

Online Workshop on Carbon Balances, 4 March 2022

C-balances on farm level

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On behalf of:



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Bio Forschung Austria

Research for organic farming

- Non-profit research institute supported by City of Vienna

Topics

- Soil fertility
- Catch crops
- Compost: composting, compost quality
- Closing Nutrient and carbon cycles
- Multifunctional windbreaks
- Biological pest control
- Urban gardening
- Ecological management of green spaces

Projects funded by EU & national sources

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Training course for farmers „Soil practitioner“

Practical soil and soil fertility training for farmers

- 9 days` course

- Soil life
- Nutrient dynamics
- Compost & circular economy
- Tillage & catch crops



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Ländliches
Fortbildungsinstitut LFI



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Carbon balancing seminars for farmers

- since 2009
- ca. 1.100 graduates
- in cooperation with organic farmers' associations and agricultural extension



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Ländliches
Fortbildungsinstitut LFI



unser Boden
wir stehen drauf!



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Soil organic matter – decisive for soil fertility

- Water storage
- Infiltration
- Erosion prevention
- Nutrient supply
- Cation exchange capacity

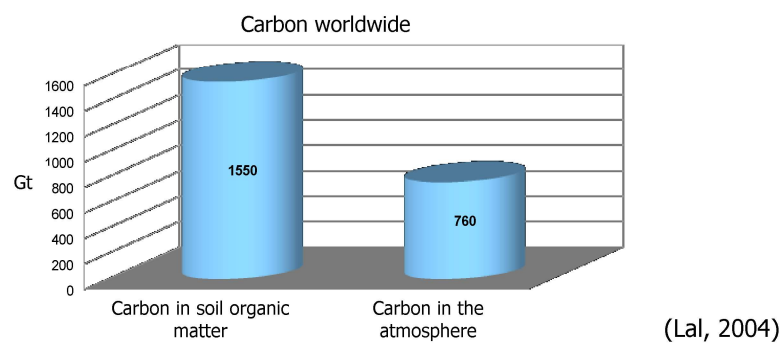
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... and for carbon sequestration

CO₂ is bound in the soil in the medium term



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**It is important to know
in which direction
the humus content on the farm
is developing!**



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Carbon (soil organic matter) balances

- 1) Balance methods based on process models
- 2) Balance methods based on statistics



Site-adjusted organic matter–balance method
(following Kolbe, 2010)



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Principle of carbon (soil organic matter) balances

Humus addition

- organic fertilizers
- straw
- green manuring
- humus increasing crops

-

Humus decomposition

- crops
- soil
- climate

=

Humus balance

Increase or decrease of soil organic matter



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Development of the site-adjusted balance method

Dr. Hartmut Kolbe
DI I. Prutzer
Sächsische Landesanstalt
für Landwirtschaft (D)

Review and adaptation of humus accounting models on the basis of long-term arable land trials

- Data basis: **40 long-term field experiments** in Europe – with 400 treatments
- Duration min. 10 years
- all necessary data for organic matter balances
- soil C data
- conventional and organic

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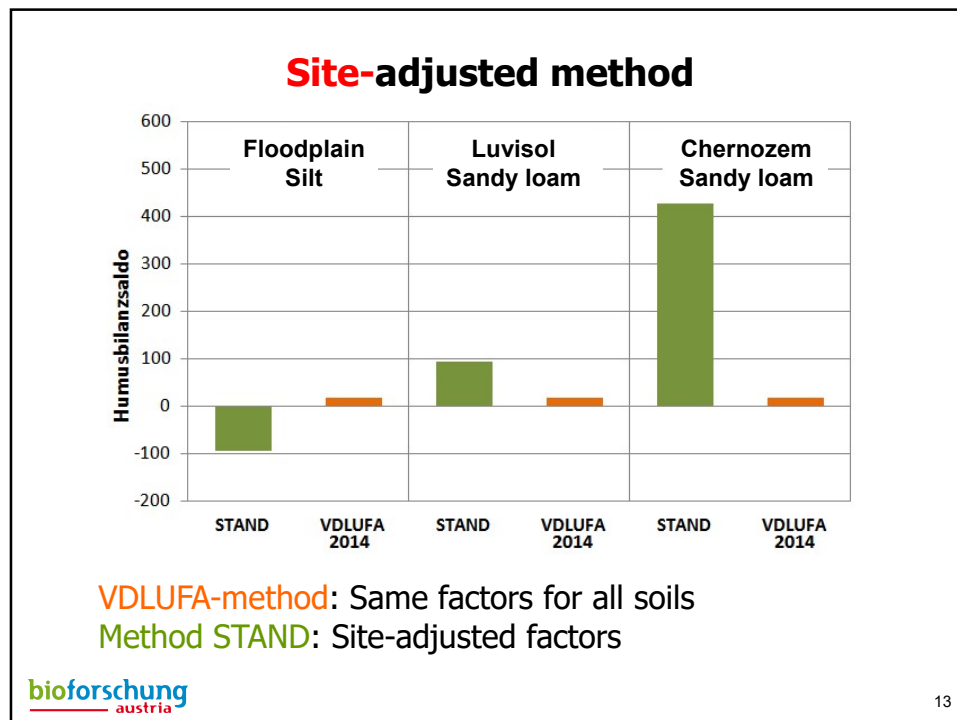
- Soil organic matter balances with VDLUFA-method:
large deviations from reality, particularly
with sandy and clayey soils (Kolbe, 2010)

➡ Evaluation of the results of the long term field
experiments using multiple regression :

Soil organic matter content depends heavily on
site conditions:
soil texture, temperature, precipitation

- ➡ **Identification of groups of sites,
which have the same organic matter decay
rates**
- ➡ Development of the site-adjusted organic matter
balance method





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Site-adjusted method

- ❖ **good correlation** between **calculated** organic matter balance results **and** soil organic matter contents **measured** in long-term field experiments (**$r=0,74$**)
(Kolbe, 2015)
- ❖ **easy to use**
few, easily available input parameters




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Calculation of carbon (soil organic matter) balances - which input data are necessary?

- Crop rotation (incl. catch crops/ intercrops)
- Amount of straw
- Addition of organic fertilizers (manure, liquid manure, compost)
- Soil texture, in some cases soil type
- Average temperature

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Site groups for the site-adjusted organic matter balance method

Site group	Soil texture, soil type	Clay (%)	C/N ratio of the soil	Temperature average (°C)	Precipitation (mm/year)
1	- Chernozem	cca. 17-30	-	-	-
	- Clay	≥ 38	-	-	Mountain regions ≥ 700, Plains ≥ 800
	- boggy soils strongly influenced by groundwater	-	-	-	-
2	- sand, poor loamy sand, and loamy sand	≤ 13	-	≤ 8,5	-
	- Loamy clay, clay	≥ 28	-	-	-
3	- sand, poor loamy sand, and loamy sand	≤ 13	-	≥ 8,5	-
4	- high-sandy loam and sandy loam	14-21	-	≤ 8,5	-
5	- high-sandy loam and sandy loam	14-21	-	≥ 8,5	-
	- Loam	22-27	≥ 9	-	-
6	- Loam, Silt (with high decay rate)	22-27	≤ 9	-	-
	- boggy soils without contact to groundwater	-	-	-	-

Source: SÄCHSISCHE LANDESANSTALT FÜR LANDWIRTSCHAFT (2007), modified

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Factors denominating the organic matter loss/gain through the crops (kg Humus-C/ha/year)

	Site group					
	1	2	3	4	5	6
Main crops						
Root crops: beets*, potatoes	-510	-610	-710	-660	-760	-900
Maize: silage corn and grain maize*	-310	-410	-510	-460	-560	-700
Cereals*, oilseeds, fibre plants*, sunflower*	-30	-130	-230	-180	-280	-420
Grain legumes	410	310	210	260	160	20
Fodder legumes*						
Clover, clover grass, alfalfa						
Per main year	850	750	650	700	600	460
In the first year, if seeded in spring	650	550	450	500	400	260
In the first year, if seeded undersown	450	350	250	300	200	60
In the first year, if seeded in summer	350	250	150	200	100	-40
Cover crops*						
Winter cover crops	370	270	170	220	120	-20
Frost-killed cover crops	330	230	130	180	80	-60
Undersown	450	350	250	300	200	60

* Straw of cereals, maize, sunflower, oilseeds and fibre plants, beet leaves and biomass of fodder legumes and cover crops is calculated as an additional organic fertilizer, if it stays on the field.

Source: adapted from KOLBE (2007)

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Factors denominating the organic matter loss/gain through the crops (kg Humus-C/ha/year)

	Site group					
	1	2	3	4	5	6
Main crops						
Root crops: beets*, potatoes	-510	-610	-710	-660	-760	-900
Maize: silage corn and grain maize*	-310	-410	-510	-460	-560	-700
Cereals*, oilseeds, fibre plants*, sunflower*	-30	-130	-230	-180	-280	-420
Grain legumes	410	310	210	260	160	20
Fodder legumes*						
Clover, clover grass, alfalfa						

Rising temperatures accelerate organic matter decay!

Franke u. Gründling (2015)

Source: adapted from KOLBE (2007)

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Addition of organic matter

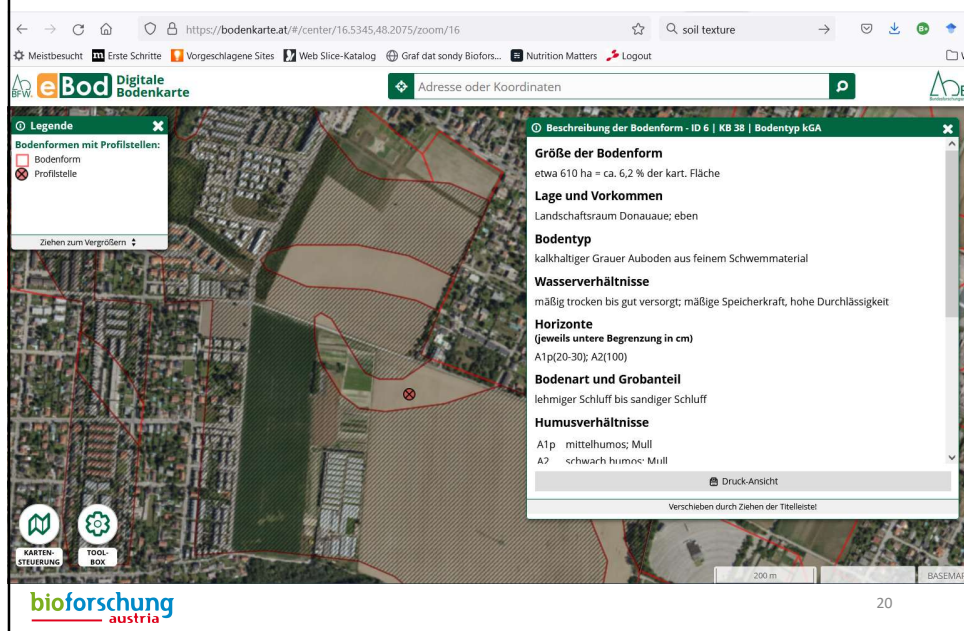
Kind of organic material	Average dry matter content (% of fresh matter FM) *	Annual addition (average of crop rotation (t FM/ha/year)	Organic carbon / humus coefficients (kg C/t FM)
Straw	86	up to 3	83
		3 - 6	68
		> 6	41
Manure	25	up to 10	33
		10 - 20	26
		> 20	23
Manure compost	55	up to 10	92
		10 - 20	74
		> 20	58
Liquid manure (cattle)	7	up to 25	8,6
		> 25	8,1
Liquid manure (pigs)	8	up to 25	6,5
		> 25	5,8
Biowaste compost (mature)	60	up to 10	90
		10 - 20	75
		> 20	60
Green manure / catch crops	10	up to 10	5,5
		10 - 20	3,2
		> 20	1,0
Liquid digestate	4	up to 10	5,60
		10 - 20	5,44
		> 20	5,28

Source: following Kolbe (2007)

*Factors are valid at the dry matter content stated. If the dry matter content is higher /lower, this should be taken into account 

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Soil texture, soil type: Soil maps



The screenshot shows the eBod Digitale Bodenkarte web application. The main map displays a satellite view with soil texture overlays. A legend on the left identifies 'Bodenformen mit Profilstellen' (soil forms with profile locations) and 'Profilstelle' (profile location). A detailed information panel on the right provides data for a specific soil profile (ID 6 | KB 38 | Bodentyp kGA).

Größe der Bodenform
etwa 610 ha = ca. 6,2 % der kart. Fläche

Lage und Vorkommen
Landschaftsraum Donauaue; eben

Bodentyp
kalkhaltiger Grauer Auboden aus feinem Schwemmaterial

Wasserverhältnisse
mäßig trocken bis gut versorgt; mäßige Speicherkraft, hohe Durchlässigkeit

Horizonte
(jeweils untere Begrenzung in cm)
A1p(20-30); A2(100)

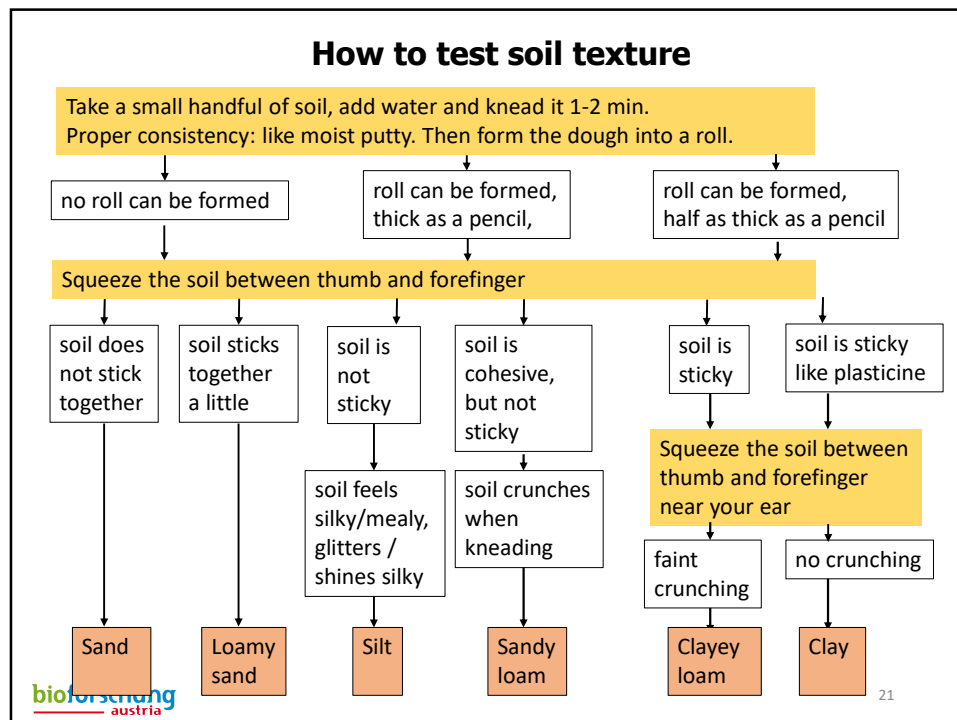
Bodenart und Grobanteil
lehmiger Schluff bis sandiger Schluff

Humusverhältnisse
A1p mittelhumos; Mull
A2 schwach humos; Mull

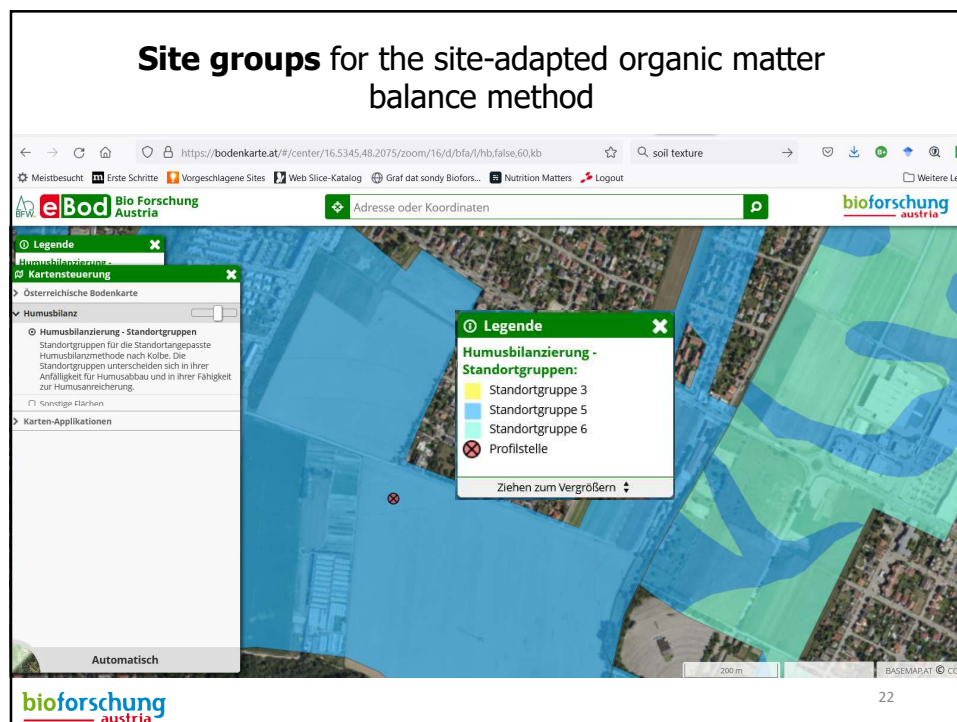
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Example: crop rotation on Chernozem soil

1 st year	Alfalfa
2 nd year	Alfalfa
3 rd year	Winter wheat + cover crop
4 th year	Grain maize
5 th year	Vetchling
6 th year	Winter wheat + cover crop
7 th year	Sugar beet

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Organic carbon balance example

Soil: Chernozem, **Site group 1**

	Crop rotation	Organic matter decay /increase (kg Humus-C/ha)	Addition of organic materials and organic fertilizers	Humus factor (kg C/t FM) *	Humus C addition (kg Humus-C/ha)
1	Alfalfa	650			
2	Alfalfa	850			
3	Winter wheat	-30	4 t/ha straw	83	332
	+frost-killed CC	330	25 t/ha FM CC	3,2	80
4	Grain maize	-310	7 t/ha straw	83	581
5	Vetchling	410			
6	Winter wheat	-30	4 t/ha straw	83	332
	+frost-killed CC	330	25 t/ha FM CC	3,2	80
7	Sugar beet	-510	26 t/ha FM beet leaves	3,2	83
Sum		1690			1488

Organic carbon balance:

3178 kg C/ha

Per year:

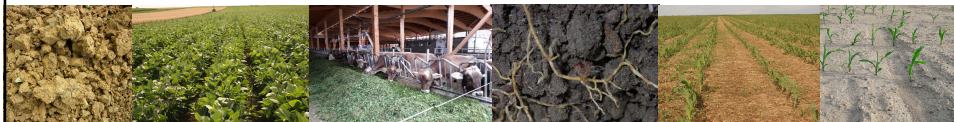
454 kg C/ha/J

* organic fertilizers are allocated to the whole crop rotation.

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Maintaining or increasing the organic matter content of the soil

- Humus increasing crop rotation
- Leaving crop residues (straw) on the field
- Supply of organic material (e.g. compost or manure)
- Green manuring
- Avoid unnecessary tillage steps and excessive tillage intensity



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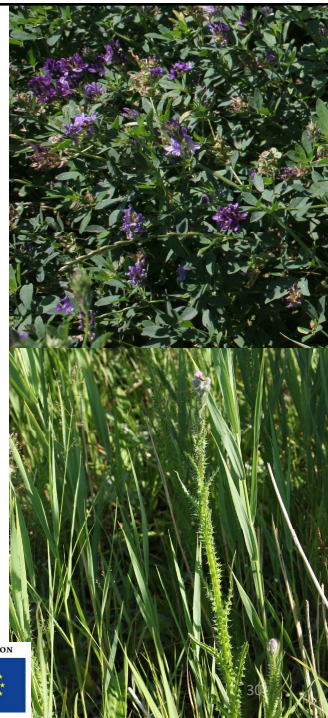
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Large potential of unused biomass

- Alfalfa biomass
- Grassland biomass
- Biomass from landscaping
- Biomass from nature conservation areas



Closing loops!



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MIT UNTERSTÜTZUNG VON BUND, LÄNDERN UND EUROPÄISCHER UNION
MINISTERIUM FÜR LANDWIRTSCHAFT, FORSTWIRTSCHAFT UND NATURENTWICKLUNG
LE 14-20
Europäische Landwirtschaft durch die Förderung der nachhaltigen Entwicklung der ländlichen Gebiete



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„Cut & carry“: Transfer-mulch – a regional organic fertilizer



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EIP Project „Kreisläufe schließen“ – „Closing the loops“

Einladung zum Online-Fachtag "Kreisläufe schließen":
Erfolgreiches Management von Kohlenstoff und Stickstoff am
landwirtschaftlichen Betrieb



Online-Fachtag: Versuchsergebnisse von innovativen Wirtschaftsweisen auf
Acker- und Grünland Donnerstag, 10.03.2022, 9-15 Uhr Transfermulch (Cut
& Carry) Wiese ...

Registration: www.bioforschung.at

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KREUTER BERGMANN
BUND IN KÖRPERLICHKEIT
— 1907 1984 —

jugovits

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Mit Unterstützung von Bund, Ländern und Europäischer Union

Bundesministerium
Landwirtschaft, Regionen
und Tourismus

LE 14-20
Erneuerung des ländlichen Raums

Europäische Union
Landwirtschaftlicher
Beihilfen für
die Entwicklung des
ländlichen Raums
das Wachstum fördern
die Lebensqualität verbessern



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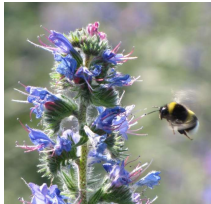


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Thank you
for your attention!

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