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?
Earth Overshoot Day (EOD), in the past also Ecological Debt Day (EDD), indicates on an illustrative level the day in which humanity entirely consumes the resources produced by the planet in a whole year.

How many Earths do we need if the world’s population lived like...

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Earths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>5.2</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>5.0</td>
</tr>
<tr>
<td>South Korea</td>
<td>3.4</td>
</tr>
<tr>
<td>Russia</td>
<td>3.4</td>
</tr>
<tr>
<td>Germany</td>
<td>3.2</td>
</tr>
<tr>
<td>Switzerland</td>
<td>3.1</td>
</tr>
<tr>
<td>France</td>
<td>3.0</td>
</tr>
<tr>
<td>U.K.</td>
<td>3.0</td>
</tr>
<tr>
<td>Japan</td>
<td>2.9</td>
</tr>
<tr>
<td>Italy</td>
<td>2.6</td>
</tr>
<tr>
<td>Spain</td>
<td>2.4</td>
</tr>
<tr>
<td>China</td>
<td>2.1</td>
</tr>
<tr>
<td>Brazil</td>
<td>1.8</td>
</tr>
<tr>
<td>India</td>
<td>0.6</td>
</tr>
<tr>
<td>World</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Source: Global Footprint Network National Footprint Accounts 2017

Overshoot Day 1991-2017

Ecological Debt Day (EDD), indicates on an illustrative level the day in which humanity entirely consumes the resources produced by the planet in a whole year.

1.7 Earths
The actual agriculture impact on global carbon footprint

The consumer choice can have a great impact!!
Actually to produce, transform, transport and consume 1 calorie of food, on average in the world 7.3 calories of energy are consumed.

- Farming: 1.6 calories
- Transport: 1.0 calorie
- Processing: 1.2 calorie
- Packaging: 0.5 calorie
- Commercial food service: 0.5 calorie
- Food retail: 0.3 calorie
- Household storage and preparation: 2.3 calories
The actual agricultural inputs (nitrogen, phosphate, irrigation water and pesticides) are not sustainable!!!

For feeding the world (9 billion of people in 2040) can we increase again the inputs?

**Global trends in cereal and meat production**

- Per capita cereal production (kg)
- Per capita meat production (kg)

**Global total use of nitrogen and phosphorus fertilizers.**

- Millions of tonnes, World, excluding former USSR

**Increased use of irrigation**

- Global irrigation (billions [m³]/ha)

**Total global pesticides production**

- Millions of tonnes

*Source: Tilman et al., 2002*

*David Tilman et al. Science 2001*
Industrial agriculture works ... but at what cost??

How many people could feed the current agricultural production??

Eric Holt Gimenez
“Food Rebellions: Crisis and the Hunger for Justice”

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

Hunger and malnutrition: one case of extreme diversity

1.5 billion overweight, 500 million obese

842 million extremely undernourished, 165 million children stunted, 1.2 billion malnourished
What we know about our foodstuff?
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)

Il mangiafagioli (1583, A. Carracci)
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"

Fungicides

Pesticides

Herbicides

Genocide

Concept: Mike Adams
Art: Dan Berger

Soda
Snacks

www.newstarget.com
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-Romagna 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.

The most detected active ingredient found over the environmental standard quality

**Surface water:**
- AMPA
- GLIFOSATE

**Deep water:**
- ATRAZINA DES. DESIS.
- GLIFOSATE
- AMPA

Source: "Rapporto nazionale pesticidi nelle acque, 2015-2016", Ispra, 2018, pag. 33
In 2018, world agricultural production used over **200 million tons of synthetic fertilizers** (with an increase of 2.5% compared to 2017) and over **2 million tons of pesticides** (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.
A case study
(COOP Sverige)

The Organic Effect

Human exposure to pesticides from food
A pilot study
For Coop Sverige AB

Jörgen Magnér, Petra Wallberg, Jasmin Sandberg, Anna Palm Cousins
A case study (COOP Sverige)
A case study (COOP Sverige)
A case study (COOP Sverige)
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 PESTICIDES

And the remaining 70-80% of ADDITIVES

In ORGANIC FOOD, PESTICIDES are forbidden as most of the synthetic ADDITIVES (the most dangerous!!)
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.
**Table 4. Multivariable Associations Between a Simplified Organic Food Score (Modeled as a Continuous Variable and as Quartiles) and Overall Cancer and Cancers of the Breast, Prostate, Skin, and Non-Hodgkin Lymphoma**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Q1 (Reference)</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>for Trend&lt;sup&gt;b&lt;/sup&gt;</th>
<th>HR (95% CI) for a 5-Point Increase</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall cancer</td>
<td>1 [Reference]</td>
<td>0.94 (0.81-1.09)</td>
<td>0.95 (0.83-1.09)</td>
<td>0.75 (0.63-0.89)</td>
<td>.005</td>
<td>0.92 (0.88-0.96)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>1 [Reference]</td>
<td>1.06 (0.81-1.39)</td>
<td>1.01 (0.79-1.30)</td>
<td>0.88 (0.66-1.16)</td>
<td>.38</td>
<td>0.95 (0.88-1.01)</td>
<td>.11</td>
</tr>
<tr>
<td>Premenopausal breast cancer</td>
<td>1 [Reference]</td>
<td>1.10 (0.75-1.60)</td>
<td>1.14 (0.80-1.61)</td>
<td>1.01 (0.67-1.52)</td>
<td>.85</td>
<td>0.99 (0.99-1.09)</td>
<td>.86</td>
</tr>
<tr>
<td>Postmenopausal breast cancer</td>
<td>1 [Reference]</td>
<td>1.03 (0.73-1.45)</td>
<td>0.89 (0.60-1.33)</td>
<td>0.79 (0.53-1.18)</td>
<td>.18</td>
<td>0.91 (0.83-1.01)</td>
<td>.07</td>
</tr>
<tr>
<td>Prostate cancer</td>
<td>1 [Reference]</td>
<td>1.14 (0.77-1.68)</td>
<td>1.34 (0.92-1.95)</td>
<td>1.03 (0.61-1.73)</td>
<td>.39</td>
<td>1.02 (0.91-1.15)</td>
<td>.68</td>
</tr>
<tr>
<td>Skin cancer</td>
<td>1 [Reference]</td>
<td>0.85 (0.54-1.35)</td>
<td>0.53 (0.33-0.86)</td>
<td>0.79 (0.49-1.28)</td>
<td>.11</td>
<td>0.89 (0.78-1.01)</td>
<td>.06</td>
</tr>
<tr>
<td>Non-Hodgkin lymphoma</td>
<td>1 [Reference]</td>
<td>0.80 (0.35-1.81)</td>
<td>1.21 (0.61-2.43)</td>
<td>0.27 (0.07-0.96)</td>
<td>.23</td>
<td>0.75 (0.60-0.93)</td>
<td>.009</td>
</tr>
<tr>
<td>All lymphomas</td>
<td>1 [Reference]</td>
<td>0.56 (0.27-1.17)</td>
<td>0.97 (0.54-1.74)</td>
<td>0.23 (0.08-0.69)</td>
<td>.05</td>
<td>0.75 (0.60-0.93)</td>
<td>.03</td>
</tr>
</tbody>
</table>

*Only Consumers of CONVENTIONAL foodstuff*

*Only consumers of ORGANIC foodstuff*
Chemicals (pesticides-fertilizers)

The farmer needs more chemicals

The farmer forgets agroecology

Agroecosystem depletion (Land, biodiversity etc.)

Specialization of the production (MONOCULTURE)

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

Non-conventional agriculture (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...
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 AGRICULTURAL SYSTEMS

Conventional

**System Comparison**

Organic

**Speed**
- Conventional: 300 km/h
- Organic: 120 km/h

**Fuel Consumption**
- Conventional: 1 liter per 2 km
- Organic: 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: different 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.
CULTIVATING health
AGROECOLOGICAL APPROACH

**Principles**

- **ECOLOGICAL SERVICES**
  - Ecological infrastructures (hedges, trees, grassy and flowery bands)

**Methods**

- **MINIMUM TILLAGE**
  - Ploughing without inversion of the soil layers
  - Sod seeding (if possible)

- **CROP ROTATION**
  - Long and complex rotation
  - Allopathic crops

- **AGRO TECHNIQUES**
  - Cover crops/mulching
  - Blinding cultivation, mechanical and physical weed controls
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)
A small farm of one hectare has specific needs...

..simplified management...

Your crops and animals look healthy. What have you done?

I started applying organic methods.

Provide good farm-own feed to livestock

Grow crops in a planned rotation

Grow different crops together

Recycle plant materials and animal manure to make compost
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

Automation (robotics)
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!

What are Biopesticides?

Natural products derived from plants, micro and other organisms
LOWEST RISK Category of Pest Management Products

<table>
<thead>
<tr>
<th>Microbials</th>
<th>Biochemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fungi</td>
<td>Pheromones</td>
</tr>
<tr>
<td>Bacteria</td>
<td>Plant Extracts</td>
</tr>
<tr>
<td>Viruses</td>
<td>Soaps/Fatty Acids</td>
</tr>
<tr>
<td>Protozoa</td>
<td></td>
</tr>
</tbody>
</table>
FOOD waste and diet change

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

- Per capita food losses and waste (kg/year)

- 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

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.
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)

<table>
<thead>
<tr>
<th>% Wastage reduction in food-competing feed</th>
<th>Climate change impact on yields</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Organic</td>
<td>Zero</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>-16</td>
</tr>
<tr>
<td>100</td>
<td>-26</td>
</tr>
<tr>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
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<td>100</td>
<td>-30</td>
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<td>0</td>
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<tr>
<td>50</td>
<td>-11</td>
</tr>
<tr>
<td>100</td>
<td>-25</td>
</tr>
</tbody>
</table>

[Graph showing comparison of different strategies]
CONCLUSIONS???
<table>
<thead>
<tr>
<th>PRODOTTO</th>
<th>CONVENTIONAL</th>
<th>ORGANIC</th>
<th>Differenza</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ordinario</td>
<td>bio</td>
<td>in %</td>
</tr>
<tr>
<td>Latte 1 lt</td>
<td>1,29</td>
<td>1,89</td>
<td>47%</td>
</tr>
<tr>
<td>Marmellata 330 gr</td>
<td>2,25</td>
<td>2,99</td>
<td>33%</td>
</tr>
<tr>
<td>Farina 1 kg</td>
<td>0,76</td>
<td>1,49</td>
<td>96%</td>
</tr>
<tr>
<td>Polpa di pomodoro 500 ml</td>
<td>0,95</td>
<td>2,05</td>
<td>116%</td>
</tr>
<tr>
<td>Succo di frutta 3X200 ml</td>
<td>1,50</td>
<td>1,85</td>
<td>23%</td>
</tr>
<tr>
<td>Mozzarella 100 gr*</td>
<td>1,30</td>
<td>1,59</td>
<td>22%</td>
</tr>
<tr>
<td>Biscotti 400gr</td>
<td>2,15</td>
<td>3,39</td>
<td>58%</td>
</tr>
<tr>
<td>Spaghetti 500 gr</td>
<td>0,85</td>
<td>1,59</td>
<td>87%</td>
</tr>
<tr>
<td>Differenza media in % tra pro</td>
<td><strong>11.05</strong></td>
<td><strong>16.84</strong></td>
<td><strong>60%</strong></td>
</tr>
</tbody>
</table>

*per il prodotto ordinario la confezione è da 125 gr

HAMBURGER (1kg)                | 13.9         | 2.60    | 6 organic eggs |
|                               | 3.50         | 300 g chikpea |

24.5                            | 22.94
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