Organic Agriculture

The Principles of High Yielding Systems

Andre Leu

IFOAM, President
Organic Federation of Australia, Chairman

IFOAM is the international umbrella organization of organic agriculture movements worldwide

International Federation of Organic Agriculture Movements

Mission
IFOAM's mission is leading, uniting and assisting the organic movement in its full diversity.

Vision
Our goal is the worldwide adoption of ecologically, socially and economically sound systems that are based on the principles of Organic Agriculture.

The principles of Health, Ecology, Fairness, and Care are the roots from which organic agriculture grows and develops. They express the contribution that organic agriculture can make to the world, and a vision to improve all agriculture in a global context.

Organic Industry Overview

organic: *means the application of practices that emphasize the:*

- *use of renewable resources; and*
- *conservation of energy, soil and water; and*
- *recognition of livestock welfare needs; and*
- *environmental maintenance and enhancement, while producing optimum quantities of produce without the use of artificial fertiliser or synthetic chemicals*

Organic Industry Overview

Organic systems improve soil fertility by using

- Composts
- Natural mineral fertilisers
- Cover crops
- Organic materials

Organic Industry Overview

Cultural and ecological management systems are used as the primary controls of:

- Pests
- Weeds
- Diseases
- Limited use of biocides of mineral, plant and biological origin as the tools of last resort.

Organic Industry Overview

Best Practice Organic Agriculture has Numerous Benefits

- High Yields
- Premium Prices
- Rapidly Growing Industry
- Low Input Costs
- Resilient to Climate Extremes
- Environmentally, Economically and Socially Sustainable

High Yields

United Nations Study – Organic Agriculture Increased Yields

- Report by UNCTAD and UNEP –average increase in crop yield
- *116 per cent increase for all African projects*
- *128 per cent increase for the projects in East Africa.'*

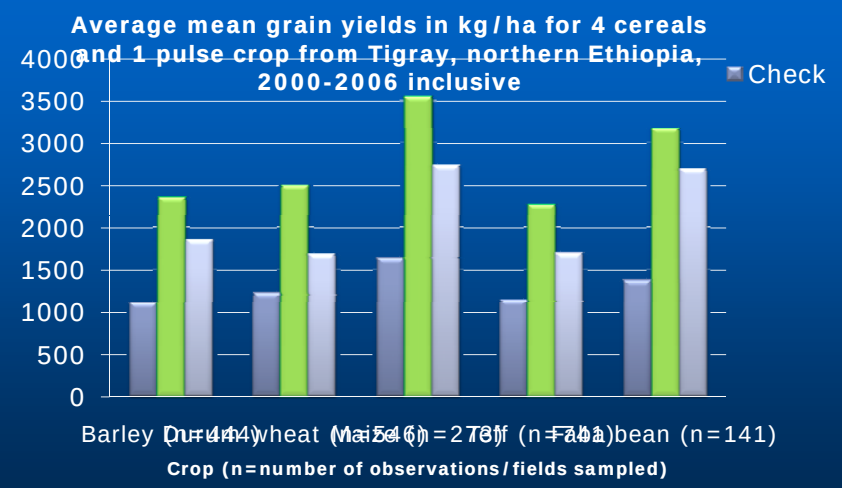
High Yields

United Nations Study – Organic Agriculture Increased Yields

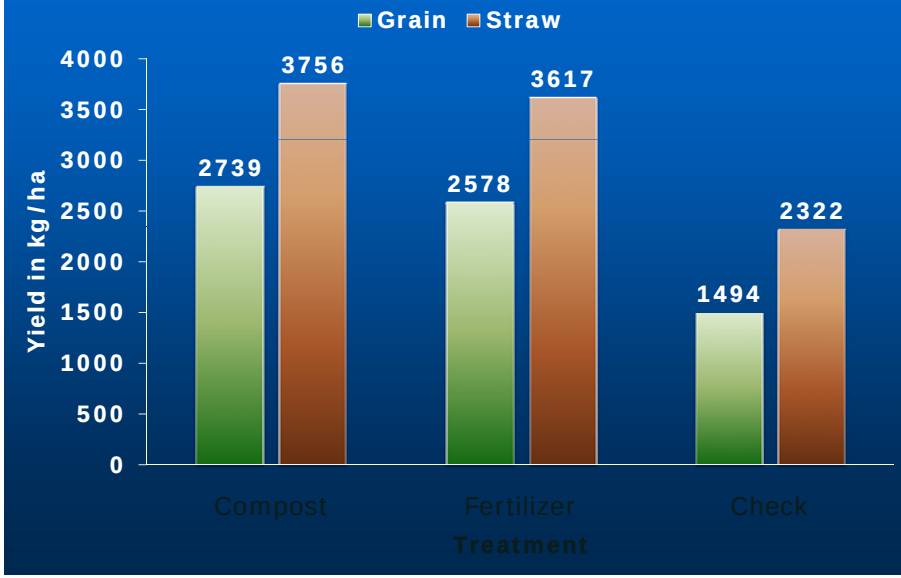
'The evidence presented in this study supports the argument that organic agriculture can be more conducive to food security in Africa than most conventional production systems, and that it is more likely to be sustainable in the long term.'

Supachai Panitchpakdi, Secretary general of UNCTAD and Achim Steiner, Executive Director of UNEP

Impact of using compost - Grain yields from over 900 samples from farmers fields over 7 years

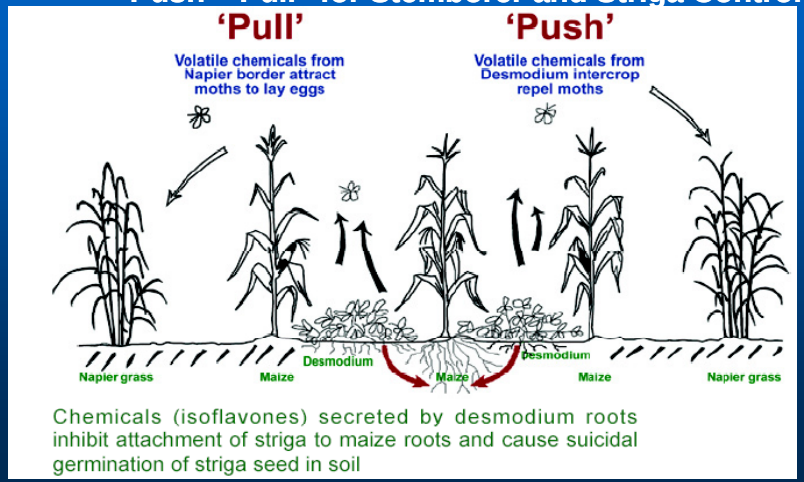


Initial impacts on wheat yields in Hintalo Wejerat, Tigray, 2010



High Yields

"Push – Pull" for Stemborer and Striga Control



Chemicals (isoflavones) secreted by desmodium roots inhibit attachment of striga to maize roots and cause suicidal germination of striga seed in soil

The System's Approach: Eco-intensification

Using natural systems to regulate pest outbreaks

(example of push-pull greater farm productivity vs higher yields 2 to 10X)

High Yields

Scientific Review by Cornell University into the System of Rice Intensification (SRI)

- Organic SRI yields greater than the traditional crops
- Organic SRI had significantly lower input costs (fertiliser, pesticide, weeding etc) than the conventional crops
- *"...the technology generates the estimated average output gains of more than 84%."*

Source: **Barrett C et al (2004),** Better technology, better plots, or better farmers? Identifying changes in productivity and risk among Malagasy rice farmers , Am.J.Agric.Econ., 2004, 86, 4, 869-888

High Yields

System of Rice Intensification (SRI)

In Madagascar, SRI has increased yields from the usual 2-3 tons per hectare to yields of 6,8 or 10 tons per hectare.

Source: Nicolas Parrott, Cardiff University, 'The Real Green Revolution'

High Yields

System of Rice Intensification (SRI)

- **Cuba – Two rice plants the same age and same variety**
  - *By: Dr. Norman Uphoff, Cornell University*

HIGH YIELDS

After typhoon, FFS farmer in Dông Trù village, Hanoi Province, Viet Nam

By: Dr. Norman Uphoff, Cornell University

High Yields

Recent Scientific Field Trials in the USA

US Agricultural Research Service (ARS) Pecan Trial

- The ARS organically managed pecans out-yielded the conventionally managed, chemically fertilized Gebert orchard in each of the past five years. Yields on ARS' organic test site surpassed the Gebert commercial orchard by 18 pounds of pecan nuts per tree in 2005 and by 12 pounds per tree in 2007. *(Bradford J.M .2008)*

The Wisconsin Integrated Cropping Systems Trials

- found that organic yields were higher in drought years and the same as conventional in normal weather years. *(Posner et al. 2008)*

High Yields

Recent Scientific Field Trials in the USA

- **IOWA State University Trials**
- The results from the Long Term Agroecological Research (LTAR), a 12 year collaborative effort between producers and researchers.
- organic corn harvests averaged 130 bushels per acre while conventional corn yield was 112 bushels per acre.
- organic soybean yield was 45 bu/ac compared to the conventional yield of 40 bu/ac in the fourth year.
- Cost-wise, on average, the organic crops' revenue was twice that of conventional crops due to the savings from non-utilization of chemical fertilizers and pesticides.

High Yields

Recent Scientific Field Trials in the USA

- **Rodale Organic Low/No Till**
- The Rodale Institute has been trialling a range of organic low tillage and no tillage systems.
- 'The 2006 trails resulted in organic yields of 160 bushels and acre (bu/ac) compared to the Country average of 130 bu/ac. *(Rodale 2006)*

Minimum Till without Herbicides

High Yields

Scientific Review by Cornell University into a 22 year-long Field Study

- The improved soil allowed the organic land to generate yields equal to or greater than the conventional crops after 5 years
- The conventional crops collapsed during drought years.
- The organic crops fluctuated only slightly during drought years, due to greater water holding capacity in the enriched soil.
- The organic crops used 30% less fossil energy inputs than the conventional crops.
  - Published in the Journal Bioscience

High Yields

High Yields , Sustainability and Climate Resilience are achieved by:

- Adequate Levels of Soil Organic Carbon (Organic Matter)
- Mineral Balance
- Ecological Intensification
- Good Management Systems

Organic Matter

Nutrient availability:

- **Stores 90 to 95% of the nitrogen in the soil, 15 to 80% of phosphorus and 20 to 50% of sulphur in the soil**
- **Has many sites that hold minerals and consequently dramatically increases the soils' Total ion Exchange Capacity**
- **Stores cations, such as calcium, magnesium, potassium and all trace elements**

Organic Matter

Nutrient availability:

- **Organic acids (humic and fulvic) help make minerals available by dissolving locked up minerals**
- **Prevents mineral ions from being locked up**
- **Encourages a range of microbes that make locked up minerals available to plants.**
- **Helps to neutralise the pH**
- **Buffers the soil from strong changes in pH**

Organic Matter

Soil Structure:

- **Promotes good soil structure which creates soil spaces for air and water by**
- **Assisting with good/strong ped formation**
- **Feeding macro organisms (ie earthworms and beetles etc) the form pores in the soil.**

Organic Matter

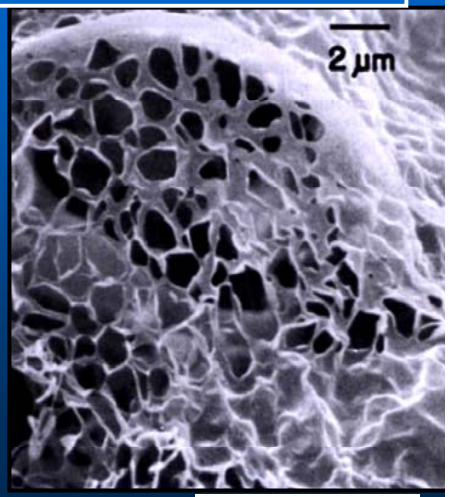
Directly assisting plants:

- **The spaces allow microorganisms to turn the nitrogen in the air into nitrate and ammonia (air is 78% N)**
- **Soil carbon dioxide contained in these air spaces increases plant growth**
- **Helps plant and microbial growth through growth stimulating compounds**
- **Helps root growth, by making it easy for roots to travel through the soil**

Soil organic matter

- Holds water
- Cements soil particles
- Increases nutrient storage & availability
- Humus can last 2000 years in the soil

Electron micrograph of soil humus



The RODALE INSTITUTE

Resilient to Climate Extremes

Research Shows that Organic Systems use Water More Efficiently

'Soil water held in the crop root zone was measured and shown to be consistently higher … in the organic plots than the conventional plots, due to the higher organic matter …' (Lotter 2003)

Resilient to Climate Extremes

Research Shows that Organic Systems use Water More Efficiently

- *'The exceptional water capture capability of the organic treatments stood out during the torrential downpours during hurricane Floyd in September of 1999.*
- *The organic systems captured about twice as much water as the conventional treatment during that two day event' (Lotter 2003)*

Organic Corn - 1995 Drought

Organic Matter

Research Shows that Organic Systems use Water More Efficiently

- Volume of Water Retained /ha (to 30 cm) in relation to soil organic matter (OM).
- 0.5% OM = 80,000 litres (average 2004 level)
- 1 % OM = 160,000 litres
- 2 % OM = 320,000 litres
- 3 % OM = 480,000 litres
- 4 % OM = 640,000 litres
- 5 % OM = 800,000 litres (pre-settlement level)

Organic Matter

Organic Soil Carbon Systems Have Less Soil Erosion

- The results of a study that compared erosion in organic and conventional farming over 38 years.
- *'This study indicates that, in the long term, the organic farming system was more effective than the conventional farming system in reducing soil erosion and, therefore, in maintaining soil productivity' (Reganold et al. 1987).*

Organic Matter

- Higher corn and soybean yields in drought years
- Increased soil C and N

- Higher water infiltration
- Higher water holding cap.
- Higher microbial activity

Organic Matter

Organic Soil Carbon Systems Improve Soil

- "Results of this research suggest that organic farming systems can provide greater long-term soil improvement than conventional no-tillage systems, despite the use of tillage in organic systems."
- Journal of Soil and Water Conservation entitled "Strategies for Soil Conservation in No-tillage and Organic Farming Systems" (Nov/Dec 2007, Vol. 62, Number 6).

Organic Matter

Synthetic Nitrogen Fertilisers Deplete Carbon

Scientists from the University of Illinois analysed the results of a 50 year agricultural trial and found that synthetic nitrogen fertiliser resulted in all the carbon residues from the crop disappearing as well as an average loss of around 10,000 kg of soil carbon per hectare.

This is around 36,700 kg of carbon dioxide per hectare on top of the many thousands of kilograms of crop residue that is converted into CO_2 every year.

Organic Matter

Synthetic Nitrogen Fertilisers Deplete Carbon

The researchers found that the higher the application of synthetic nitrogen fertiliser the greater the amount of soil carbon lost as CO_2.

This is one of the major reasons why conventional agricultural systems have a decline in soil carbon while organic systems increase soil carbon.

Organic Matter

Use Plants to Grow Soil Carbon

$6CO_2$ Carbon dioxide + $6H_2O$ Water $\xrightarrow{\text{Light}}$ $C_6H_{12}O_6$ Sugar + $6O_2$ Oxygen

- Between 95 and 98% of plant minerals come from water, carbon dioxide and oxygen
- The remaining 2-5% comes from the soil.
- Photosynthesis produces the carbon compounds that plants need to grow and reproduce

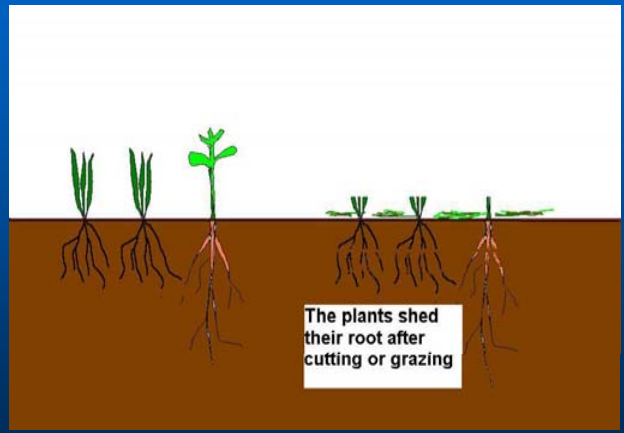
Organic Matter

The Carbon Gift

- 30-60% of the carbon and energy used by plants is deposited into the soil by plant roots as exudates and sheaths
- Plant roots put thousand of tonnes per hectare of organic carbon and bio available minerals into the soil every year

MANAGING GROUND COVERS

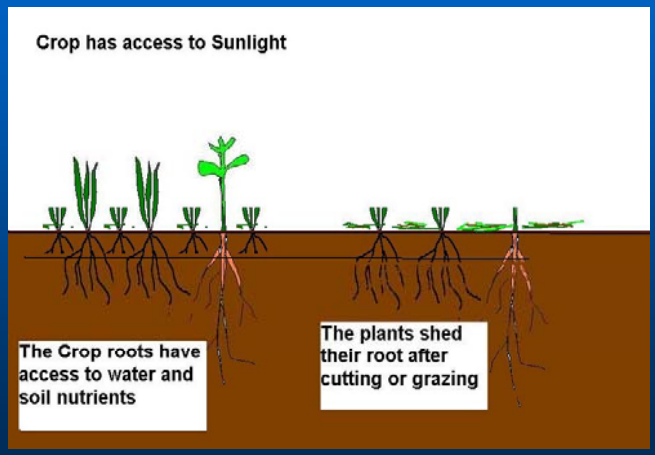
Plants shed their roots after losing leaves because they cannot produce enough sugars to feed their roots



MANAGING GROUND COVERS

Cut plants shed their roots and add organic carbon and minerals into the soil to feed the microorganisms and the crop

MANAGING GROUND COVERS



MANAGING GROUND COVERS

Tall plants have deeper roots and deposit more carbon deeper into the soil

Minimum Till without Herbicides

Pasture Cropping

Onions Growing in Rye Grass

Pasture Cropping

Oats Sown into Pasture

Pasture Cropping

Oats Sown into Pasture

Composting Methods

Anaerobic compost

- Mix and make the same way as aerobic however there is no need to turn.
- No oxygen means that it takes more than twice as long before it is ready to use
- Less nitrogen loss
- Anaerobic bacteria create a range of organic acids and enzymes that are useful in making mineral rock dusts (lime, rock phosphate, crushed basalt, dolomite, gypsum etc) bio available
- Cheaper to make due to less costs for turning to oxygenate