

Dipartimento di Scienze e Tecnologie Agro-alimentari

Università di Bologna

SUSTAINABLE AGRICULTURE

Giovanni Dinelli

La Bergerie De Villarceux (FR), 25-07-2019





What about sustainability?

What we know about our foodstuff?

How our foodstuff is produced?

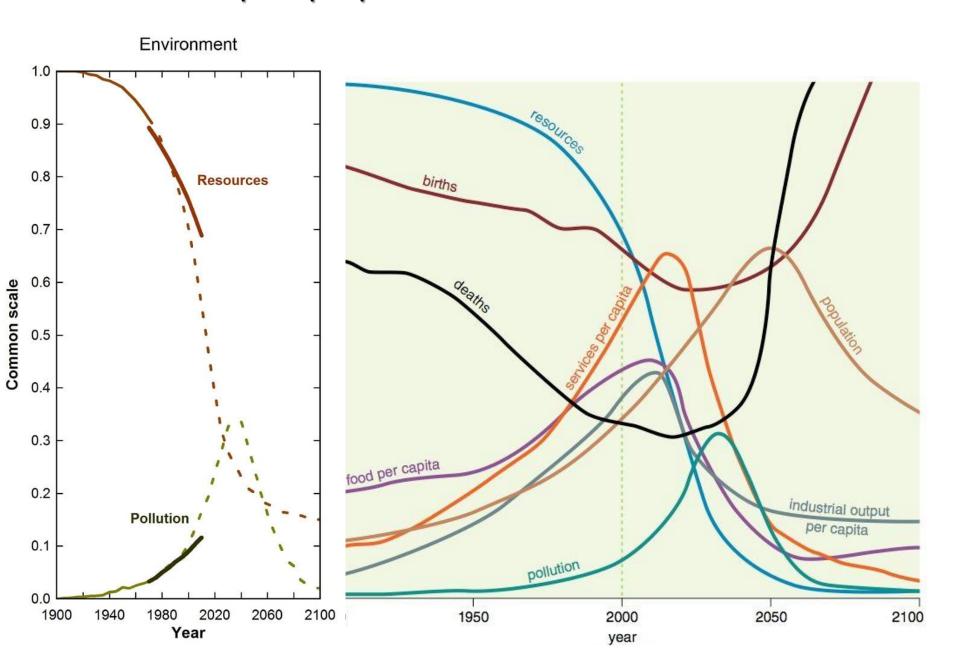
WHAT ALTERNATIVES ???

CULTIVATING health

CONCLUSIONS???

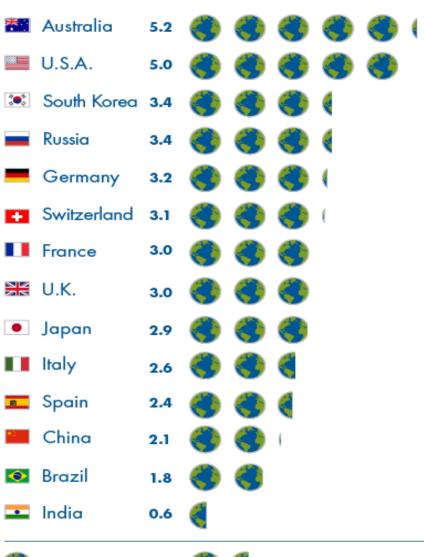
What about sustainability?

Catastrophic prophecies or realistic forecasts?



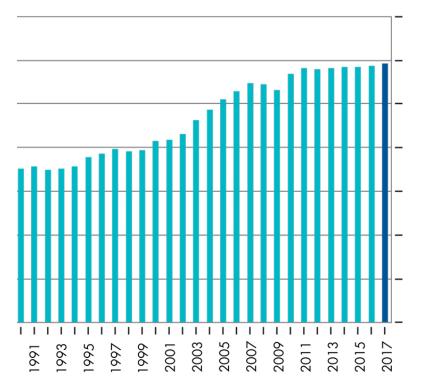
How many Earths do we need

if the world's population lived like...



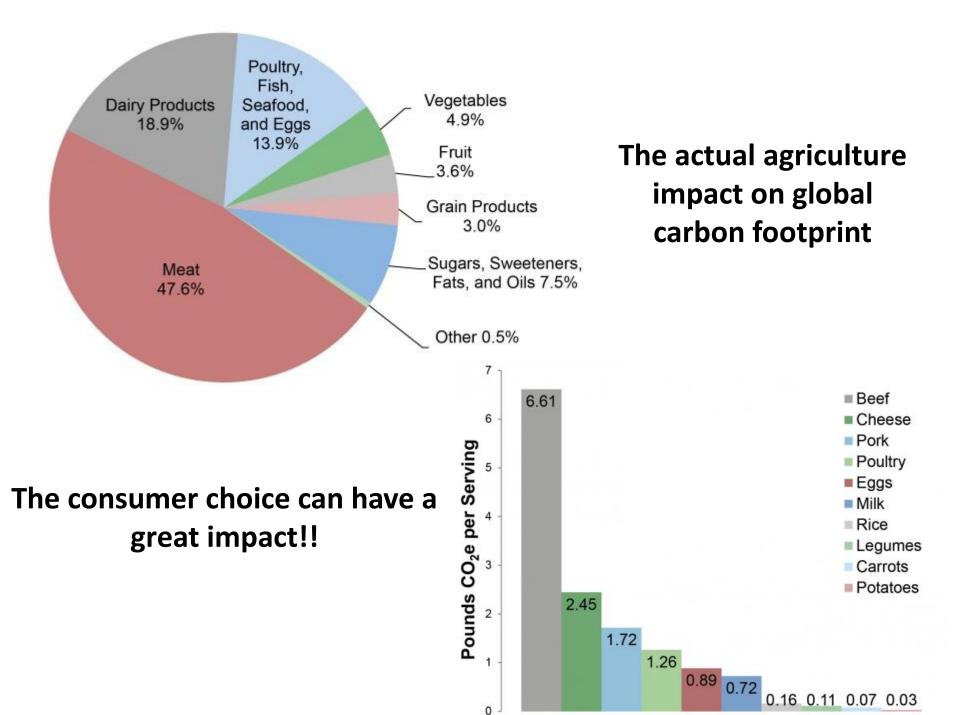
Overshoot Day 769-2017





stwork National Footprint Accounts 2017

ogical DebtDay (EDD), indicates on an ely consumes the resources produced by the

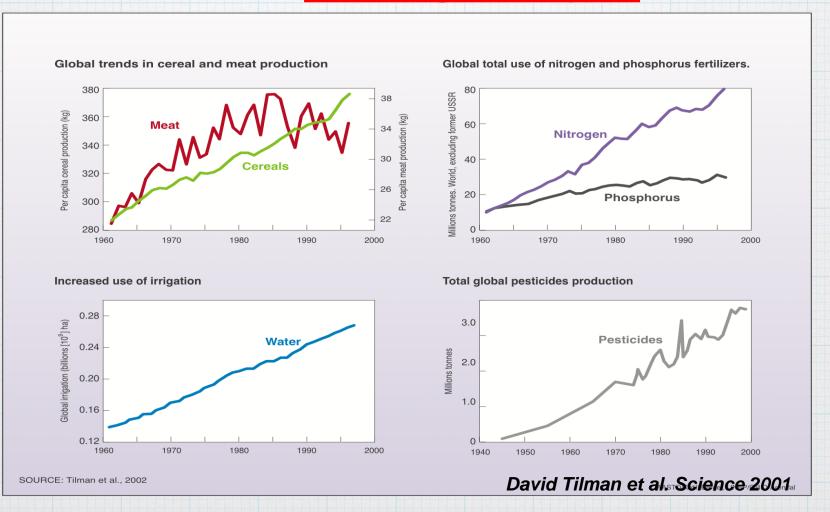


ACTUALLY TO PRODUCE, TRANSFORM, TRANSPORT AND CONSUME 1 CALORIE OF FOOD, ON AVERAGE IN THE WORLD 7.3 CALORIES OF ENERGY ARE CONSUMED



SUSTAINABILITY

- The actual agricultural inputs (nitrogen, phosphate, irrigation water and pesticides) are not sustainable !!!
- For feeding the wolrd (9 bilion of peolple in 2040) can we increase again the inputs?



Industrial agriculture works ... but at what cost ??

How many people could feed the current agricultural production ??



<u>Eric Holt Gimenez</u>

<u>"Food Rebellions: Crisis and the Hunger for Justice"</u>

The calculation: considering the world production of foodstuffs, the main classes of food were multiplied by their caloric intake, obtaining the annual world production of "food calories". This value was divided by 2000 kcal (the daily calories that humans should introduce with the diet), thus obtaining the number of people that could be fed by the current production.

The result: about 10 billions of people!!!

With a 50% reduction of the meat consumption:

about 14 billions of people

Too much and too little



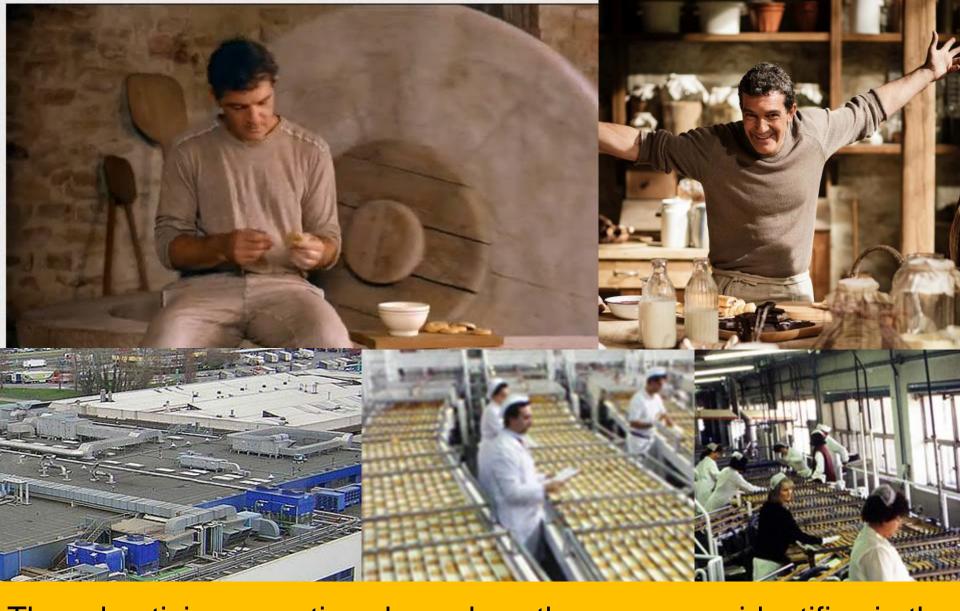
1.5 billion overweight,500 million obese

Hunger and malnutrition: one case of extreme diversity



842 million extremely undernourished, 165 million children stunted, 1.2 billion malnourished





The advertising narrative shows how the consumer identifies in the ancient the "good" and in modernity the "bad": advertising tells or always tries to tell what the consumer wants!!

The importance of what we eat and how we eat it

The Mediterranean diet





The key elements of the Mediterranean diet

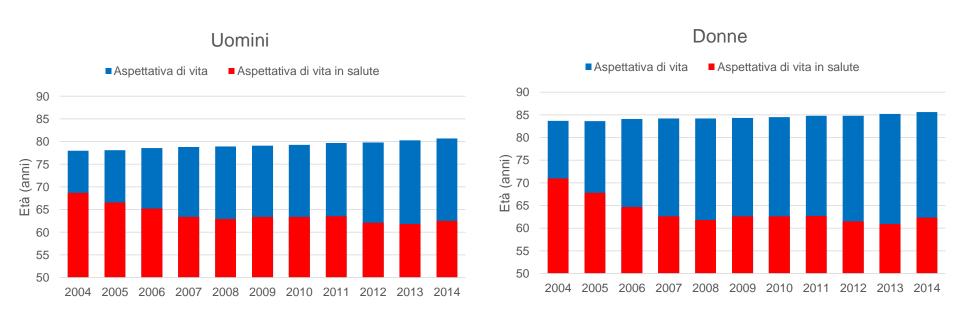


Life expectation (Italy)

80,6 years M 85,1 years F

(source ISTAT 2017)

We live more and more, but not healthy



EUROSTAT data show a clear trend for most of Europe (and especially for Italy): life expectancy is rising, but healthy life expectancy is falling.

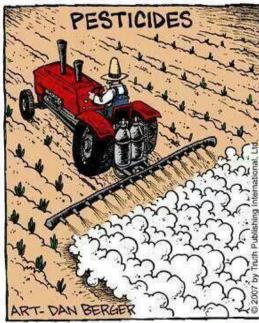
How our foodstuff is produced?



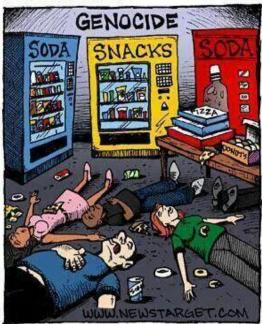
COUNTERTHINK

"THE MANY CIDES OF MODERN FOOD PRODUCTION"











April 2019: Brennero Highway





In 2018, world agricultural production used over 200 million tons of synthetic fertilizers (with an increase of 2.5% compared to 2017) and over 3 million tons of pesticides (with an increase of about 1% compared to the 2017) (source FAO 2018).

The large use of CHEMICALS induces several type of problems!!!!

Chemical agriculture

Environmental contamination

Farmer Exposure

Consumer exposure

Other indirect side effects

The health of the environment

Italy (2014): **130,000 tons** of plant protection products (about **2.1 kg / inhabitant per year** !!). National average sales per hectare (2014): **4.6** kg / ha Average **Emilia-Romagn**a sales per hectare (2014): **7.6 kg / hectare**

Use of pesticides in the region: from 9-10 kg / ha in the early 2000s to the current 7-7.2 kg / ha.



Superamento SQA - acque superficiali Superamento SQA - acque sotterranee ■ % punti di monitoraggio % punti di monitoraggio AMPA (184:385) ATRAZINA DES DESIS * (42:139) GLIFOSATE (112:458) Surface water: :361) METOLACLOR-ESA (8:50) :355) QUINCLORAC (12:118) **AMPA** 1763) METOLACLOR (80:1036) :706) **GLIFOSATE** ESACLOROCICLOESANO (9:316) :456) ESACLOROBENZENE (15:721) 1356) DIMETOMORF (10:486) :751) METALAXIL (14:852) **Deep water:** OXADIAZON (14:970) 1808) BOSCALID (11:766) ATRAZINA DES. DESIS. :677) TRIFLURALIN (14:1111) 2248) **GLIFOSATE** AZOSSISTROBINA (8:650) 2315) CLORPIRIFOS (15:1419) 1397) **AMPA** PIRIMETANIL (6:570) :711) MALATION (5:920) 2398) CLORIDAZON (3:672) TERBUTILAZINA-DESETIL (13:2261) ATRAZINA (10:2488) TERBUTILAZINA+metabolita (5:1209) 10% 20% 30% 40%

Source: "Rapporto nazionale pesticidi nelle acque, 2015-2016", Ispra, 2018, pag. 33

The most detected active ingredient found over the environmental standard quality



In 2018, world agricultural production used over <u>200 million</u> tons of synthetic fertilizers (with an increase of 2.5% compared to 2017) and over <u>2 million tons of pesticides</u> (with an increase of about 1% compared to the 2017) (source FAO 2018).

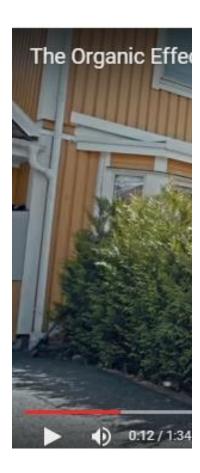
From 2012 in France Parkinson's disease is recognized as an occupational disease in agriculture by the Ministry of Health

The French High Commission for Occupational Diseases in Agriculture recognizes the link between some malignant blood cancers and the use of pesticides: the inclusion of these pathologies among occupational diseases is being considered

In Italy, INAIL (National Accident Insurance Institute) has recorded a significant increase in occupational diseases in the agricultural sector, without indicating precisely which type of disease is affecting farmers. The fact remains that in 2014, complaints of occupational diseases were 11,131, almost double compared to 2010 (6,392) and incomplete data for 2016 already exceed 12,500, the highest values ever recorded in agriculture in 40 years of survey. In 2011, 7,500 cases of cancer related to work in the agricultural sector were reported, up from 5,700 cases a year earlier and 3,500 in 2007.



NR U 5080 | JANUARY 2015 | REPORT



Human exposure to pesticides from food

A pilot study

For Coop Sverige AB

Jörgen Magnér, Petra Wallberg, Jasmin Sandberg, Anna Palm Cousins

















Experts estimate that
every year with
CONVENTIONAL foodstuff
roughly we introduce
from

1 to 5 Kg OF NON-FOOD

Of which about 20-30% of <u>PESTICIDES</u>

And the remaining 70-80% of ADDITIVES



In ORGANIC FOOD, PESTICIDES are forbidden as most of the synthetic ADDITIVES (the most dangerous!!)

Association of Frequency of Organic Food Consumption With Cancer Risk

Findings From the NutriNet-Santé Prospective Cohort Study

Julia Baudry, PhD¹; Karen E. Assmann, PhD¹; Mathilde Touvier, PhD¹; et al

Author Affiliations

JAMA Intern Med. Published online October 22, 2018. doi:10.1001/jamainternmed.2018.4357

Key Points

Question What is the association between an organic food-based diet (ie, a diet less likely to contain pesticide residues) and cancer risk?

Findings In a population-based cohort study of 68 946 French adults, a significant reduction in the risk of cancer was observed among high consumers of organic food.

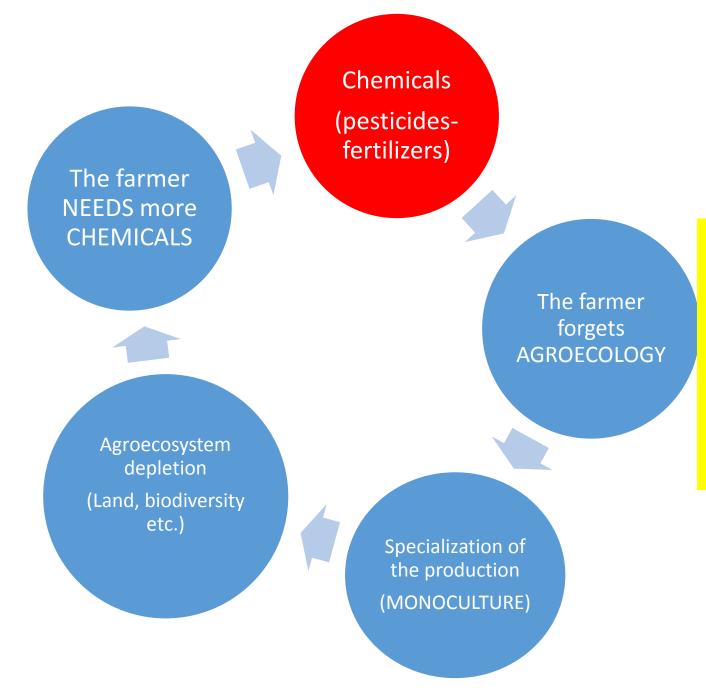
Meaning A higher frequency of organic food consumption was associated with a reduced risk of cancer; if the findings are confirmed, promoting organic food consumption in the general population could be a promising preventive strategy against cancer.

JAMA Internal Medicine | Original Investigation

Association of Frequency of Organic Food Consumption With Cancer Risk Findings From the NutriNet-Santé Prospective Cohort Study

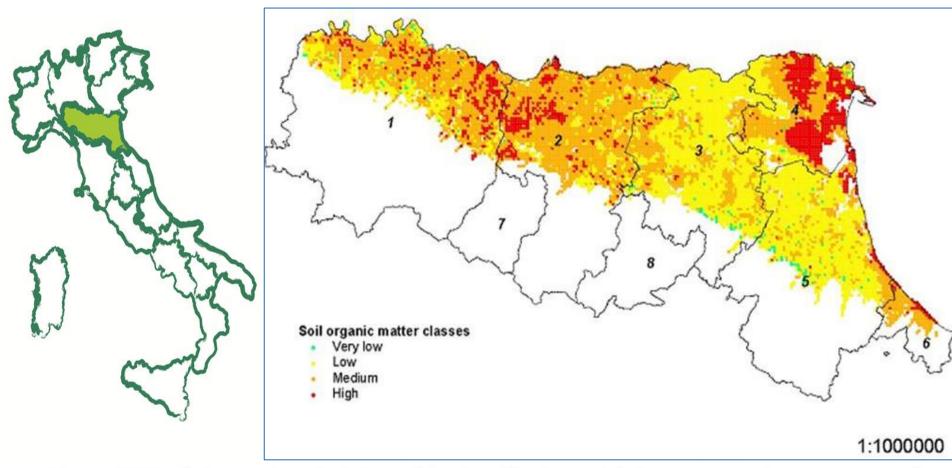
Julia Baudry, PhD; Karen E. Assmann, PhD; Mathilde Touvier, PhD; Benjamin Allès, PhD; Louise Seconda, MSc; Paule Latino-Martel, PhD; Khaled Ezzedine, MD, PhD; Pilar Galan, MD, PhD; Serge Hercberg, MD, PhD; Denis Lairon, PhD; Emmanuelle Kesse-Guyot, PhD

Table 4. Multivariable Associa		_		_	Quartiles)				
and Overa Only C	Only Consumers of			Analyses, NutriNet-S Only consumers of			t		
CONVENT	ORGANIC foodstuff								
Variable	Q1	Q2		Q3		Q4	for Trend ^b	HR (95% CI) for a 5-Point Increase	P Value
Overall cancer	1 [Reference]	0.94 (0.8	1-1.09)	0.95 (0.8	3-1.09)	0.75 (0.63-0.89)	.005	0.92 (0.88-0.96)	<.001
Breast cancer	1 [Reference]	1.06 (0.8	1-1.39)	1.01 (0.7	9-1.30)	0.88 (0.66-1.16)	.38	0.95 (0.88-1.01)	.11
Premenopausal breast cancer	1 [Reference]	1.10 (0.7	5-1.60)	1.14 (0.8	0-1.61)	1.01 (0.67-1.52)	.85	0.99 (0.99-1.09)	.86
Postmenopausal breast cancer	1 [Reference]	1.03 (0.7	(3-1.45)	0.89 (0.6	0-1.33)	0.79 (0.53-1.18)	.18	0.91 (0.83-1.01)	.07
Prostate cancer	1 [Reference]	1.14 (0.7	7-1.68)	1.34 (0.9	2-1.95)	1.03 (0.61-1.73)	.39	1.02 (0.91-1.15)	.68
Skin cancer	1 [Reference]	0.85 (0.5	4-1.35)	0.53 (0.3	3-0.86)	0.79 (0.49-1.28)	.11	0.89 (0.78-1.01)	.06
Non-Hodgkin lymphoma	1 [Reference]	0.80 (0.3	5-1.81)	1.21 (0.6	1-2.43)	0.27 (0.07-0.96)	.23	0.75 (0.60-0.93)	.009
All lymphomas	1 [Reference]	0.56 (0.2	7-1.17)	0.97 (0.5	4-1.74)	0.23 (0.08-0.69)	.05	0.75 (0.60-0.93)	.03



- No addition of organic matter to the soil
- Eradication of ecological infrastructures (hedges, trees, spontaneous flora)
- NO crop rotation

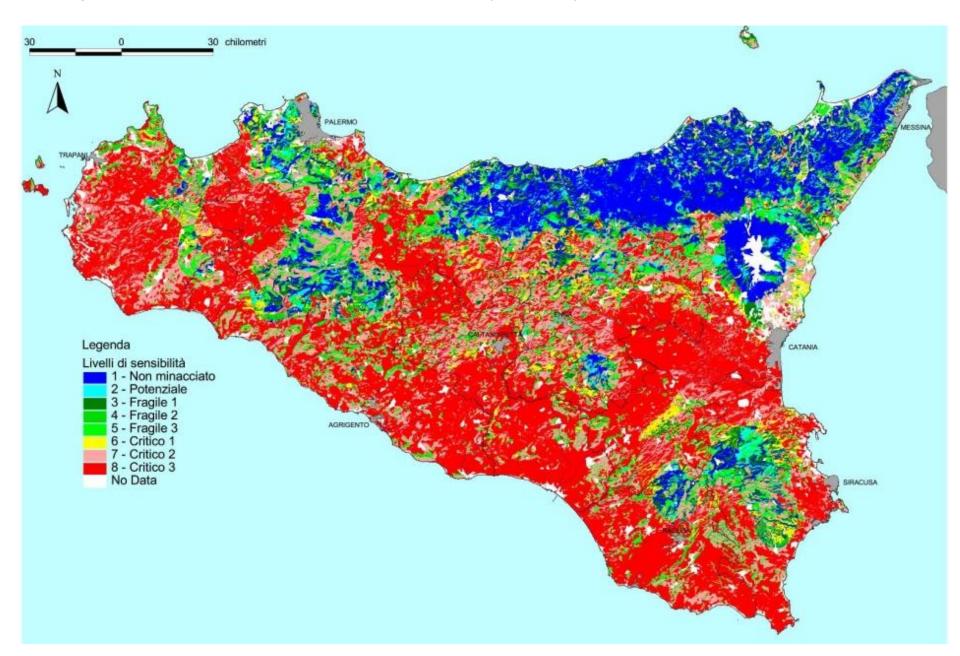
The organic matter content in the Po valley of the Emilia Romagna Region



About 50% of the regional plain soil is classified as with low or very low content of organic matter (< 2%)

According to FAO, the desertification threshold is OM < 2%

Maps of the Sensitive Areas to Desertification (Medalus). Piccione et al., 2010



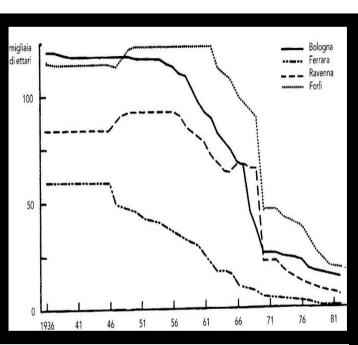


Agriculture and landscape





Agriculture and landscape



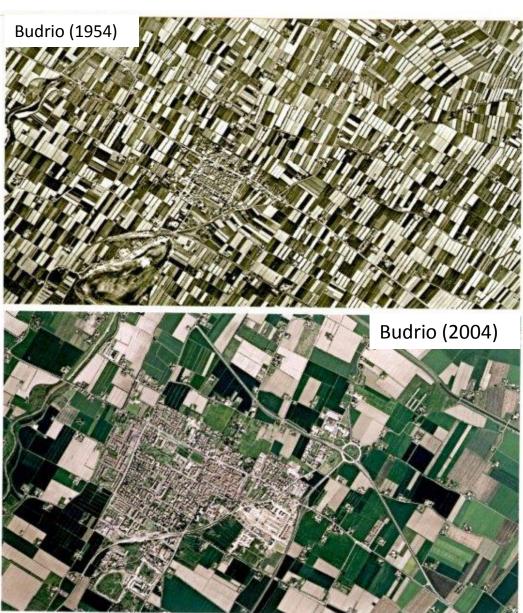
As an example, industrial agriculture has led to an extreme simplification of agro-systems: as evidenced for example by the decrease in the area dedicated to mixed crops (Agnoletti, 2010).

With obvious repercussions on the landscape: bigger and bigger fields, absence of other structures (trees, hedges, ditches etc.), ecological services not requested and substituted by chemicals.



L'agricoltura e il paesaggio

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WHAT ALTERNATIVES ???

CONCEPTS

Conventional farming is a cultivation system that uses highly productive varieties (often in monoculture), strong mechanization, chemical fertilizers and pesticides

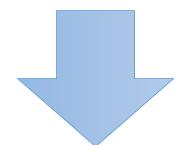


(biological, permaculture, biodynamic, agro-homeopathy) uses varieties adapted to the cultivation environment (consociations of different crops and rotations), light mechanization, fertilization with manure and green manure, natural substances and biological control against pathogenic

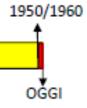
Non-conventional agriculture



ORGANIC FARMING



New production model strictly "Industrial"



Conventional Farming

- Open cycle: animal and plant production
- Market oriented production: maximization of productions
- Great external input request
- Need for capital
- Non-self-sufficient agricultural systems
- Supply chains with obvious "scale diseconomies"



The sustainability COMPARISON OF DIFFERENT AGRICUTURAL SYSTEMS

Conventional



SYSTEM COMPARISON



Speed= 300 km/h
Fuel Consumption= 1 liter per 2 km

Speed = 120 km/h Fuel Consumption = 1 liter per 20 km



Different performances and different environmental impact!!

What is the right approach? What is the risk in feeding the world without any other consideration? What is the real cost of the food?

Conventional and organic agriculture: differente approaches

Organic farming is not a conventional agriculture without the use of chemistry: farmers who practice it with this assumption simply make a "bad" agriculture !!!

In a sense the differences between conventional and organic farming are similar to the differences between Western and Eastern medicine



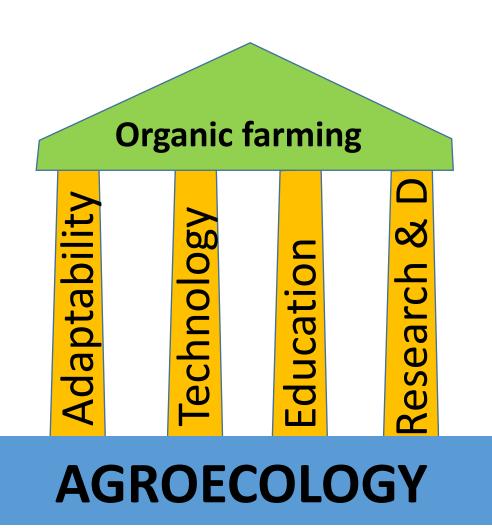
ACTIVE APPROACH CURATIVE APPROACH PARZIAL VISION

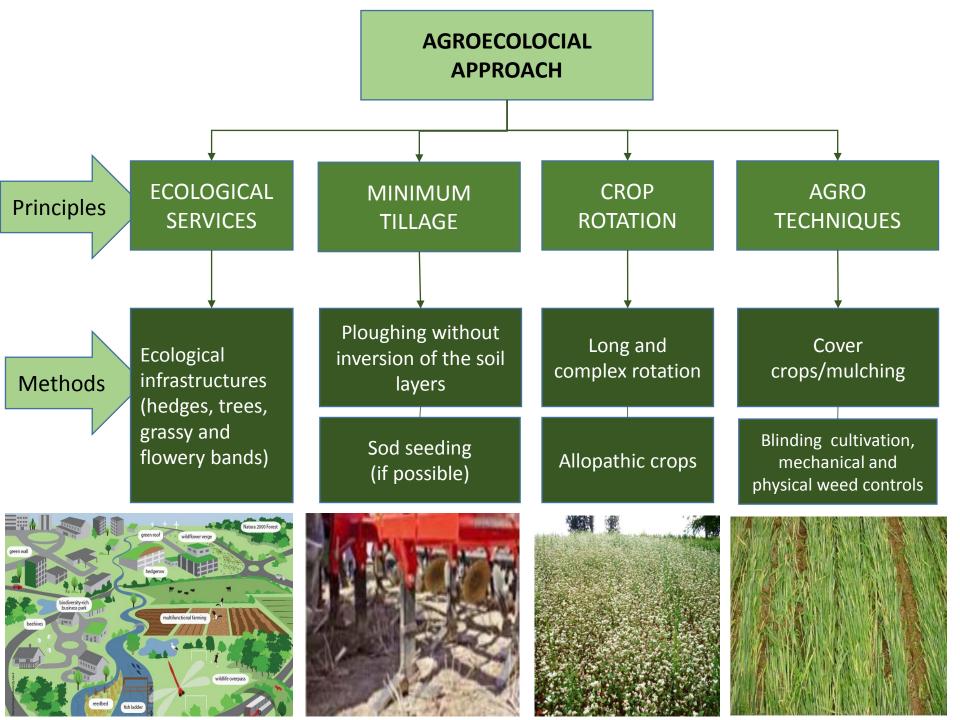


PROACTIVE APPROACH
PREVENTIVE APPROACH
HOLISTIC VISION

CULTIVATING health

ORGANIC FARMING 3.0





AGROECOLOGY



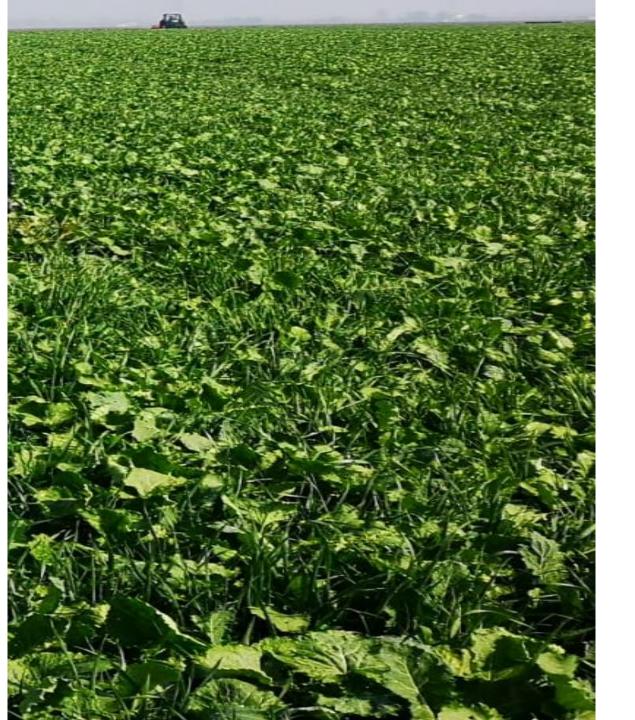
BLIND CULTIVATION

"Blind cultivation" is the easiest and best opportunity to destroy the weeds that would be growing within the rows and presenting direct competition to the crop. In blind cultivation, the entire field is tilled shallowly with the implement, paying little attention to where the rows are.



NAKED SOIL: CHEMICALS (HERBICIDES) or A LOT OF MANPOWER





COVER CROPS: WITHOUT CHEMISTRY AND WITHOUT MAN POWER

Keeping the ground covered with highly competitive species prevents weeds from colonizing the soil

The cover is maintained until the spring sowing

The cover crop is terminated:

INNOVATIVE SYSTEM (machine for burying stones)



Spring sowing: mulch crops (maintenance of the covered land)



The cover of the soil by matter-B mulching prevents:

Weed competition;

Demolition of soil structure;

Water losses.

In addition, the mulching facilitates the soil conversion of organic matter into humus (anaerobiosis)



ADAPTABILITY



A small farm of one hectare has specific needs ...

..simplified management...



ADAPTABILITY



A big farm of several hectares has specific needs ...

Flexibility

- -not a single type of organic farming -> several models
- proximal agriculture -> medium-small farms, disadvantaged areas, short supply chains
- agriculture for large-scale retail trade → big farms, fertile areas (plains)

TECHNOLOGY

BEFORE

The Green Revolution



Farm management based on **MANPOWER**

AFTER

The Green Revolution



Farm management based on **CHEMICALS**

TECHNOLOGY

AFTER

The Green Revolution



Farm management based on **CHEMICALS**

NEXT

ORGANIC Revolution



Replace the chemistry with the

TECHNOLOGY

Precision farming

Vision systems



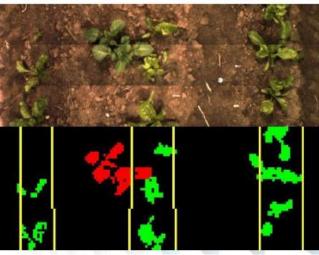














System integration input/output management Robotics
Decisional processes (DSS)





HI-tech innovations







ORGANIC FARMING can feed the World?? FOR SURE, BUT...we need more and more TECHNOLOGY!

Biopesticides

ElectroHerb

What are Biopesticides?



Natural products derived from plants, micro and other organisms

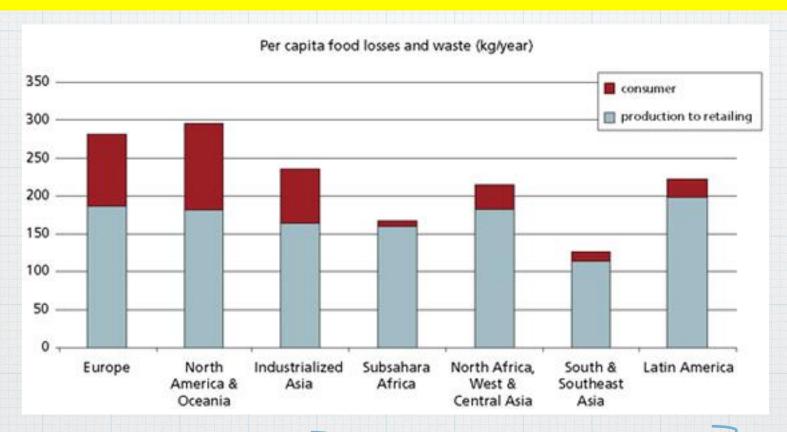
LOWEST RISK Category of Pest Management Products

Microbials	Biochemicals		
Fungi	Pheromones		
Bacteria	Plant Extracts		
Viruses			
Protozoa	Soaps/ Fatty Acids Marrone'		



FOOD waste and diet change

Annual food waste in Europe 88 milions of tons= 148 bilions €



- ✓ Agricultural production
- ✓ Post harvest and storage
- ✓ Transformation

75% ✓ CONSUMER

25%

Energy cost of meat production



1 cup broccoli, 1 cup eggplant, 4 oz. cauliflower, 8 oz. rice

FOSSIL FUEL ENERGY NEEDED TO PRODUCE EACH DISH



0.0098 gallons of gasoline equivalent



0.4 pounds of CO₂-eq



6 oz. of beef steak



0.1587 gallons of gasoline, 16 times as much



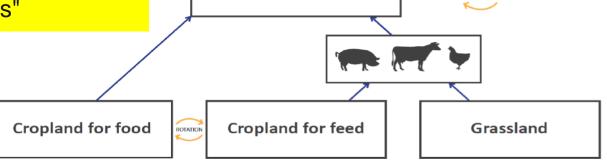
10 pounds of CO₂-eq, 25 times as much

Source: Bittman M., NY Times, 27/01/08

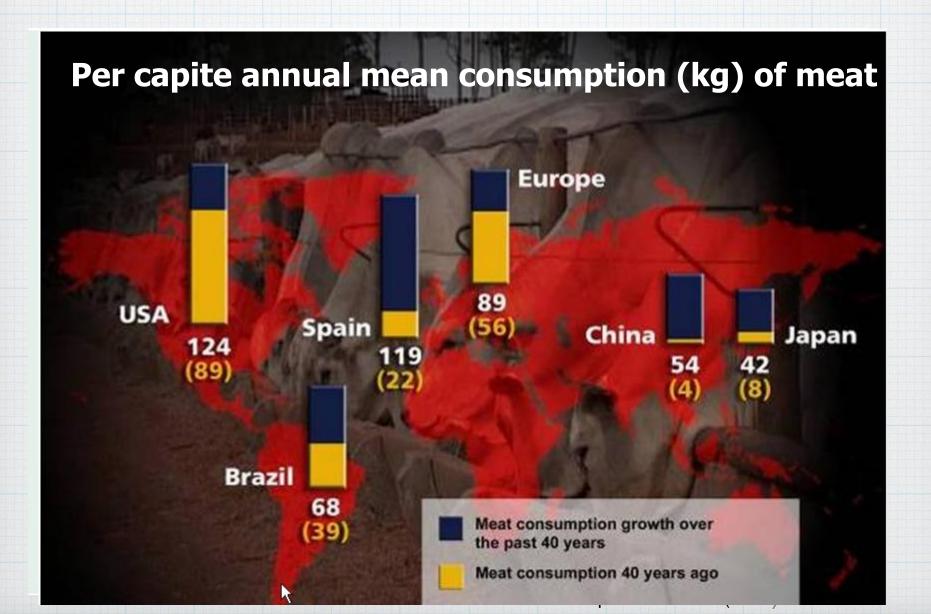
FOOD waste and diet change

- ✓ Around 70% of the total agricultural area in the world and around 30% of the total land area are used for animal production worldwide
- ✓ Worldwide, animal husbandry accounts for 64% of ammonium emissions
- ✓ At world level, animal husbandry is the first productive sector in generating nitrate and phosphate pollution in water / soil systems
- ✓ Worldwide about 2/3 of antibiotics are used as growth regulators in the animal production sector
- ✓ The "World Cancer Research Fund" suggests:
 - "Eat more plant-based foods"

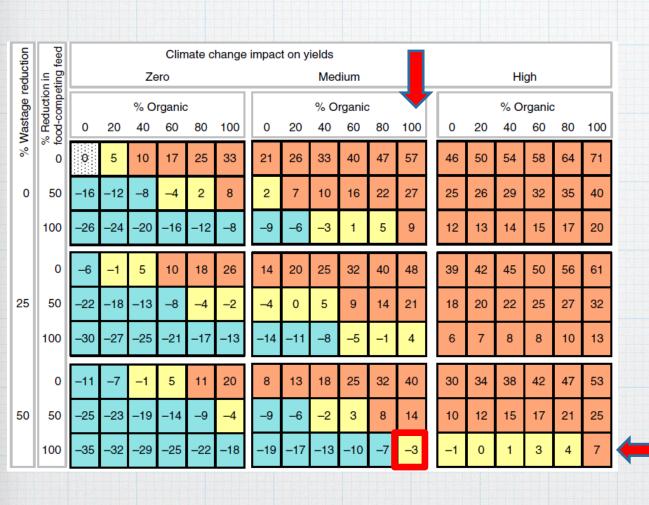
Feed production reduction (FCF) Livestock reduction Water saving and cultivation area Greater intake of vegetable proteins Flows of product **Food Consumption** Flows of land

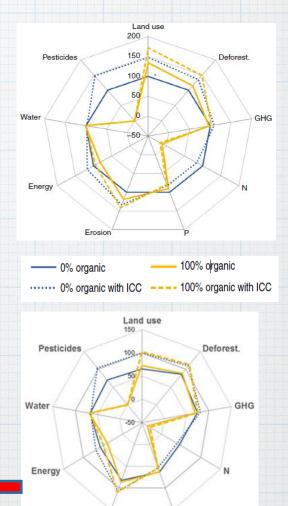


For producing 1 kg of meat approximately 15 kg of vegetal feeding are requested



Strategies for feeding the world more sustainably with organic agriculture (Muller et al., 2017)





Erosion

CONCLUSIONS???

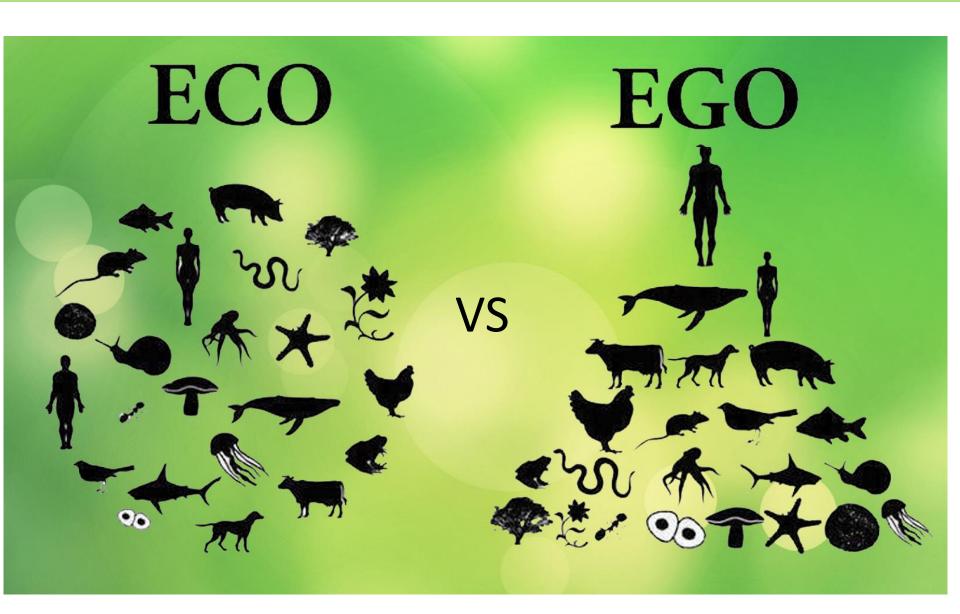
PRODOTTI BIOLOGICI

		Prezzo	Prezzo	Differenza	
PRODOTTO	CONV	ENTIONAL	ORGAN	<mark>IC</mark>	
		ordinario	bio	111 /6	
Latte 1 It		1,29	1,89	47%	
Marmellata 330 gr		2,25	2,99	33%	
Farina 1 kg		0,76	1,49	96%	
Polpa di pomodoro 5	00 ml	0,95	2,05	116%	
Succo di frutta 3X200	0 ml	1,50	1,85	23%	
Mozzarella 100 gr*		1,30	1,59	22%	
Biscotti 400gr		2,15	3,39	58%	
Spaghetti 500 gr		0,85	1,59	87%	
Differenza media in %	6 tra pro	11.05	16.84	60%	
*per il prodotto ordinario la confezione è da 125 gr					
HAMBURGER (1kg)		13.9	2.60 3.50	6 organic eggs 300 g chikpea	

An organic shopping on average costs 60% more than conventional one: With a limitation of the meat the gap is enormously reduced

24.5 22.94

AGROECOSYSTEM vs AGROEGOSYSTEM



Our civilization is not protected by any predetermined and inherent finalistic mechanism in the becoming of the universe. We must face this reality and be clear that the responsibility to save civilization lies with man himself.

Konrad Lorenz

