The "Grignon Model":
Qualitative Assessment of Maize Cropping Systems

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ABSTRACT

An important goal of the SIGMEA project is to develop computer-based decision support systems (DSS) for the assessment of the impacts of using GM crops at the field and regional levels. Here we present the so-called "Grignon Model", a qualitative multi-attribute model for the assessment of ecological and economic impacts of GM and non-GM maize crops at the farm level for one agricultural season. This is an ex-ante model developed according to the DEX methodology. In this model, cropping systems are described by four groups of features: (1) crop sub-type, (2) regional and farm-level context, (3) crop protection and crop management strategies, and (4) expected characteristics of the yield. The assessment of cropping systems is based on four groups of ecological and two groups of economic indicators: biodiversity, soil biodiversity, water quality, greenhouse gasses, variable costs and production value. The evaluation of cropping systems is governed by expert-defined rules. In addition to the evaluation of cropping systems, the model facilitates various analyses (e.g., what-if analysis), identification of advantages and disadvantages of specific cropping systems, and generation of improved variations of existing cropping systems.

MODEL STRUCTURE (top-level)
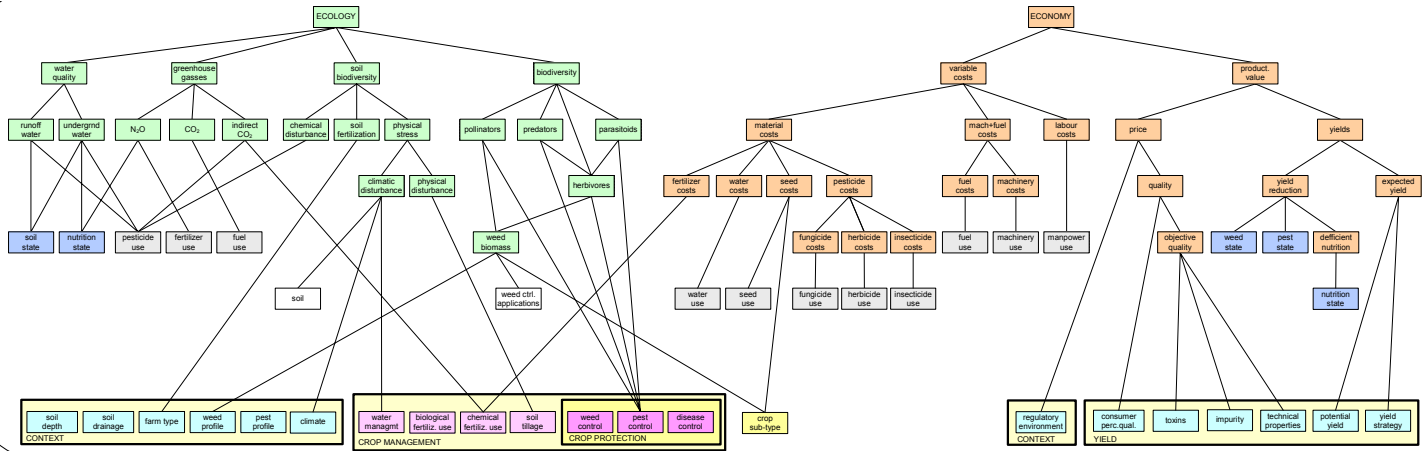
MODEL STRUCTURE (low-level concepts)
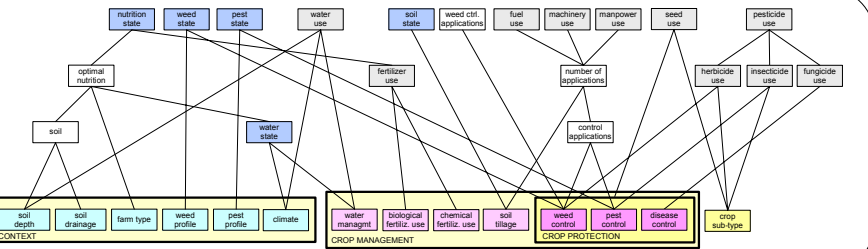
DECISION RULES

pest_control	herbivores	predators
	34,21%	65,79%
1 >=integrated	very low	very low
2 no treatment	<=low	low
3 <=organic	very low	low
4 >=integrated	low:medium	low
5 <=organic	medium	medium
6 organic	low:medium	medium
7 >=integrated	high	medium
8 <=organic	high	high

weed_control	crop_subtype	herbicide_use
74,80%	25,20%	
1 pre+post-emergence	*	high
2 2post-emergence	conventional	high
3 2post-emergence	Bt	high
4 pre-emergence	*	medium
5 post-emergence	conventional	medium
6 post-emergence	Bt	medium
7 2post-emergence	Bt	medium
8 2post-emergence	Bt+Ht	medium
9 pre-emergence:post-emergence	Ht	low
10 pre-emergence:post-emergence	Bt+Ht	low
11 no treatment	*	none

ASSESSMENT of CROPPING SYSTEMS

Attribute	Foulum c pl	Foulum c mt	Foulum Bt pl	Foulum Bt mt	Varois c	Varois Bt	Narbons c	Narbons Bt
INPUT DATA	*	*	*	*	*	*	*	*
crop_subtype	conventional	conventional	Bt	Bt	conventional	Bt	conventional	Bt
previous_crop	maize	maize	maize	maize	maize	maize	maize	maize
soil_depth	deep	deep	deep	deep	deep	deep	deep	deep
soil_drainage	well_drained	well_drained	well_drained	well_drained	well_drained	well_drained	shallow	shallow
climate	severe_drought_stress	severe_drought_stress	severe_drought_stress	severe_drought_stress	temp_drought_stress	temp_drought_stress	severe_drought_stress	severe_drought_stress
farm_type	cereal	cereal	cereal	cereal	cereal	cereal	cereal	cereal
weed_profile	regular_problems	regular_problems	regular_problems	regular_problems	low_problems	low_problems	low_problems	low_problems
pest_profile	low_problems	low_problems	low_problems	low_problems	low_problems	low_problems	regular_problems	regular_problems
soil_tillage	ploughing	superficial	ploughing	ploughing	ploughing	ploughing	ploughing	ploughing
chem_fert_use	>200	>200	>200	>200	>200	>200	150-200	150-200
bio_fert_use	>250	>250	>250	>250	none	none	none	none
water_management	no irrigation	no irrigation	no irrigation	no irrigation	no irrigation	no irrigation	optimal	optimal
weed_control	pre+post-emergence	pre+post-emergence	pre+post-emergence	pre+post-emergence	2post-emergence	2post-emergence	2post-emergence	2post-emergence
pest_control	no treatment	no treatment	no treatment	no treatment	conventional	conventional	conventional	conventional
disease_control	no treatment	no treatment	no treatment	no treatment	no treatment	no treatment	no treatment	no treatment
regulatory_environment	priceSup+milkQta	priceSup+milkQta	priceSup+milkQta	priceSup+milkQta	priceSup+milkQta	priceSup+milkQta	priceSup+milkQta	priceSup+milkQta
potential_yield	medium	medium	medium	medium	high	high	medium	medium
yield_strategy	maximum	maximum	maximum	maximum	maximum	maximum	maximum	maximum
tech_properties	adequate	adequate	adequate	adequate	adequate	adequate	adequate	adequate
impurity	low	low	low	low	low	low	low	low
toxins	adequate	adequate	adequate	adequate	adequate	adequate	adequate	adequate
consum_perc_quality	medium	medium	medium	medium	medium	medium	medium	medium
OVERALL ASSESMENT								
ECONOMY	1	3	1	1	3	3	2	2
variable_costs	3	3	3	3	3	3	3	3
product_value	4	4	4	4	5	5	5	4
ECOLOGY	1	1	1	1	1	1	1	1
greenhouse_gasses	1	1	1	1	2	2	2	2
water_quality	1	1	1	1	2	2	2	2
biodiversity	1	1	1	1	1	1	1	1
soil_biodiversity	2	2	2	2	2	2	2	2

Foulum (all)

Varois (all)

Narbons c

Narbons Bt