Field traffic planning for reduced soil compaction

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Soil compaction

Soil compaction

- ✓ increased power requirements
- ✓ Increased energy requirements
- ✓ increased CO2 emissions
- ✓ difficulties in seedbed preparation,
- ✓ difficulties plants emergence
- ✓ reduced yields
- ✓…

Underlying approach

Green O (50%) ; Bochtis D (50%). **System for reducing compaction of soil**. PA 2009 70230, U.S. patent application.

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B-patterns (Bochtis 2008)
Algorithmically derived optimal traversal sequence of field-work tracks.
optimisation criterions

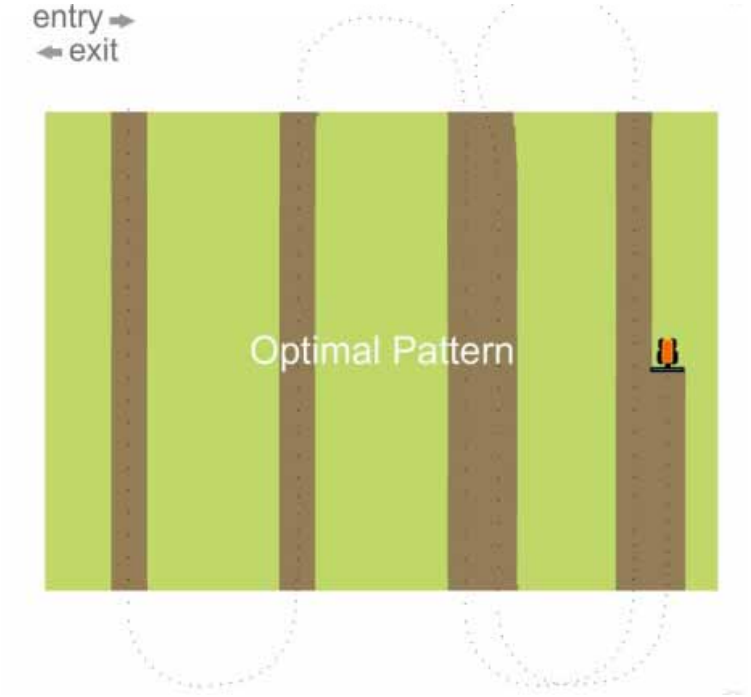
- non-working travelling distance,
- non-productive operational time,
- a soil compaction measure, etc.

Contrary to any traditional field work pattern, B-patterns **do not follow the repetition of standard motifs**
BUT they are the unique result of the optimisation approach on the specific combination of the

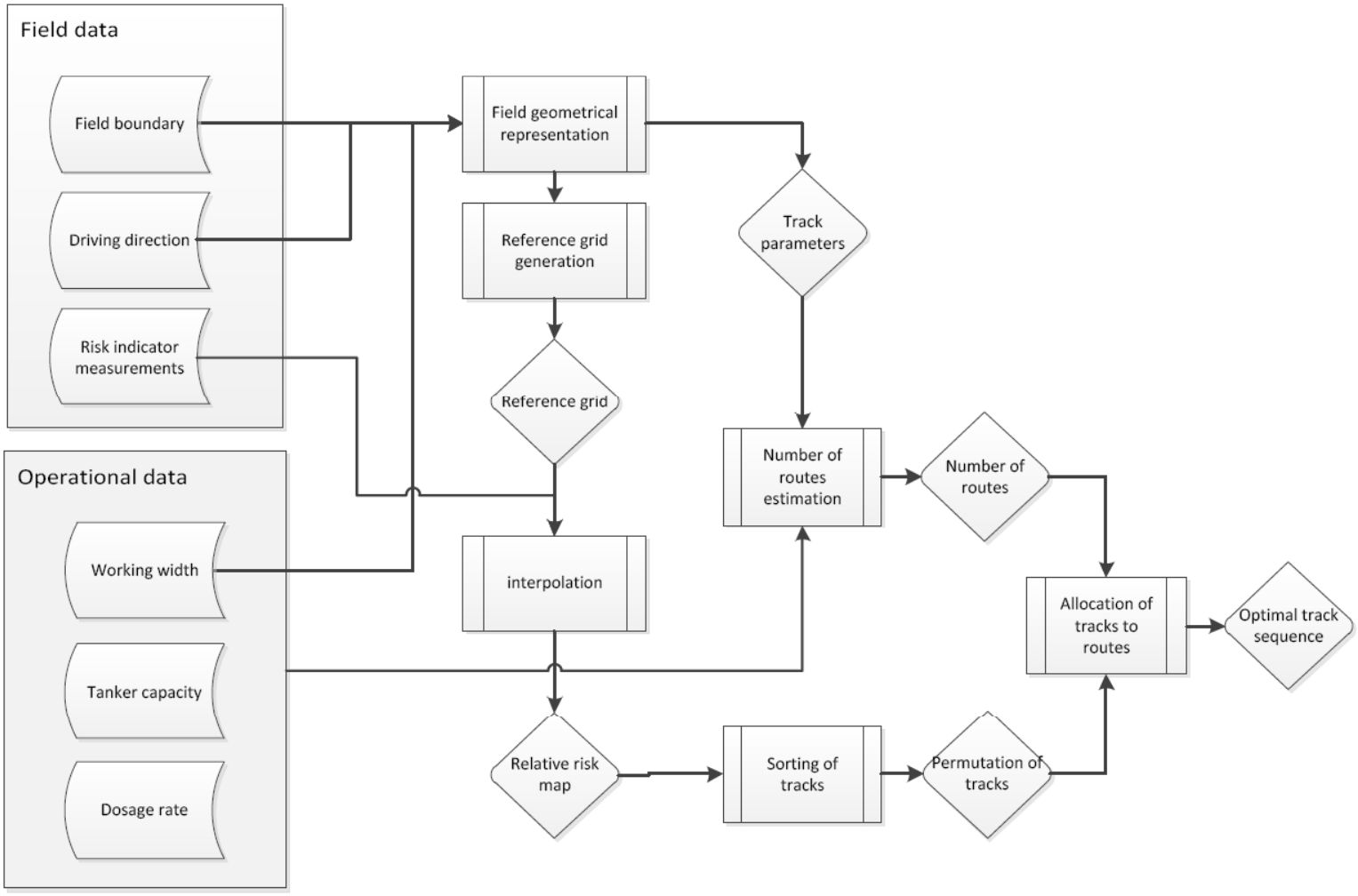
- mobile unit kinematics and dimensions,
- operating width,
- field shape, and
- the optimisation/s criterion/s

B-patterns (an example)

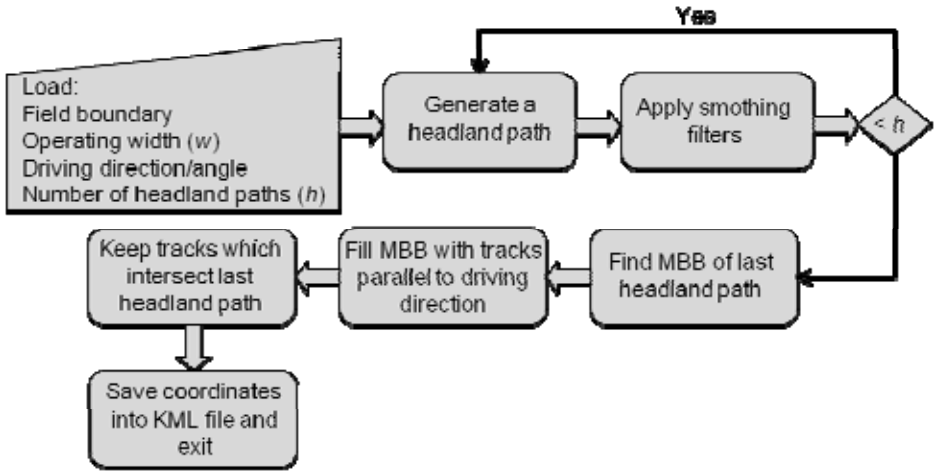
Optimal pattern for a simple 20 tracks field and a given combination of inputs:



Overview of the system



Field geometrical representation



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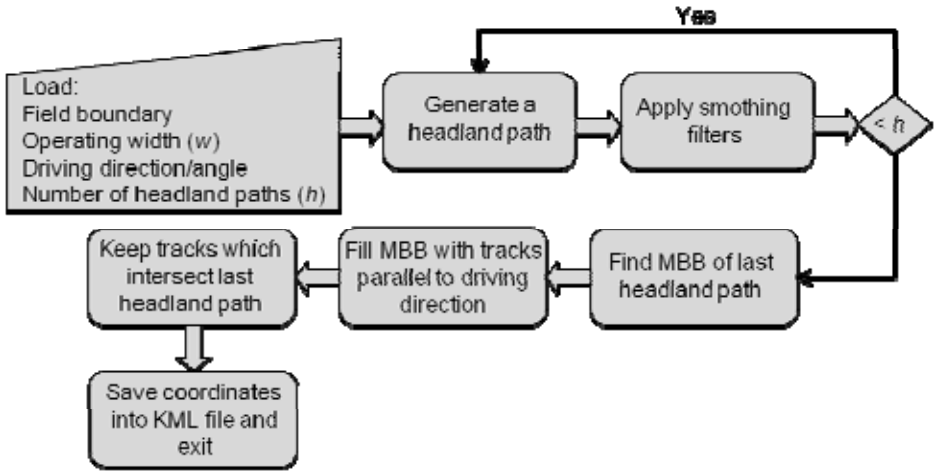

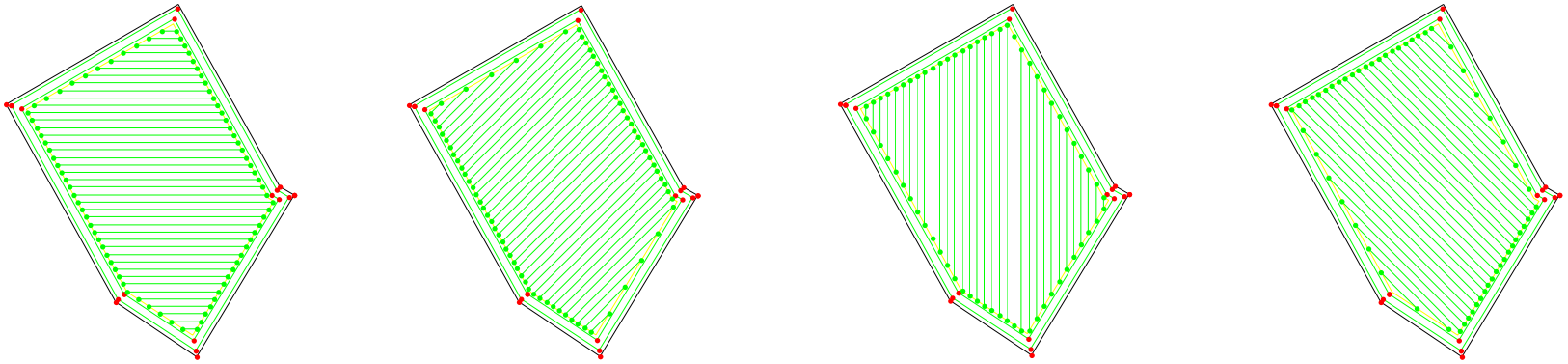

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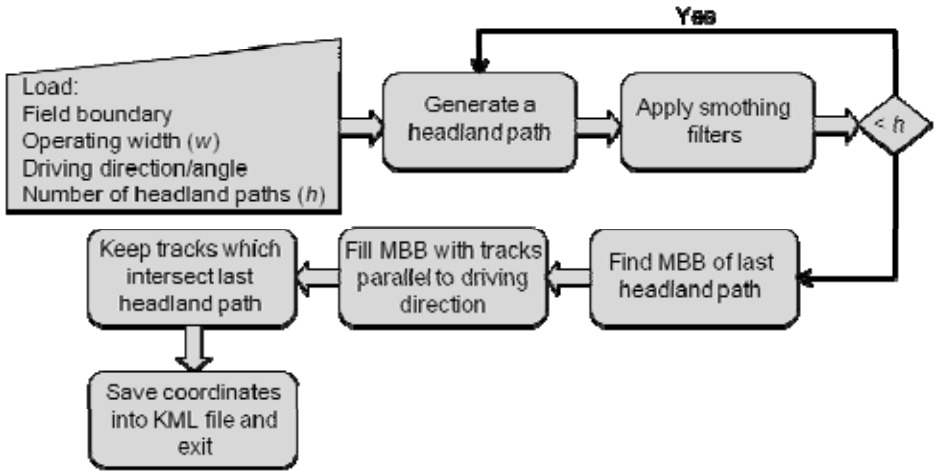
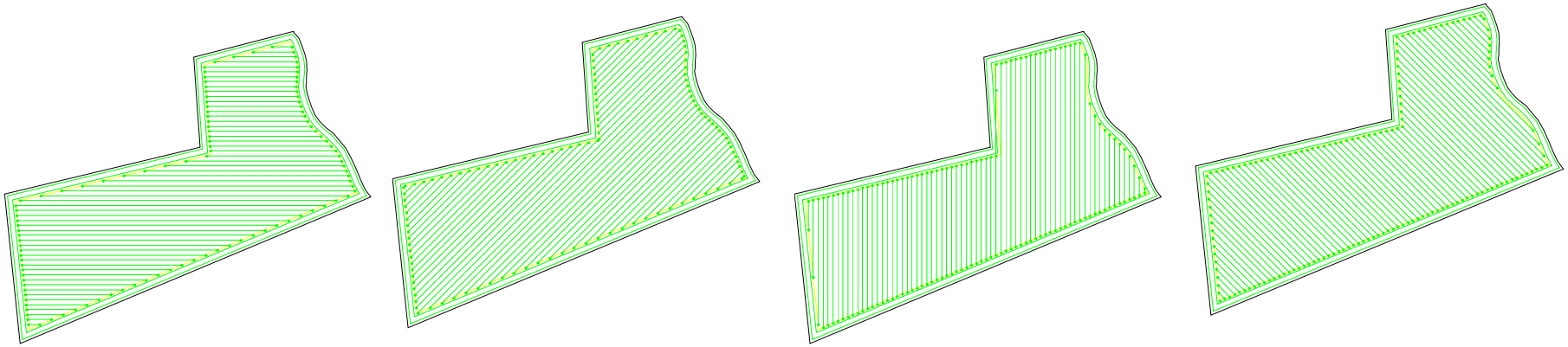




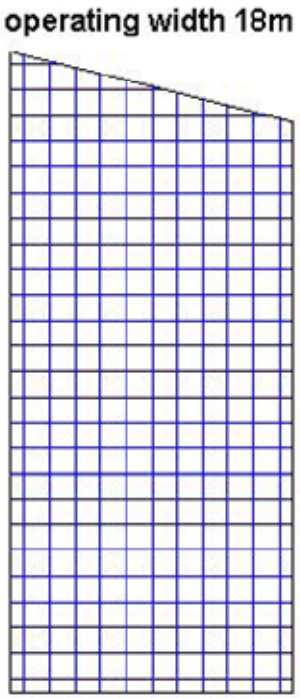
Reference grid

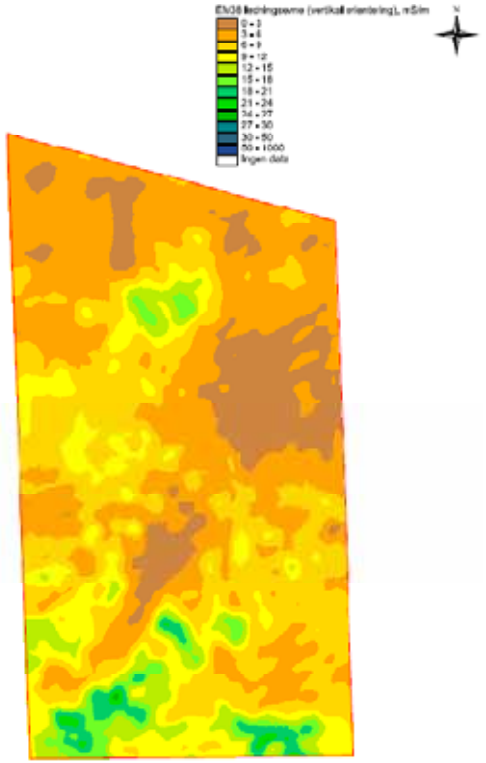
The reference grid for two different operating widths

Reference grid

RISK INDICATOR MEASUREMENTS

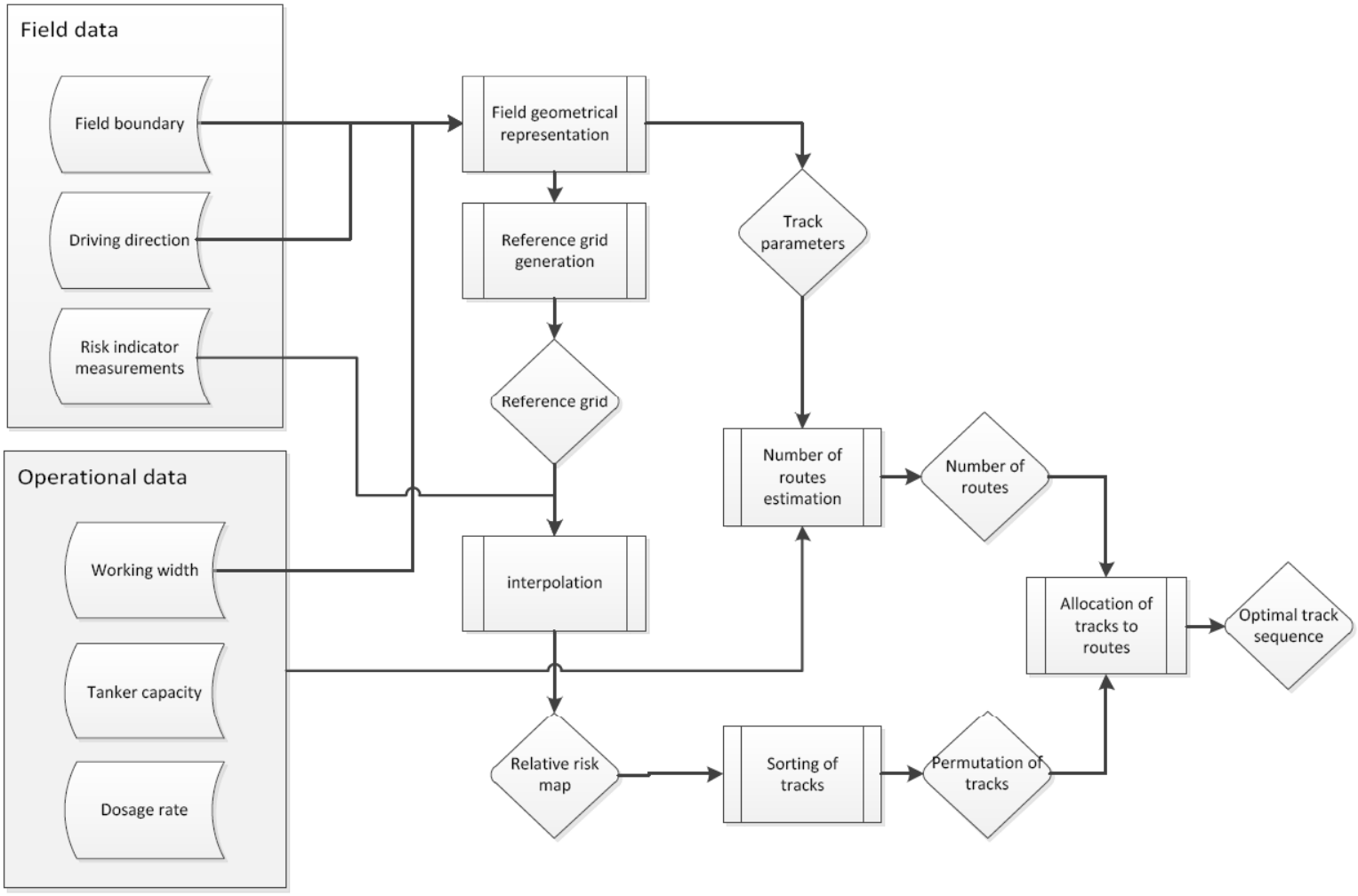
interpolation



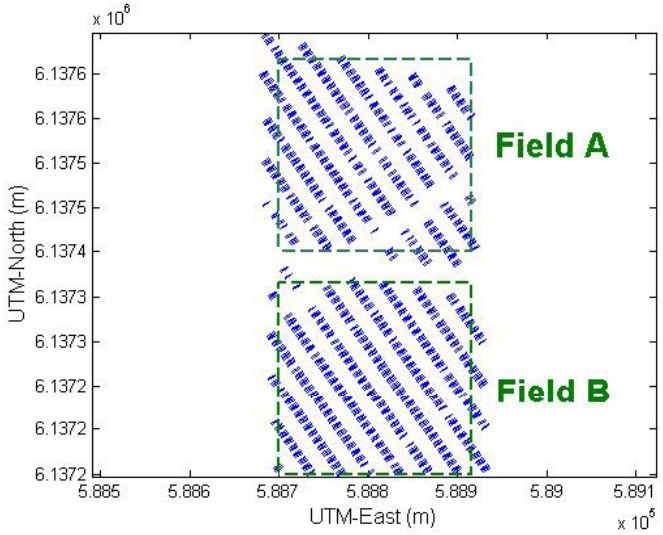


RELATIVE RISK MAP

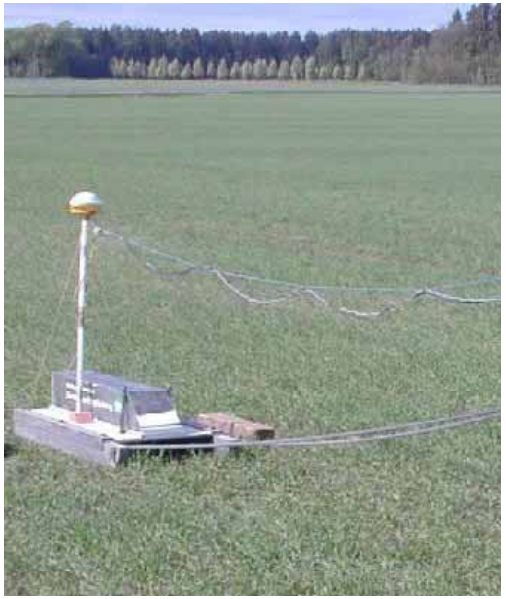
Overview of the system



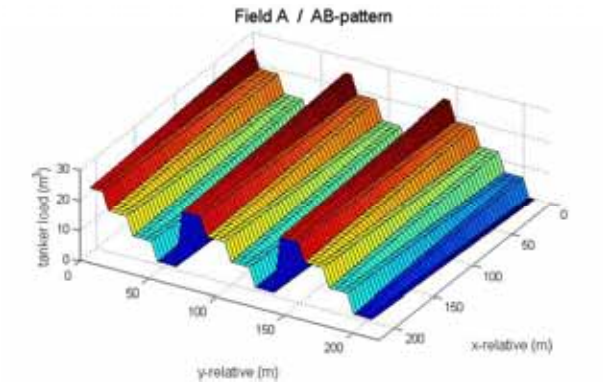
The experimental field

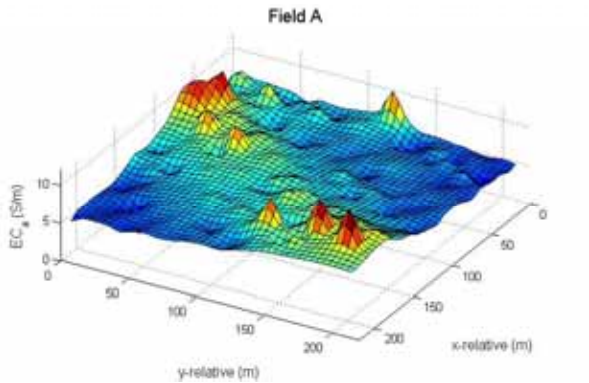


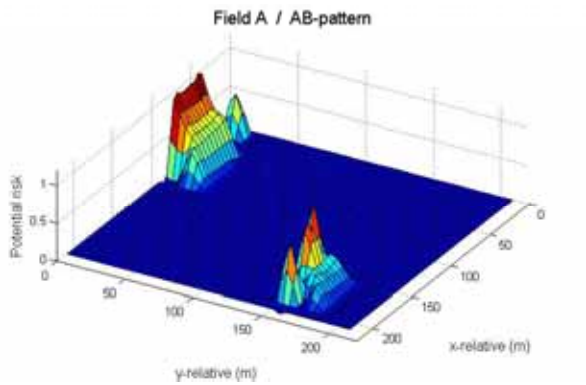
Technology used



Results (field A)







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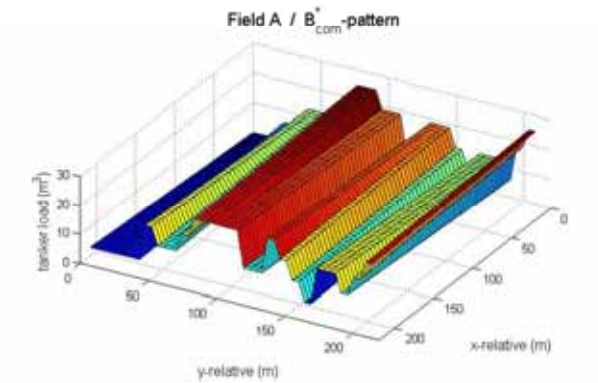

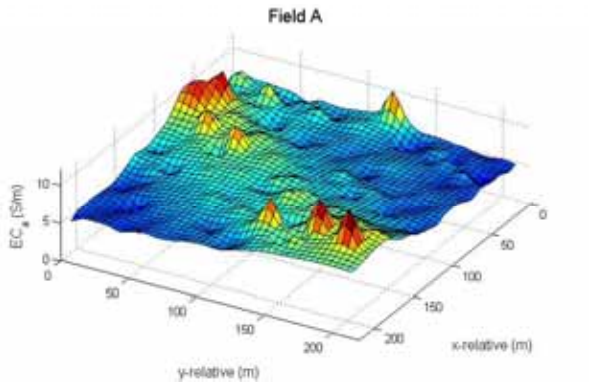

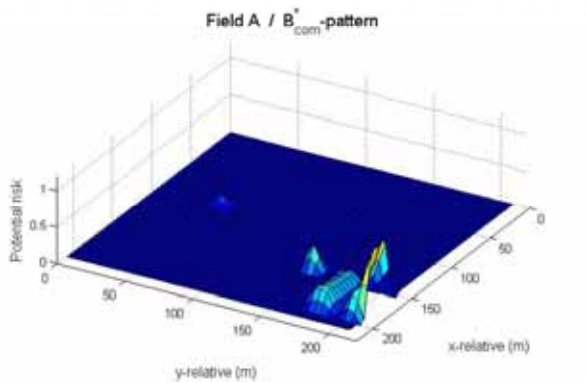

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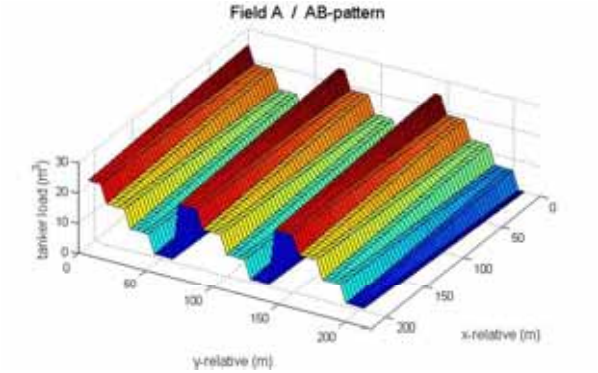
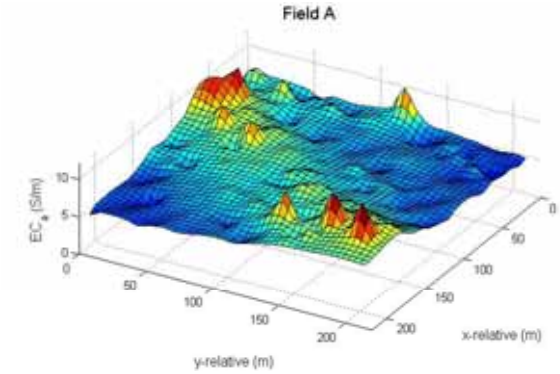
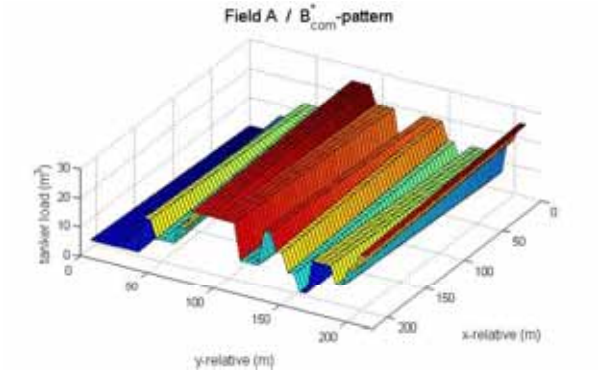
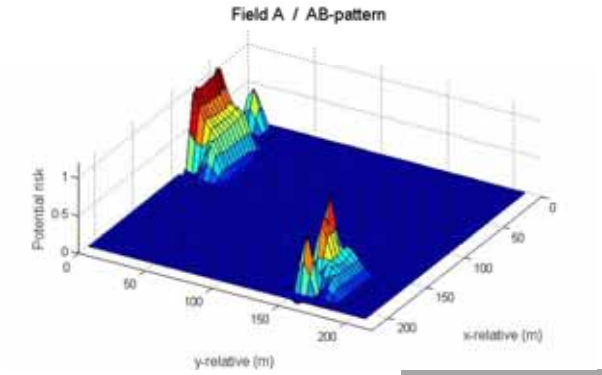
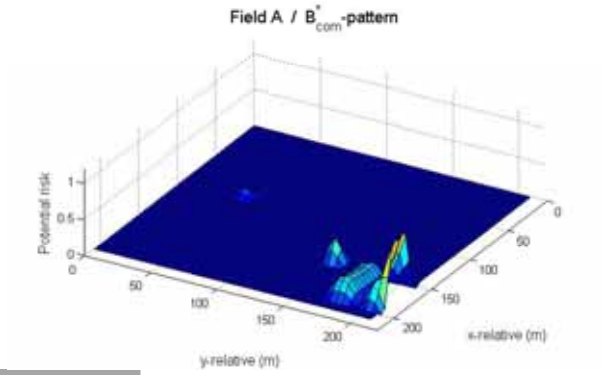




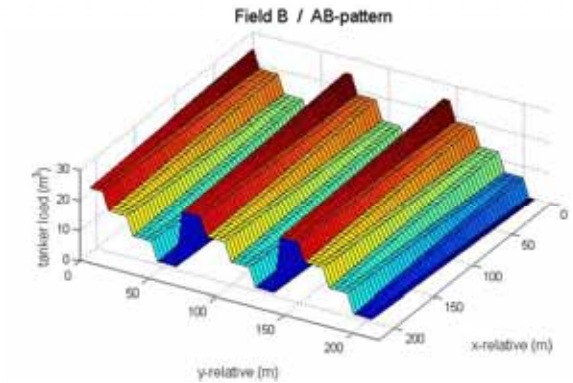


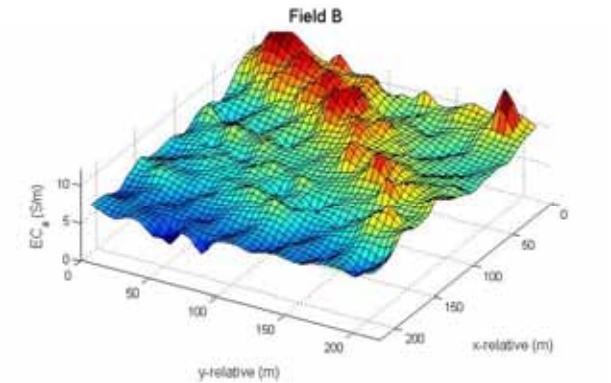


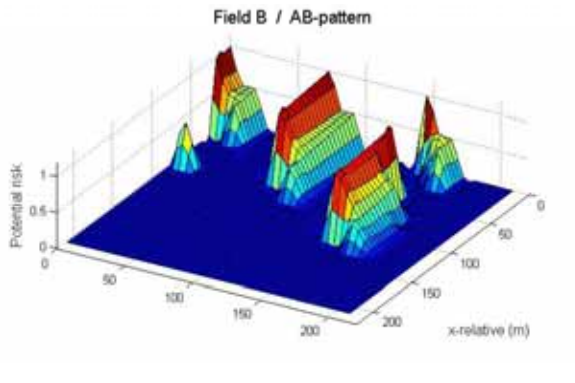


	Optimal (B^*_{com})		Conventional (AB)	
	Plan	Risk factor	Plan	Risk factor
Field A	R1=<1 4 5 19 8 9 10 24> R2=<2 7 17 18 14 15 12 22> R3=<3 6 16 20 23 13 21 11>	0.058	R1=<1 2 3 …> R2=<9 10 11 …> R3=<17 18 19 …>	0.075

Results (field B)







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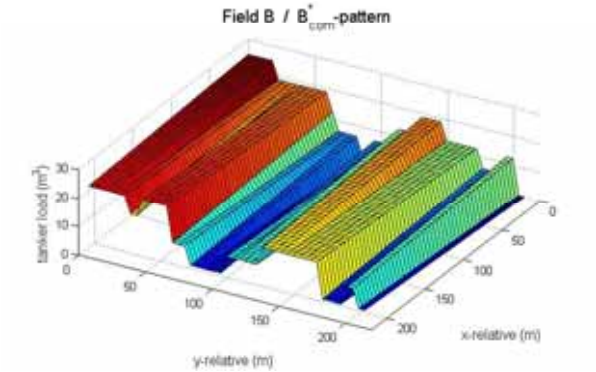

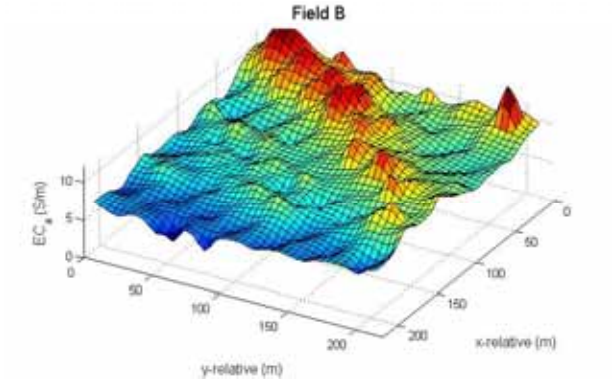

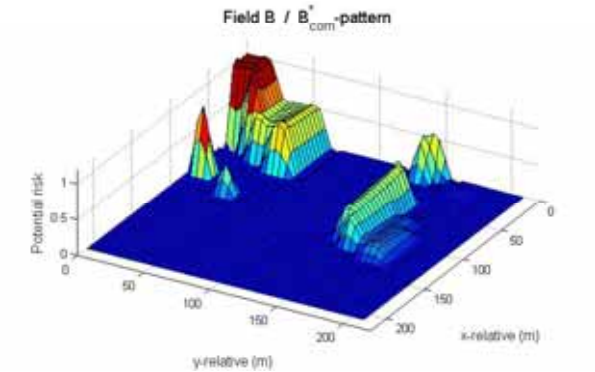

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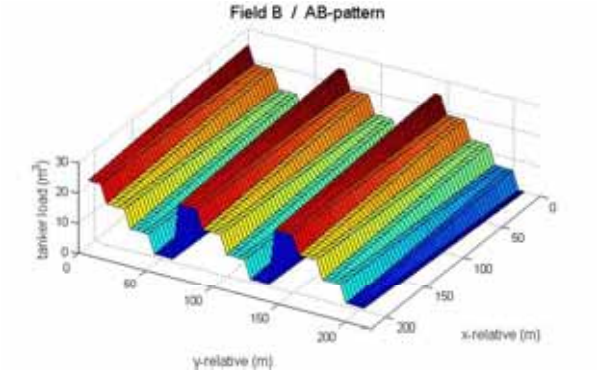

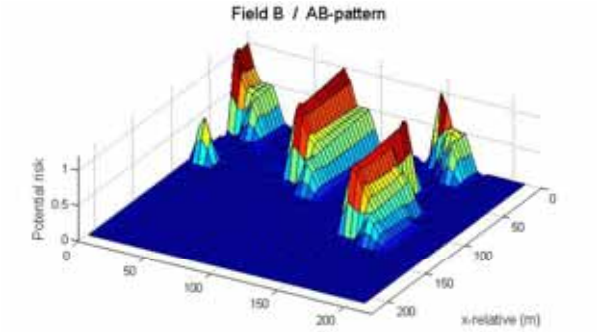

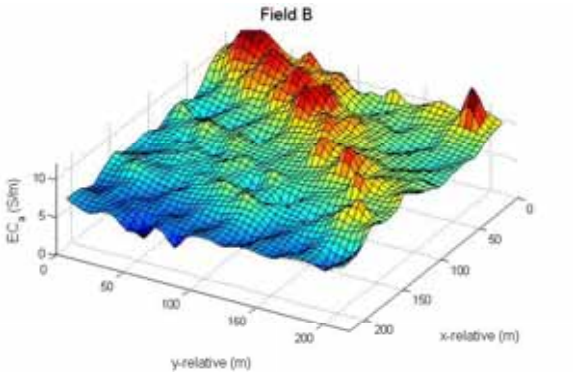

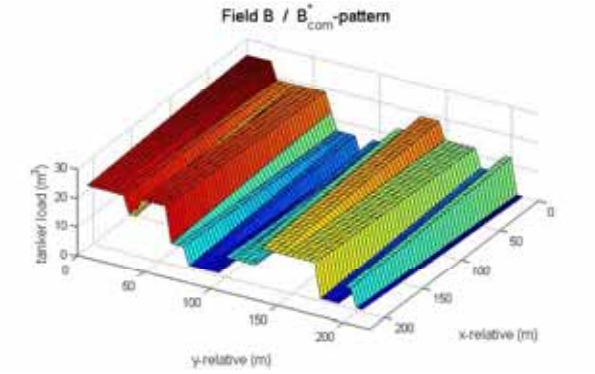

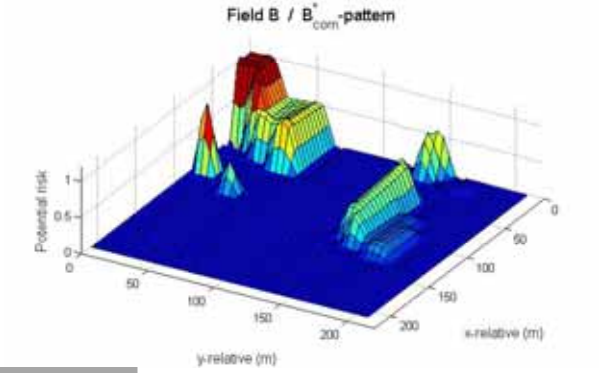

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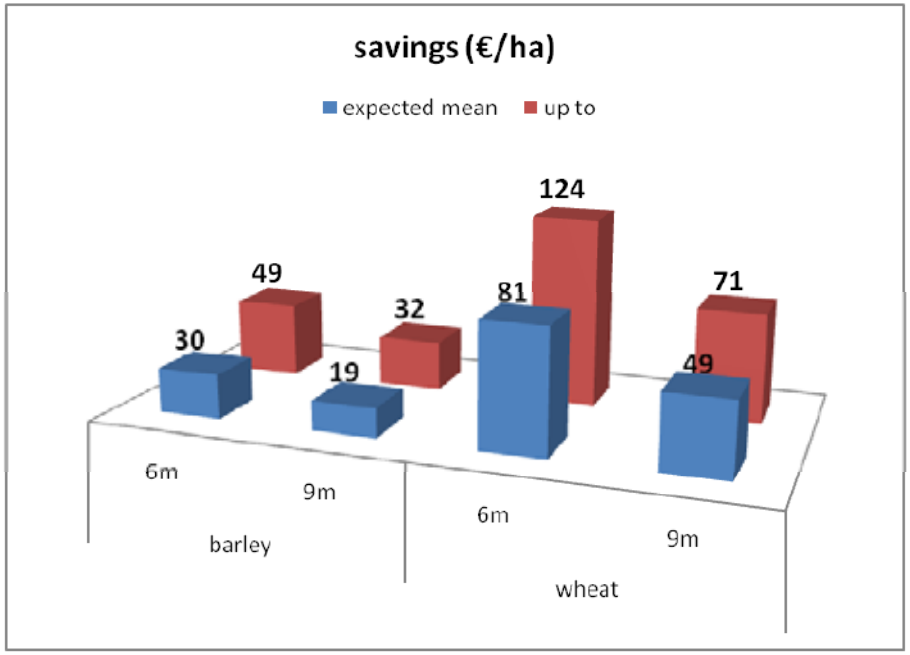
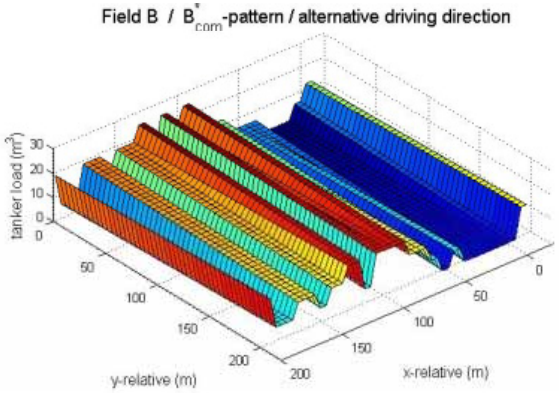
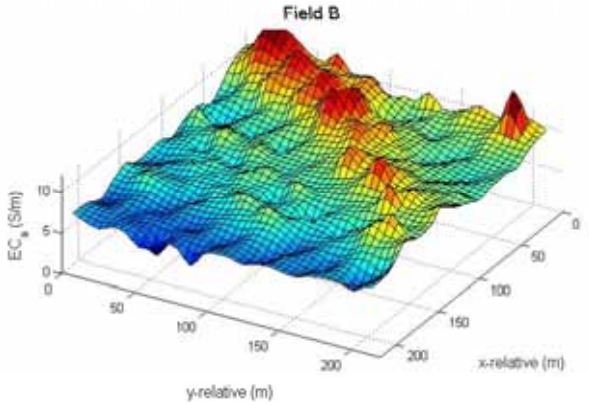
Cost benefit analysis

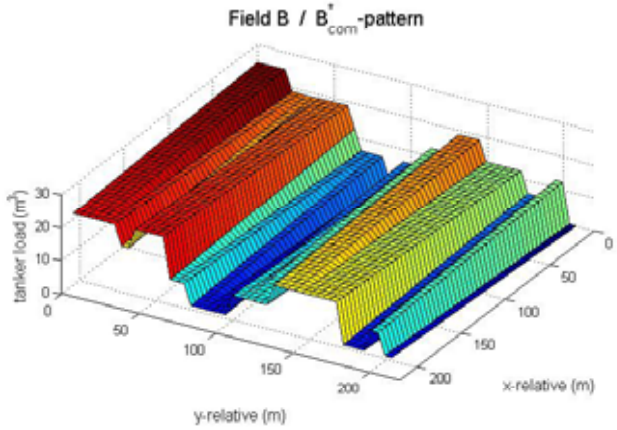


Further improvements (I)

Taking into account the driving direction







Further improvements (II)

Multi-criteria optimisation

Pattern	Non-working distance (m)	In-field operational time (s)	In-field productivity (m^2/s)	Deviation from AB-pattern productivity
AB / fields A&B	1,468	11,285	4.13	
B^*_{dis} / fields A&B)	1,132	10,934	4.27	+3.2%
B^*_{com} / field A	2,024	11,492	4.06	-1.8%
B^*_{com} / field B	2,390	11,695	3.99	-3.5%

→ +0.7%

Heuristics, e.g. "swap" operations:

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Associate Professor,
industrial engineering in bio-production systems

Thank you

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