

Reduced Tillage in Organic Vegetable Production

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December 13, 2011

http://www.extension.org/organic_production



Can we model a productive Organic vegetable production system on no-till natural systems?

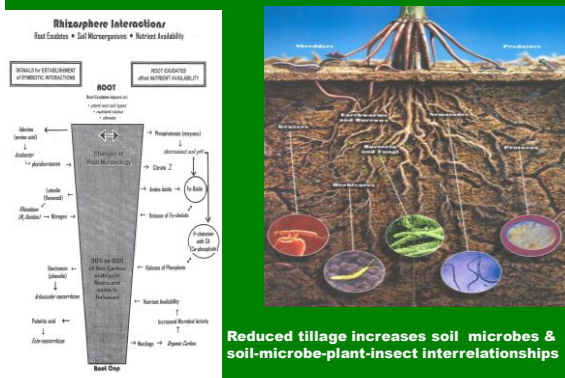
Increase Plant Diversity?

Reduce Tillage ?

Manage Complex Ecological Interrelationships?



WHY REDUCE TILLAGE?



Reduced Tillage Journey:

FARMING WITH NATURE
MASANOBU FUKUOKA
1980 - 1983 Georgia
189 acres
grain successions,
vegetables & fruits.

Soil covered year round.



1986 NJ:
200 acres Organic Vegetable and fruit production:

Mulch creates habitat for beneficial insects & reduces exposed bare soil.



1989 NJ:
25 acres organic vegetable production - Living Mulch

weeds
between
crop
rows



Biodesign Farm 1992 - 2010:
30 acres
Organic vegetables and fruit



Legume Living Mulches
Parabinga medic

Living Mulch Reduced Tillage:
Soil covered most of the year



LIGHT TILLAGE IN SPRING (late May):
LOTS OF RESIDUE LEFT



Reseed living mulch each spring.
Alsike clover recruits from previous year still present.



Leave "islands" or strips of no-till areas

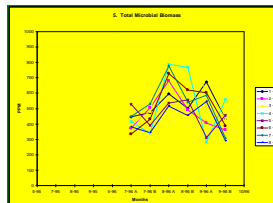
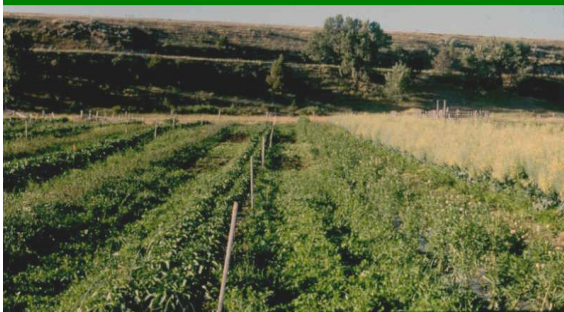


Soil covered by early June

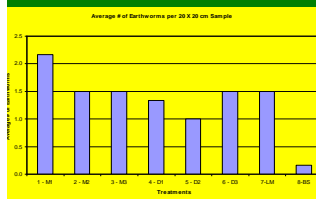


White Clover

1995-1996 Living Mulch Experiment:
How to manage lots of plant residue?
Compared mowing and light tillage at different times (fall, summer, or spring) to monthly tillage between crop rows.



Tillage decreased SOM, earthworms and Total Microbes.
All increased with regular additions of fresh, organic residue - clover mowed monthly.



1995 - 2004 farmed with living mulch reduced tillage system, tweaking eco-system design pieces.

Broccoli left to flower as pollen/nectar source for beneficial insects



Results:
IMPROVED YIELD AND QUALITY



IMPROVED COLD TOLERANCE

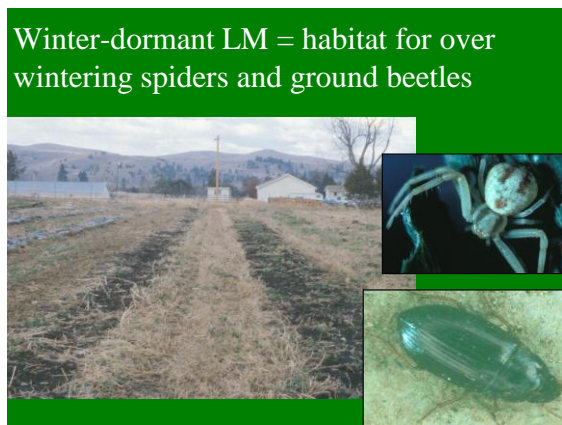
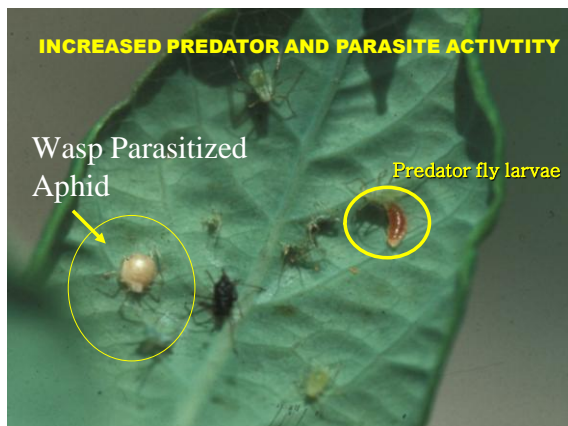


HABITAT FOR BENEFICIALS

And wind protection in the spring!



Yellow Sweet Clover
"island" planted previous
year blooming in mid June

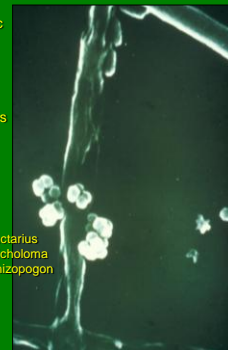


LM plus broccoli residue = habitat for insects, birds, and **voles** & garter snakes



Improved **Habitat** for Beneficial Microbes

- Antagonistic/Competitive/Mycoparasitic Fungi
 - Trichoderma/Gliocladium
 - Pythium
 - Penicillium
 - Aspergillus
- Antagonistic/Competitive Actinomycetes
 - Streptomyces
- Antagonistic/Competitive Bacteria
 - Bacillus
 - Clostridium
 - Pseudomonas
- Ectomycorrhizal Fungi
 - Pisolithus
 - Thelephora
 - Suillus
 - Amanita
 - Scleroderma
 - Russula
 - Cantharellus
 - Boletus
 - Lactarius
 - Tricholoma
 - Rhizopogon
- Endomycorrhizal Fungi
 - Glomus
 - Endogone
 - Rhizophagus
 - Sclerocystis
 - Gigaspora



Disease Suppression? CMV 2004



CMV normally causes stunted plants and decreased yield.



Long-term soil health improved with Living Mulch system

Increase over 10 years –
% OM = 2%, TMB = from 300 to 780 ppm,
P = 150 ppm, NO₃ = 28 ppm

YEAR	Sample Size	%OM	ENR	P _i	P _o	K	ppm	Ca	pH	Na	% Olsen	Microbial	Mg	CA
1993	2	3.5	83	9	19	145	225	1568	6.9	15	4	18	78	
1995	10	4.2	91	58	109	384	310	1731	7.3	41	8	21	71	
1996	16	5.0	—	147	181	612	410	2029	7.6	81	10	22	67	
1999	2	5.7	—	182	198	574	422	2016	7.7	82	10	23	67	
OPTIMUM LEVELS														
2003	2	5.4		204	222	613	397	1998	7.6	44	N levels drop without manure			
2006	2	5.2		260	261	323	254	2024	7.6	33				

* Tests performed by Midland Labs, Inc. - Nebraska

Cover Crop Biomass or Regular Additions of "Quality" Residue?

MONTHLY AVERAGE Nutrient Content of Living Mulch

	Percent							PPM			
	C/N Ratio	N	S	P	K	Mg	Ca	Fe	B	Zn	
July	16	3.3	0.27	0.43	4.1	0.40	1.4	503	21	35	
August	10	4.3	0.31	0.46	4.2	0.35	1.4	165	24	30	
September	11	4.1	0.30	0.45	3.9	0.31	1.2	191	23	30	

Biodesign Farm - 1996

2004 -
Can we move towards more:
plant diversity?
complex interrelationships?
reduced tillage?

New 6 Ac.
Field – Pasture
for 50 yrs.

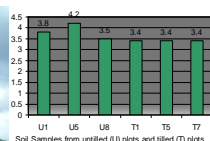


Sheep Tillage – Fall 2004



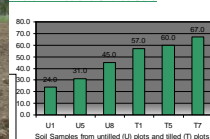
Minimum Tillage April 2005 –
Significant **decrease** in SOM after 2
weeks; Significant **increase** in Nitrate.

Organic Matter in Tilled and Untilled Soil



Soil Samples from untilled (U) plots and tilled (T) plots

Nitrate in Tilled and Untilled Soils



Soil Samples from untilled (U) plots and tilled (T) plots

**TILLAGE CAUSES
RELEASE OF AVAILABLE
NITRATE-N FROM SOM
AND ORGANIC RESIDUE.**

3 – Pass Seeding May 2005 (Eric Brennan USDA, Salinas, CA)



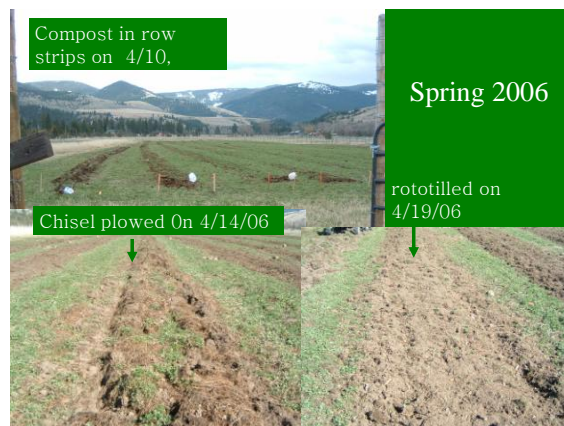
Red Clover – Triticale Cover Crop – August 2005



Red Clover dominant in October 2005



Soil covered in winter to avoid frost heave & provide habitat for soil microbes and predators. Soil covered all year round? How much can we reduce tillage?



Tilling, bed making and planting plastic-mulched minimum-till beds to warm soils.



UNDISTURBED CLOVER IN ROW MIDDLES LATE MAY and JUNE



No-till Experiment - flaming



No-till Brussels sprouts: 36% yield reduction.



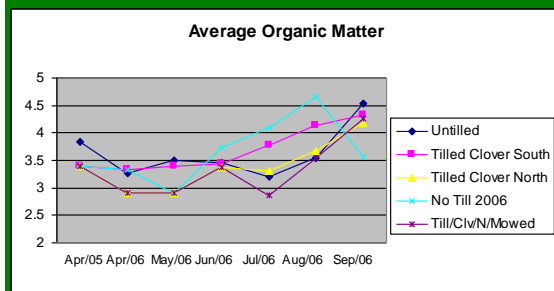
There are better choices than red clover! Annuals that winter kill.....



**Good yield
& quality
in
minimum
tillage
beds**

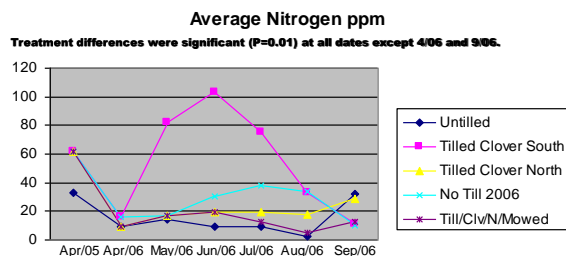
SOIL DATA – SOM. Highest in untilled and No-till plots. The difference between treatments was significant ($P=0.01$) only on 4/05 and 8/06.

SOM added by tilling in clover, but highest SOM in flamed, no-till.



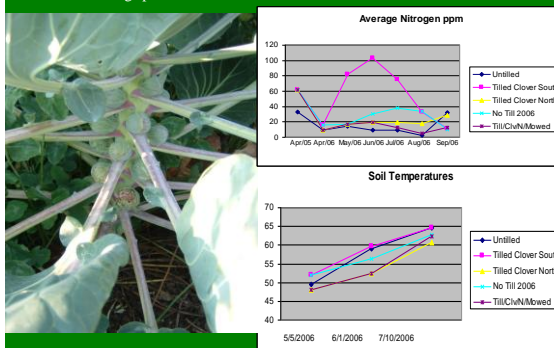
SOIL DATA – NITRATE. Highest in clover minimum-till.

N is released quickly by minimal tillage of clover. N not avail. in no-till until early July. N low in untilled grass & clover & mowed clover but lowest in grass. N lower in mowed vs. unmowed clover



NO-TILL BRUSSELS SPROUTS YIELD = DOWN 36%.

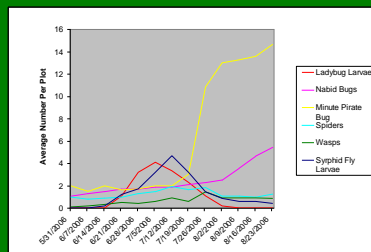
Probably due to lower soil temperatures and slow release of N compared to minimum-till broccoli/cabbage plots.



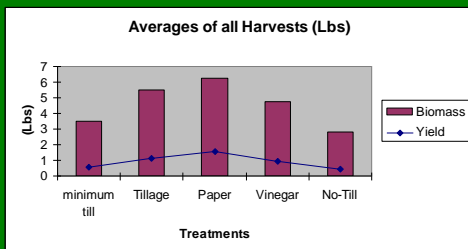
Earlier and increased numbers of predators and parasites and....



**more diversity of species.
Stopped spraying in 2000.**



WEED STUDY 2007 – compared different types of in-row weed management. Yield lowest in no-till.



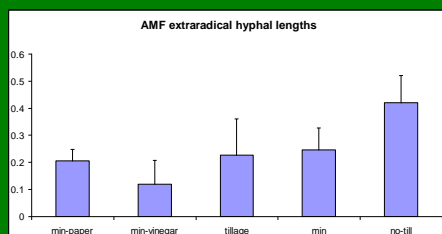
Monitored weed invasion.

Results:

Weeds came from compost source and soil disturbance.



Mycorrhizae fungi (AMF) were highest in no-till plots and lower in all other treatments, indicating that any kind of soil disturbance, even minimum tillage and weed cultivation decreases population levels of these beneficial fungi, at least within a single growing season.



SUMMARY



Slightly lower yield, excellent quality, reduced labor, increased profitability (No off-farm fertilizer, no spraying, little weeding).

Challenges:
Grasses moving into LM
Vole & Bird damage
Seeded crops



Biodesign April 2011

Biodesign 2011



Reduced Tillage Possible on a Larger Scale?
Experiments in CO on a 2000 acre organic vegetable farm with a 5000 member CSA in 2011–
potato & spinach interplanting





Future Directions.....

veganicpermaculture.com

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