AMG :
a simple SOC balance model used in France for decision support

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Content

1 - AMG: description

2 - AMG-Research: a research tool

- Description
- Evaluation on several databases

3 - Simeos-AMG: a decision support tool

AMG model is derived of **Hénin & Dupuis (HD) model** used to simulate SOC evolution on the long term (1945),

Characteristics of HD model :

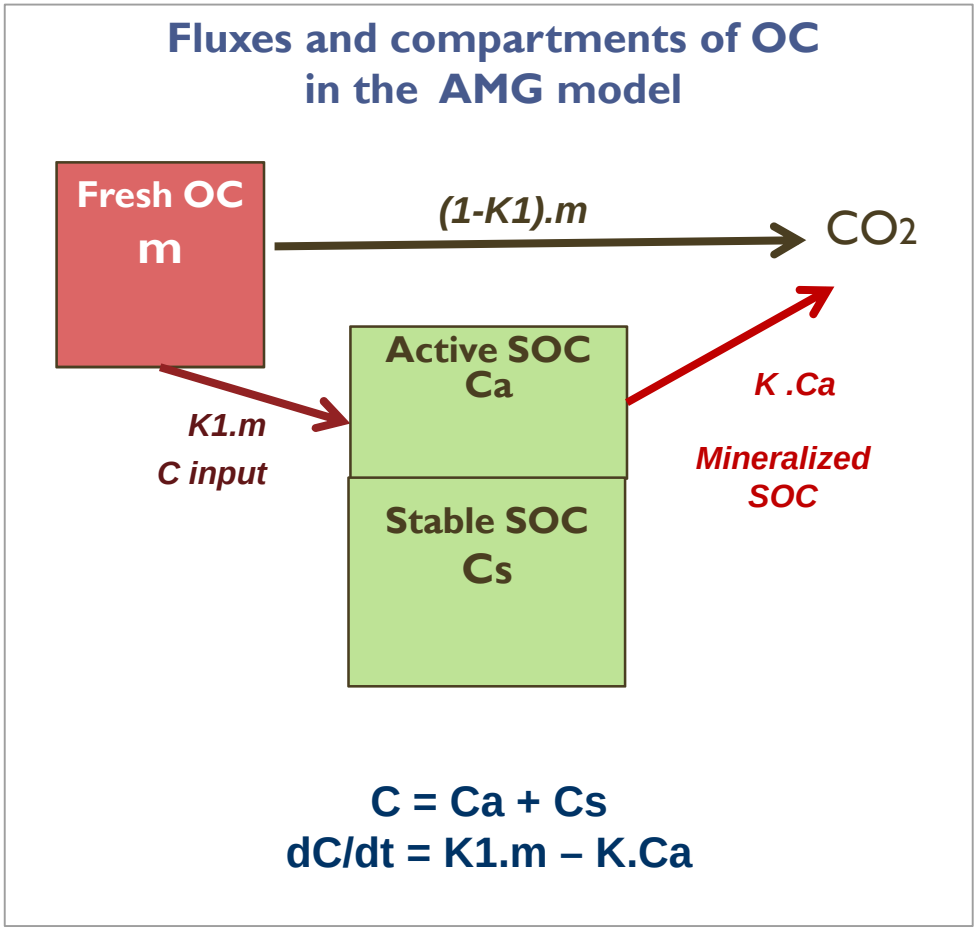
- 2 compartments of SOC
- time step = 1 year
- only 2 parameters
- input information easily available at the field and the farm level

H&D model has been widely used in France as a support for decision making and formation until recently

Characteristics:

- **3 compartments of OC**
  - Fresh OC
  - Ca = Active SOC
  - Cs = Stable SOC
- **Time step = 1 year**
- **3 parameters:**
  - K1 humification coefficient
  - K annual mineralization rate
  - Cs/Co initial fraction of stable C

AMG structure



$$Ct = CS + Ca \,.\, \exp(-k \,.\, t) \,.\, K1 \,.\, m \;/\; K \,.\, (1 - \exp(-K \,.\, t))$$

Andriulo et al., 1999

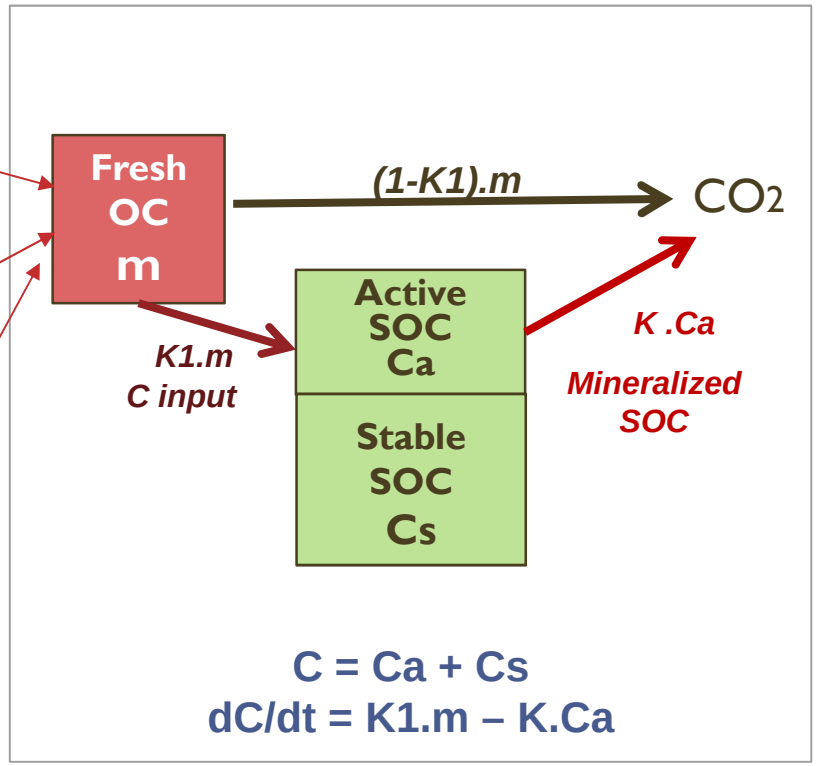
Determination of FOM inputs

Aerial residues Roots

Main crops

Catch crops

Organic Amendments

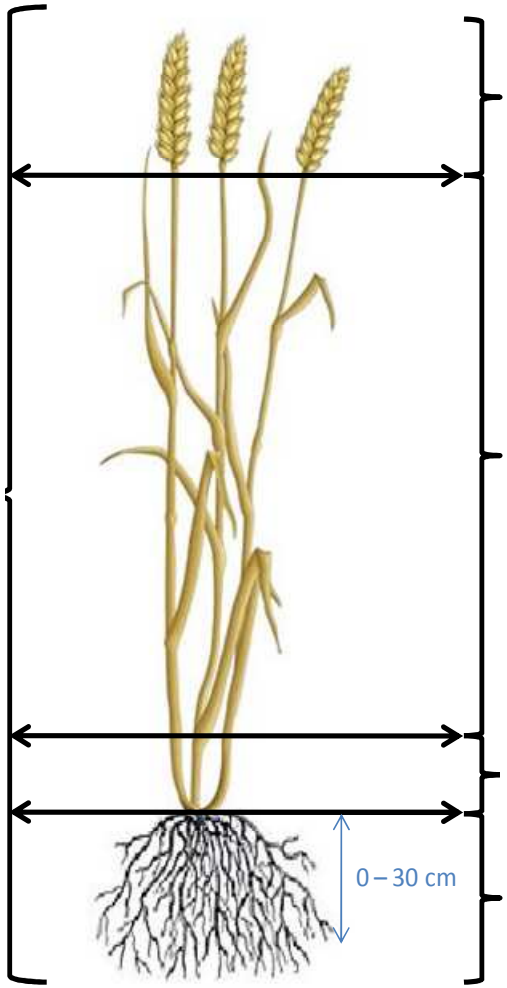


FOM = crop residues and organic wastes

m =f(crop yield and amount of organic wastes; C concentration)

K1 = f(nature and composition of FOM)

Inputs from crop residues (grain crops)



DMgrain = yield * DM content

total ADM

total vegetative ADM

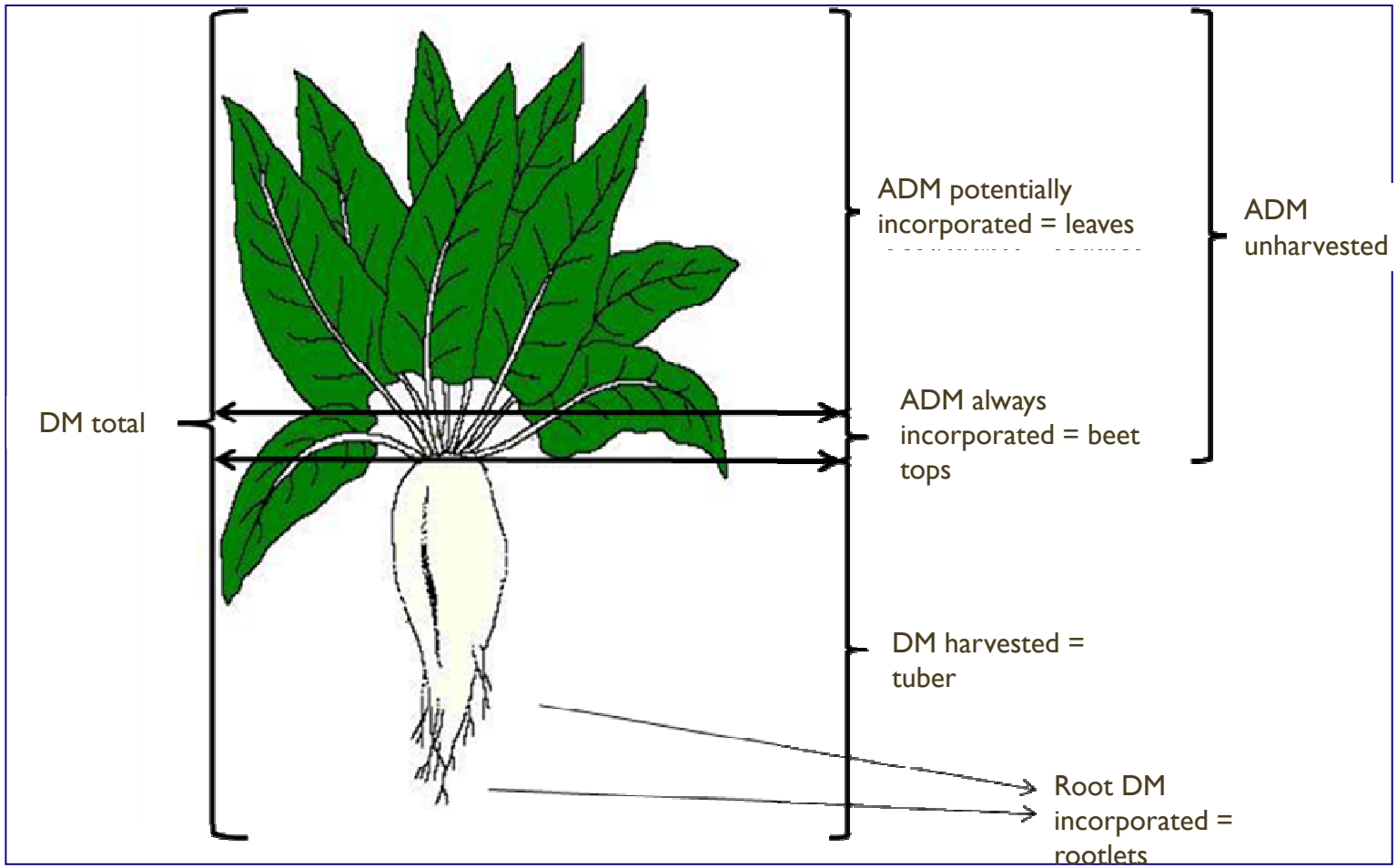
ADM Total = DMgrain / HI

ADM always incorporated

= (ADM Total – DMgrain) * a'

Root DM = ADM Total * CR / (1-CR)

Inputs from crop residues (root crops)



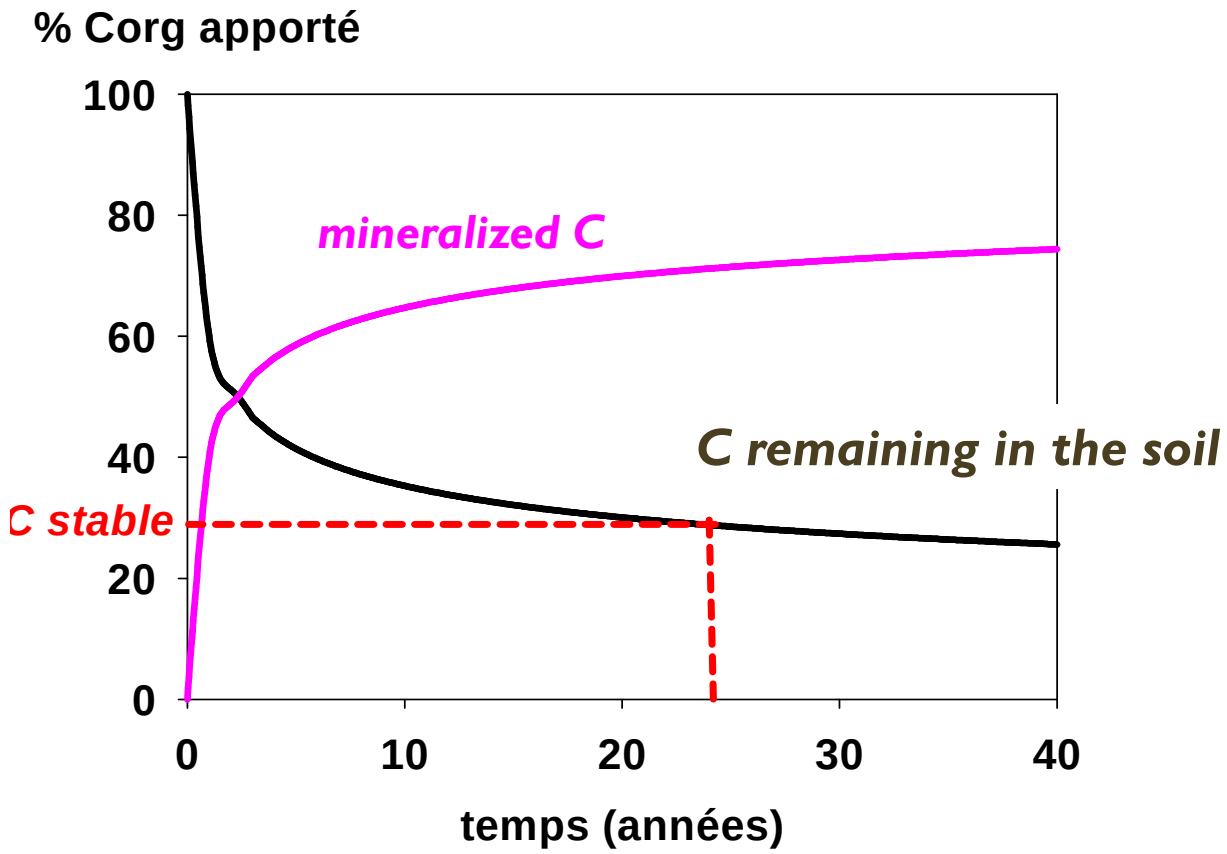
Determination of K1

3 main methods:

- **M1) Model fitting versus observed data in LTE**
- **M2) Calibration with laboratory incubations**
- **M3) Calibration with biochemical analyses**

Method M2

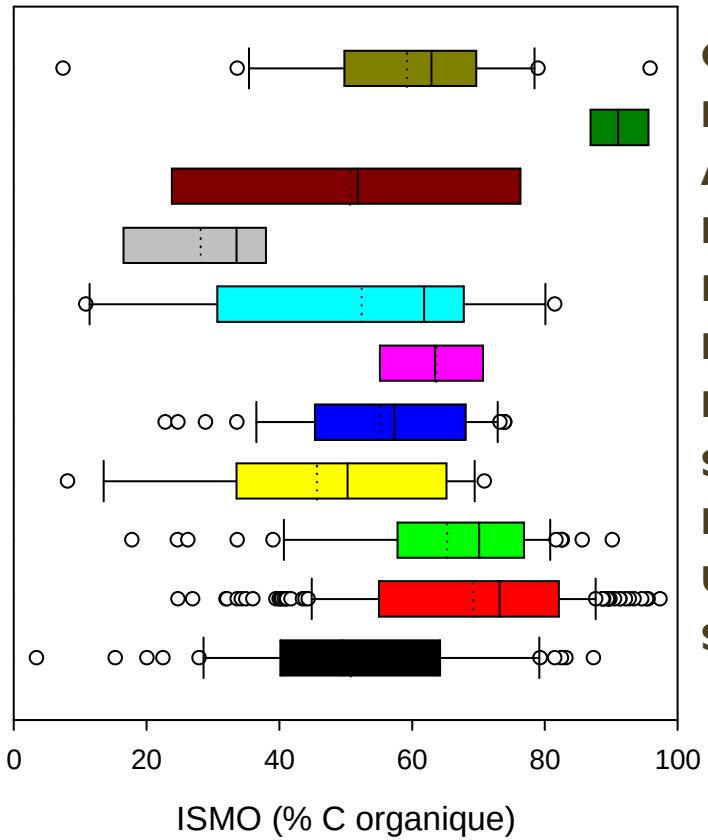
Asymptotic remaining C ≈ K1



Method M3

Biochemical index ISMO ≈ K1

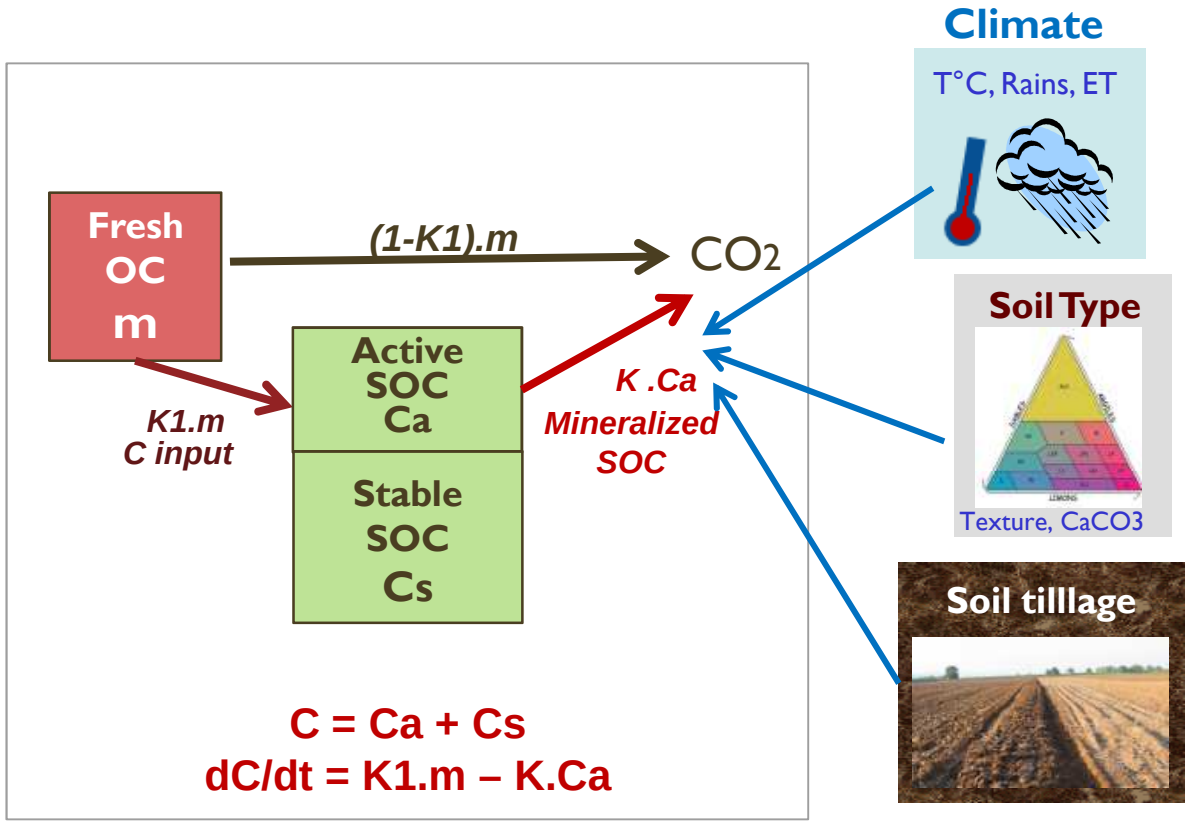
More than 650 organic wastes of different types characterized



Other
Digestate
Animal material
Fertilizers
Plant material
Mulch
Manure
Slurry
Manure compost
Urban compost
Sewage sludge

Lashermes et al., 2009

Calculation of mineralization rate K



K = K0 * f(clay) * f(lime) * f(T) * f(P-PET) * f(tillage)

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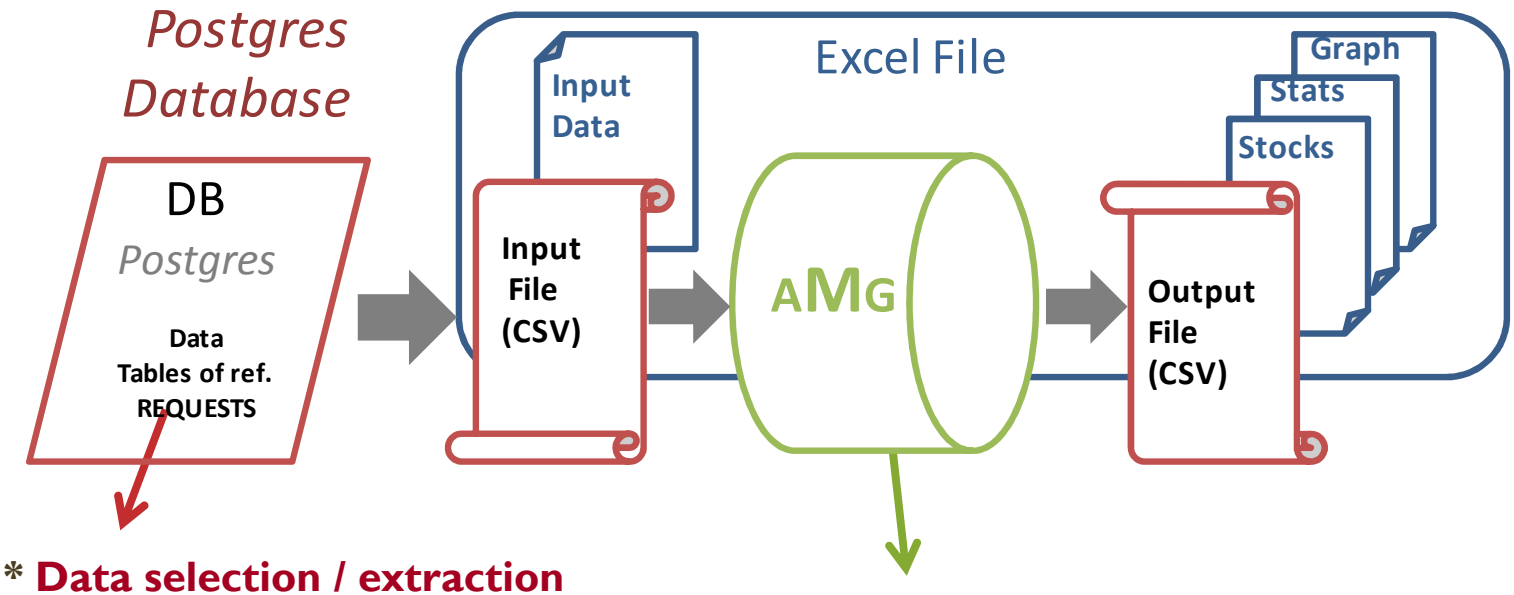
AMG Research



*** Data selection / extraction**

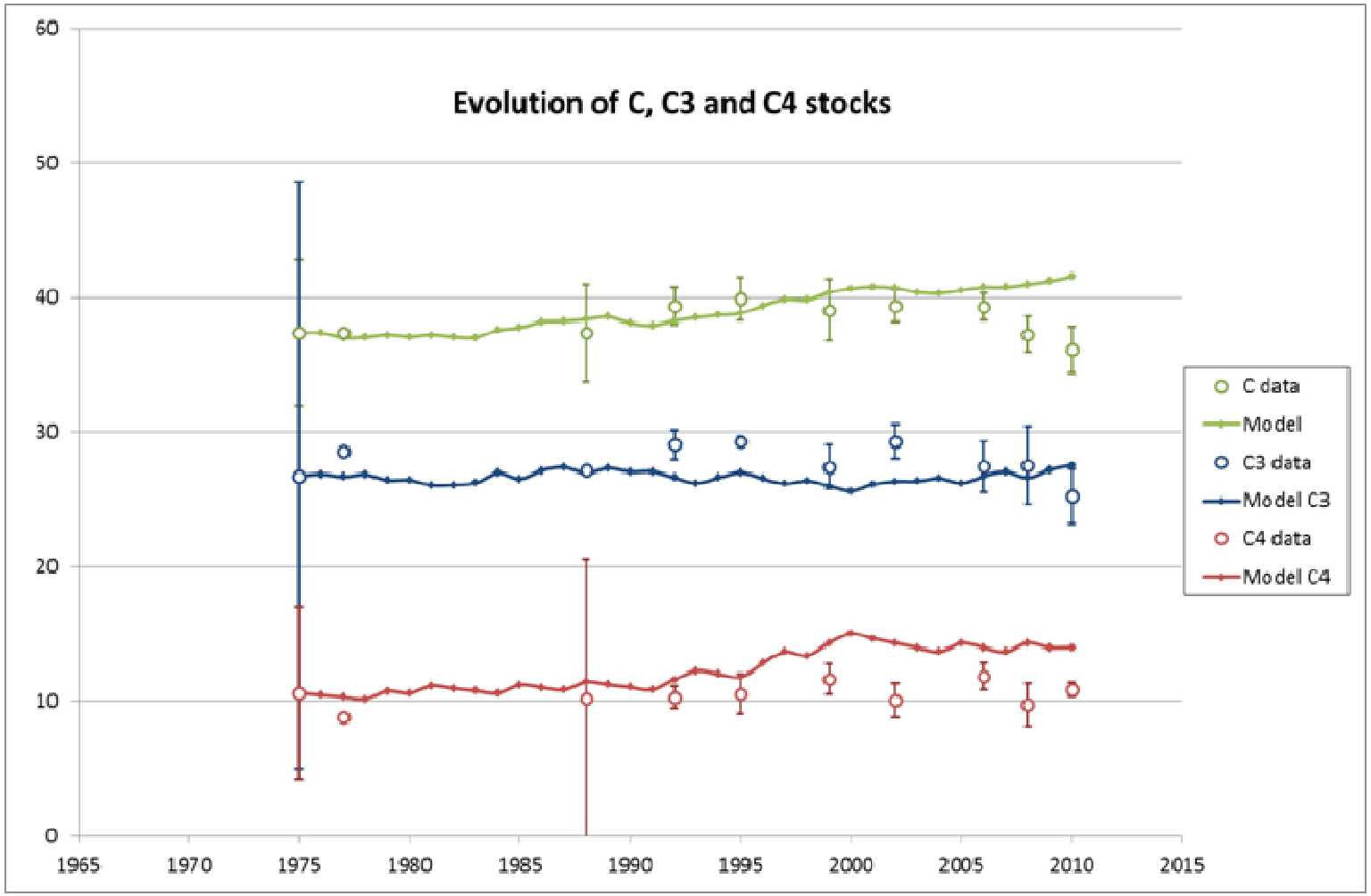
*** Calculation of :**
- **Means**
- **Standard deviations**
- **Observed soil OC evolution**
- **Inputs of C from residues and organic amendments**

*** Génération of CSV input file**

*** Calculation of :**
- **Simulated soil OC evolution**
- **Statistic parameters** relative to the evaluation of the ajustment of the model to the data

*** Optimisation of model parameters** (MCMC process)

Example of SOC variations



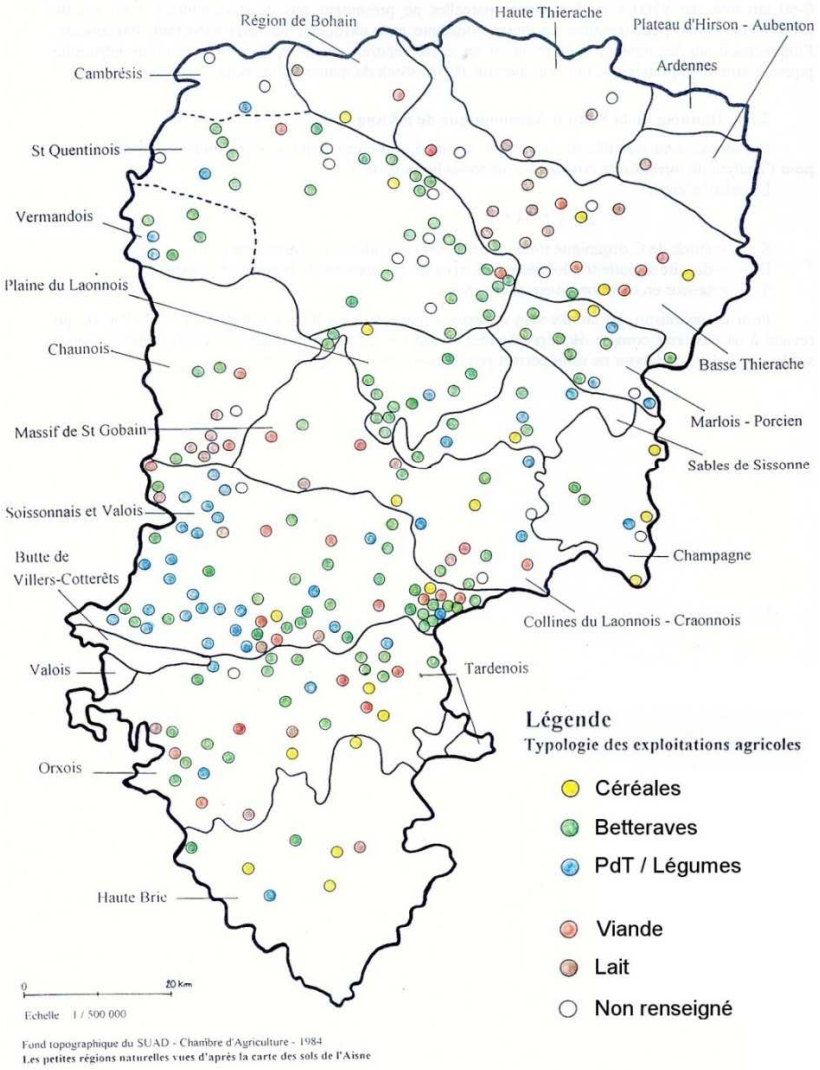
AMG: a simple SOC balance model used in France for decision support
A. Duparque, J.L Dinh, B. Mary and coll. , France

1) Evaluation on a database of soil analyses in arable farms

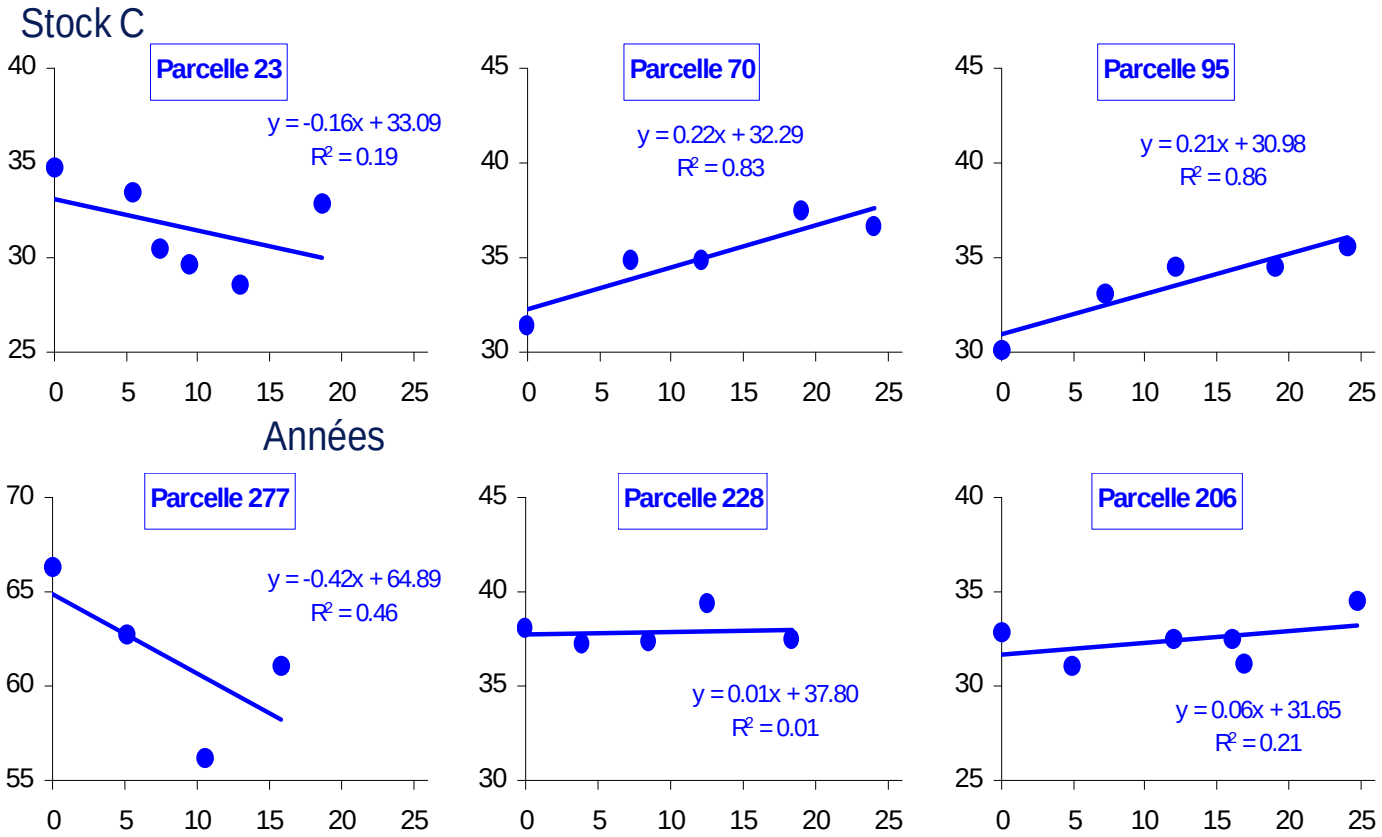
Years 1970-1997

391 fields selected

Analyzed 3, 4 or 5 times



Selection of the 391 fields

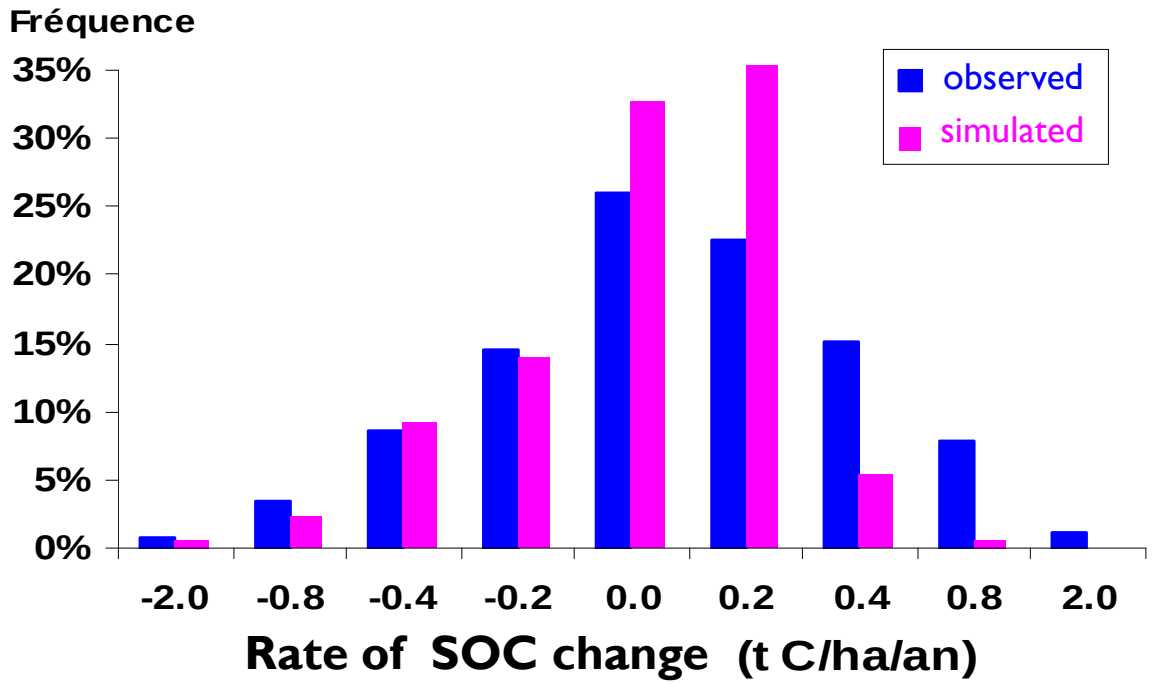


Linear regression versus time
Consistancy of the SOC variation kinetics
Slope = mean rate of change of SOC

Source : B. Mary

Model evaluation

Simulated vs observed rates of change



Source : B. Mary

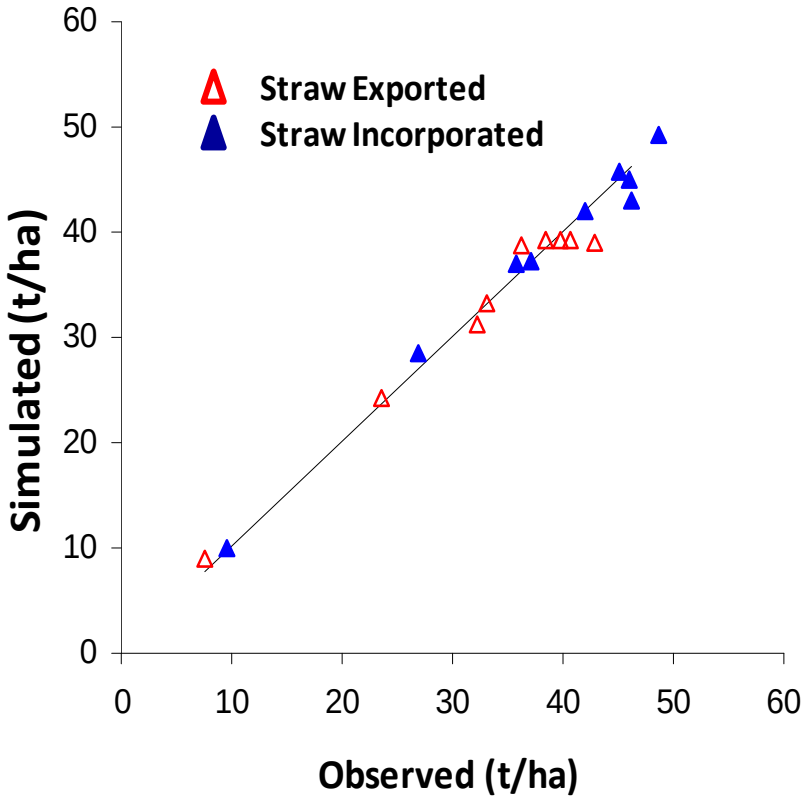
2) Evaluation on 9 long-term experiments

9 LTE with or without straw removal

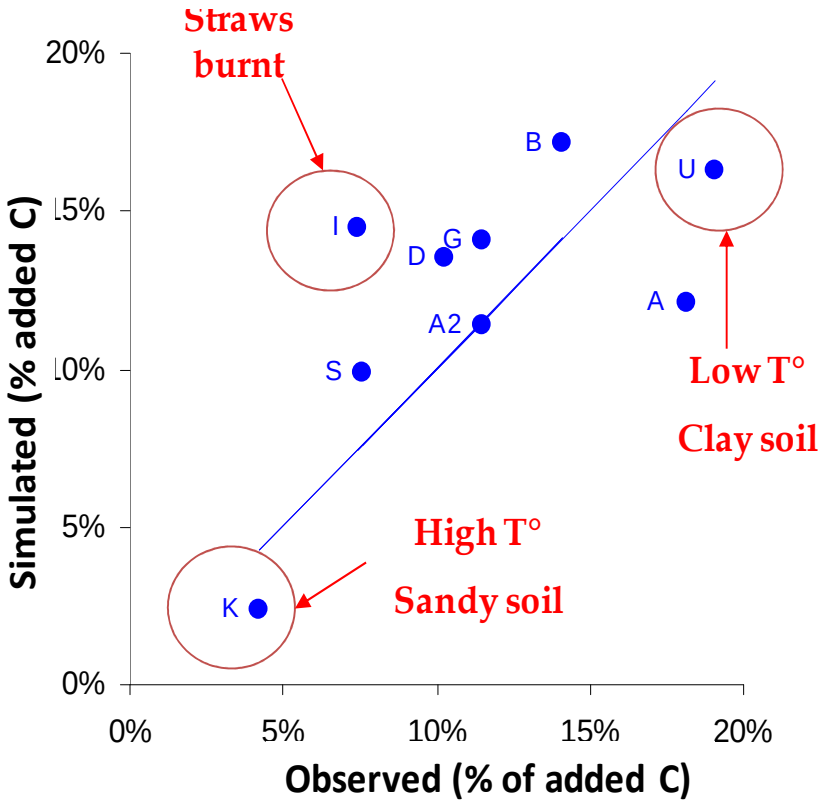
• Ultuna (Sweden)	35 years
• Askov (Denmark)	31 years
• Askov 2 (Denmark)	20 years
• Khon Kaen (Thaïland)	26 years
• Issoudun (France)	32 years
• Serreslous (France)	24 years
• Doazit (France)	13 years
• Grignon (France)	18 years
• Boigneville (France)	12 years

Saffih and Mary, 2008

Simulated vs observed SOC stocks



Simulated vs observed changes in SOC stocks due to straw addition



Saffih and Mary, 2008

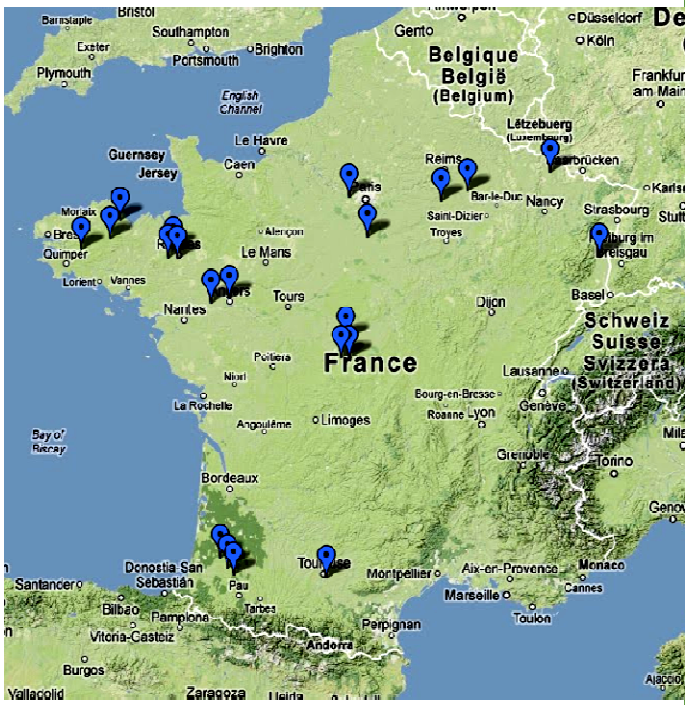
3) Evaluation on 23 long-term experiments in France

AMG project, (2009-2012)

Database of LTE available in France for testing SOM models

Selection of adequate LTE based on:

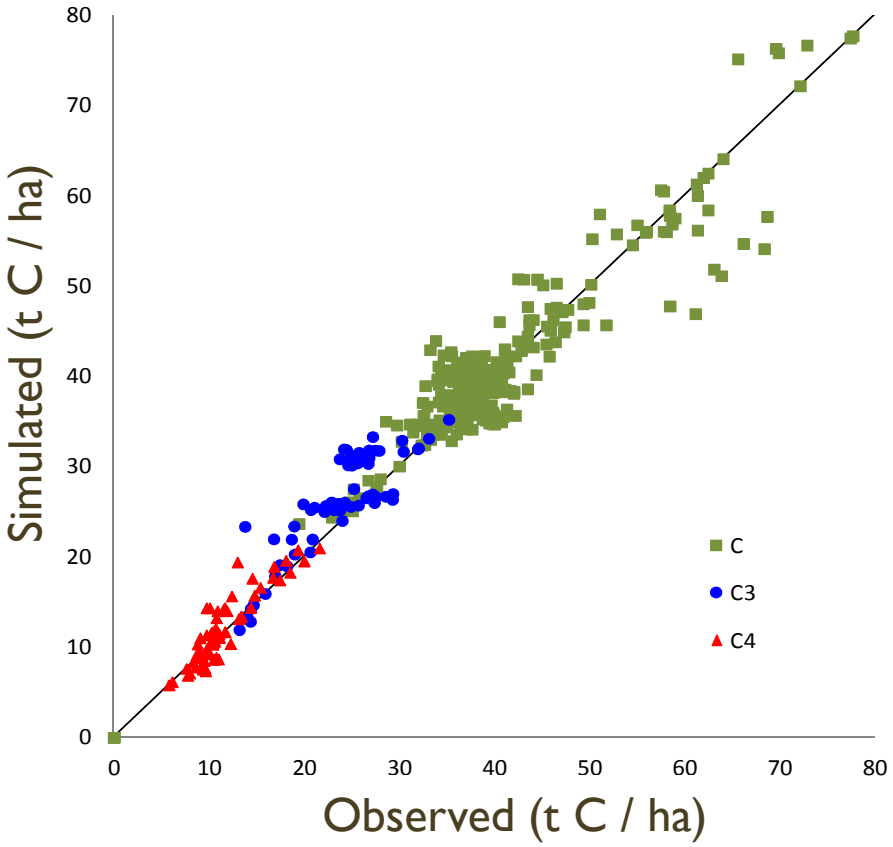
- Consistent evolution of SOM versus time
- Available information on crops, yields, residues and organic wastes management
- Number of measurement dates > 3
- Available information on sampling and/or tillage depths

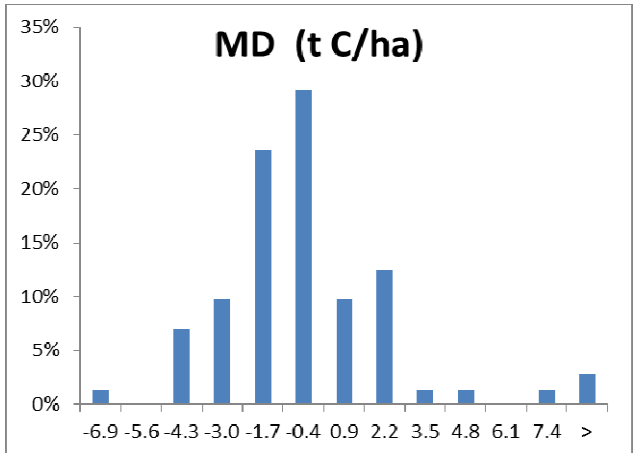


Global evaluation

Simulated vs observed SOC stocks

First results





AMG project, (2009-2012)

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SIMEOS-AMG

GCEOS Project (2004-2011)

Cropping system with vegetables and potatoes in a sandy loam

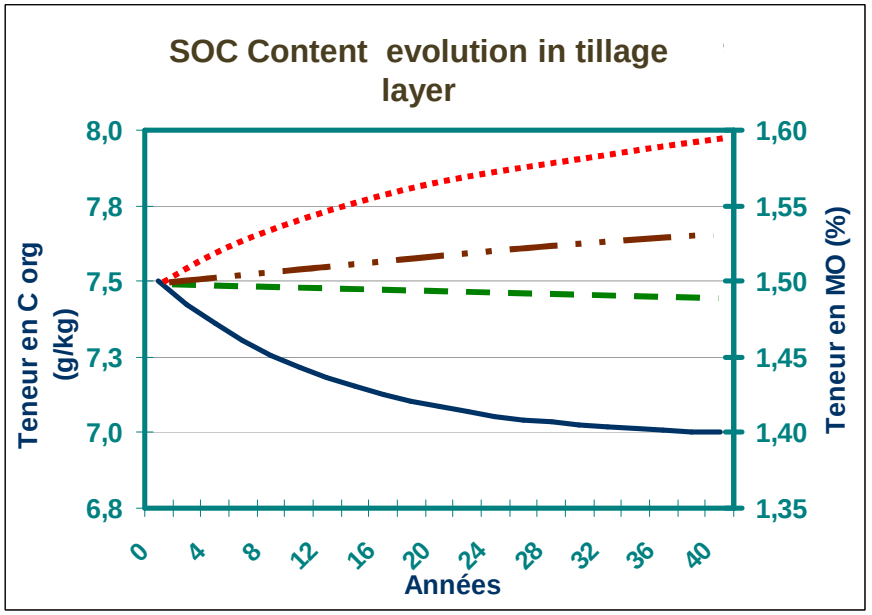
Potatoes / Wheat / Peas / Sugar Beet / Carots

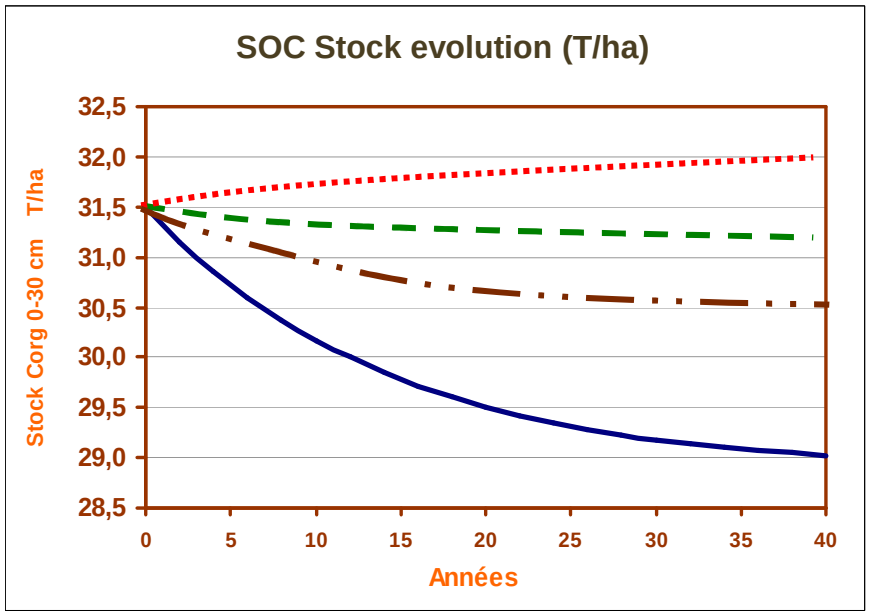
Current system :
- Plowing : 4 yrs/5
- Plowing depth : 28 cm
- Catch crops : 2 yrs/5

1st modif. of the system :
- 1 plowing suppressed : 3 yrs/5
- Plowing depth reduced to 22 cm

3nd modif. of system :
- + 10 T/ha of compost /5yrs
- 1 plowing suppressed and plowing depth reduced to 22 cm

2nd modif. of system :
- + 10 T/ha of compost /5yrs
- Catch crops : 3 yrs/5





A decision support tool for advisory services

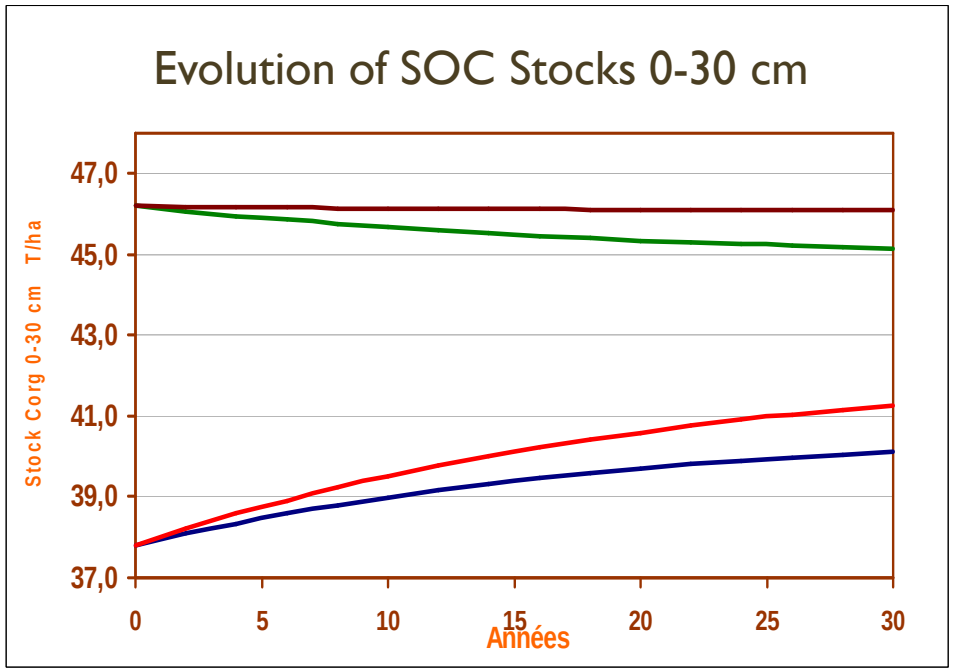
Wich proportion of straw might be exported without a risk at the field scale ?

System '‘cereals + sugarbeet'‘
Loamy soil

betterave – blé – orge - colza – blé.
Engrais verts : 1 année/5
Labour à 25 cm

Hypothesis on soil OM content	*Hypothesis on soil tillage*	
1,8 % of OM	80%Plough	1
	40% Plough	2
2,2 % of OM	80%Plough	3
	40% Plough	4

Simulations by Simeos-AMG



Allowed straw exportation

4 → 3 → 2 → 1 → ?

The C org reference concentration

Principle :

Avoiding the deterioration of soil organic status and related soil properties on the long term for each main agronomical situation

(type- situation = combination of a soil type and a cropping system type)

Corg reference concentration = Median value of the distribution of observed Corg concentrations for a type-situation in the region

System ''cereals + sugarbeet''
Loamy soil

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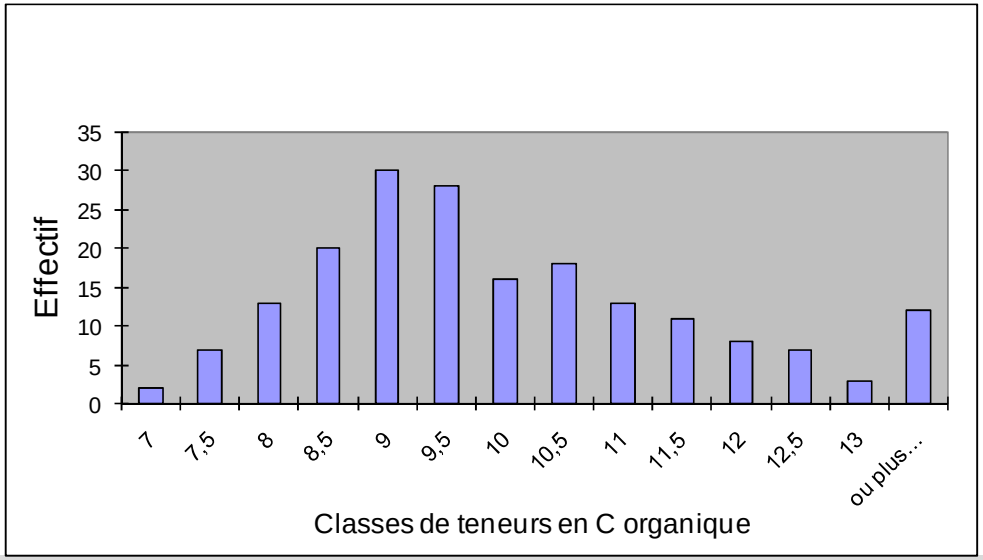
Labour à 25 cm



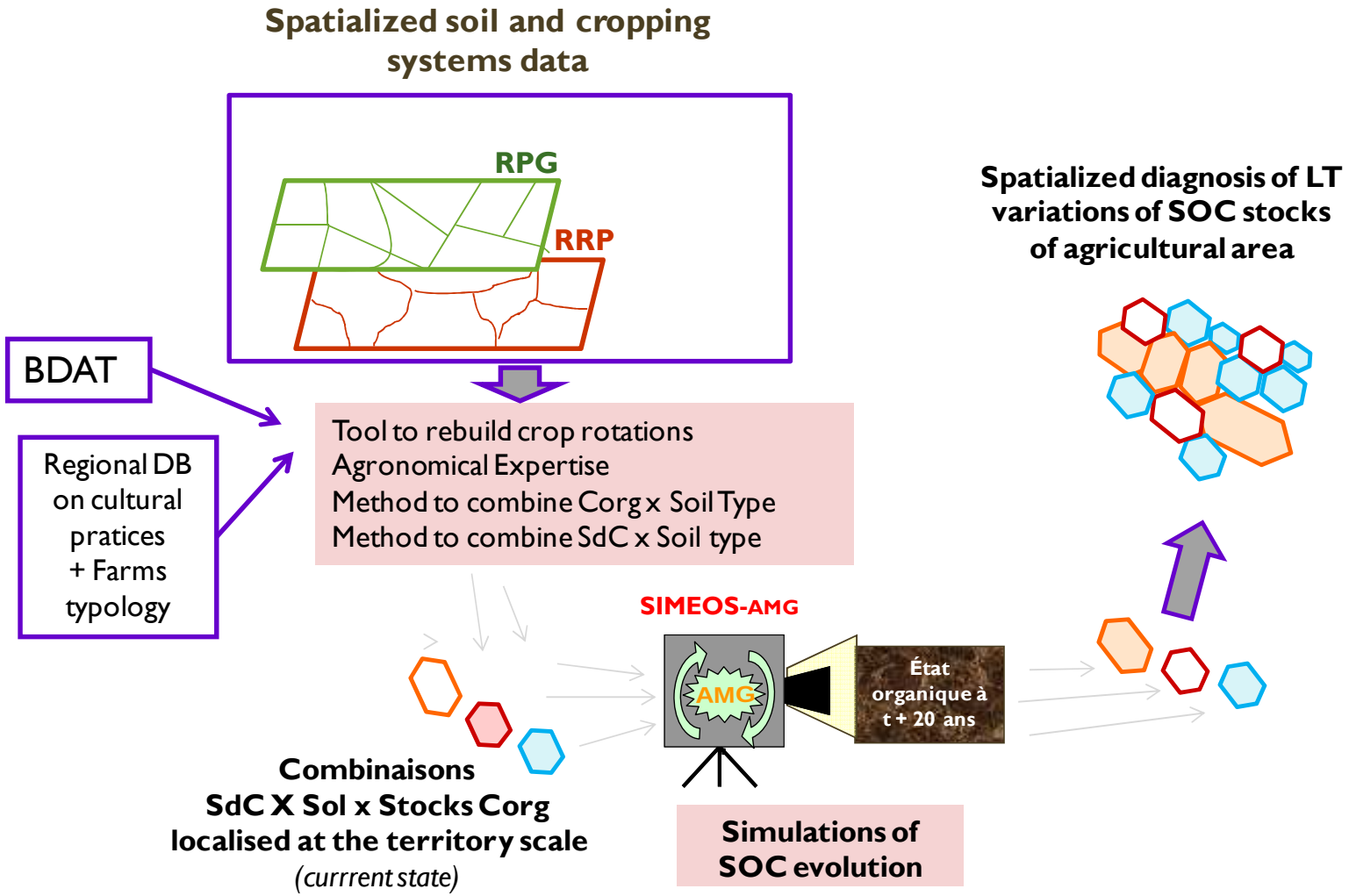
A decision support tool for advisory services

Proportion of straw that might be exported without major risks at the field scale

Cas-types		Teneurs en C organique actuelles du sol (en g/kg)	Teneurs en MO actuelles du sol (en ‰)	Possibilités d'exportation des pailles sans apports organiques extérieurs	Possibilités d'exportation des pailles avec apports organiques extérieurs
Système de culture	Type de sol				
Cas 1 : 0 à 25 % de céréale + pdt – légumes – betteraves 1 céréale tous les 5 – 6 ans	Sables et limons			Teneurs en MO faibles et restitutions organiques faibles => pas d'exportation	Teneurs en MO faibles et restitutions organiques faibles => pas d'exportation
Cas 2 : 25 à 40 % de céréale – colza + betteraves - pdt – légumes 1 céréale tous les 3 ans	Sables, limons et limons argileux				
Cas 3 : 40 à 60 % de céréale – colza + betteraves – pdt – protéagineux 1 céréale tous les 2 ans	Sables et limons	7 à 10	14 à 20	Pas d'exportation	1 paille/4
	Limons argileux	8,5 à 10,5	17 à 21	Pas d'exportation	1 paille/2
Cas 4 : 60 à 70 % de céréale - colza + betteraves - protéagineux	Sables	7 à 9	14 à 18	Pas d'exportation	1 paille/3
	Limons	8,5 à 10,5	17 à 21	1 paille/5	1 paille/2
	Limons argileux	9 à 11	18 à 22	1 paille/3	3 pailles/4
	Cranettes	11 à 14	22 à 28	1 paille/3	3 pailles/4
Cas 5 : 65 à 85 % de céréale – colza + betteraves - protéagineux *Exemple de rotation :* *betterave – blé – orge – colza - blé*	Sables	7 à 9	14 à 18	1 paille/4	3 pailles/4
	Limons	8,5 à 11	17 à 22	1 paille/3	3 pailles/4
	Limons argileux	9 à 11	18 à 22	1 paille/3	3 pailles/4
	Argiles	10 à 12,5	20 à 25	1 paille/2	Toutes les pailles
	Cranettes	11,5 à 14	23 à 28	1 paille/2	Toutes les pailles

Application of Simeos-AMG to the diagnosis of SOC evolution at the territory scale

ABC'Terre Project (2013-2015)



AMG Model: limitations and improvement prospects

- The **model does not apply to grasslands and other perennial crops** (miscanthus, …)
- The **effect of soil moisture** (through a water balance indicator) **must be improved**
- The values of **humification coefficients of organic wastes** (manures, sludges, composts, slurry, …) **must be updated** using a database of laboratory experiments

These issues are addressed in on going studies in France.

Future prospects

An interest for evaluating AMG on other datasets in Europe and comparing with other models, in this Sompatic group !

THANK YOU

FOR

YOUR ATTENTION