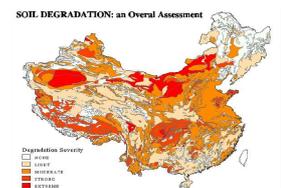
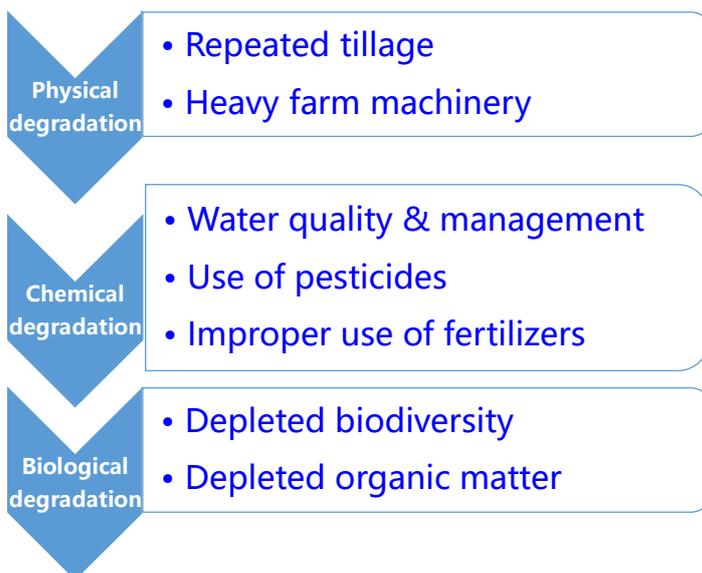




Conservation agriculture practices in China -from plot research to field application

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Regional Planning, CAAS
16 Mar. 2022

Soil degradation is a worldwide problem



Three principles of Conservation Agriculture:

Minimum mechanical soil disturbance

(i.e. no tillage) through direct seed and/or fertilizer placement.



Permanent soil organic cover

(at least 30 percent) with crop residues and/or cover crops.



Species diversification

through varied crop sequences and associations involving at least three different crops.



FAO

Benefits of Conservation Agriculture

Economic benefits that improve production efficiency.

- Time saving and thus reduction in labor requirement.
- Reduction of costs, e.g. fuel, machinery operating costs and maintenance, as well as a reduced labor cost.
- Higher efficiency in the sense of more output for a lower input.



Benefits of Conservation Agriculture

Agronomic benefits that improve soil productivity.

- Adopting conservation agriculture leads to improvement of soil productivity:
- Organic matter increase.
- In-soil water conservation.
- Improvement of soil structure, and thus rooting zone.



Benefits of Conservation Agriculture

Environmental benefits that protect the soil and make agriculture more sustainable:

- Reduction in soil erosion, and thus of road, dam and hydroelectric power plant maintenance costs.
- Improvement of water quality.
- Improvement of air quality.
- Biodiversity increase.
- Carbon sequestration.



Regional specified conservation agriculture development

Experimental site distribution in China

类型区	place	Longitude and latitude	Precipitation (mm)	Average temperature °C	Soil type	Crop
Cold area in northeast Pain	Shuangcheng Heilongjiang	125°41' E 45°08' N	480	4.4	mollisol	Spring maize
Cool area in northeast plain	Lishu jilin	124°53' E 43°46' N	576	5.8	mollisol	Spring maize
North China plain	Langfang hebei	116°36' E 39°36' N	550	11.9	Fluvo-aquic soils	Winter wheat/summer corn
	Jiyang shandong	116°52' E 36°41' N	713	14.9	Cinnamon soils	Winter wheat/summer corn
	gaomishandong	119°26' E 36°8' N	614	13.8	Brown soils	Winter wheat/summer corn
	Luoyang henan	112°56' E 34°80' N	650	13.7	Brown soils	Winter wheat



1. pelletized straw returning in the cold area

Research and development of field self-walking straw picking and pelletizing machine

Traditional tillage

pelletized straw returning

Pelletized straw

Raw straw

- collection
- Pulverize
- Mixing with fertilizer
- Granulation in situ

1. Small volume;
2. better soil seedbed quality;
3. fast decomposition;
4. does not affect cultivation and growth of subsequent crops.

(1) Degradation and nutrient release of granular straw

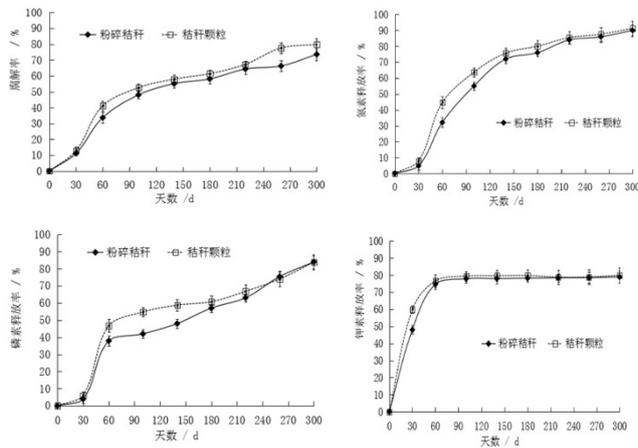
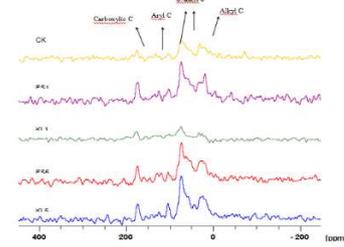


Fig. Differences in decomposition and nutrient release



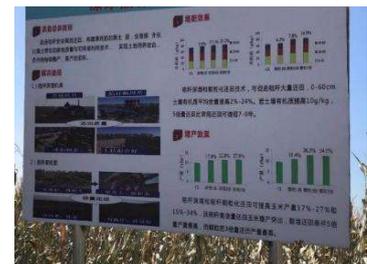
Soil ^{13}C NMR spectra characteristic



- straw returned to the field increased HA/FA and PQ value significantly,
- Straw granules can increase the ratio of carbonyl carbon and aromatic carbon, increase the degree of aroma and decrease the degree of lipidization
- It is beneficial to the stability of soil organic carbon structure

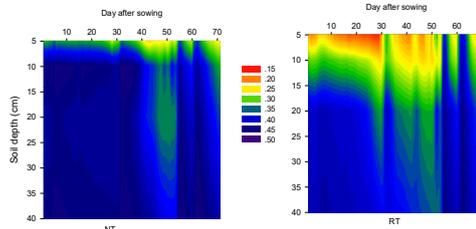
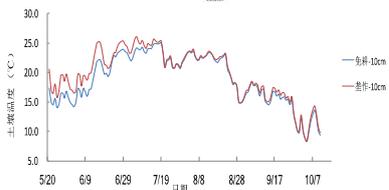
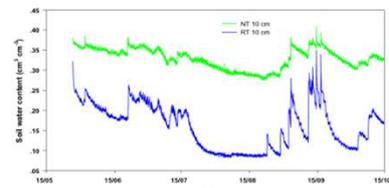
(2) The suitable amount, time, yield increasing effect and economic benefit

The yield was increased by more than 400kg per hectare and the net benefit was slightly higher than that of traditional straw return

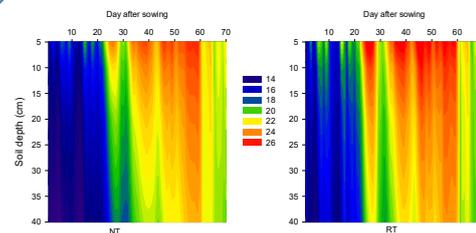


tillage	Straw return	Straw treatment cost yuan/ha	Tillage cost yuan/ha	Other input yuan/ha	Net benefit of production yuan/ha	CO ₂ emission kg C/ha-year	Yield kg/ha-year	Carbon emission per unit grain kg C/kg
rotary tillage 3000kg/ha	traditional	990	435	14835	14577	9990	13819	0.72
	pelletized straw	2700	435	14835	14475	11535	14948	0.77
ploughing 3000kg/ha	traditional	990	531	14835	13905	10396	13453	0.77
	pelletized straw	2700	531	14835	14809	9824	14582	0.67

2. conservation strip tillage in Northeast China Plain



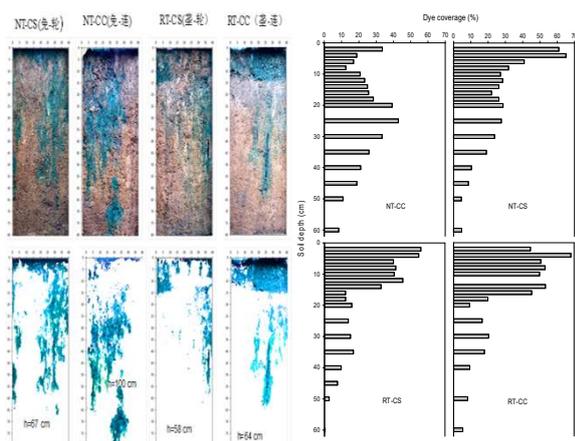
Seasonal variation of soil water in soil profile (cm³/cm³)



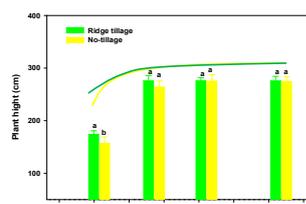
Seasonal variation of soil temperature in soil profile (°C)

The problems of low soil temperature in spring seeding in cold areas were solved

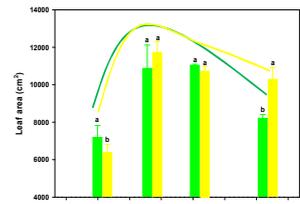
(1) soil pore characteristics and crop growth



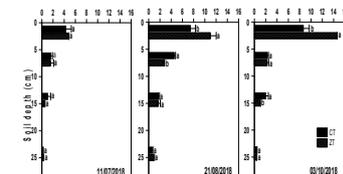
Pore distribution in soil profile



Seasonal variation of plant height



Seasonal variation of maize leaf area



Crop root distribution in soil profile



- No-tillage increased the porosity of deep soil (20-35cm), especially 0.05-0.3mm
- No tillage increases the depth of soil water infiltration, which can reach less than 1m

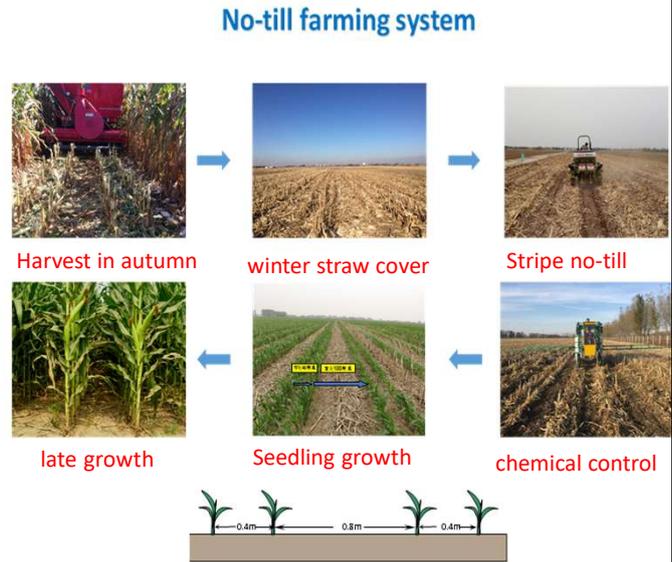
- No tillage promotes root and shoot growth in later period

(2) conservation strip tillage in northeast plain

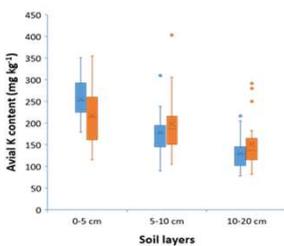
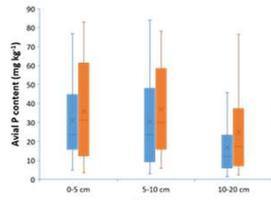
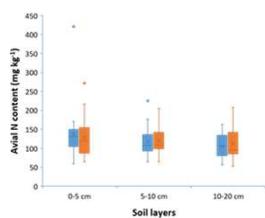
autumn: Mechanical harvesting of corn, straw return and cover all land, water storage and soil conservation, reduce erosion

spring: The original wide row of corn straw was cleaned and collected into the original narrow row to form a clean sowing seedling

operation	No tillage (yuan/ha)	Traditional (yuan/ha)	cost saving (yuan/ha)
Stubble removal	0	700	700
Seeding and fertilizer	500	300	-200
Herbicide spraying	100	100	0
fertilizer		300	300
Straw clean up	0	700	700
total	600	2100	1500



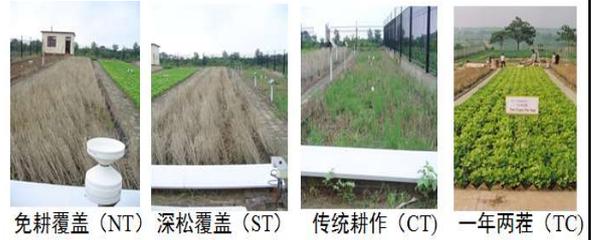
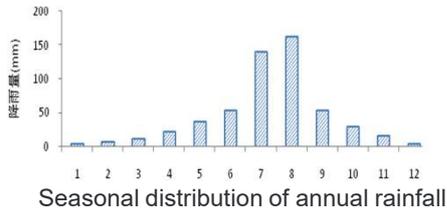
(3) Demonstration of strip conservation tillage



	West	middle	East
County	吉林省：长岭县、双辽市、乾安县、内蒙古：科尔沁左翼中旗	吉林省：九台区、农安县、榆树市、梨树县、东丰县、辽宁省：昌图县、铁岭县	黑龙江省：佳木斯市、大同区、肇州县
climate	年有效积温2884-3118°C；年均降雨量426-494mm；无霜期140-146天	年有效积温2850-3046°C；年均降雨量508-672mm；无霜期143-155天	年有效积温2521-2800°C；年均降雨量428-514mm；无霜期130-143天
Soil	砂土及砂壤土	粘壤土及粘土	砂土及粘壤土



3、 conservation tillage in North China Plain

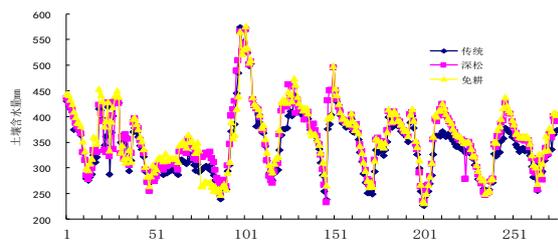
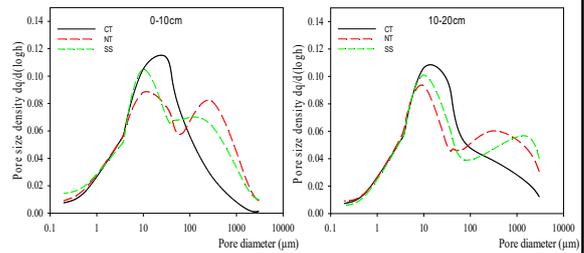


mainly for higher water use efficiency, soil and water conservation

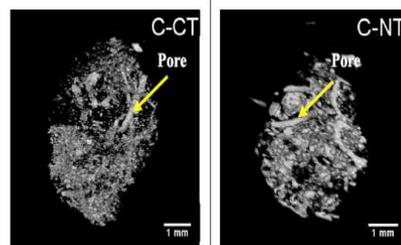


(1) Water conservation ability

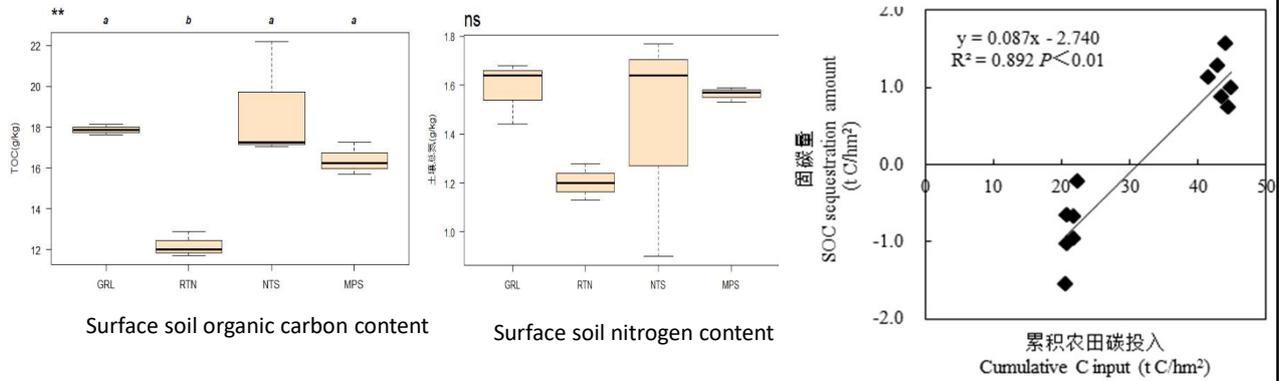
- Increased water infiltration, reduced runoff by more than 80%, increased soil water storage by 19-36 mm during the rainy season, and increased water use efficiency by 11-23%.
- Increased the proportion of permeable pores and water-retaining pores of 100-1000 μm and 10-100 μm



图、不同耕作下土壤水分周年变化



(2) Soil carbon and nitrogen enrichment in surface layer

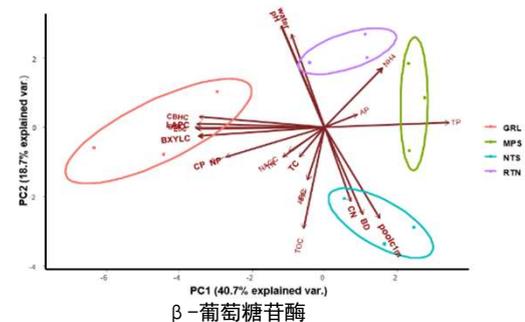
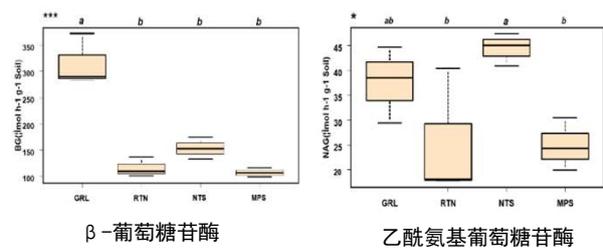


- ◆ Soil organic carbon and nitrogen content was significantly increased by returning straw and no tillage.
- ◆ The carbon sequestration rates of no-tillage and subsoiling were 0.09 tc /hm²/yr and 0.06 TC /hm²/yr.
- ◆ 2.4t.hm⁻² straw input is needed every year To maintain the carbon balance of farmland

(3) Increased biological fertility

Microbial diversity of cultivated soil

团聚体粒级 (μm)	处理	Shannon-Weaver指数		
		细菌	真菌	古菌
> 2000	少耕	2.81	1.91	3.14
	免耕	3.00	2.29	3.30
	深松	2.94	2.36	3.29
	两茬	2.99	2.47	3.37
	传统	2.84	2.07	3.15
1000-2000	少耕	2.99	1.60	3.33
	免耕	3.05	2.44	3.19
	深松	3.05	2.53	3.4
	两茬	3.04	2.27	3.36
	传统	3.03	2.28	3.01
250-1000	少耕	2.92	2.06	3.21
	免耕	3.02	2.18	3.17
	深松	2.91	2.46	3.28
	两茬	2.91	2.18	3.28
	传统	2.84	1.77	2.88
< 250	少耕	2.84	1.78	3.06
	免耕	2.85	2.38	2.98
	深松	2.85	2.55	3.06
	两茬	2.84	2.29	2.93
	传统	2.84	1.54	2.70



- Conservation tillage increases soil microbial abundance
- No-tillage with straw returning increased soil C/N and changed the stoichiometric balance
- Conservation tillage increases the activities of carbon, nitrogen and phosphorus enzymes activities

(4) Integrated conservation tillage technology in NCP

1 no tillage with straw returning :

Operation: mechanical harvesting and crushing straw at the same time, covering the ground annually. Stubble height $\leq 10\text{cm}$, straw crushing length $\leq 10\text{cm}$; The straw covers the ground evenly

2 subsoiling and deep fertilizer application:

Operation: deep soiling once every year or every two years, depth $\geq 30\text{-}40\text{cm}$; Fertilize at side depth $\geq 10\text{cm}$ at the same time of sowing.



Mechanical harvest, straw coverage



(5) Field demonstration and farmer class

palaces	Lang fang Xingtai Hebei 河北：廊坊、邢台	Mengjin Luoning Yichuan Henan河南：孟津、洛宁、伊川	Linyi Gaomi Jiyang Shandong 山东：临邑、高密、济阳
Soil types	Fluvo-aquic soils	Loess soil	Fluvo-aquic soils、Cinnamon soil

the total extension area is more than 200,000 mu.



(三) Machinery and tools for full mechanization of conservation tillage

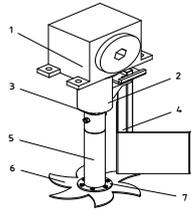
(1) no-tillage maize planter



no-tillage maize planter



应用效果



Draft of stubble cleaning device



seed-metering device

2BTFQ-4 型玉米苗带清茬施肥播种机

试验报告

设计单位: 山东农业机械化科学研究院
生产企业: 潍县
试验类别: 田间试验
试验时间: 2018年5月

Effect of the seeder

项目	average/mm	Percent of pass/%	Coefficient of variation/%
sowing depth	46.7	92.3	21.1
depth of fertilization	71.5	94.3	19.7
seed spacing	15.5	93.0	11.2

(2) Corn ridge seeding machine with intelligent control



Control system



传感器照片

2BYMQF-4 型玉米灭茬起垄施肥播种机

试验报告

设计单位: 山东农业机械化科学研究院 吉林大学
生产企业: 潍坊江隆农牧机械有限公司
试验类别: 田间试验
试验时间: 2018年4月



Sorn ridge seeding machine

Parameters of seeding

	Hight of ridges	Width of ridge	Distance between ridges
average/mm	131.6	264.7	659.2
Agronomy/mm	130	260	650
pass/%	94.73	90.64	90.13
SD	7.8	18.58	38.43
CV/%	5.93	7.02	5.83



The cooperation in future

- Share information/knowledge with partners from LMC/GSP
- Personnel visit exchange if the COVID-19 is not a problems
- Soil doctor program in China
- ...

Thanks for the partners (Cai Dianxiong, Wang Jing, Gaoweida, Jian Shichun, Zhang Yingpeng) from project "conservation tillage research in dryland area"

Thanks for the financial support of the project from MOST



Thank you for your attention !