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An integrated crop-vermiculture system for treating organic waste on formland

Zhenjun Sun, Yupeng Wu

Department of Ecology and Engineering,
College of Resources and Environment,
China Agricultural University,
Beijing, 100193
CHINA

Outline:

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2.System design

3.Experimental design

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4.2 The effect of soil improvement and crop growth

4.3 System output

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1. Introduction

Humans produce more and more organic waste every day.
household garbage, agricultural waste, sludge, etc

How to properly dispose of these organic wastes has become the focus of much research.
landfills, fermentation, farmland use, etc

Using earthworms to process organic waste is a relatively new technology.
simper, less investment, better treatment effect, etc

However, using earthworms to process organic wastes has been limited to specially adapted places.
earthworm farms, do not use on site, etc

1. Introduction

So we introduces an integrated crop-vermiculture system for treating organic waste on farmland using earthworms.

Through vermiculture, this system disposes of organic waste and produces organic fertilizer. At the same time, nutrients in the organic waste can be used by the agricultural plants on site.

We evaluate the effectiveness of this model in terms of organic waste treatment, system production, and soil improvement relative to conventional agriculture.

2. System design

The model basically consists of alternating bands of crop plant ridges and worm farming troughs.

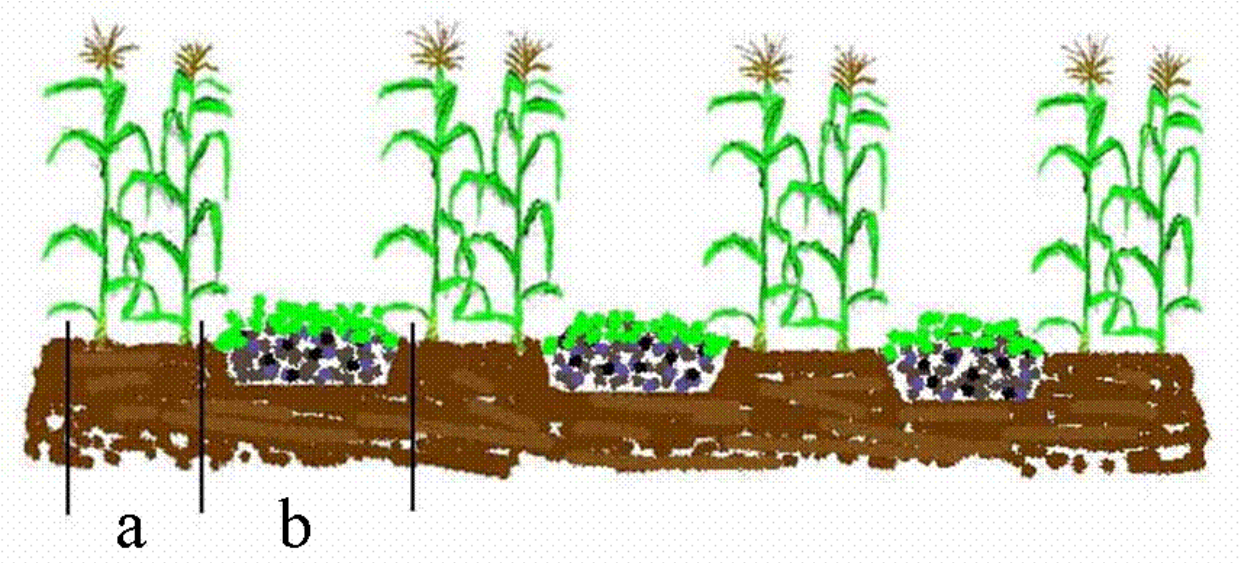


Fig. The integrated ecosystem model of crop-vermiculture waste treatment

In Fig.

a is 0.5 meters wide crop planting band with winter wheat-summer maize rotation which has higher density than conventional agriculture.

b is worm farming trough with 0.8 meters wide, 0.2 meters deep, organic waste is treated while breeding earthworm (*Eisenia foetida*) .

2. System design

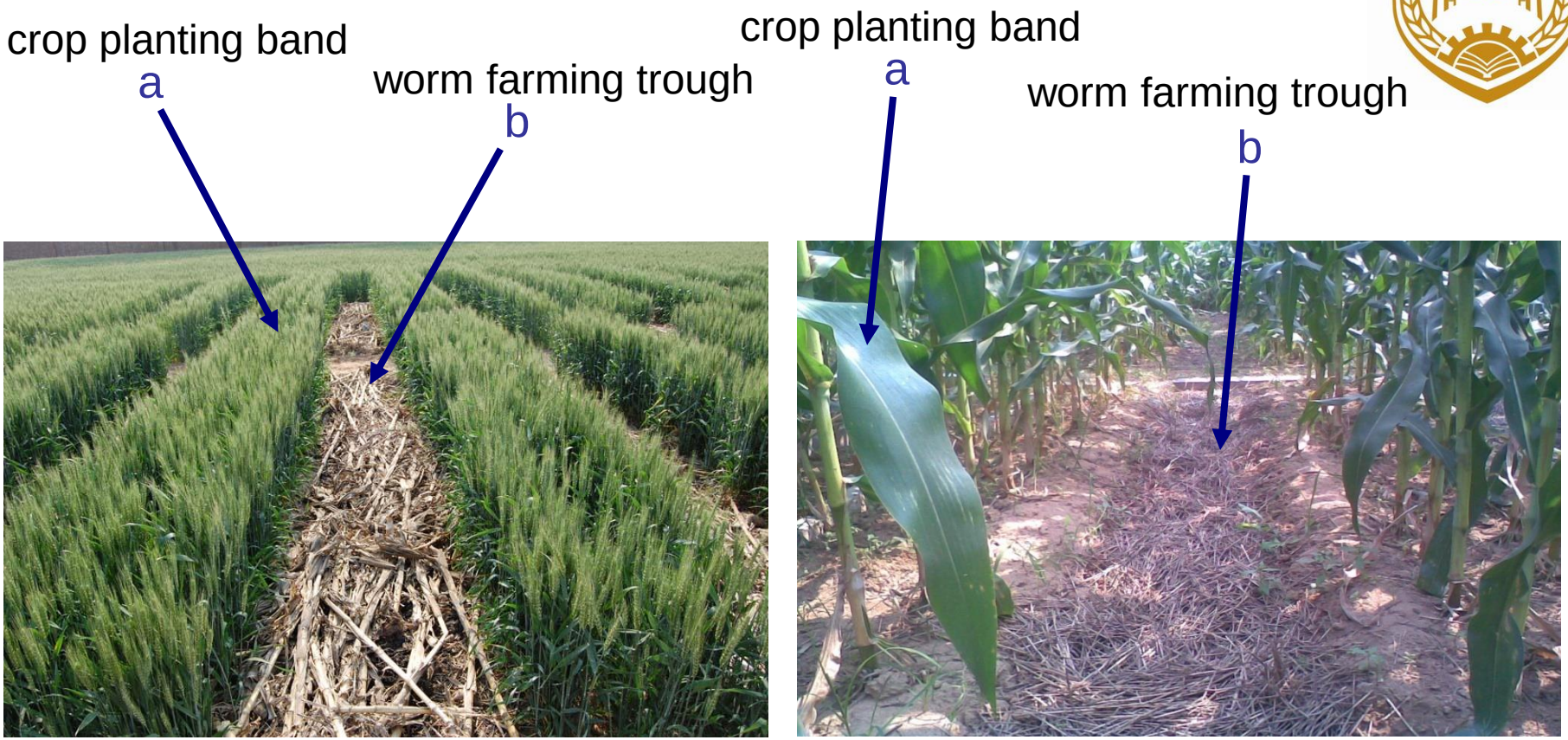


Fig. Field photographs of the integrated crop-vermiculture system

3. Experimental design

We conducted plot experiments with a total of four treatments:

dung (NF)

sludge (WN)

mushroom residue (MGZ)

In accordance with the requirements of the design, dung, sludge, and mushroom residues were placed in their respective troughs.

conventional cultivation (CK)

The CK treatment served as a control and included no earthworm breeding troughs. Following local crop rotation practices.

4.1 Organic waste treatment and recycling

4. Results and discussion: **Organic waste treatment and recycling**

Effect of organic waste treatment and organic fertilizer output

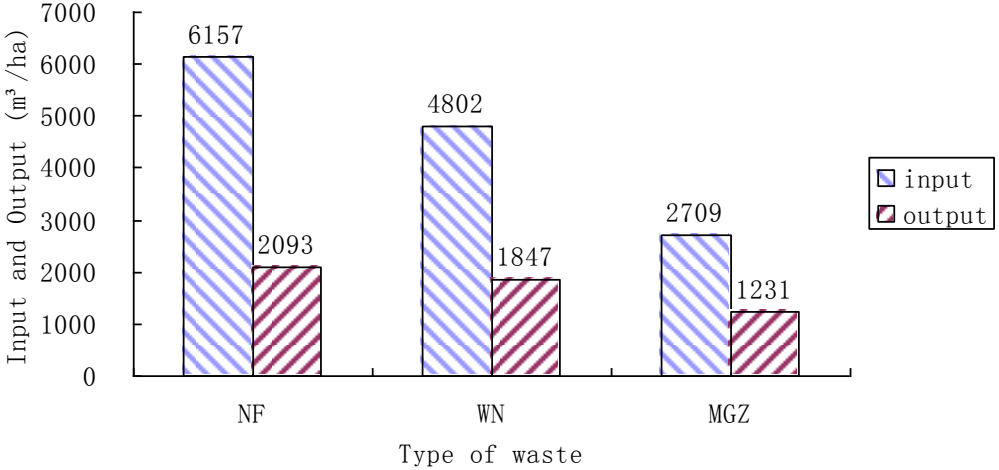


Fig. Annual inputs and outputs of organic waste, dung (NF), sludge (WN), and mushroom residue (MGZ)

Model is effective at disposing of organic waste, while capacity varied significantly with organic waste type ($P < 0.05$). This may be related to properties of the organic waste itself, such as the C/N ratio.

4. Results and discussion: Organic waste treatment and recycling

The nitrogen, phosphorus, potassium, and organic matter content of organic fertilizer produced by vermiculture

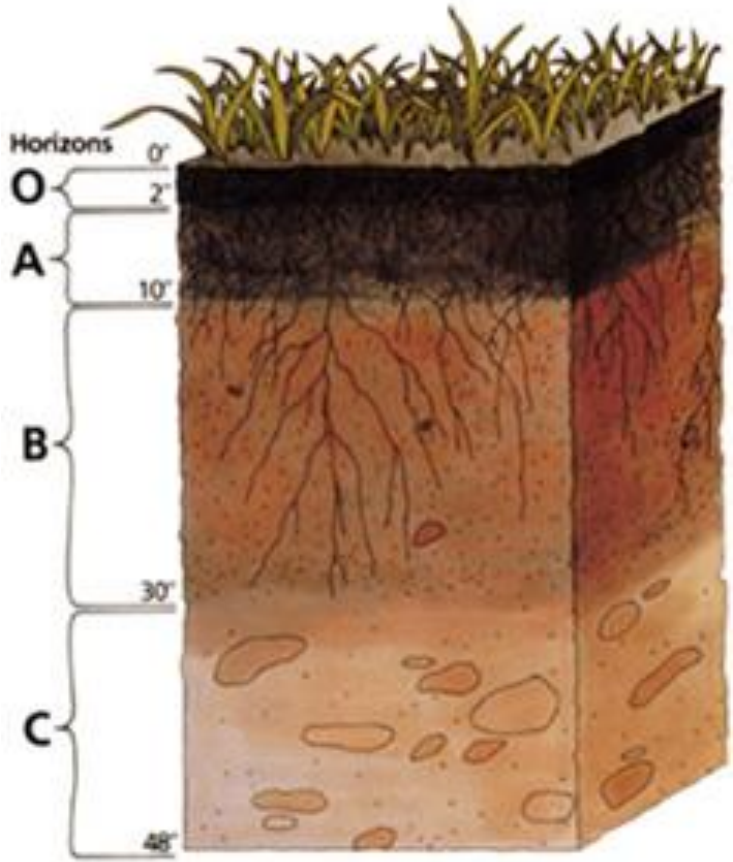
Table. The nutrient content of earthworm dung output

Treatment	Total-N (N) %	Total-P (P_2O_5) %	Total-K (K_2O) %	Total nutrient %	Organic matter %
NF	1.49	1.51	1.29	4.29a	37.09a
WN	1.22	3.31	1.14	5.67b	37.79a
MGZ	0.69	0.65	1.51	2.85c	34.28b
National standard				4.00d	30.00c

Different letters in the same column indicate significant differences at p=0.05 based on the least-significant difference (LSD) test method.

The total nutrient content and organic matter content of the fertilizer produced in the NF and WN treatments comply with the Chinese national standards for agricultural organic fertilizer.

4.2 The effect of soil improvement and crop growth



4. Results and discussion: **The effect of soil improvement and crop growth**

Soil bulk density

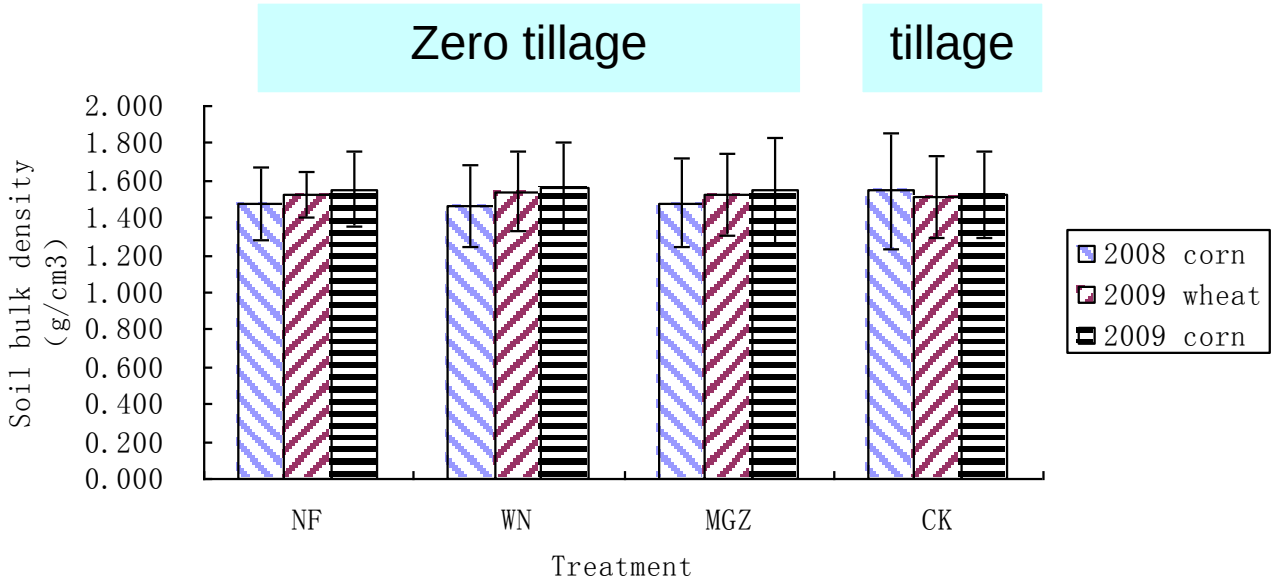


Fig. Soil bulk density after each harvest

There was no significant different between the treatments and conventional agriculture for the same period.

4. Results and discussion: The effect of soil improvement and crop growth

Soil nutrient content

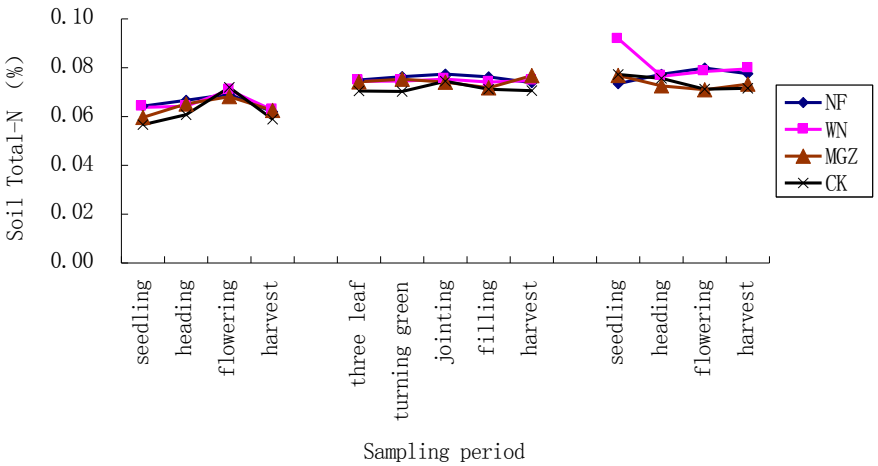


Fig. Soil total-N during various stages of crop growth

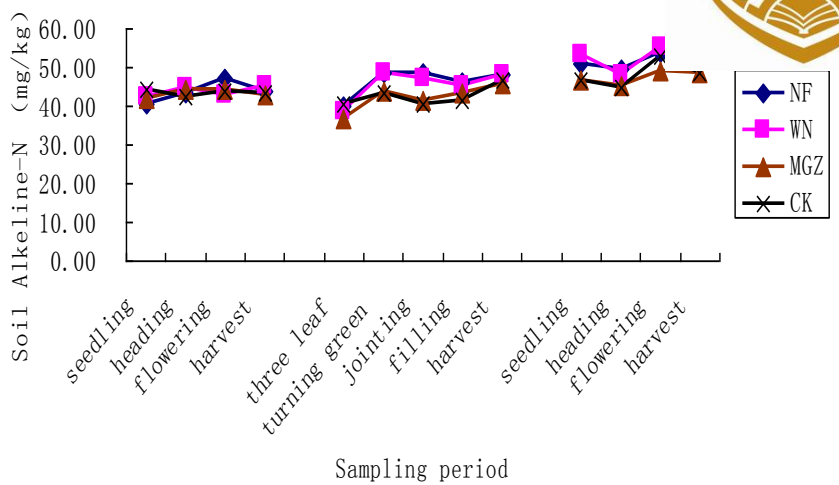


Fig. Soil alkaline-N during various stages of crop growth

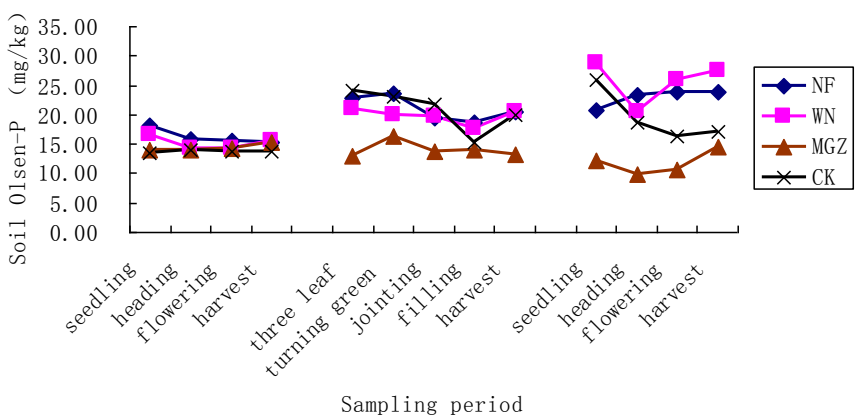


Fig. Soil Olsen-P during various stages of crop growth

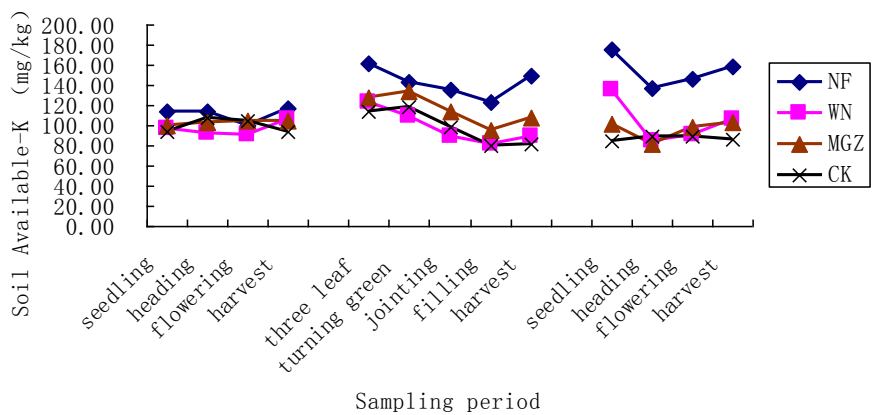


Fig. Soil available-K during various stages of crop growth

4. Results and discussion: **The effect of soil improvement and crop growth**

Soil nutrient content

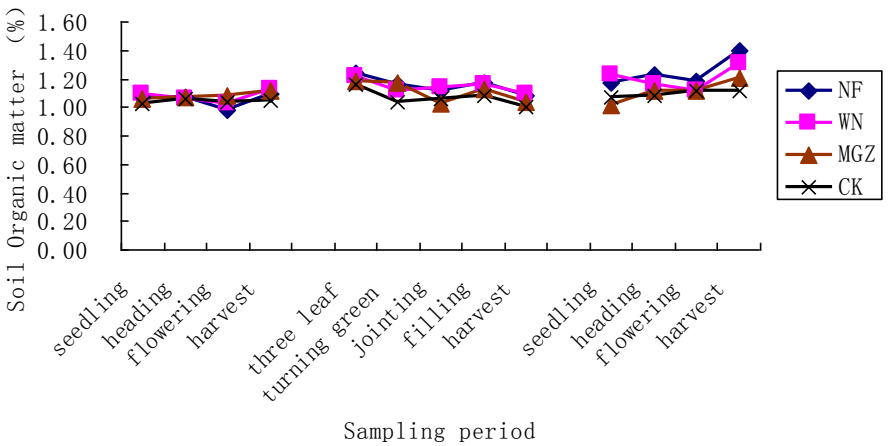


Fig. Soil organic matter during various stages of crop growth

These results indicate that while the model avoids fertilizer inputs in the planting process, the soil nutrient which are important to crop growth, did not decrease rapidly.

Furthermore, use of higher nutrient content organic waste in this model would in turn improve soil nutrient contents.

4. Results and discussion: The effect of soil improvement and crop growth

Soil heavy metal content

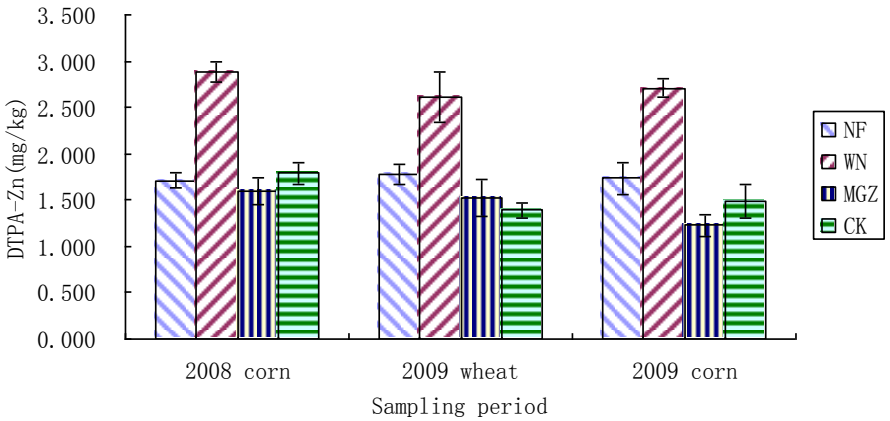


Fig. Soil DTPA-Zn after each harvest

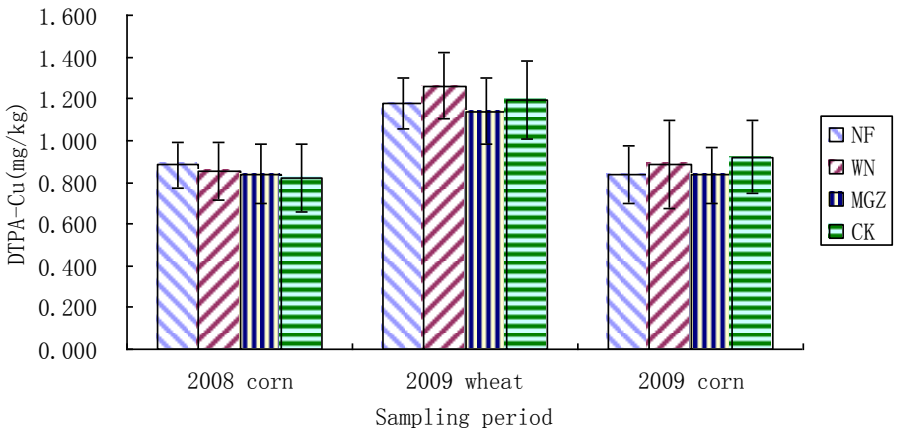


Fig. Soil DTPA-Cu after each harvest

Sludge treatment resulted in DTPA-Zn levels significantly higher than levels under conventional agriculture, while the other treatments had no significant effect on DTPA-Zn levels. DTPA-Cu levels were not significantly affected by the treatments.

4. Results and discussion: The effect of soil improvement and crop growth

The impact on plant height and leaf area

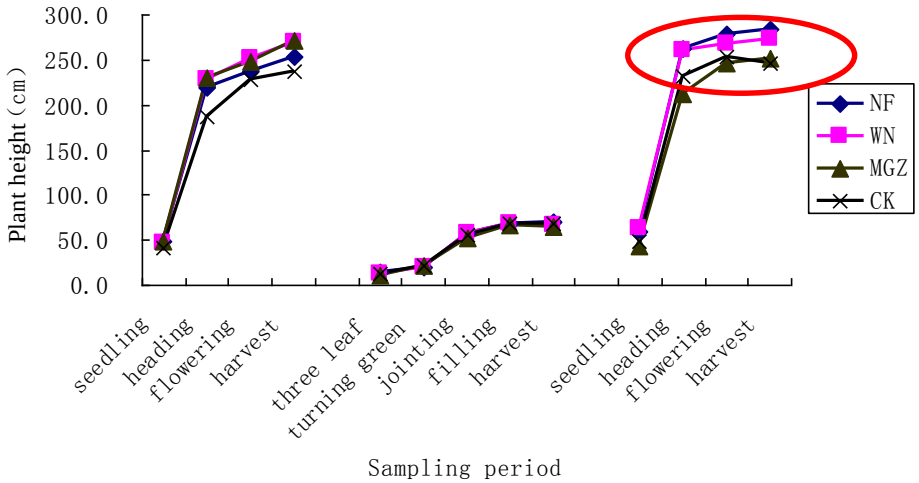


Fig. Plant height

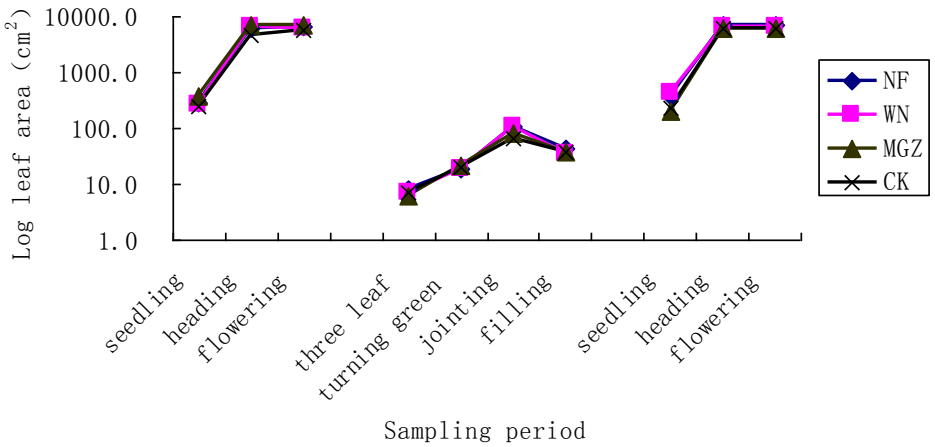
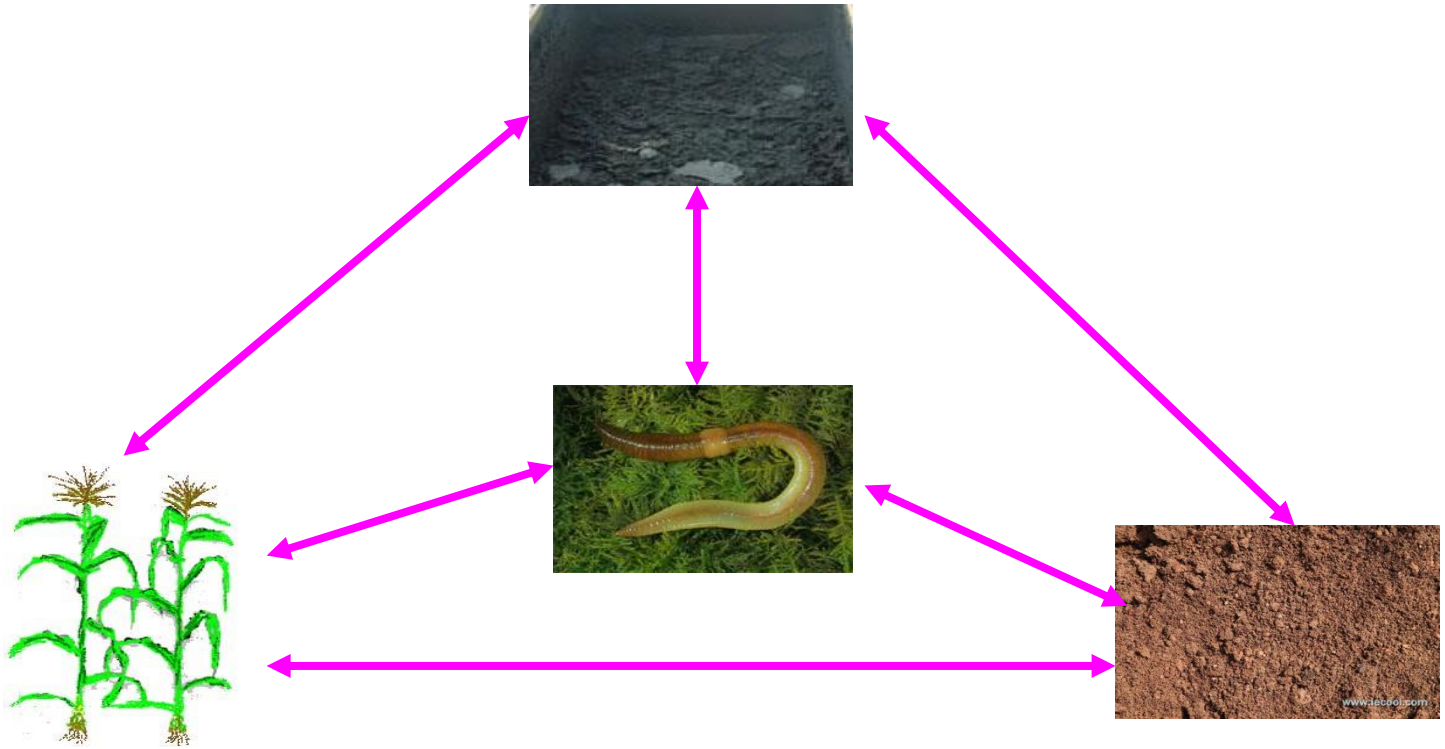


Fig. Log leaf area

The treatments did not have a significant effect on plant height or leaf area for a given sampling stage, but over time, plant height in the MGZ treatment did show a downward trend relative to the other treatments.

4.3 System output



4. Results and discussion: System output

Crop yield and quality

Table. Yield and 1000-Kernel Weight (TKW)

	2008 corn		2009 wheat		2009 corn	
	Yield kg/ha	TKW g	Yield kg/ha	TKW g	Yield kg/ha	TKW g
NF	10290a	299.04a	4380a	41.01a	10650a	311.30a
WN	10,020ab	322.98a	3930a	39.65a	10385a	310.92a
MGZ	8865b	252.03ab	4395a	42.07a	8355b	289.43b
CK	6480c	228.43b	7290b	35.12b	7770b	292.52ab

Different letters in the same column indicate significant differences between treatments based on the LSD test method (p=0.05).

By using a denser corn planting system than normal, we obtained a higher corn yield than produced by conventional methods. On the other hand, wheat yields were halved.

4. Results and discussion: System output

Crop yield and quality

Table. N, P, K, and crude protein content in the harvested grain

	Treatment	Sampling period and crop		
		2008 corn	2009 wheat	2009 corn
Total-N %	NF	1.2181a	2.1454ab	1.3660a
	WN	1.2120a	2.2408a	1.3227a
	MGZ	1.2460b	2.0396b	1.2631b
	CK	0.9895c	2.1696ab	1.1923c
Total-P %	NF	0.3895a	0.4385a	0.3430a
	WN	0.3880a	0.4374a	0.3160a
	MGZ	0.3092a	0.3850a	0.3226a
	CK	0.3462a	0.3997a	0.3585a
Total-K %	NF	1.8227a	2.1341a	2.0722a
	WN	2.2984b	2.9941a	1.9078a
	MGZ	1.9327a	2.2618a	1.8332a
	CK	1.7219a	2.8836a	1.9193a
Crude protein %	NF	8.3559a	13.8519a	8.6997a
	WN	8.1730a	14.1416a	8.6303a
	MGZ	8.1761a	13.8221a	7.8980b
	CK	6.6984b	14.0491a	8.0331b

Different letters in the same column indicate significant differences between treatments based on the LSD test method (p=0.05).

However, in all treatments, the TKW, and grain nitrogen, phosphorus, potassium, and protein contents were better than those under conventional agriculture.

4. Results and discussion: System output

Crop yield and quality

Table. Cu and Zn content in the harvested grain

		NF	WN	MGZ	CK	National standard
Cu content mg/kg	2008 corn	3.25A	3.28A	3.19A	3.31A	10
	2009 wheat	2.43A	3.23A	3.63A	3.32A	10
	2009 corn	4.02A	4.26A	3.23A	3.95A	10
Zn content mg/kg	2008 corn	18.46A	39.01aA	12.90A	13.23A	50
	2009 wheat	25.63aA	37.78aA	33.34aA	11.04A	50
	2009 corn	19.49A	35.23aA	26.79A	22.47A	50

a: significant difference between the treatment and CK at the 0.05 level.

A: significant difference between the treatment and national standards at the 0.05 level.

There were no significant differences in Cu content. However, Zn content was significantly higher in the WN treatment than in the CK, and in 2009, all of the treatments had significantly higher wheat grain Zn content.

4. Results and discussion: System output

Earthworm harvest and Cu and Zn content

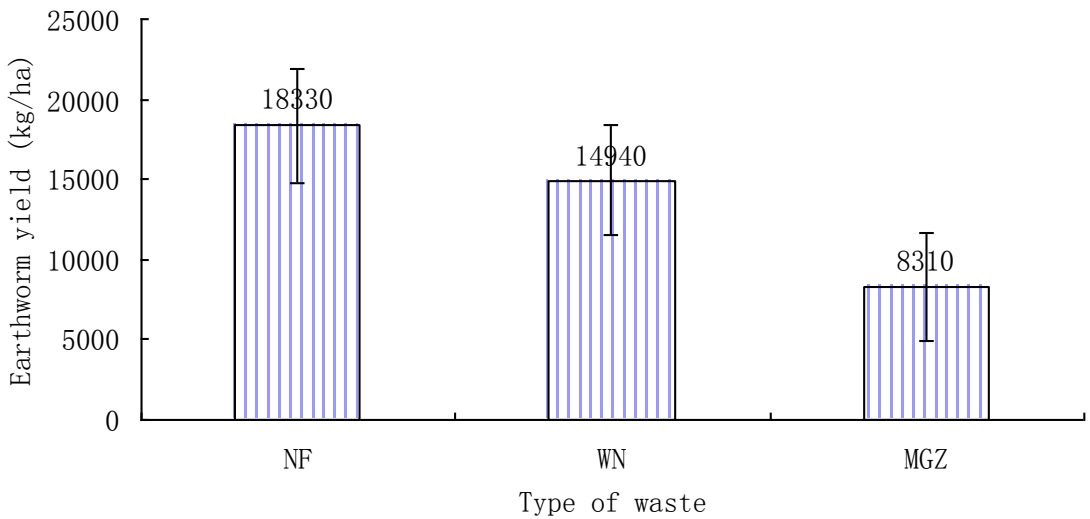


Fig. Earthworm annual yield (fresh weight)

These results indicate that by using this model to treat organic waste, earthworms can also be farmed at the same time. The annual yield was significantly higher in NF and WN than in MGZ.

4. Results and discussion: System output

Earthworm harvest and Cu and Zn content

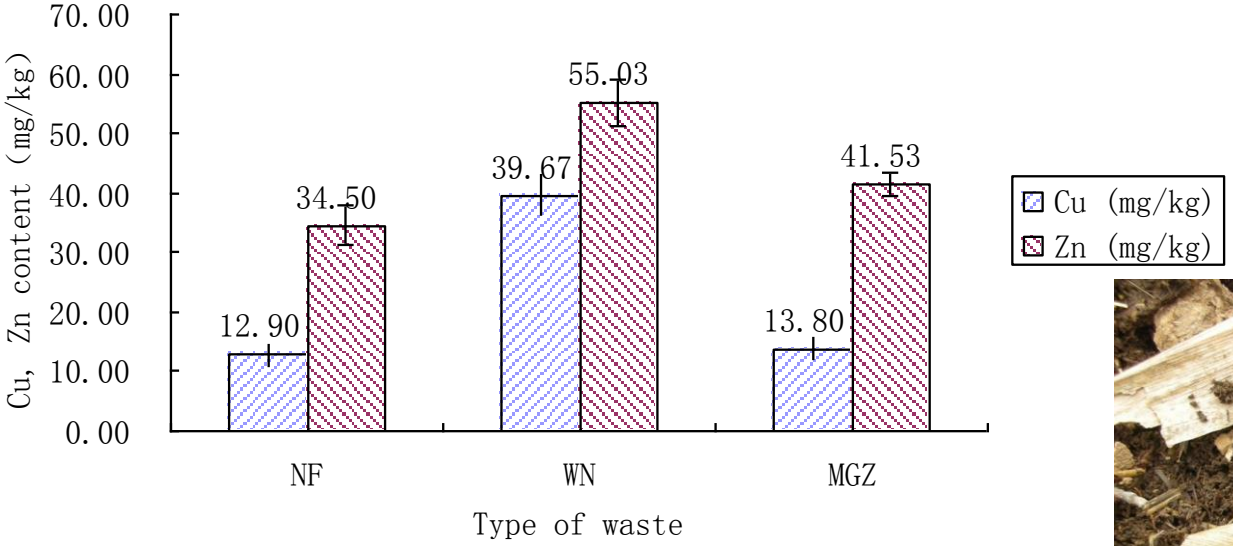


Fig. Cu and Zn content of earthworms

The Cu content was significantly higher in earthworms raised on sludge than in those raised on dung or mushroom residue. The Zn content of earthworms raised on dung, sludge, and mushroom residue was varied significantly with waste type.

5. Conclusion

We have already conducted 1.5 years of research, the results show that the social and economic benefits of the corn/wheat-vermiculture system are greater than those of the traditional corn/wheat cropping pattern.

(1)The crop-vermiculture system is an effective method of waste processing, although the waste treatment capacity and nutrient content vary with the type of organic waste used.

(2)The crop-vermiculture system attained a higher corn yield than the traditional method, but half the wheat yield of the traditional method. However, the quaintly of grain were better than in the traditional method.

(3)In the harvest season, we can obtain not only corn or wheat, but also earthworms and organic fertilizer, with zero chemical fertilizer input and a reduction in mechanical cultivation. Revenue can be increased.

(4) Although we did not use urea or other fertilizers in this system, earthworm activity certainly improved the soil physical structure and maintained or increased soil nutrients.

(5)Treatment with sludge, which has a high heavy metal content, resulted in a slight enrichment of soil Zn content; Zn levels were also higher in grain and worms with sludge treatment.

5. Conclusion

In conclusion, we found the crop-vermiculture system of processing organic waste to be feasible and effective at treating, transforming, and using organic waste. The system can provide larger outputs and good economic benefits, improve the physical properties of soil and soil fertility. All results were greatly affected by the type of organic waste used, with the order of treatment effect from greatest to least being dung > sludge > mushroom residue.


Thank
you!!