# Dynamics of polysaccharides in soil and its modelling

Delphine Derrien, Christine Marol, Jérôme Balesdent, . Commissariat À L'Energie Atomique, . Université Aix-Marseille 2, . Centre National de La Recherche Scientifique

# Dynamics of Polysaccharides in Soils and Its Modelling

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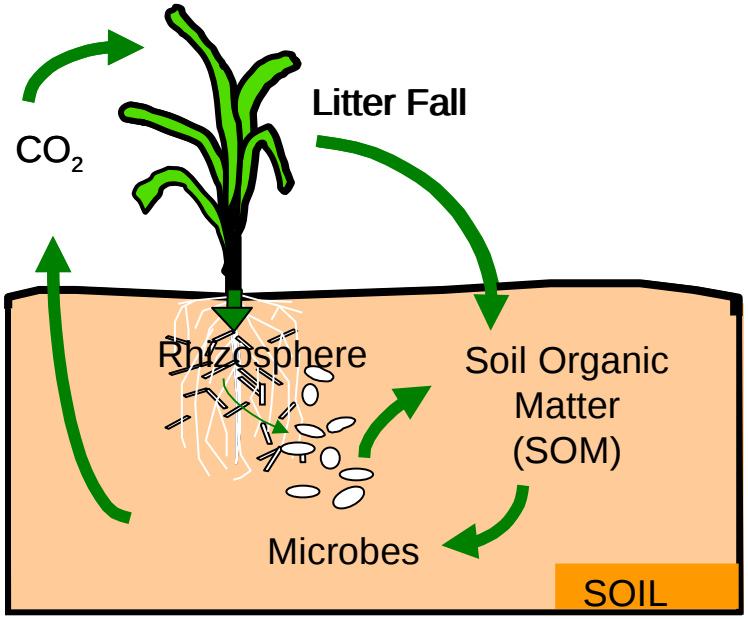
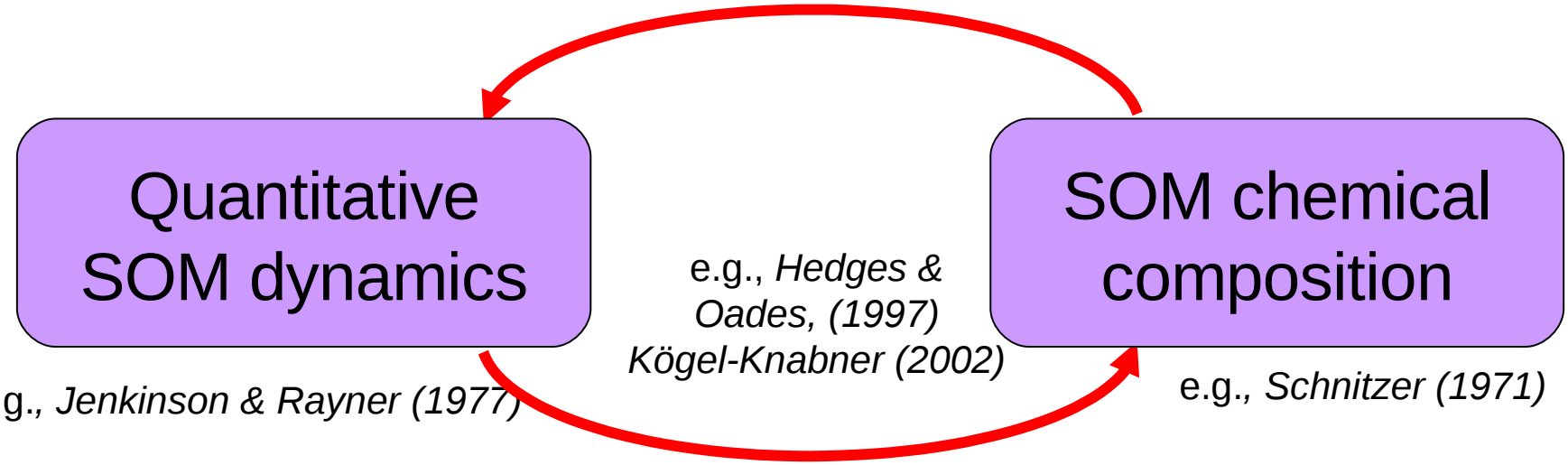
INRA Nancy, France & INRA Aix-en-Provence, France



# Organic matter chemistry and dynamics have to be related, in quantitative terms

Composition partly controls
the dynamics of bulk C
recalcitrance,mobility, sorption …

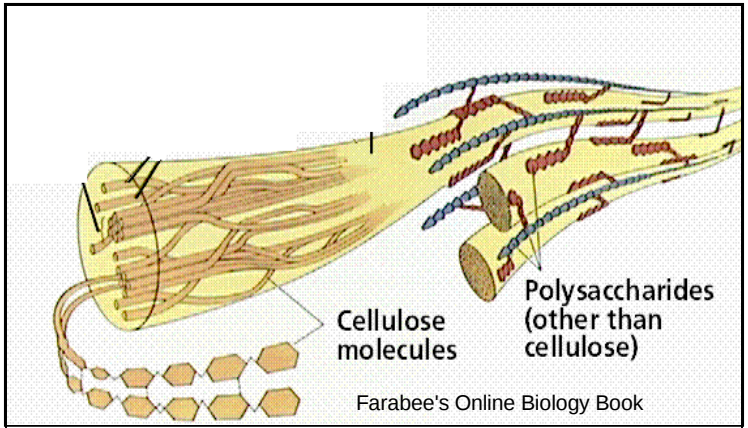



Composition of SOM is not steady
It results from the dynamics of individual compounds and reactions

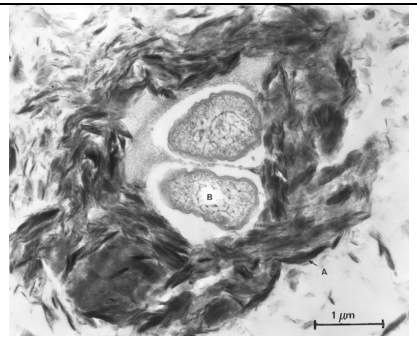
# Carbohydrate in soils

- main input of plant organic matter into soils
- paradoxal fate in soils:

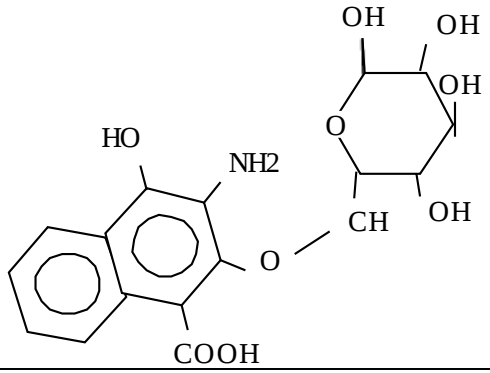
  very degradable but still 10 to 20% of organic matter




Plant-derived polysaccharides



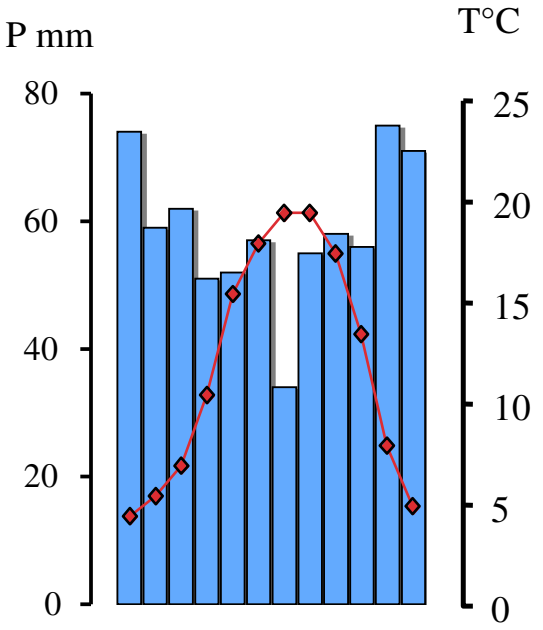

Microbial polysaccharides




Humified/protected saccharides

# Location

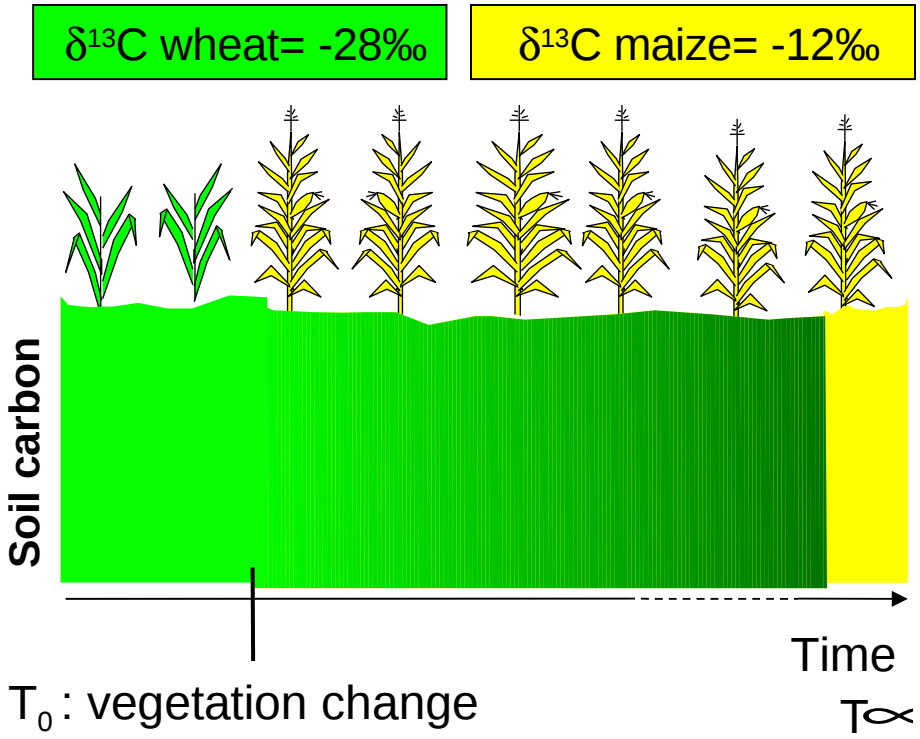
Versailles

# Carbohydrate turn-over

Carbohydrate turnover :

# Isotopic tools : The natural $^{13}C$ labelling of SOC




Balesdent & Mariotti, 1996

$$\frac{C_{maize-derived}}{C_{tot}} = \frac{\delta^{13}C_{maize\_plot} - \delta^{13}C_{wheat\_plot}}{\delta^{13}C_{maize} - \delta^{13}C_{wheat}}$$

Carbohydrate turnover :

# A method to quantify $^{13}C$ in neutral carbohydrate

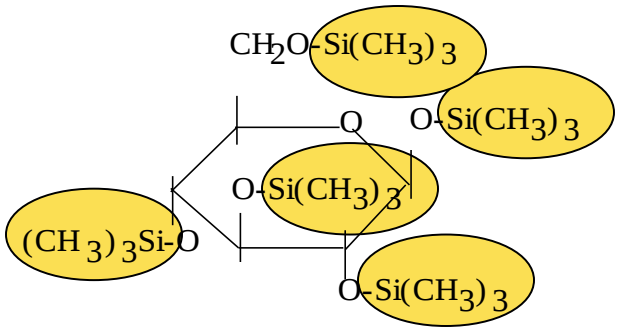
Saccharides

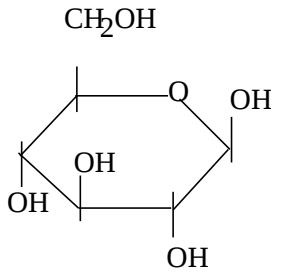
hydrolysis

Mono-saccharides

derivatisation

Trimethylsilyl-carbohydrate




References

$CO_2$. $N_2$

He

GC

Combustion
+ on-line reduction

Ionisation

IRMS

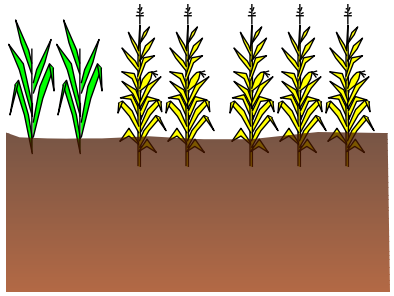
44 45 46

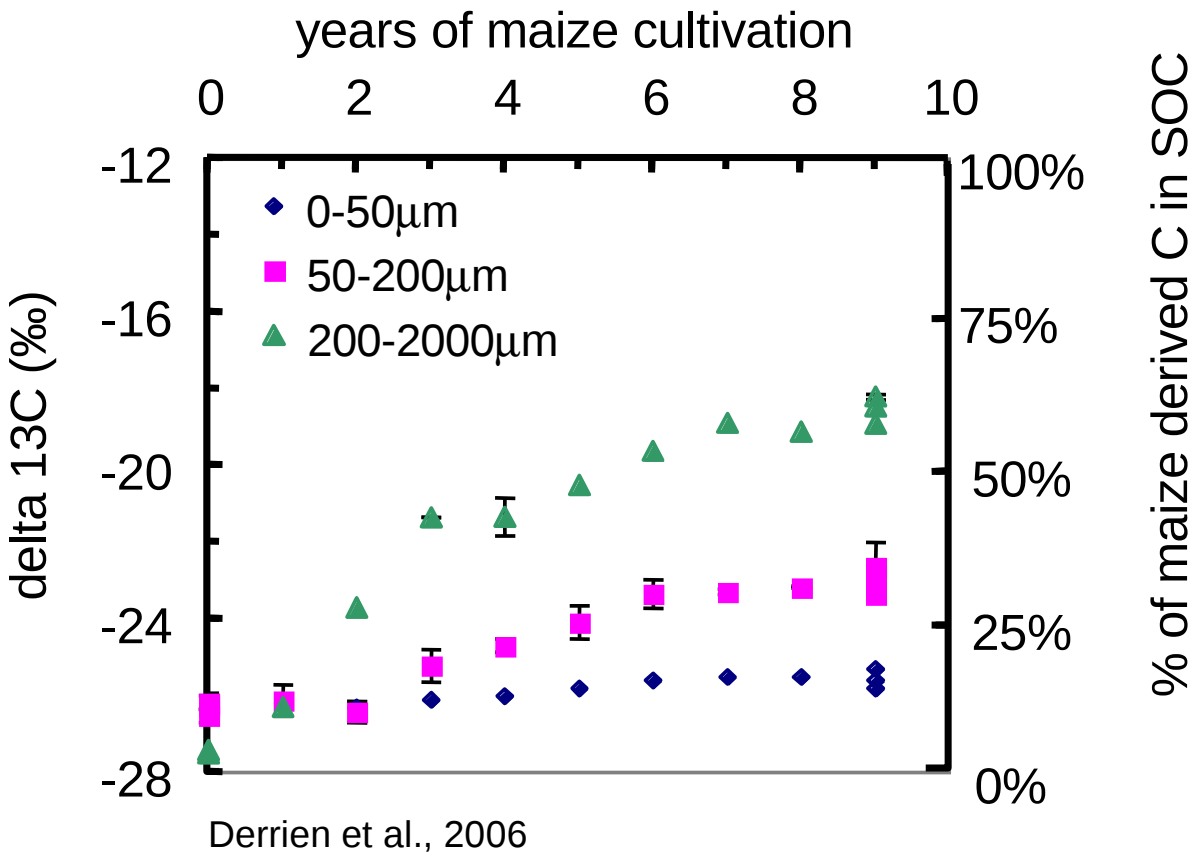
GC-C-IRMS

Isotopic correction of trimethylsilyl C

Carbohydrate turnover :

# Bulk SOC turnover





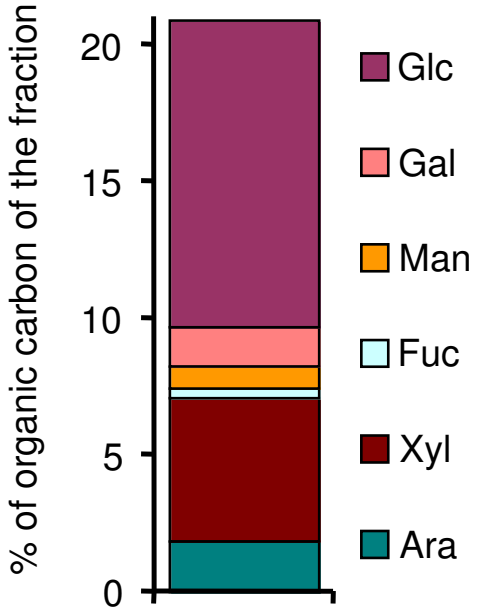

Derrien et al., 2006

The coarse fractions incorporated maize-derived C more quickly than the fine fraction

Carbohydrate turnover :

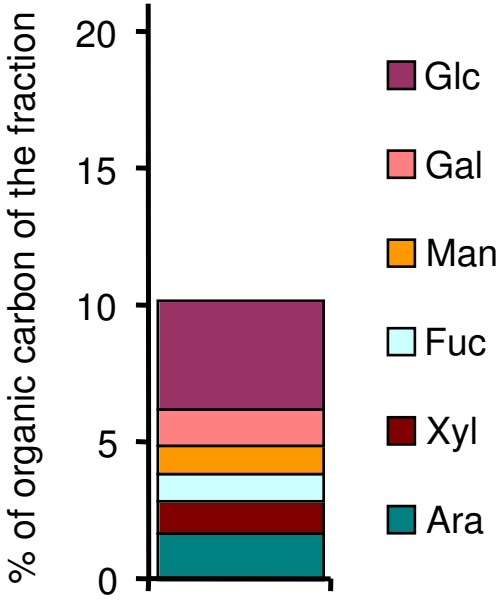
# Individual sugar distribution in particle-size fractions

Particle-size fraction 200-2000 µm




Dominance of plant carbohydrates

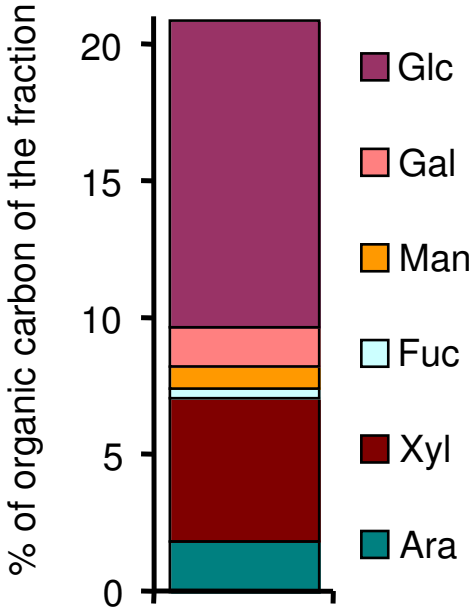
Particle-size fraction 0-50 µm

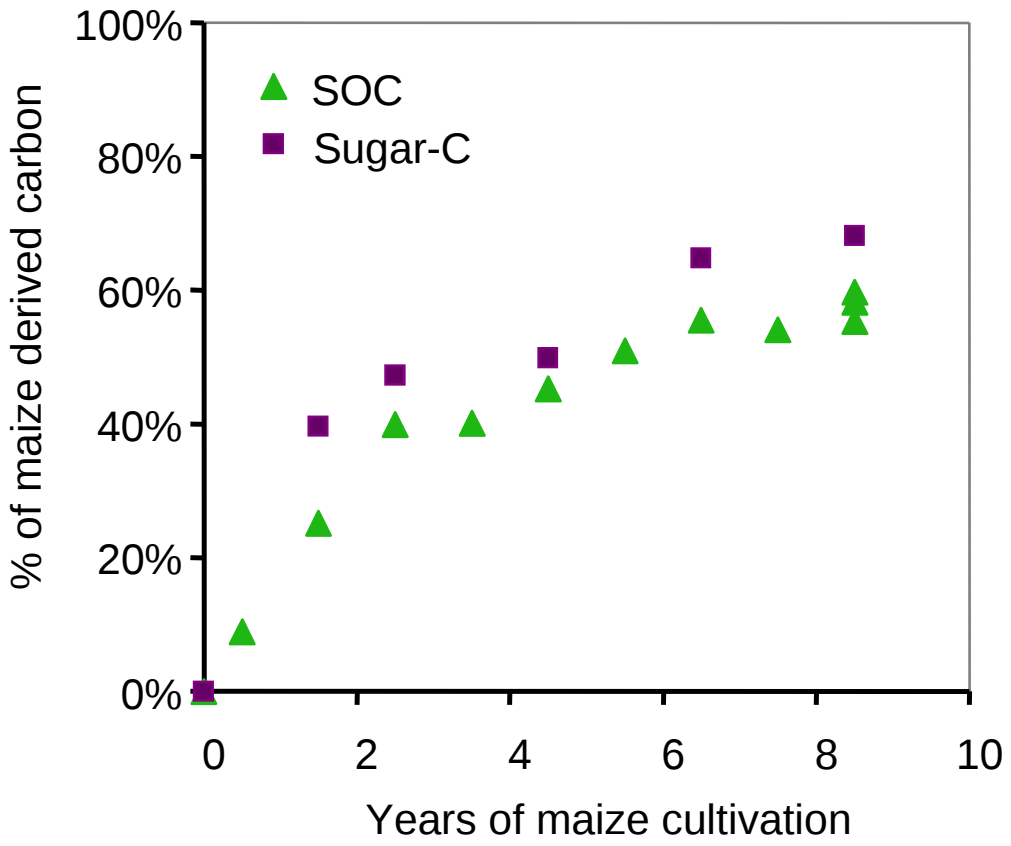



Increasing contribution of microbial carbohydrates

Carbohydrate turnover :

# Particle-size fraction 200-2000 µm

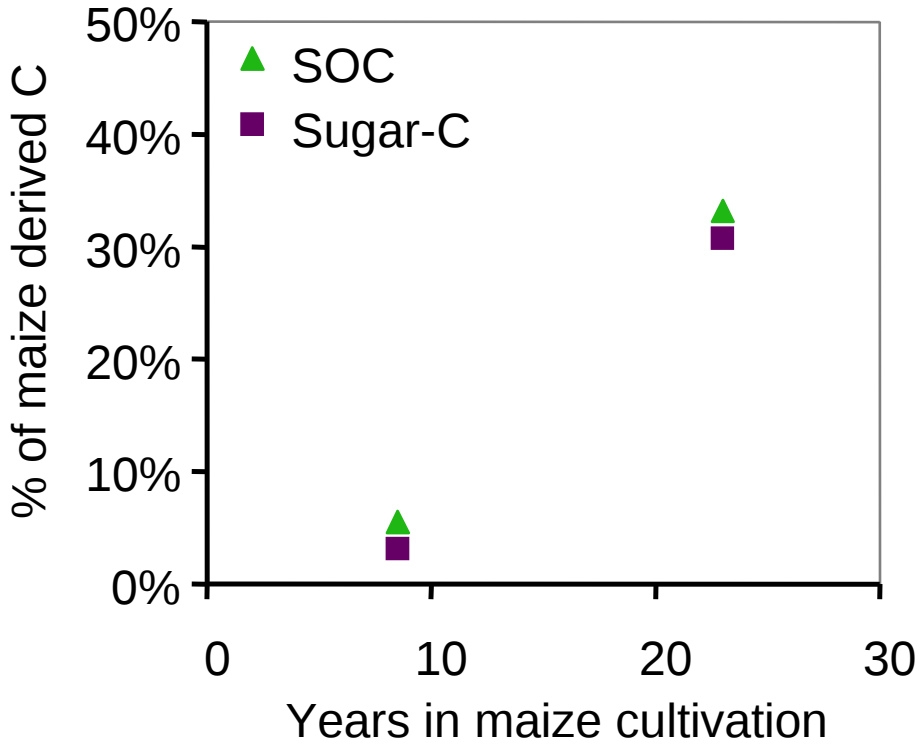


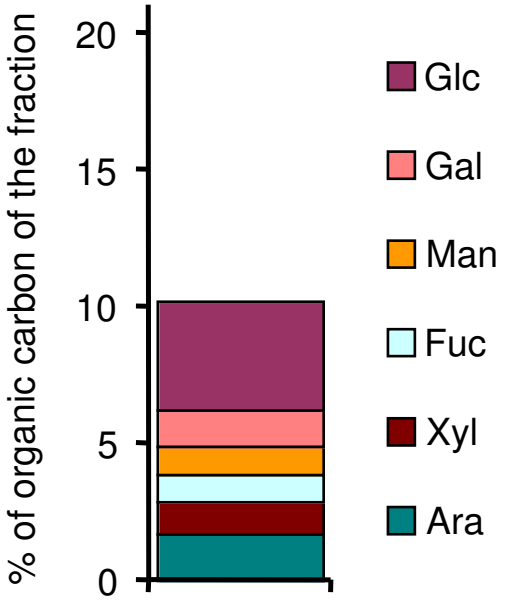




In coarse fractions, the incorporation of maize-C in sugar is almost the same than in bulk OC, a bit faster

Carbohydrate turnover :

# Particle-size fraction 0-50 µm




In fine fractions, incorporation of maize derived-C is very similar in bulk OC and in sugar.

# Carbohydrate turnover :

**In both particle-size fractions, carbohydrate-C seems to have the same turnover, so the same age, than bulk SOC**

**But sugar is labile, isn't it ?**

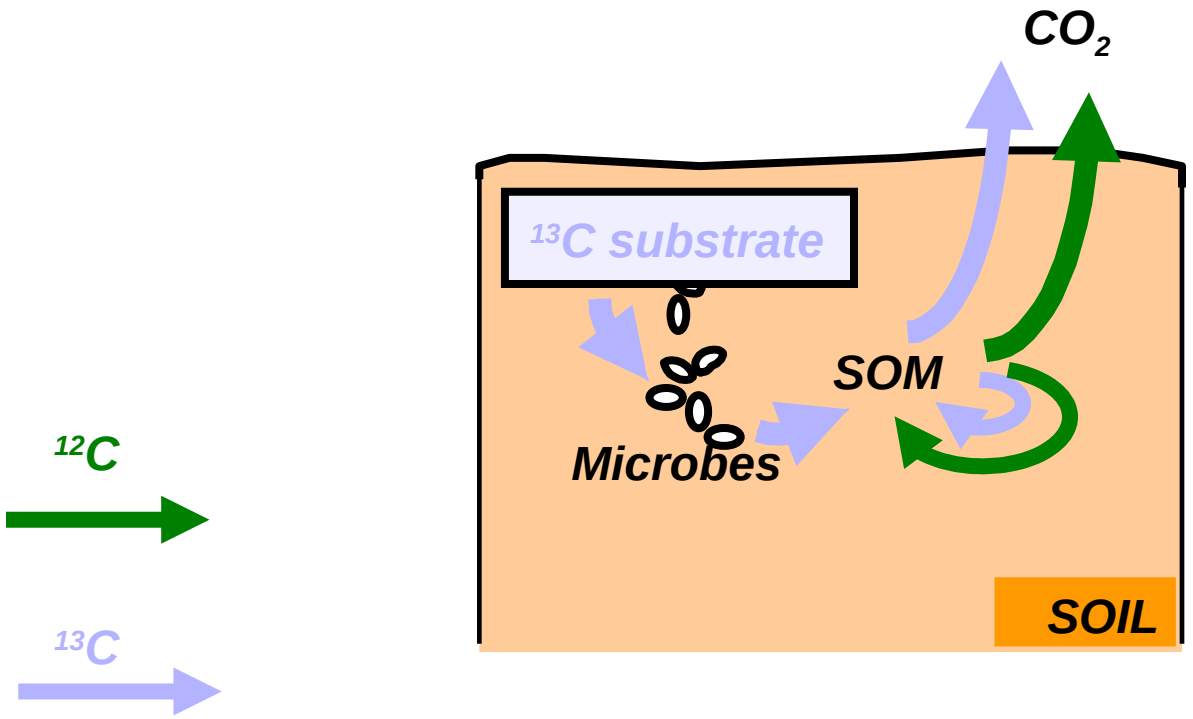
chemical and physical protection of carbohydrate
Or microbial carbohydrate produced from old organic matter
Or active recycling of microbial products

von Lützow et al., 2006

# Microbial biosyntheses of carbohydrate

Quantification of microbial sugar biosyntheses?
Effect of substrate quality ?

# Microbial biosyntheses of carbohydrate :
# Labelling procedure




Short term incubations of labelled substrates:

$^{13}$C-glucose. $^{13}$C-cellulose. $^{13}$C-glycine

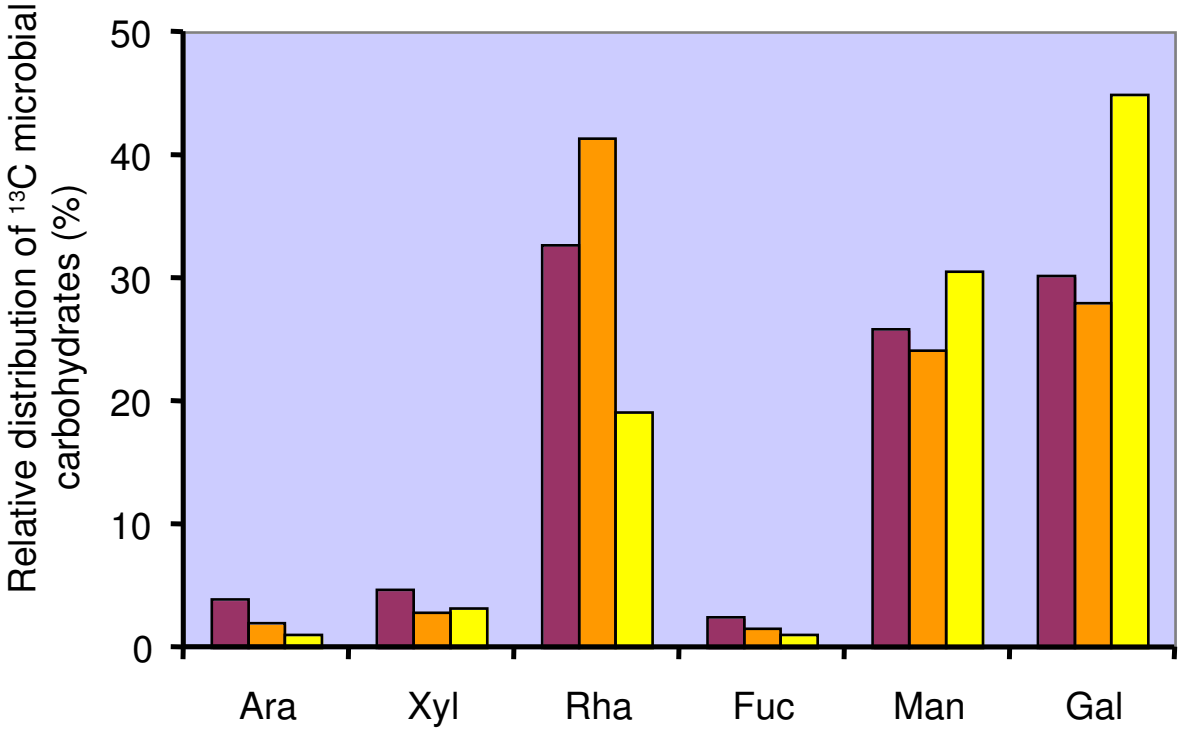
Microbial biosyntheses of carbohydrate :

# Influence of substrate quality

Incubations on the same cambisol

glucose. glycine: 15 days; cellulose: 1 month

subtrate-C= 4% SOC




Incubations of

glucose

glycine

cellulose

• Yield of substrate conversion into sugar: about 20% of microbial metabolites, whatever the substrate

• Very similar distributions of biosynthesized sugars (glucose contribution removed)

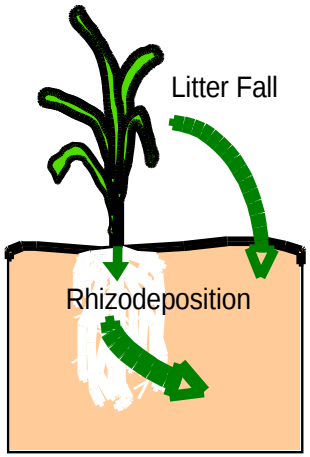
Microbial sugar production relatively independant on substrate quality

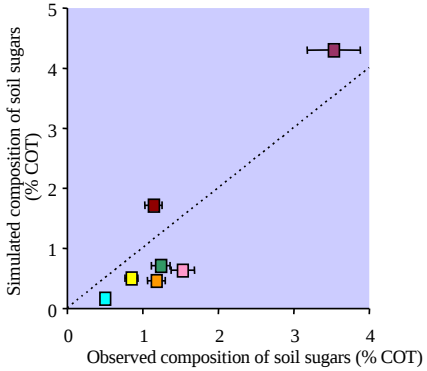
# Modelling. A way to explain experimental data on carbohydrate dynamics

Plant input

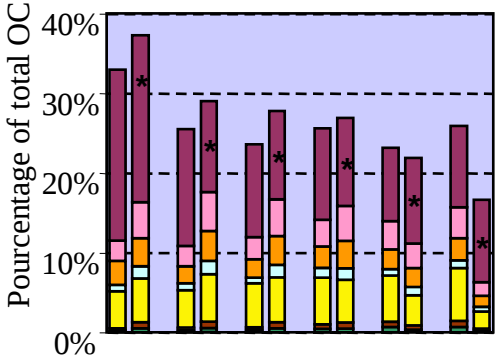
SOM composition at steady state

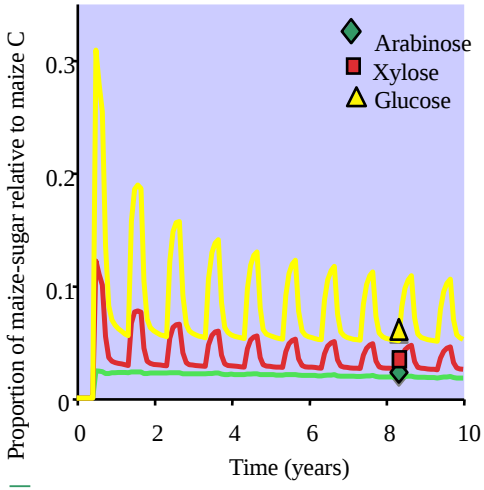
9 year chronosequence of wheat-maize conversion



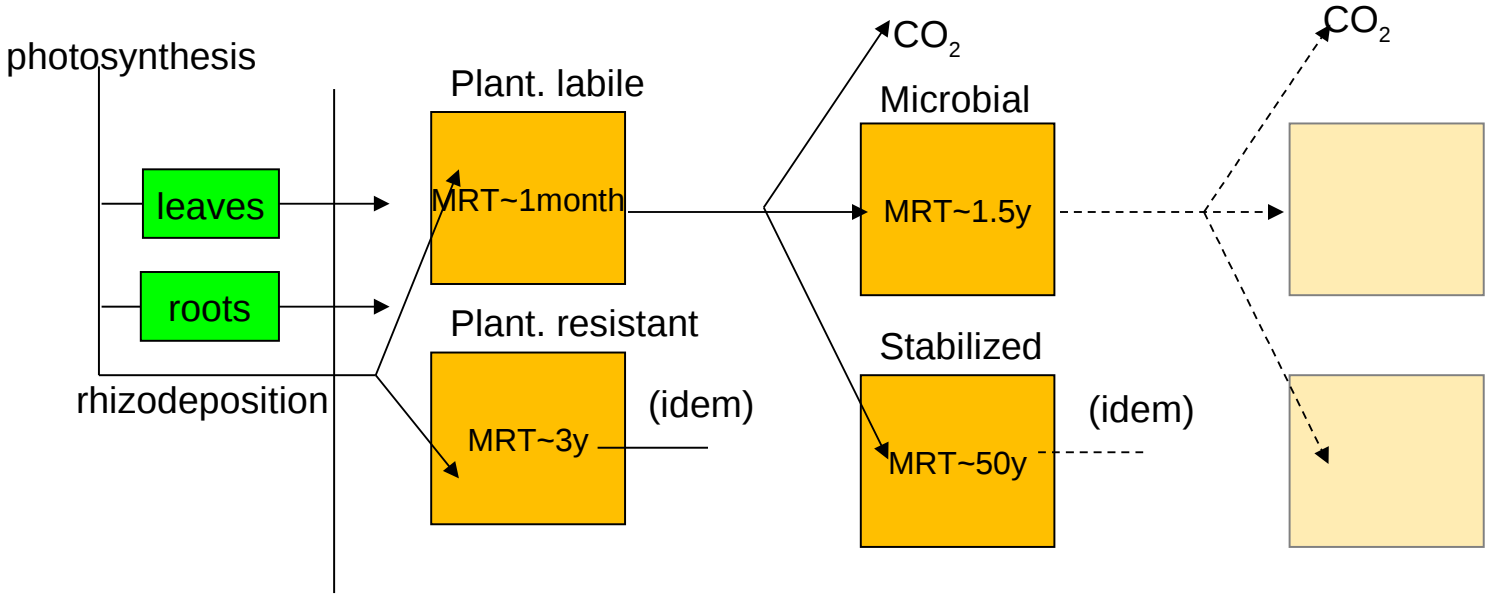

Incubations experiments



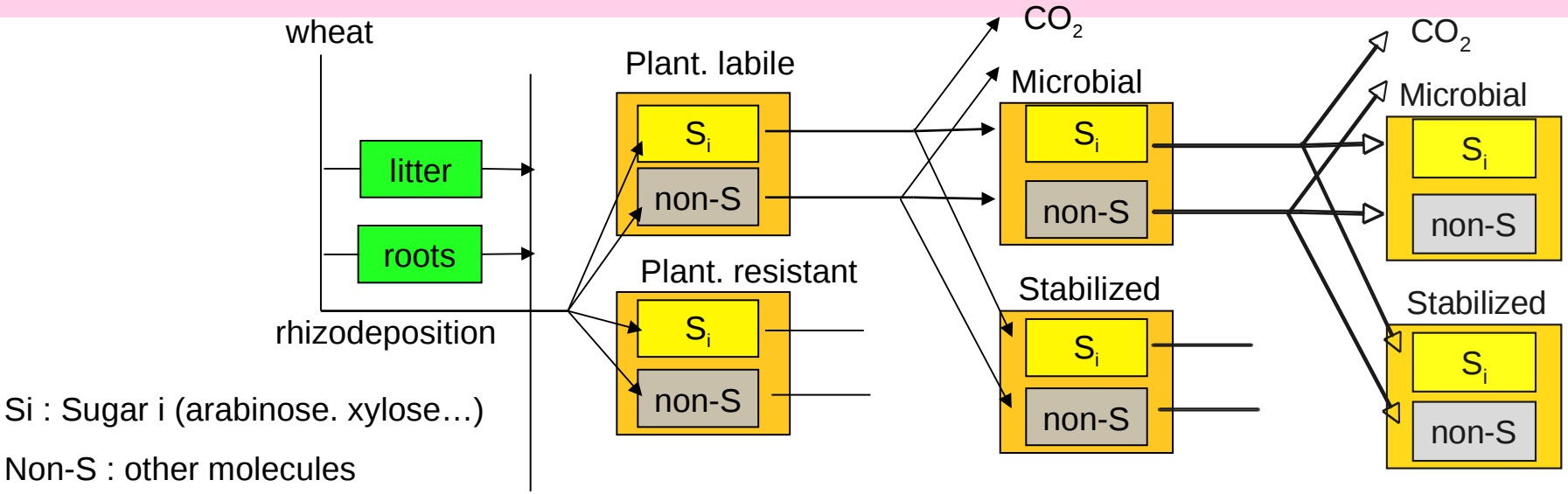
# An example of representation of bulk C dynamics : the Roth C model (Jenkinson & Rayner, 1977)

A model of sugar-C dynamics respecting the frame of the RothC model



Model of sugar-C dynamics:

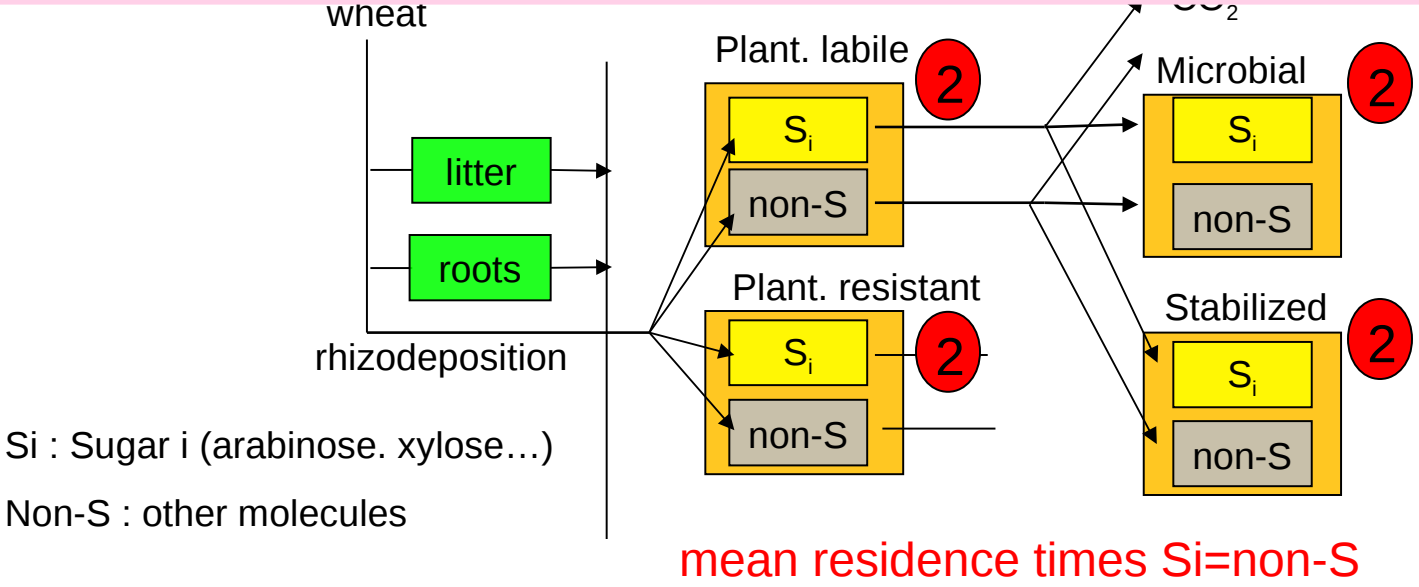
# Structure of the model




1. Compartmental model

Model of sugar-C dynamics:

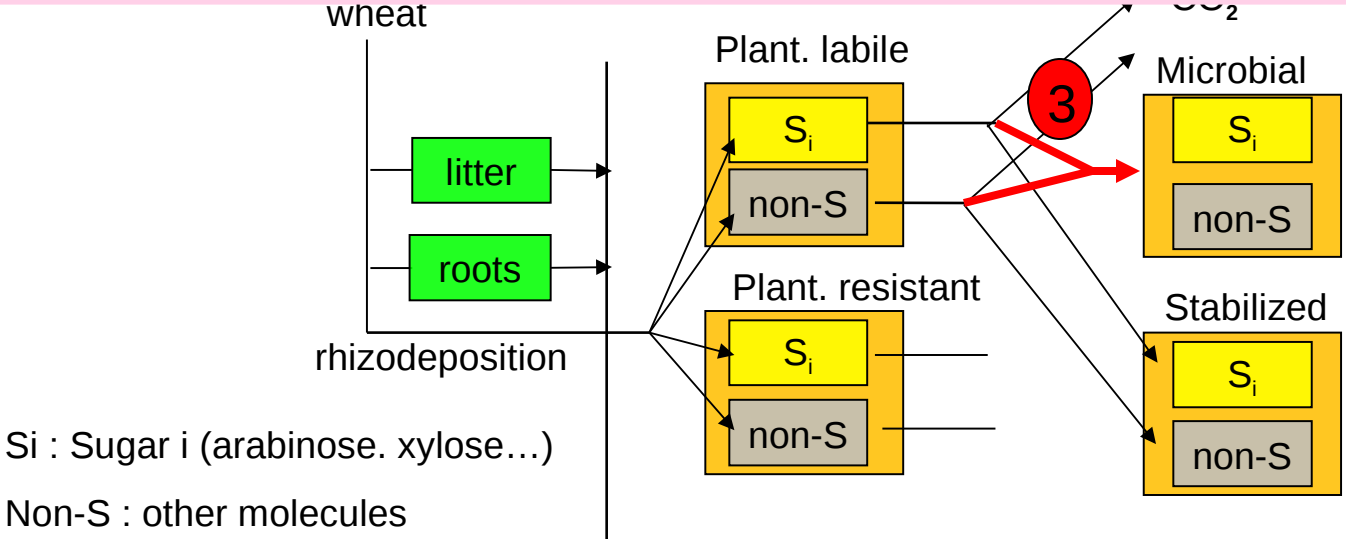
# Structure of the model




1. Compartmental model
2. Same turnover for sugar and non-sugar inside of a pool

Model of sugar-C dynamics:

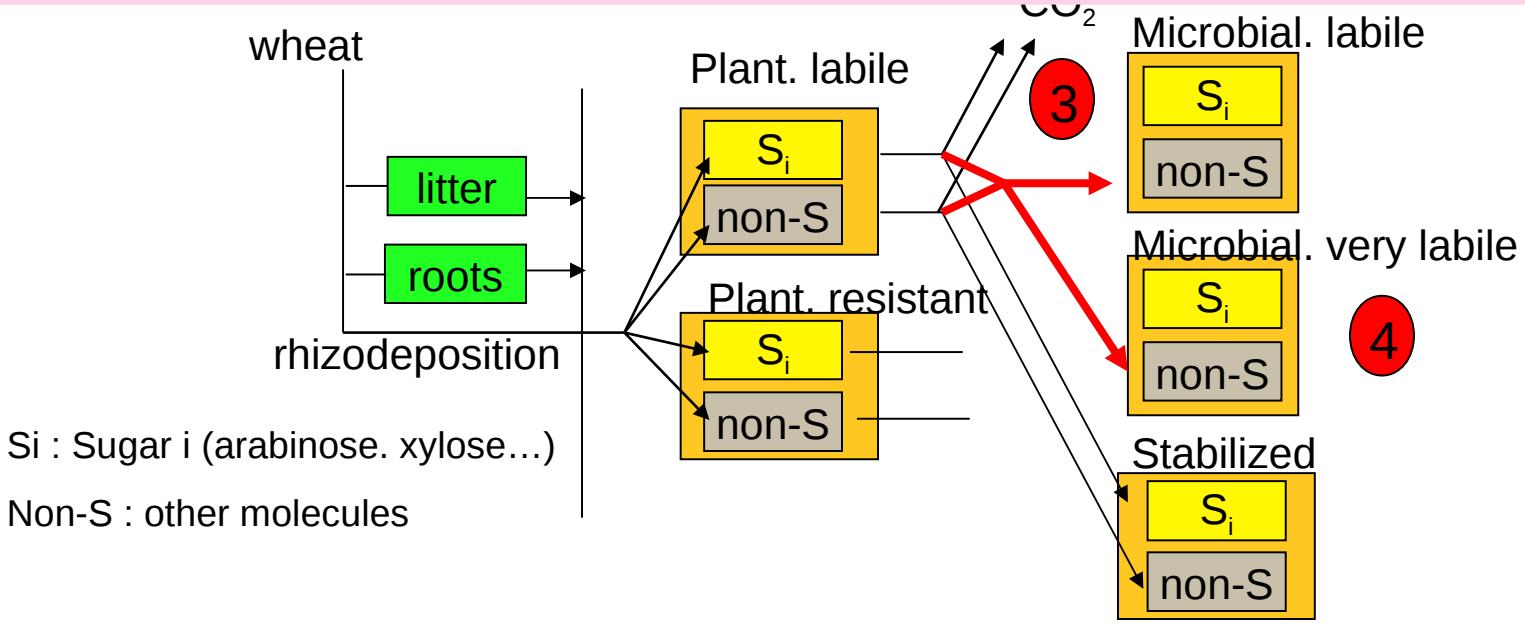
# Structure of the model




1. Compartmental model
2. Same turnover for sugar and non-sugar inside of a pool
3. Unique molecular signature of microbial biosyntheses

Model of sugar-C dynamics:

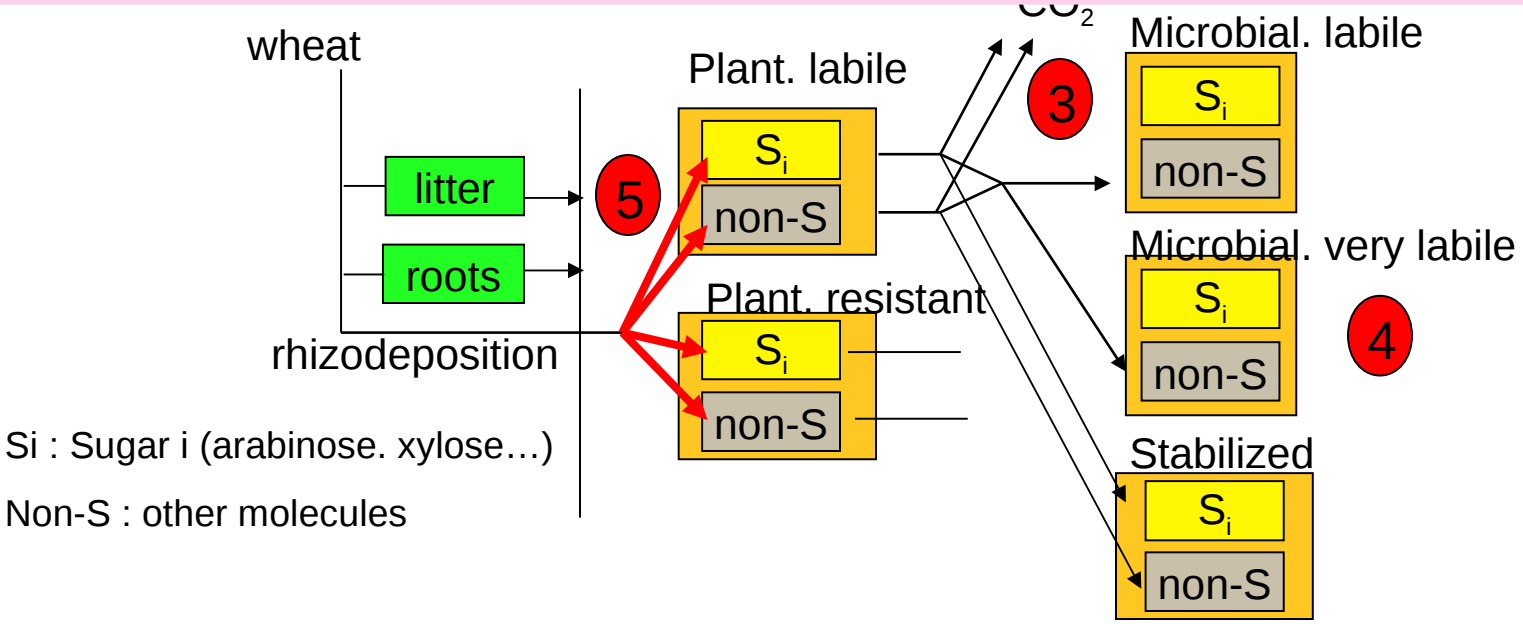
# Structure of the model




1. Compartimental model
2. Same turnover for sugar and non-sugar inside of a pool
3. Unique molecular signature of microbial biosyntheses
4. Introduction a second microbial compartment. very labile

Model of sugar-C dynamics:

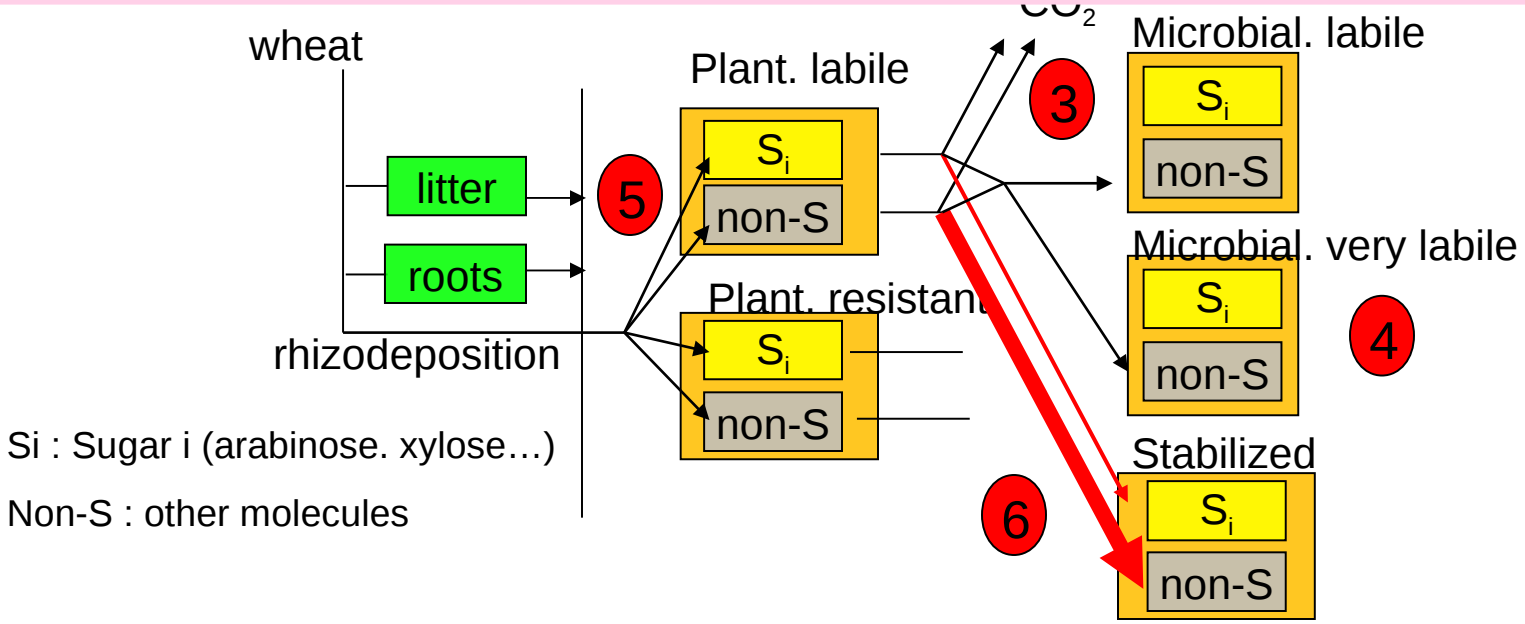
# Structure of the model




1. Compartimental model
2. Same turnover for sugar and non-sugar inside of a pool
3. Unique molecular signature of microbial biosyntheses
4. Introduction a second microbial compartment. very labile
5. Molecular partition into labile or resistant plant material dependant on chemical nature of the molecule

Model of sugar-C dynamics:

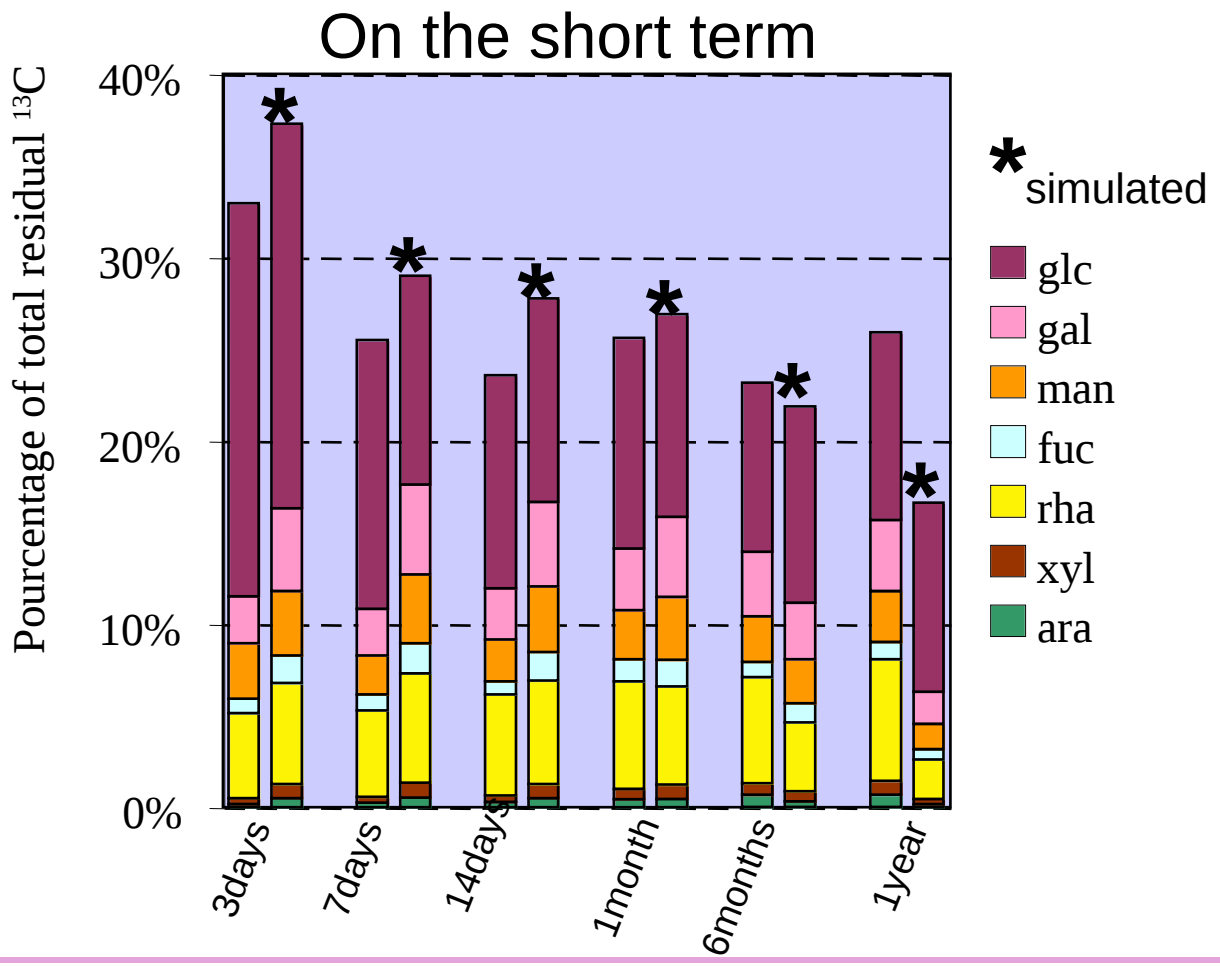
# Structure of the model




1. Compartimental model
2. Same turnover for sugar and non-sugar inside of a pool
3. Unique molecular signature of microbial biosyntheses
4. Introduction a second microbial compartment. very labile
5. Molecular partition into labile or resistant plant material dependant on chemical nature of the molecule
6. Sugars less stabilized than other molecules

Model of sugar-C dynamics:

# Fit to observed data

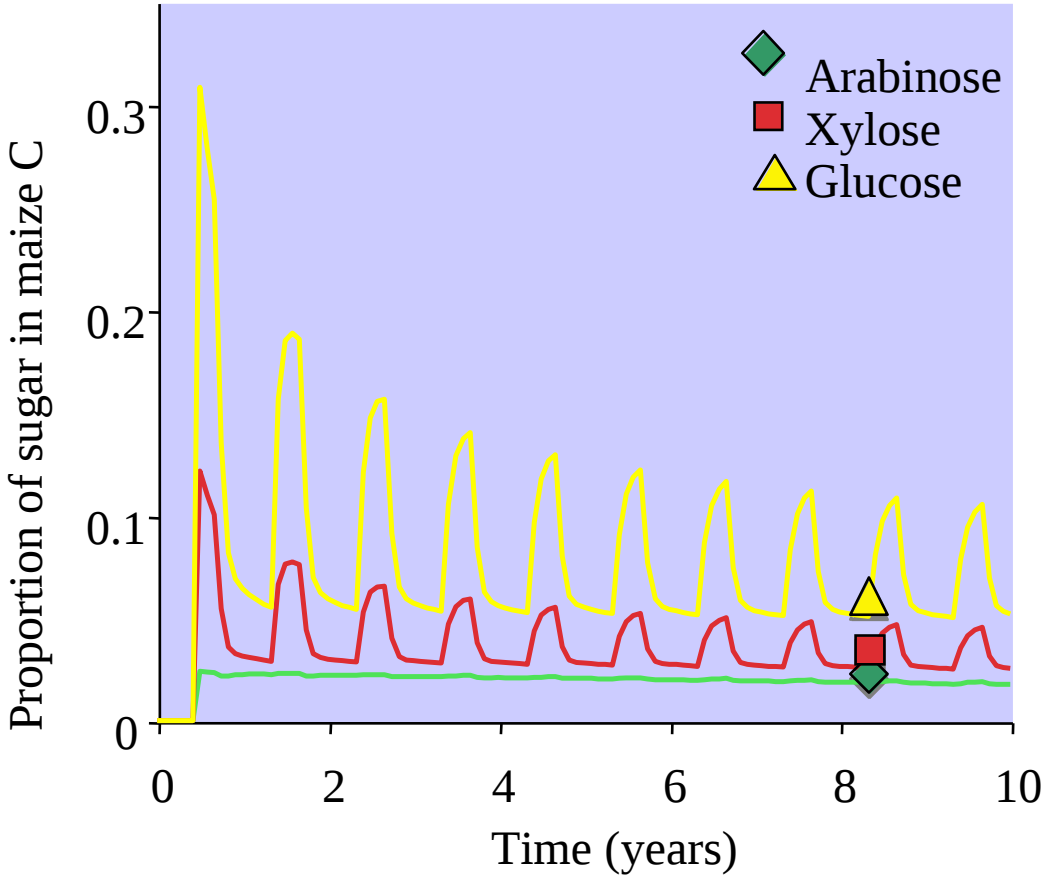



- Good simulations of microbial biosyntheses from glucose substrate
- Good simulation of the fate of the microbial metabolites
- But after one year, rhamnose amount underestimated : selective preservation

Model of sugar-C dynamics:

# Fit to observed data

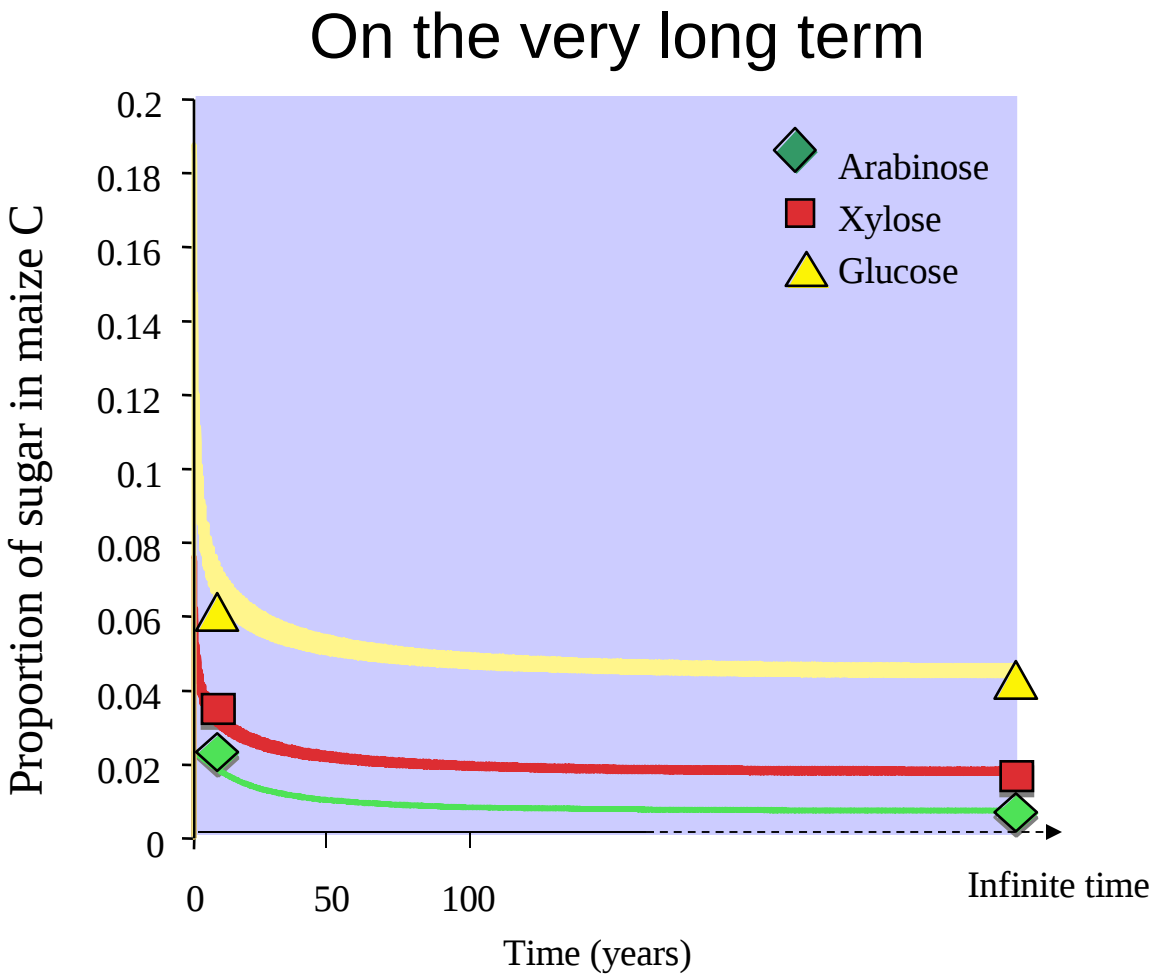
## On the long term




Nice simulation of the proportion of carbohydrate in maize derived C after 9 years of maize cultivation

Model of sugar-C dynamics:

# Fit to observed data




At infinite time, the simulation gives results that fit nicely the sugar composition at steady-state

# The paradox of carbohydrate in soils

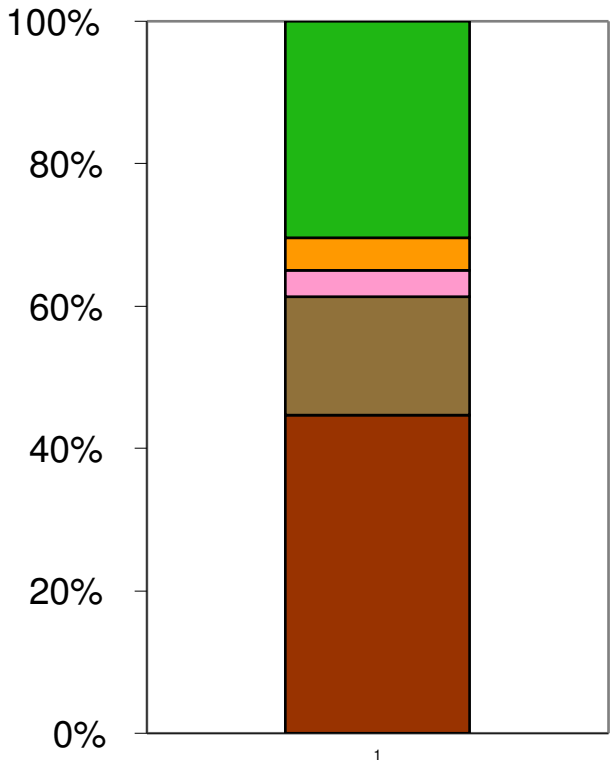
## How to conciliate lability and large amounts of old carbohydrate ?

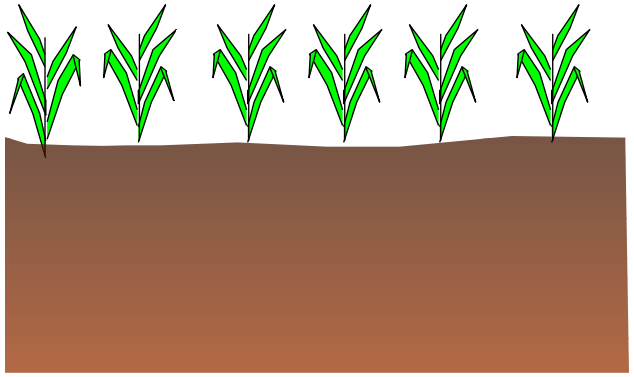
- chemical and physical protection of carbohydrate
- microbial carbohydrate produced from old organic matter
- active recycling of microbial products

Model of sugar-C dynamics:

# Simulations

## Distribution of sugar-C in the field cultivated in wheat for a very long time



Plant-sugar

Plant derived microbial sugar

Recycled microbial sugar

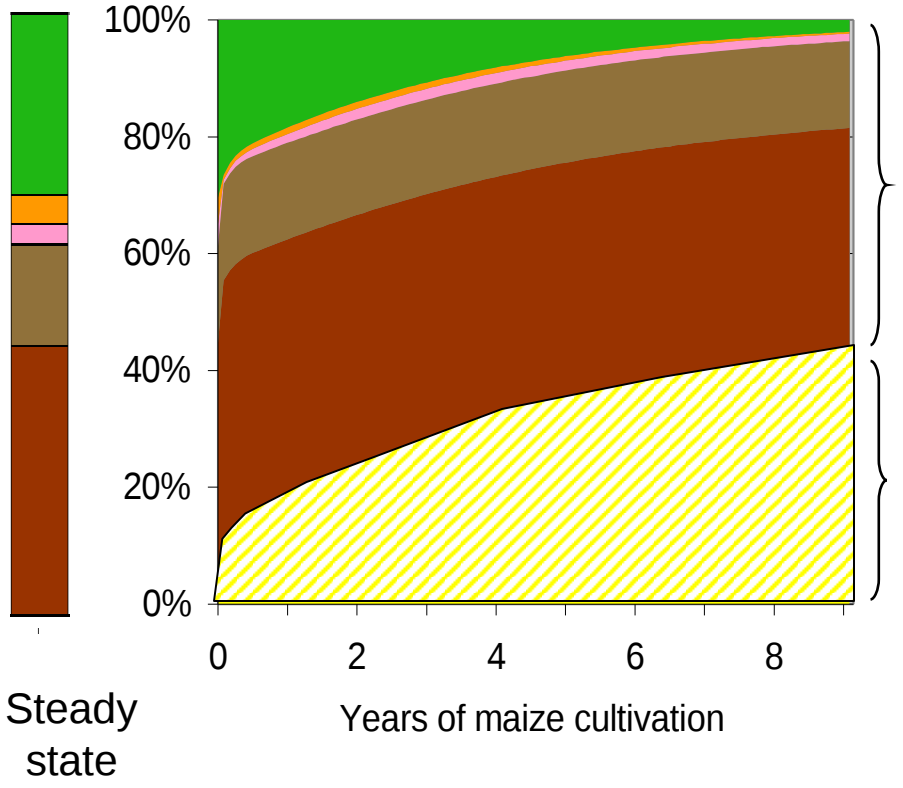
Microbial preserved sugar

Plant preserved sugar

Model of sugar-C dynamics:

# Simulations

## Distribution of wheat derived sugar-C after change in vegetation (from wheat to maize)




Wheat derived sugar

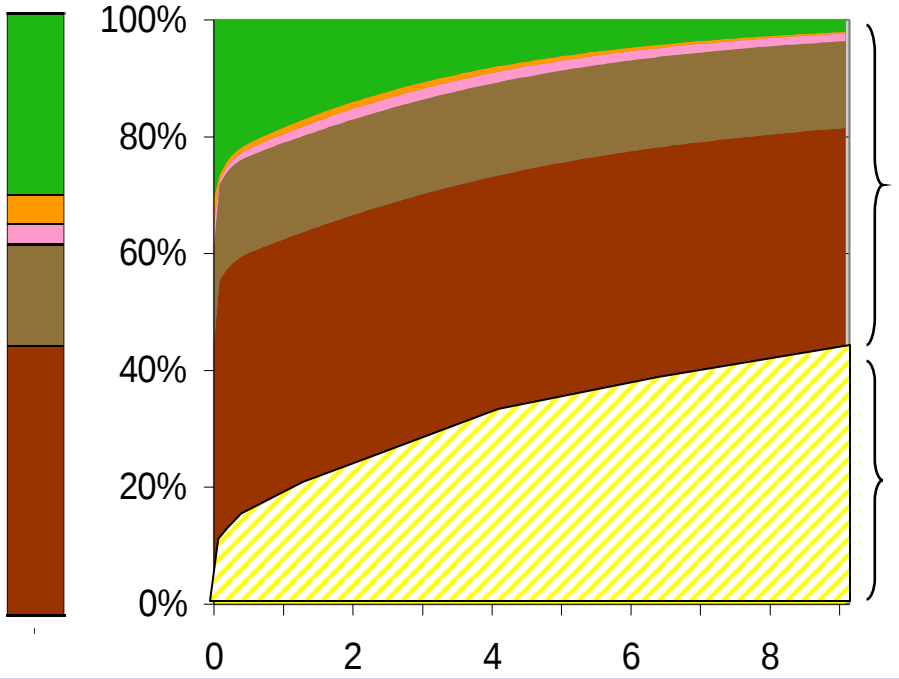
- Plant-sugar
- Plant derived microbial sugar
- Recycled microbial sugar
- Microbial preserved sugar
- Plant preserved sugar

Maize derived sugar

Model of sugar-C dynamics:

# Simulations

## Distribution of wheat derived sugar-C after change in vegetation (from wheat to maize)




Wheat derived sugar

- Plant-sugar
- Plant derived microbial sugar
- Recycled microbial sugar
- Microbial preserved sugar
- Plant preserved sugar

Maize derived sugar

- **Chemical and physical protection of wheat carbohydrate**
- microbial carbohydrate produced from old wheat organic matter
- active recycling of wheat derived microbial products

# Conclusions, perspectives

# Interest / limits of the model

**+**

- Describes the amount and ages of sugars
- Describes a molecular composition of SOM changing with time

**-**

- Only a description of monomers, not of molecules
- Inert pool non-quantified

This model coupling chemistry and dynamics of SOM is very promising and offers new ways to understand carbon dynamics in soils

# Perspectives

Improve the model and validate
in other places

Apply this modelling approach
to other compounds

| | | | DPM | RPM | BIO1 | BIO2 | HUM | IOM | DPM | RPM | BIO1 | BIO2 | HUM | IOM | DPM | RPM | BIO1 | BIO2 | HUM | IOM | DPM | RPM | BIO1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ga | ga | ga | ga | ga | ga | bu | bu | bu | bu | bu | bu | zo | zo | zo | zo | zo | zo | meu | meu | meu |
| | | | class A | class B | classC | glass | gloss | klaasK | class A | class B | classC | glass | gloss | klaasK | class A | class B | classC | glass | gloss | klaasK | class A | class B | classC |
| DPM | ga | class A | | | 0,155 | 0,995 | 0,5249 | 0,4492 | | | 0,6359 | 0,9427 | 0,7591 | 0 | 0,0673 | 0,2775 | 0,8984 | 0,3793 | 0,6748 | 0,0788 | 0,1311 | 0,4861 | 0,4243 |
| RPM | ga | class B | | | 0,1492 | 0,2598 | 0,8669 | 0,6556 | | | 0,6462 | 0,6929 | 0,9023 | 0,8508 | 0,7708 | 0,2491 | 0,2853 | 0,7877 | 0,1693 | 0,3935 | 0,3419 | 0,3448 | 0,1913 |
| BIO1 | ga | classC | 0,4992 | 0,2943 | | 0,6274 | 0,7846 | 0,9672 | 0,2114 | 0,9129 | 0,4192 | 0,881 | 0,8499 | 0,2207 | 0,8623 | 0,5254 | 0,1462 | 0,91 | 0,6515 | 0,1572 | 0,0873 | 0,2762 | 0,166 |
| BIO2 | ga | glass | 0,6305 | 0,1069 | 0,2917 | | 0,9251 | 0,6664 | 0,0556 | 0,8225 | 0,0367 | 0,3741 | 0,7551 | 0,688 | 0,3882 | 0,3587 | 0,0504 | 0,4525 | 0,4769 | 0,6314 | 0,1964 | 0,3051 | 0,5938 |
| HUM | ga | gloss | 0,6961 | 0,5326 | 0,7831 | 0,5236 | | 0,5303 | 0,8746 | 0,6396 | 0,1911 | 0,2347 | 0,7388 | 0,3547 | 0,9115 | 0,9425 | 0,0133 | 0,8912 | 0,8988 | 0,6785 | 0,6567 | 0,2006 | 0,9182 |
| IOM | ga | klaasK | 0,9968 | 0,8944 | 0,9795 | 0,5341 | 0,4348 | | 0,2678 | 0,7442 | 0,8812 | 0,1006 | 0,5182 | 0,9737 | 0,6457 | 0,05 | 0,1294 | 0,6313 | 0,8028 | 0,9869 | 0,6509 | 0,242 | 0,6591 |
| DPM | bu | class A | 0,5808 | 0,8355 | 0,1643 | 0,2785 | 0,8646 | 0,8939 | | 0,3644 | 0,7692 | 0,5615 | 0,7328 | 0,7191 | 0,2227 | 0,1542 | 0,2793 | 0,4666 | 0,3416 | 0,2823 | 0,4186 | 0,6249 | 0,4308 |
| RPM | bu | class B | 0,2194 | 0,2687 | 0,4244 | 0,9778 | 0,7853 | 0,4194 | 0,2688 | 0,8161 | 0,4997 | 0,3258 | 0,0426 | 0,9578 | 0,9355 | 0,5646 | 0,5643 | 0,835 | 0,6939 | 0,336 | 0,7744 | 0,3519 | 0,5352 |
| BIO1 | bu | classC | 0,1328 | 0,2571 | 0,5723 | 0,6899 | 0,3559 | 0,0081 | 0,7161 | 0,1695 | 0,1933 | 0,2266 | 0,776 | 0,996 | 0,096 | 0,8859 | 0,5383 | 0,2559 | 0,1359 | 0,1443 | 0,5949 | 0,0382 | 0,857 |
| BIO2 | bu | glass | 0,0821 | 0,9499 | 0,0465 | 0,6277 | 0,6511 | 0,0641 | 0,1918 | 0,719 | 0,3764 | 0,4498 | 0,3962 | 0,7201 | 0,5159 | 0,6026 | 0,9898 | 0,7096 | 0,7032 | 0,9068 | 0,583 | 0,4016 | 0,2889 |
| HUM | bu | gloss | 0,8186 | 0,9584 | 0,5177 | 0,8501 | 0,964 | 0,5087 | 0,6956 | 0,2959 | 0,6604 | 0,3574 | 0,7084 | 0,9532 | 0,3067 | 0,6925 | 0,9346 | 0,8183 | 0,0338 | 0,5757 | 0,0743 | 0,8767 | 0,3684 |
| IOM | bu | klaasK | 0,9913 | 0,4959 | 0,1233 | 0,6888 | 0,6616 | 0,2868 | 0,3667 | 0,3303 | 0,4767 | 0,5358 | 0,7509 | 0,9986 | 0,8543 | 0,934 | 0,8906 | 0,2817 | 0,9061 | 0,4234 | 0,7674 | 0,7362 | 0,2501 |
| DPM | zo | class A | 0,2536 | 0,9091 | 0,7192 | 0,3754 | 0,0212 | 0,2761 | 0,4616 | 0,2876 | 0,6653 | 0,8589 | 0,6249 | 0,3535 | 0,6746 | 0,0804 | 0,3719 | 0,1441 | 0,0693 | 0,7994 | 0,3364 | 0,1092 | 0,9618 |
| RPM | zo | class B | 0,0237 | 0,4143 | 0,2454 | 0,8921 | 0,471 | 0,8986 | 0,6884 | 0,2545 | 0,614 | 0,7105 | 0,5371 | 0,4811 | 0,6676 | 0,901 | 0,923 | 0,7006 | 0,7699 | 0,3062 | 0,446 | 0,5703 | 0,3068 |
| BIO1 | zo | classC | 0,2496 | 0,4733 | 0,3538 | 0,6003 | 0,6873 | 0,9542 | 0,7656 | 0,2113 | 0,4451 | 0,7082 | 0,522 | 0,3002 | 0,7353 | 0,5614 | 0,0369 | 0,8705 | 0,5767 | 0,6844 | 0,2435 | 0,1079 | 0,64 |
| BIO2 | zo | glass | 0,2535 | 0,0364 | 0,4527 | 0,0285 | 0,8901 | 0,8843 | 0,677 | 0,2218 | 0,6609 | 0,8299 | 0,1672 | 0,6368 | 0,8526 | 0,4289 | 0,9885 | 0,5631 | 0,2383 | 0,2446 | 0,374 | 0,4812 | 0,5621 |
| HUM | zo | gloss | 0,5359 | 0,5448 | 0,8825 | 0,8641 | 0,1376 | 0,999 | 0,7331 | 0,4136 | 0,6112 | 0,4269 | 0,2884 | 0,0432 | 0,8988 | 0,3872 | 0,9605 | 0,2722 | 0,2636 | 0,8612 | 0,0132 | 0,9894 | 0,6377 |
| IOM | zo | klaasK | 0,4931 | 0,6714 | 0,6956 | 0,3979 | 0,8453 | 0,6676 | 0,6722 | 0,5967 | 0,6761 | 0,3091 | 0,9862 | 0,7191 | 0,2282 | 0,1253 | 0,5977 | 0,2493 | 0,2498 | 0,9947 | 0,1496 | 0,5764 | 0,7733 |
| DPM | meu | class A | 0,4504 | 0,9835 | 0,7687 | 0,6041 | 0,611 | 0,6864 | 0,5921 | 0,8662 | 0,5023 | 0,6712 | 0,9026 | 0,6097 | 0,0113 | 0,2748 | 0,9371 | 0,9461 | 0,5366 | 0,1397 | 0,9754 | 0,5846 | 0,2971 |
| RPM | meu | class B | 0,0101 | 0,2153 | 0,4272 | 0,5853 | 0,0181 | 0,9148 | 0,4394 | 0,0246 | 0,7919 | 0,8593 | 0,0378 | 0,9346 | 0,9045 | 0,7116 | 0,8055 | 0,2386 | 0,0061 | 0,6649 | 0,1717 | 0,6722 | 0,4437 |
| BIO1 | meu | classC | 0,2258 | 0,5754 | 0,3942 | 0,8206 | 0,125 | 0,3274 | 0,9338 | 0,1801 | 0,8175 | 0,5373 | 0,4247 | 0,3032 | 0,7466 | 0,212 | 0,2096 | 0,8506 | 0,9068 | 0,2296 | 0,6311 | 0,8449 | 0,1998 |
| BIO2 | meu | glass | 0,7383 | 0,88 | 0,0565 | 0,0964 | 0,7383 | 0,0764 | 0,412 | 0,2498 | 0,4098 | 0,4419 | 0,0191 | 0,4334 | 0,3337 | 0,1097 | 0,3679 | 0,5602 | 0,3164 | 0,8591 | 0,9801 | 0,6104 | 0,4601 |
| HUM | meu | gloss | 0,3169 | 0,2554 | | 0,7983 | 0,6084 | 0,8167 | 0,1007 | 0,4601 | 0,3398 | 0,9694 | 0,9117 | 0,3807 | 0,9885 | 0,5998 | 0,7505 | 0,2128 | 0,6633 | 0,9334 | 0,6978 | 0,8981 | 0,3089 |
| IOM | meu | klaasK | 0,2072 | 0,1217 | 0,088 | 0,9547 | 0,4428 | 0,6673 | 0,745 | 0,9096 | 0,6859 | 0,8916 | 0,6698 | 0,2488 | 0,0105 | 0,6357 | 0,1006 | 0,4031 | 0,7344 | 0,6509 | 0,0042 | 0,9881 | 0,1259 |
| DPM | ni | class A | 0,7111 | 0,1271 | 0,[illegible] | 0,3662 | 0,5191 | 0,5951 | 0,3186 | 0,8001 | 0,127 | 0,1467 | 0,157 | 0,2137 | 0,1472 | 0,1316 | 0,6646 | 0,5161 | 0,7602 | 0,0017 | 0,563 | 0,9159 | 0,8832 |
| RPM | ni | class B | 0,0903 | 0,3154 | 0,5708 | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,393 | 0,0447 | 0,3379 | 0,3749 |
| BIO1 | ni | classC | 0,8278 | 0,5187 | 0,6079 | 0,9[illegible] | 0,[illegible] | 0,9504 | 0,[illegible] | 0,8636 | 0,[illegible] | 0,4485 | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,5744 | 0,45 | 0,0908 | 0,8276 |
| BIO2 | ni | glass | 0,6685 | 0,6083 | 0,6802 | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,8897 | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,[illegible] | 0,9281 | 0,3913 | 0,3226 |
| HUM | ni | gloss | 0,9831 | 0,6281 | 0,8537 | 0,7737 | 0,5754 | 0,2611 | 0,6354 | 0,3226 | 0,8455 | 0,267 | 0,9566 | 0,3444 | 0,6744 | 0,5156 | 0,0846 | 0,2093 | 0,4326 | 0,8694 | 0,5416 | 0,2724 | 0,8135 |
| IOM | ni | klaasK | 0,436 | 0,5905 | 0,3712 | 0,0457 | 0,8187 | 0,2024 | 0,3075 | 0,0891 | 0,1831 | 0,5371 | 0,3418 | 0,7986 | 0,8237 | 0,476 | 0,5841 | 0,225 | 0,9031 | 0,1929 | 0,6626 | 0,5428 | 0,0041 |
| DPM | ga | class A | 0,833 | 0,0685 | 0,1325 | 0,9067 | 0,0959 | 0,2749 | 0,7192 | 0,9219 | 0,628 | 0,1222 | 0,4284 | 0,208 | 0,9672 | 0,343 | 0,1401 | 0,838 | 0,7823 | 0,0564 | 0,8405 | 0,1819 | 0,9652 |
| RPM | ga | class B | 0,5837 | 0,6978 | 0,9213 | 0,7316 | 0,2832 | 0,0425 | 0,6188 | 0,6752 | 0,9494 | 0,7537 | 0,1054 | 0,0416 | 0,0309 | 0,1668 | 0,8851 | 0,6889 | 0,5676 | 0,6188 | 0,0697 | 0,149 | 0,6679 |
| BIO1 | ga | classC | 0,5768 | 0,6826 | 0,5622 | 0,4384 | 0,2083 | 0,7052 | 0,7051 | 0,8967 | 0,5533 | 0,0189 | 0,379 | 0,8035 | 0,1178 | 0,4188 | 0,7652 | 0,8863 | 0,0229 | 0,2315 | 0,2946 | 0,3464 | 0,5763 |
| BIO2 | ga | glass | 0,1975 | 0,0745 | 0,5184 | 0,6619 | 0,9494 | 0,0284 | 0,4553 | 0,5643 | 0,9241 | 0,0527 | 0,7239 | 0,0309 | 0,3137 | 0,6854 | 0,1647 | 0,3326 | 0,5033 | 0,1949 | 0,4383 | 0,9191 | 0,3234 |
| HUM | ga | gloss | 0,0932 | 0,4505 | 0,0862 | 0,991 | 0,1698 | 0,2142 | 0,8926 | 0,3627 | 0,6708 | 0,58 | 0,674 | 0,0997 | 0,9722 | 0,9943 | 0,1747 | 0,467 | 0,4672 | 0,1118 | 0,5858 | 0,6168 | 0,3033 |
| IOM | ga | klaasK | 0,4109 | 0,859 | 0,3992 | 0,9963 | | 0,4214 | 0,0562 | 0,7237 | 0,4596 | 0,3654 | 0,6705 | 0,9971 | 0,509 | 0,7839 | 0,4698 | 0,469 | 0,452 | 0,1984 | 0,0852 | 0,9243 | 0,4481 |
| DPM | bu | class A | 0,372 | 0,4705 | 0,2542 | 0,5643 | 0,5274 | 0,7965 | 0,4642 | 0,2549 | 0,4378 | 0,0779 | 0,9285 | 0,3099 | 0,5114 | 0,5263 | 0,0429 | 0,2861 | 0,365 | 0,8198 | 0,4828 | 0,8447 | 0,226 |
| RPM | bu | class B | 0,9801 | 0,5538 | 0,7938 | 0,9603 | 0,029 | 0,6745 | 0,5448 | 0,2665 | 0,7407 | 0,3048 | 0,5475 | 0,574 | 0,5481 | 0,7368 | 0,0641 | 0,3601 | 0,5506 | 0,0381 | 0,0142 | 0,8471 | 0,0073 |
| BIO1 | bu | classC | 0,8453 | 0,9036 | 0,8089 | 0,9318 | 0,2479 | 0,2963 | 0,0911 | 0,7009 | 0,0802 | 0,6779 | 0,9963 | 0,9387 | 0,1501 | 0,6501 | 0,636 | 0,5025 | 0,3093 | 0,4216 | 0,4698 | 0,5337 | 0,2445 |
| BIO2 | bu | glass | 0,565 | 0,214 | 0,5482 | 0,0882 | 0,1237 | 0,9189 | 0,3489 | 0,302 | 0,4441 | 0,2046 | 0,8521 | 0,7261 | 0,8314 | 0,9165 | 0,9496 | 0,1192 | 0,4958 | 0,5769 | 0,6247 | 0,6741 | 0,2617 |
| HUM | bu | gloss | 0,2982 | 0,6477 | 0,8946 | 0,415 | 0,2381 | 0,5571 | 0,6047 | 0,253 | 0,6558 | 0,9617 | 0,8984 | 0,808 | 0,9571 | 0,8884 | 0,7418 | 0,5064 | 0,5192 | 0,3333 | 0,7859 | 0,48 | 0,5105 |
| IOM | bu | klaasK | 0,2207 | 0,3481 | | 0,3072 | 0,2274 | 0,8249 | 0,4164 | 0,2515 | 0,3898 | 0,7326 | 0,7907 | 0,7141 | 0,4086 | 0,5558 | 0,6412 | 0,3771 | 0,0928 | 0,9722 | 0,016 | 0,4009 | 0,6209 |
| DPM | zo | class A | 0,8161 | 0,8927 | 0,4601 | 0,7984 | 0,0516 | 0,3591 | 0,6098 | 0,7907 | 0,9596 | 0,7775 | 0,7486 | 0,7278 | 0,3666 | 0,5097 | 0,9764 | 0,2086 | 0,3519 | 0,7373 | 0,0429 | 0,5159 | 0,9416 |
| RPM | zo | class B | 0,7648 | 0,5495 | 0,2058 | 0,3914 | 0,4473 | 0,0176 | 0,3626 | 0,5495 | 0,8803 | 0,8762 | 0,8601 | 0,9002 | 0,4109 | 0,6498 | 0,3271 | 0,1809 | 0,0838 | 0,7424 | 0,4438 | 0,8521 | 0,1555 |
| BIO1 | zo | classC | 0,599 | 0,9694 | 0,8515 | 0,7687 | 0,6628 | 0,0582 | 0,4098 | 0,4431 | 0,4972 | 0,9539 | 0,3163 | 0,5225 | 0,7329 | 0,3143 | 0,0052 | 0,7245 | 0,2685 | 0,9162 | 0,7816 | 0,1664 | 0,6374 |
| BIO2 | zo | glass | 0,5778 | 0,1786 | 0,6596 | 0,5364 | 0,9597 | 0,8422 | 0,9168 | 0,879 | 0,2873 | 0,929 | 0,2528 | 0,7875 | 0,2783 | 0,0826 | 0,5794 | 0,542 | 0,5745 | 0,62 | 0,5131 | 0,9788 | 0,6959 |
| HUM | zo | gloss | 0,9593 | 0,6577 | 0,9813 | 0,2957 | 0,2316 | 0,8047 | 0,8962 | 0,7392 | 0,2707 | 0,1905 | 0,8591 | 0,6086 | 0,3201 | 0,9911 | 0,6876 | 0,0715 | 0,954 | 0,2008 | 0,0292 | 0,0014 | 0,2421 |
| IOM | zo | klaasK | 0,9737 | 0,4371 | 0,8885 | 0,6433 | 0,5369 | 0,1372 | 0,0468 | 0,4667 | 0,845 | 0,7443 | 0,7418 | 0,2451 | 0,0257 | 0,1483 | 0,5825 | 0,6193 | 0,9741 | 0,7084 | 0,0554 | 0,0165 | 0,7961 |
| DPM | meu | class A | 0,1819 | 0,6687 | 0,9467 | 0,8824 | 0,6281 | 0,0106 | 0,2766 | 0,6177 | 0,2407 | 0,4068 | 0,9705 | 0,7996 | 0,4599 | 0,1831 | 0,3312 | 0,2709 | 0,8554 | 0,5077 | 0,9492 | 0,2658 | 0,2029 |
| RPM | meu | class B | 0,5693 | 0,6669 | 0,2893 | 0,7593 | 0,8526 | 0,8539 | 0,9954 | 0,7451 | 0,4308 | 0,4885 | 0,2501 | 0,128 | 0,5369 | 0,7503 | 0,7976 | 0,2061 | 0,2368 | 0,5862 | 0,9632 | 0,2683 | 0,1728 |
| BIO1 | meu | classC | 0,2566 | 0,5194 | 0,4396 | 0,4078 | 0,662 | 0,5895 | 0,0118 | 0,3291 | 0,6606 | 0,6653 | 0,5973 | 0,7549 | 0,7905 | 0,3164 | 0,9075 | 0,3459 | 0,4622 | 0,871 | 0,2542 | 0,6966 | 0,1036 |
| BIO2 | meu | glass | 0,0844 | 0,2835 | 0,0338 | 0,9555 | 0,9435 | 0,1886 | 0,6339 | 0,4806 | 0,5657 | 0,3392 | 0,5999 | 0,4135 | 0,3791 | 0,2373 | 0,8581 | 0,5914 | 0,3718 | 0,8315 | 0,1827 | 0,2884 | 0,3727 |
| HUM | meu | gloss | 0,1664 | 0,4599 | 0,2604 | 0,6898 | 0,2881 | 0,7537 | 0,6133 | 0,3309 | 0,3892 | 0,6041 | 0,3215 | 0,85 | 0,1439 | 0,6179 | 0,456 | 0,6093 | 0,6797 | 0,3308 | 0,2 | 0,9264 | 0,8034 |
| IOM | meu | klaasK | 0,3059 | 0,2364 | 0,1352 | 0,022 | 0,9441 | 0,1724 | 0,9488 | 0,4848 | 0,185 | 0,1147 | 0,2875 | 0,0224 | 0,2439 | 0,4472 | 0,1746 | 0,6139 | 0,278 | 0,8969 | 0,9383 | 0,564 | 0,8495 |
| DPM | ni | class A | 0,0897 | 0,2937 | 0,8404 | 0,8482 | 0,0185 | 0,7576 | 0,9231 | 0,5741 | 0,6335 | 0,8435 | 0,1276 | 0,886 | 0,3978 | 0,8113 | 0,5417 | 0,5932 | 0,9221 | 0,5245 | 0,7279 | 0,2621 | 0,5451 |
| RPM | ni | class B | 0,343 | 0,2521 | 0,34 | 0,533 | 0,3896 | 0,6294 | 0,6338 | 0,1708 | 0,7392 | 0,9106 | 0,5593 | 0,8372 | 0,484 | 0,2922 | 0,5838 | 0,4535 | 0,3855 | 0,9589 | 0,762 | 0,682 | 0,1943 |
| BIO1 | ni | classC | 0,607 | 0,9688 | 0,2856 | 0,5462 | 0,9898 | 0,6477 | 0,2703 | 0,2672 | 0,1553 | 0,0909 | 0,4677 | 0,789 | 0,2733 | 0,7866 | 0,3895 | 0,3369 | 0,7559 | 0,9172 | 0,1277 | 0,557 | 0,7482 |
| BIO2 | ni | glass | 0,4298 | 0,2572 | 0,0519 | 0,1038 | 0,4898 | 0,0339 | 0,2141 | 0,7147 | 0,6432 | 0,9341 | 0,3168 | 0,5449 | 0,5753 | 0,3525 | 0,7358 | 0,9946 | 0,8056 | 0,4255 | 0,0925 | 0,8858 | 0,0578 |
| HUM | ni | gloss | 0,8478 | 0,6661 | 0,819 | 0,9204 | 0,0222 | 0,3353 | 0,6404 | 0,1292 | 0,2084 | 0,5261 | 0,5628 | 0,6308 | 0,7628 | 0,6632 | 0,7757 | 0,3175 | 0,7333 | 0,2919 | 0,726 | 0,3884 | 0,156 |
| IOM | ni | klaasK | 0,592 | 0,9515 | 0,2499 | 0,7405 | 0,8137 | 0,0972 | 0,8579 | 0,3291 | 0,8196 | 0,3122 | 0,1716 | 0,6799 | 0,6265 | 0,8572 | 0,1298 | 0,5211 | 0,7194 | 0,9727 | 0,9246 | 0,9981 | 0,978 |
| IOM | meu | klaasK | 0,5264 | 0,8179 | 0,1738 | 0,3896 | 0,273 | 0,0609 | 0,3059 | 0,6995 | 0,1912 | 0,2301 | 0,1646 | 0,97 | 0,2618 | 0,7378 | 0,7358 | 0,2637 | 0,4022 | 0,7837 | | | 0,782 |
| DPM | ni | class A | 0,[illegible] | | 0,3365 | 0,9057 | 0,9519 | 0,7764 | 0,766 | 0,4538 | 0,4696 | 0,8922 | 0,4723 | 0,9464 | 0,4768 | 0,6126 | 0,3774 | 0,4567 | 0,9[illegible] | 0,4545 | | | 0,7351 |
| RPM | ni | class B | 0,[illegible] | | 0,1453 | 0,2697 | 0,3189 | 0,1753 | 0,5078 | 0,3169 | 0,626 | 0,3567 | 0,4015 | 0,8 | 0,9362 | 0,7942 | 0,4658 | 0,1826 | 0,[illegible] | 0,6521 | | | 0,1043 |
| BIO1 | ni | classC | 0,[illegible] | | 0,087 | 0,0774 | | 0,902 | 0,2032 | 0,8306 | 0,8356 | 0,4896 | 0,9274 | 0,5855 | 0,7089 | 0,4537 | 0,8656 | 0,4135 | 0,3125 | 0,6835 | 0,9184 | 0,7187 | 0,6496 |
| BIO2 | ni | glass | 0,[illegible] | | 0,0622 | 0,8244 | 0,0037 | 0,2499 | 0,5785 | 0,7659 | 0,2764 | 0,8588 | 0,6048 | 0,2563 | 0,0327 | 0,4289 | 0,052 | 0,3418 | 0,1374 | 0,876 | 0,3249 | 0,0299 | 0,5447 |
| HUM | ni | gloss | 0,[illegible] | | 0,5847 | 0,4101 | 0,3291 | 0,6253 | 0,5333 | 0,8318 | 0,1298 | 0,9276 | 0,9409 | 0,8986 | 0,0182 | 0,4827 | 0,6003 | 0,877 | 0,0417 | 0,6677 | 0,9616 | 0,2975 | 0,8721 |
| IOM | ni | klaasK | 0,[illegible] | | 0,399 | 0,0064 | 0,5952 | 0,8431 | 0,2466 | 0,5454 | 0,1363 | 0,2799 | 0,8904 | 0,789 | 0,1197 | 0,7978 | 0,3544 | 0,478 | 0,0369 | 0,1825 | 0,97 | 0,6068 | 0,3935 |
| DPM | ga | class A | 0,1026 | 0,634 | 0,6007 | 0,3575 | 0,0059 | 0,4596 | 0,4863 | 0,4905 | 0,3907 | 0,1366 | 0,2863 | 0,1835 | 0,5182 | 0,4184 | 0,8715 | 0,915 | 0,5228 | 0,5024 | 0,6062 | 0,438 | 0,3957 |
| RPM | ga | class B | 0,5179 | 0,3179 | 0,0119 | 0,886 | 0,4322 | 0,949 | 0,7943 | 0,2351 | 0,0847 | 0,5105 | 0,0768 | 0,2538 | 0,1079 | 0,4958 | 0,0288 | 0,7435 | 0,0636 | 0,1662 | 0,1623 | 0,2474 | 0,3768 |

Model of sugar-C dynamics:

# Model Predictions

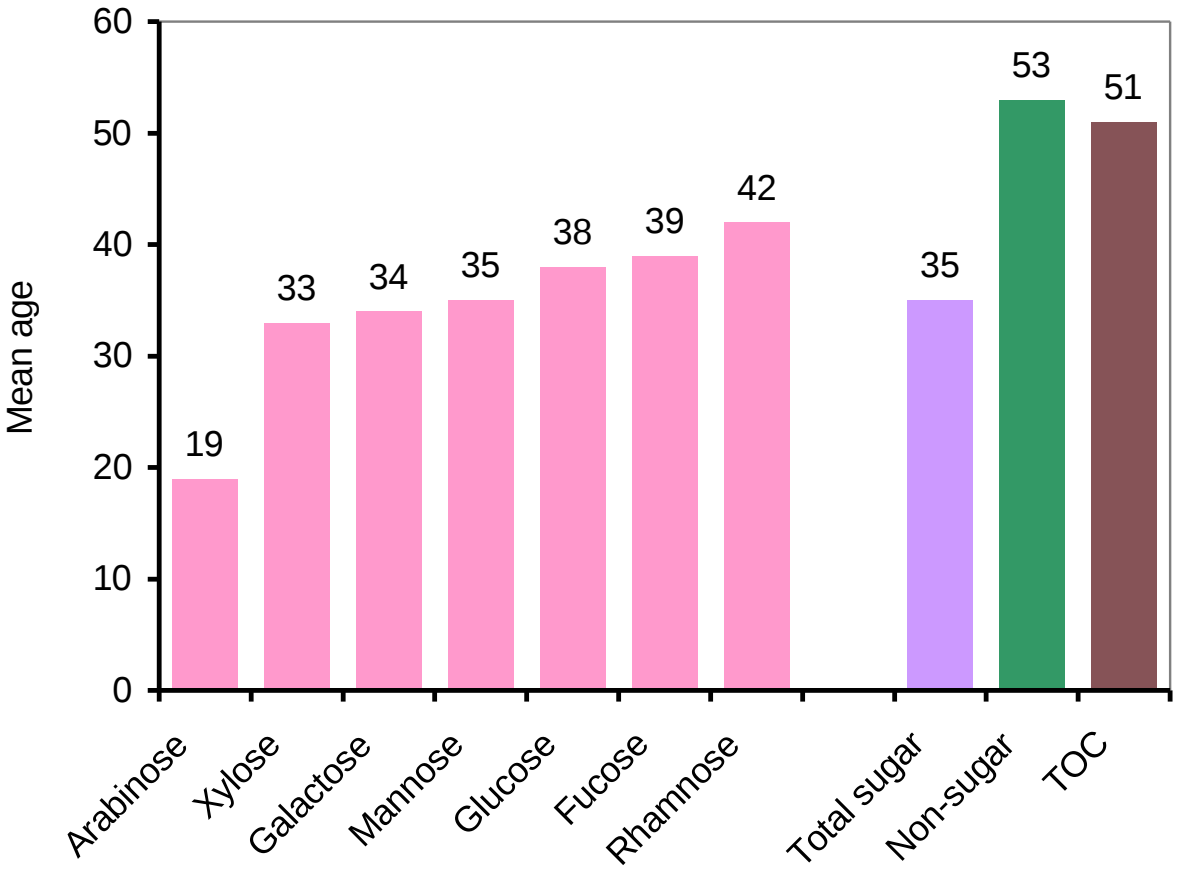
## Steady state composition of soil organic matter

| | Distribution of SOC in the various compartments (%) | Sugar content of each compartment (%OC) | Distribution of sugars in the various compartments (%) |
|---|---|---|---|
| Decomposable Plant Material | 1 | 79 | 6 |
| Resistant Plant Material | 16 | 13 | 24 |
| Microbial Biomass | 2 | 29 | 8 |
| Humified and Protected | 82 | 6 | 61 |
| SOC | 100 | 10 | 100 |

Model of sugar-C dynamics:

# Model Predictions

## Age distribution of neutral carbohydrates



Model of sugar-C dynamics:

# Model Predictions

## Fate of incubated wheat straw