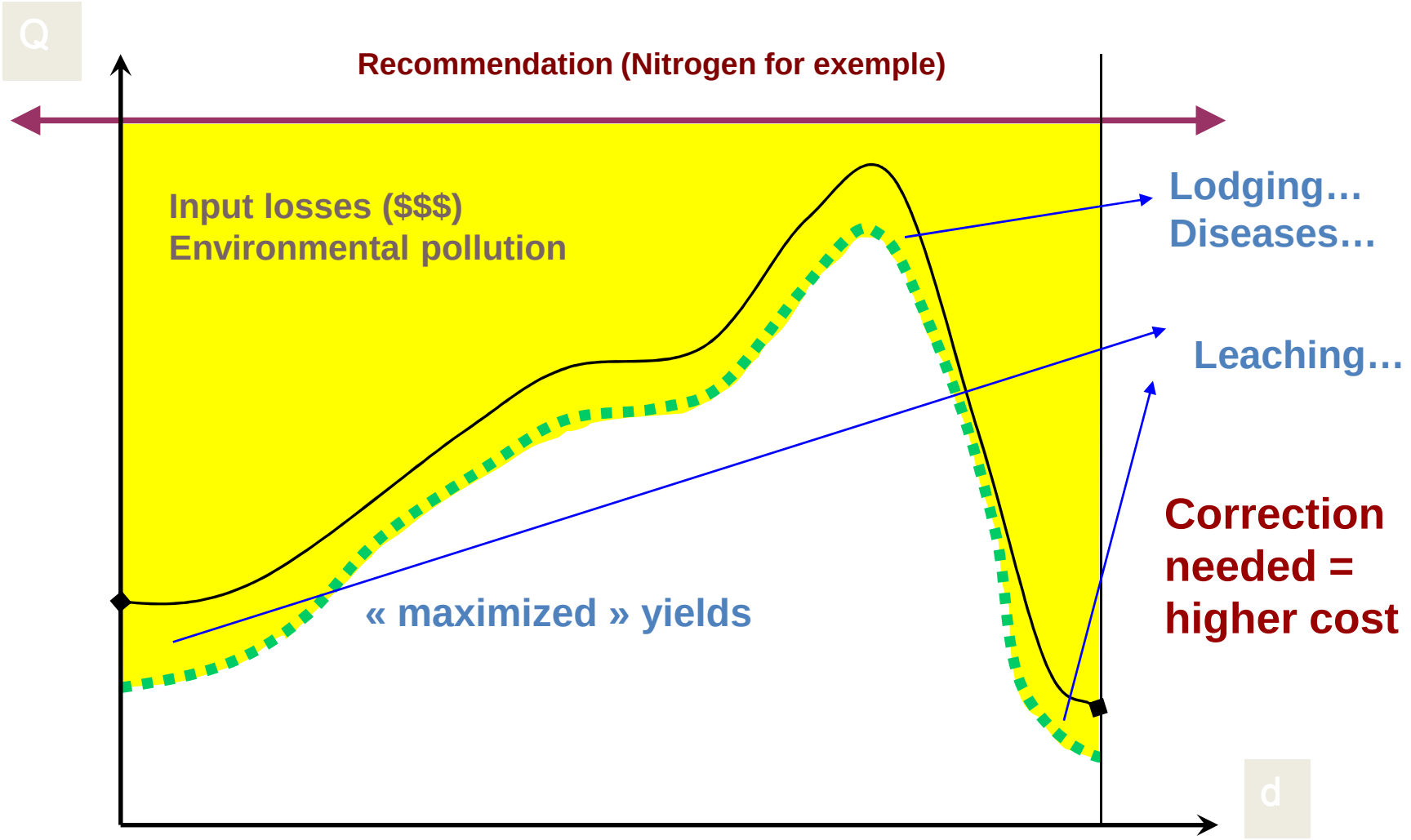
Inter and intra-field heterogeneity



The production potential between point A and point B is heterogeneous

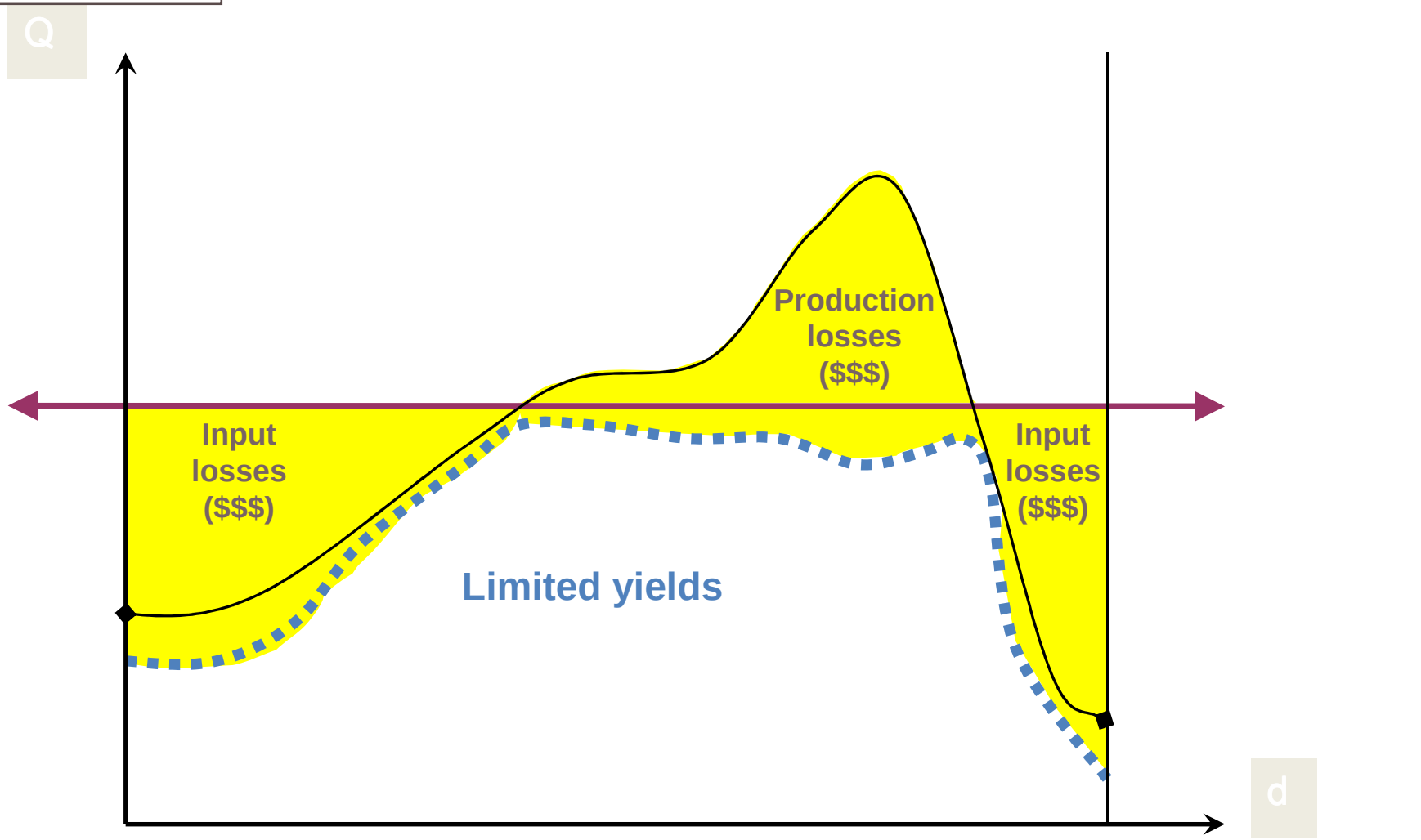
The challenge of variability

Conventional production



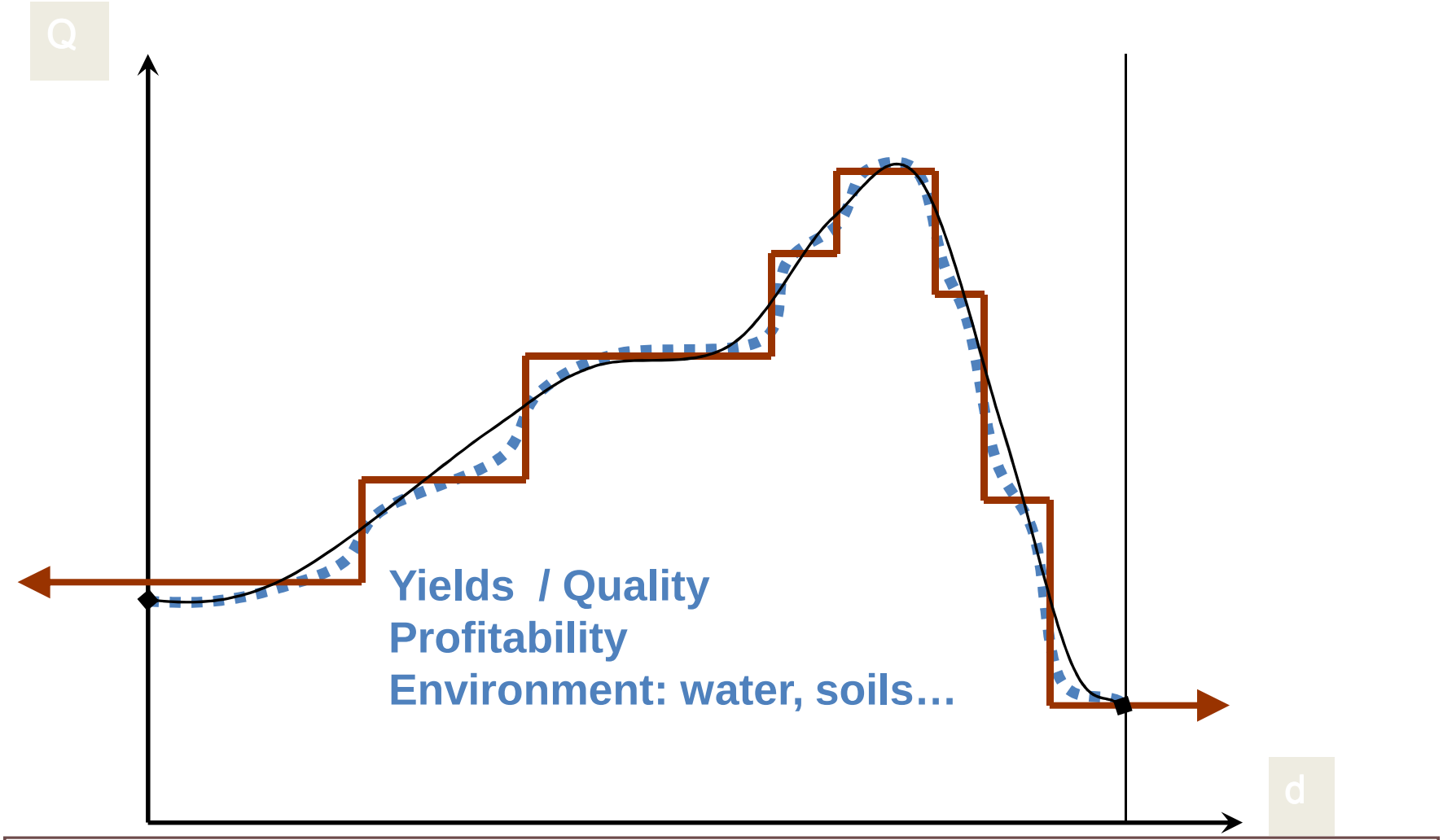
No concideration for spatial variation

Reasoned agriculture (?)



Variability and environmental pollution partialy taken into account

The right action at the right place



Precision Agriculture deals with heterogeneity

Basics of Precision Agriculture

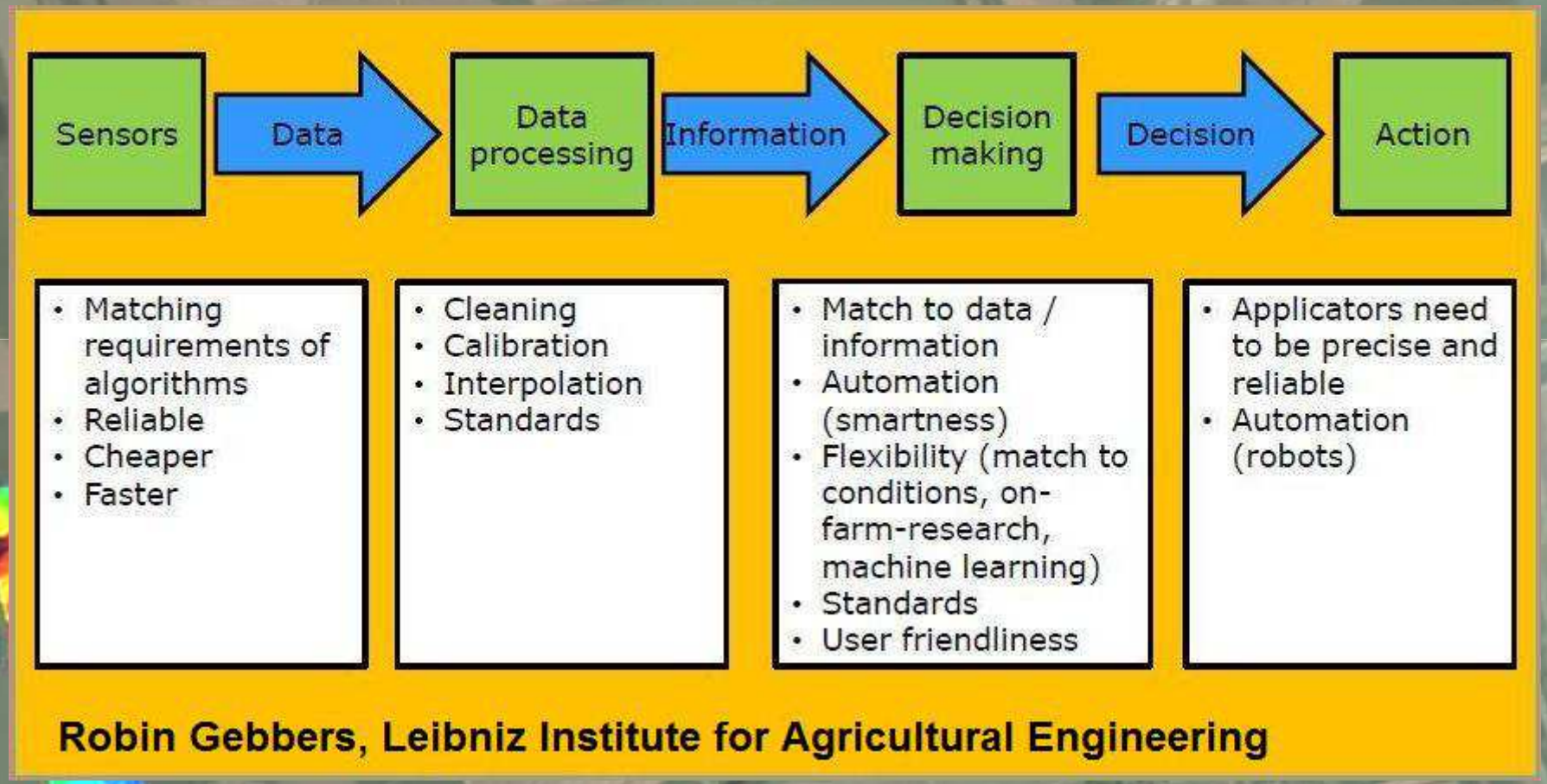
1- Determine variability

2- Determine possible actions

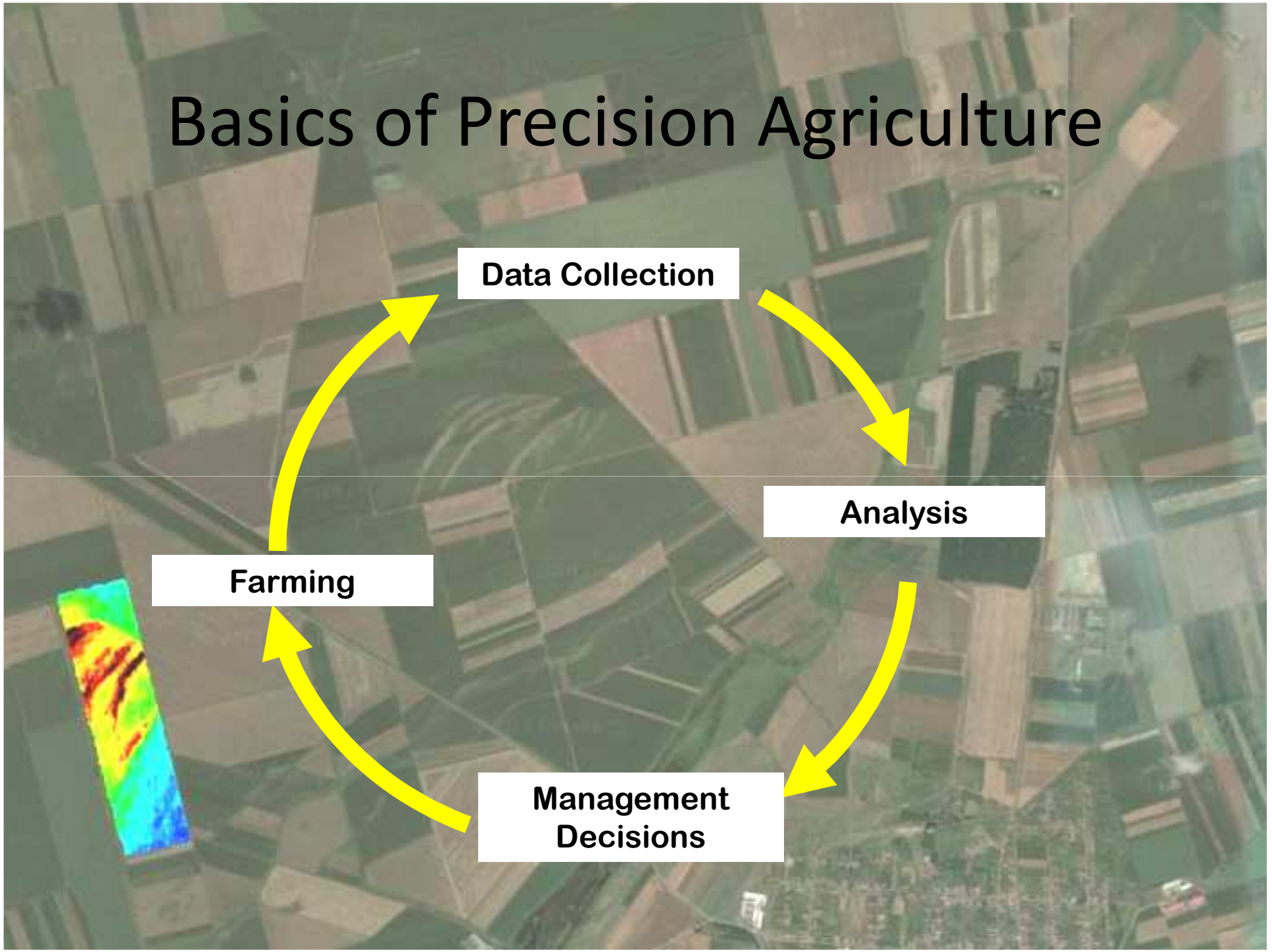
3- Implement profitable actions

REPEAT

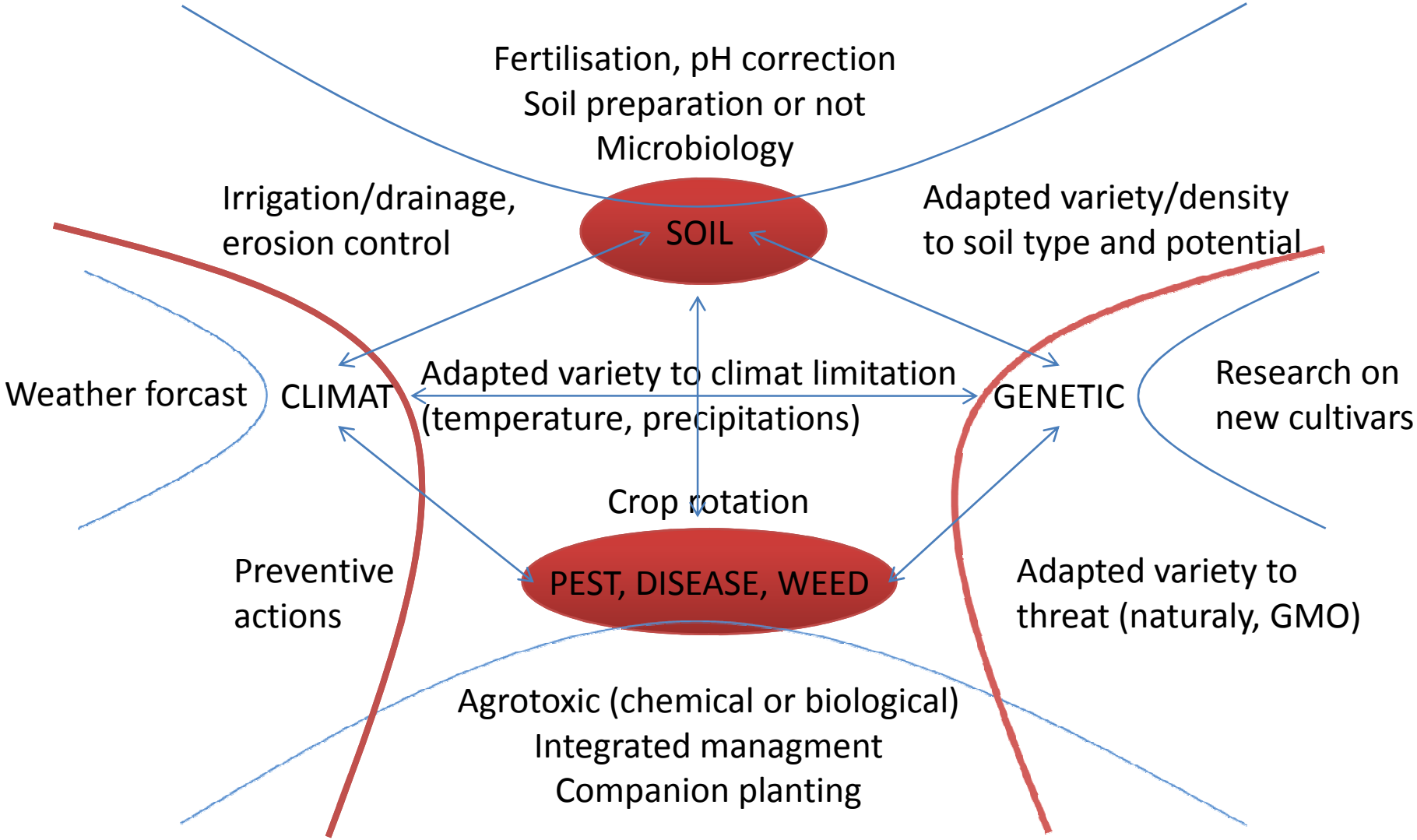
Basics of Precision Agriculture



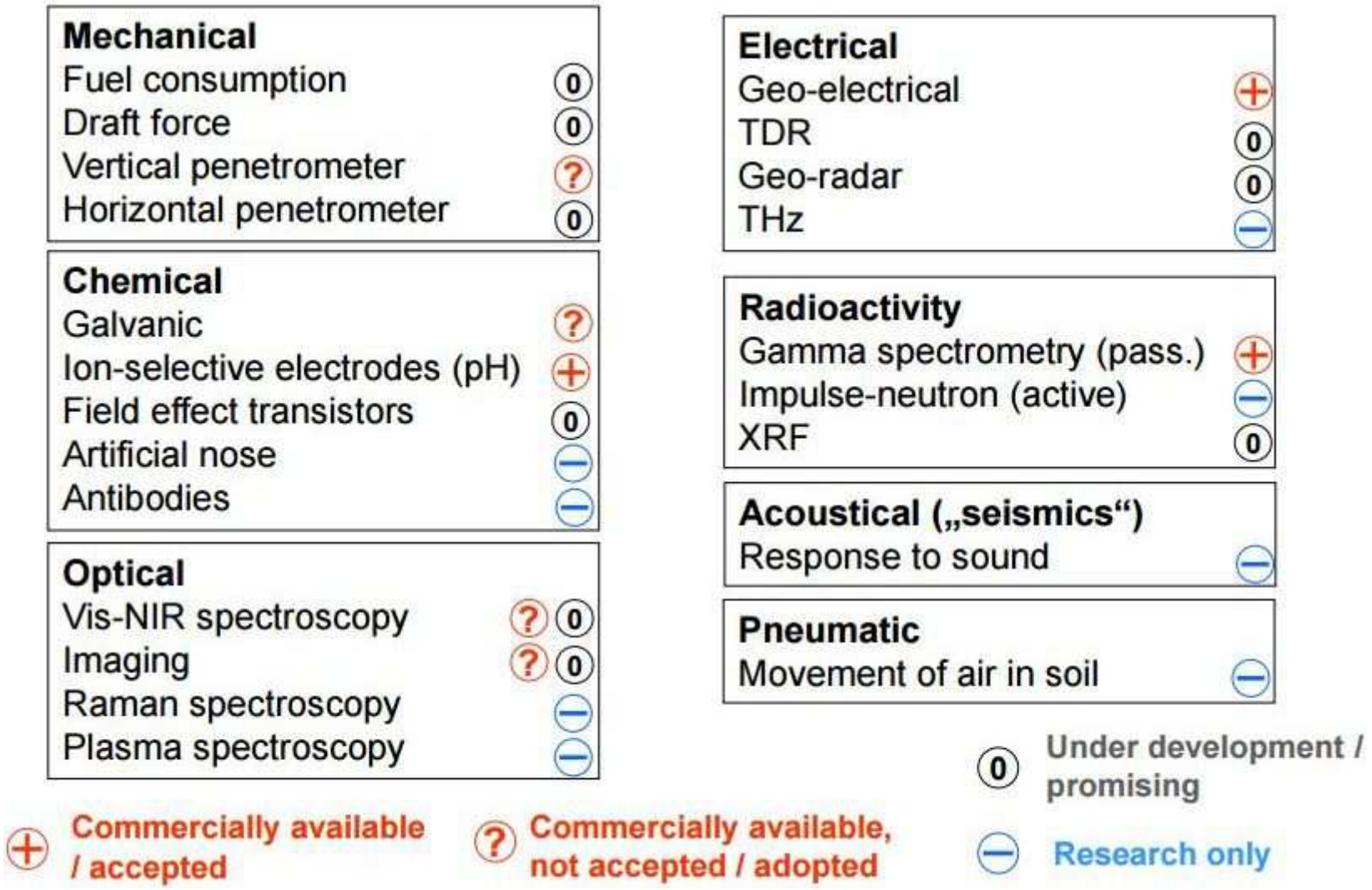
Basics of Precision Agriculture



Natural factors that affect productivity



Soil sensors



http://www.atb-potsdam.de/uploads/feupload/Gebbers_SensorsPrecisionAgriculture_ConBAP2014_v04.pdf

Soil sampling....

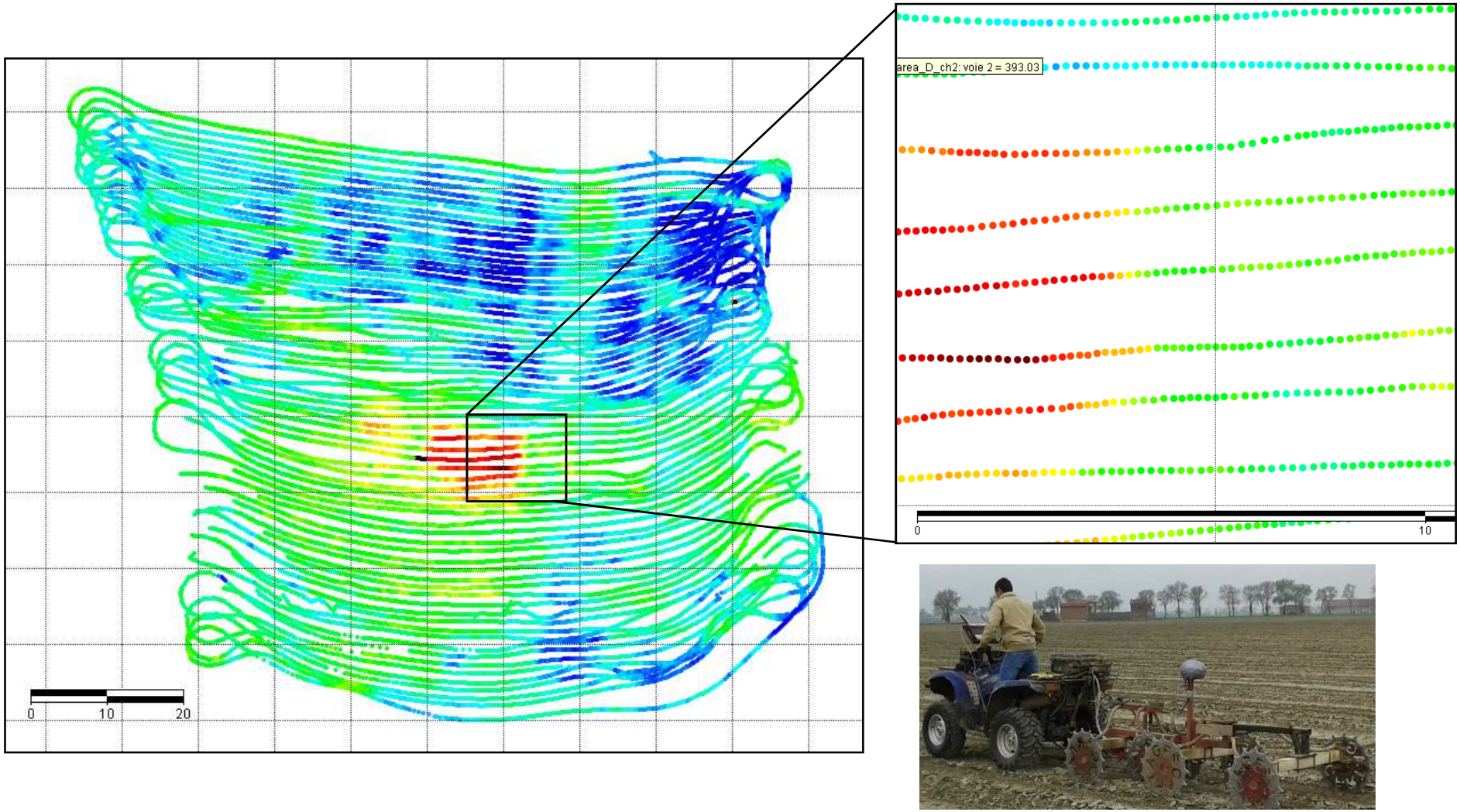
Scale?

Sample density?

Definition?

Cost?

Geophysic mapping : the first layer

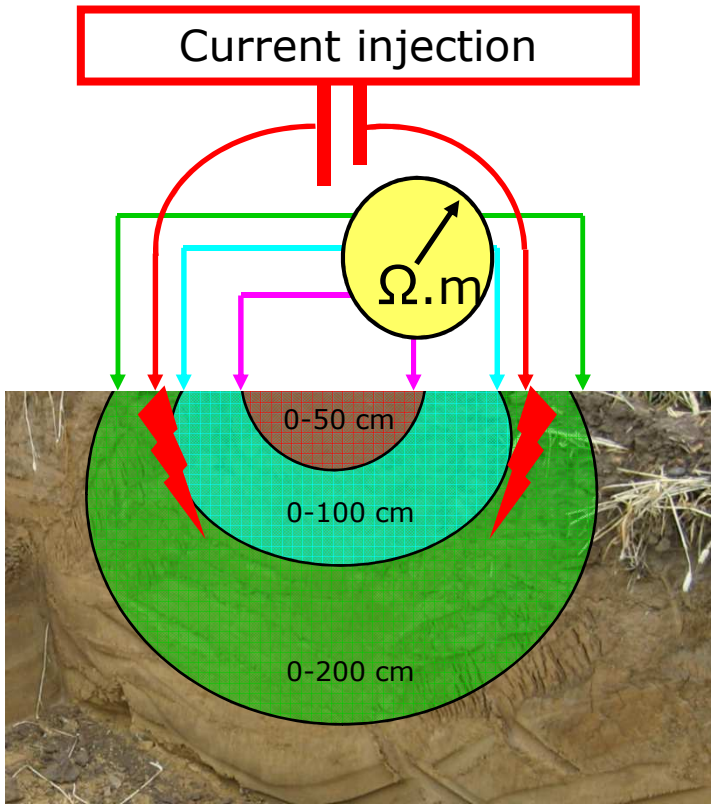


Geophysic mapping gives an overall vision of the physical variations of the soil for further managment zone definition and smart sample grid production

How geo-electric mapping works?

ARP Sistem

(Automatic Resistivity Profiling)



The soil electric resitivity is the capacity of the soil to not let an electrical current go through it.

The ARP sistem mesures the soil resistivity at 3 depths (0-50cm, 0-100cm e 0-200 cm).

Soil's electric resitivity varies in function of its characteristics:

-Texture: + sandy = +resistive / +clay = -resistive

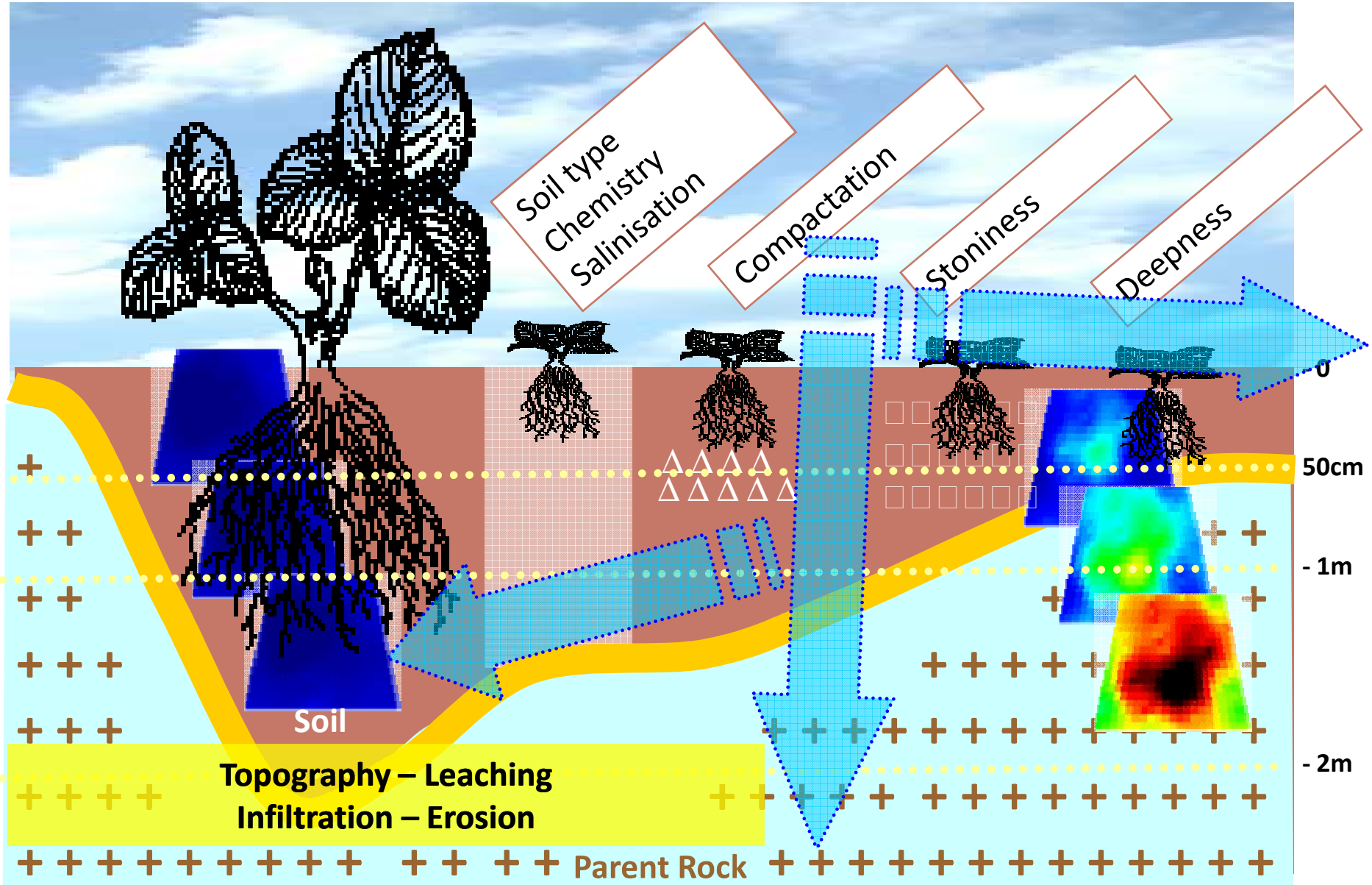
-Deepness: shallow = +resistive / deep = -resistive

-Porosity: +porosity = +resistive

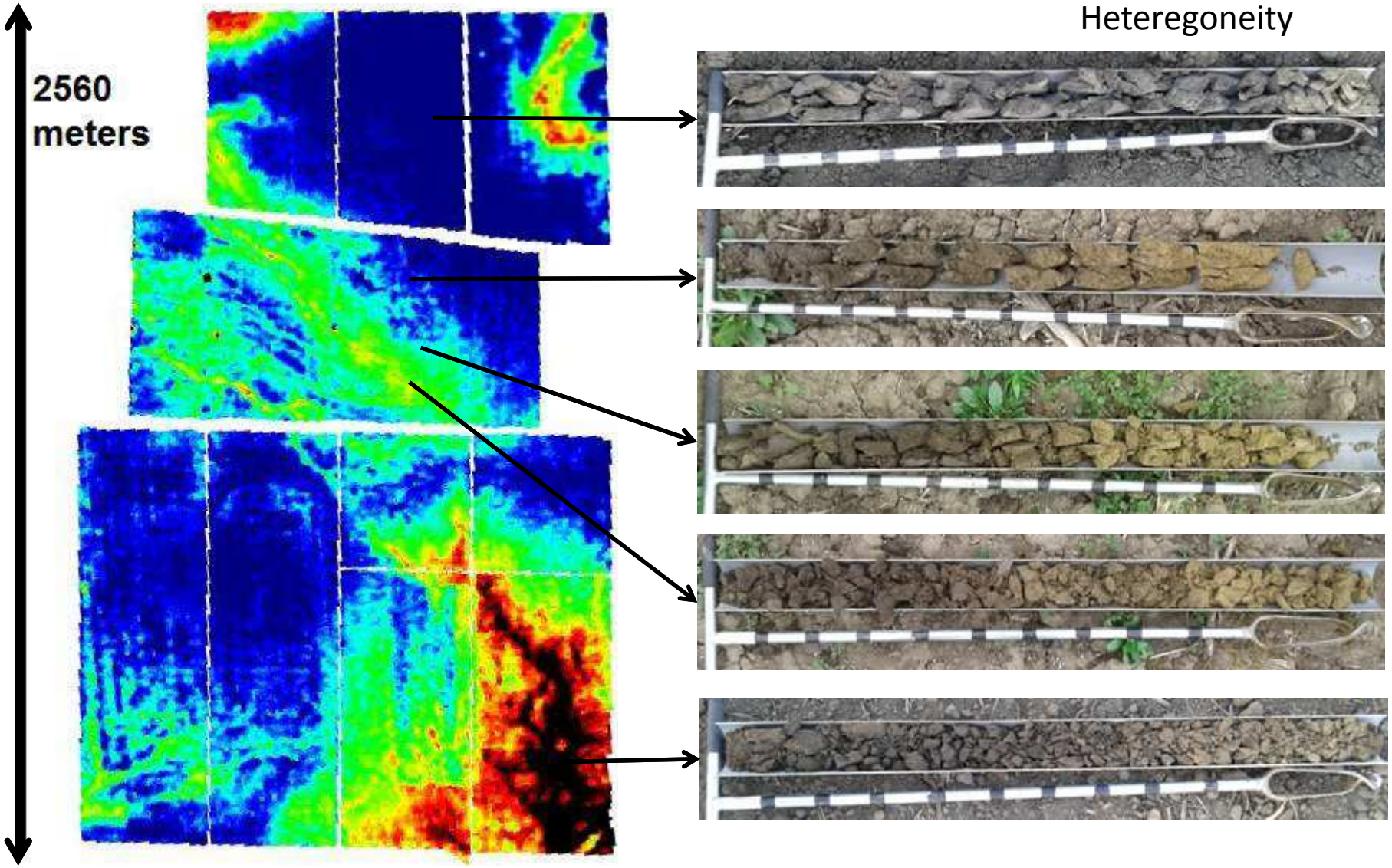
- Salinity: +salinity = -resistive

=> Available Water Content (AWC)

Factors that affect soil potential



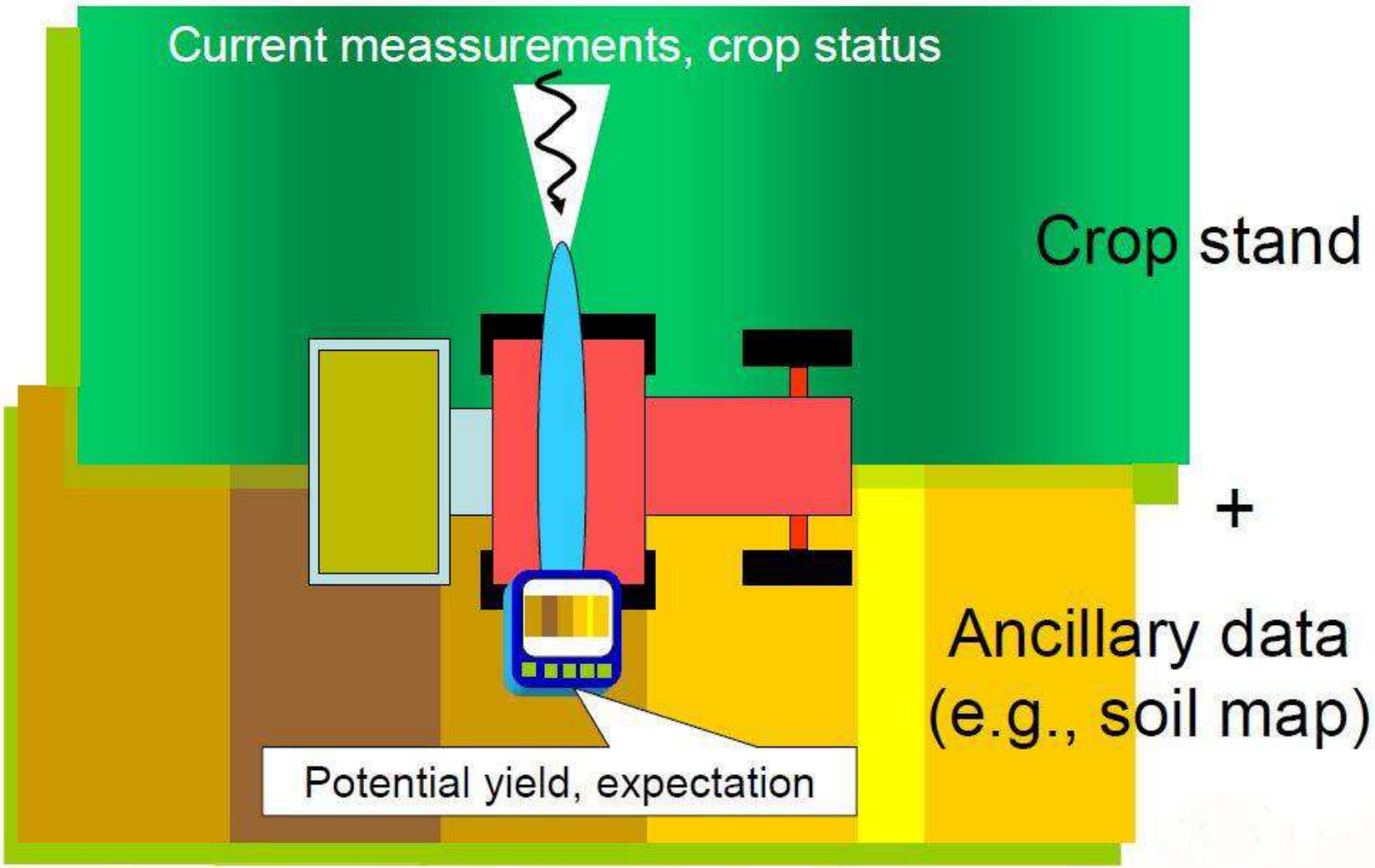
Evaluating soil potential and lowering operational risks



Crop sensors:
Multiplicity of commercial products

http://www.atb-potsdam.de/uploads/feupload/Gebbers_SensorsPrecisionAgriculture_ConBAP2014_v04.pdf

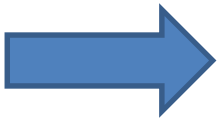
Sensing strategies : off-line, on-line and on-line with map overlay



Robin Gebbers, Leibniz Institute for Agricultural Engineering

Data processing / Recommendation production

- Software & Data base
- Open source / Proprietary
- Who keeps the data? Own / Cloud
- Compatibilty Sensor / Software / Equipment
- Big data? Get it slim!

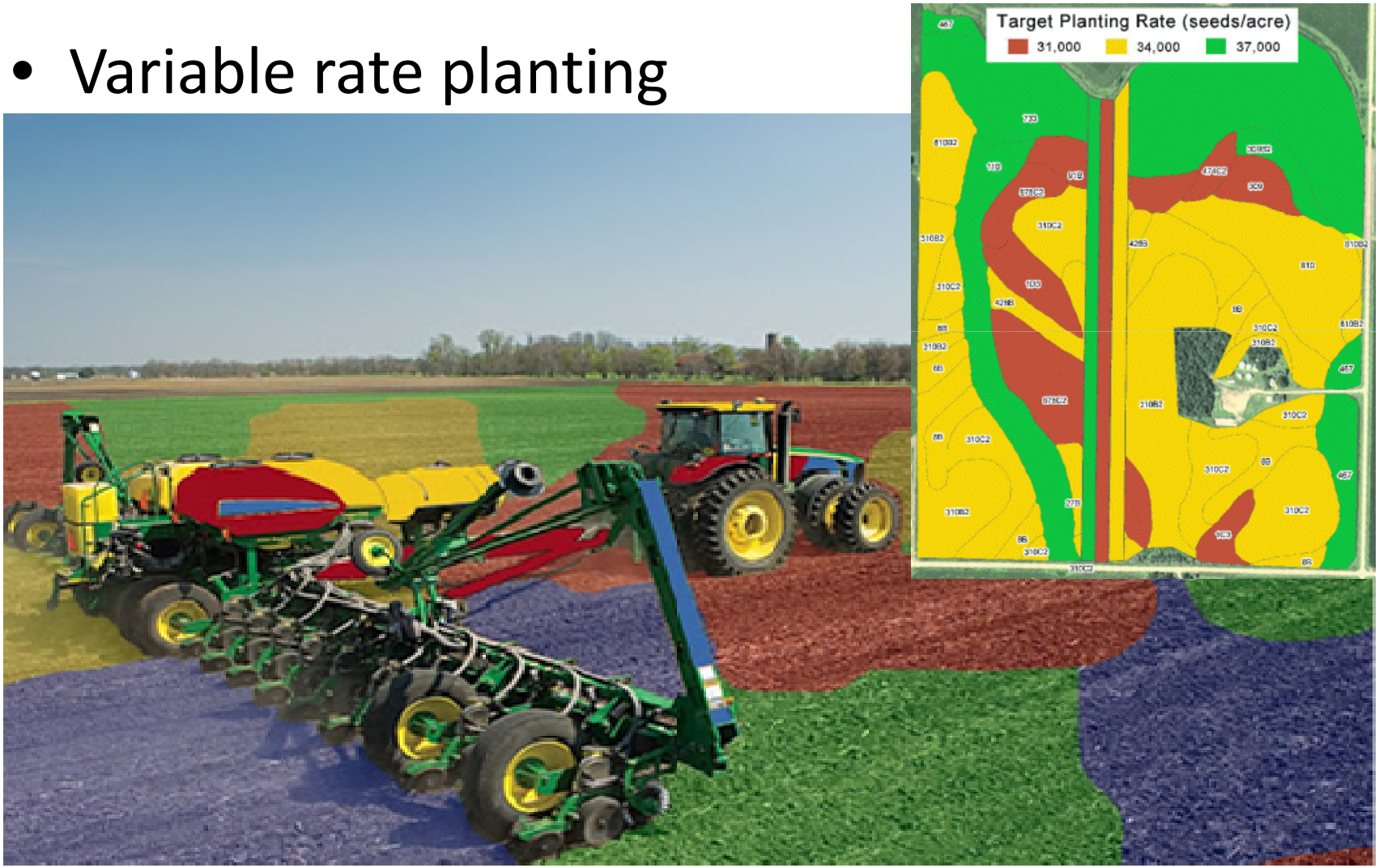


Valuable data for

valuable recommendation

Variable Rate Technologies (VRT)

- Variable rate planting



Variable Rate Technologies (VRT)

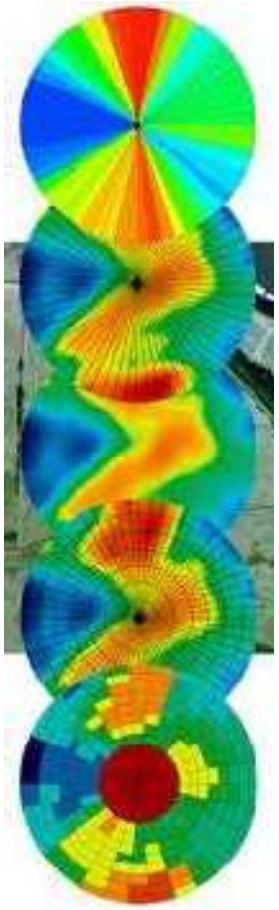
- Spreading solid material

Variable Rate Technologies (VRT)

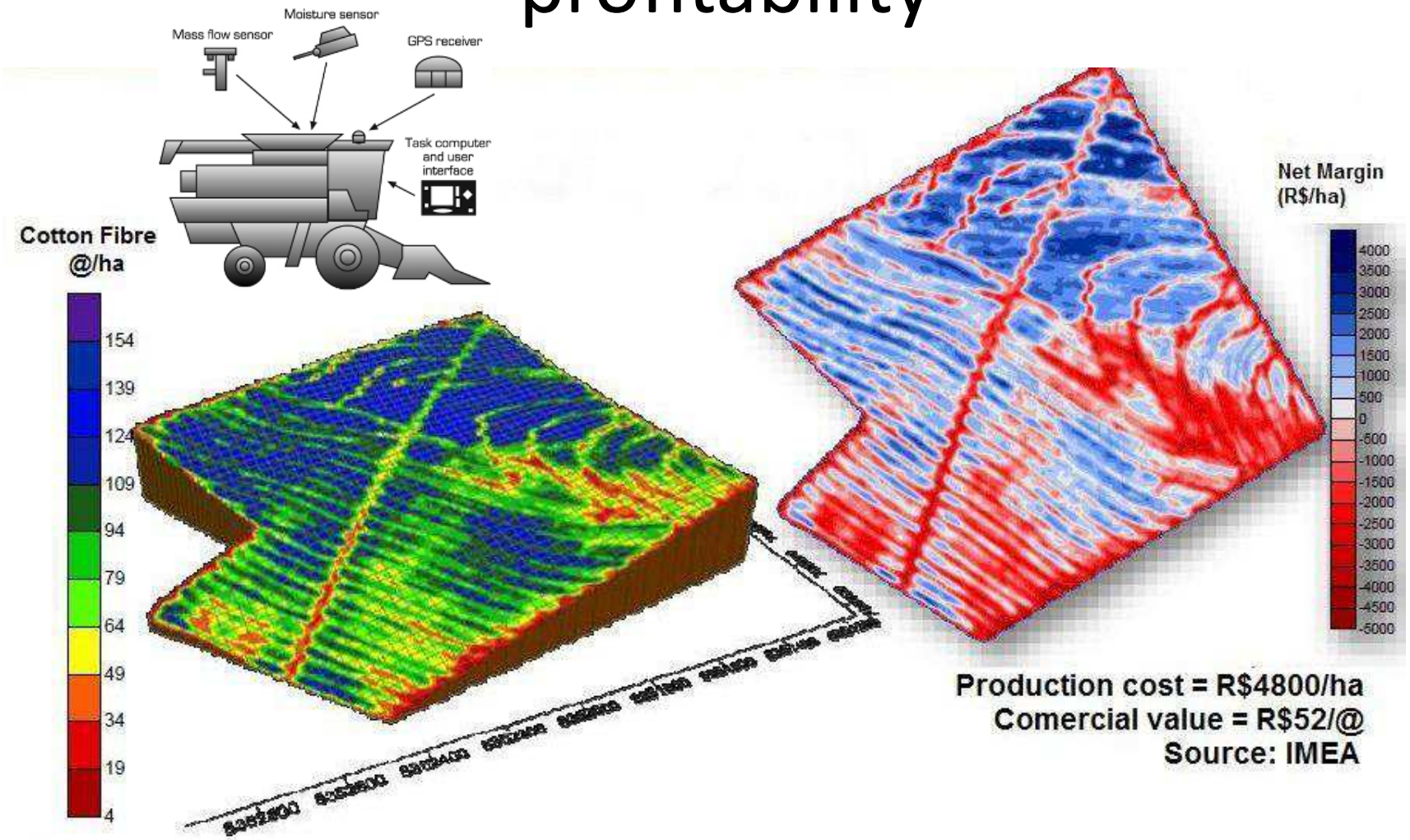
- Spraying liquid material (0/I or variable)

Variable Rate Technologies (VRT)

- Variable rate irrigation



Yield monitor : mapping the profitability



Fundação MT

GAPE

EPIS-CENTRE APPROACH FOR PRECISION AGRICULTURE BASED ON PRECISE SOIL KNOWLEDGE

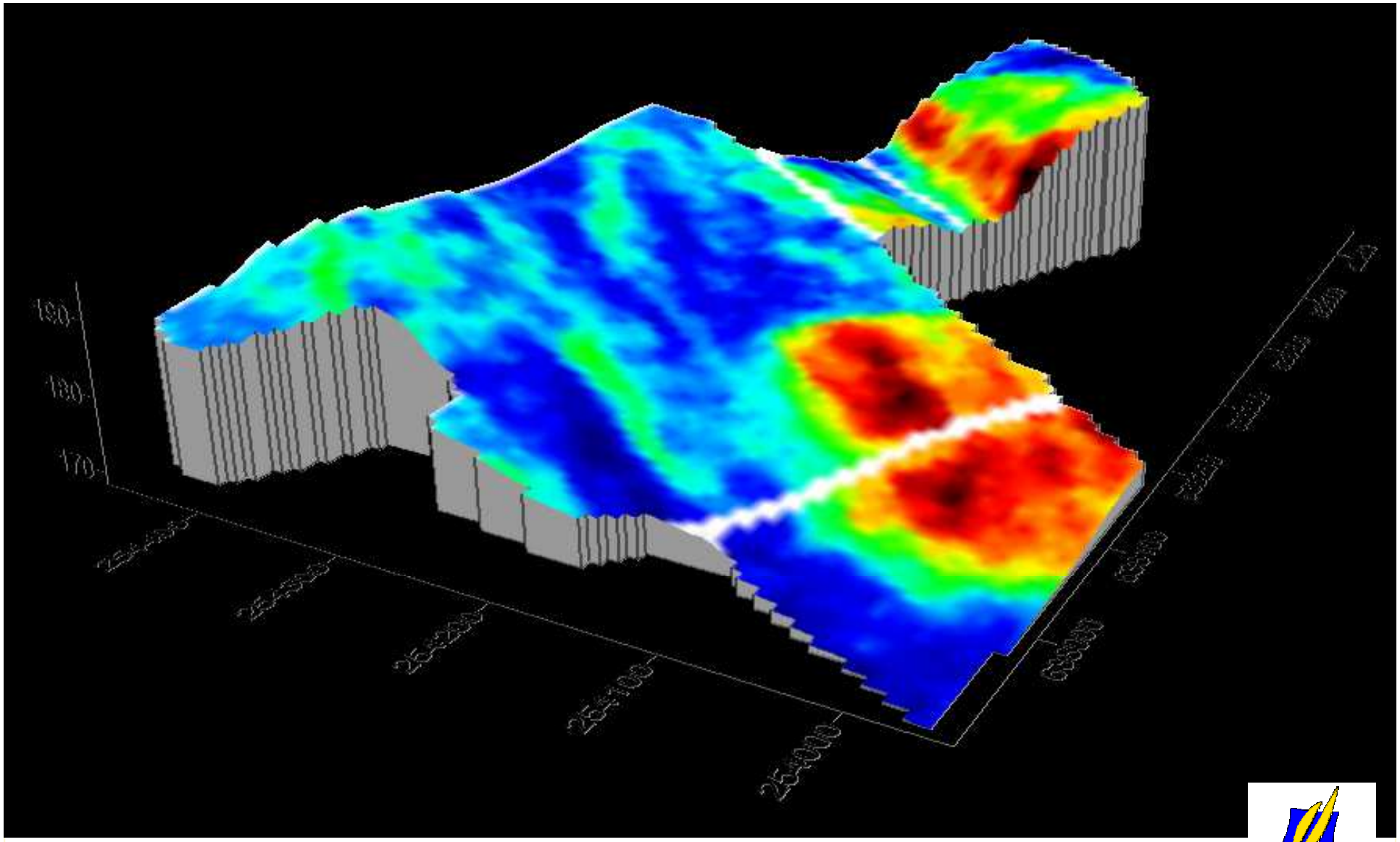
EPIS-CENTRE

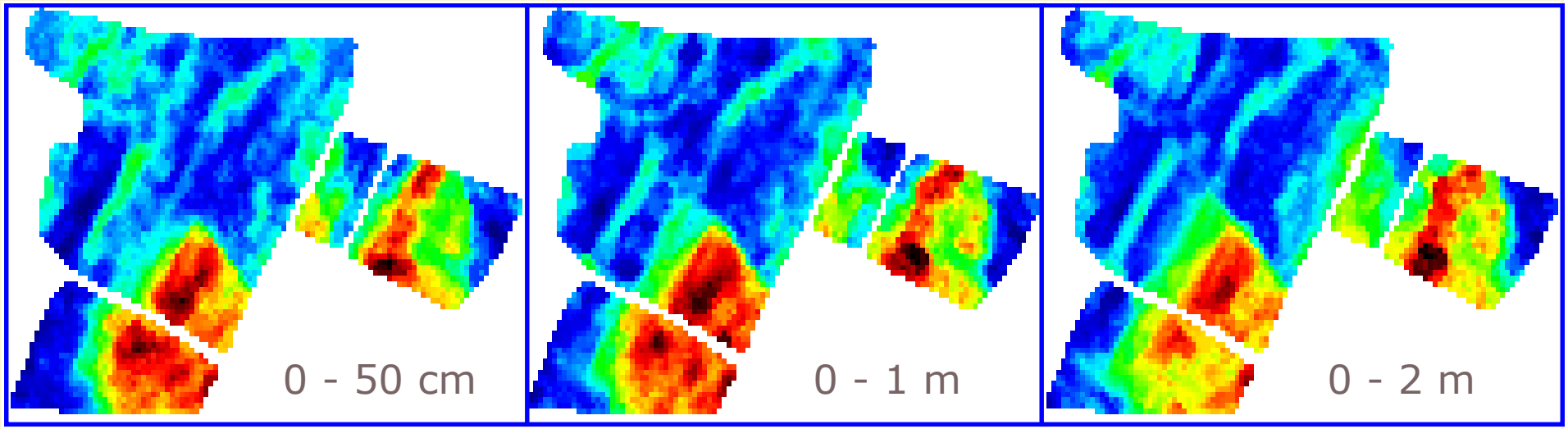
AXEREAL

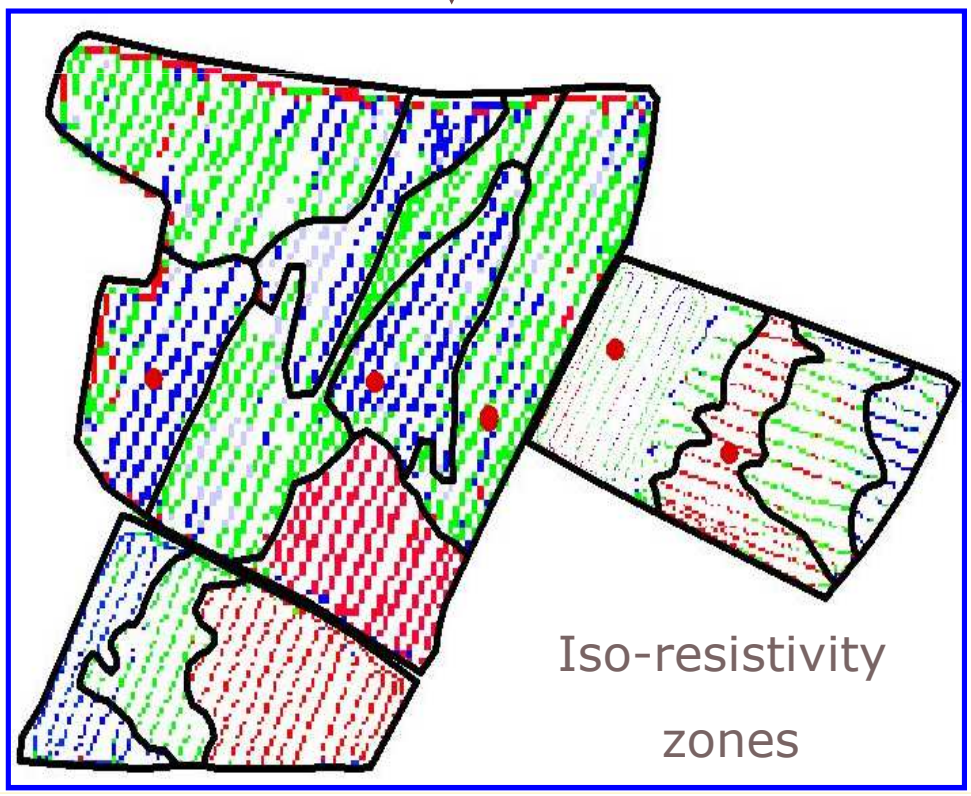
La terre, les hommes, le futur

13.000 members
8 million tons of grain
10% of cereals sold in France

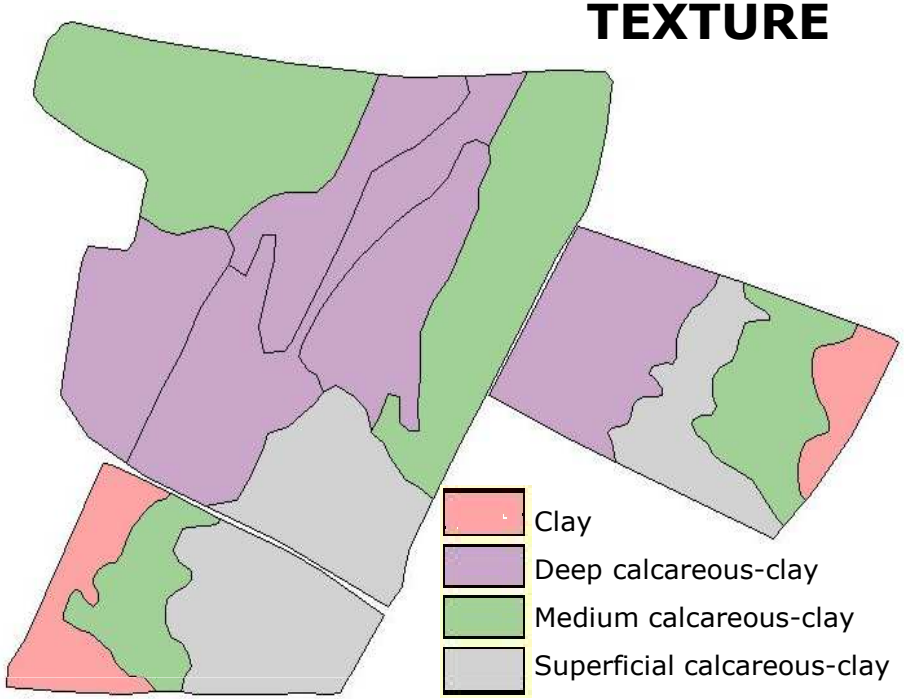
Geophysic mapping: topography and resistivity map



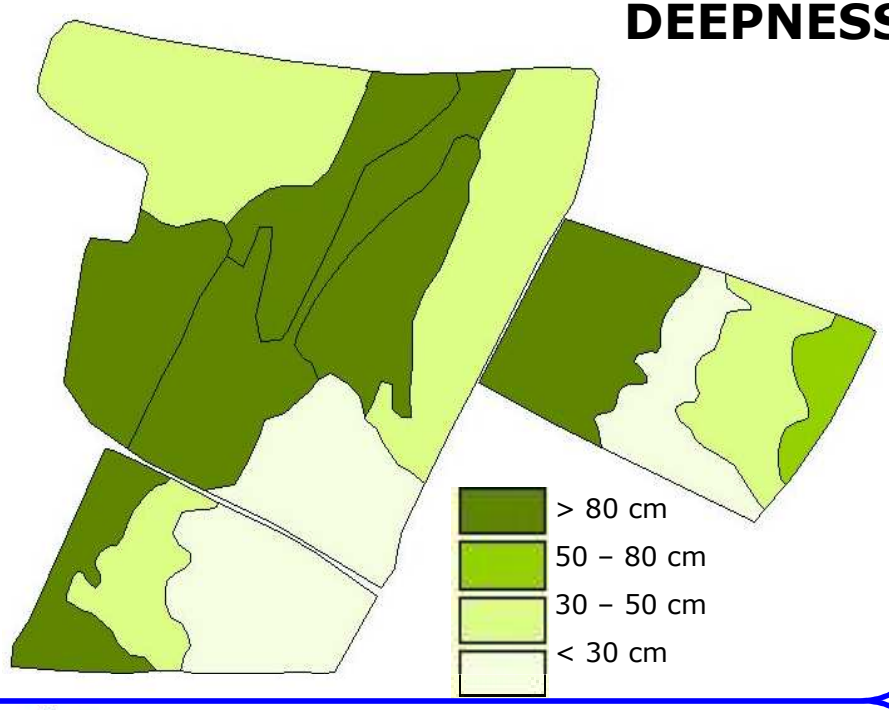

0 - 50 cm
0 - 1 m
0 - 2 m


Iso-resistivity
zones

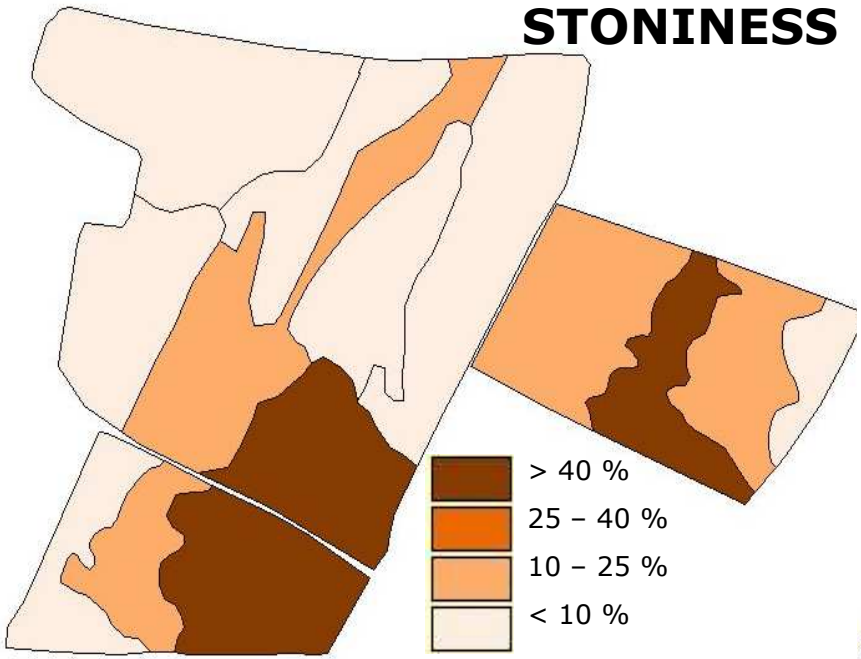
TEXTURE



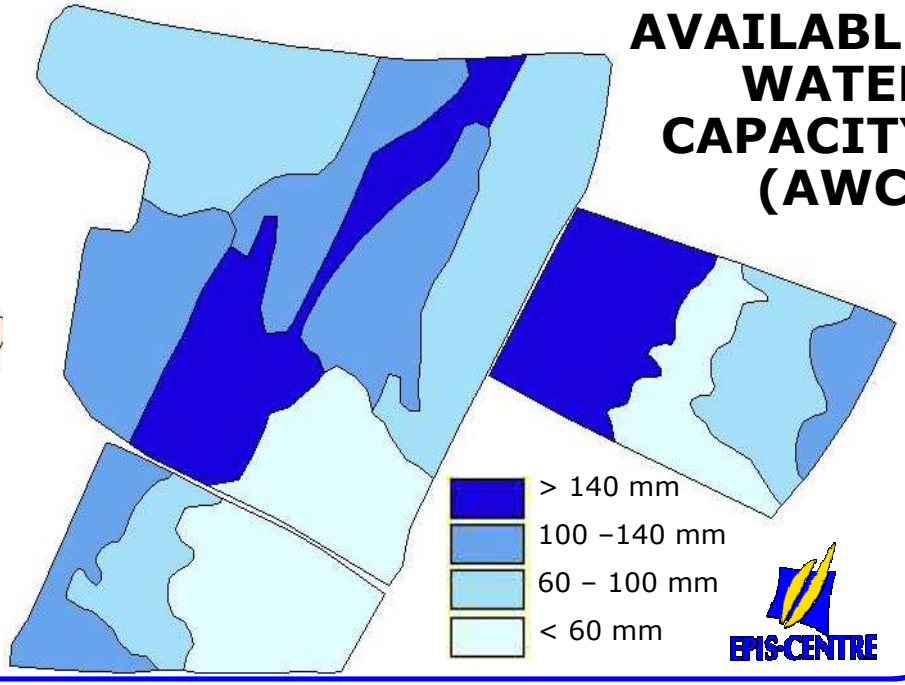
DEEPNESS



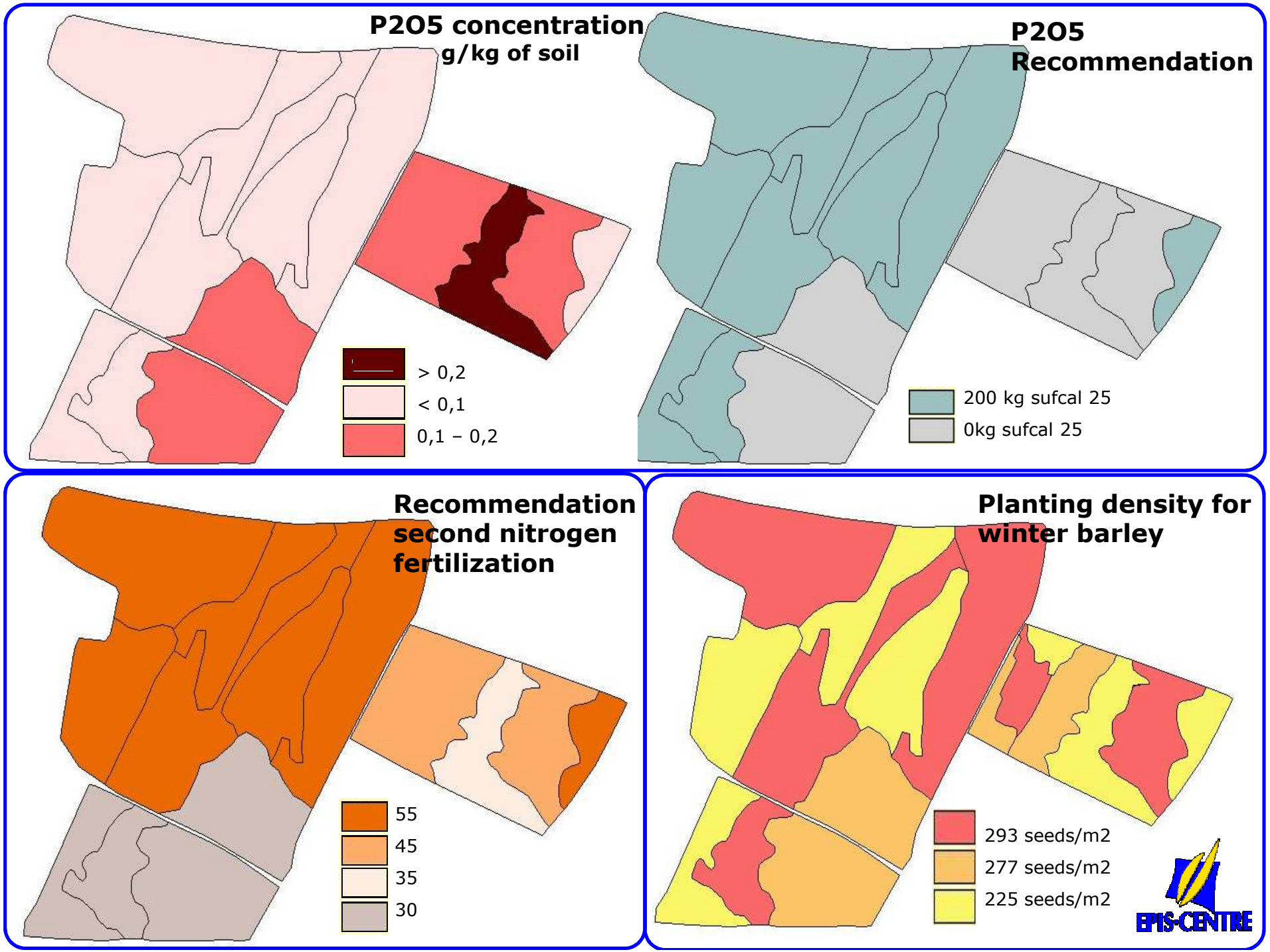
STONINESS



AVAILABLE WATER CAPACITY (AWC)



EPIS-CENTRE


P2O5 concentration
g/kg of soil
> 0,2
< 0,1
0,1 – 0,2
P2O5
Recommendation
200 kg sufcal 25
0kg sufcal 25
Recommendation
second nitrogen
fertilization
55
45
35
30
Planting density for
winter barley
293 seeds/m2
277 seeds/m2
225 seeds/m2
EPIS-CENTRE

SOSUCAM APPROACH FOR PRECISION AGRICULTURE BASED ON PRECISE SOIL KNOWLEDGE ON A 20.000 HA SUGAR CANE PLANTATION

SOMDIAA

€ 489 million turnover
7 african countries
361.000 tons of sugar
Husbandry, processing, distribution

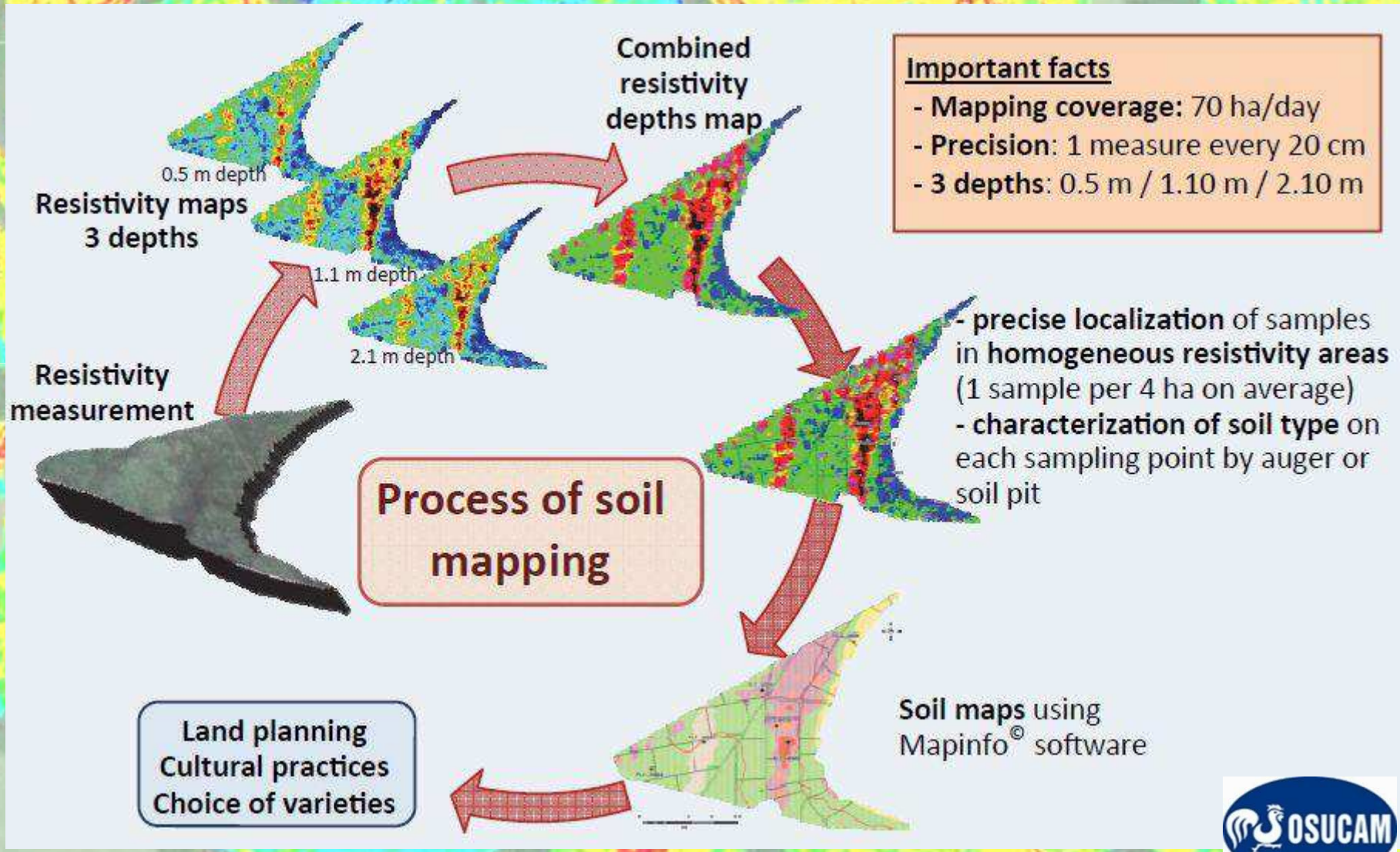
How to adapt agricultural practices according to soil potential and its sensibility to erosion ?

3 STEPS:

1. Soil mapping
2. Land planning through management zone made according to soil variability
3. Adaptation of farming practices for each type of management zone

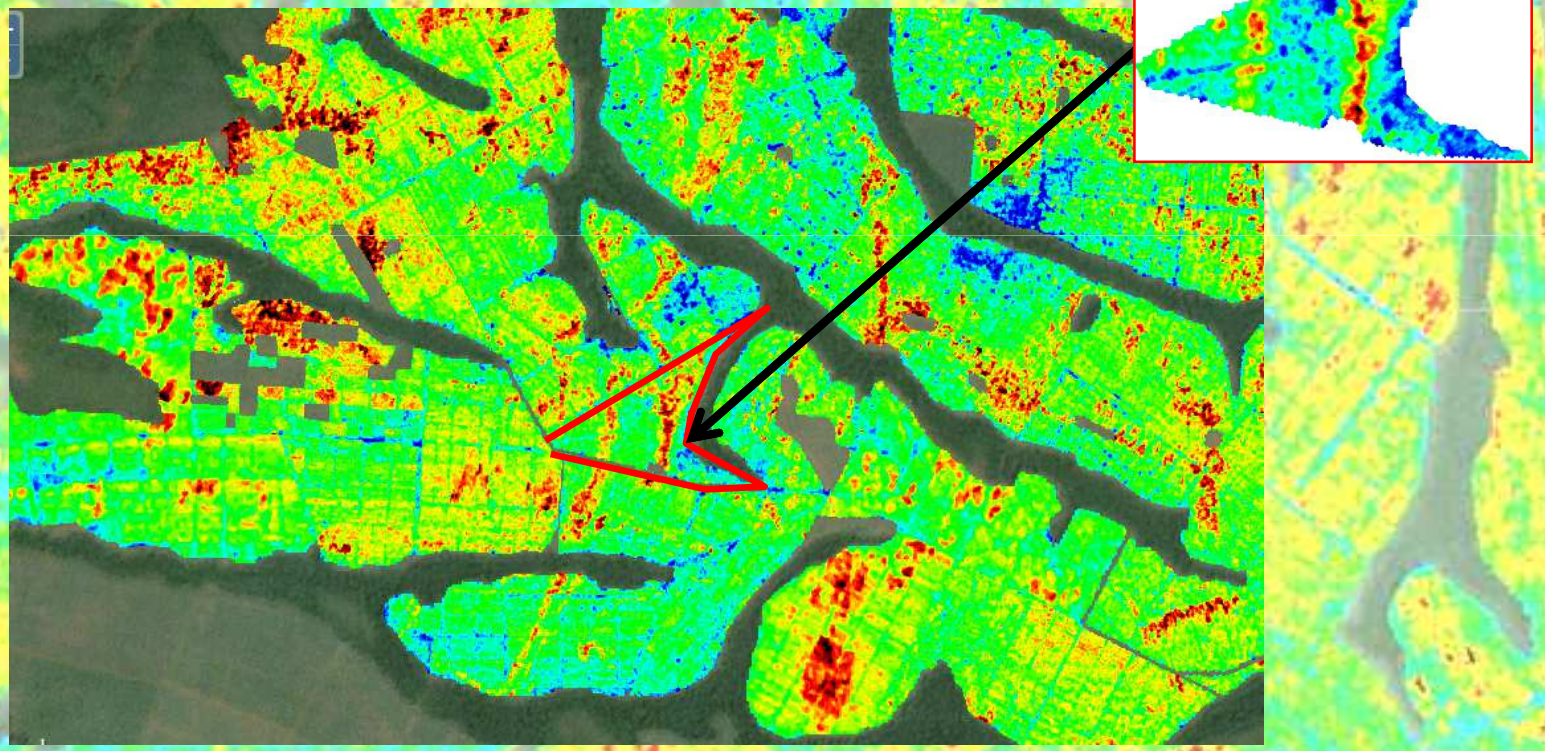
http://www.issct.org/pdf/proceedings/2007/Papers/2007%20Viremouneix,%20ELECTRICAL%20RESISTIVITY%20MEASUREMENTS%20FOR%20FAST%20AND%20PRECISE.pdf (english)
http://www.canne-progres.com/publications/pdf/congres/AG118.pdf (french)

Soil map production



Soil map production

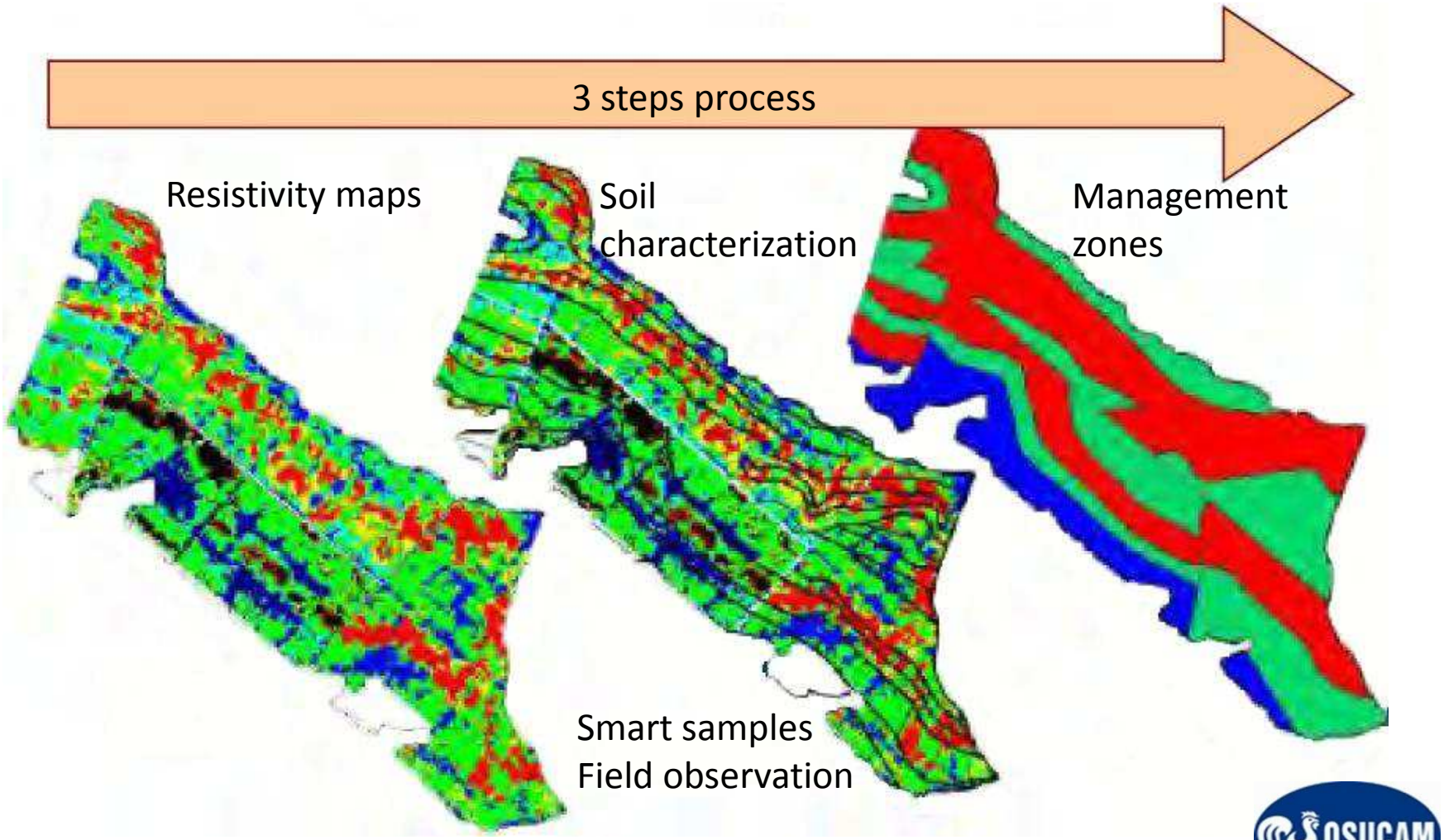
Soil patterns continues out of the fields…



⇒ Soil sampling reduction

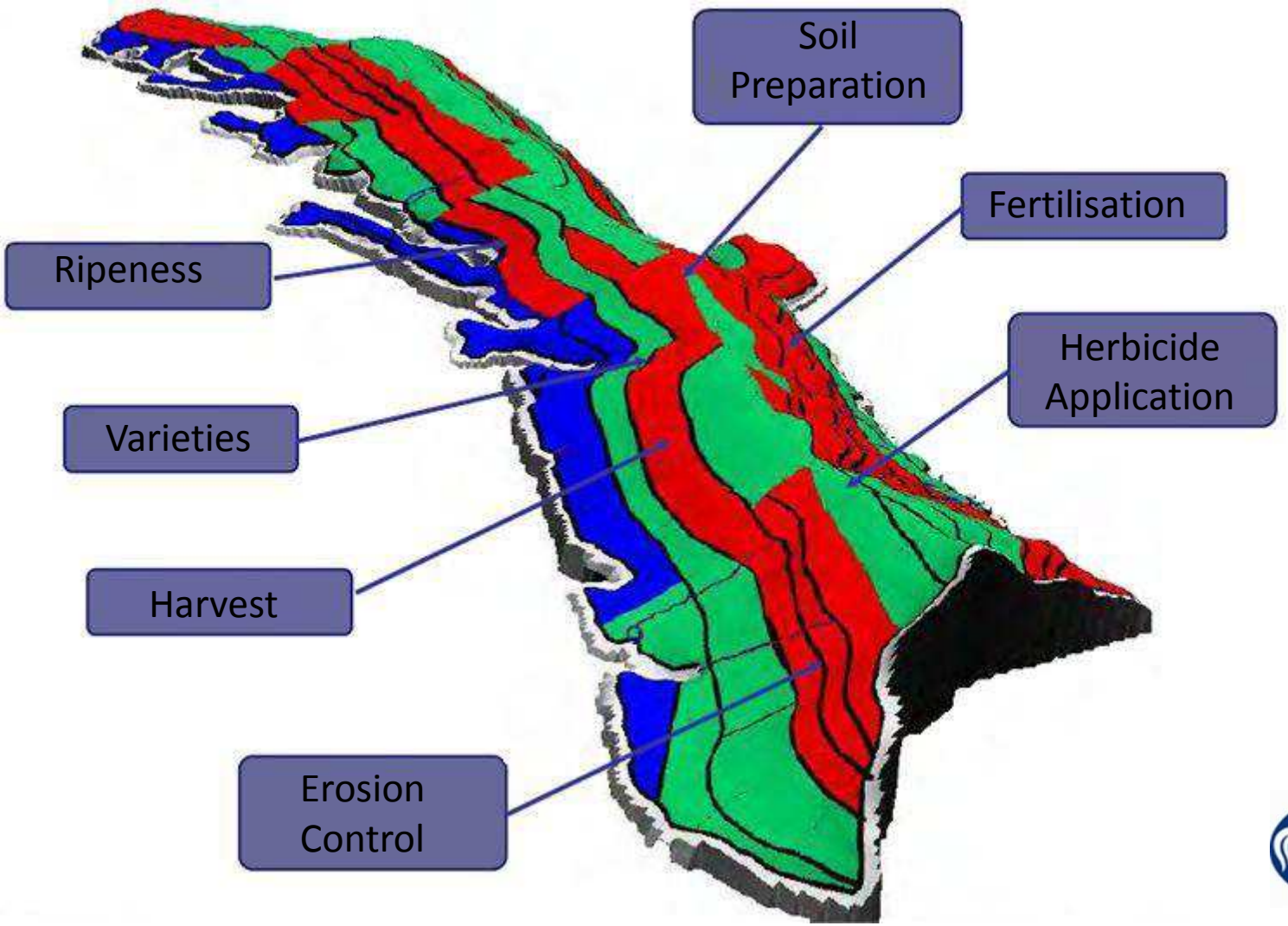
⇒ High resolution maps

Management zone identification



Farming practices

MANY ELEMENTS



Farming practices

Harvest schedule made upon Available Water Capacity (AWC), erosion and mud bogging risks

Hydromorphic soils:
-High AWC
-High risks of compaction and mud bogging
= Harvest in the middle of the harvest periode

Flat oxidized, deep ferralitic soils:
-Good medium AWC
= Harvest at the beginning of the harvest periode

Steep lateritic and gravelly soils:
-Low AWC
-High erosion risks
-Low compaction risks
= Harvest at the end of the harvest periode

Farming practices

Soil preparation, planting practices and varieties adaptation to soil type

Flat oxidized, deep ferralitic soils:
-Disking before furrowing
-Large raw, « controlled traffic »
-Demanding, high potential variety
- Renewal rate: low

Hydromorphic soils:
-Sub-soiling
-Tightened wide row planting
-Variety adapted to humide soil
-Renewal rate: medium

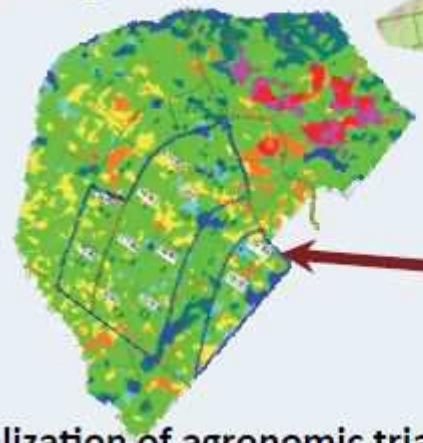
Steep lateritic and gravelly soils:
-Zero-tilage
-Simple row planting
-Variety adapted to low AWC
-Renewal rate: high

Other uses of high-definition soil maps

Field planning

Combined to topography, soil maps are used for land parcel management with a view to:

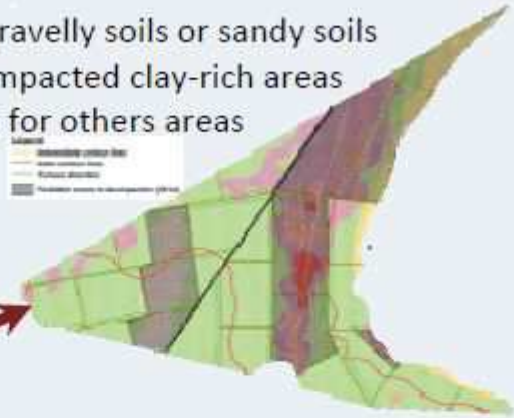
- **matching crop and harvest units** (2-3 hectares squares) with soil types
- **reducing erosion**



Land preparation

Soil mapping is used to define **the most appropriate technical itinerary**:

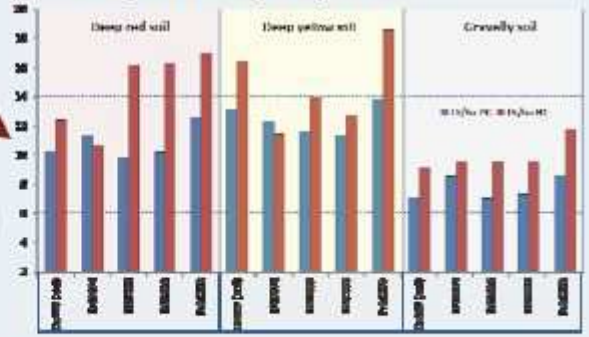
- **zero tillage** for shallow gravelly soils or sandy soils
- **sub-soiling** limited to compacted clay-rich areas
- **disking** before furrowing for others areas



Soil mapping for sustainable farming

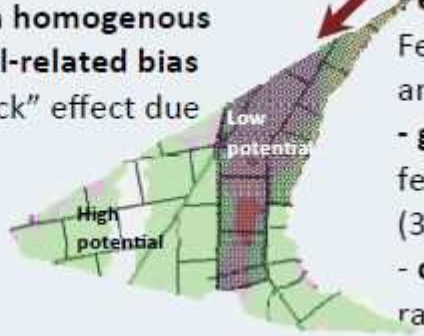
Choice of varieties

Following variety trials, located on main soil types, it is possible to **leverage variety capacities**



Localization of agronomic trials

Localization of trials on **homogenous areas could reduce soil-related bias** by decreasing the "block" effect due to soil heterogeneity



Fertilization

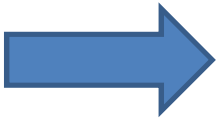
Fertilization is adjusted to soil types and soil potential

- **gravelly and sandy soil:** low mineral fertilizer rates and high scum dose (30 t/ha) to improve fertility
- **deep red soil** : high mineral fertilizer rates and normal scum dose (15 t/ha)

OSUCAM

Does Precision Agriculture Pay?

- Remote Sensing - No
  Great immediate data but no immediate cost savings
- Direct Sensing – No
  More data but you only increase money spent
- Soil Samples – No
  More data but you only increase money spent
- VRT - No/Maybe
  Fields will often require the same amount of input
- Yield Monitors – No
  The farmer receives a lot of data, which helps on management decisions



There is no one silver bullet, but selecting the right combination of Precision Agriculture can decrease input costs, and more importantly increase yield and revenue

EPIS-CENTRE ECONOMIC ANALYSE FOR PRECISION AGRICULTURE PROFITABILITY 2011

EPIS-CENTRE

AXEREAL

La terre, les hommes, le futur

13.000 members
8 million tons of grain
10% of cereals sold in France

PA economic study: investment

Map investment

Agro-pedologic study including: -Electric resitivity mapping -Field observations -Smart sample grid -Sampling (1 sample/5ha) -Laboratory analyses -Data base	€ 75 flat/ha (15 €/ha within a 5 years amortization schem)
Annual recommendation including: -variable rate planting map -variable rate fertilization map -productivity diagnostic	€ 15 flat/ha/year
Total /ha/year (5 years amortization)	€ 30

EPIS-CENTRE

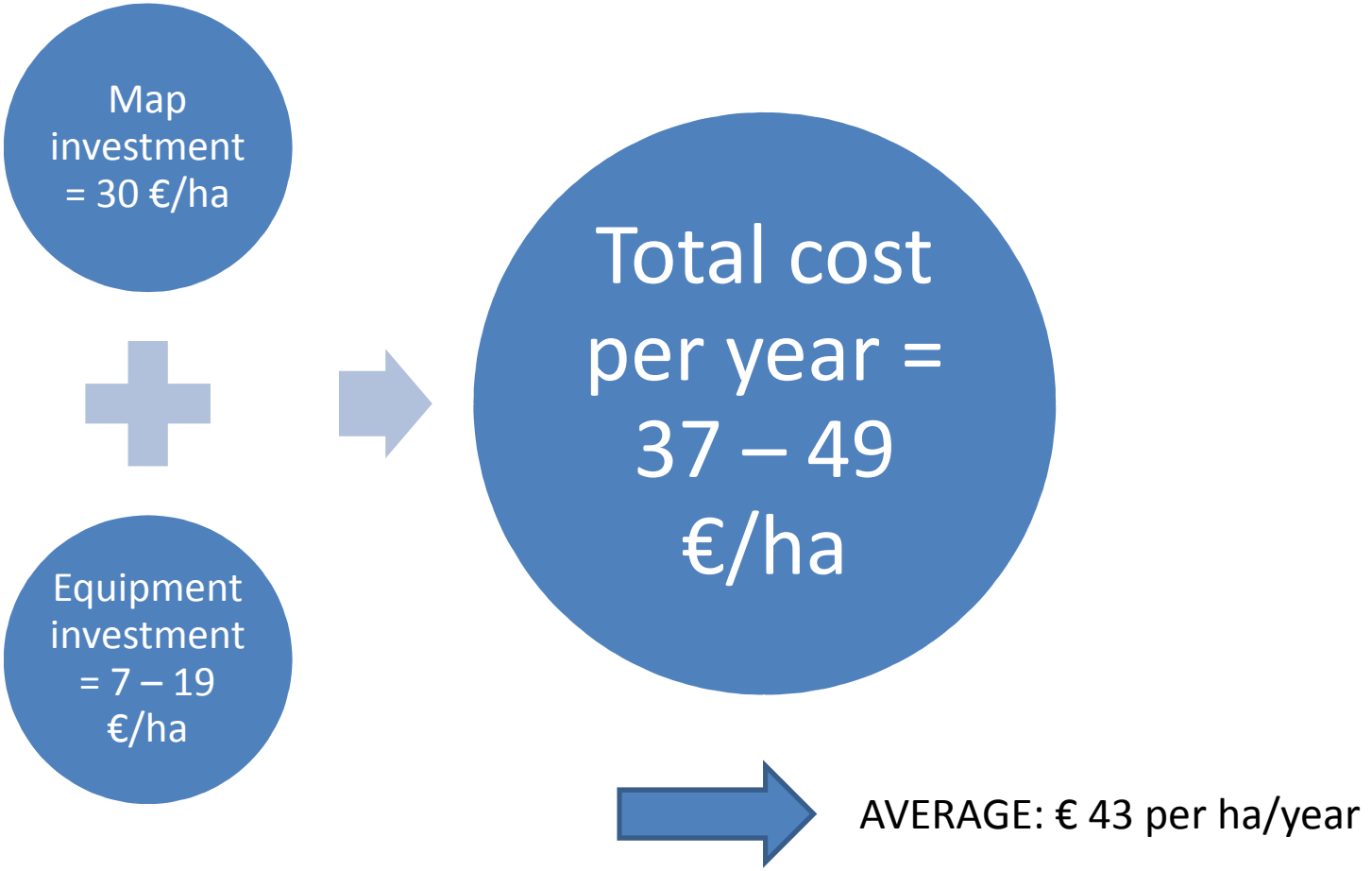
PA economic study: investment

Equipment investment for a 250 ha farm

Equipment for combine and tractor (GPS, computer, software…)	€ 8 200 – € 12 200
Planter adaptation	€ 0 - € 3 000
Spreader adaptation	-
Sprayer adaptation	€ 0 - € 9 000
Total	€ 8200 – € 24 200
Total /ha (ref. 250 ha)	€ 33 - € 97
Total /ha/year (5 years amortization)	€ 7 - € 19

EPIS-CENTRE

PA economic study: investment



Soil type	ACP / LA / A		
	Data base Epis Centre 2011	Precision Agriculture 2011	Difference between Precision Agriculture and Data base
Number of fields	1068	26	
Yield target	39,0	40,5	
Yield	32,0	34,8	**2,8** q/ha
Nitrogen quantity	157	184	**27** U/ha
		Gains from yields	**100,8** €/ha
		Gains from Nitrogen	**-19,2** €/ha
		Gains from planting, P and K	**38,0** €/ha
		Total Gain	**119,6** €/ha
		AP cost	**43** €/ha
		NET Gain	**77 €/ha**

Soil type	ACS		
	Data base Epis Centre 2011	Precision Agriculture 2011	Difference between Precision Agriculture and Data base
Number of fields	749	27	
Yield target	37,0	38,0	
Yield	28,0	30,3	**2,3** q/ha
Nitrogen quantity	165	178	**13** U/ha
		Gains from yields	**82,8** €/ha
		Gains from Nitrogen	**-9,2** €/ha
		Gains from planting, P and K	**38,0** €/ha
		Total Gain	**111,6** €/ha
		AP cost	**43** €/ha
		NET Gain	**69 €/ha**

Soil type	L / LS / S		
	Data base Epis Centre 2011	Precision Agriculture 2011	Difference between Precision Agriculture and Data base
Number of fields	765	14	
Yield target	38,0	40,2	
Yield	30,0	33,6	**3,6** q/ha
Nitrogen quantity	155	180	**25** U/ha
		Gains from yields	**129,6** €/ha
		Gains from Nitrogen	**-17,8** €/ha
		Gains from planting, P and K	**38,0** €/ha
		Total Gain	**149,9** €/ha
		AP cost	**43** €/ha
		NET Gain	**107 €/ha**

Rapeseed

Harvest 2011

Average Nitrogen price	0,71 €/Unity
Average rapeseed price	36 €/q

EPIS-CENTRE

Winter wheat

Harvest 2011 687

Soil type	ACP / LA / A		
	Data base Epis Centre 2011	Precision Agriculture 2011	Difference between Precision Agriculture and Data base
Number of fields	1205	34	
Yield target	80,0	85,0	
Yield	63,0	67,8	4,8 q/ha
Nitrogen quantity	156	174	18 U/ha
		Gains from yields	81,6 €/ha
		Gains from Nitrogen	-12,8 €/ha
		Gains from planting, P and K	38,0 €/ha
		Total Gain	**106,8** €/ha
		AP cost	43 €/ha
		NET Gain	**64 €/ha**

	Data base Epis Centre 2011	Precision Agriculture 2011	Difference between Precision Agriculture and Data base
Number of fields	779	20	
Yield target	77,0	81,0	
Yield	56,7	56,8	**0,1** q/ha
Nitrogen quantity	165	155	**-10** U/ha
		Gains from yields	**1,7** €/ha
		Gains from Nitrogen	**7,1** €/ha
		Gains from planting, P and K	**38,0** €/ha
		Total Gain	**46,8** €/ha
		AP cost	**43** €/ha
		NET Gain	**4 €/ha**

Soil type	L / LS / S		
	Data base Epis Centre 2011	Precision Agriculture 2011	Difference between Precision Agriculture and Data base
Number of fields	763	16	
Yield target	77,0	83,0	
Yield	59,0	64,8	**5,8** q/ha
Nitrogen quantity	152	132	**-20** U/ha
		Gains from yields	**98,6** €/ha
		Gains from Nitrogen	**14,2** €/ha
		Gains from planting, P and K	**38,0** €/ha
		Total Gain	**150,8** €/ha
		AP cost	**43** €/ha
		NET Gain	**108 €/ha**

Average Nitrogen price	0,71 €/Unity
Average wheat price	17 €/q

EPIS-CENTRE

Financial results

Investment(ref. 250 ha)

- Maps: 18 750 € + 15 €/ha/year
- Equipement: 8 200 - 24 200 €

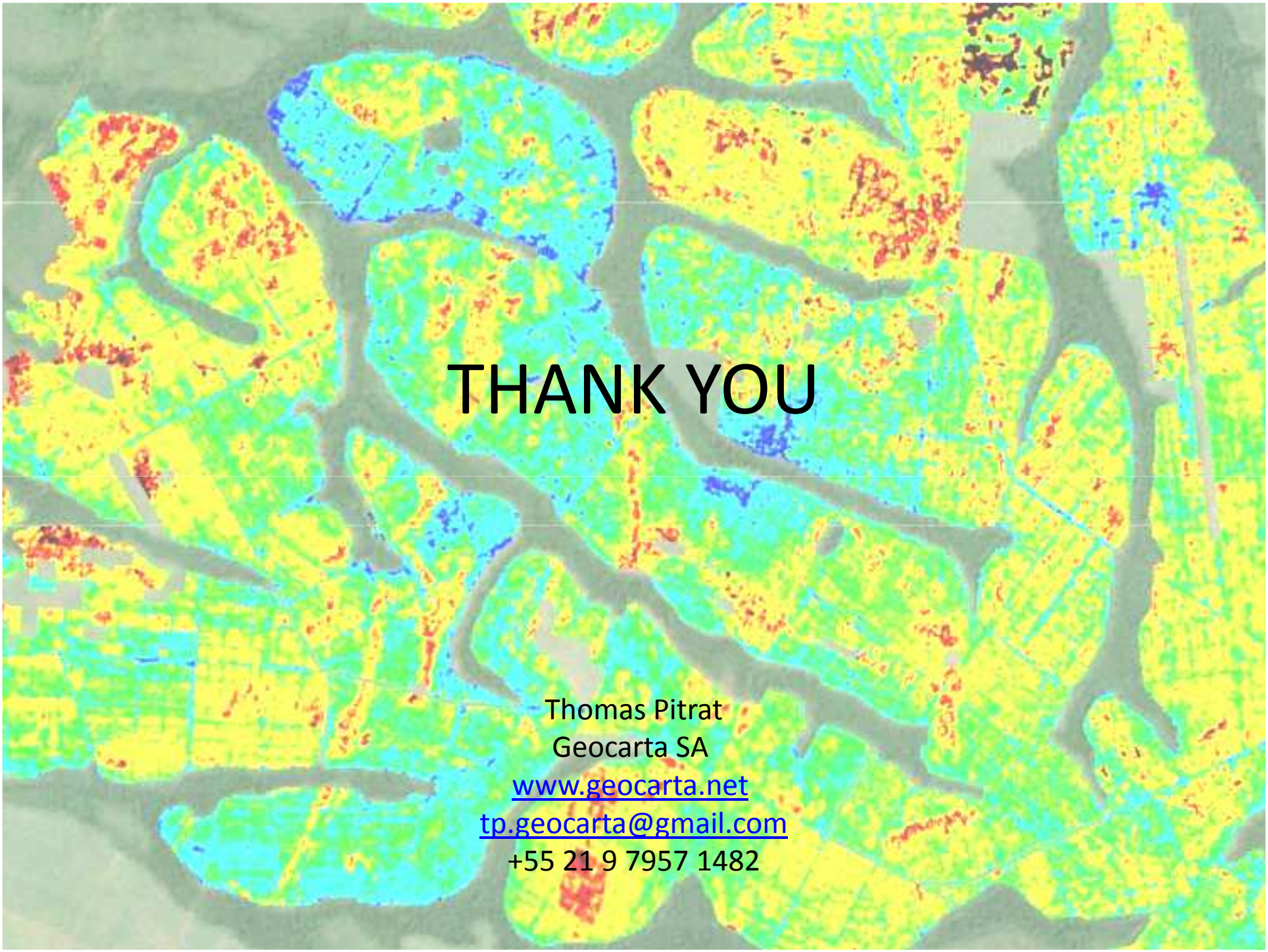
TOTAL = 37 - 49 €/ha/year

Financial results

Total gain (réf. 2 years = rapeseed + wheat):
average 115 €/ha/year

Net result/ha: € 66 to € 78
Environmental balance:
20 to 40 u lower

EPIS-CENTRE



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