

### A generic Decision Support System for integrated weed management

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#### and:

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## Change of jobs

- Mr Per Rydahl and Mr Ole M Bojer
- From 1 October, 2014:
  - Owners of IPM Consult Ltd., Denmark (new SME)
  - focus on DSS for IWM
  - finalize DSS acitivities in PURE



### EU-project 'ENDURE'

- Analyses of 70 European DSS on IPM
- 9 DSS on weed control
- 'Best parts' in 3 DSS:
  - 1. 'DecidHerb'
    - Weed Potential Threat (WPT)
  - 2. 'CPO-weeds'
    - Target Efficacy (TE)
    - Herbicide dose-response functions
    - Optimization of herbicide tank-mixtures
  - 3. 'GestInf':
    - Economic Net Return (ENR)



### New DSS – ideas of potential

- Weeds are not evenly distributed
- Different weeds cause different losses
- Different control measures provide different efficacy
- -> so, rational weed management is complex!
- Combine:
  - field reports
  - results from weed research and expert knowledge
  - legal restrictions
- Expected results:
  - safe control
  - legal control
  - reduced cost/TFI
  - good compliance with IPM



## **Decision flow**



<sup>1)</sup> Multiple treatments -> multible field reports

#### **DSS - 'decision engine':**

- 1. Needs for weed control (WPT / TE)
- 2. Legal restrictions
- 3. Herbicides and dose rates
- 4. Optimized tank-mixtures
- 5. Non-chemical control
- 6. Max. Economic Net Return (ENR), <u>or,</u> min. cost, TFI, etc.



### Integrated 'best parts' - Weed Potential Threat (WPT)

#### Decision algorithms

- 'fuzzy logic':
  - WPT in actual crop
  - WPT in crop rotation
  - actual WPT = maximum
- In maize:
  - WPT in actual crop <u>exceeds</u>
     WPT in crop rotations
     -> WPT in crop rotation can be ignored (simpler design)



### Integrated 'best parts' - Target Efficacy (TE)

- Decision algorithms
   designed by experts to avoid:
  - yield loss

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- propagation of weeds
- ... and more ...



### Integrated 'best parts' - herbicide dose-response functions

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### Integrated best parts

- optimization of herbicide tank-mixtures

- Linear optimization
- Meet needs for control (TE / WPT)
- Minimize e.g. cost, TFI
- Include 2-4 way herbicide mixtures
- Add adjuvants as required



### Integrated best parts

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- Economic Net Return (ENR)





### New features

- Anti herbicide resistance strategies
  - Control of resistant biotypes:
    - resistant biotype = new weed species
    - automatic selection of alternatives
  - Prevention/delay of resistance:
    - now in design phase
- Mechanical weed control



### Customization

• Crop = maize

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- Needs for control:
  - WPT: 'very safe' 'r
  - TE: 'reliable'
- 'reliable'
  'risky'

- Control:
  - herbicides
  - mechanical (to prove concept)
- Country partners decide:

Country	Herbicides	Weeds			
Slovenia	19	17			
Italy	20	16			
Germany	29	58			



## IT system architecture

- Code: ASP.net / JAVA (2001)
- Microsoft SQL databases:
  - estimates of parameters
  - user-interfaces
  - … everything!
- New IT system architecture:
  - now in design phase
  - better, faster, new features



# Bencmarks of DSS with IPM - Directive 2009/128/EC

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No	Principle	DSS
1	Crop rotation, fertilization, soil cultivation, etc.	No
2	Monitoring	Yes
3	Thresholds	Yes
4	Non-chemical control	Yes
5	Targeted use of herbicides	Yes
6	Use of herbicides on necescary levels	Yes
7	Anti-resistance strategies	Yes
8	Evaluation	Yes



### Field tests of DSS - experimental protocol

- 3 countries x 2 years x 2 sites = 12 trials
- Treatments:
  - Untreated
  - Standard = local 'best practice'
  - DSS WPT 'very safe'
  - DSS WPT 'reliable'
  - DSS TE 'reliable'
  - DSS TE 'risky'
- Measurements:
  - Efficacy, yield, residual weeds
  - Cost/TFI

Agricultural Institute of Slovenia



Results from field tests of DSS in Slovenia (examples from 2014)

by

Robert Leskovšek Igor Zidarič Gregor Urek





#### 2014, efficacy









#### 2014, residual weeds









#### 2014, yield







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### 2014, TFI













### Results from field tests of DSS in Italy (examples from 2013)

#### by

Roberta Masin, University of Padova, Italy Maurizio Sattin (IBAF-CNR), Italy Emanuele Germiniani, Università di Bologna, Italy





Consiglio Nazionale delle Ricerche









Weed Biomass (g/m<sup>2</sup>)

Farmer's practice

















Consiglio Nazionale delle Ricerche





### Cost, avg. 4 trials

Cost		Cost
(Euro/ha)		(%)
0		$\frown$
80		100%
66		82%
96		120%
77		96%
82		103%
	Cost (Euro/ha) 0 80 66 96 77 82	Cost         (Euro/ha)         0         0         80         66         96         777         82







### Results from field tests of DSS in Germany (averages of 2013-2014)

by

Arnd Verschwele Julius- Kühn-Institut, Braunschweig







#### Efficacy, avg. 3 trials









### Yield, avg. 3 trials

Maize yield









### TFI, avg. 3 trials

Nr.	Treatments	TFI	
		Site A	Site B
1	Untreated	-	-
2	TE reliable	1.00	0.63
3	TE risky	1.30	0.45
4	WPT reliable	1.55	1.06
5	WPT very safe	1.64	0.60
6	Standard	(1.00)	1.75



### **Common conclusions**

- A generic, online DSS for IWM has been designed and constructed
- Compliance with 7/8 general principles on IPM
- Customization for maize in Slovenia, Italy and Germany
- Recommendations are traceable
- Need for:
  - check/correction of 'strange behavior' by some prototypes
  - inclusion of more herbicides, weeds and data



### **Conclusions from Slovenia**

3/4 trials and 2/4 DSS prototypes show that:

- efficacy, yield and residual weeds were on level with local standards
- TFI was reduced by 20-40%



### **Conclusions from Italy**

4/4 trials and 2/4 DSS prototypes show that:

- efficacy, yield and residual weed infestation were on level with local standards
- cost was +/- 10-20%



### **Conclusions from Germany**

3/4 trials and 4/4 DSS prototypes show that:

- efficacy and yield were on level with local standards
- TFI varied from +60% to -70% (varying standards)



### Bottlenecks

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- Limited access to data on herbicide efficacy (joint problem for DSS and IPM)
- Limited interest for field inspections (ENDURE)



### Perspectives

- Results from PURE indicate that the DSS has potential for upscaling:
  - more crops
  - more countries
- ... just give us more data, more money and more time ... <sup>©</sup>



## **Online demonstration**

- Today, Market square, room GAMMA
- 15 min. introductions:

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- 16:30, 17:00,17:30,18:00 hours
- THANK YOU FOR YOUR ATTENTION ©