Centrifugal spreader eco-evaluation method: Sulky Econov example

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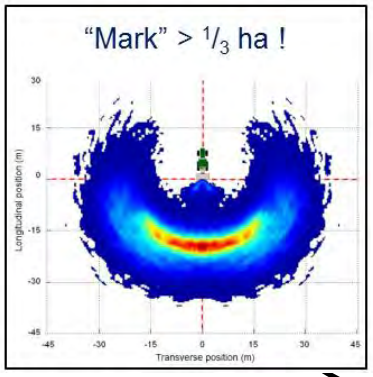
Introduction

- great majority: fertiliser spreading = centrifugal spreader
  - small (~[3m × 2m]) / easy to handle, maintain,
  - very efficient (high work speeds and working widths),
  - adapted to numerous types of granules to spread,

Wind effect

Field geometry

In order to achieve a rate objectiv

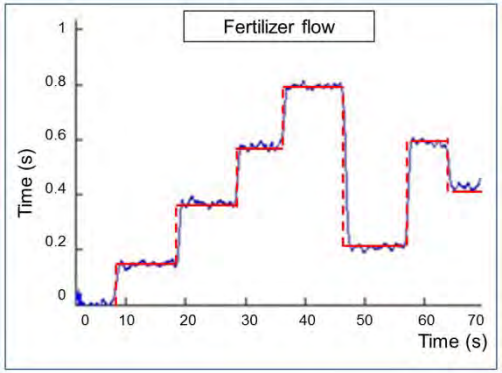


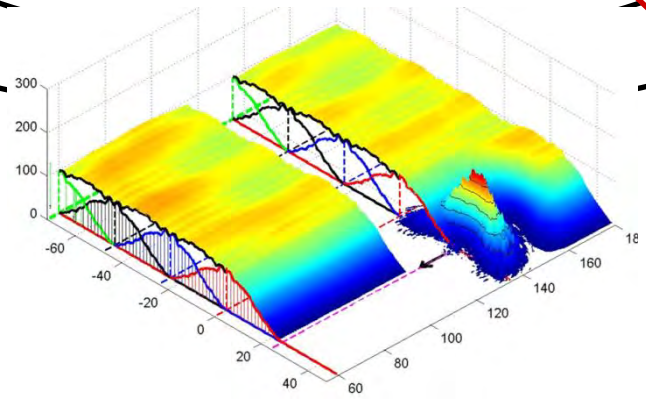
Spreading= Cross of intrinsic caracteristics

Distributed spread pattern « Mark »

X

Flow « Multiplier »





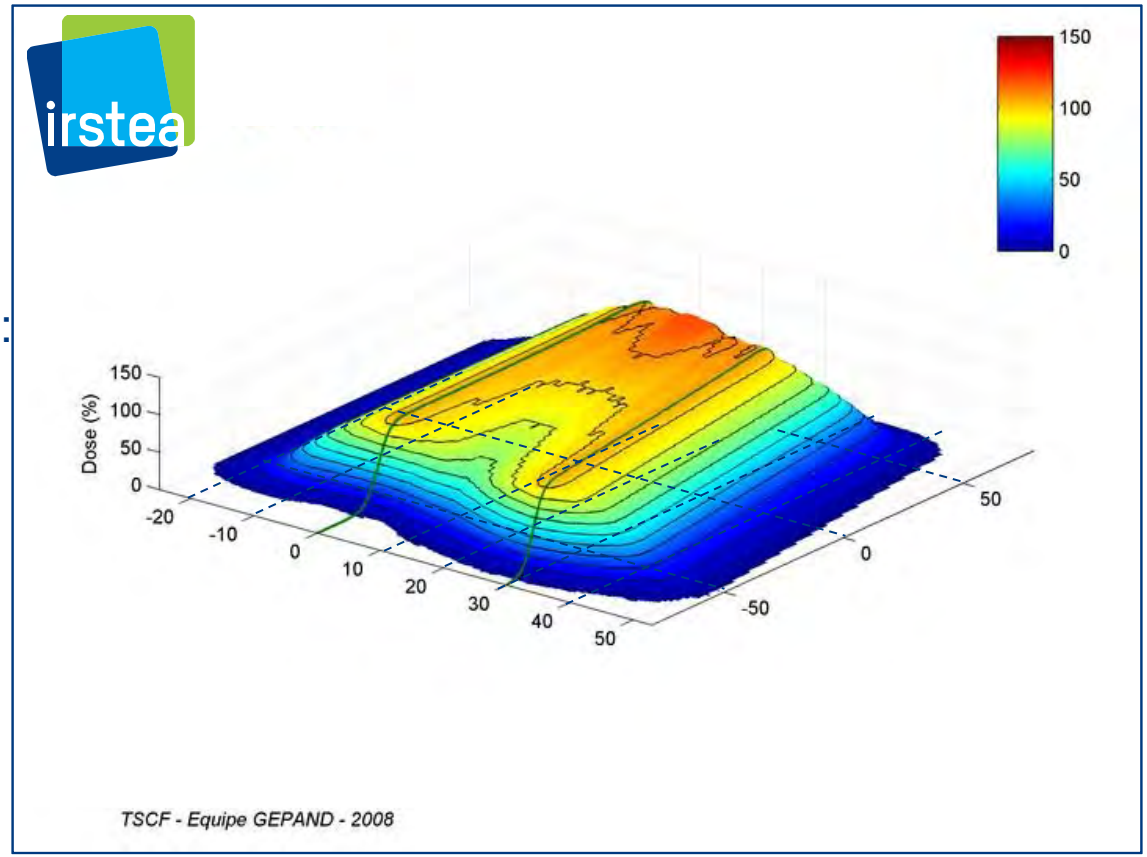
Fertilizer variability:
- Mécanical = form / size / density, …
- Chemical (N, P, K, MO, …)

Field elevation variations

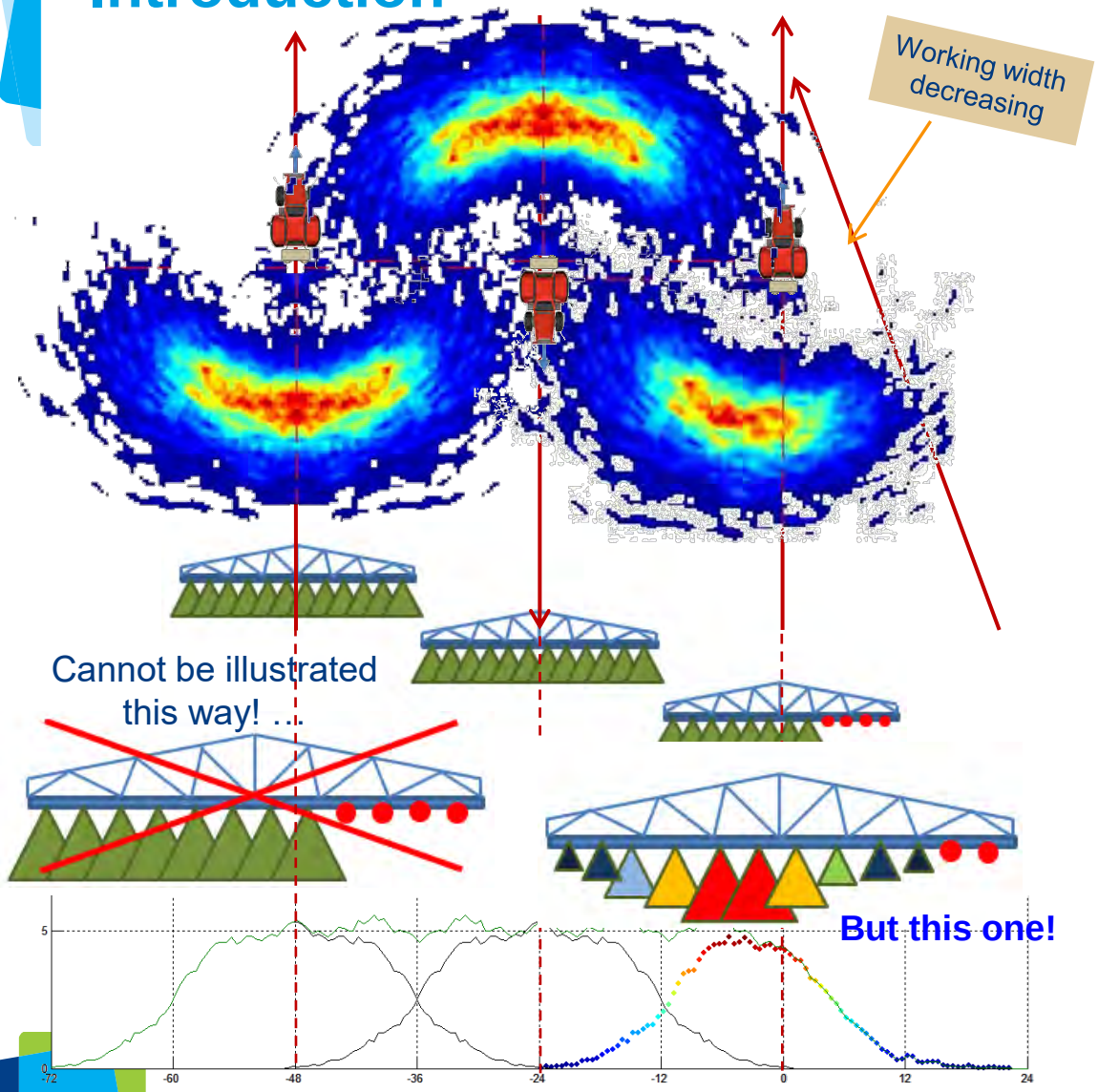
Introduction

- great majority: fertiliser spreading = centrifugal spreader
  - small (~[3m × 2m]) / easy to handle, maintain,
  - very efficient (high work speeds and working widths),
  - adapted to numerous types of granules to spread,

- Transverse curve analyse:
  - Correct as soon as tramlines are regular,
  - Not representative of field reality for variable tramlines, real fields.
- Section control technologies:
  - Developed to optimize field distribution.



Introduction



What's section control?

Section control :

Centrifugal spreader Comportement
(**Continuous** Flow rate + working width Adjustement)

Sprayer comportement
(**On/off** flow on spray nozzle)

Introduction

Agenda:

- Method used to evaluate at the field level
- Application to Econov section control evaluation
  * Econov device
  * Data acquisition
  * Developed and used simulator
  * Obtained maps for actuator states
- Results and conclusion

Which method to evaluate at the field level?

Testing GPS section control

Five lines of 22 trays collected fertiliser as the spreader travelled converging tramlines.

Econov Profi test 2015

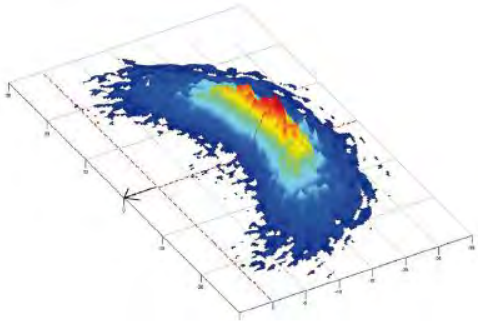
- Too heavy
- Long to get results
- Not representative of all the field
- Subject to random effects

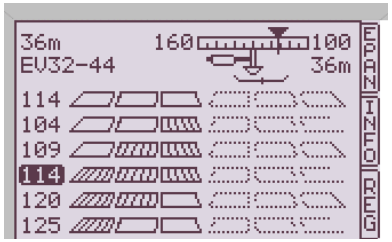
→ New method

Econov evaluation example

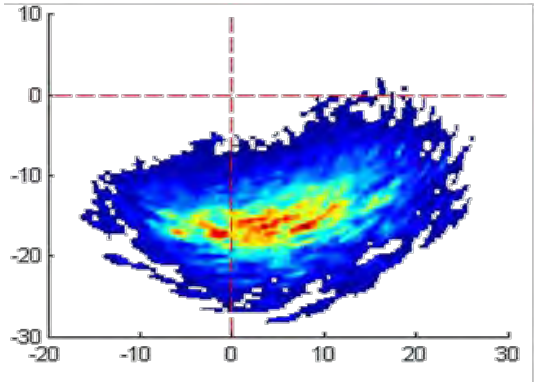
ECONOV: adapts the centrifugal spreading according to the shape of the field = Section Control

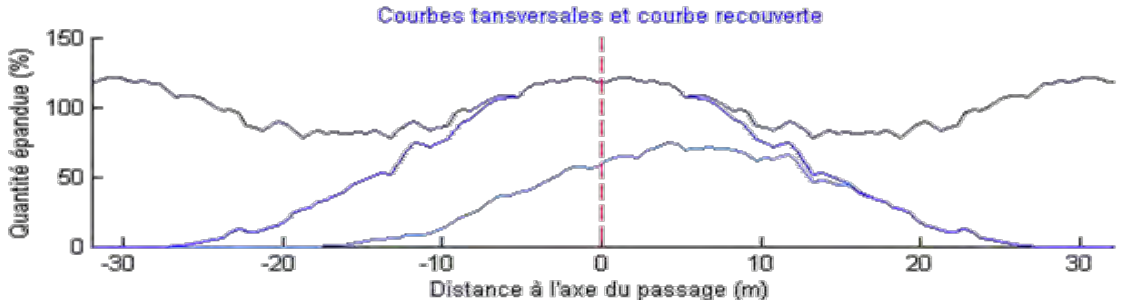
Econov presentation





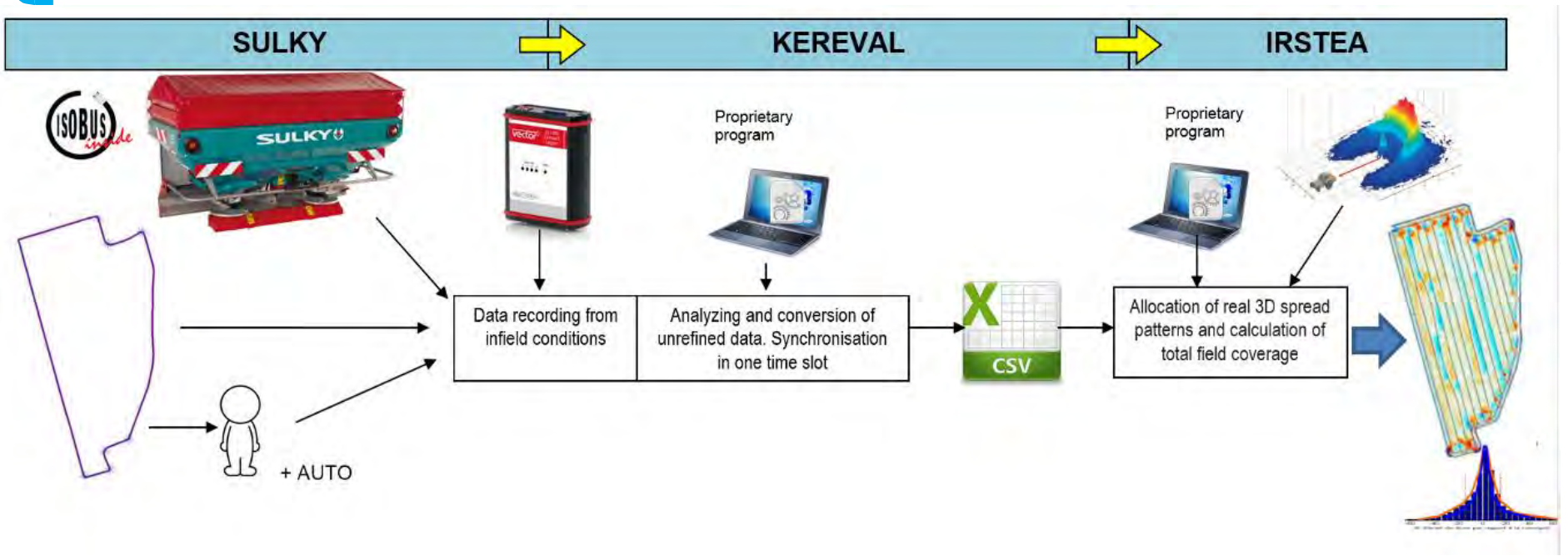
Distribution homogeneity is automatically optimized using the fertilizer drop point adjustment which induces an angular variation of the spread pattern position





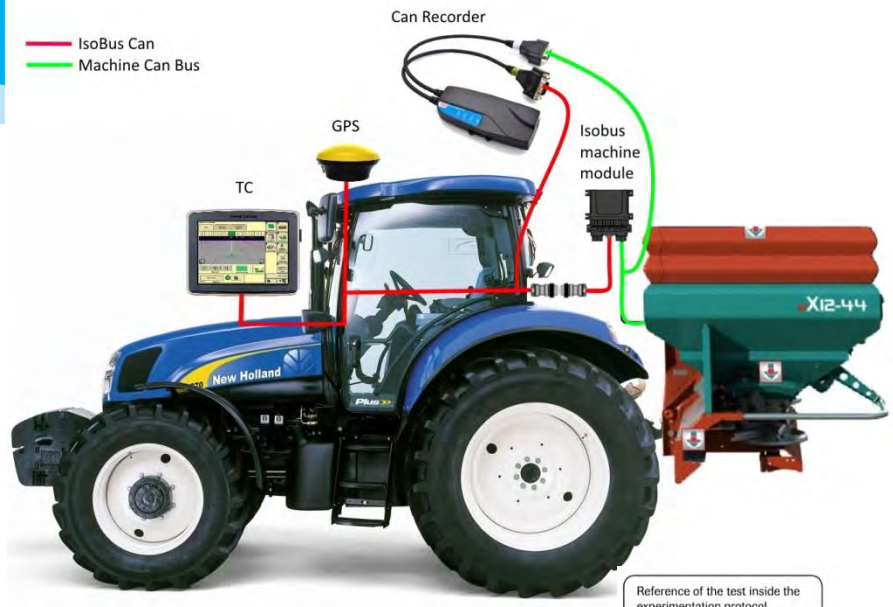
Econov evaluation example

Successives followed steps



- 2 field geometries
- 2 spreader drinving ways: manually / Automatic Econov
- 2 fertilizers (i.e. 2 transverse curves)

Econov evaluation example



Spreader state data acquisition step

Three types of acquisition

- From ISOBUS bus (data transferred between task controller and spreader) = **Section Control informations**
- From proprietary CAN bus (“in live” data of all sensors and actuators of the spreader: ex. real target rate, width of work adjustment, etc)
- GPS informations. They were proprietary messages: interception of frames for the display on the UT.

Data reorganization:

- Select only valuable datas (from 1.5 million frames per bus)
- Resample at the same timeslot

vector

Reference of the test inside the experimentation protocol

Parcelle 1	Mode manuel	fichier 1
	Mode auto/Econov	fichier 2
Parcelle 2	Mode manuel	fichier 3
	Mode auto/Econov	fichier 4

MATLAB

Fichier 2	Serie nmea				Consigne ISOBUS												Réel relevé sur la machine CAN RDS							
temps	latitude	longitude	cap	vitesse	tronçon 1	tronçon 2	tronçon 3	tronçon 4	tronçon 5	tronçon 6	tronçon 7	tronçon 8	tronçon 9	tronçon 10	tronçon 11	tronçon 12	réel goulotte g	réel goulotte d	réel débit g	réel débit d	réel S&G g	direction g	réel S&g d	direction d
s	°	°	°	km/h																				
0,00	0,000000	0,000000	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0,20	0,000000	0,000000	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0,40	0,000000	0,000000	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0,60	0,000000	0,000000	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0,80	48,052076	0,000000	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128
1,00	48,052076	13,860765	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128
1,20	48,052076	13,860765	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128
1,40	48,052076	13,860765	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128
1,60	48,052076	13,860765	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128
1,80	48,052076	13,860765	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128
2,00	48,052076	13,860765	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128
2,20	48,052076	13,860765	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128
2,40	48,052076	13,860765	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128
2,60	48,052076	13,860765	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128
2,80	48,052076	13,860765	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128
3,00	48,052076	13,860765	0	0,00	0	0	0	0	0	0	0	0	0	0	0	0	167	169	0	0	1	128	2	128

Interpretation of all data coming from GPS NMEA

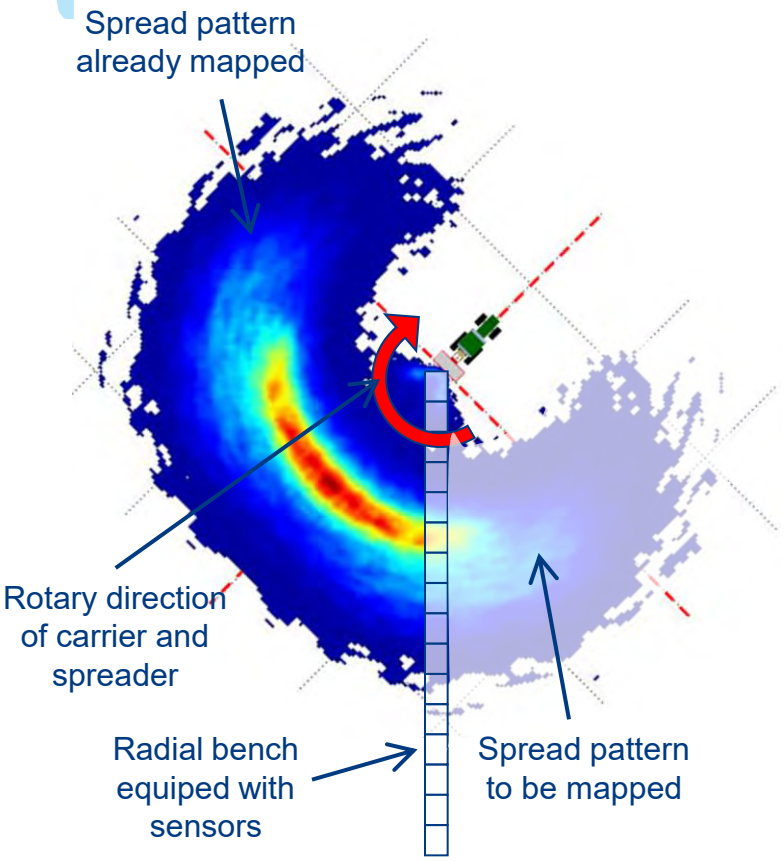
Intetrpretation of all data coming from ISOBUS bus. Task controller

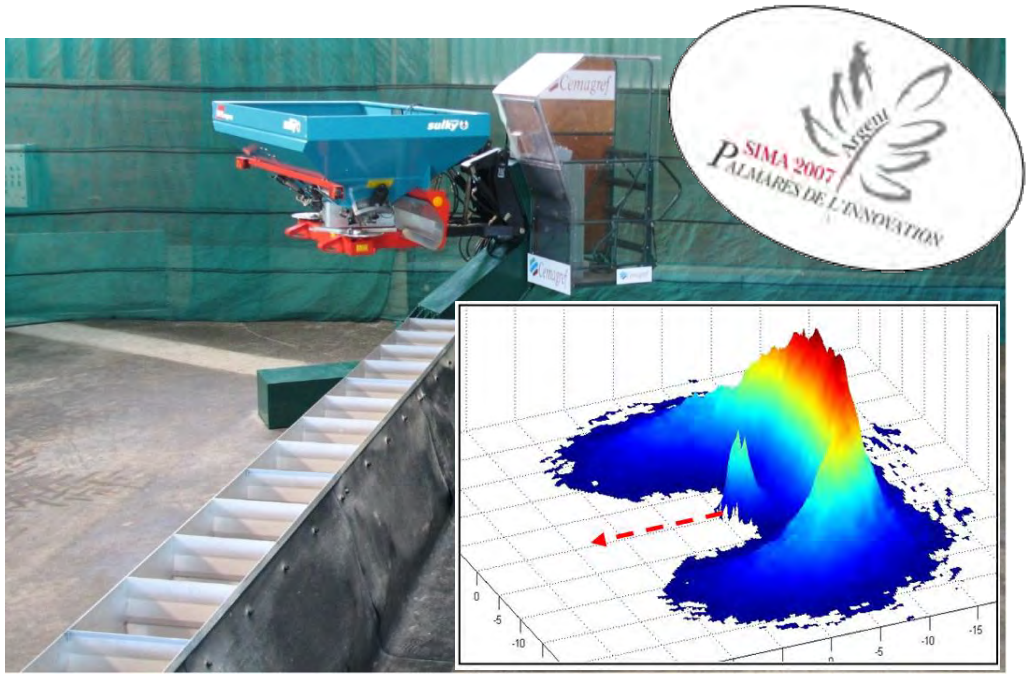
Interpretation of all data coming from proprietary CAN bus

Econov evaluation example

Spread pattern acquisition step

Use of CEMIB Bench





- Many different working width configurations measured
- Fit calculation for all potential working cases

Econov evaluation example

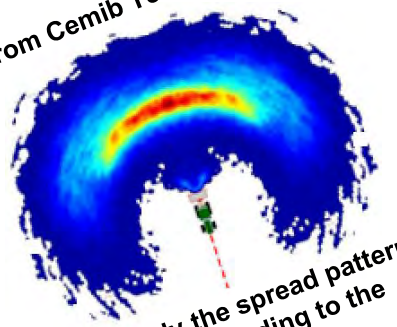
Field spreading simulation step

3. Random selection of particles regarding the flow rate (Monte-carlo simulation)

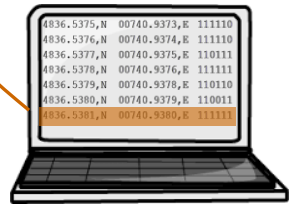
4. Rate map result after data processing (Filed fixed grid)

5. Rate histogram on field processed data

From Cemib Test bench



2. Apply the spread pattern corresponding to the sensor states

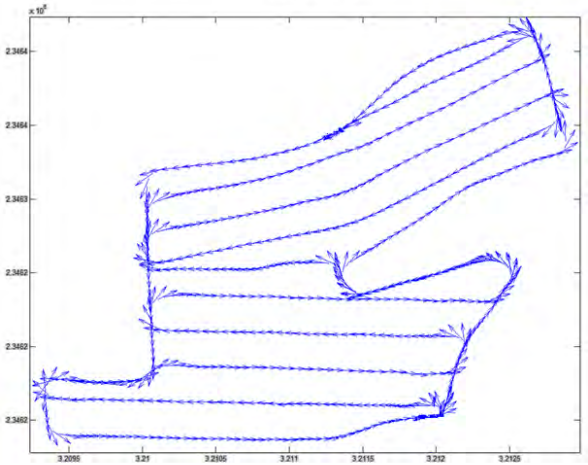


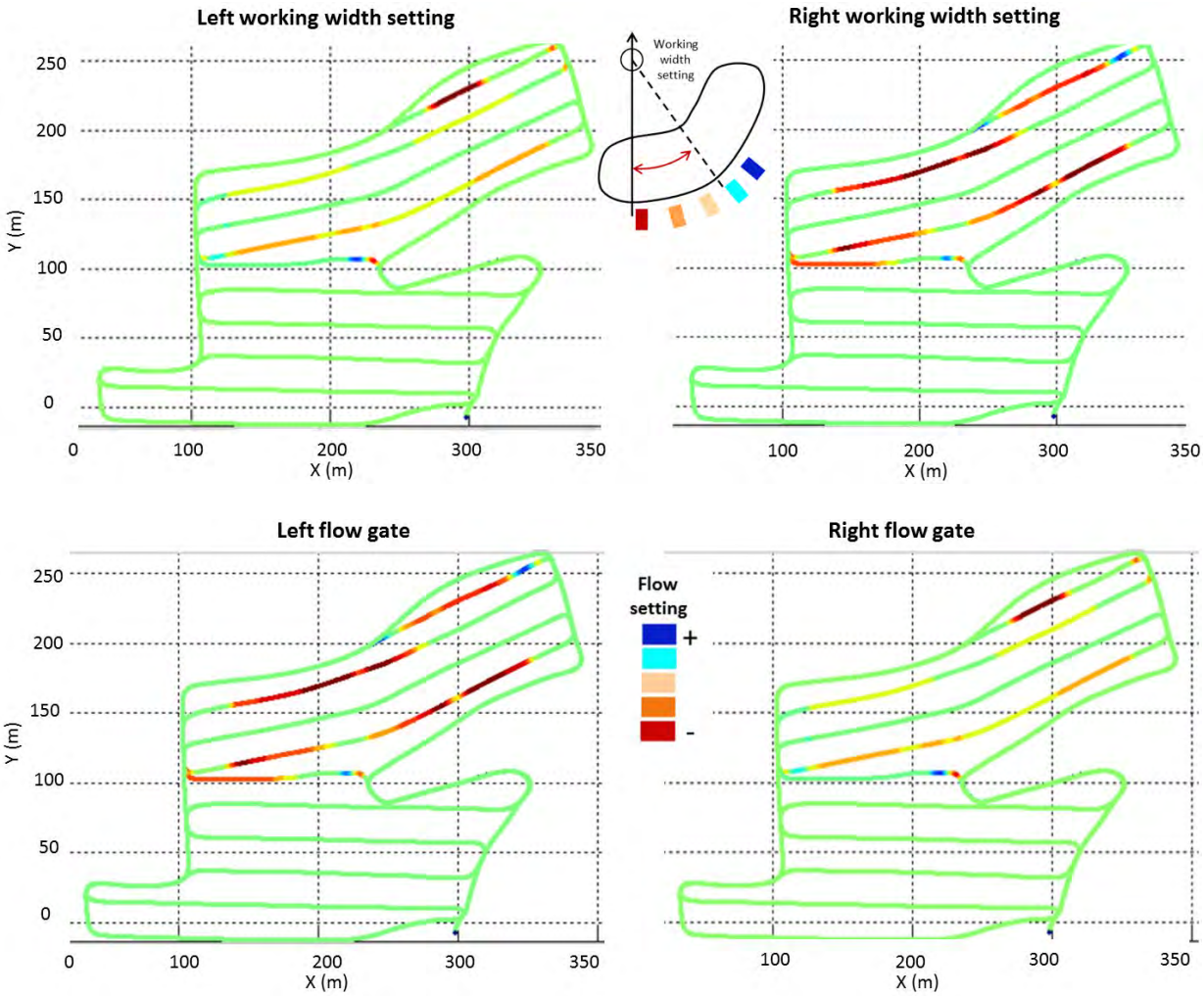
1. Sensor states + GPS recording

Econov evaluation example

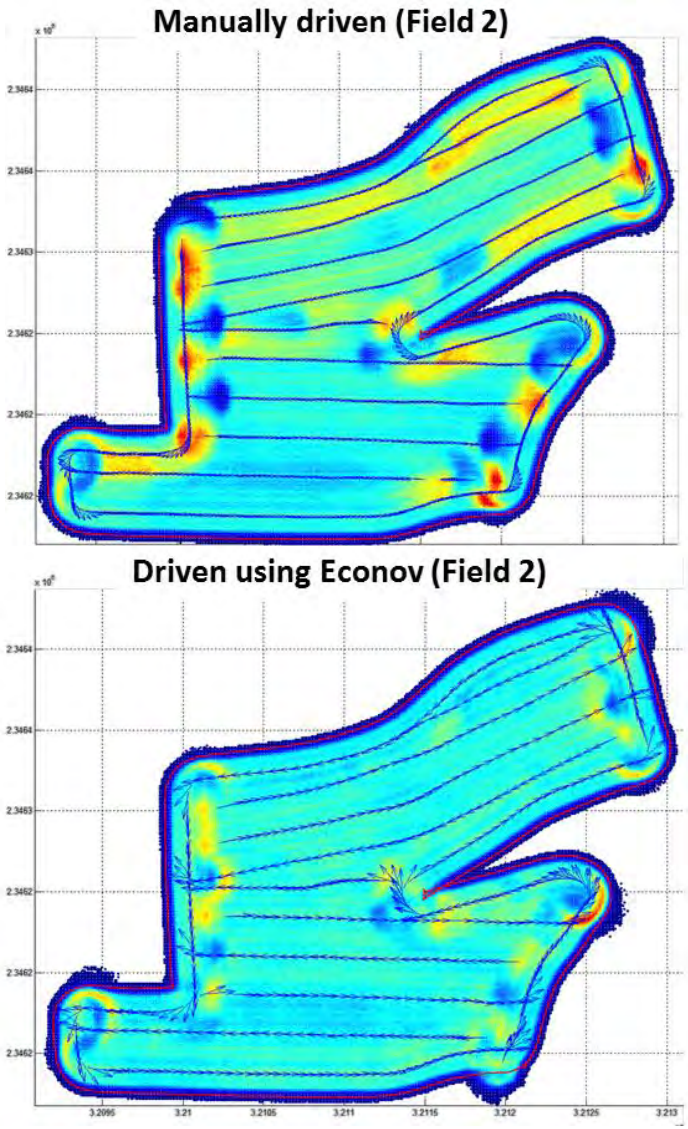
Obtained spreader state maps

Field N. 2

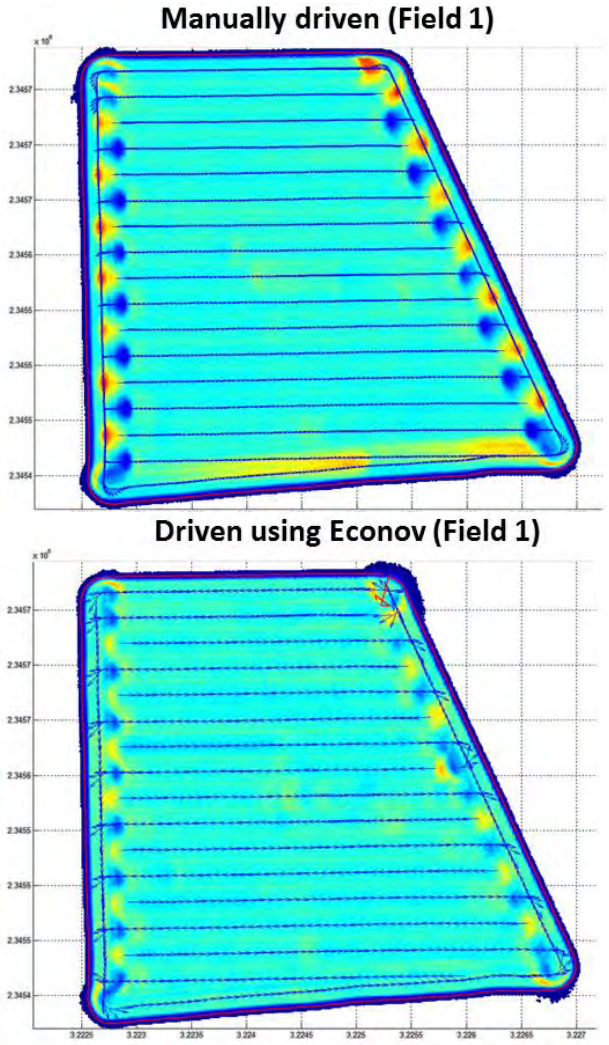




Econov evaluation example



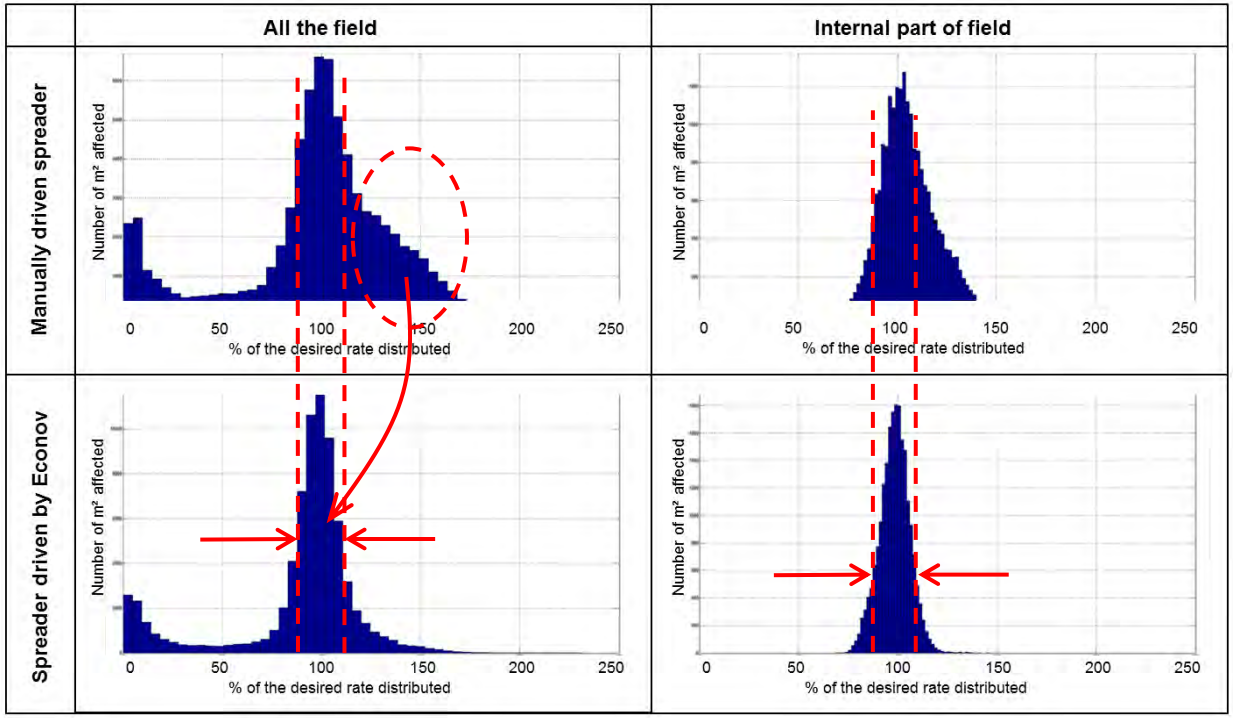
Obtained spreading rate maps

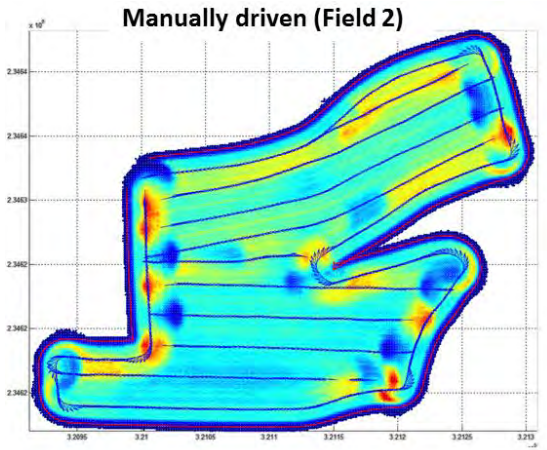


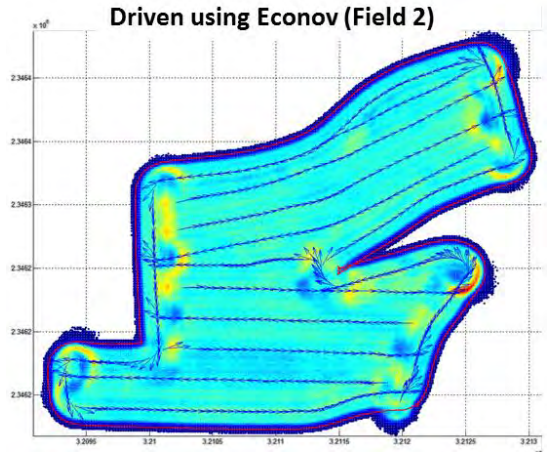
Econov evaluation example

Global analysis

For field N.2



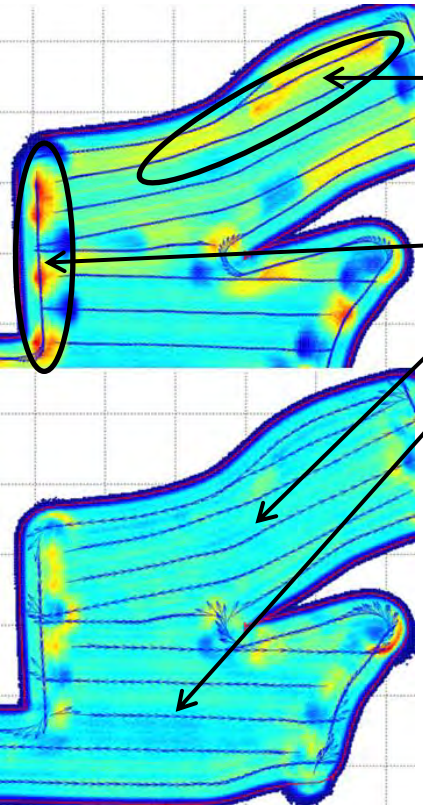




- Correction of the global mean rate
- High decrease of rate dispersion

Econov evaluation example

Global analysis



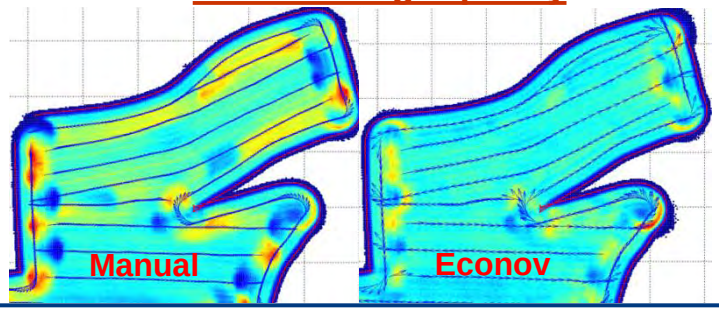
1 - Effect on field global amount

- Globally allows decreasing global fertilizer amount in the field
  - ±1% in regular fields and tramline paths
  - ± 8 to 9% in irregular fields and tramline paths
- Depends on the field part purcentages
  - Important gain
  - Quite no gain
- Depends on the field lenght: important gain at each start and end point
- Not so much affected by fertilizer caracteristics, i.e. by transverse curve

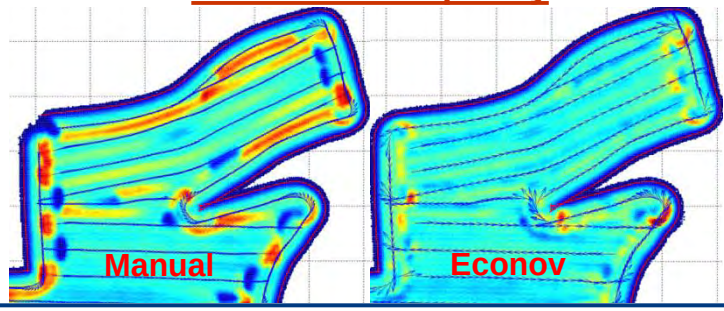
2 - Effect on field rate dispersion

- Econov section control always decreases rate dispersion (from under / over applications)
- Gain affected by:
  - field regularity (spreading is already very good in large fields / regular paths)
  - Lenght of boarder limite (-10 points on StD in the boarder part)
  - All the more efficient the fertilizer is of low quality

Fertilizer high quality



Fertilizer low quality



Conclusion

Method:

- Available method whatever the field size, fertilizer, technology to be tested (PA for example), etc
- Doesn't require absolutely to go in the field (trajectory to follow can be sent to the spreader by a computer)
- Same configuration can also be used for 2, 3, etc different spreaders / technologies to be tested
- Allows identifying precisely where are the most important effects

Econov:

- Improves a lot spreading quality:
  - adjusts exactly to the global desired amount
  - reduces under and over-applications (increases quality, crops yield, etc)
- Allows taking into account all external parameters (fertilizer used, field shape, tramline paths, etc)
- All the more important fields are small and with irregularly paths

Thanks for your attention,

Any question ?