Technologies and Practices of Black Soils Conservation and Utilization in China

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Contents

Part 1

Status quo of black soils

1 Black soil definition

◆ What are black soils?

The International Network of Black Soils (INBS)

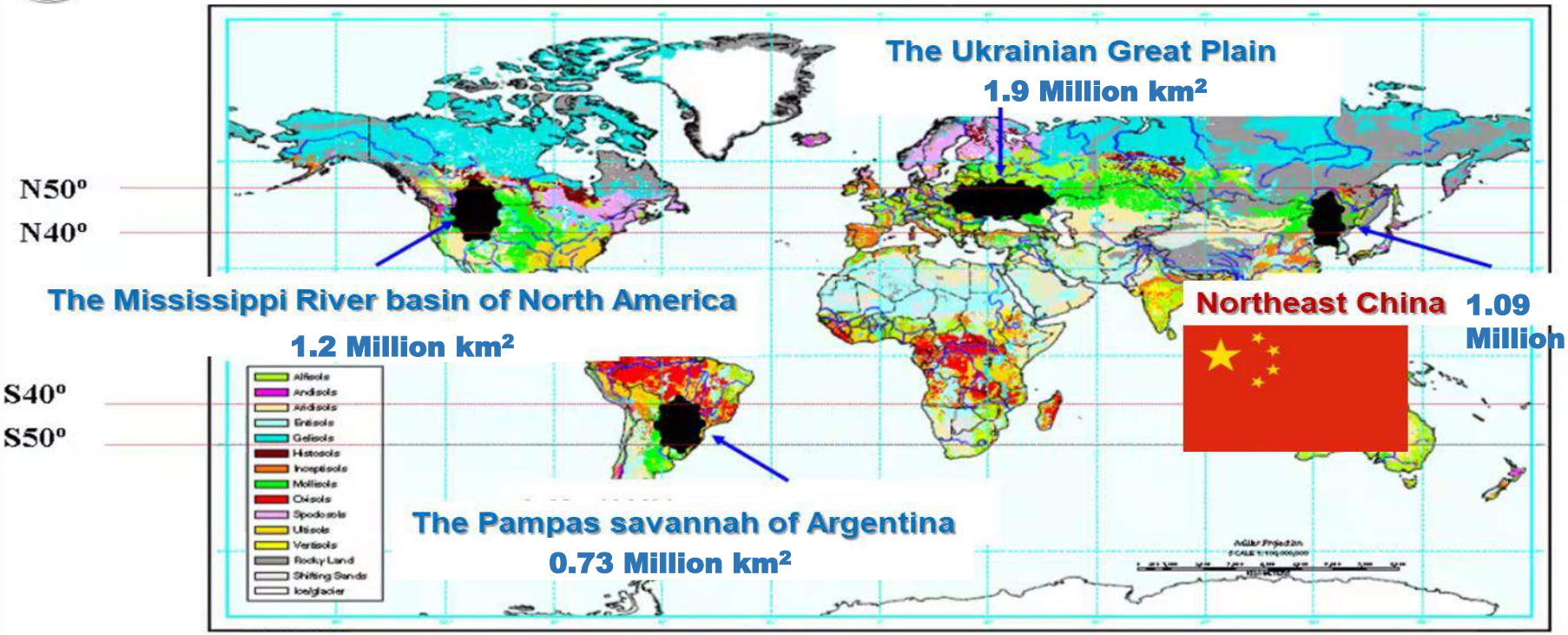
Black soils are soils with thick, dark-coloured horizons, rich in organic carbon.

FAO (2021)

Black soils are mineral soils which have a black surface horizon, enriched with organic carbon that is at least 25 cm deep.

Photo: July, Heilongjiang province, Zhang Jiuming

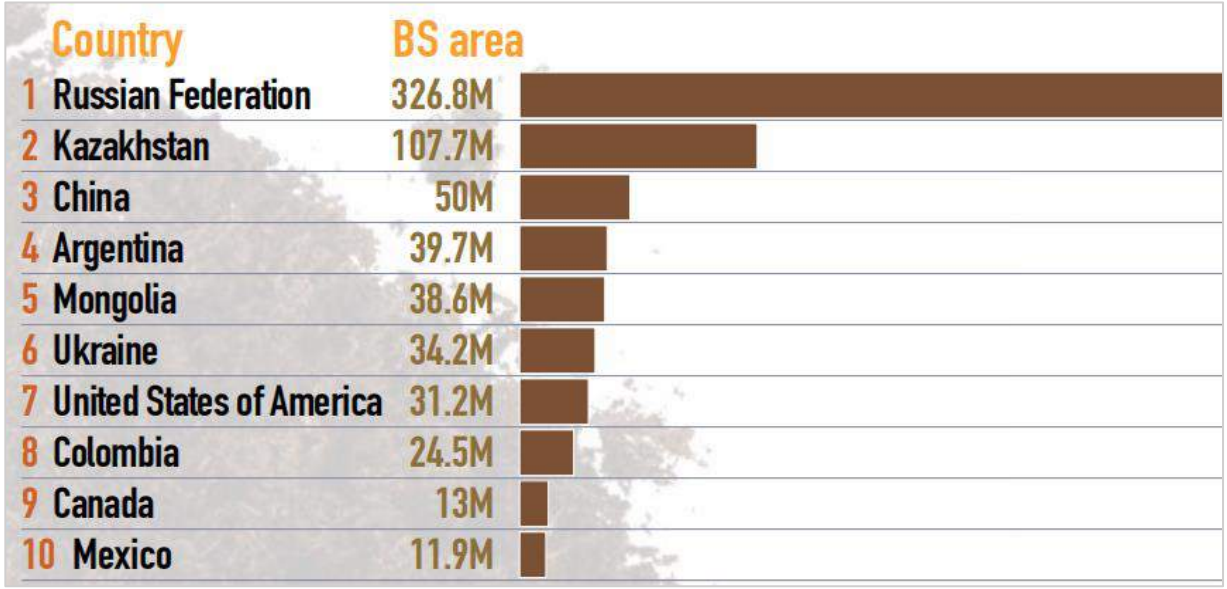
2 Black soils distribution



- Globally, there are an estimated 725 million hectares of black soils worldwide, the total area of black soil accounts for less than 17% of the global land area, and there are four black soil areas on the earth.

3 The importance of BS in the world

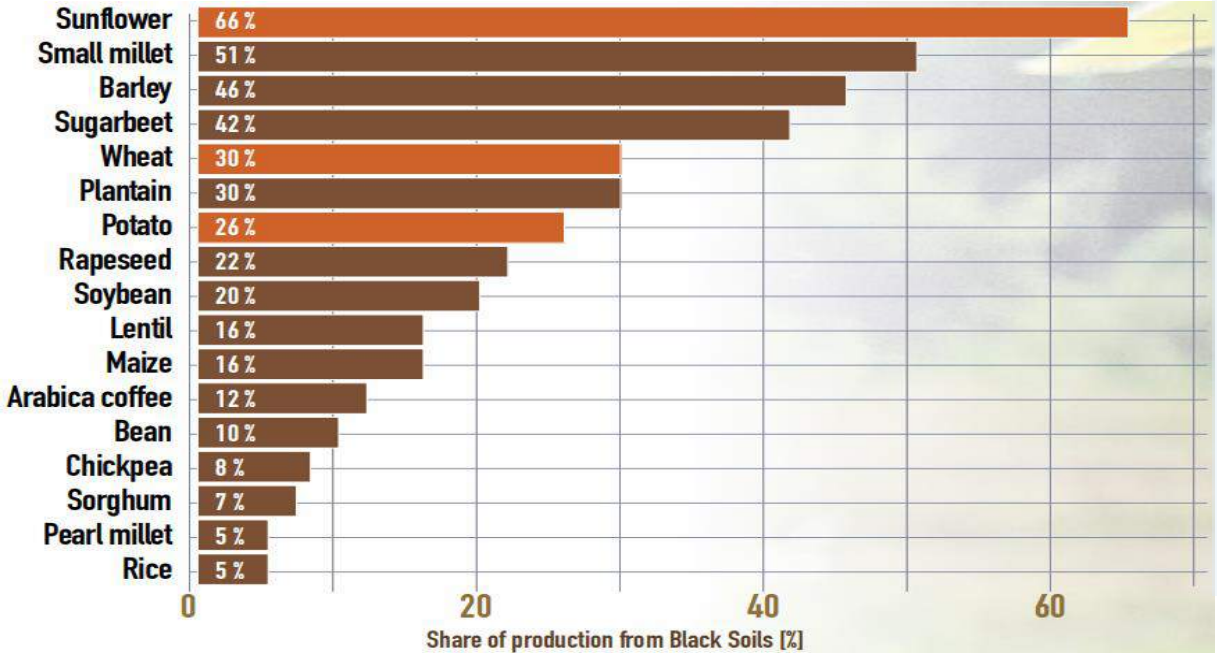
3.1 BS contribute to the sustainable development of human



Top ten black soil countries (Area in million hectares)

- Approximately 223 million people live on BS, representing less than 3% of the world's population.
- However, BS concentrate a substantial portion of the population in these countries.
- About 93% of the Moldovan population live in a black soil area.
- In the Russian Federation, BS account for 19% of the country's land area and yet are home to nearly half of the Russian.
- BS cover 14% of Argentina's area and yet are home to over half of the country's population.

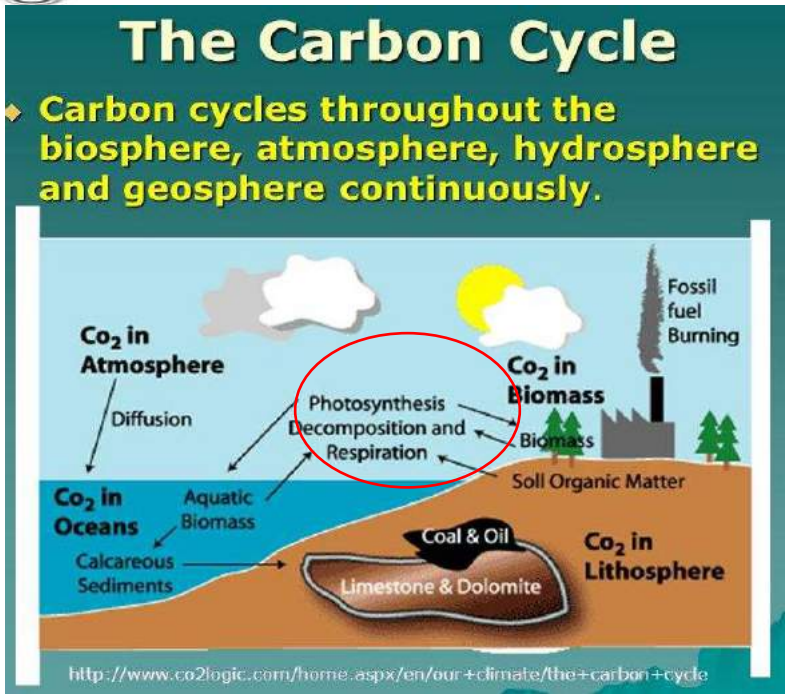
3.2 Black soils feed the world



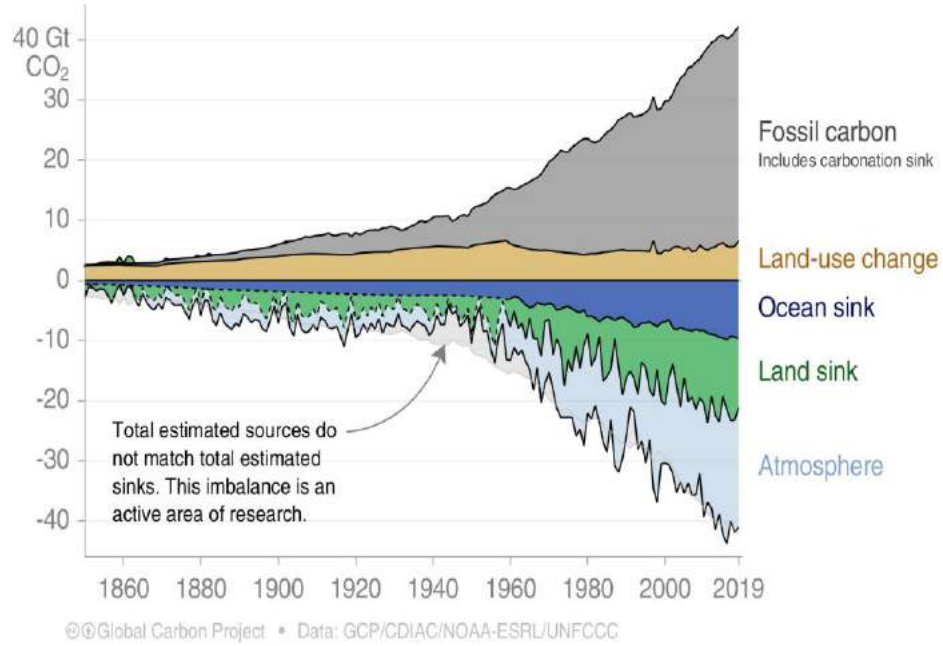
- The second importance is the function of grain production.
- Globally, BS produces 66% of sunflowers, 51% of millet, 46% of barley, 42% of sugarbeet, 30% wheat,etc.
- BS not only sustain the people settled on them, but also feed the rest of the world through agricultural exports, despite representing a small proportion of the world's soils.

Global Spatially-Disaggregated Crop Production Statistics Data for 2010 Version 2.0

3.3 BS keep the global carbon pool balanced



Balance of carbon sources and sinks from Global Carbon Budget 2020

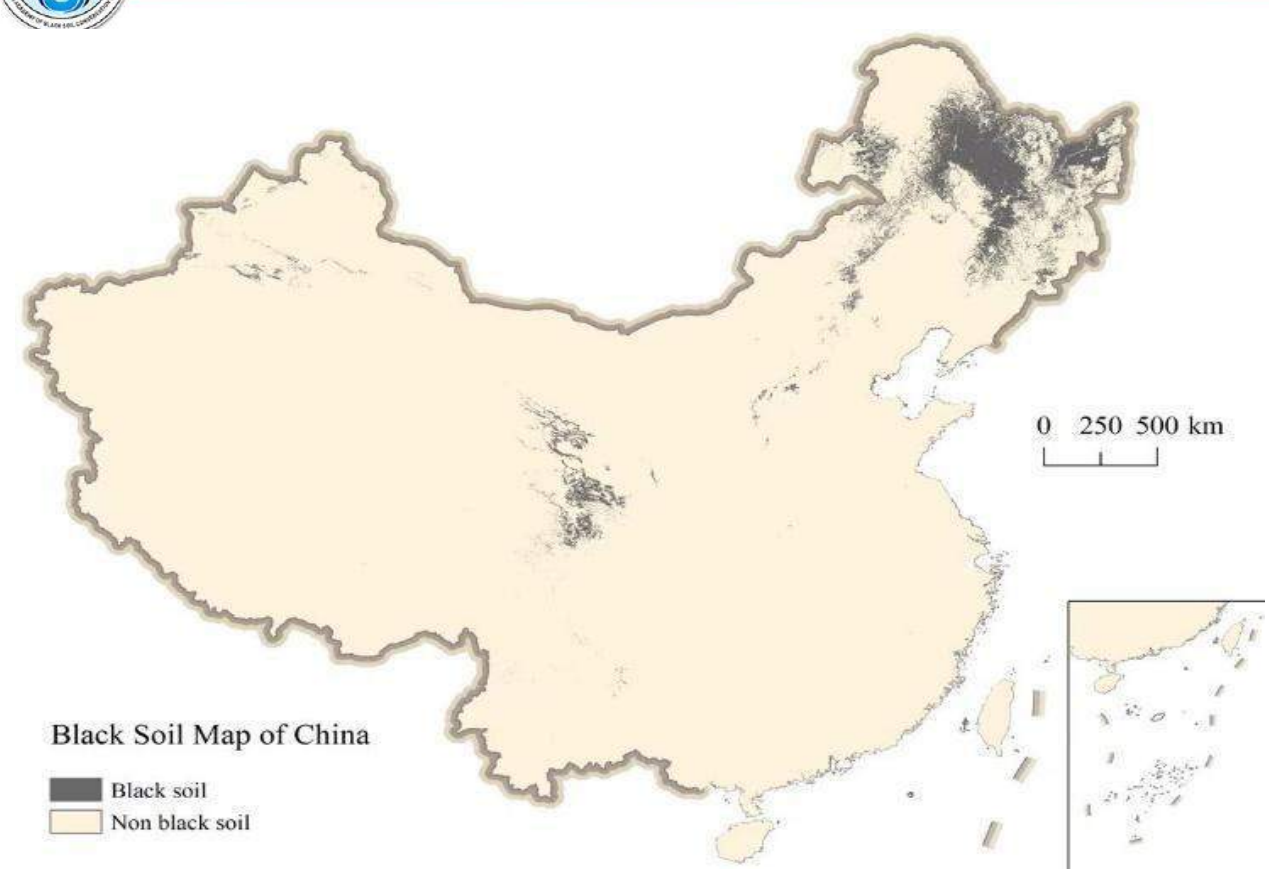


- **Black soil is formed under the vegetation of shrub meadow steppe, and its formation process is mainly the leaching process of humus. The average content of organic matter is generally between 3% and 10%, and the proportion of organic carbon in BS is the highest.**

Part 2

Status quo of black soils in China

1 Black soils in China



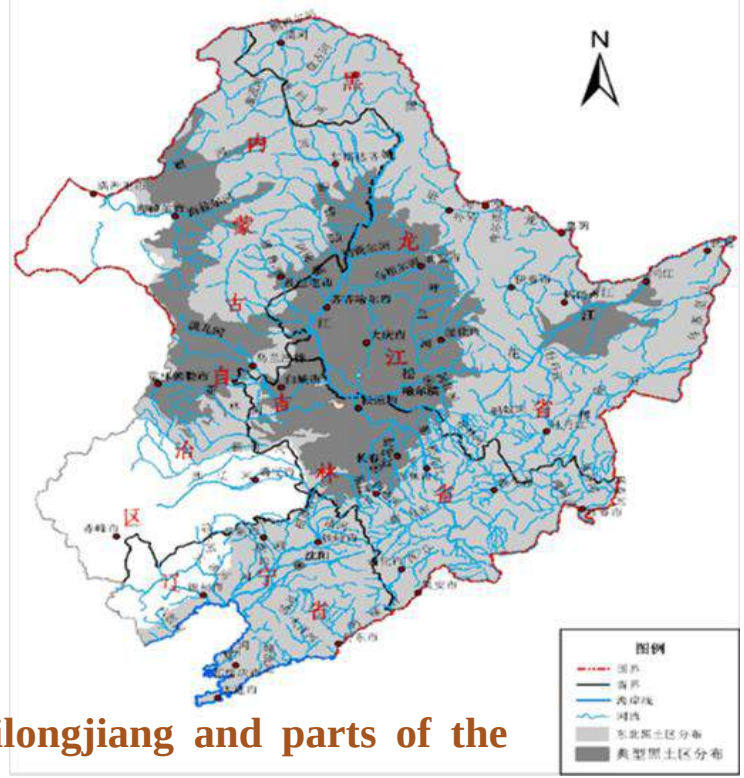
- China is a large agricultural country, raising 20% of the population on 7% of the world's land.
- The BS area is not only an important production base of grain, but also the most important base of energy, wood, coal, and iron and steel in China, and also the ecological shelters for China.
- The area of black soil in China is 1.09 million km^2, of which 41.9% is cultivated land.

Data source: International Black soil Union, Food and Agriculture Organization of the United Nations, Liu Feng, Nanjing soil Research Institute

2 BS distribution in Northeast China

BS areas & distribution in China

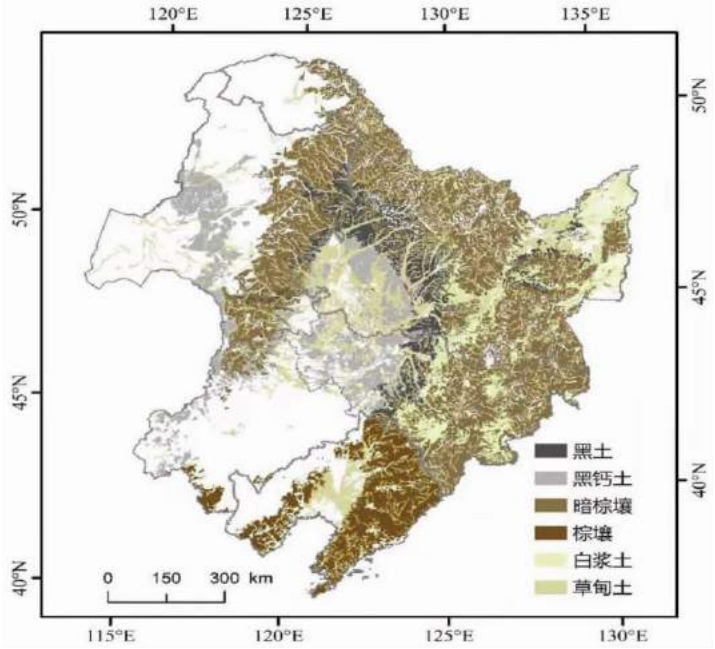
Provinces	Area (million ha)	Percentage (%)
Liaoning	1.86	10.05
Jilin	4.60	24.82
Heilongjiang	10.40	56.13
Inner Mongolia	1.67	9.01
Total	18.53	100

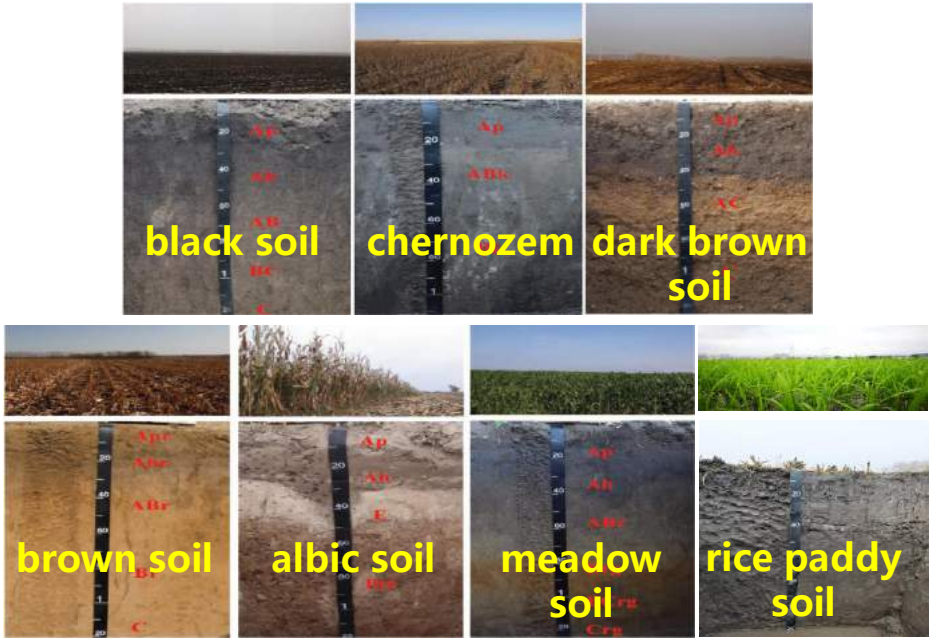


- The administrative region involves Liaoning, Jilin, Heilongjiang and parts of the eastern Inner Mongolia.

3 BS types in China

- There are 7 subtypes of black soils in China.

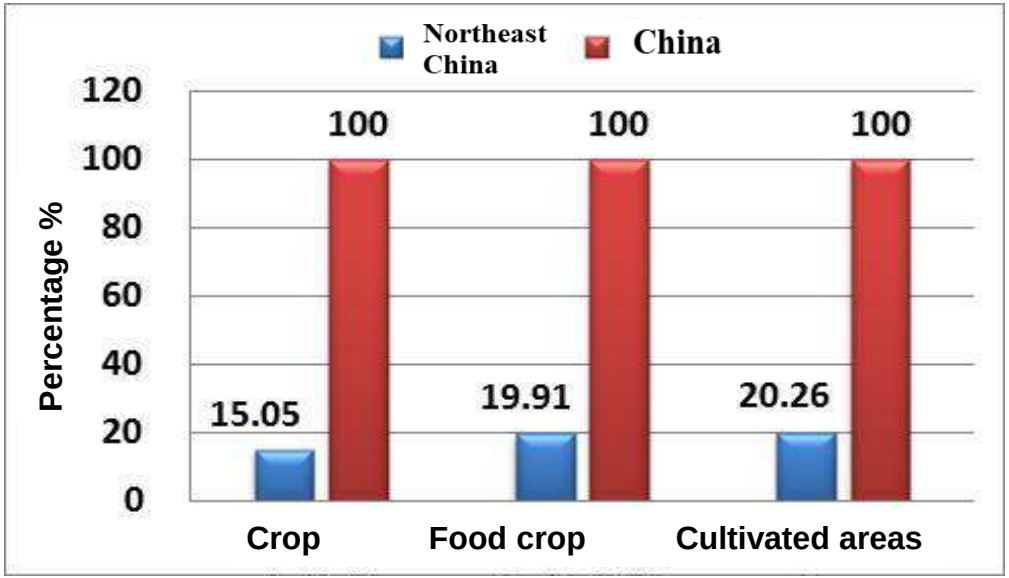




Data Source: 1: 1 million Chinese soil data set Mapping

Picture Source: Chinese Academy of Sciences

3 BS and grain output in China

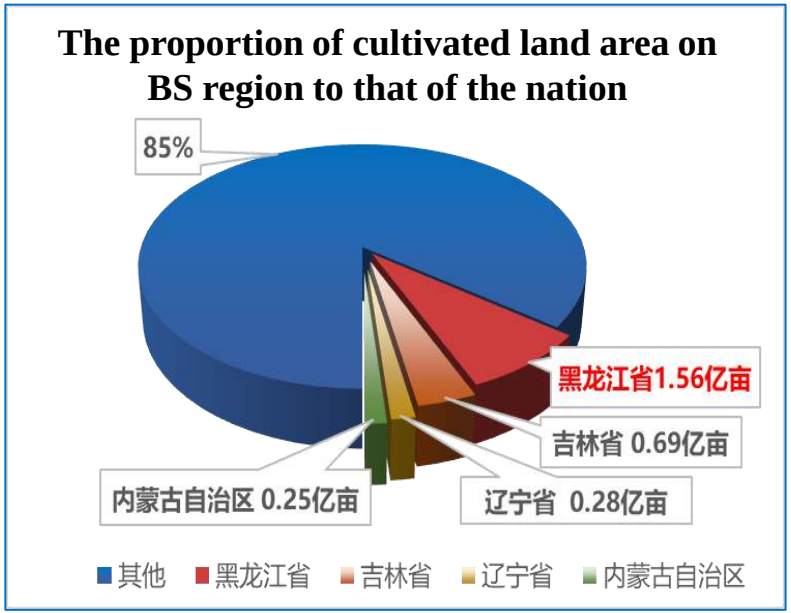


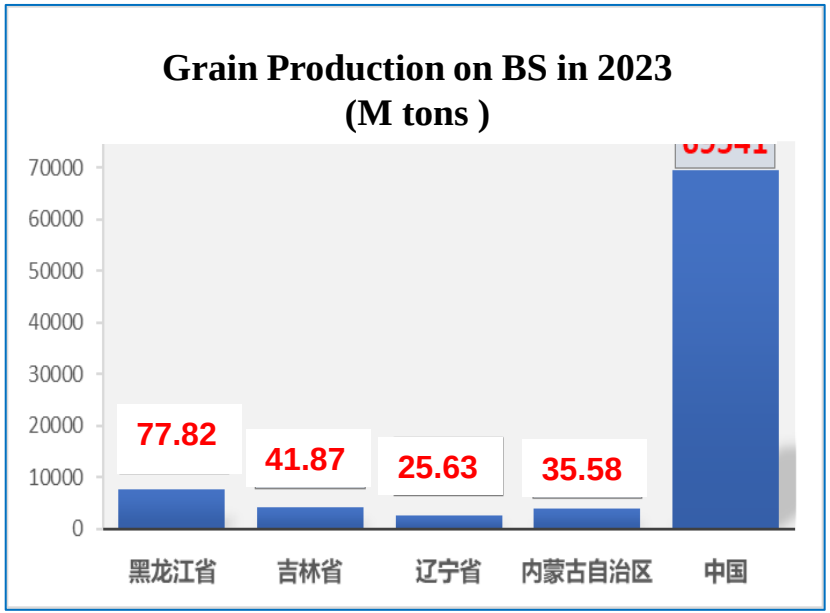
Grain output in BS region compared with total grain output of China

Cultivated areas of provinces in NE China

- The black soils in Northeast China accounts for 1 / 5 of grain production, and the commodity rate is 1 / 3, ranking 1st in the country.

4 The grain yield in Heilongjiang





- **Heilongjiang Province is the core area of black soil in Northeast China, with a stable grain yield of 75 million tons, achieving "20 consecutive harvests" and ranking 1st in the country in total production for 14 consecutive years.**

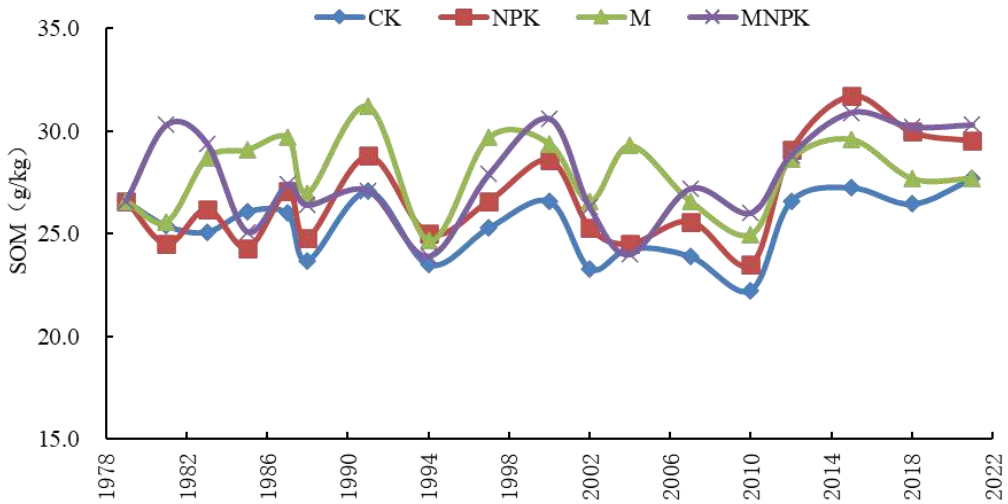
Part 3

BS quality evolution and sustainable utilization

- **A long-term field postion experiment has been conducted since 1979 in Harbin.**
- **24 fertilizer treatments were established in a randomized complete block design with three replications.**

1. CK	2. N	3. P	4. K	5. NP	6. NK	7. PK	8. NPK
9. M	10. MN	11. MP	12. MK	13. MNP	14. MNK	15. MPK	16. MNPK
17. CK_2	18. N_2	19. P_2	20. N_2P_2	21. M_2	22. M_2N_2	23. M_2P_2	24. $M_2N_2P_2$

1 Evolution of SOM under long-term fertilization



Changes in soil organic matter content

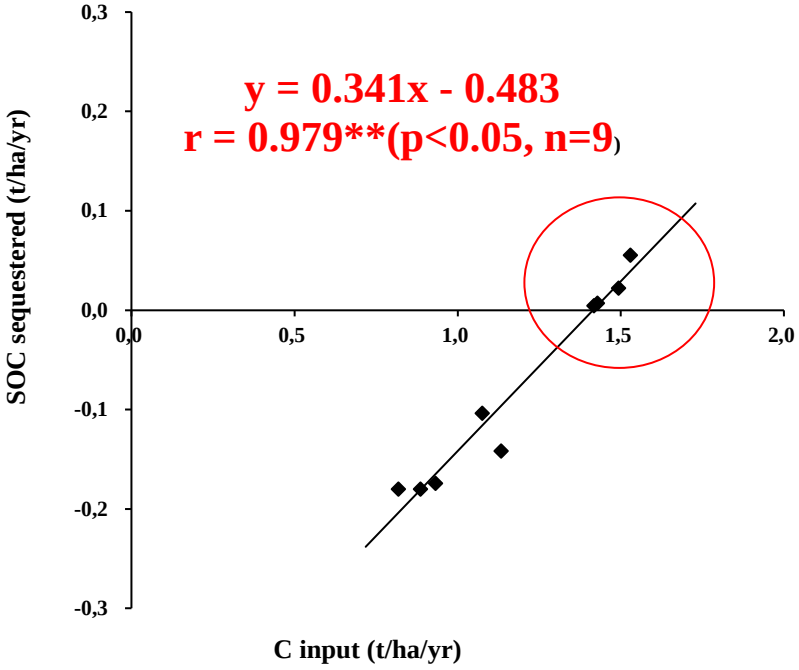
- **The soil organic matter content decreased under long-term no fertilization and chemical fertilizer application. The average annual decline rate is about 0.03g/kg.**
- **The combined application of organic and inorganic fertilizers increased.**

CK： **decrease 16.8%；**

NPK： **decrease 11.6%**

MNPK： **increase 8.4%**

How to balance SOC pool

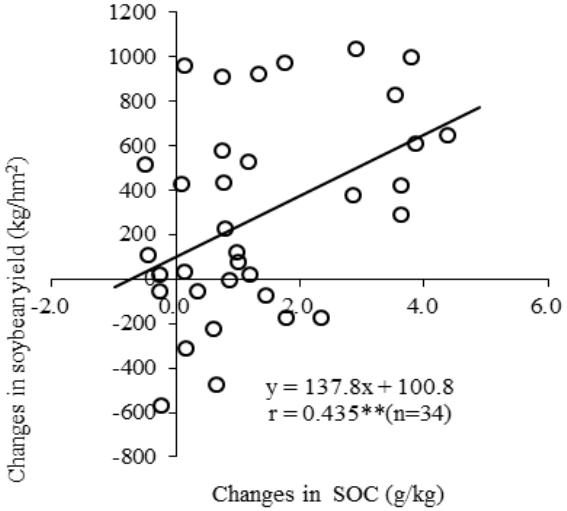


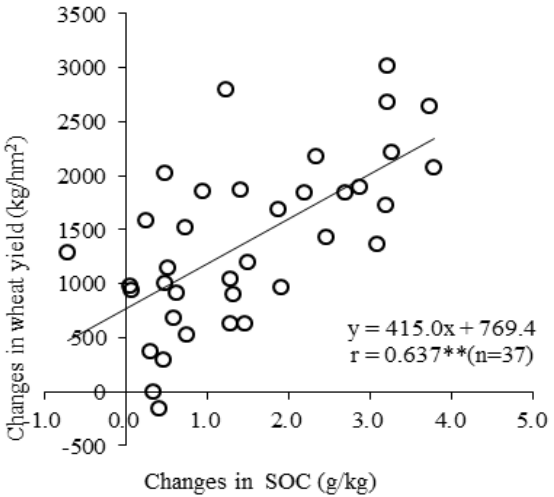
The relationship between organic carbon input and changes in SOC storage

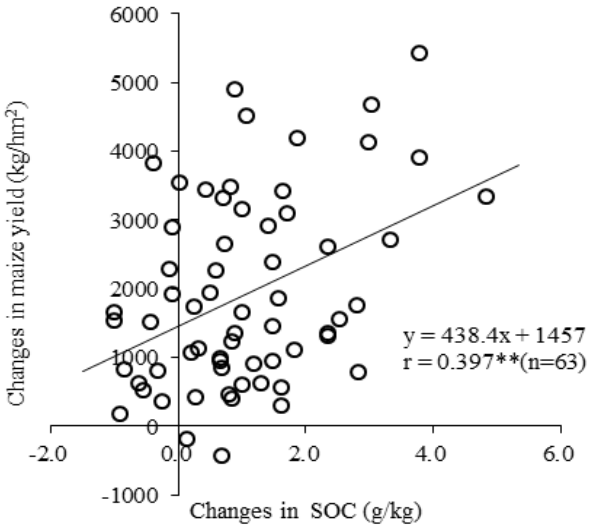
- The correlation analysis between the annual average organic carbon input (x) and the corresponding annual average organic carbon storage change (y) under different fertilization treatments shows a significant linear positive correlation (P<0.05).
- After 34 years of continuous fertilization, the SOC conversion rate is 0.341t/（hm^2·a）, which means 1 ton of organic material is applied annually.

- To maintain the balance of black soil organic carbon pool, at least 1.416 t/（hm^2·a） of organic carbon should be applied annually.

Correlation between SOC content and crop yield

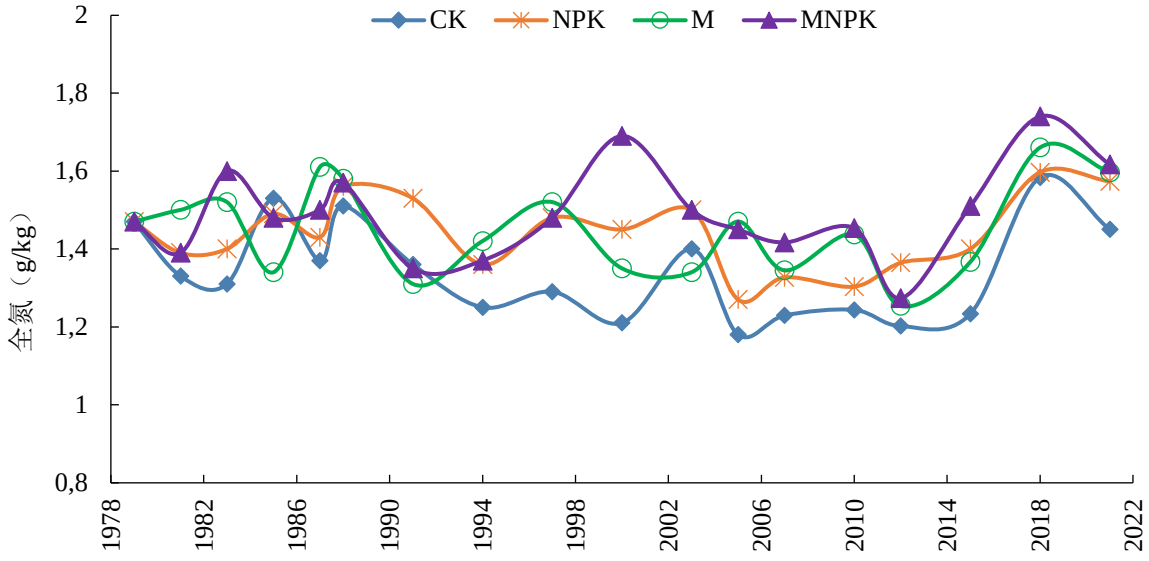






- **The changes of SOC content under fertilization treatment were significantly positively correlated with the relative yields of wheat, soybean and maize, indicating that the higher the SOC content, the higher the yield.**
- **The yield of wheat, soybean and maize increased by 415, 138 and 438 kg/hm^2 with an increase of 1 g/kg of SOC content, respectively.**

2 The evolution of soil total nitrogen (TN)

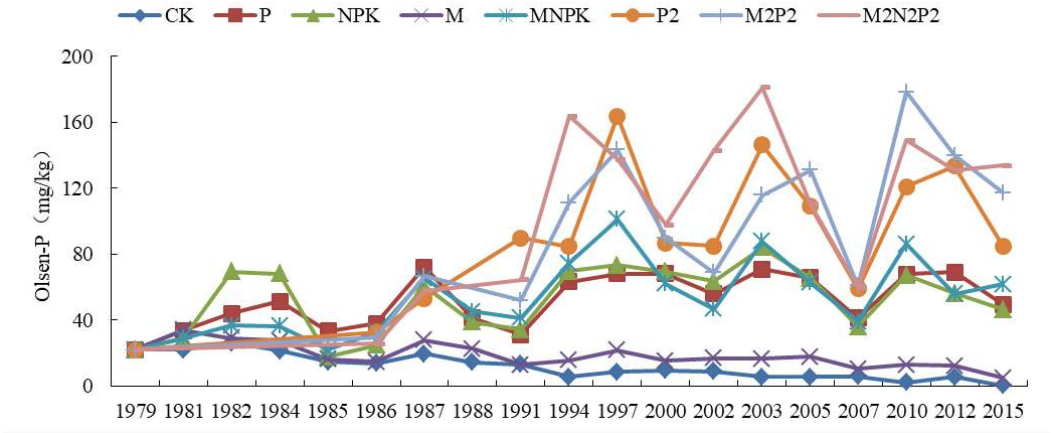


Changes in total nitrogen of black soil topsoil (0-20cm) under different fertilization conditions (1979-2021)

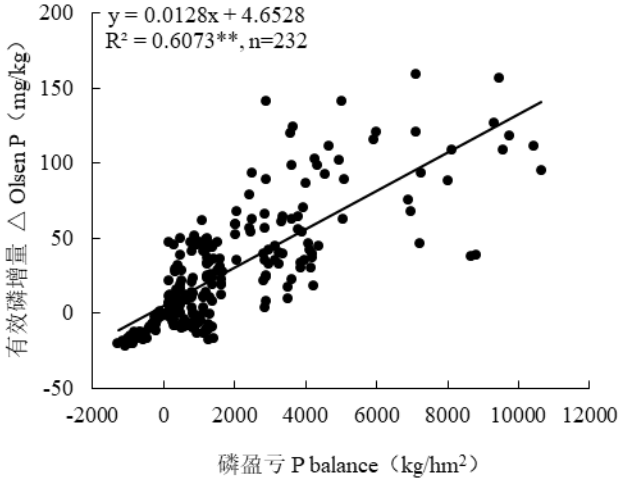
- **Without fertilization for a long time, the overall trend of soil total N is decreasing**
- **Single application of N fertilizer and N fertilizer combined with P and K fertilizer also showed a downward trend in soil TN, but the downward trend slowed down compared to no fertilization.**
- **Applying N fertilizer increased the N content in black soil compared to no fertilization and no N fertilizer application.**

✓ **The application of organic fertilizer is the key to soil N balance.**

3 Evolution of phosphorus under long-term fertilization



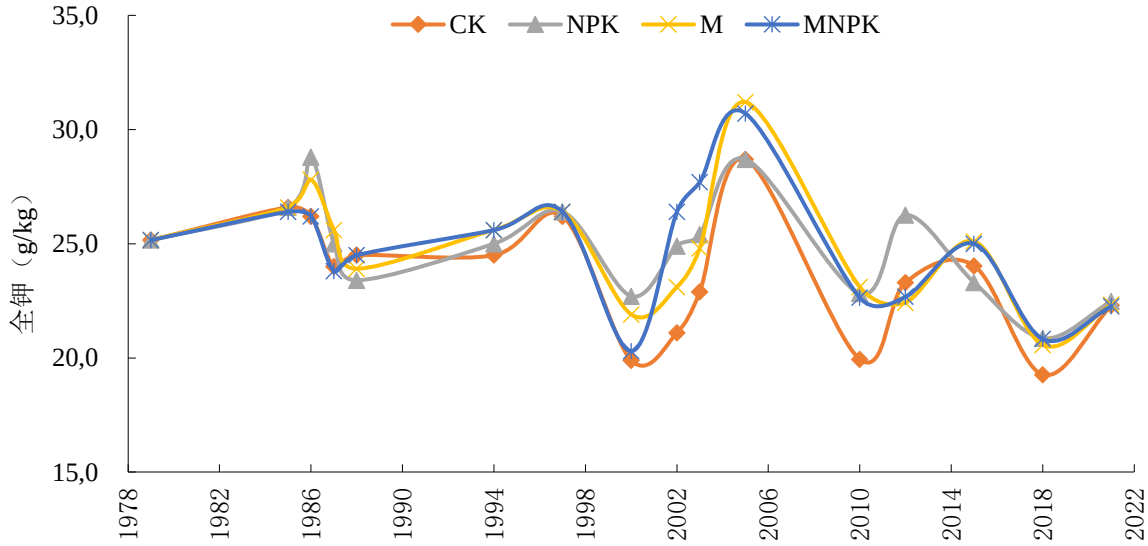
Changes in total phosphorus in black soil topsoil (0-20cm) under different fertilization conditions (1979-2021)



Correlation between soil Olsen-P change and P balance under long-term different treatments

- **Chemical P and manure combined fertilization shows more efficiency in improving the phosphorous availability coefficient than chemical fertilizer alone.**

5 Evolution of potassium under long-term fertilization

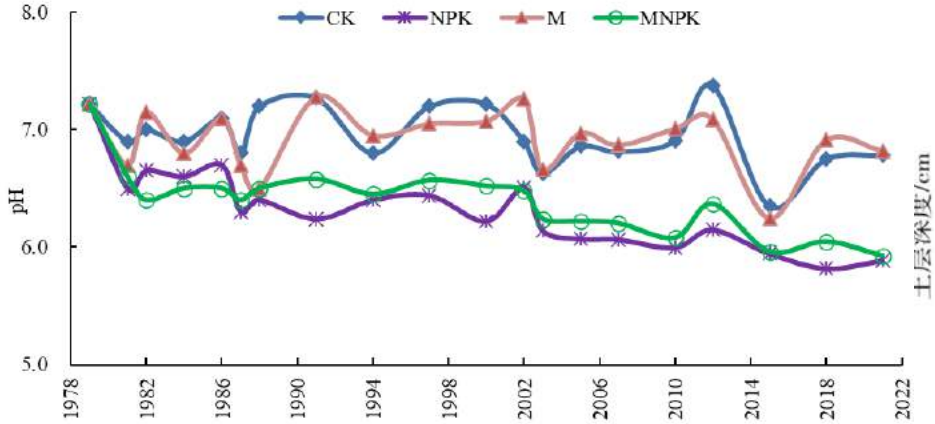


Changes in total potassium in black soil topsoil (0-20cm) under different fertilization conditions (1979-2021)

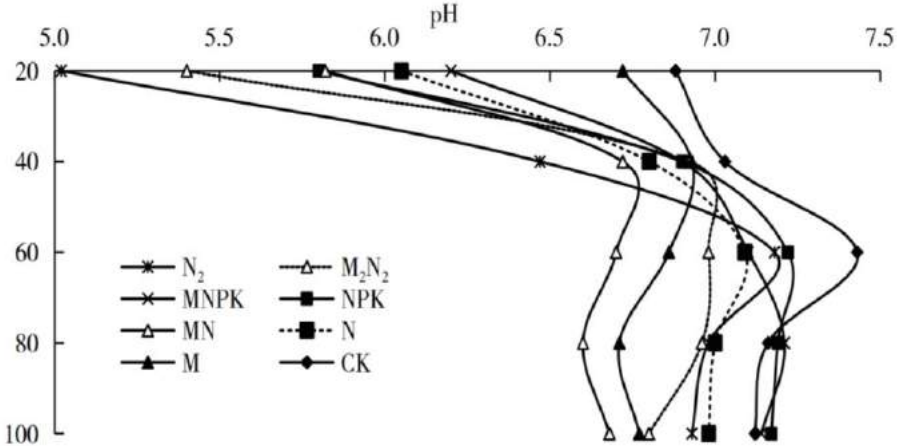
- **Reasonable application of N, P, and K fertilizers is an effective measure to alleviate the decreasing trend of soil total potassium based on the trend of changes in soil total potassium.**

6 Evolution of soil pH under long-term fertilization

- Long term application of nitrogen fertilizer (urea) can cause soil acidification, and the decrease in soil pH increases with the increase of nitrogen fertilizer dosage.
- The decreasing trend of pH in the treatment of organic fertilizer or chemical fertilizer combined with organic fertilizer was slowed down.
- Fertilization not only affects the pH of the topsoil, but also the pH of the soil below the topsoil.



Changes in pH of black soil under long-term different fertilization treatments (1978-2022)



Changes in pH of Black Soil Profile under Long term Different Fertilization Treatments (2006)

Brief summary

- Rational application of chemical fertilizer or combined application of organic fertilizer with chemical fertilizer can maintain and improve soil fertility, and irrational fertilization is an important reason for the degradation of black soil.

- In the black soil area, chemical fertilizer combined with organic fertilizer is an effective way to improve soil fertility, maintain soil health and increase grain productivity.

Part 4

Practices of black soils conservation in China

1 China attaches great importance to black soils

- **Xijinping, general secretary of the CPC Central Committee, emphasized during his inspection in Heilongjiang in 2016, It is necessary to take various measures such as engineering, agronomy, biology, etc., to mobilize the enthusiasm of farmers, and to protect and make good use of black soil.**
- **Ensure that black soils is not reduced in quantity and quality is not degraded. Protect and make good use of the black soil, just like protecting giant pandas.**

2 China enacted the Black Soils Protection Law

The Chinese government was the first country to protect black soils through legislaiotn.

Li Zhanshu, chairman of the NPC Standing Committee went to Heilongjiang Academy of Black Soil Conservation and Utilization to solicit opinions and suggestions on Black Soil Protection Law

全国人民代表大会
The National People's Congress of the People's Republic of China

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当前位置：首页

中华人民共和国黑土地保护法

（2022年6月24日第十三届全国人民代表大会常务委员会第三十五次会议通过）

来源：中国人大网　浏览字号：大 中 小　2022年06月24日 16:

第一条　为了保护黑土地资源，稳步恢复提升黑土地基础地力，促进资源可持续利用，维护生态平衡，保障国家粮食安全，制定本法。

第二条　从事黑土地保护、利用和相关治理、修复等活动，适用本法。本法没有规定的，适用土地管理等有关法律的规定。

本法所称黑土地，是指黑龙江省、吉林省、辽宁省、内蒙古自治区（以下简称四省区）的相关区域范围内具有黑色或者暗黑色腐殖质表土层，性状好、肥力高的耕地。

第三条　国家实行科学、有效的黑土地保护政策，保障黑土地保护财政投入，综合采取工程、农艺、农机、生物等措施，保护黑土地的优良生产能力，确保黑土地总量不减少、功能不退化、质量有提升、产能可持续。

Black Soils Protection Law of the People's Republic of China

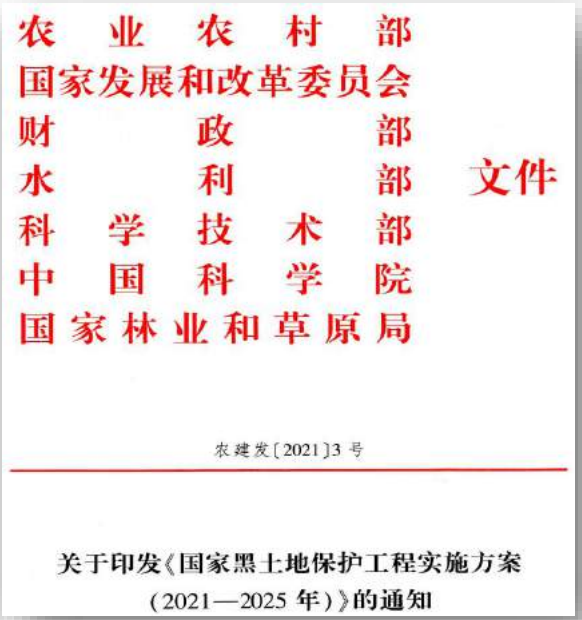
3 China launched policies to protect black soils

农业部
国家发展改革委
财政部
国土资源部
环境保护部
水利部
文件

农农发〔2017〕3号

农业部 国家发展改革委 财政部 国土资源部 环境保护部 水利部关于印发《东北黑土地保护规划纲要(2017—2030年)》的通知

Outlines of the Northeast Black soil Protection Plan (2017-2030)



农业农村部
国家发展和改革委员会
财政部
水利部
科学技术部
中国科学院
国家林业和草原局
文件

农建发〔2021〕3号

关于印发《国家黑土地保护工程实施方案(2021—2025年)》的通知

National Black soil Protection Project implementation Plan (2017-2025)

- By 2030, 1.667 million hectares of black soil farmland will be protected, and the average soil organic matter (SOM) content will reach more than 32g/kg, with an increase of more than 2g/kg.

4 Continuous funding to protect the black soils

Since 2015, the Chinese government has allocated an annual fund of 70 million US dollars to carry out pilot projects for the protection and utilization of black soil in 17 counties in the black soil region of northeast China. The second batch of pilot projects was launched in 32 counties nationwide in 2019.

4.1 Promote straw return and organic fertilizer production

First, promote straw return and organic fertilizer production, increasing soil organic matter content, improving soil physical and chemical properties, and continue to enhance the basic fertility of cultivated land.

4. 2 Conservation tillage

Second, promote conservation tillage techniques. Through government subsidies, farmers are encouraged to purchase high-horsepower tractors and deep tillage machines and carry out conservation tillage techniques. Techniques such as less no-tillage and deep tillage will be popularized according to local conditions.

4. 3 Crop rotation and planting forage crops

Third, promote the pilot crop rotation and the conversion of grain to feed. Popularize the rotation of corn with soybeans, potatoes and oil crops. Encourage the conversion of grain to feed, develop high-quality forage such as silage corn, alfalfa, ryegrass and oats, support the development of herbivorous animal husbandry such as dairy cows, beef cattle and sheep, and promote the establishment of a scientific rotation planting system.

4.4 Reduction of chemical fertilizers and pesticides

Fourth, promote the reduction of chemical fertilizers and pesticides to increase efficiency. We will carry out action on zero growth in the use of chemical fertilizers and pesticides, promote mechanized precision fertilization and spraying, and promote new and efficient fertilizers and water and fertilizer integration technologies.

4.5 Control of soil erosion

Fifth, promote soil erosion control. In Northeast China, a number of high-standard cropland will be constructed on a large scale, land leveling will be strengthened, comprehensive management of sloping farmland will be adopted to reduce soil, water and nutrient loss.

Part 5

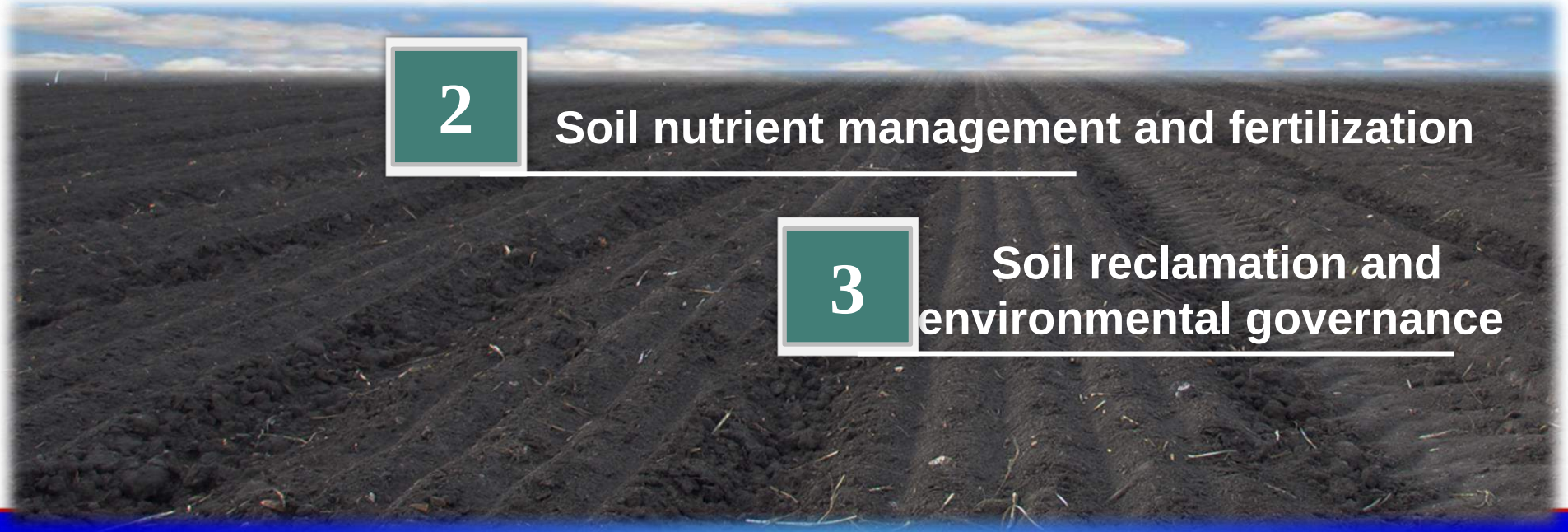
Profile of Heilongjiang academy of Black Soil Conservation and Utilization

1 Institutional Introduction

- Heilongjiang Academy of Black Soil Conservation and Utilization was established in 1956.
- Formed by the merger of the Institute of Soil Fertilizer and Environmental Resources and the Institute of Rural Energy and Environmental protection.

2 Main Tasks

1 Black soil quality monitoring and evaluation



2 Soil nutrient management and fertilization

3 Soil reclamation and environmental governance

3 Scientific Research Groups

The only national team in agricultural area of Heilongjiang

National innovation team of key areas

01 Black soil conservation innovation team

02 Soil reclamation innovation team

03 Plant nutrient and soil fertilizer innovation team

04 Soil microbiology innovation team

05 Agricultural environment innovation team

06 Agricultural wastes innovation team

07 Soil and plant interaction innovation team

08 Evaluation and test of environmental resource

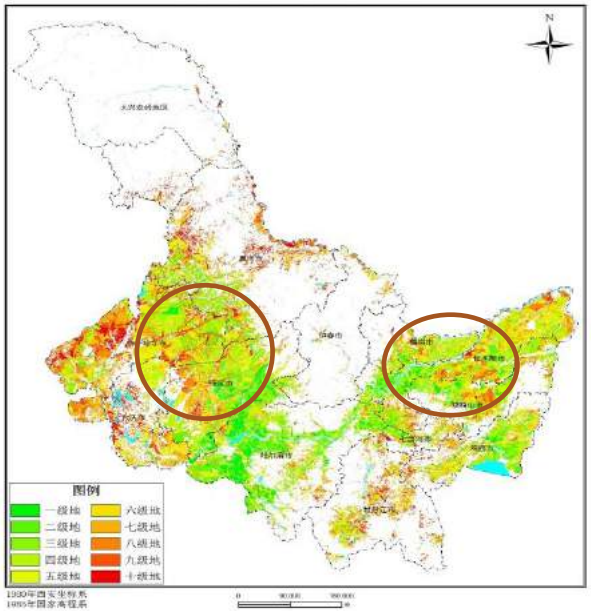
4 Research & development Platforms

3	Key Laboratories of Ministry of Agriculture and Rural Affairs	Key Laboratory of Black Land Conservation and Utilization Key Laboratory of Combination Of Farming And Animal Husbandry Key laboratory of Agricultural Environment in Northeast Plain
3	Provincial Key Laboratory	Soil Environment and Plant Nutrition Laboratory Key Laboratory of Straw Energy Utilization in Heilongjiang Province Key Laboratory of Microbial Ecology
2	Long term field positioning experiment station	Key Scientific Observation and Test Station of BS Ecological Environment Scientific Observation and Test Station of Cultivated Land Conservation and Agricultural Environment
1	Testing Center	A China Metrology Accreditation certified testing centre with the ability to conduct laboratory analysis of plant, soil, fertilizer, etc
1	National Popular Science Base	Popular Science Base of Northeast Black Soil Resources and Environmental Protection aproved by the Ministry of Ecology and Environment and the Ministry of Science and Technology
1	International Research Platform	International Research Institution of Black soils of the Global Soil Partnership , FAO

5 Achievements

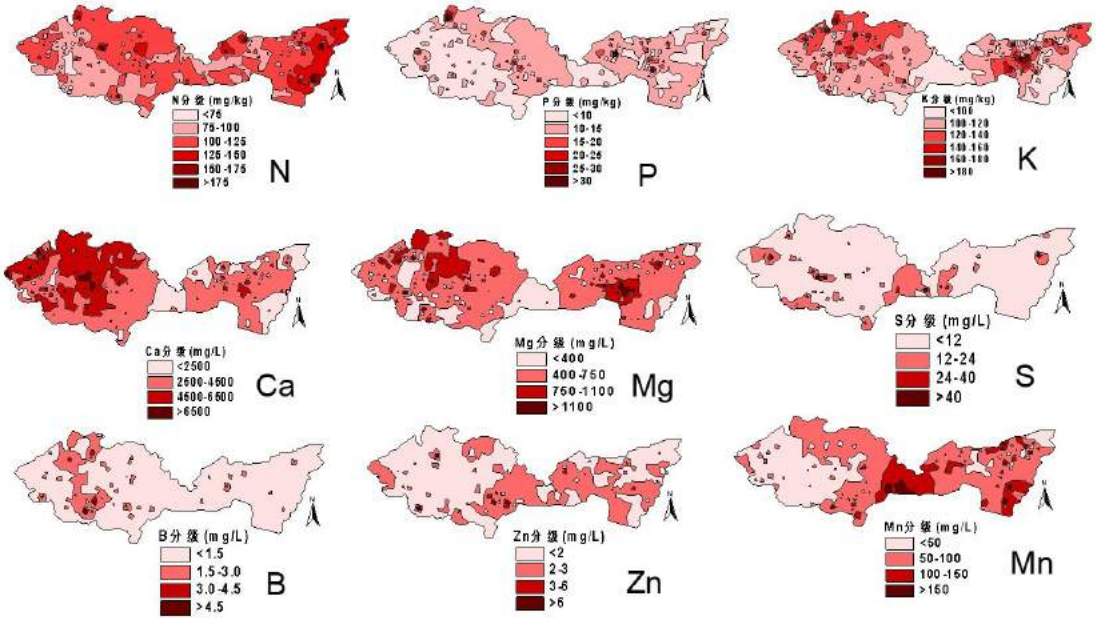
5.1 Evaluation of soil fertility

- Soil quality survey was carried out for 10 years.
- The classification and distribution characteristics of arable land were determined to provide basic support for farming production .



5.2 Nutrient management and fertilization

- A regional scale soil nutrient survey was conducted to determine the distribution of large, medium, and trace elements in the cultivated land of the province, in order to guide farmers in fertilization in different regions



Two provincial science and technology progress awards were acquired.

5.3 Soil Reclamation

- The mechanism of typical low-yield soil obstacles in northeast of China was revealed, such as albic soil, saline soil, continuous cropping obstacle and pesticide contaminated soil. The comprehensive soil improvement model was initiated.

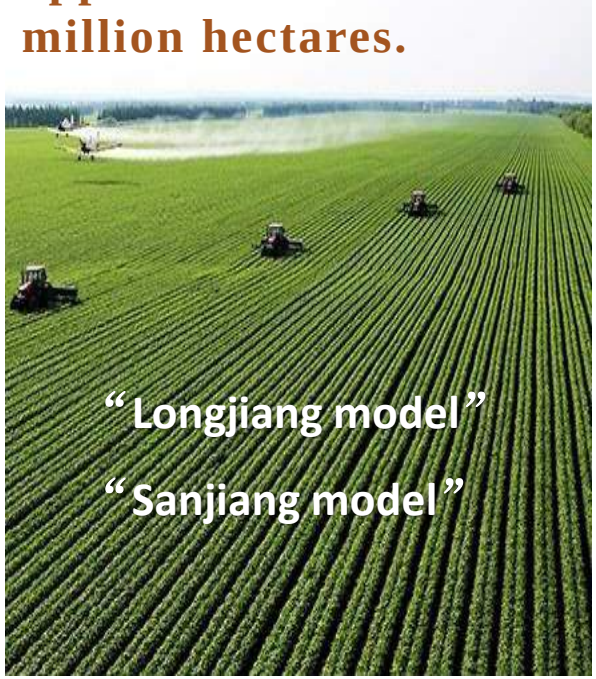
➢ **Alkali-saline Soil** ——
Machinery deep application of agricultural waste .Soil with continuous cropping obstacles——Machinery replacement of Soil layer

➢ **Albic soil** ——
Subsoil tillage, subsoil-fertilizing and mechanical soil improvement

➢ **Low-wet soil**——
Rice husk deeply burying and subsoiling.

5.4 Achievements Popularization

8 technology models have been constructed, with application areas over 10 million hectares.



1. Black soil conservation and fertility enhancement technology model
2. Integrated management technology model of slope arable land and erosion soil.
3. Albic soil comprehensive reconstruction and subsoil-fertilization.
4. Mechanical deep-buried and salt-reducing technology model for organic materials in saline soil
5. Black soil remediation technology model of all straw return, rotation tillage and crop rotation.
6. The model of straw decaying and simplified fertilizer returning to field.
7. Technology model of straw returning and nitrogen cycle regulation in paddy field
8. Technical model of reduction for soil continuous cropping obstacle.

6 Vision & Mission

Protecting black soil to achieve sustainable human development.

- **Eight of the 17 SDGs are directly related to the conservation and use of black soil.**
- **Therefore, the conservation and use of black soil concerns all people on the planet.**

Thank you for your attention!