Cost-effectiveness of screening deoxynivalenol contamination in wheat

EUROCEREAL 7 december 2011

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Research Background

- Deoxynivalenol (DON) impacts human health
- Formed by *Fusarium* spp. under conducive conditions
  - Climate
  - Agronomical practices
- Quality and safety concerns for cereal cultivation
- EC limits for cereal and derived products for human consumption + recommendations for levels in feeding stuffs
- Managing DON in the cereal chain by testing and predictive modelling
- Test methods vary in characteristics (accuracy, costs)

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Research Objective

- Calculate the cost-effectiveness of different methods for screening DON contamination of wheat batches at collector reception

Wheat fields → Collector → Miller

transport

transport

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Model assumptions

- Monte Carlo modelling of screening DON in wheat batches, associated costs and number of undetected batches (DON>1250 ppb)
- Wheat chain stages:
  - 20 wheat farmers → transport
  - 1 collector with 3 silos → transport
  - 1 miller
- Fixed sizes: farm (176t), transport (8t), silo (200t), transport (33t)
- Mixing during transport (truck) and storage (silo)
- Farmers produce wheat batches
  - DON contamination, 10 yr field data from NL (n=425)

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Screening DON

- At collector:
  - Batches tested for DON at intake
  - Stored in 1 out of 3 silos, based on DON
- Six DON testing scenarios:
  - No testing
  - Dipstick
  - HPLC (alone)
  - Model predictions (alone), with dipstick, with HPLC
- Dipstick testing at mill intake
- In case DON>1250 ppb at collector than not delivered to miller but feed industry

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Predictive DON model

- Empirical model for DON levels in Dutch wheat at harvest
- Model variables:
  - Region, spraying, cultivar resistance level
  - Flowering date (FD)
  - Length FD- harvest (HD)
  - Weather variables in critical periods (-17 FD to HD)
    - Rainfall (mm) and Relative humidity (# hours > 80) in -17 to -10 days FD
    - Average temperature in all time blocks, except 0 to +10 FD
- $R^2 = 65.6$

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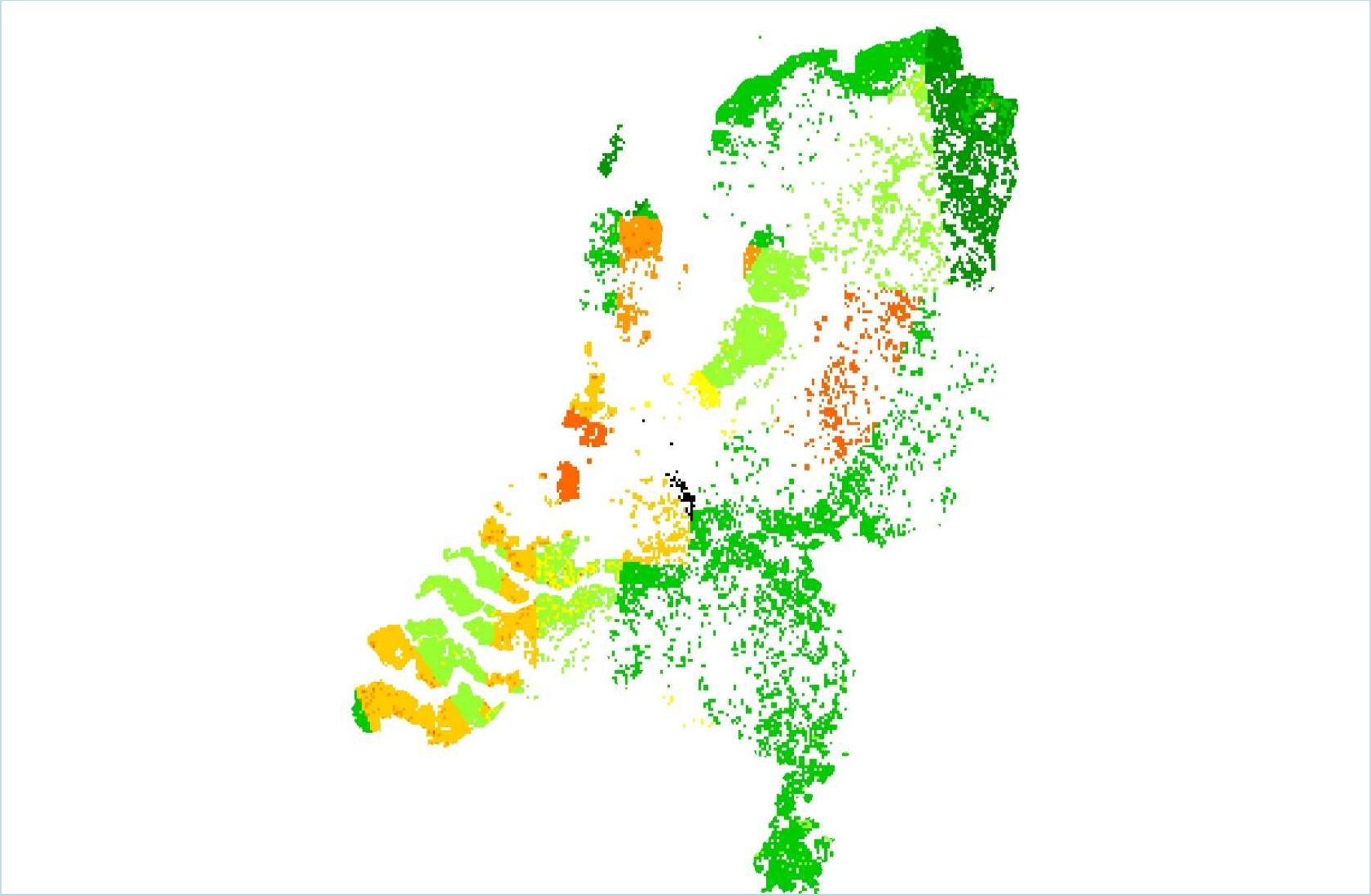
GIS application DON model



Assumed DON test characteristics

- Dip stick

Dipstick	Real DON (ppb)			
Estimated DON	0-500	500-1250	>1250	
0-500	80%	10%	10%	accept
500-1250	10%	80%	10%	accept
>1250	10%	10%	80%	reject

- HPLC: value within 1% (2 x 0.5%) above and 1% below real DON level

- Predictive DON model:

Value within 50% (2 x 25%) above and 50% below real DON level

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Model calculations

- 1 run, 100 iterations
- Number of batches with DON > 1250 ppb (EC limit of food)
- Costs
    - Each screening method
        - €8 for dipstick test and €50 for HPLC
    - Extra transport for rejected batches (€36.67/km)
    - Lower revenue for rejected batches (€15/t)
        - Used in feed industry

Evaluate costs vs undetected batches

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Preliminarily results

- Highest costs
  - Two scenarios with HPLC
  - Nearly 100% avoiding undetected batches with high DON levels (false negatives)
- Lowest costs
  - No testing, the predictive model alone, or with quick testing of positive batches
  - Of these, numbers of false negative batches remained low for predictive modelling with dip stick testing

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Summarized preliminarily results

	Test at collector					
	No test	Dipstick	HPLC	Model	Model/ dipstick	Model/ HPLC
testing costs collector	€ -	€ 3,520	€ 22,000	€ -	€ 343	€ 2,144
other costs collector	€ 8,632	€ 12,295	€ 10,025	€ 9,629	€ 8,736	€ 9,483
testing costs miller	€ 833	€ 703	€ 769	€ 770	€ 787	€ 4,851
total chain costs	€ 9,465	€ 16,518	€ 32,794	€ 10,399	€ 9,866	€ 16,478
amount false neg. (kg)	50,853	5,787	-	-	4,667	-
% of false negative (DON>1250 ppb)	1.48%	0.18%	0.00%	0.00%	0.14%	0.00%

% false negative: kg false negative/kg produced by farmers

Conclusion

Most cost-effective way of screening DON at collector intake

√ Predictive model with dip-stick testing

But,

What risk is acceptable?

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