Sunflower in the global food system
Situation and perspectives

Etienne Pilorgé

21st International Sunflower Conference
China, August 21-24, 2024

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- ✓ Sunflower production development in the world
- ✓ Sunflower trade
- ✓ Effects of the war in Ukraine on production and exports
- ✓ Climate change is coming
- ✓ Non-traditional uses
- ✓ Sunflower protein for food.
- ✓ conclusions

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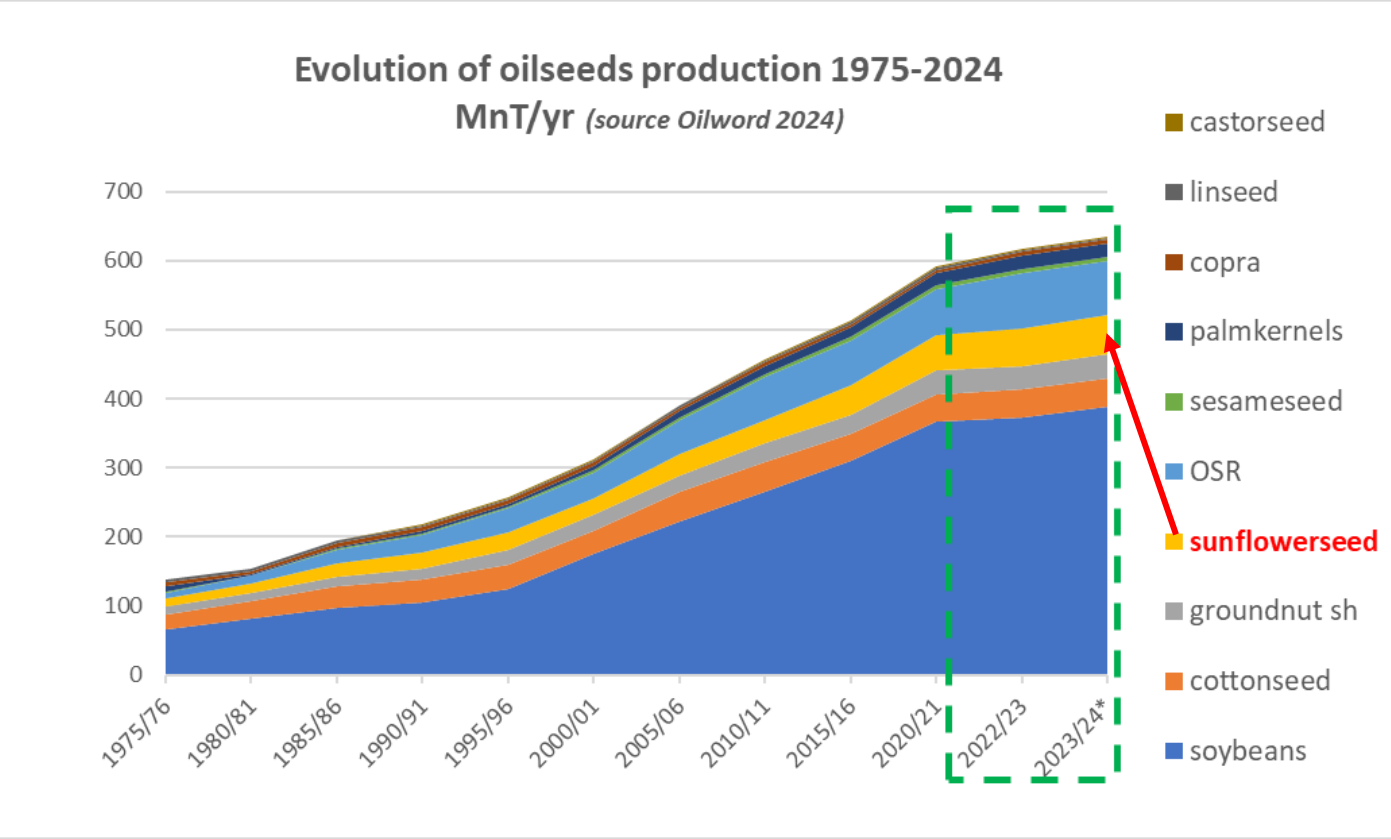
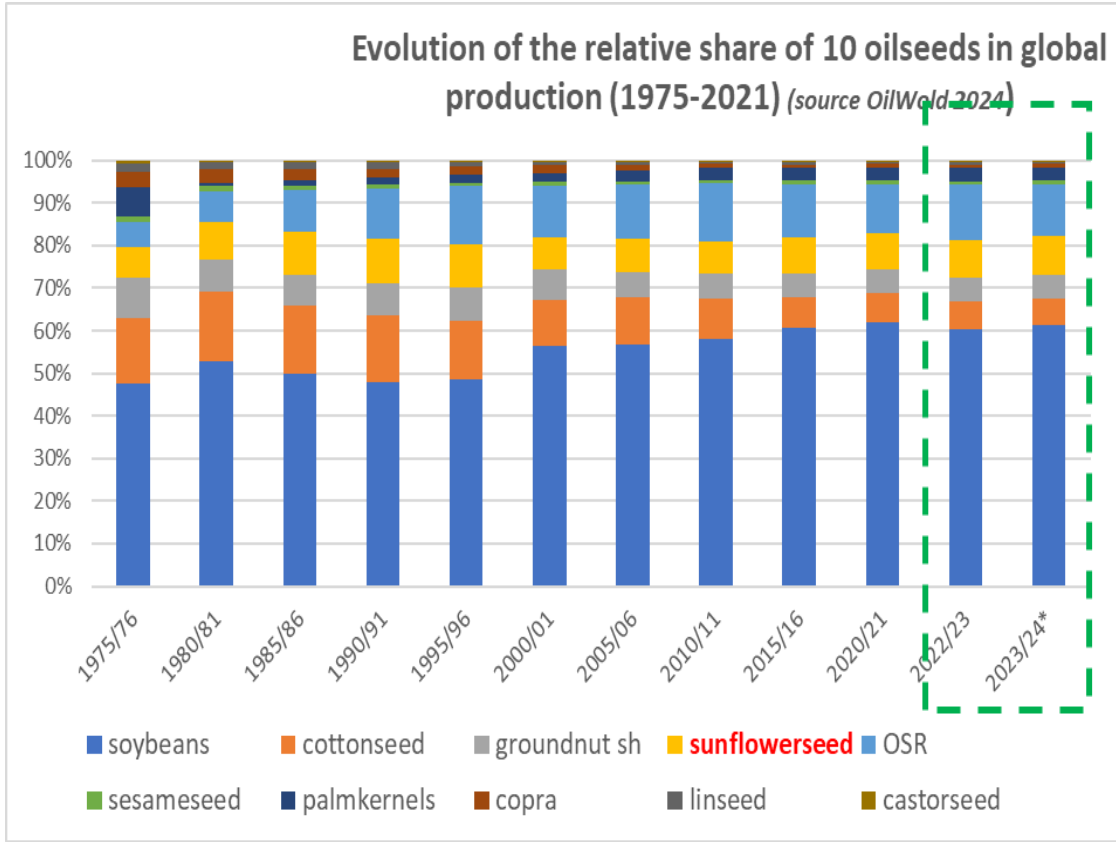
Oilseed crops at global scale





Continuous increase of **Soybeans** (>60% now)
Rapeseed seeds reached 15 % of all oilseeds in 2012/13 and then stabilized around 12 %
Sunflower seeds reached 10% of all oilseeds between 1985 and 1995 and stabilized around 9%
Relative decrease of **cotton seed**

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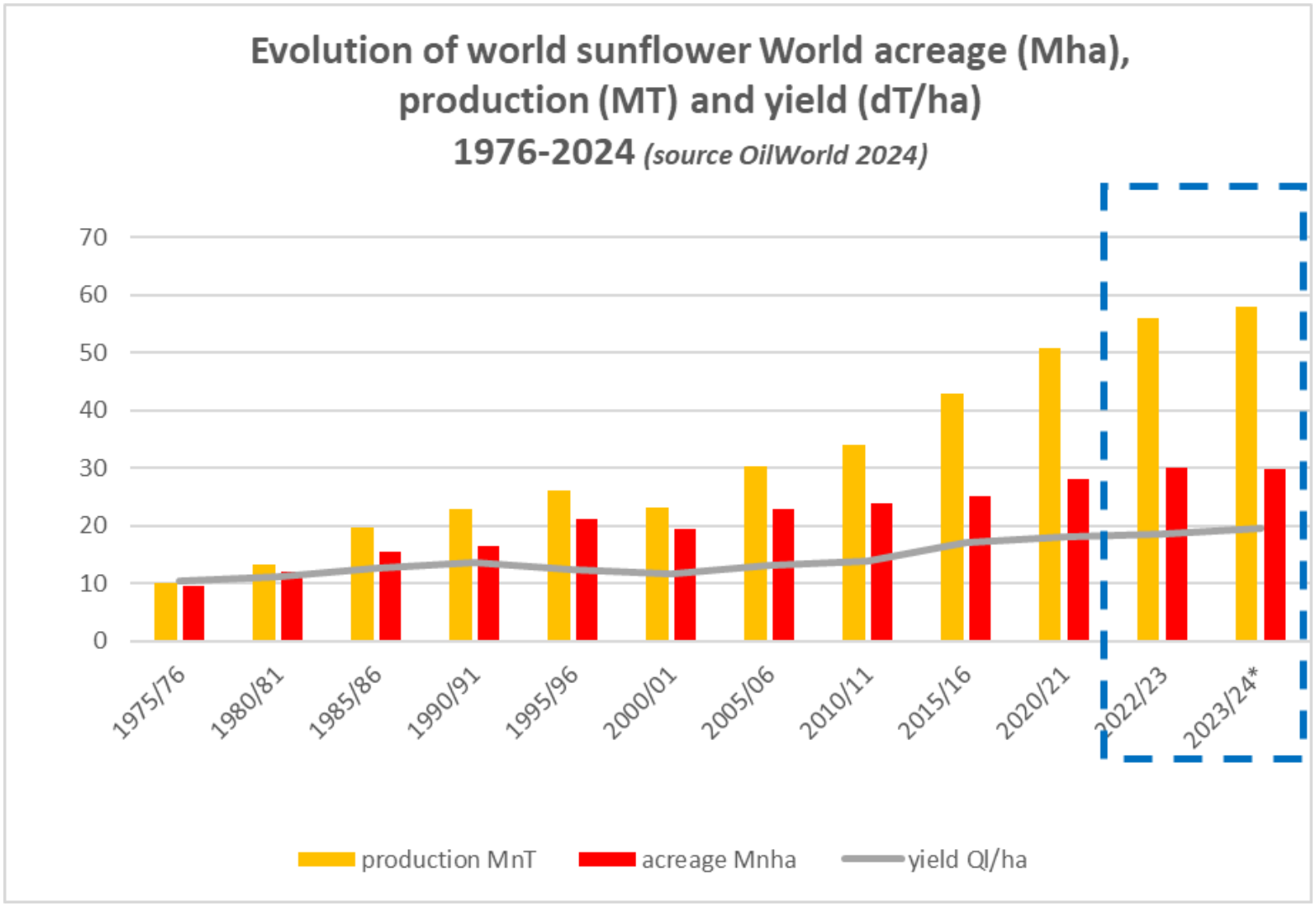
A remarkable growth of the seeds production



56MT
on 30 Mha

Since 2000:
Production X 2,3
Acreage x 1,45
Yield x 1,55

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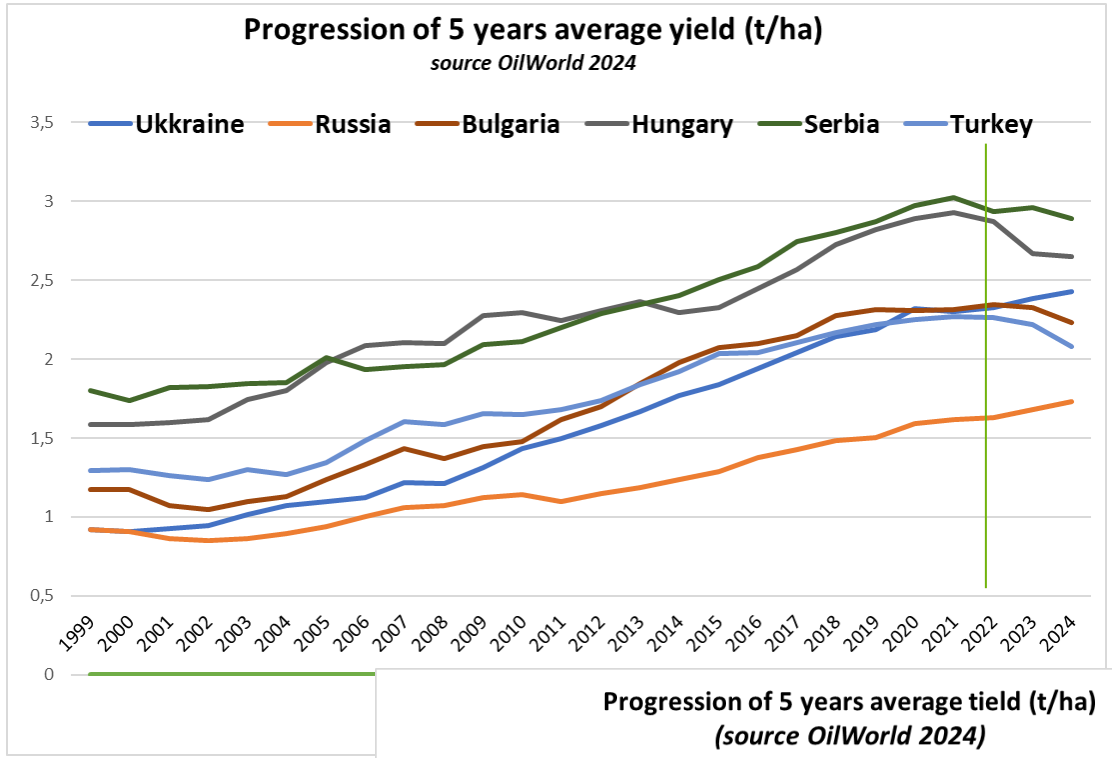
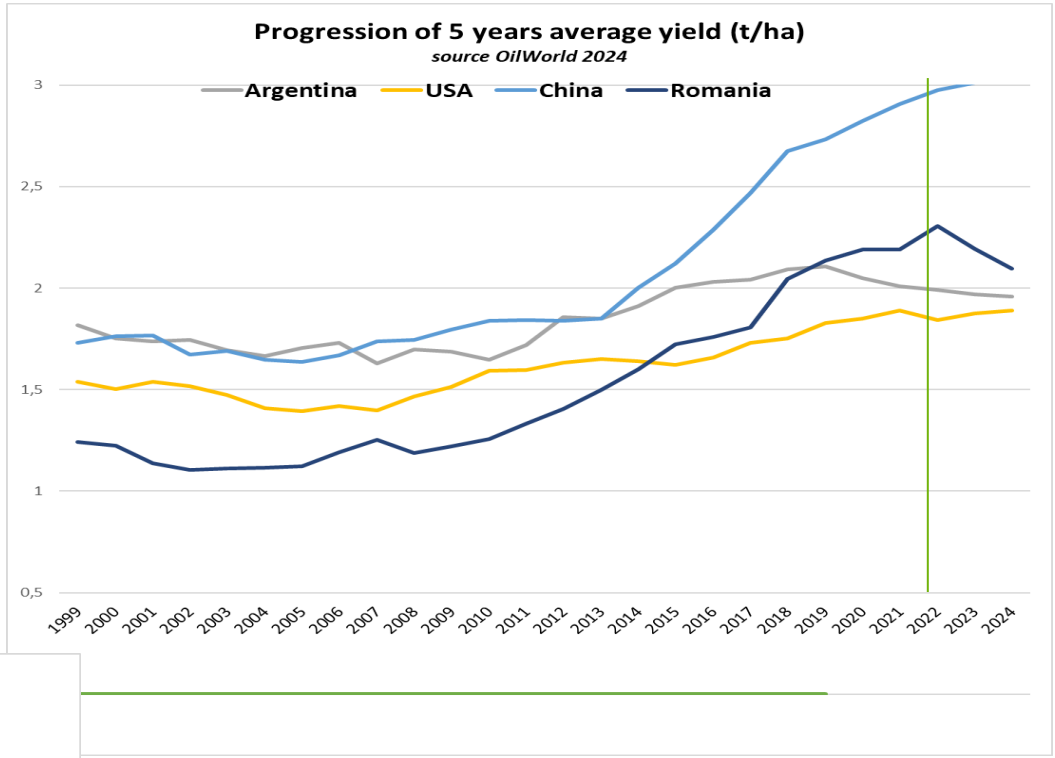
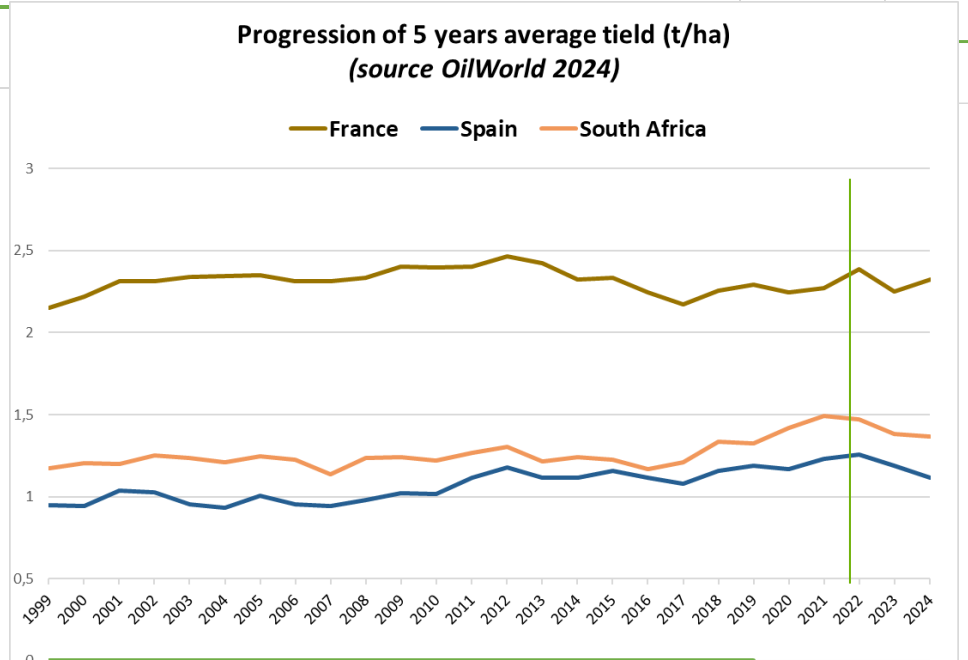
Yields: 3 different dynamics accross top 10 countries







NB: Tanzania: stable yields 1 to 1,1 t/ha

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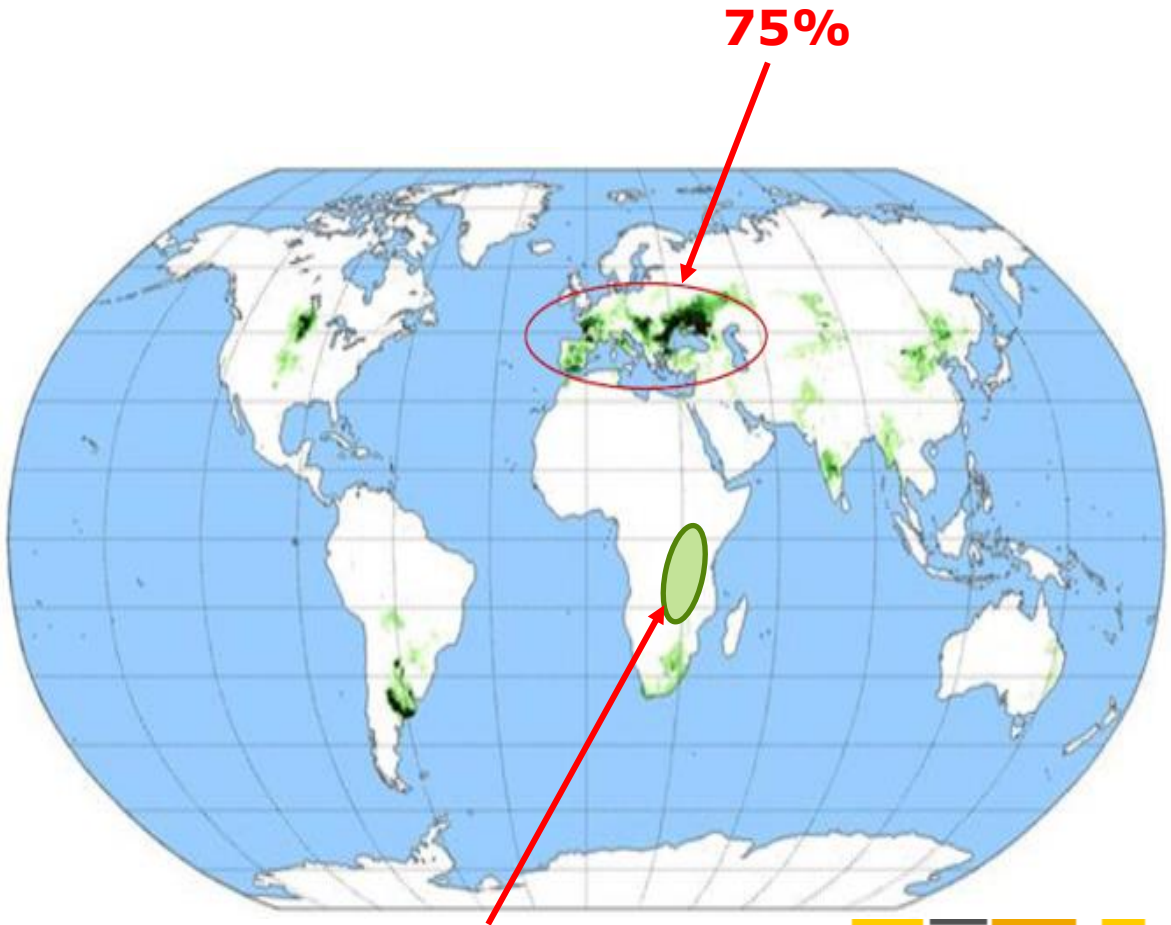
Sunflower : a relatively spatially concentrated crop

- ✓ **Sunflower is grown significantly in 63 countries. 80% in 10 countries, and up to ¾ in Europe (continent): passing from 2/3 in 2009-13 to 3/4 in 2019-23: *growing concentration***

Acreage and Production	average 2014/2018		average 2019:2023		% increase
source: Oil World 2024	1000ha	1000T	1000ha	1000T	production
WORLD	25927	45463	28506	54522	20%
Ukraine	5760	12370	6316	15030	22%
Russia	6944	10300	8818	14854	44%
Argentina	1424	2966	1756	3442	16%
China	957	2561	916	2758	8%
Romania	1045	2094	1165	2549	22%
Bulgaria	842	1921	836	1948	1%
Turkey	689	1494	750	1658	11%
Hungary	625	1707	626	1656	-3%
France	634	1423	701	1571	10%
→ Tanzania	906	932	1026	1077	16%
USA	618	1084	513	1067	-2%
Top 10	*19826*	*37768*	*22910*	*46543*	23%
Top 10%	*76%*	*83%*	*80%*	*85%*	
(European Union)	4304	8904	4454	9567	7%
(Serbia)	190	534	229	664	24%



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Where is sunflower developing?

- A new production area in Africa, apparently based on the growth of acreage.
- In 15 years, Ukraine grew from 16% to 28% of the global production, and Russia from 20 to 27%.
- → 32% to 55% from these two countries.

	acreage	yield	production	% of world production 2019-23
	muliplied by X from 2004-08 to 2019-13			
WORLD	1,25	1,52	1,90	100%
Ukraine	1,67	1,95	3,25	28%
Russia	1,75	1,46	2,55	27%
Moldova	1,37	1,53	2,09	1%
Kazakstan	2,12	1,40	2,96	2%
China	0,97	1,52	1,47	5%
European U.	1,17	1,36	1,59	18%
Serbia	1,24	1,47	1,82	1%
Tanzania/Uganda/Zambia	3,93	1,01	3,98	3%

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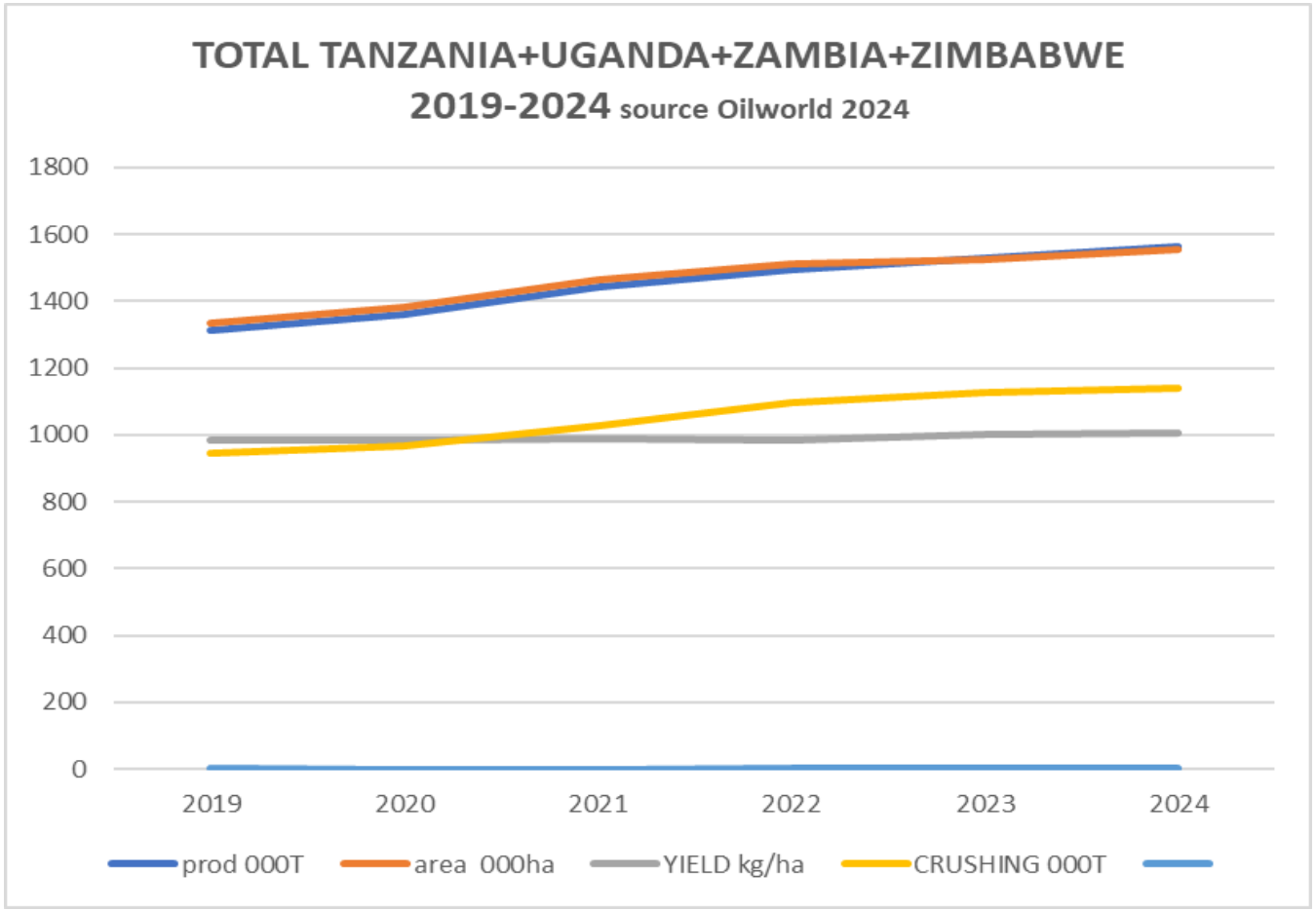

Production, area

crushing

yield

Regular growth in acreage and production
But apparently not yet in yields (are statistics reliable?)
70% of the production is crushed locally
For local consumption
Limited trade exchanges

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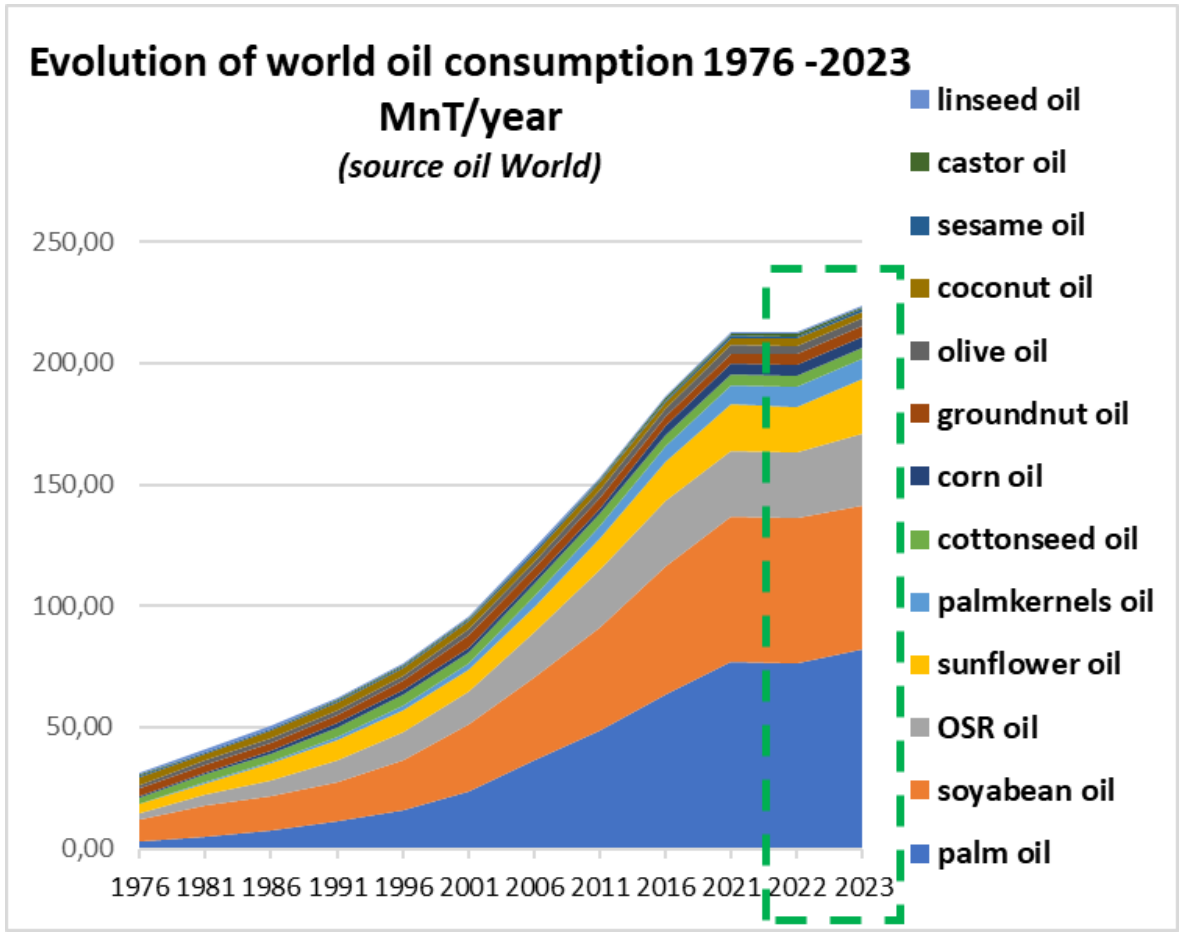
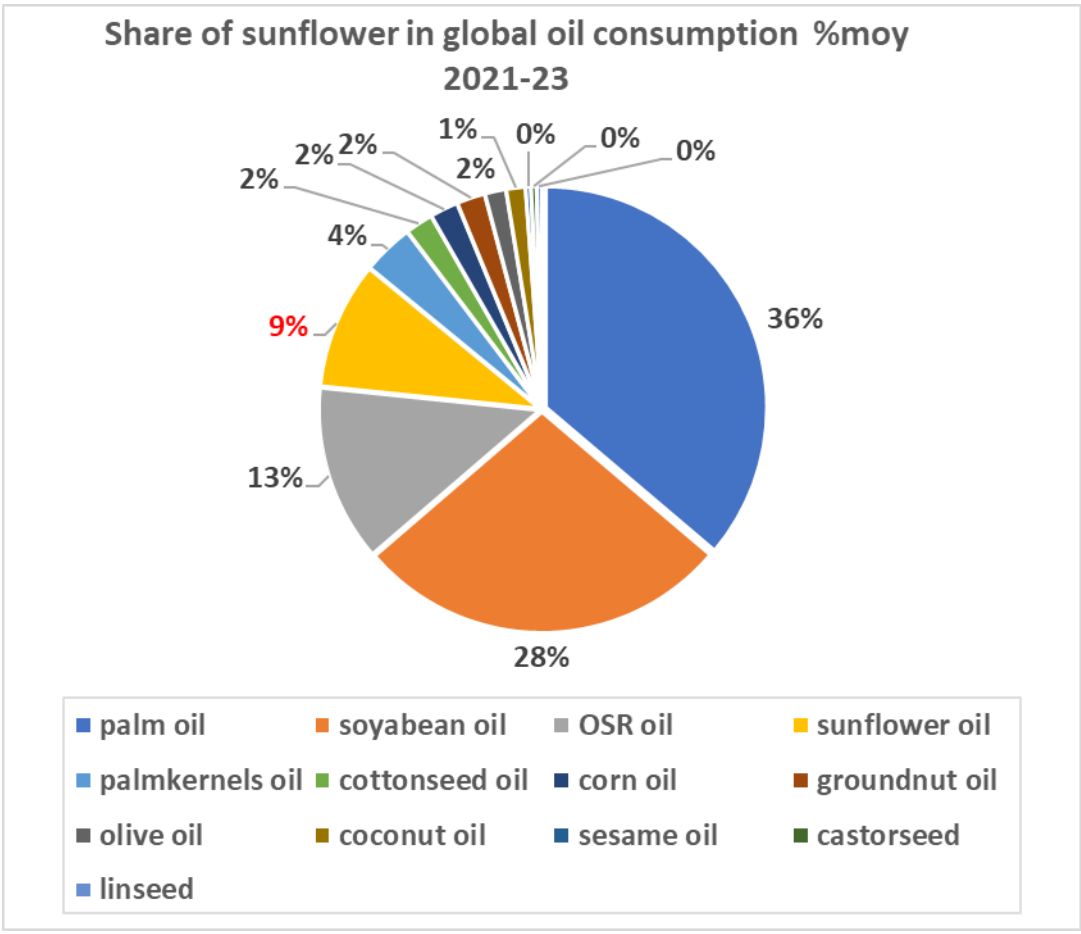
oil consumption: palm first, sunflower 4th





- ✓ Vegetable oils & fats: 259,8MT in 22/23
- ✓ Vegetable oils = 80%
- ✓ Sunflower stable since 2000 at 9-10% of VO, 4th oil in the world

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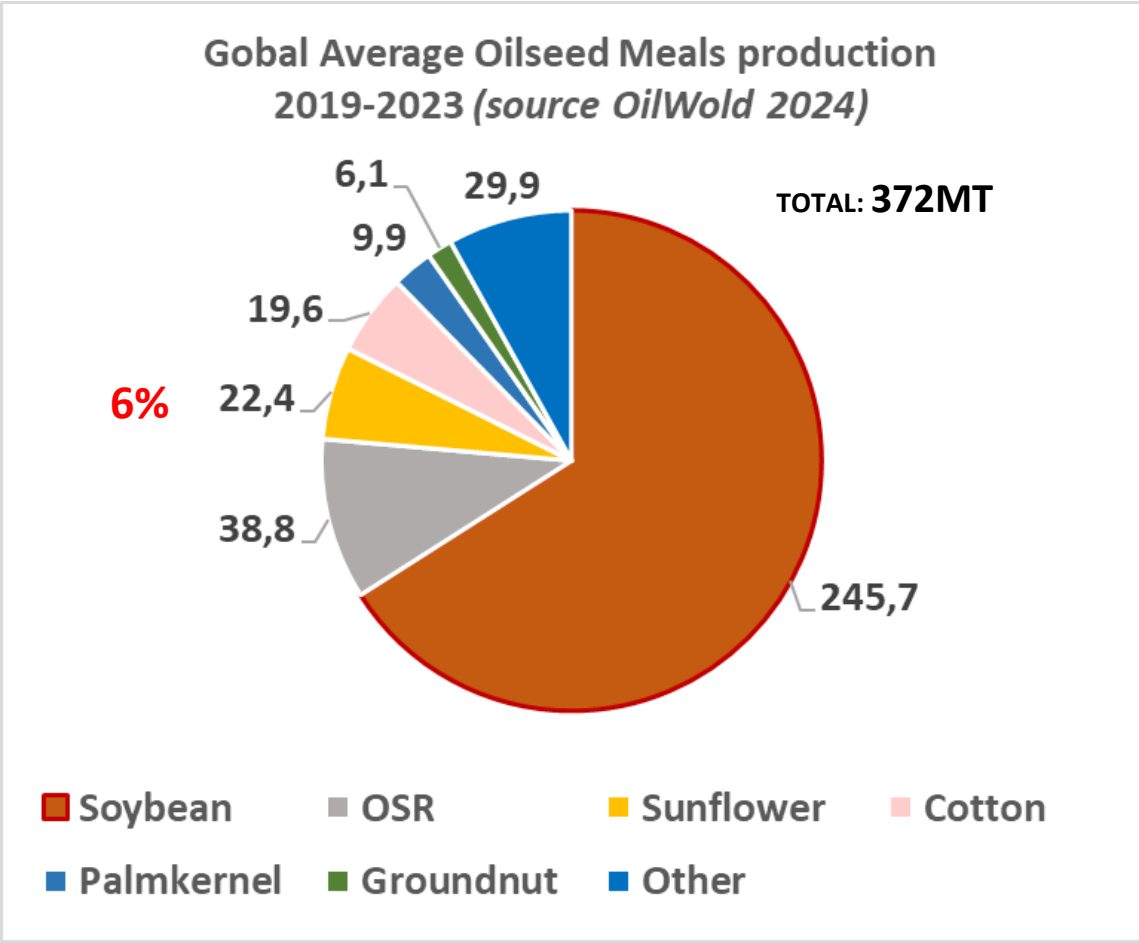
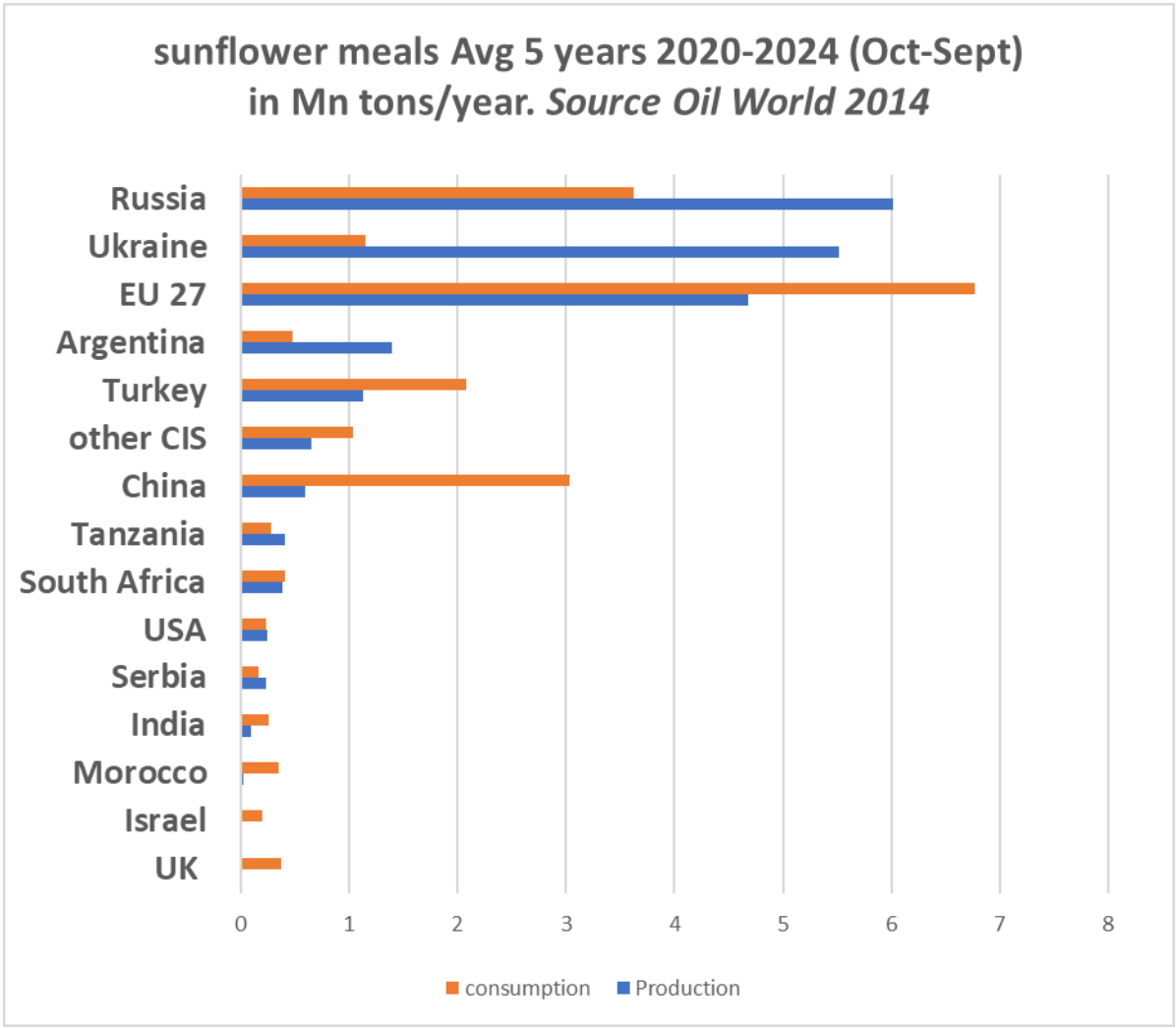
Sunflower meals





- ✓ Sunflower meal is at 3rd rank in production with 23MT
- ✓ Main importers: EU, Turkey, China, other CIS, Morocco, Israël, UK

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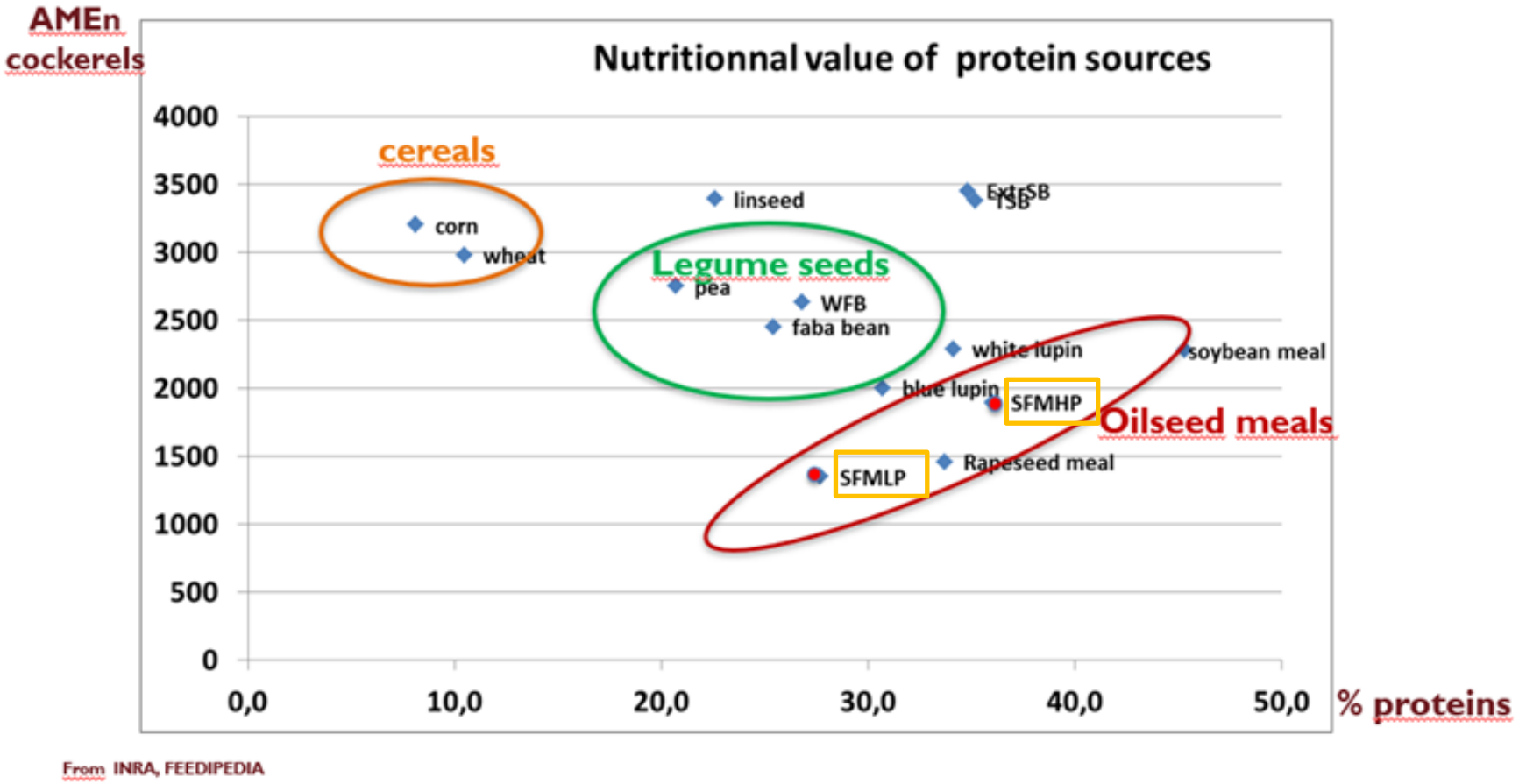
Feed protein sources: high pro sunflower meals among the best



SFMHP: Sunflower Meal high Pro ; SFMLP: Sunflower Meal Low Pro.
(source: Terres Univia)

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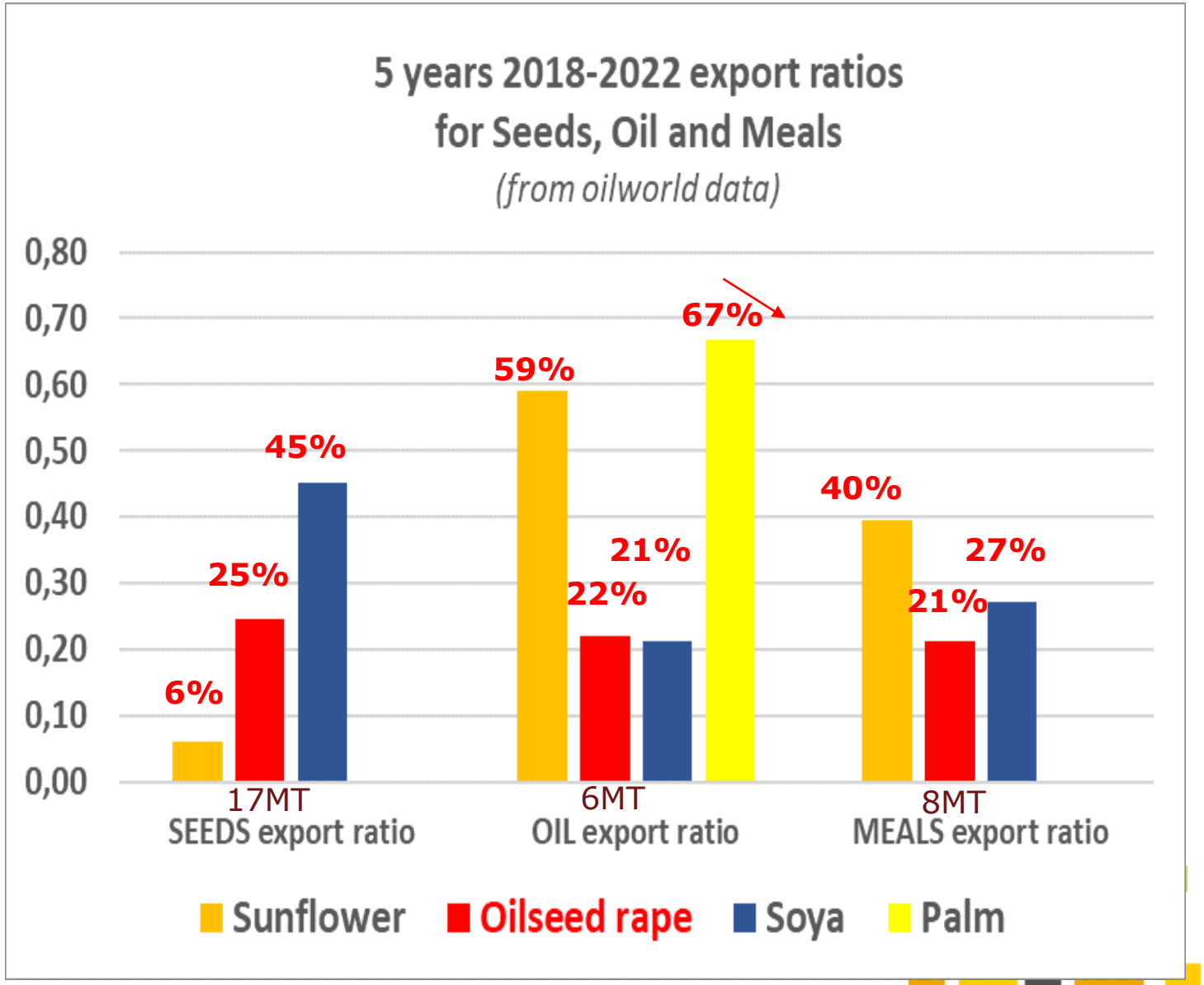
Trade

- ✓ Oilseed products are highly traded commodities, around 28% of total production, more than most grain commodities
- ✓ Sunflower is traded mainly after processing: only 5% of seeds are exported out of the production countries
- ✓ Industrial development has accompanied the sunflower seeds production



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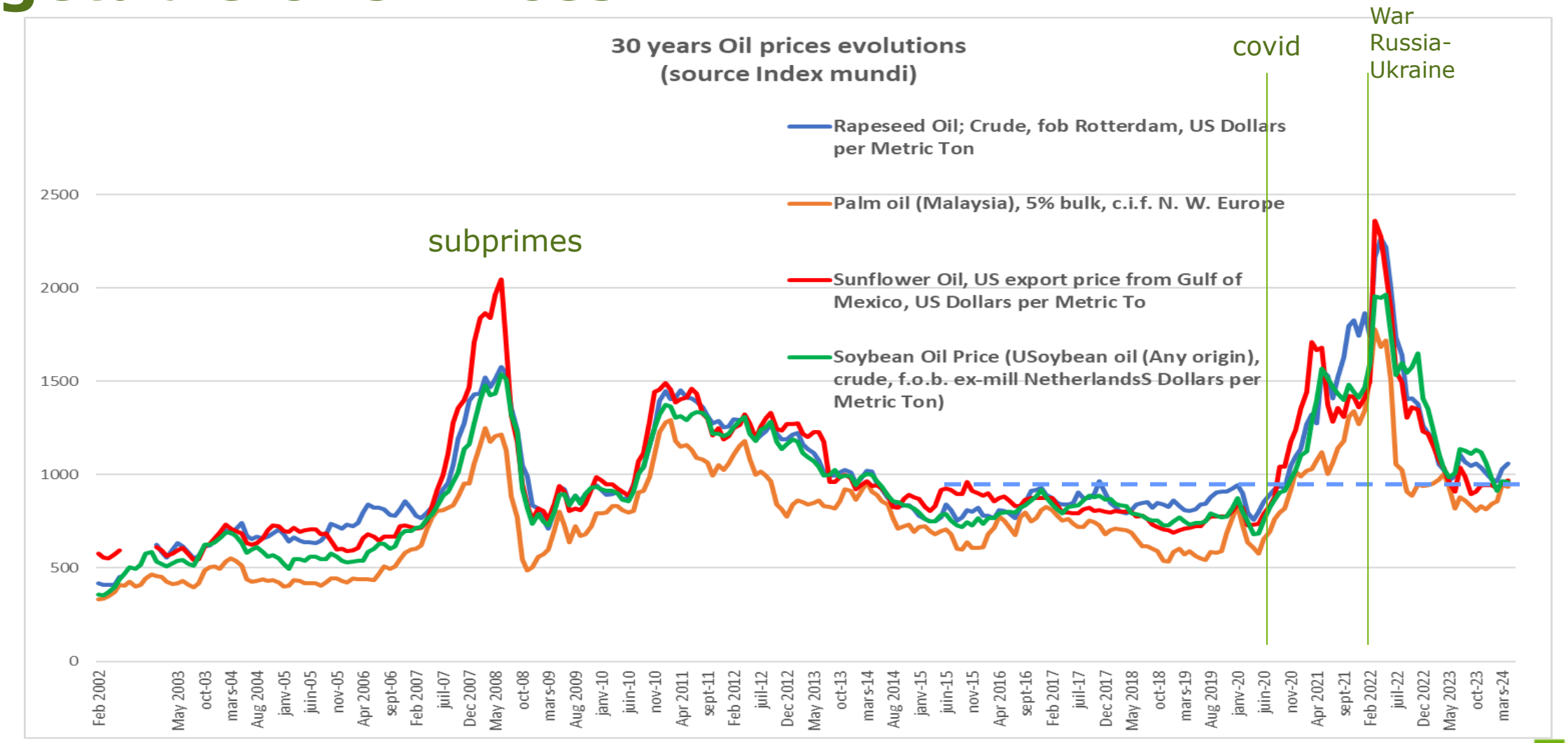
Vegetable Oils Prices



Last 5 years: sunflower oil premium about -0,4 US$ versus SBO (-304 to +423)
+219 US$ versus Palm Oil (-23 to + 678)
-61 US$ versus Rapeseed Oil (-453to + 392)

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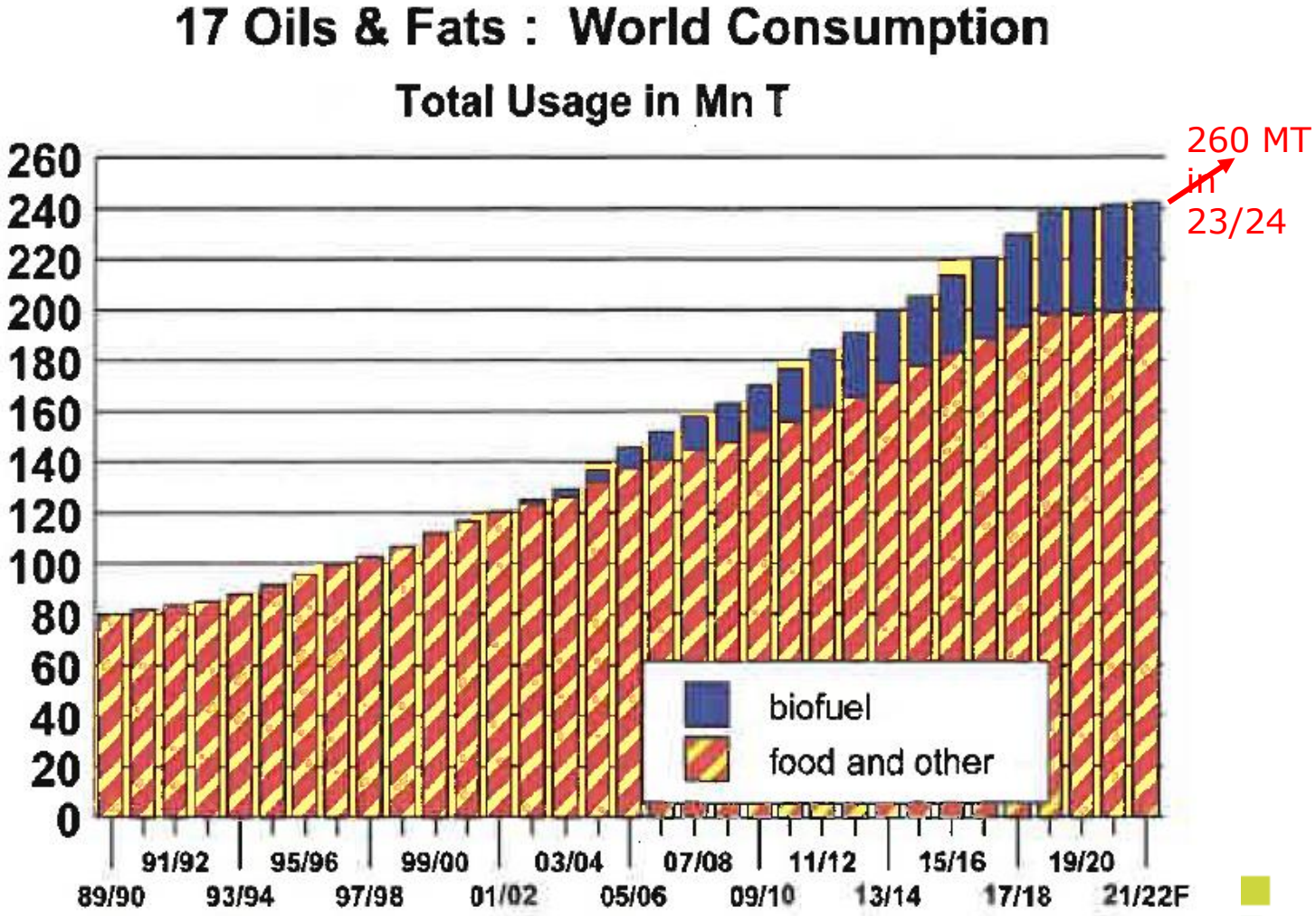
Vegetable oils and Biodiesel

- With 59.2 MT, of which **50.5MT are based on first use vegetable oils and fats**, Biodiesel absorbs almost 20% of the global oils & fats production (254 MT in 2023/ used oils excepted)
- Or 24% of first use vegetable edible oils.
- Main producers (2023):
  - EU27 (15,4MT)
  - USA (13,7MT)
  - Indonesia (11,5MT; more than 50% of palm oil production)
  - Brazil (7 MT; 68% soy based; 40% of soy oil go to biodiesel)



Source OilWorld 2022

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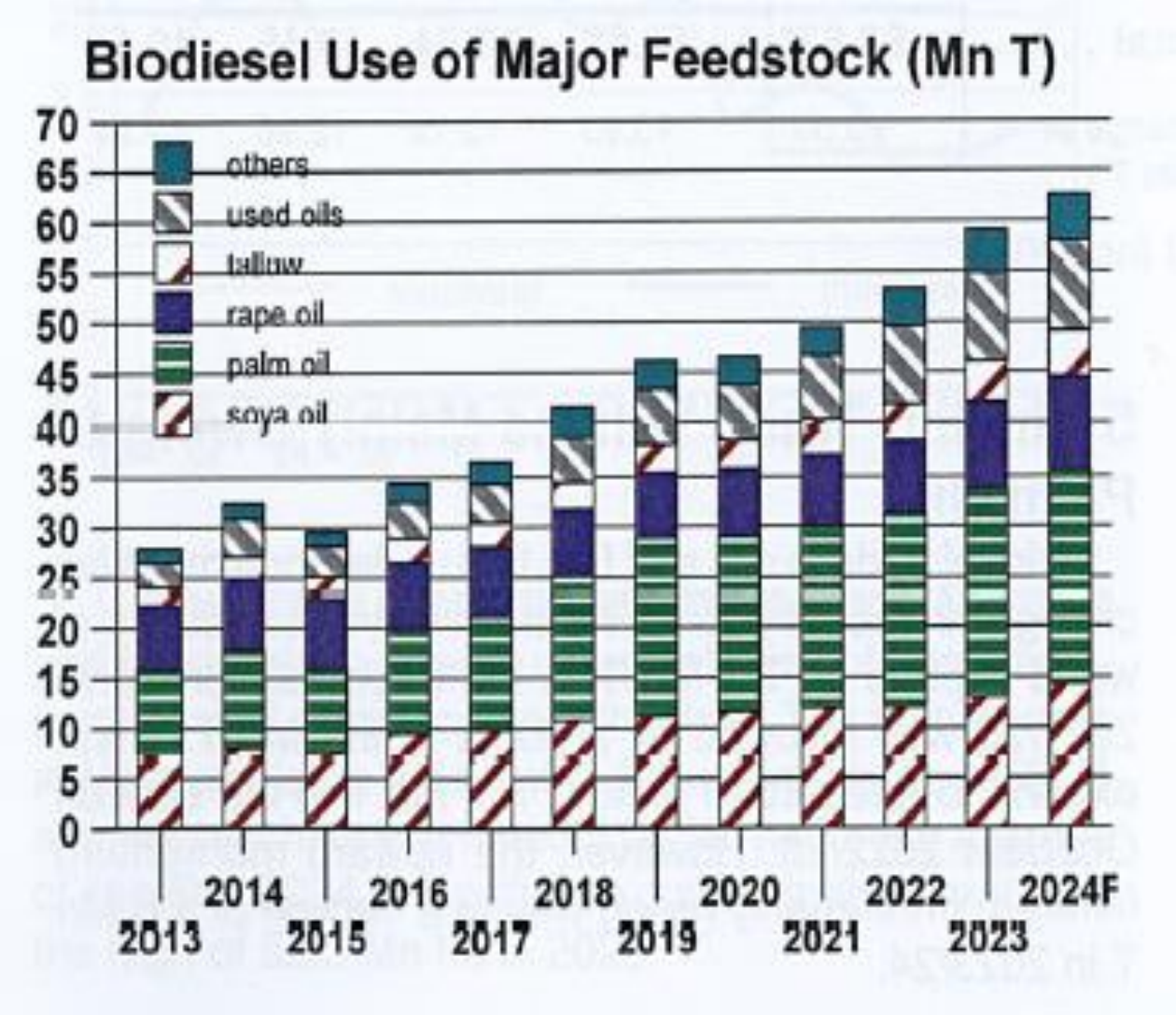
Sunflower and Biodiesel



- Sunflower oil not strongly involved in Biodiesel (<0,6MT in EU)
- But interest could be reinforced by a demand of low input/low emissions biofuels (EU)
- But concerned through the price effects on the vegetable oils complex

Source: OilWorld 2024

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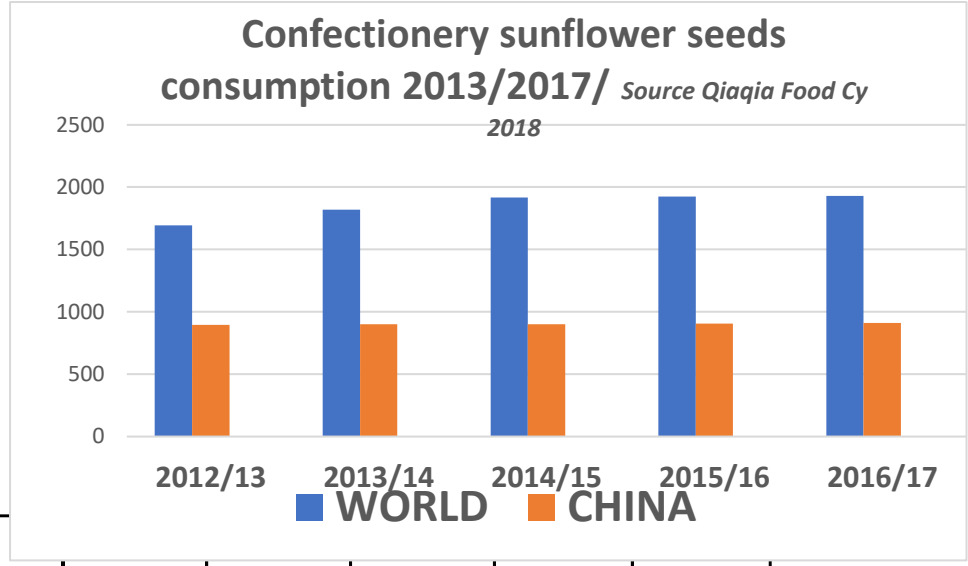
Confectionery Sunflower

- ✓ Assuming that confectionery sunflower still represents 40% of « other uses », it would reach 2,2 MT/year?
- ✓ What about bakery? Cosmetics? Some biofuels?...
- ✓ Still a niche market, corresponding to national food habits
- ✓ Should lead to a higher interest in protein content (→ breeding)



Sunflower World supply and demand MT (source Oilworld 2019 & 2024)										
Sunflower seed MT	**14/15**	**15/16**	**16/17**	**17/18**	**18/19**	**19/20**	**20/21**	**21/22**	**22/23**	**23/24***
Opening stocks	2,9	3,1	3,3	3,6	3,3	3,3	3,3	2,8	7,9	6,3
Production	41,7	43,0	49,8	49,0	51,9	55,7	50,8	58,3	55,9	58,0
Total supplies	44,6	46,0	53,0	52,6	55,2	59,0	54,2	61,2	63,8	64,3
Crushing	36,7	38,0	44,6	44,4	47,3	50,4	46,0	47,8	52,0	54,8
Other uses	4,5	4,7	4,7	4,9	4,9	5,2	5,3	5,4	5,5	5,7
Ending stocks	3,1	3,3	3,6	3,3	3,3	3,3	2,9	7,9	6,3	3,8
Stocks/ usage	7,4%	7,8%	7,3%	6,7%	6,4%	5,9%	5,6%	14,8%	11,0%	6,3%
% other uses / total uses	*10,9%*	*11,1%*	*9,6%*	*10,0%*	*9,4%*	*9,4%*	*10,4%*	*10,2%*	*9,6%*	*9,4%*
confectionery (Qiaqia Cy)	1,9	1,9	1,9	*2,0*	*2,0*	*2,1*	*2,2*	*2,2*	*2,3*	*2,3*
confectionery as % of other uses	42,6%	40,7%	40,7%							
confectionery as % of total uses	4,3%	4,2%	3,6%	1,9	2,0	2,1	2,0	2,2	2,3	2,3

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Effects of the war in Ukraine?

- ✓ Together, Ukraine and Russia represented 80% of sunflower oil and meals exports when war started.

2019/20 Oil World statistics July 2021 ed	PRODUCTION			EXPORTS		
1000 T	seeds	oil	meal	seeds	oil	meal
Ukraine	16500	7168	6440	76	6763	5164
Russia	15379	5978	5577	1278	3706	1998
Romania	2900	554	634	115	87	160
Bulgaria	1914	600	618	313	271	206
Moldova	840	171	156	379	143	112
Turquie	1470	1170	1349	48	629	5
Georgie	3	3,9	4,3	0,1	0,4	1,1
Black Sea Region	39006	15645	14778	2209	11599	7646
World	55632	21534	21978	3616	13698	8996
% from Black Sea main producers	*70%*	*73%*	*67%*	*61%*	*85%*	*85%*
% from Ukraine	*30%*	*33%*	*29%*	*2%*	***49%***	***57%***
% from Russia	*28%*	*28%*	*25%*	*35%*	*27%*	*22%*

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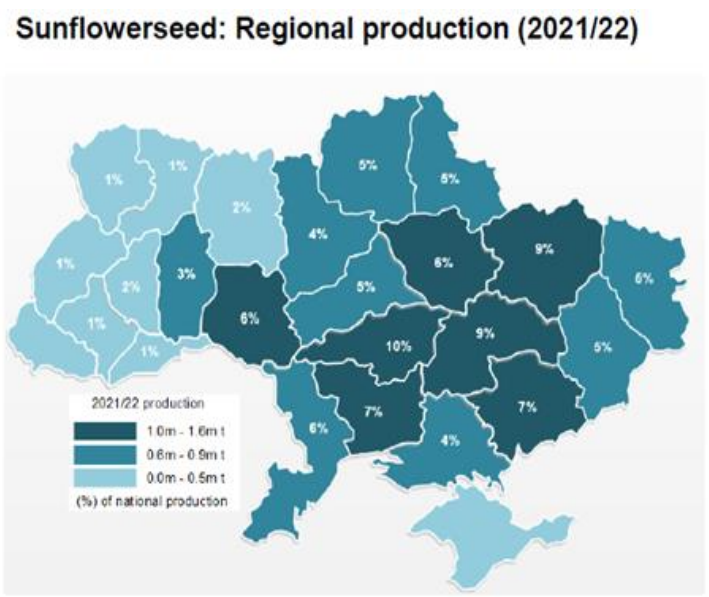
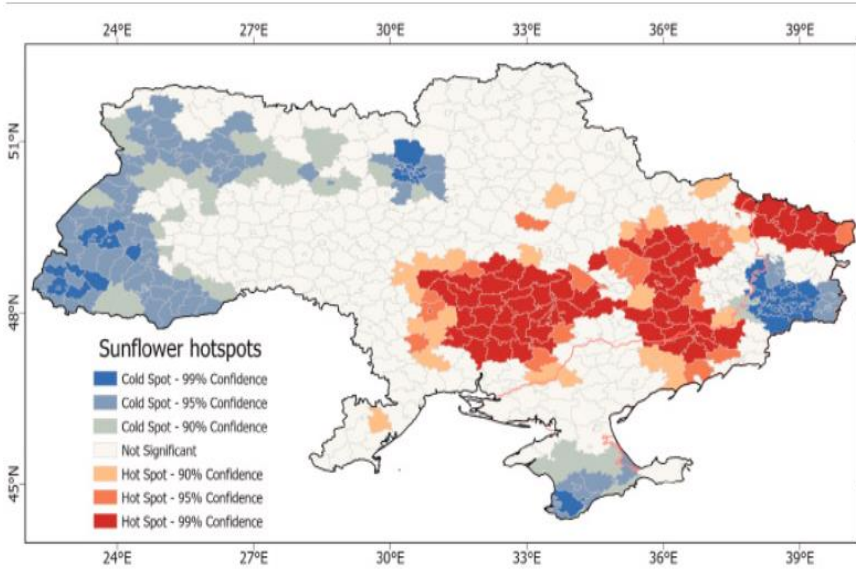
Sunflower production in Ukraine: war consequences

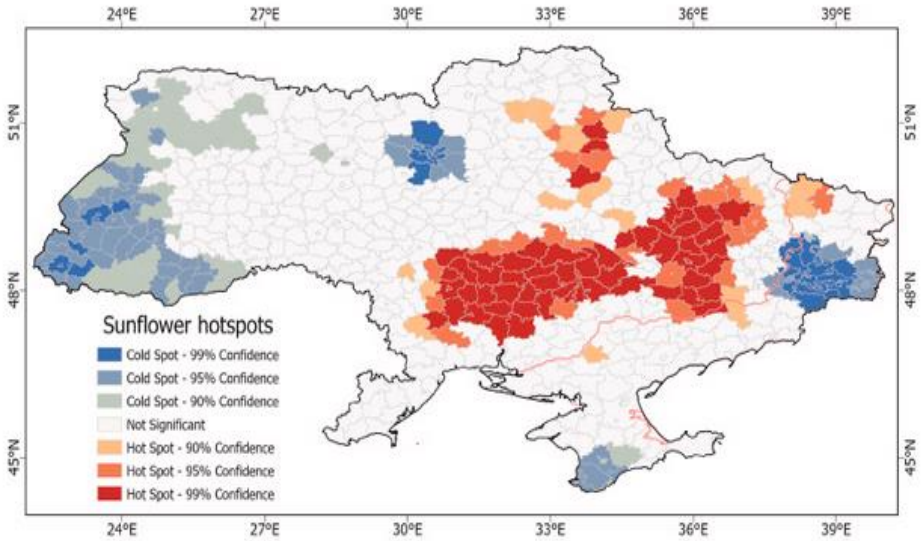
Sentinel 1 cropland hotspots

2021

2022







- Ukrainian sunflower production directly affected by the war: in 2021 more than 25% of the production acreage in the Southern part of the country
- A 5% decrease in sunflower areas in 2022 versus 2021 due to the war.
- Reduction of 29% in sunflower areas observed in occupied territories.
- 9% of sunflower fields were planted in both 2021 and 2022.
- **Gradient of sunflower hotspot shifted from south to south-central regions.**

(source Qadir, A., Skakun, S., Becker-Reshef, I., Kussul, N., & Shelestov, A. (2024). Estimation of sunflower planted areas in Ukraine during full-scale Russian invasion: Insights from Sentinel-1 SAR data. Science of Remote Sensing, 100139. https://doi.org/10.1016/j.srs.2024.100139)

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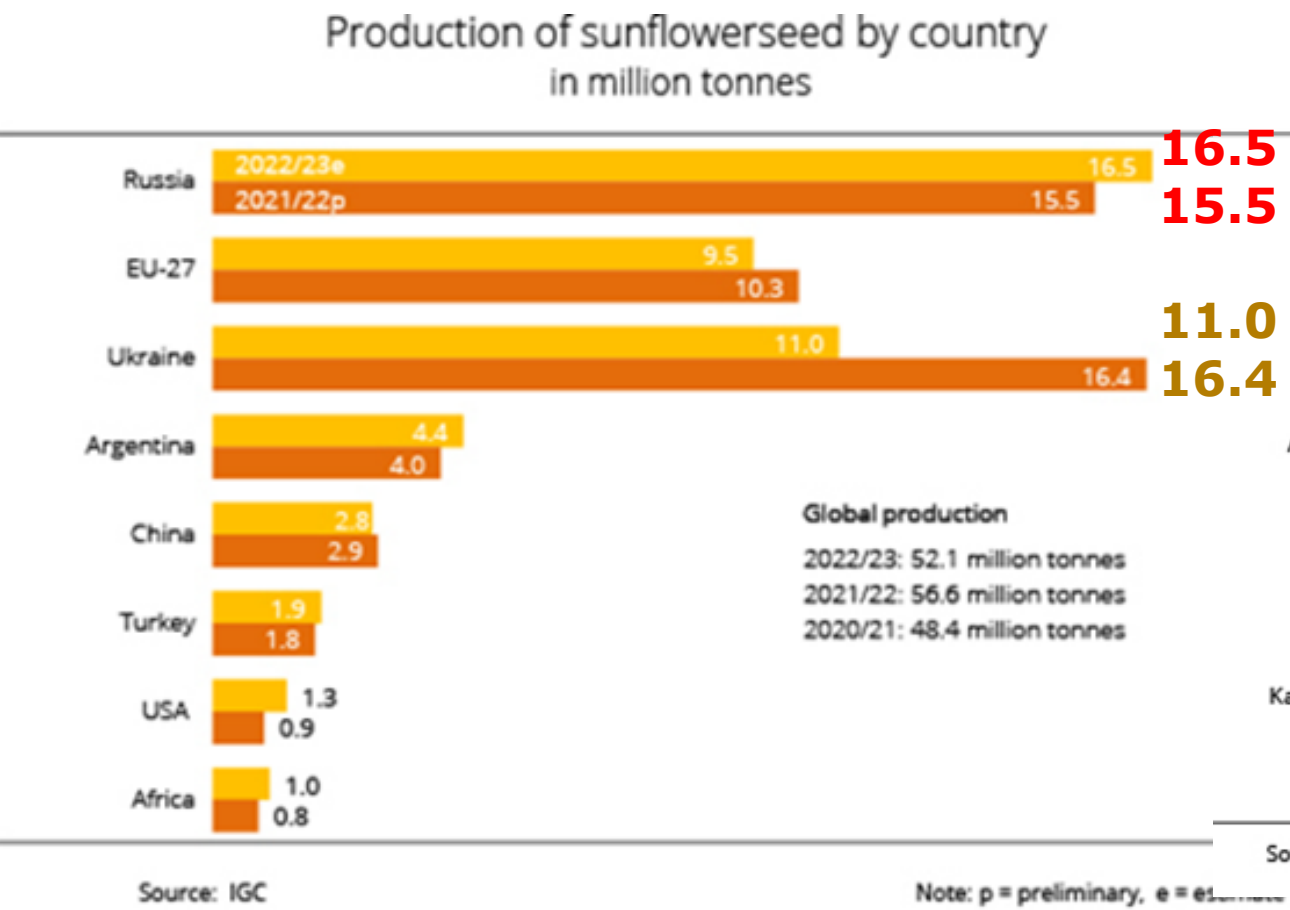
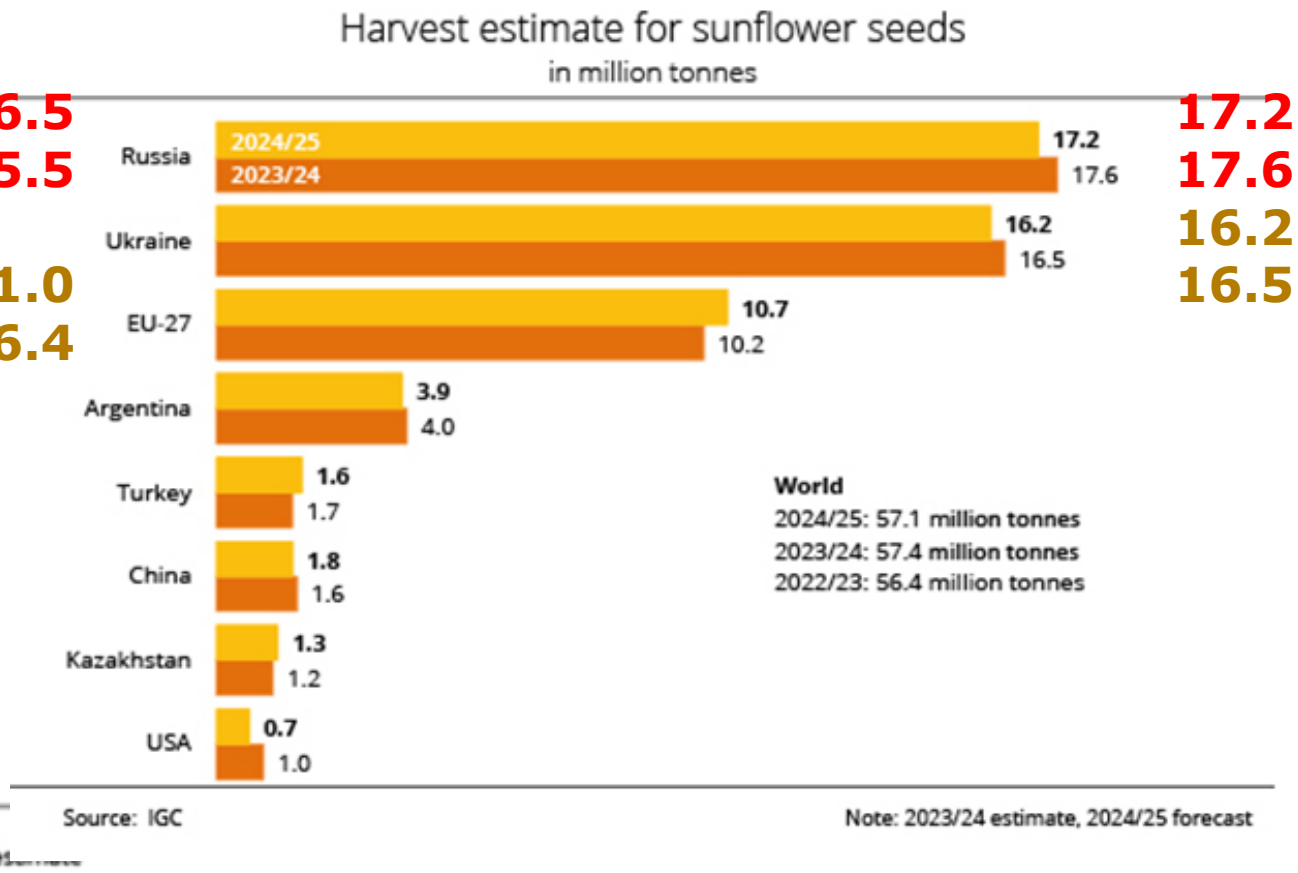
Sunflower production in Ukraine: war consequences



16.5
15.5
11.0
16.4



17.2
17.6
16.2
16.5

2021/22 and 2022/23 (top)

2022/23 and 2023/24 (top)

IGC outlook for 2024/25points out to a continuous shift in area from Cereals to oilseeds (sunflower, soyabean and rapeseed) with associated changes on exports

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Sunflower exports from Russia and Ukraine

	SUN OIL exports			
source: Oil World 2024	1000T			
	2020/21	2021/22	2022/23	2023/24*
Ukraine	5250,2	4725	5446,6	5950
Russia	3228,1	3193,3	4279	5110
	SUN SEEDS Expports			
Ukraine	185,7	1793,1	1685,3	350
Russia	527,6	280	284,7	360

From the point of view of exported quantities, the situation seems to come back to normal

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Climate change is coming

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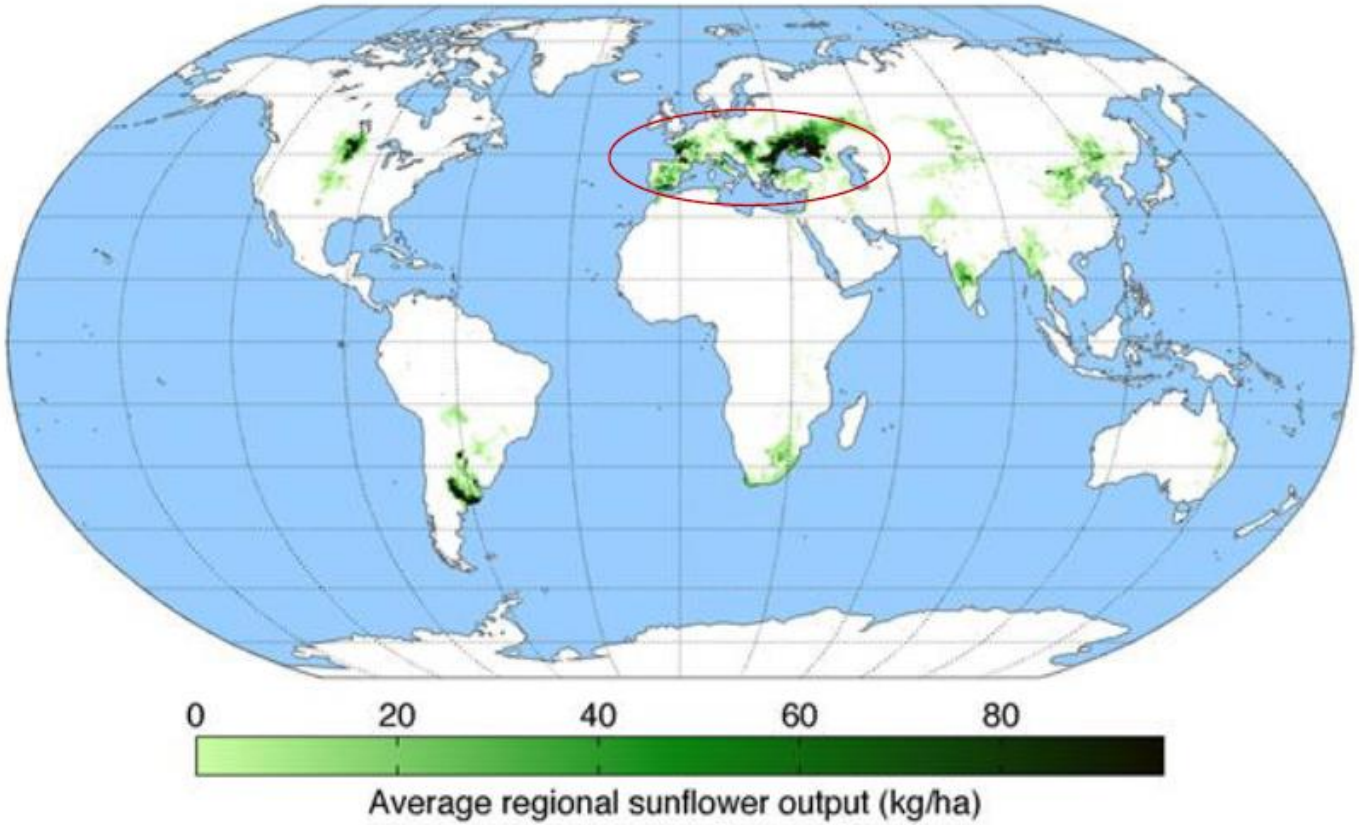
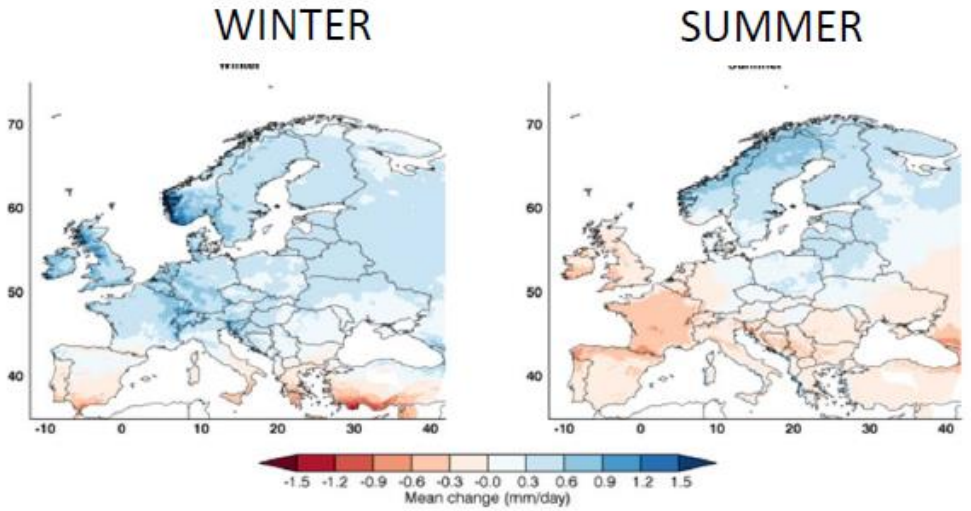
Sunflower production regions will be markedly exposed to climate change (and especially to drought)



Daily precipitation (2071-2100) – RCP8.5



Ciscar *et al.* (2018)

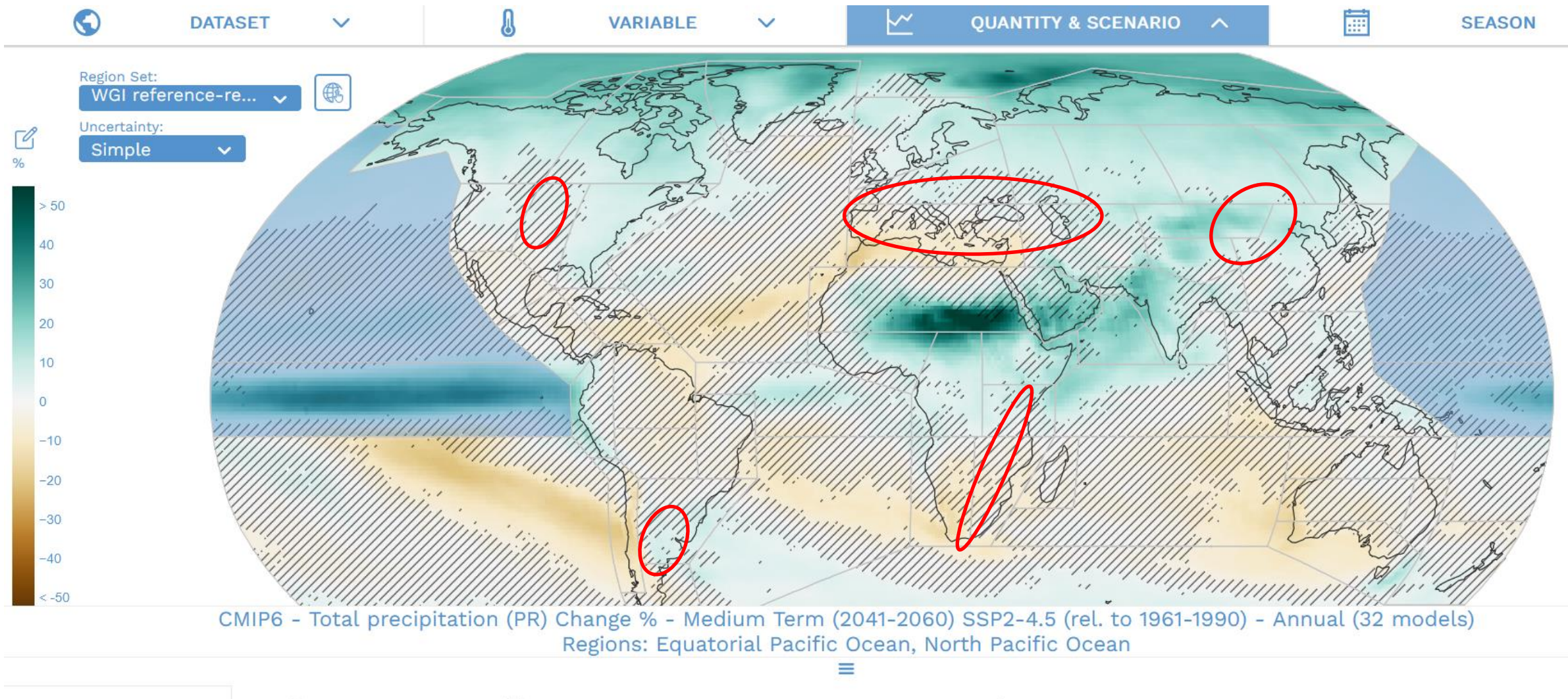
Reference year 2000

~ 70 % of sunflower production comes from Europe (Russia, Ukraine, UE-27)

→ reduction of precipitation whatever the RCP scenario

From Philippe Debaeke, ISC 2022

Climate change tendency to 2041-61. Precipitations



Tendency to dryer climate excepted in China and Argentina areas

Source:https://interactive-atlas.ipcc.ch/

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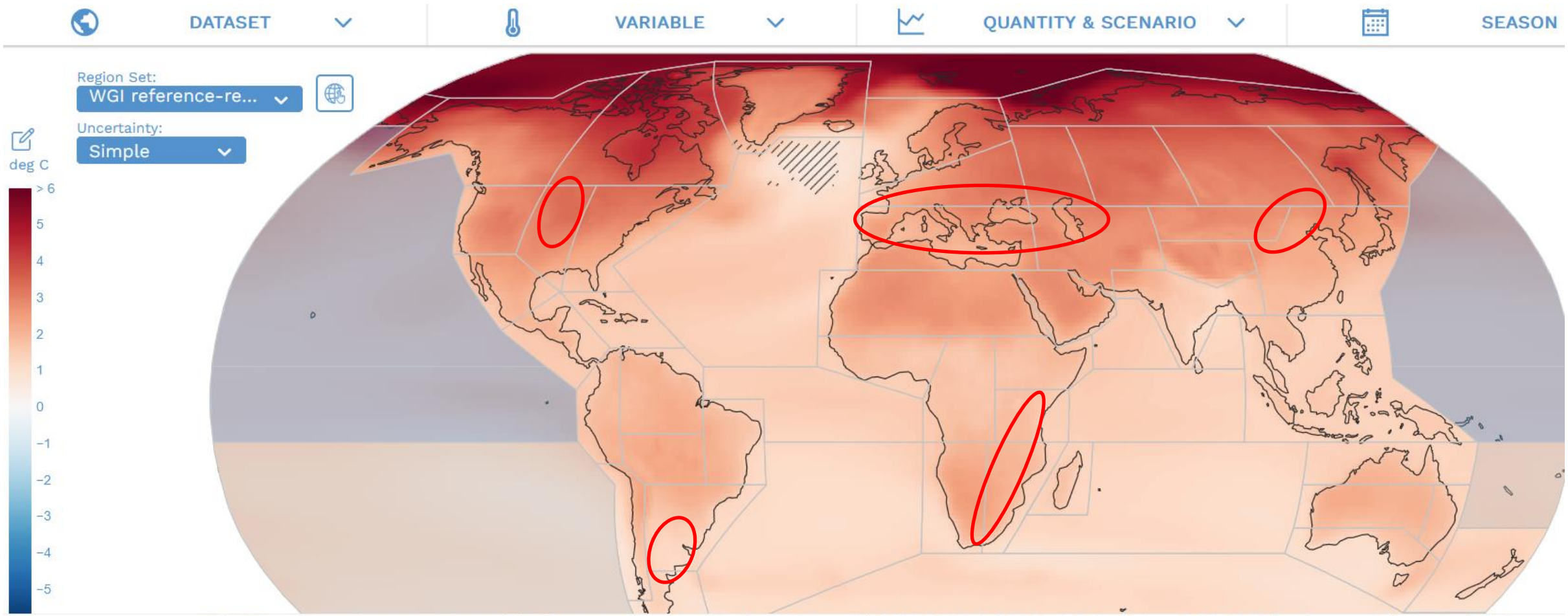
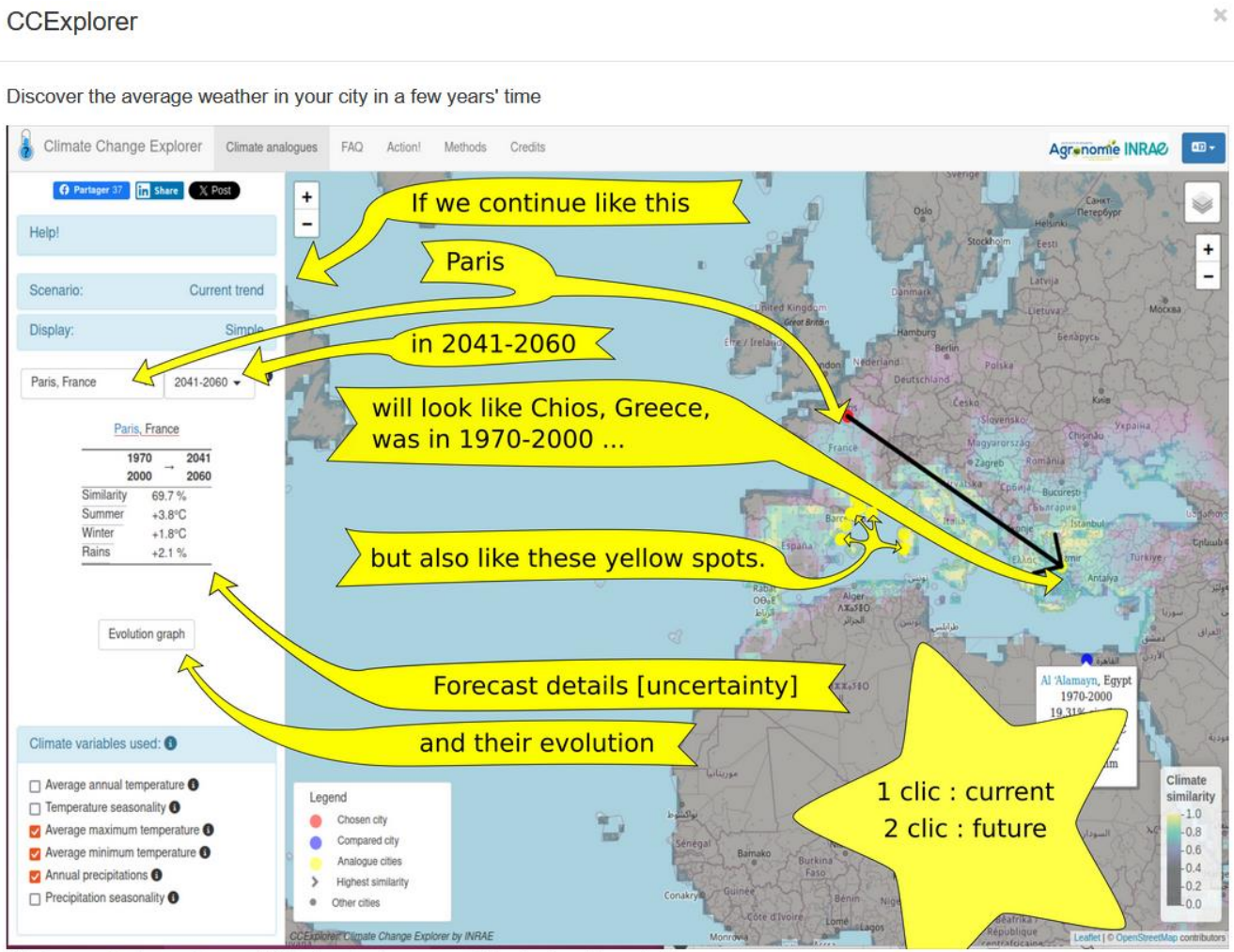
Climate change tendency to 2041-61. Temperatures



Tendencies for P and T are similar in Spring and Summer seasons

https://ccexplorer.eu/?lang=en



Click on a city to see its pre-2000 climate. One more click displays its evolution.

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Poitiers (W France) = Toulouse tomorrow 2021-41… 340km SE

Scenario: Current trend

Display: Detailed

Display:
- Simple
- Detailed

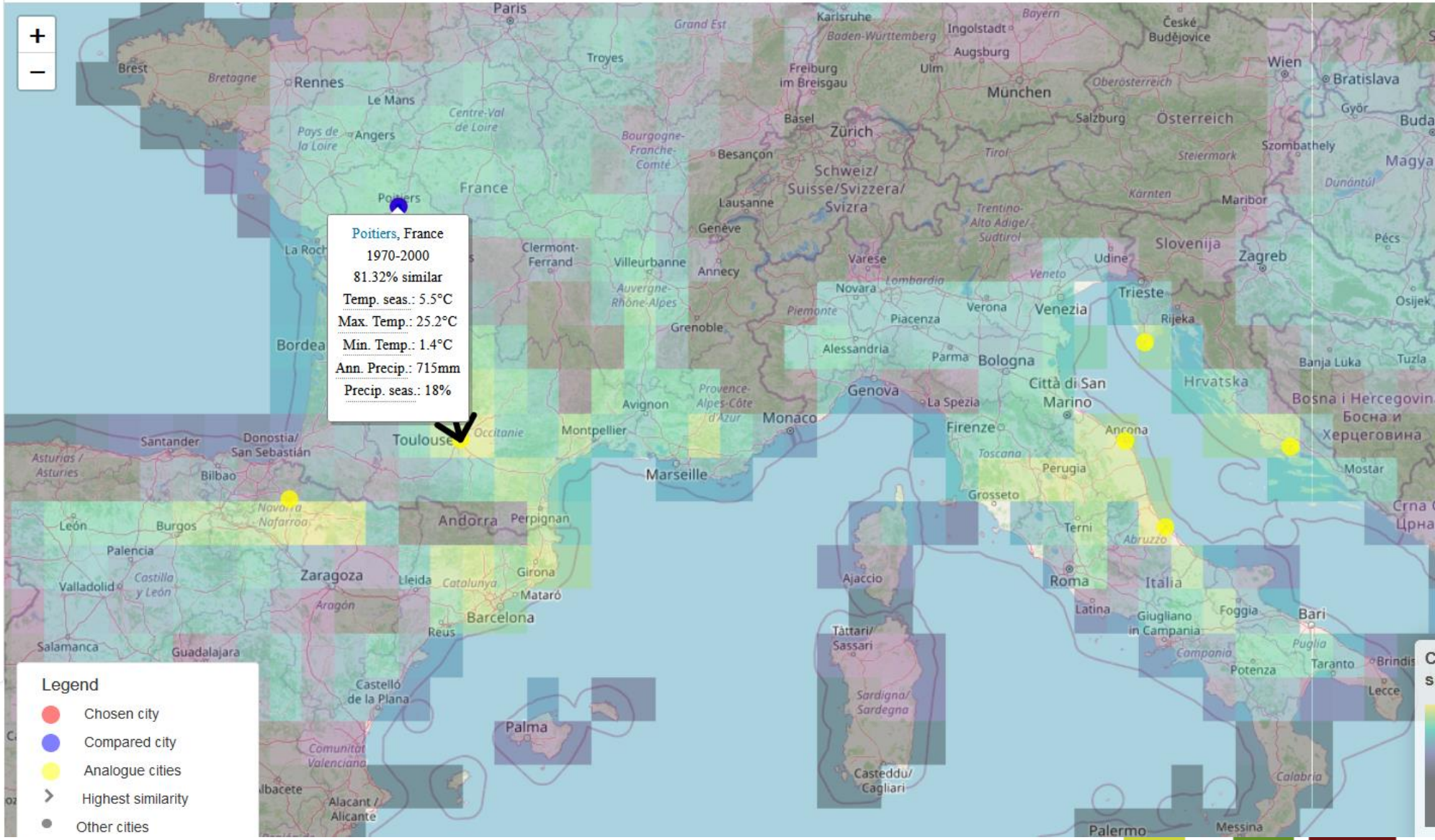
Poitiers, France | 2021-2040

Poitiers, France

	1970 2000		2021 2040	Δ
Similarity (%)	81.3		100	
Temp. seas.(°C)	5.5	→	5.9 [5.6;6.2]	+7.3 %
Max. Temp. (°C)	25.2	→	27.9 [27.1;30.2]	+2.7
Min. Temp. (°C)	1.4	→	2.4 [1.9;3.3]	+1.0
Ann. Precip. (mm)	715	→	725 [709;737]	+1.4 %
Precip. seas.(%)	18	→	22 [17;25]	+22.2 %

Evolution graph

Climate variables used:
- [ ] Average annual temperature
- [x] Temperature seasonality
- [x] Average maximum temperature
- [x] Average minimum temperature
- [x] Annual precipitations
- [x] Precipitation seasonality



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Toulouse France tomorrow 2021-41= Austalian Queenland today… or ItalianAdriatic coast similar trend for 2041-61

Scenario: Current trend

Display: Detailed

Display:
- Simple
- Detailed

Toulouse, France | 2021-2040

Toulouse, France

	1970 2000	2021 2040	Δ
Similarity (%)	80.5	100	
Temp. seas.(°C)	5.9	→ 6.3 [6.1;6.6]	+6.8 %
Max. Temp. (°C)	27.5	→30.3 [29.4;32]	+2.8
Min. Temp. (°C)	1.9	→ 3.1 [2.6;4]	+1.2
Ann. Precip. (mm)	683	→685 [668;694]	+0.3 %
Precip. seas.(%)	15	→ 17 [14;20]	+13.3 %

Evolution graph

Climate variables used:
- [ ] Average annual temperature
- [x] Temperature seasonality
- [x] Average maximum temperature
- [x] Average minimum temperature

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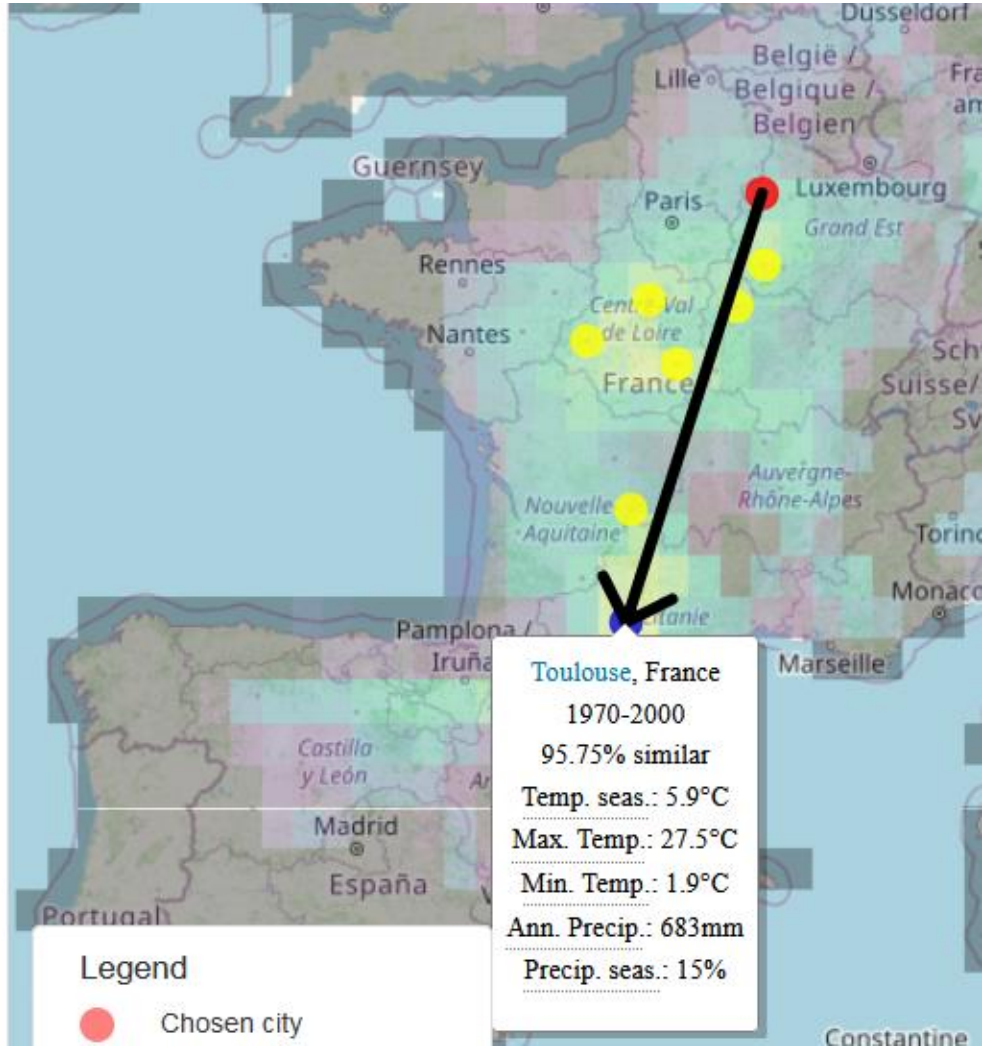
Display: Detailed

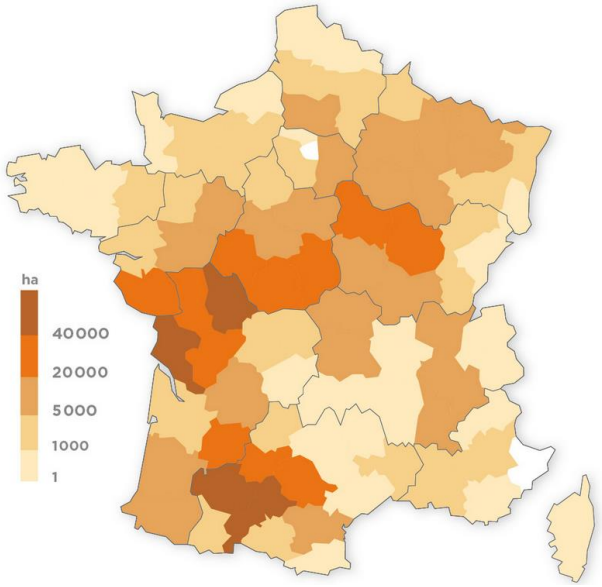
Display:
- Simple
- Detailed

Reims, France | 2021-2040

Reims, France

	1970 2000		2021 2040	Δ
Similarity (%)	82.1		100	
Temp. seas.(°C)	5.8	→	6.1 [5.8;6.4]	+5.2 %
Max. Temp. (°C)	24.4	→	27.1 [26.1;29.5]	+2.7
Min. Temp. (°C)	-0.3	→	1 [0.1;2.1]	+1.3
Ann. Precip. (mm)	627	→	639 [629;650]	+1.9 %
Precip. seas.(%)	10	→	10 [8;12]	+0.0 %





Sunflower regions in France

Probably an extension to the North of France, and need of irrigation in the traditional regions… if water resource available and properly managed

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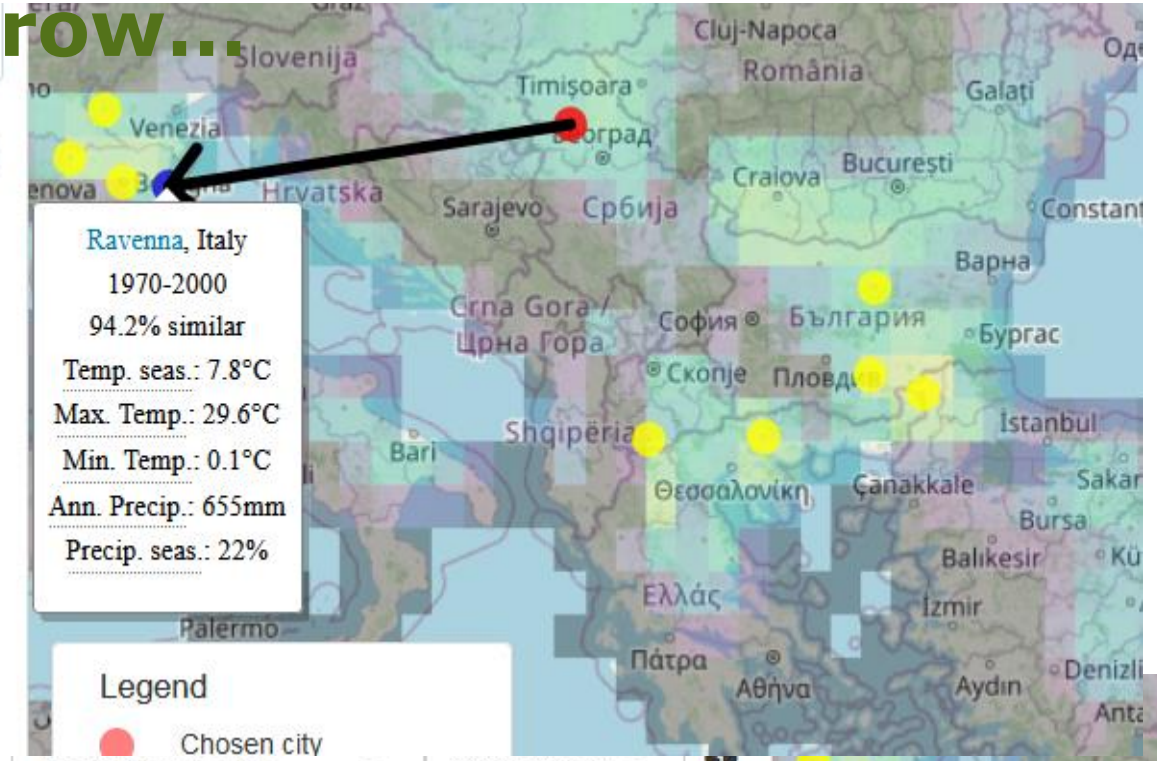
Novi-SAD tomorrow...

Novi Sad, Serbia | 2021-2040

Novi Sad, Serbia

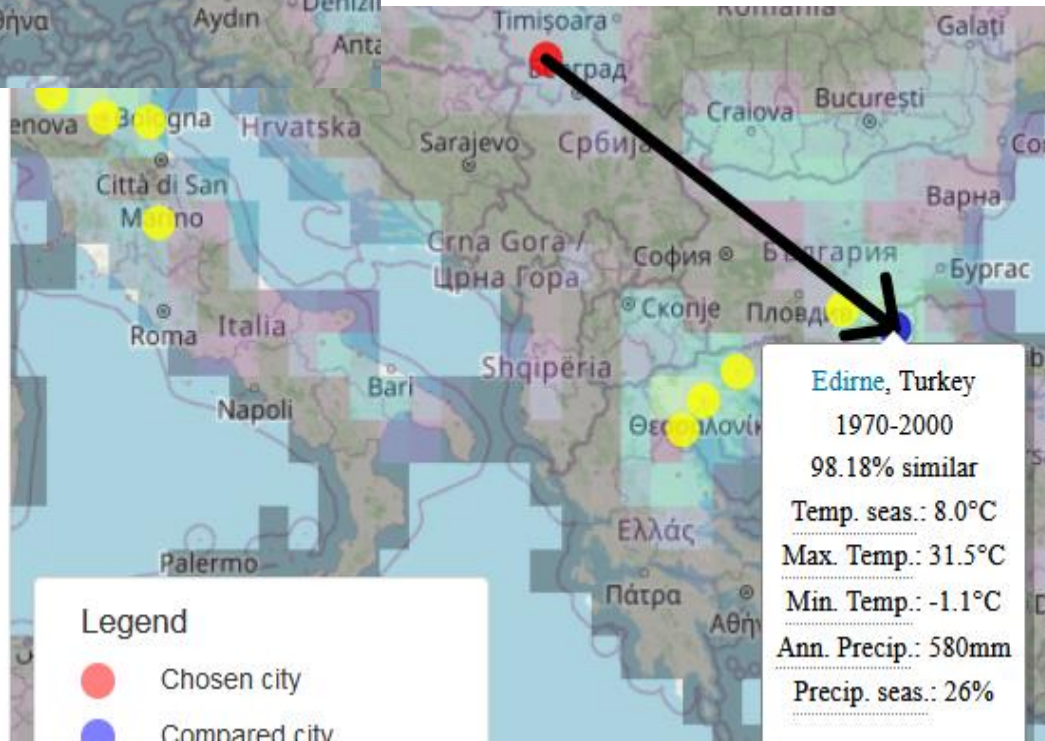
	1970 2000		2021 2040	Δ
Similarity (%)	78.4		100	
Temp. seas.(°C)	7.8	→	8 [7.7;8.2]	+2.6 %
Max. Temp. (°C)	27.1	→	30.2 [29.5;31.5]	+3.1
Min. Temp. (°C)	-3	→	-1 [-1.6;0.6]	+2.0
Ann. Precip. (mm)	610	→	625 [593;662]	+2.5 %
Precip. seas.(%)	29	→	29 [27;32]	+0.0 %



Novi Sad, Serbia | 2041-2060

Novi Sad, Serbia

	1970 2000		2041 2060	Δ
Similarity (%)	60.6		100	
Temp. seas.(°C)	7.8	→	8.1 [7.8;8.4]	+3.8 %
Max. Temp. (°C)	27.1	→	31.8 [30.5;33.7]	+4.7
Min. Temp. (°C)	-3	→	0.2 [-0.8;2.7]	+3.2
Ann. Precip. (mm)	610	→	626 [581;689]	+2.6 %
Precip. seas.(%)	29	→	27 [24;29]	-6.9 %



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Wuyuan, China…

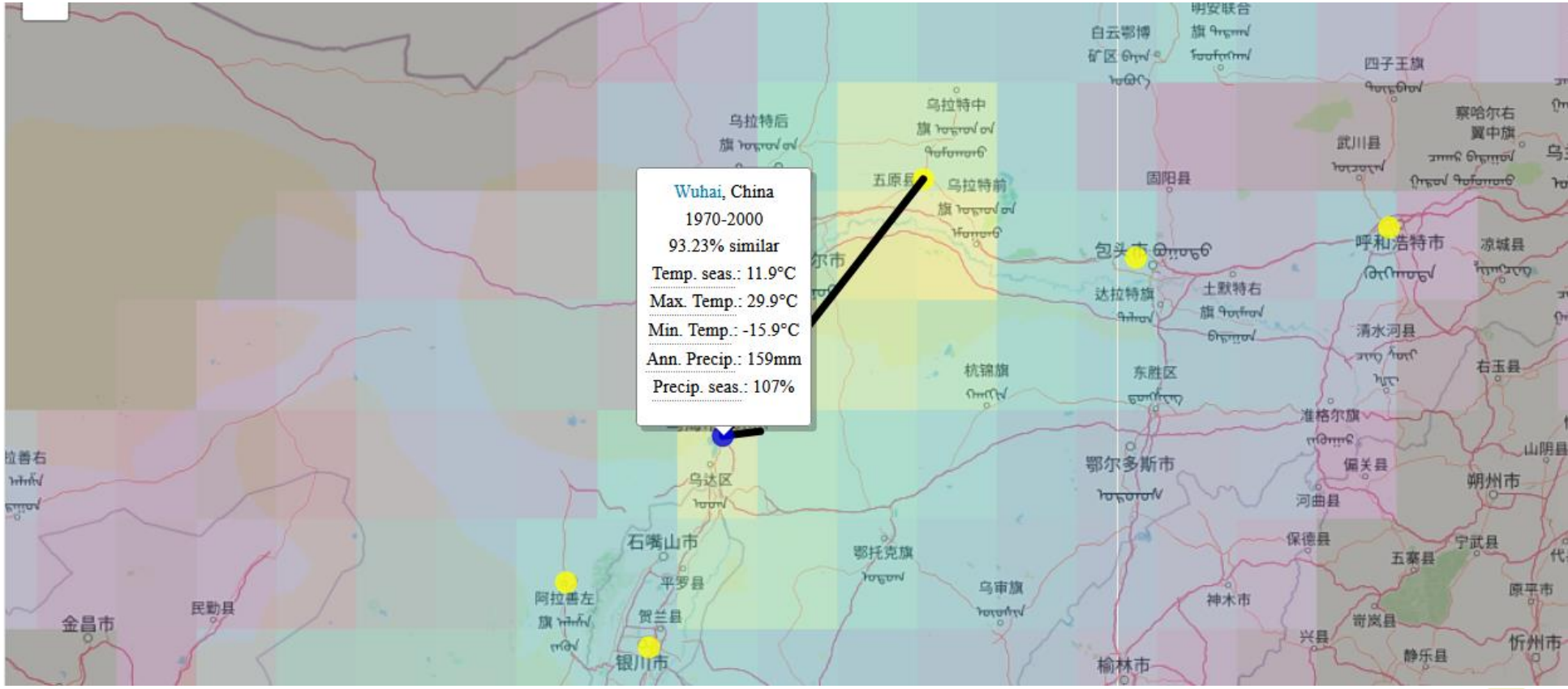
Display:
- Simple
- Detailed

Wuyuan, China | 2021-2040

Wuyuan, China

	1970 2000	2021 2040	Δ
Similarity (%)	91.7	100	
Temp. seas.(°C)	12.4 →	12.4 [12.1;12.7]	+0.0 %
Max. Temp. (°C)	28.8 →	30.2 [29.6;30.8]	+1.4
Min. Temp. (°C)	-17.4 →	-15.4 [-16.1;-14.3]	+2.0
Ann. Precip. (mm)	184 →	197 [183;229]	+7.1 %
Precip. seas.(%)	108 →	110 [105;114]	+1.9 %

Evolution graph



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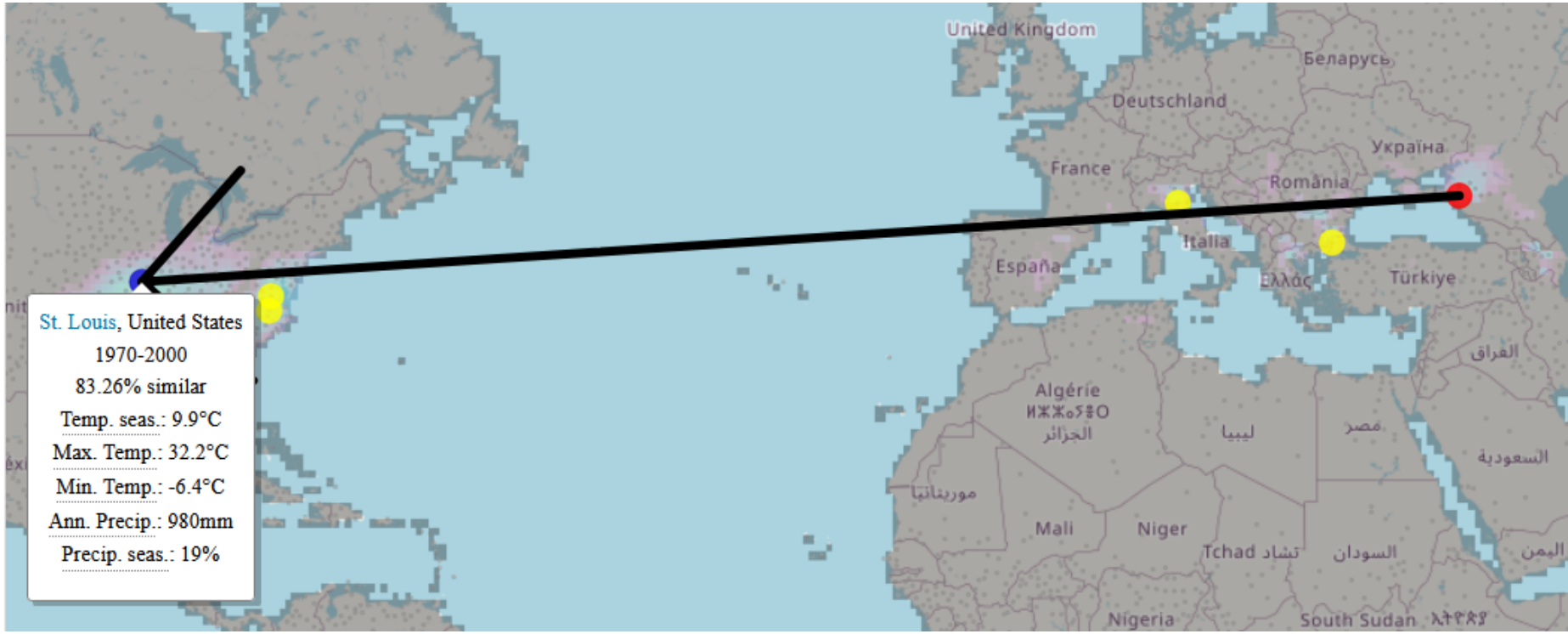
Krasnodar...

Krasnodar, Russia | 2021-2040

Krasnodar, Russia

	1970 2000		2021 2040	Δ
Similarity (%)	76.6		100	
Temp. seas.(°C)	8.8	→	9.1 [8.9;9.3]	+3.4 %
Max. Temp. (°C)	29.6	→	32.9 [32;34]	+3.3
Min. Temp. (°C)	-4	→	-2.5 [-3.2;-0.6]	+1.5
Ann. Precip. (mm)	740	→	749 [731;780]	+1.2 %
Precip. seas.(%)	17	→	19 [16;21]	+11.8 %

Evolution graph



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Zaporizhzhya, Ukraine | 2021-2040

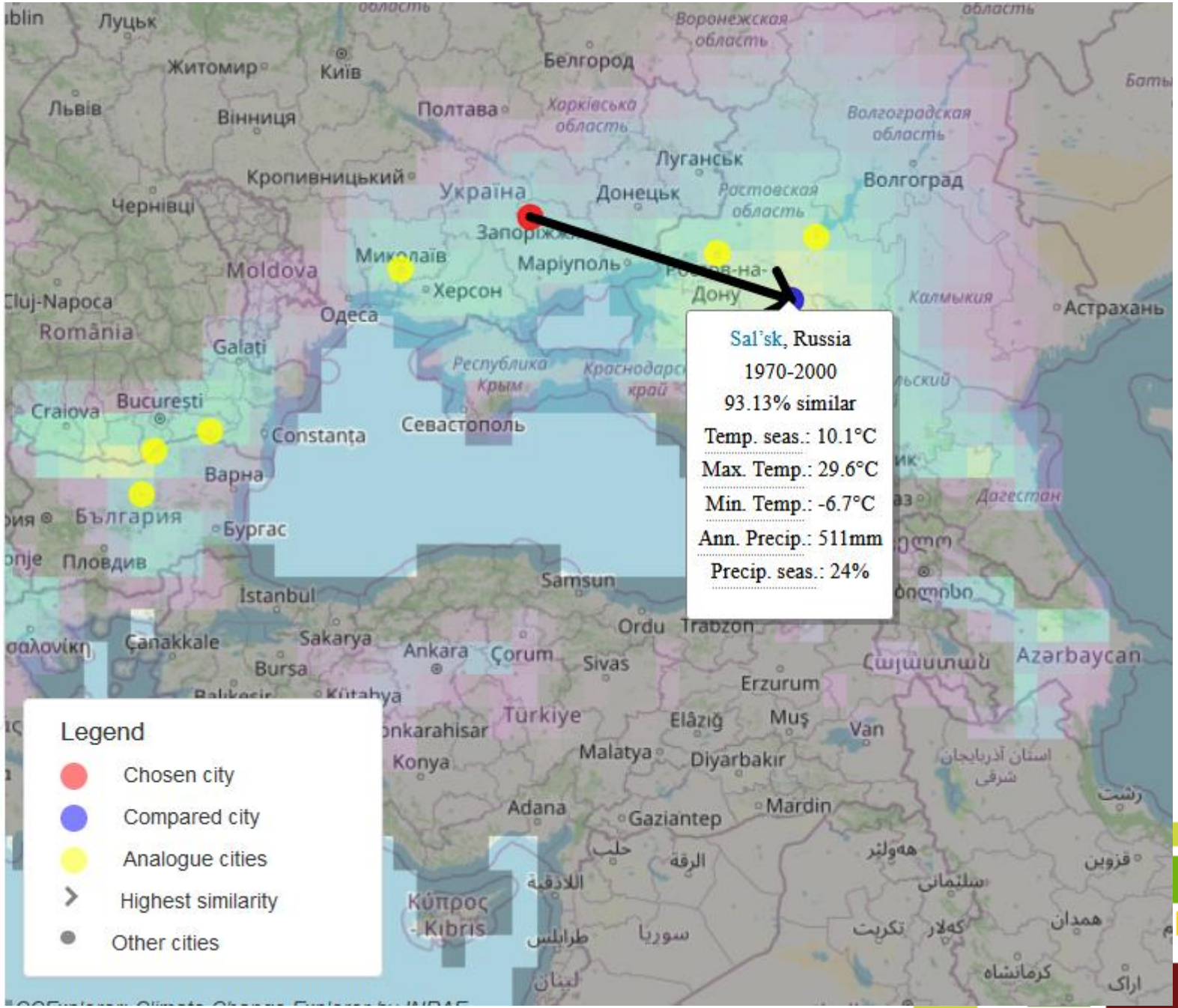
Zaporizhzhya, Ukraine

	1970 2000	2021 2040	Δ
Similarity (%)	74.4	100	
Temp. seas.(°C)	9.8	→ 9.8 [9.6;10.1]	+0.0 %
Max. Temp. (°C)	27.5	→ 30.9 [29.7;32]	+3.4
Min. Temp. (°C)	-7	→ -4.8 [-5.7;-2.8]	+2.2
Ann. Precip. (mm)	491	→ 499 [480;518]	+1.6 %
Precip. seas.(%)	21	→ 22 [19;24]	+4.8 %

Evolution graph

Climate variables used:

- [ ] Average annual temperature
- [x] Temperature seasonality
- [x] Average maximum temperature
- [x] Average minimum temperature
- [x] Annual precipitations
- [x] Precipitation seasonality



Climate change

- In Northern hemisphere, equivalent to a shift of 300 – 350km south by 2040-50; Extension to the North in Northern hemisphere
- Issue of water resource management and irrigation
- Effects of abiotic stresses (temperature, water) at key stages?
- Present/Future cultivars and positionning at global scale?
- Reinforced interest for international cooperation on abiotic stresses, for breeding and sharing genetic resources?

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Non traditional uses: biorefinery, biomaterials, proteins for food

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Non food uses in a biorefinery perspective

- Valorization of sunflower « residues » for better environmental performance: low cost, low energy, lighter, biodegradable, for comparable/ improved / optimized performances

stalks	**composite construction** materials	Avellaneda, A. et al. (2023).	Spain, France
stalks	wood-sunflower **particle boards**	Bekta P. et al 2023	Ukraine, Czechia, Slovakia
stalks / pith	**sound absorbing panels** based on sunflower pith	Gomez-Campos, A. 2023	France
stalks	straw based xerogels for thermal **insulation materials** in construction	Yang, Z.et al, 2023	China
stalks	**biofuels**: extraction of glucoses by enzymatic sacharification	Tang, Z., et al 2023	China
stalks	**bioethanol**	Taechawatchananont, N, 2022	Thailand
stalks	extracts for **corrosion inhibitors**	Lei, R et al 2024	China
stalks	production of **furfural**	Gong, L ezt al, 2022	China
husks	**composite materials** for lighter cars equipments	Irez A., 2024	Turkey
husks	advanced **biofuels**	Nieder-Heitmann, M et al , 2022	Netherlands
sunflowers heads	potential of **terpenoid**s in crop protection	Galisteo A. et al 2023	Spain
sunflower heads	**corrosion inhibitors**	Jingbao Wang et al ,	China
sunflower heads	extraction of **pectin** for medical use	Muñoz-Almagro, N, 2023	Spain
oil	Sunflower Oil-Based **Polyurethane Films**	Suthar, V., et al 2022	USA
oil	sunflower oil-based non-isocyanate polyurethane coatings	Maya Serna, M. D. P. (2022).	Columbia
oil	**resins**	Uduma, C. Et al, 2022	Nigeria
leaves, hulls, cakes	**biomethane** production without pretreatment	Ebrahimian, E et al 2022	Iran
stem and capitulum	biomethane production more effective with chem pretreatment		
sunflower meals	biodegradable **films for foodpackaging** from protein isolates and bacte	Efthymiou, MN et al ; 2022	Greece

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Sunflower proteins for food

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Plant sourcing main protein contributors

Plant origin	Production	Proteins
FAO 2017 Million metric Tons		
Cereals		
Corn	1043	92
wheat	750	73
rice	503	40
oil seeds		
Soy	366	122
Rape Seed / canola	71	16
Sunflower	51	10
Pulses		
pea	11	2
chick pea	15	3
faba bean	3	1
lupine	1	0,4
TOTAL	**2814**	**359,4**

- Despite low protein content, cereals are the main players (>40%)
- Oil seed thanks to soy are number 2
- Despite high protein content, pulses are far behind

Source: Improve SAS

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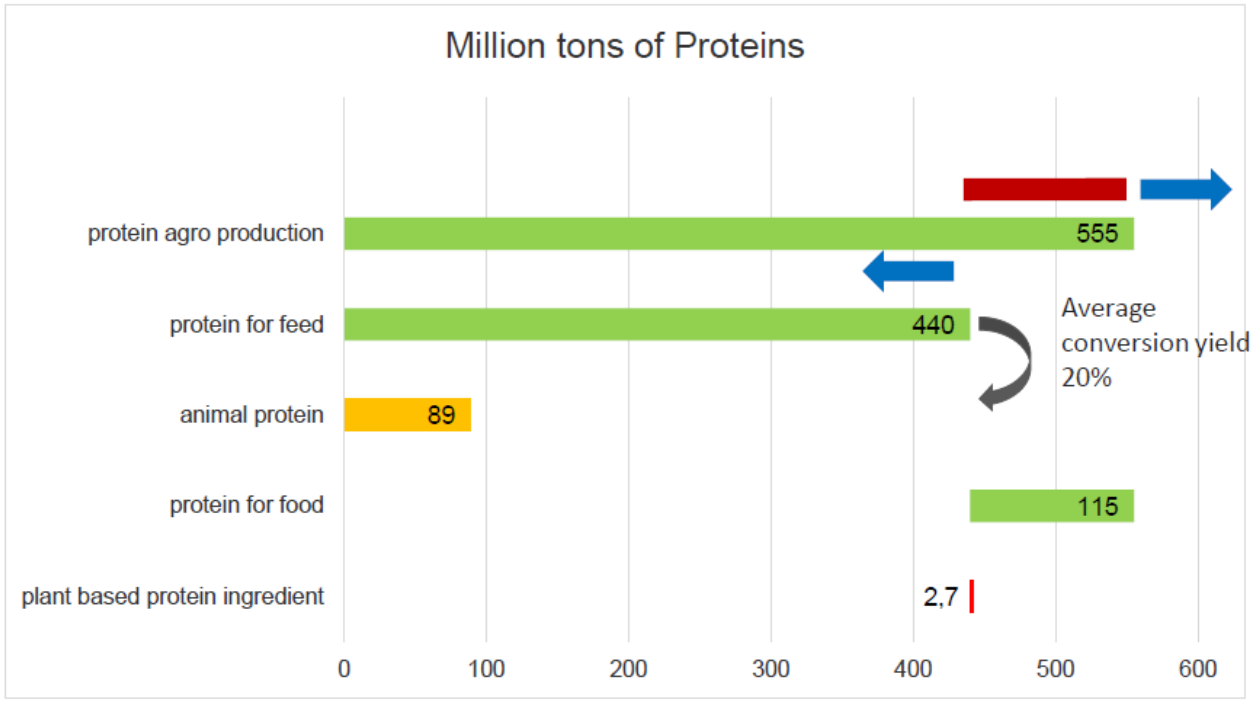
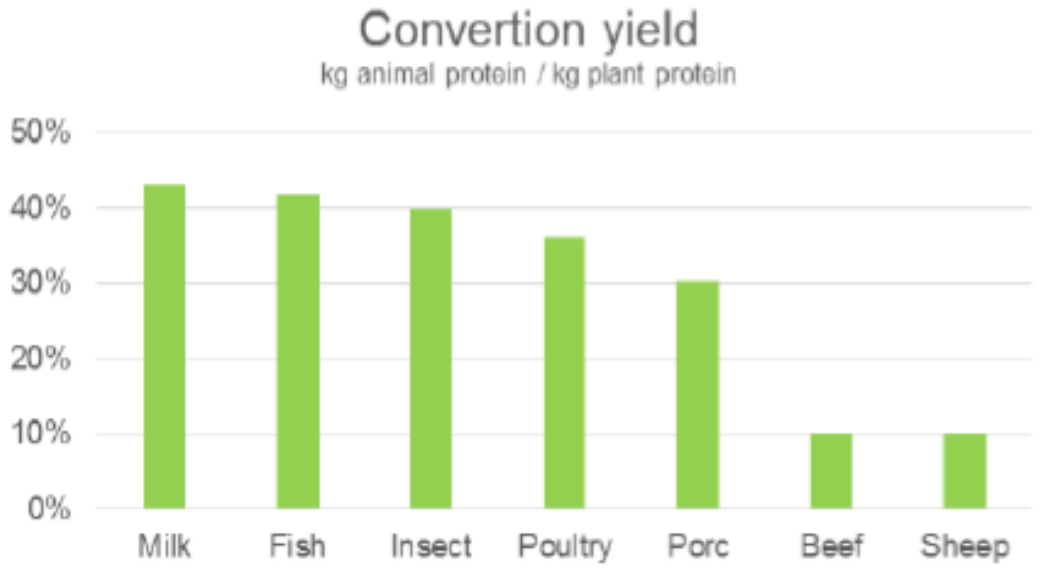
What about protein ingredients

World proteins balance: from 10 billion tons of Agromaterials





Plant based protein ingredients will not save the world ☹
They will just make our occidental life's simpler ☺

Proteins for Food today, global scale:
115 MT from vegetable proteins (55%)
89 MT from animal proteins (43%)
3 MT from plant based protein ingredients
Total: 207 MT

Source: Improve SAS

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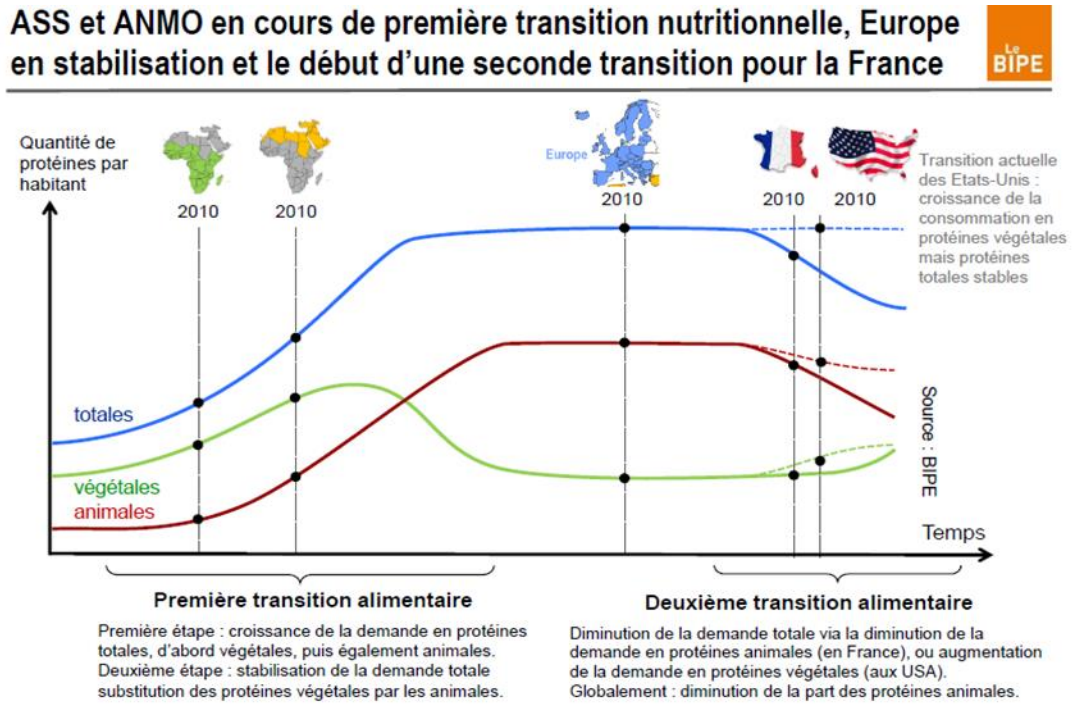
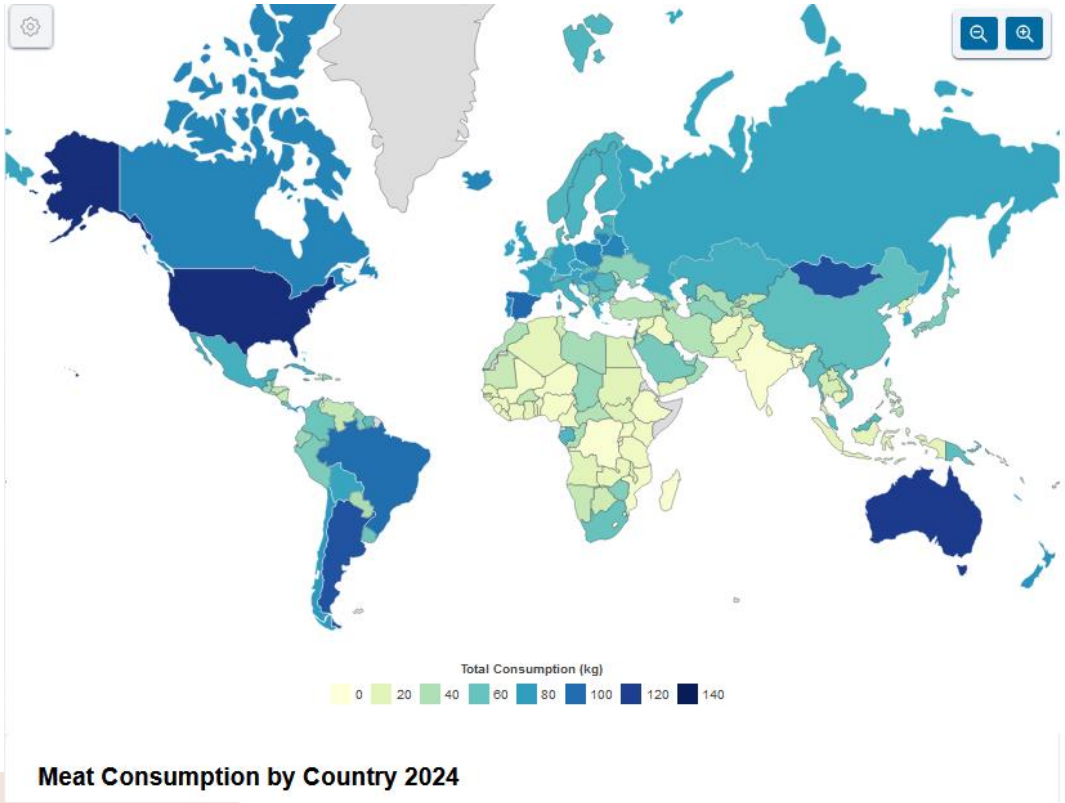
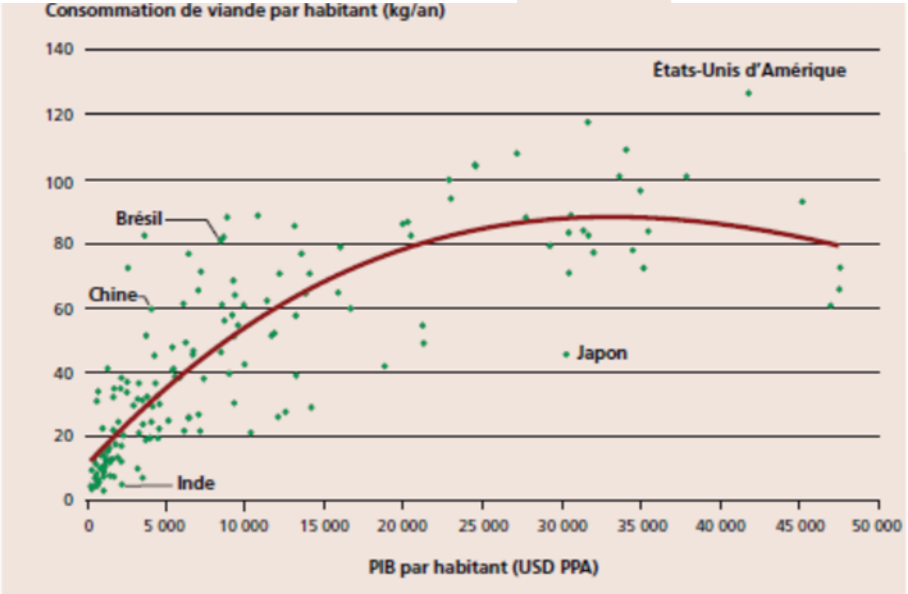
Food transitions?





Meat Consumption by Country 2024



https://worldpopulationreview.com/country-rankings/meat-consumption-by-country

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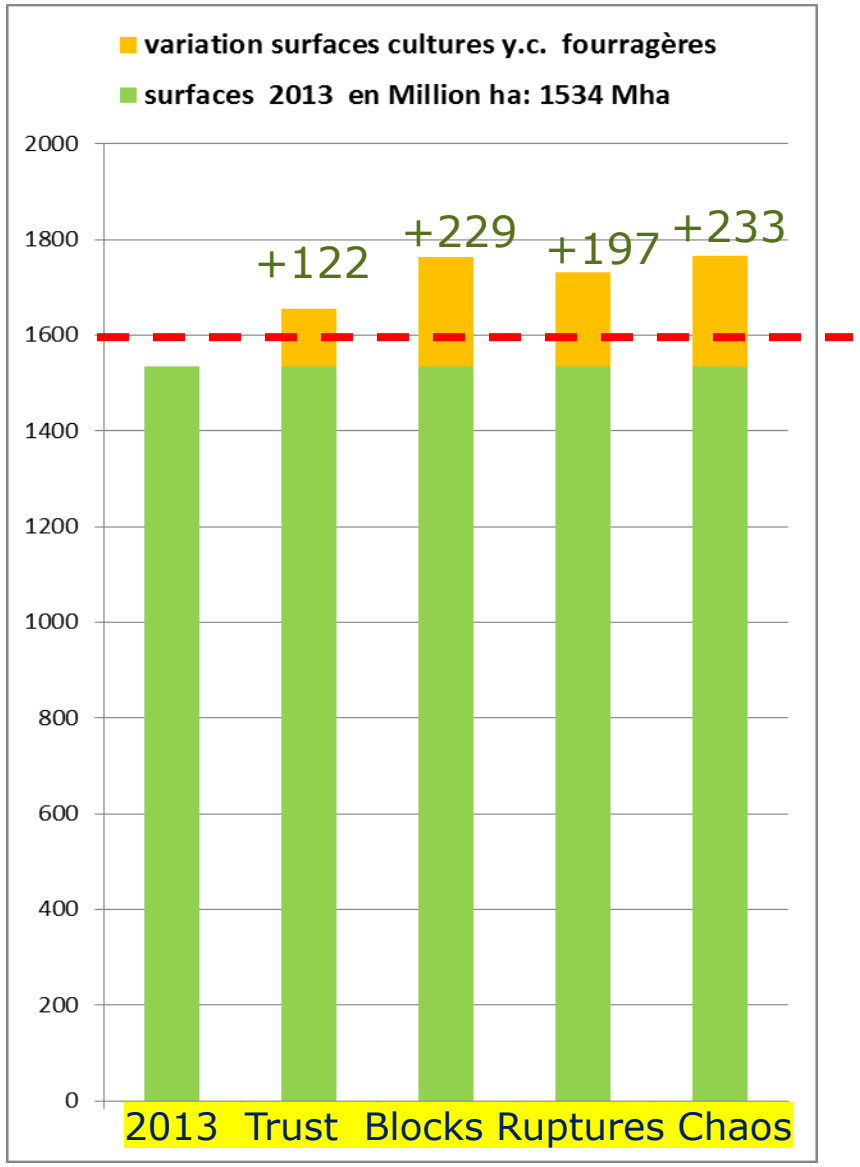
Could production follow global demand in sustainable conditions?



- Going on with land reclamation at the same pace as on 1961-2000 period (3.75Mha/yr in average) would allow to gain 67.5 Mha d'ici 2030.
- It would need to increase the pace of land reclamation 1,7 to 3,5 times
- → what development dynamics? How far is it compatible with climate change mitigation?
- →food challenge much more difficult for proteins than for oil…

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What potential levers?

Calculating in million ha cultivated

- **population effect** ranging by 100 Mha.
- **Human diets (partial substitution of vegetable proteins to animal proteins) :** from 180 to 300 Mha
- **Reduction of upsteam losses** : 50 to 100 Mha.
- **Growth of yields** : determining, but probably not enough to meet demand from population growth and increase in individual consumption
- Reduction of downstream waste ?
- Other levers?

- **Need to consider transitions in nutrition and agricultural practices**

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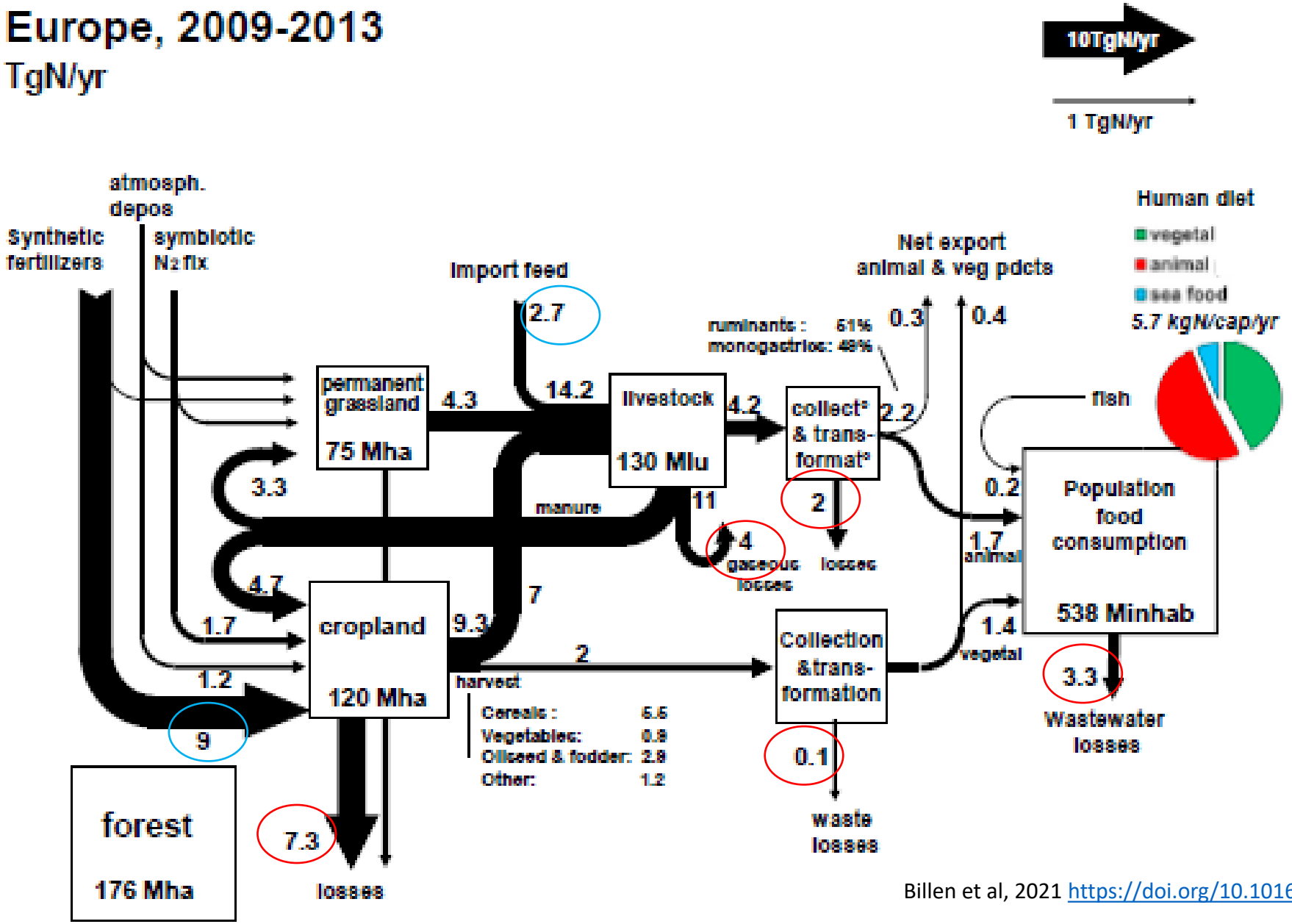
The nitrogen issue (proteins = nitrogen)



1/ Leaking system
Total losses: 16,7 MT N

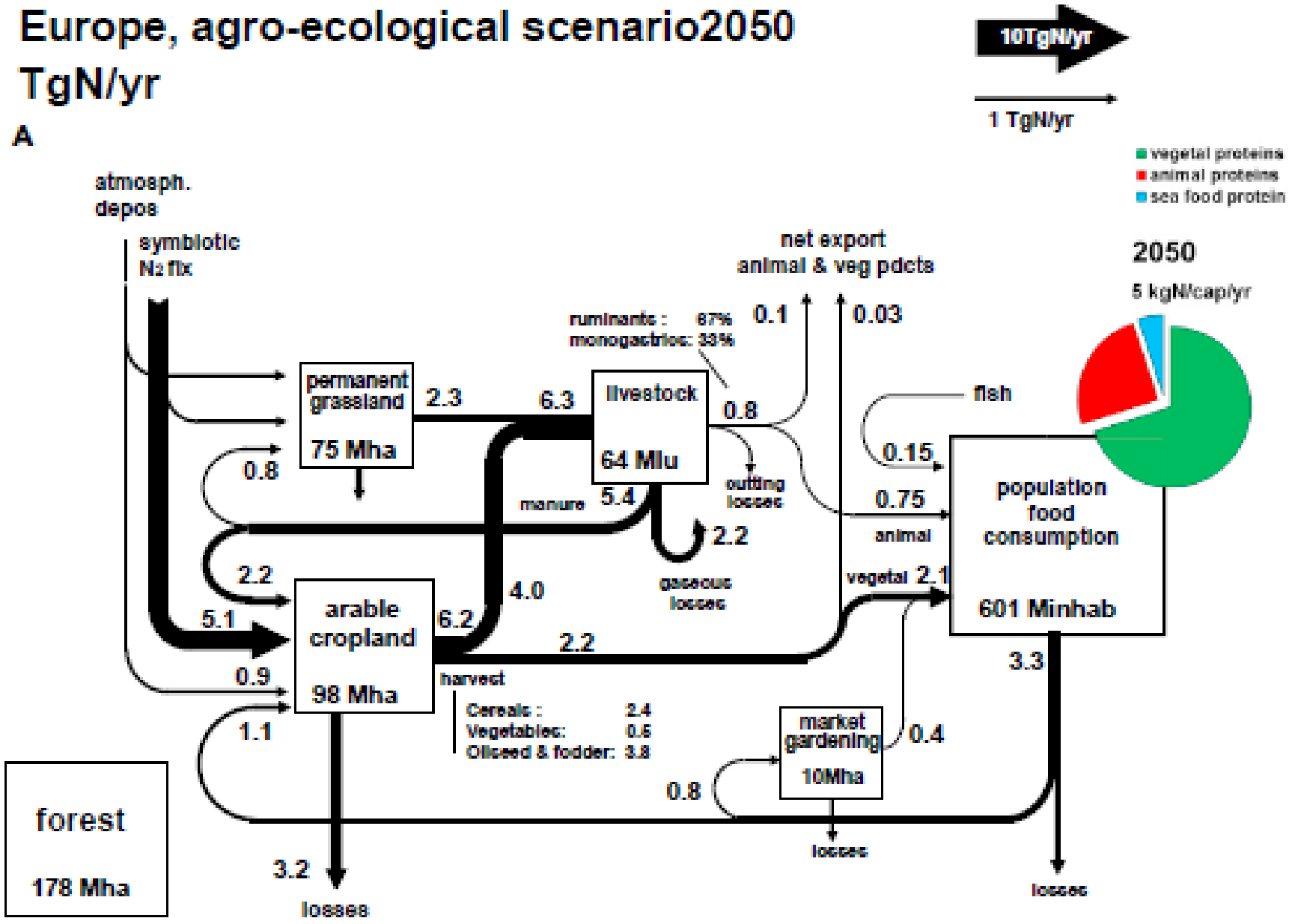
2/ Europe pays twice:
For fertilizer and for feed proteins

3/ even 3 times if including pollution costs

Billen et al, 2021 https://doi.org/10.1016/j.oneear.2021.05.008

The nitrogen issue

Billen et al, 2021 https://doi.org/10.1016/j.oneear.2021.05.008



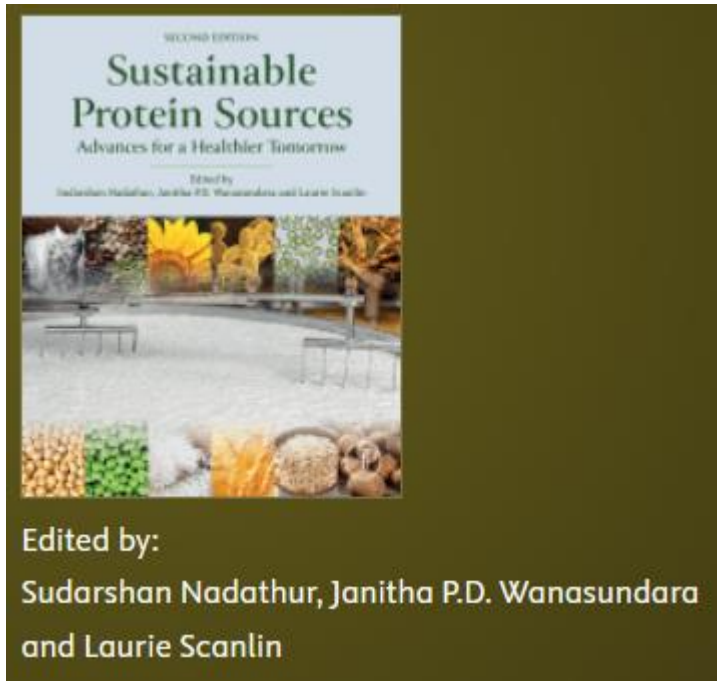
A strategic objective would be for Europe to feed itself (with a balanced import-export balance, measured in calories and proteins).

Not simple but not impossible.

Needs a shift from 5,7 kgN/cap/year to 5: -14% AND a shift from 50% animal proteins to approx. 25% of diet

Sunflower proteins for food?

- Albe-Slabi, S., & Kapel, R. (2024). Sunflower as a Developing Plant Protein Source for Food. In Sustainable Protein Sources (book chapter pp. 357-380). Academic Press. https://doi.org/10.1016/B978-0-323-91652-3.00019-8



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Technical solutions for sunflower protein products?

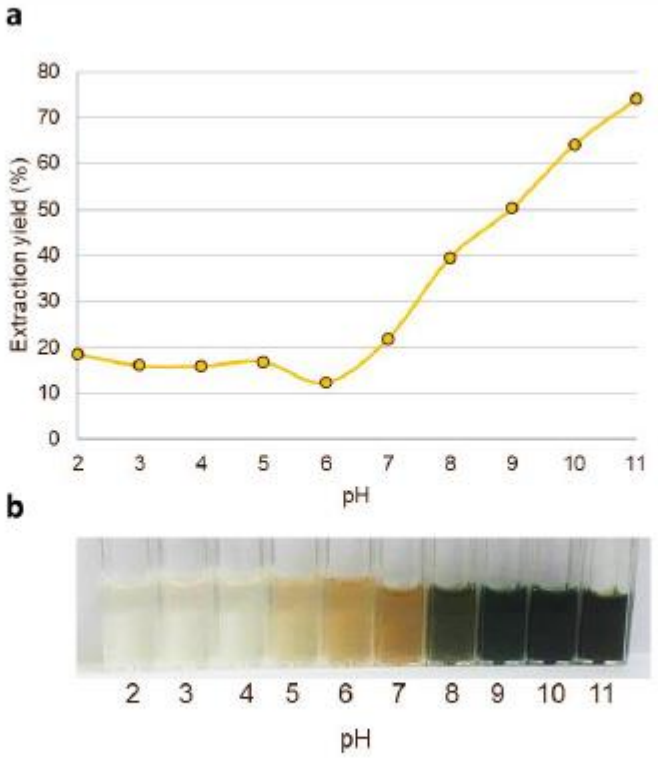

Figure 2. Extraction yield of total sunflower proteins depending on pH (**a**) and the color of resulting protein extracts (**b**) (unpublished data of Albe-Slabi *et al.*).

- Direct use of kernels
- Flours (50-60% Pi),
- Concentrates (60-90% Pi),
- Isolates (>90%Pi)
- Higher extraction rates at high pH, but phenolic compounds are co-extracted and oxydized in alkaline environment → conventional process not efficient for sun proteins

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Proteins in sunflower kernel

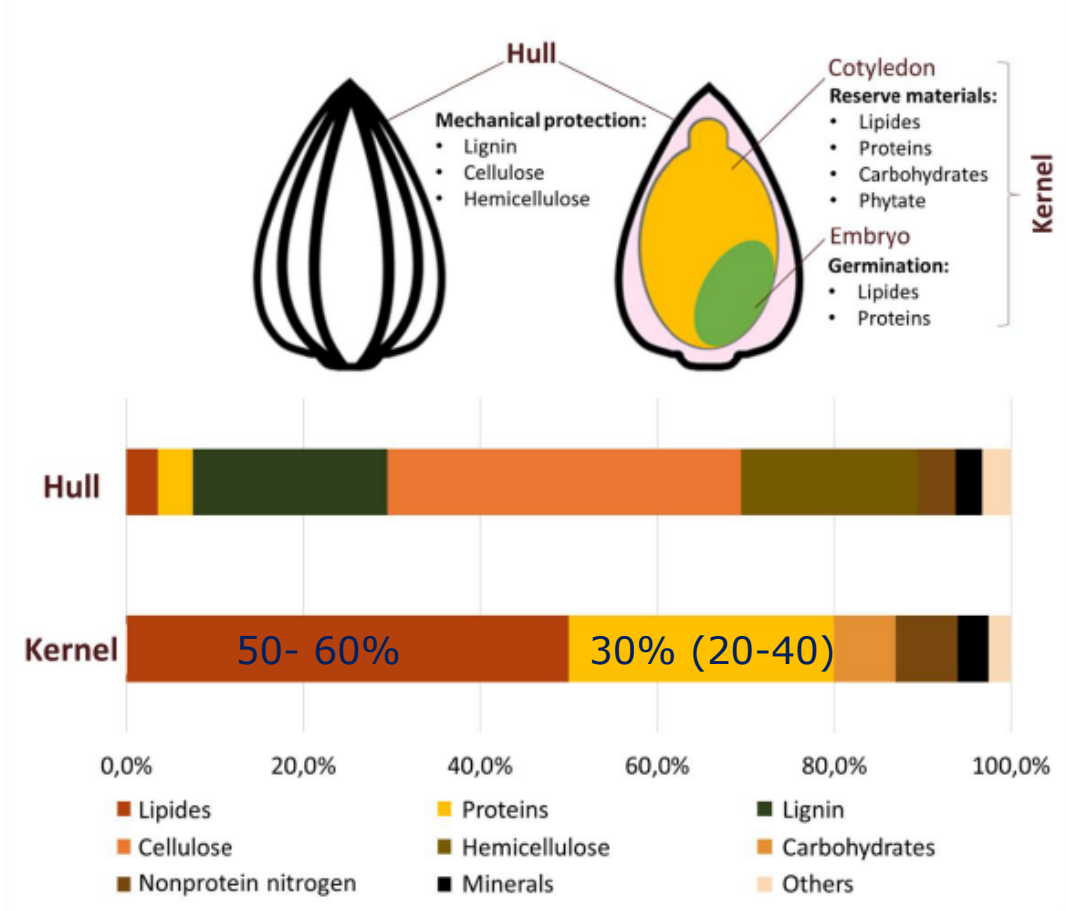

Figure 1. Chemical composition of sunflower hull and kernel according to the average values of Bau *et al.*, (1983); Tranchino *et al.*, (1983); Cancalon (1971); Evon *et al.*, (2007); Braadbaart *et al.*, (2007); Gonzalez-Perez & Vereijken (2007).

In kernels:
50 to 60% globulins
20 to 30% albumins
5% Prolamins
10% Glutelins

+ oleosins (2 to 8%) & lipid transfer proteins

Also in kernel:
- phospholipis/glycolipids: <4%DM
- Peptids/ AA! About 6%
- Carbohydrates: 4 to 10% DM
- *Phenolic compounds* : 1.1 to 4,5%
- Othe minor compounds: tocopherols, carotenoids, vit B1…

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Albe-Slabi, S., & Kapel, R. (2024).

Sunflower protein nutritional properties

- Total proteins: the chemical indices of sunflower proteins for amino-acids are high, except for lysine (70M% of the FAO reference composition)
- But very rich in sulfur-containing a.a methionin + cystein (464%) which make them complementary to other vegetable proteins sources such as pulses.
- The in vitro digestibility is relatively high (90%), but the invivo digestibilty is limited by lysine content
- Albumins: relatively low in leucine. Probably lower digestibility than globulins (helianthinins)
- The digestibility depends mainly of the purity of the protein product → need to consider the antinutritional factors, notably phytic acid

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Sunflower protein functional properties

- Globulins: U-shape curve of solubility/pH (insoluble at pH 4-5, 100% sol at pH8,5)
- Albumins: excellent solubility whatever the pH, high heat resistance, some have excellent emulsifying properties.
- Total Sunflower proteins:
  - reasonable foaming properties, but low stability
  - Good emulsion capacity and stability in reference to soy
  - Properties depend on non protein compounds, pH, T°…
- Few references about gelling

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Antinutritonal compounds

- **Phenolic compounds:**
  - protection of seeds against oxydative stress
  - Can reach 4-5% of DM in cakes
  - →70% chlorogenic acid
  - Important ability to bind with sunflower proteins
  - that colors the protein extract (green, brownish…) limiting the applications in food
  - Destabilizes the II and III structure of proteins and may contribute to decrease solubility, limit nutritional and impact organoleptic properties, despite beneficial antioxydant properies
- **Phytic acid:**
  - Main reserve of phosphorus in seeds
  - 1 to 5%DM phytic acid in sunflower cakes
  - Leads to a decrease of sunflower protein digestibility, reducing solubility of action of enzymes

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Technical solutions for sunflower protein products?

- Meal washing with solvents before alkaline extraction: quite effective but needs food grade solvents
- Micro-wave assisted extraction: still needs research
- Inhibition of phenol-protein binding during protein alkaline extraction by addition of a reducing agent (sulfites): not yet applied in industry. Decrease in P solubility?
- Extraction under flow of inert gas (at lab scale)
- Optimization between extraction rate of Pi and of C acid, at pH6-8 with addition of salt… Seems promising and also allows the elimination of a part of phytic acid. → up to 80% Pi

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Sunflower proteins

- Technical solutions under research to lift limitations to Sun Pi products development
- Challenging since the criteria of process performance and protein quality are antagonistic
- Additional efforts needed to develop appropriate food formulations with Sun Pi
- Some sunflower protein concentrates products are alrealdy available on the market, obtained from soft mechanical cold pressing of dehulled kernels

https://www.all-organic-treasures.com/

Sunbloom 60
https://www.sunbloom.de/en/products/

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Conclusions 1

- **Sunflower still growing in acreage and production, keeping on the oil and protein crops sector.**
- **But large concentration in Black sea region**
- **Climate change challenge: critical horizon might come sooner than expected in traditional regions**
  - **Breeding** for physiological tolerance traits and inputs efficiency
  - **Adapting cropping practices** in traditional regions, sustainability
  - Conquering of **new cropping regions**: TK knowledge dissemination, cultivars
  - Inter-regional **cooperation**?

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Conclusions 2

- **Climate change challenge: Growing pressure on proteins and oils for non-food uses.**
  - At global level, it is **not possible to prolong all the trends** at the same time: readjustments of agro-food systems in 15-20 years' time, within a limit of 50-60Mha of new land. **The transformation of food systems will need** societal changes and policies with quantitative and qualitative impact on food demand.
- **role of sunflower in an economy of scarcity**
  - **Maintain production and quality with less** inputs: nitrogen, water
  - Valorize **sunflower proteins for food→ dehusking techniques, soft oil extraction, protein separation, increase protein content in seeds…**
  - **Biorefinery and uses of crop "residues"**: biomaterials, composites, biofuels… to replace fossil chemistry components, save other natural resources like wood…

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Thanks for your attention

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