矿山生态安全教育部工程研究中心
Engineering Research Center of Mining Environment & Ecological Safety, Ministry of Education

土地复垦与生态重建研究所
Institute of Land Reclamation and Ecological Restoration

PROGRESS OF THE RESEARCH PROJECT ON RECLAIMING SUBSIDENCE LAND WITH YELLOW RIVER SEDIMENTS

Zhenqi HU

Institute of Land Reclamation & Ecological Restoration

China University of Mining and Technology(Beijing)

Engineering Research Center of Mining Environment & Ecological Safety, Ministry of Education

2012---2015

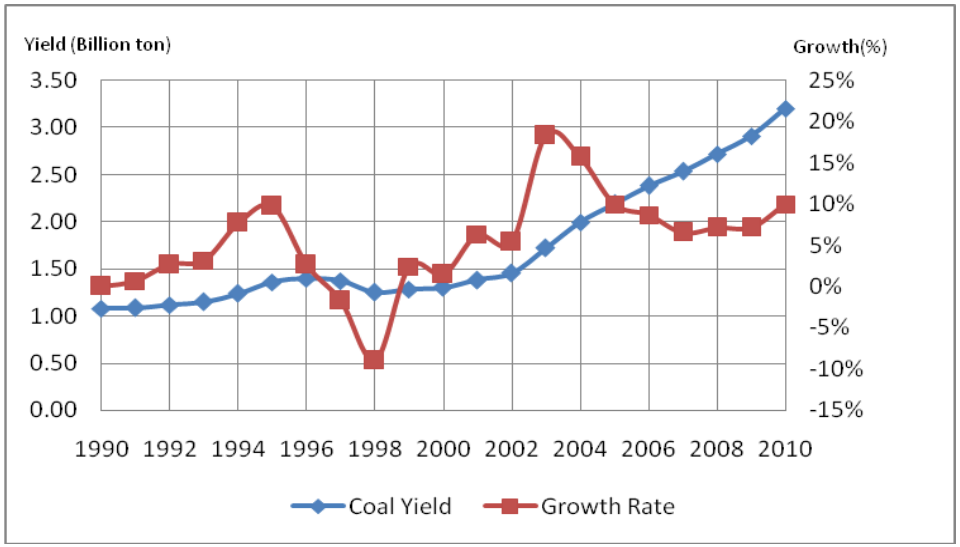
National Key Technology Research and Development Program (2012BAC04B03)

中国矿业大学（北京）
China University of Mining & Technology, Beijing

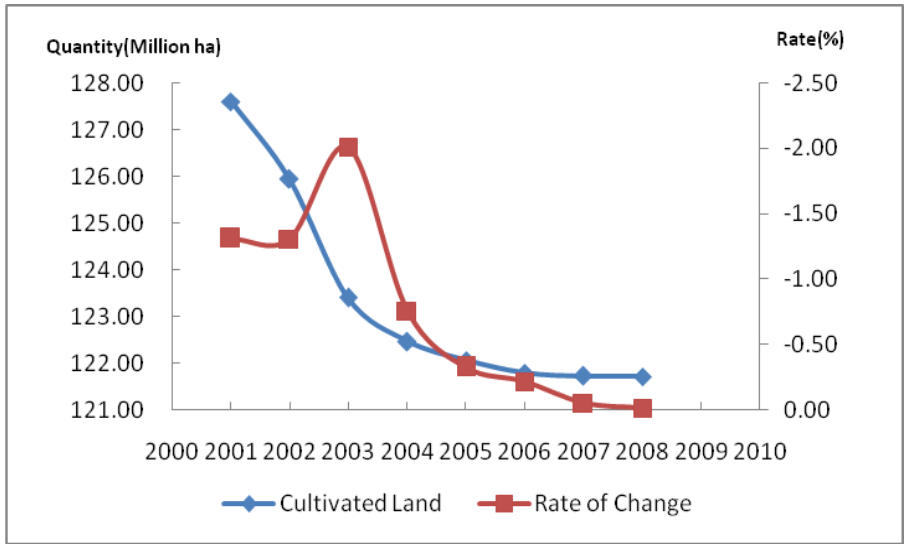
Outline

- ✓ *Background*
- ✓ *Research progress*
- ✓ *Physical and chemical properties of reclaimed soil*
- ✓ *Some countermeasures for improving the soil productivity*

1. Background



Coal yield and growth rate from 1990 to 2010 in China



Cultivated land quantity variation from 2001 to 2008 in China

Coal is the most important resource in China, accounting for about 70% of energy consumption.
China's coal output was 3.68 billion tons in 2013.
About 92% was from underground mining.

Damaged land due to mining subsidence

•**Subsidence: over 1 million hectare of subsided land; 70 thousands ha of land will be subsided every year**

Coal Mining and Mining Subsidence in China

Eastern China

Relatively Flat Terrain

High Quality Farmland

High Underground Water Level

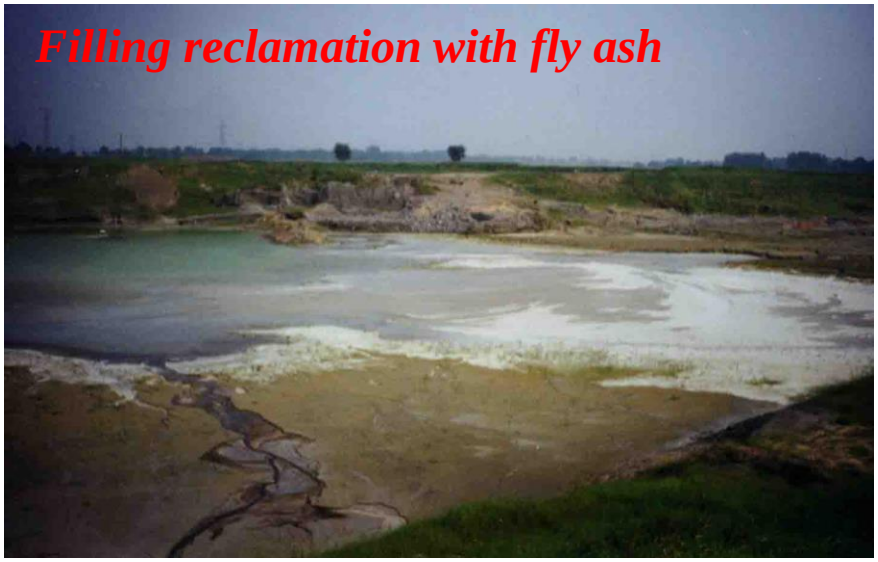
Created many lakes and wetlands, 85% of which was cultivated land before mining

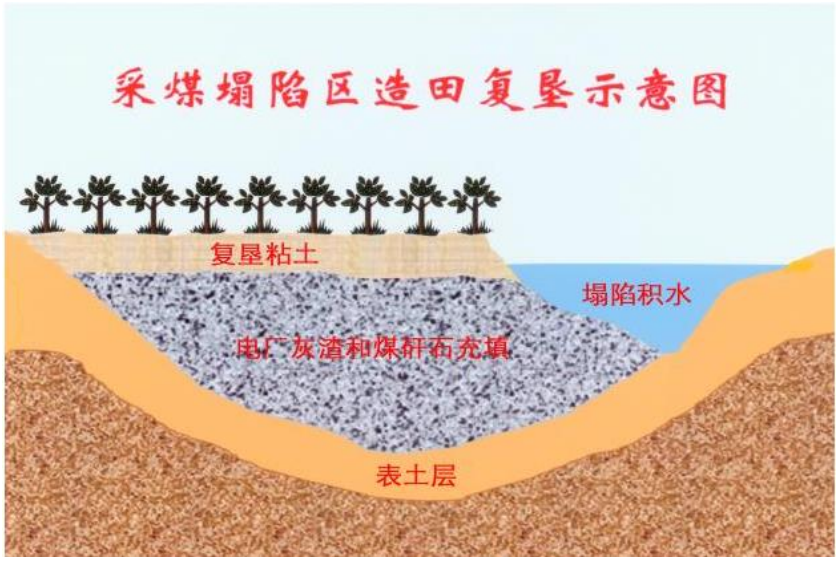
Problem:

- *overlapping region of crop and coal production base, prime farmland and high density population*
- *Conflict between human and land was serious*

It's very urgent to restore farmland as much as possible!!

1. Background





Disadvantage of *filling reclamation with coal wastes and fly ash*

- *Filling reclamation needs lots of reclaimed materials, but coal gangue and fly ash has been almost recycled in coal mine area now, there are no enough reclaimed materials*
- *The heavy metal contained in reclaimed materials may cause pollution on the quality of crop products, soil, surface water and underground water*

Filling reclamation with coal wastes

1. Background

The sediment concentration in Yellow River water is high, and Yellow River has become a river on the ground, which seriously threaten the life and property safety of the masses along the river

Therefore, Yellow River sediments could be the potential filling materials for reclaiming subsidence land

Advantage of *filling reclamation with Yellow River sediments*

- *Reduce the elevation of Yellow River bed, improve the river's flood control, turn the wastes to useful materials*
- *Increase farmland significantly*

Project: **Subsidence land reclamation filled by Yellow River sediments in large-scale coal bases**

National Key Technology Research and Development Program (2012BAC04B03), Ministry of Science and Technology, China

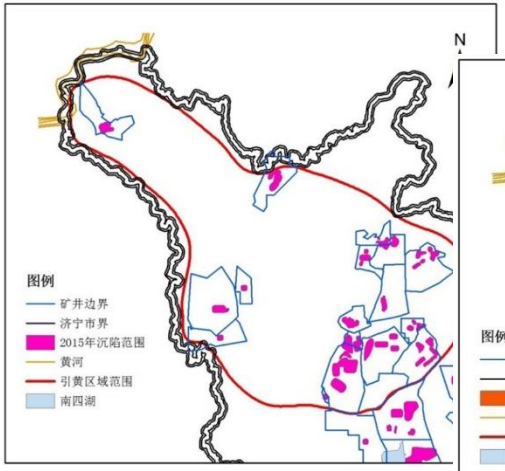
Objectives: Develop a technique for reclaiming subsided lands with Yellow river sediments

2. Research progress

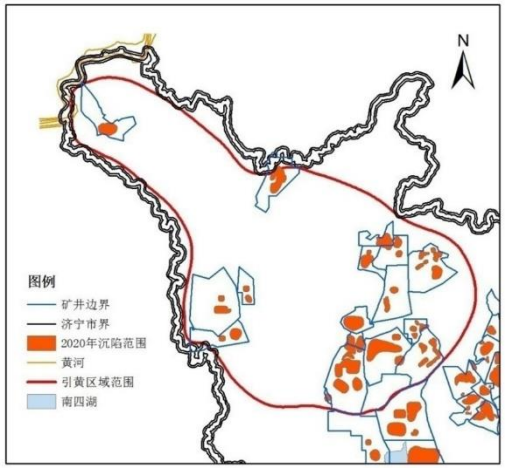
- ✓ *Identify the requirements of the filling reclamation*
- ✓ *Determine the position and method to take sediments from Yellow river*
- ✓ *Determine the transportation of the sediments----set up a laboratory*
- ✓ *Research on filling, drainage, soil reconstruction and restoration of high quality farmland*
- ✓ *Set up a experimental site*

(1) Identify the requirements of the filling reclamation by mining subsidence technology

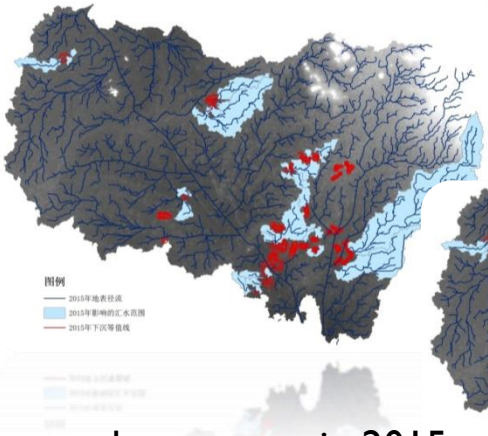
- Spatial and temporal evolution of mining subsidence areas for identifying the filling position and quantity of filling materials --- *Where, how much for filling*
- Quantitative evaluation of impacts on local ecological system due to mining subsidence and filling reclamation



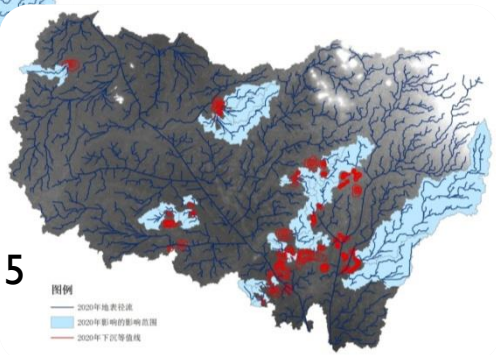
subsidence area in 2015



subsidence area in 2020



catchment area in 2015

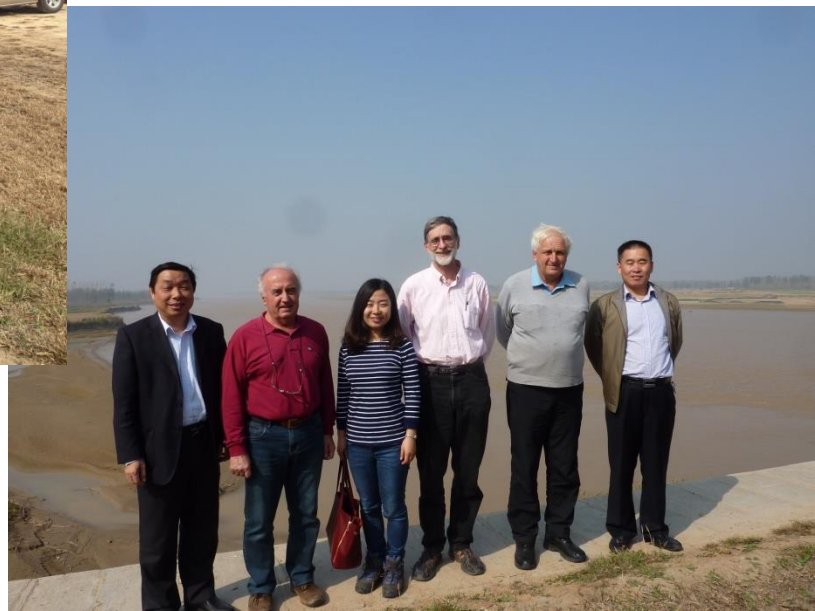


catchment area in 2020

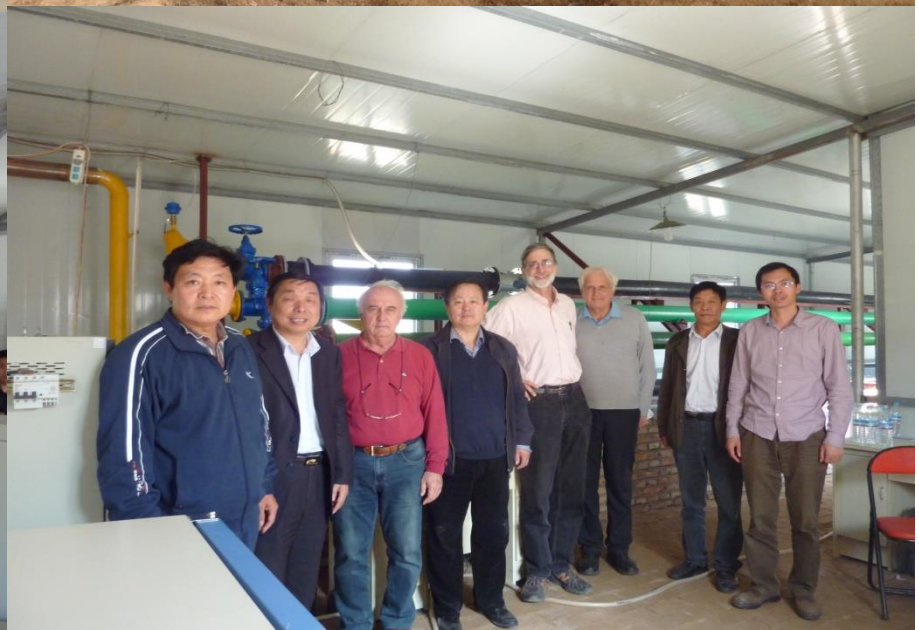
(2) Determine the position and method to take sediments from Yellow river

- Selection of the position for taking sediments from Yellow River based on the river's basic information and requirements, and distribution of subsidence land *Where*
- Technology of taking sediment from the flowing Yellow River: equipments and methods *how to take*

(2) Determine the position and method to take sediments from Yellow river



(3) Determine the sediment transportation methods



(3) Determine the sediment transportation methods

- Optimization of sediment transportation methods and spatial distribution of transportation
- Optimization and innovation of transportation materials and equipments for long distance transportation: producing some important engineering parameters.

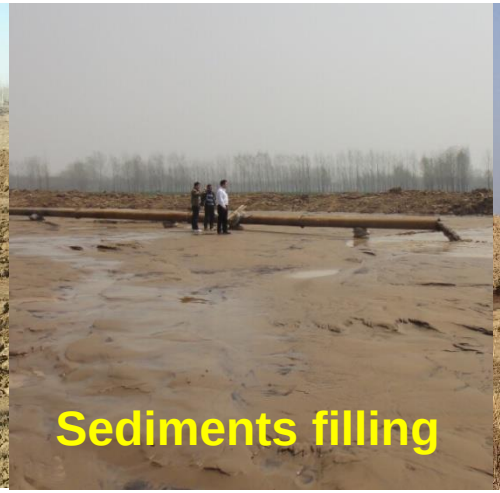
sediment transportation laboratory

control system

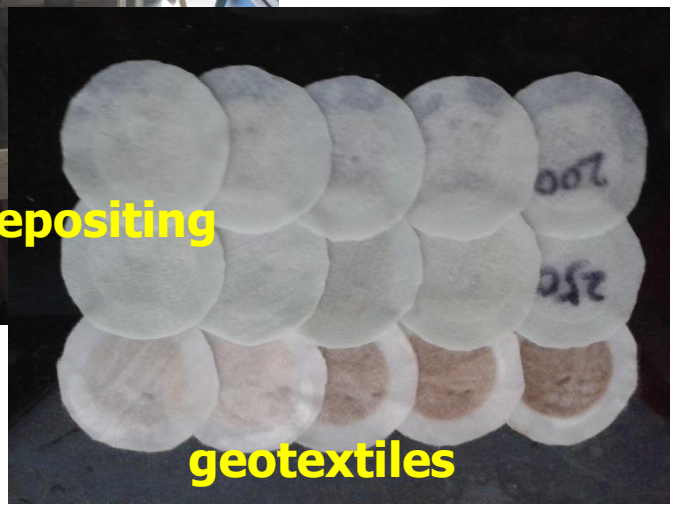
sediments pipelines

(4) Research on filling, drainage, soil reconstruction and restoration of high quality farming

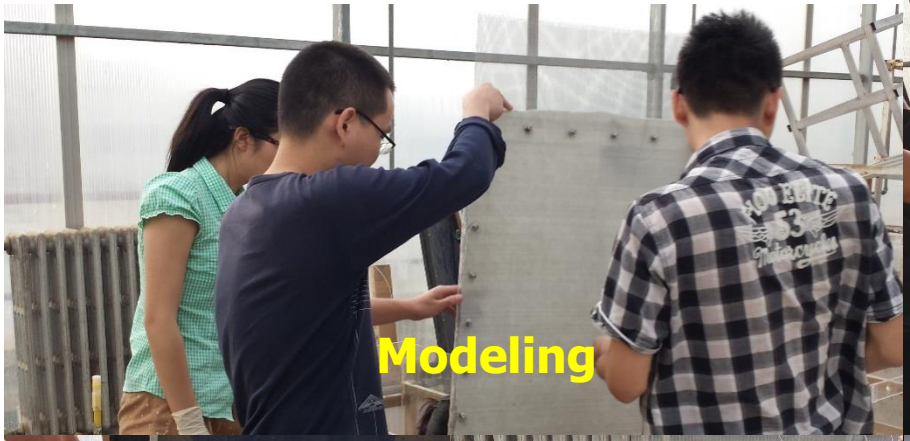
- **Filling and drainage methods for fast reconstruction of the filled land**



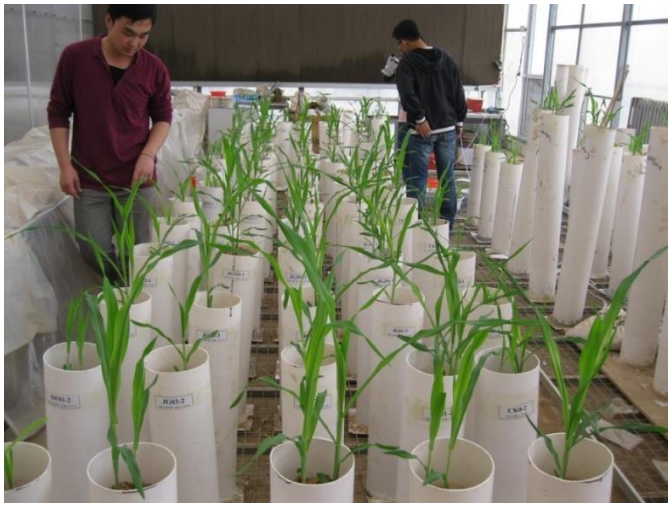
Parameters of geotextiles:



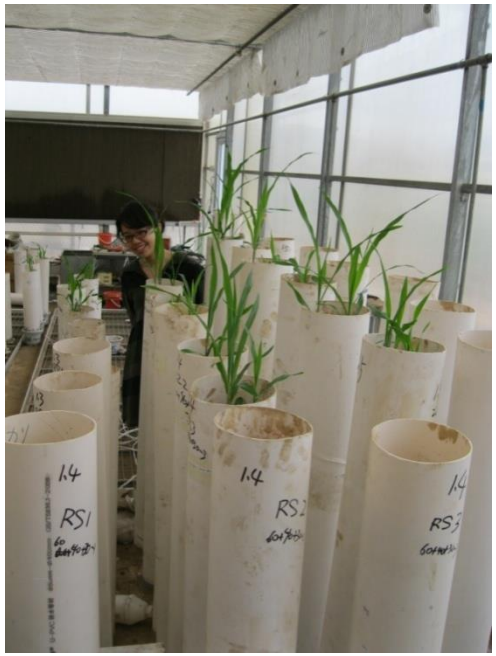
Drainage of saturated sediment filled in the glass tank using geotextiles:



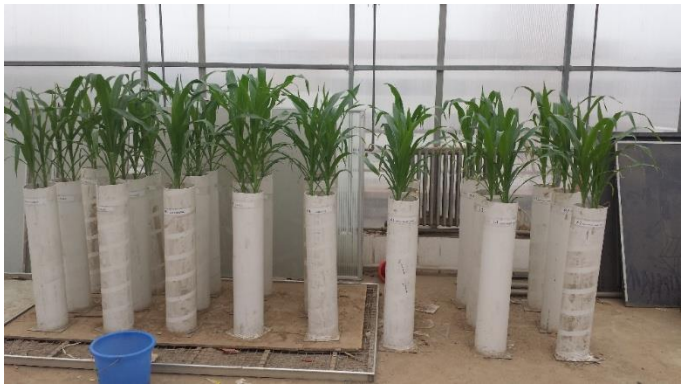
- **Soil reconstruction method**
- **Quick soil improvement technology for the reclaimed land**
- **Recovery of farmland ecosystem and productivity**



Soil improvement

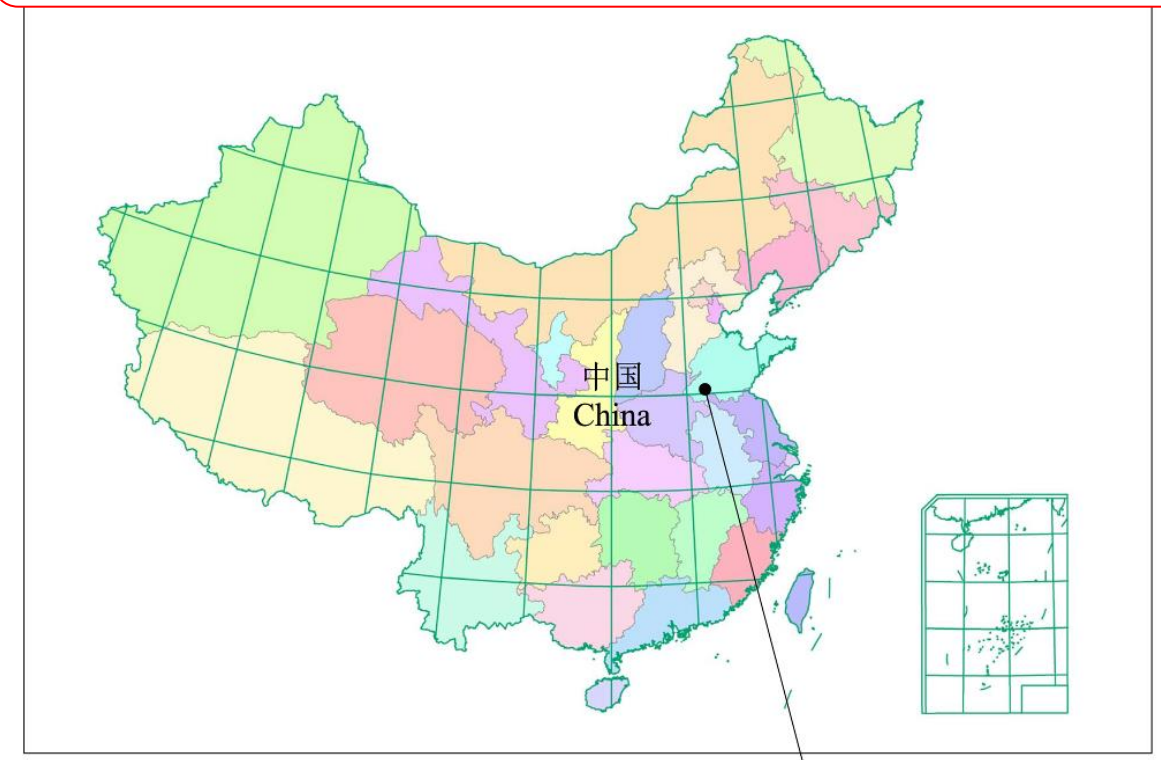


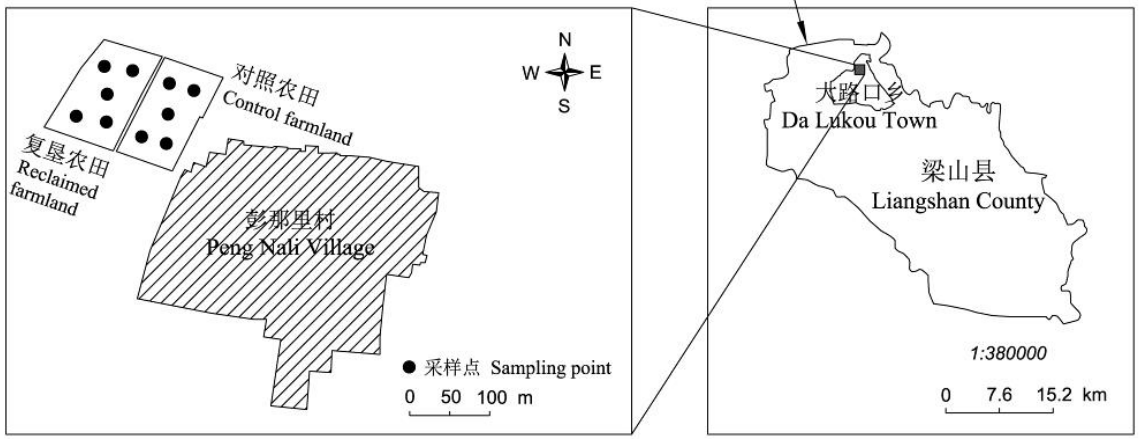
thickness of soil



soil profile

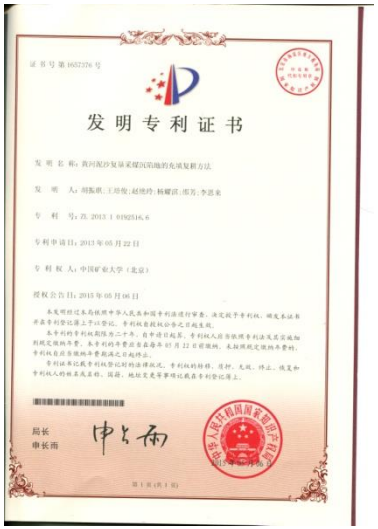
(5) Set up a experimental site





Process of filling reclamation

Short distance filling reclamation of mining subsidence land with Yellow River sediment.



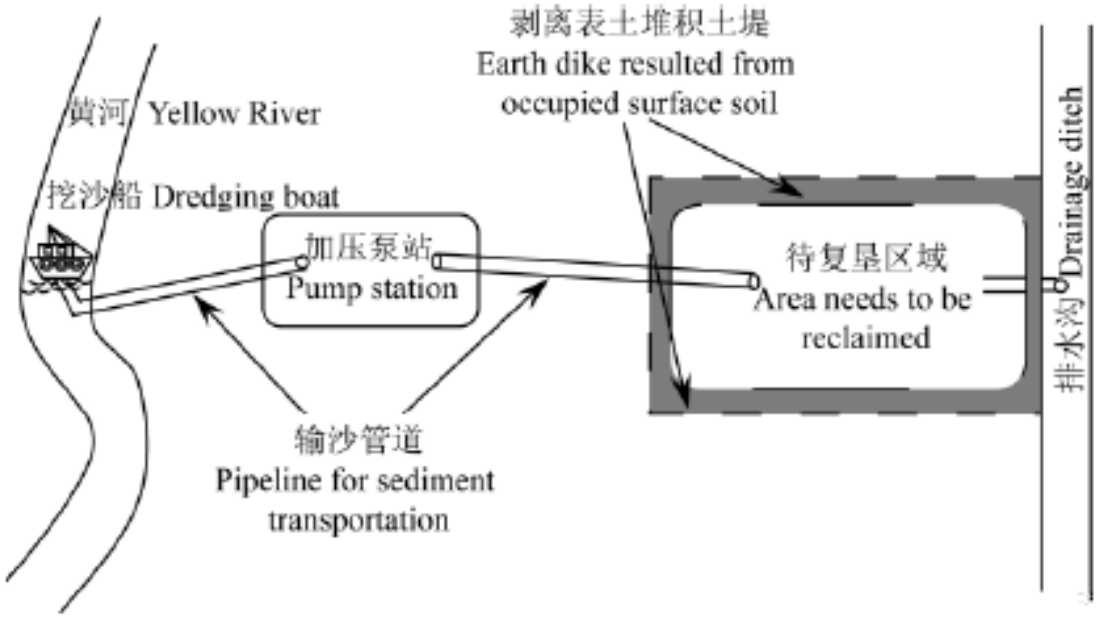
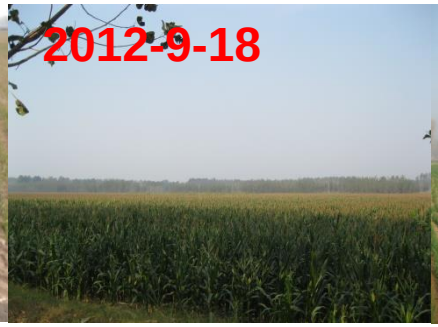


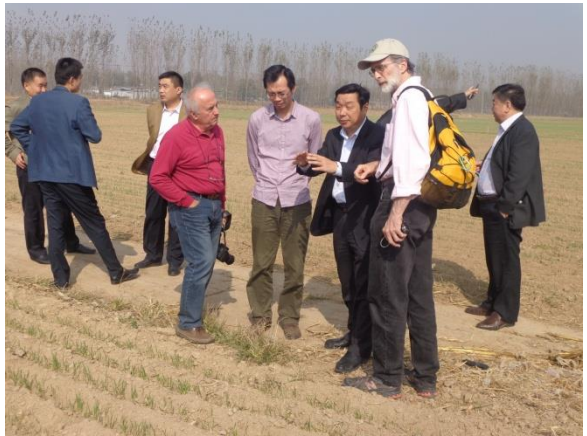
图 2　引黄河泥沙充填复垦技术工艺流程图

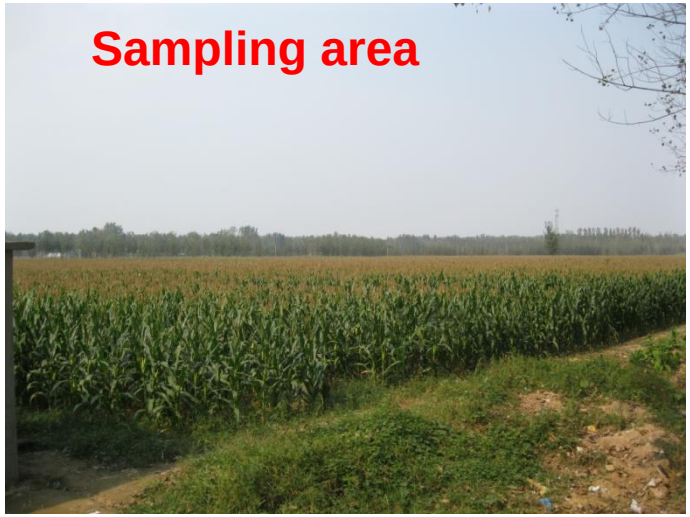
Fig.2　Process flowchart of technique of filling reclamation with Yellow River sediments

(5) Set up a experimental site

3. Soil properties of reclaimed land filled with Yellow river sediments






Sampling area


Reclaimed farmland


Normal control farmland


Water infiltration

(1) Physical and chemical properties of Yellow River sediments

表 1　黄河泥沙理化性状

Table 1　Physical and chemical properties of Yellow River sediments

黄河泥沙理化性状 Physical and chemical properties of Yellow River sediments		平均值 Means	标准差 Standard deviation
粒径分布 Soil particle distribution	黏粒 Clay (<0.002 mm)%	0	0
	粉粒 Silt (0.002～0.05 mm)%	0.9	0.06
	砂粒 Sand (>0.05～2 mm)%	99.1	2.36
pH 值 pH value		7.7	0.06
电导率 Electrical conductivity/($\mu S \cdot cm^{-1}$)		48.27	6.34
有机质 Organic matter/($g \cdot kg^{-1}$)		4.1	0.12
全氮 Total nitrogen/($mg \cdot kg^{-1}$)		10.33	7.76
碱解氮 Available nitrogen/($mg \cdot kg^{-1}$)		4.96	0.41
全磷 Total phosphorus/($mg \cdot kg^{-1}$)		228.97	19.65
有效磷 Available phosphorus/($mg \cdot kg^{-1}$)		20.48	0.32
全钾 Total potassium/($mg \cdot kg^{-1}$)		1080	114.31
速效钾 Available potassium/($mg \cdot kg^{-1}$)		54.33	6.24
Cd/($mg \cdot kg^{-1}$)		—	—
Hg/($mg \cdot kg^{-1}$)		—	—
Cr/($mg \cdot kg^{-1}$)		24	3
Cu/($mg \cdot kg^{-1}$)		0.6	0.1
Zn/($mg \cdot kg^{-1}$)		27	1.6
Pb/($mg \cdot kg^{-1}$)		14.8	1.2
Ni/($mg \cdot kg^{-1}$)		11	3
As/($mg \cdot kg^{-1}$)		6.3	1

注：土壤质地使用美国农部制进行分类。—代表未检出。

Note: Soil texture was classified according to U.S.D.A. system of textural classification. — means not detected.

silt partial types

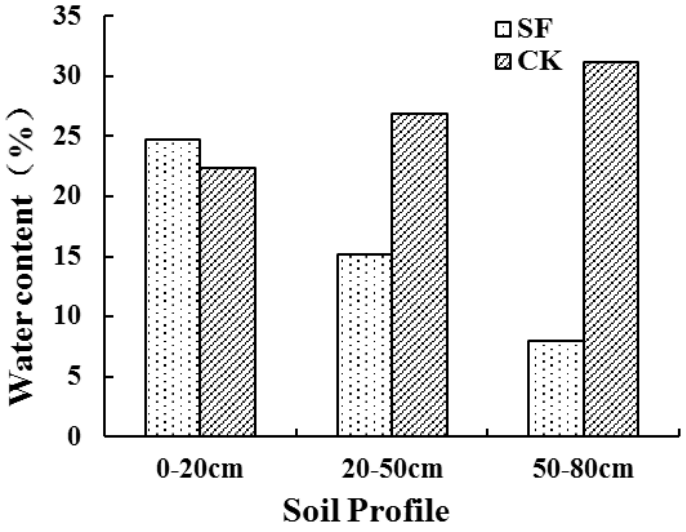
meet the requirement as the reclaimed materials

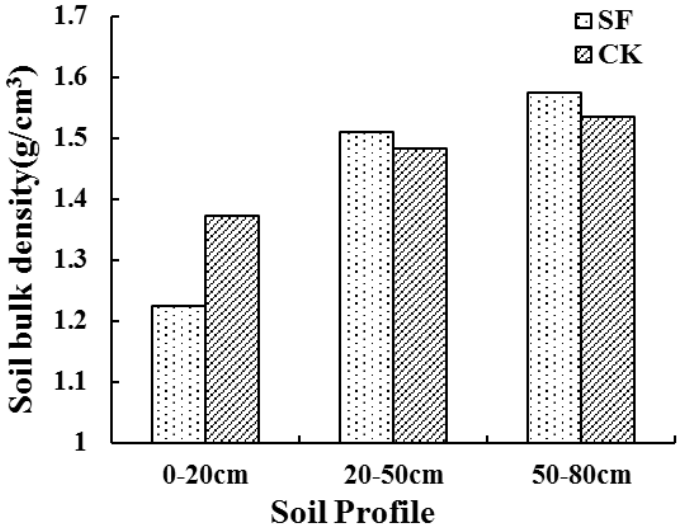
very low

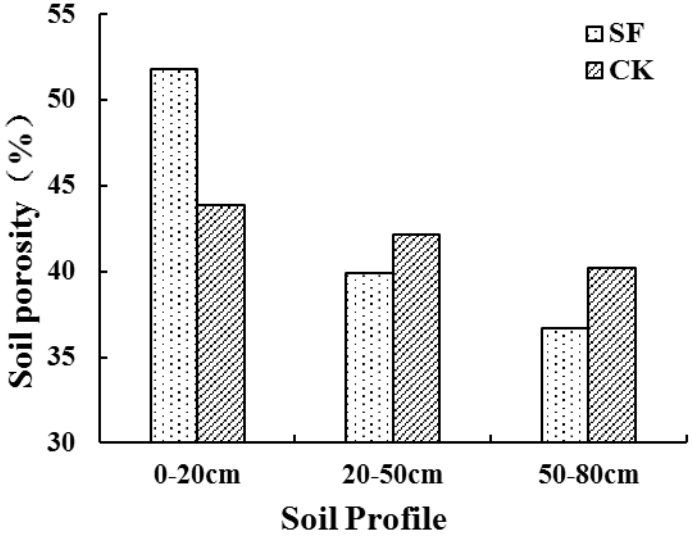
no more than the primary and secondary standard value of Environmental quality standard for soils (GB 15618-1995).

(2) Physical and chemical properties of reclaimed farmland

—— first year after filling reclamation

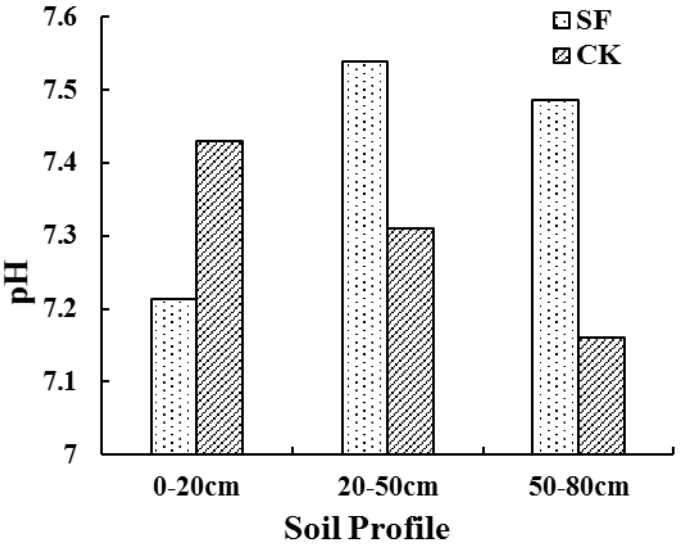


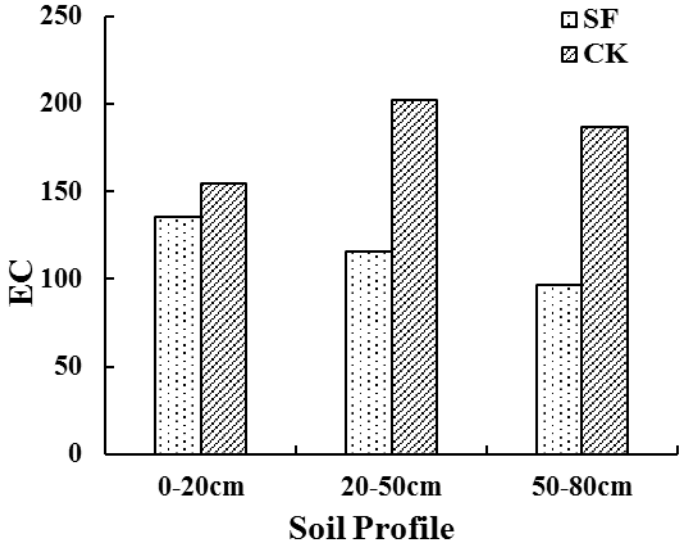


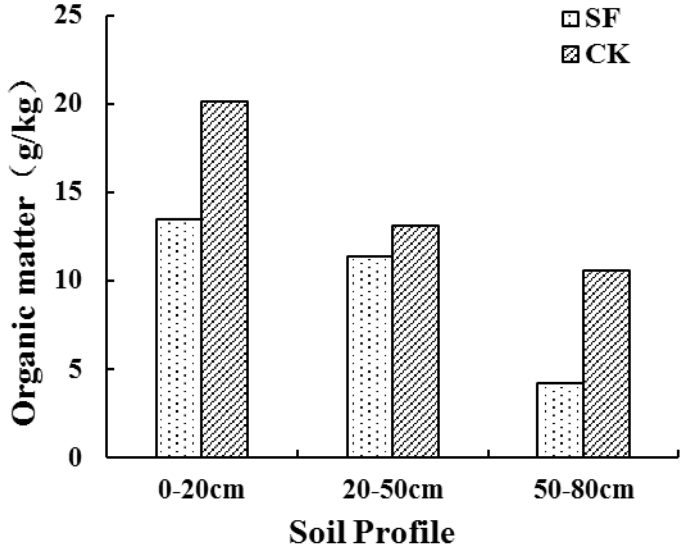


(2) Physical and chemical properties of reclaimed farmland

—— first year after filling reclamation

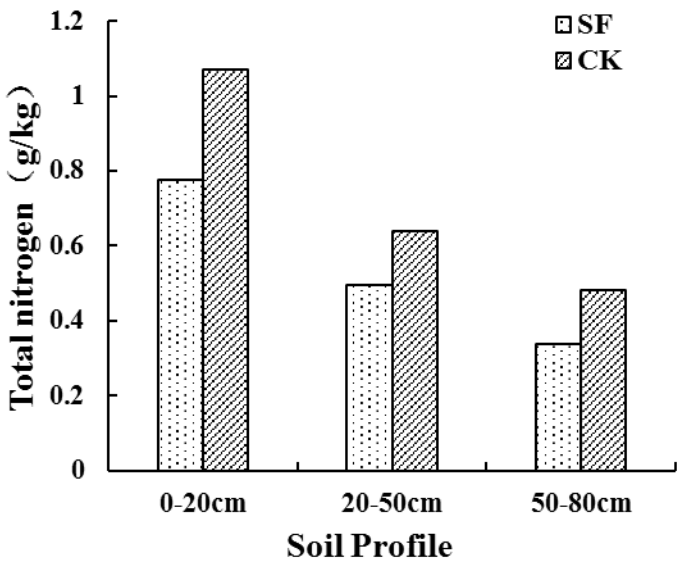


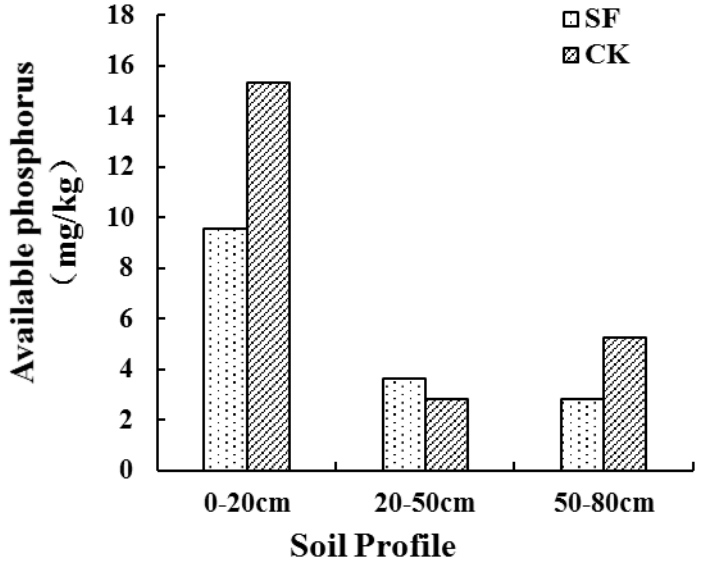


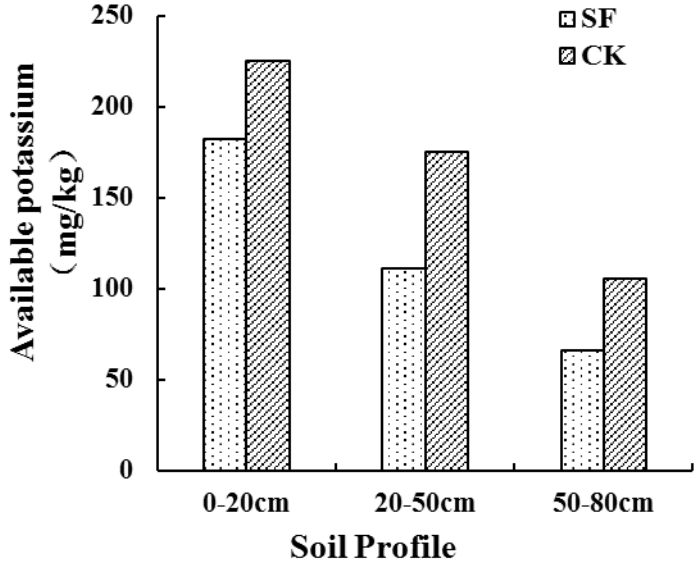


(2) Physical and chemical properties of reclaimed farmland

—— first year after filling reclamation

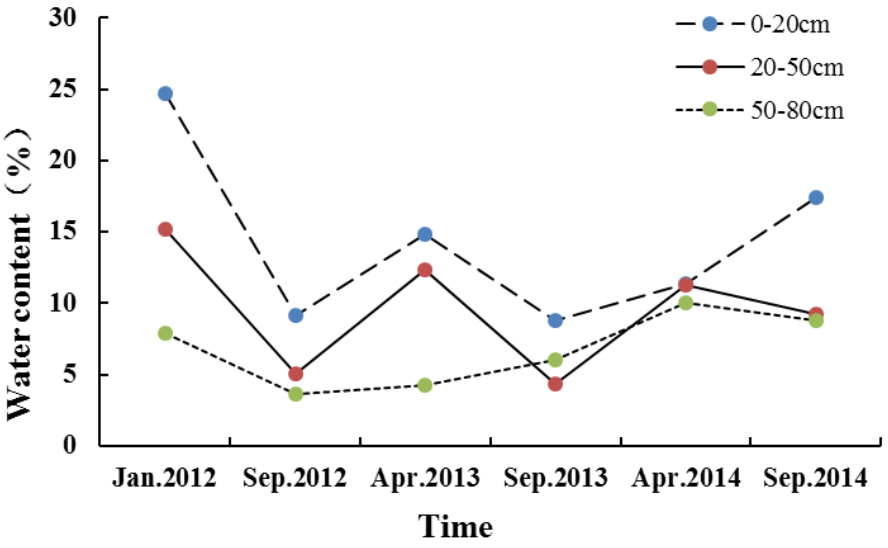


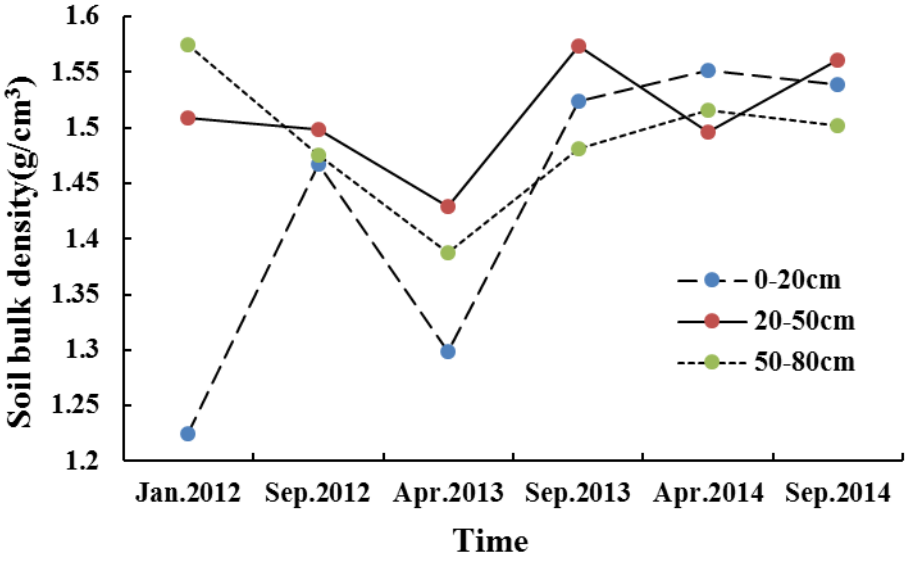


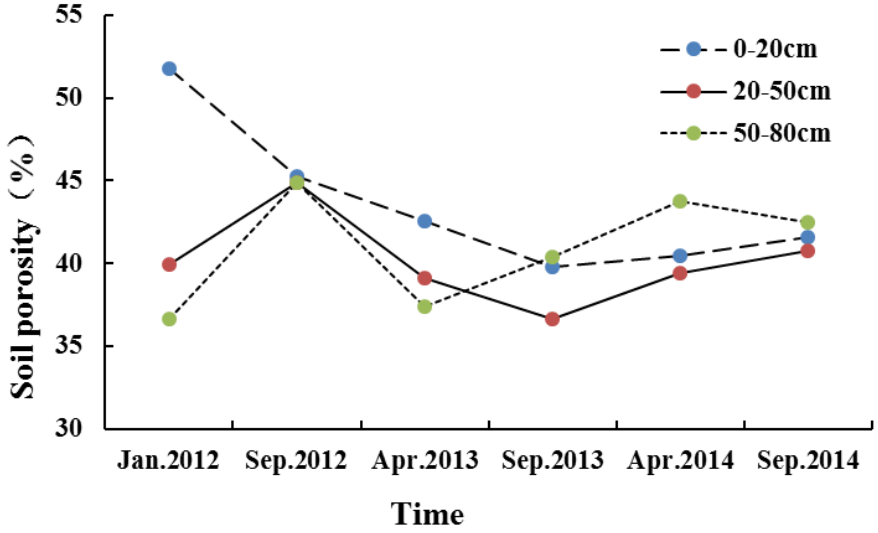


(3) Physical and chemical properties of reclaimed farmland

—— Changes with time after filling reclamation

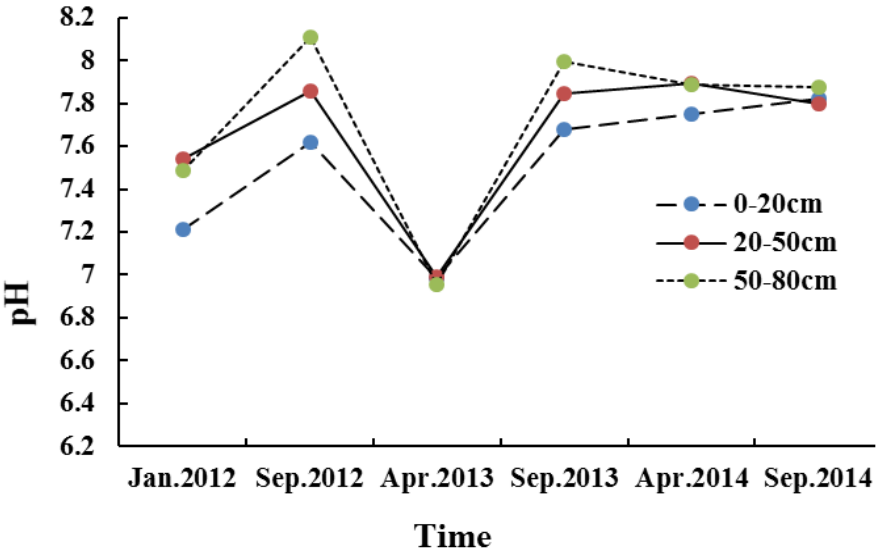


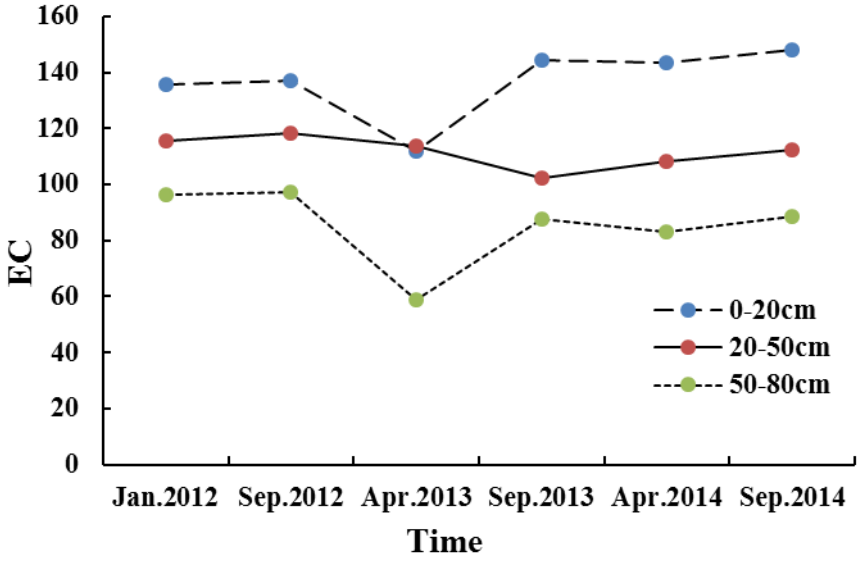


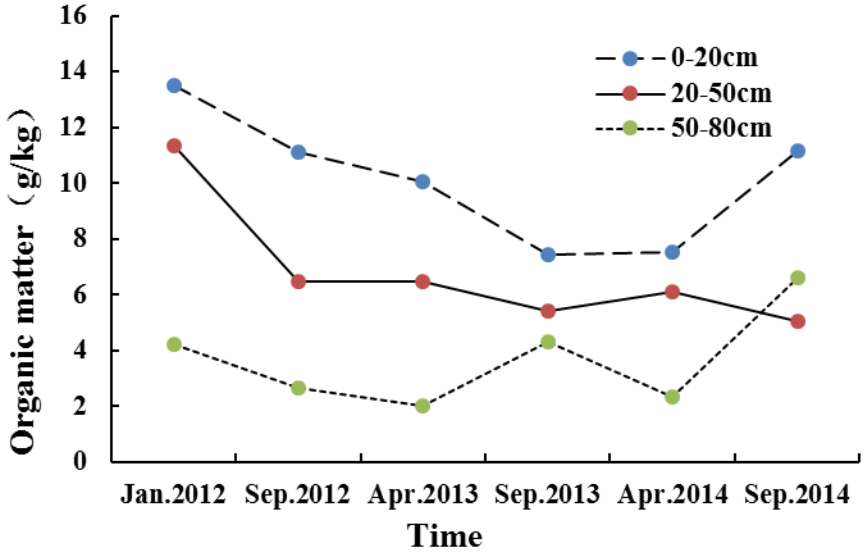


(3) Physical and chemical properties of reclaimed farmland

—— Changes with time after filling reclamation

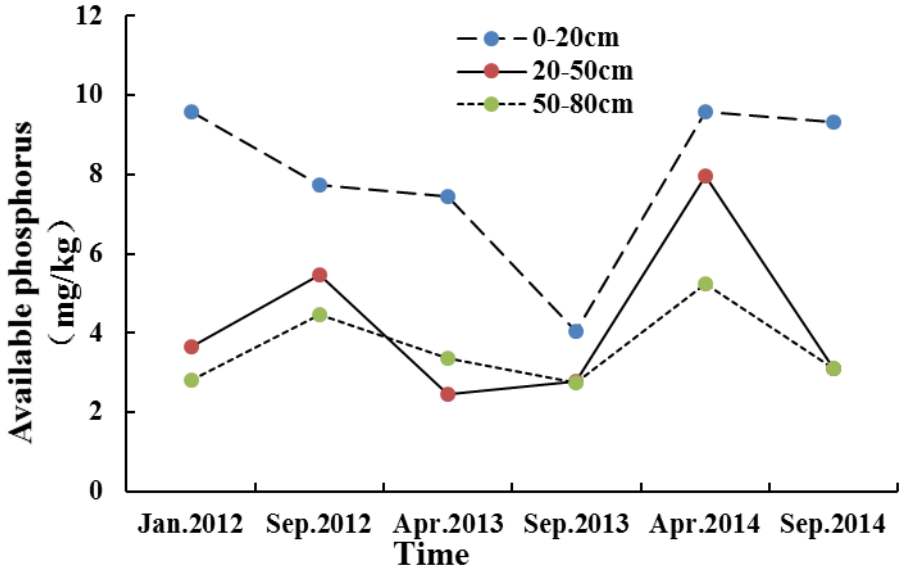


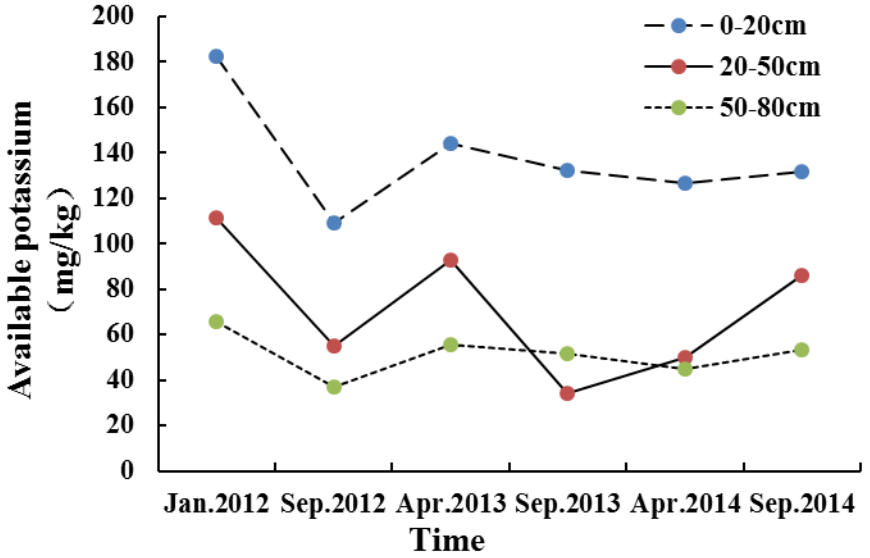


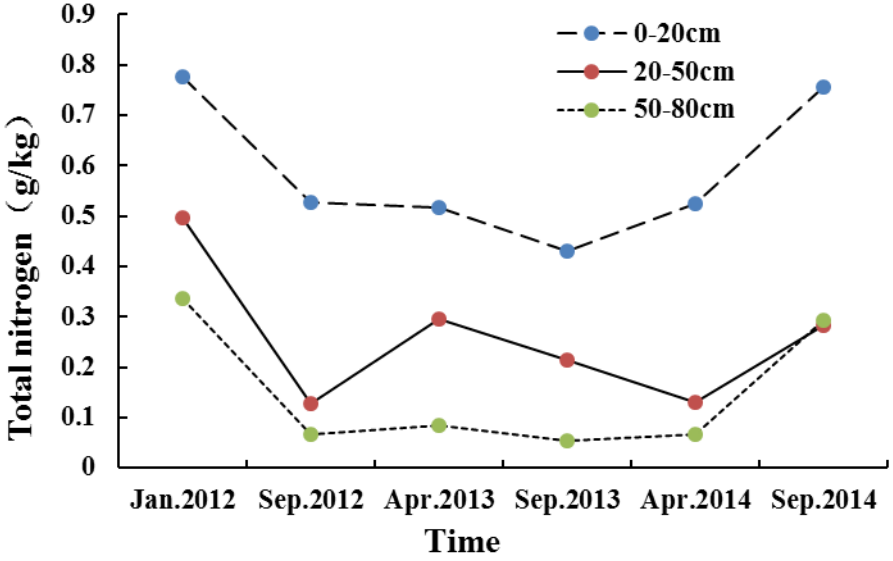


(2) Physical and chemical properties of reclaimed farmland

—— Changes in the chemical properties after filling reclamation







Wheat field(normal control farmland)

Grow well

Wheat field(reclaimed farmland)

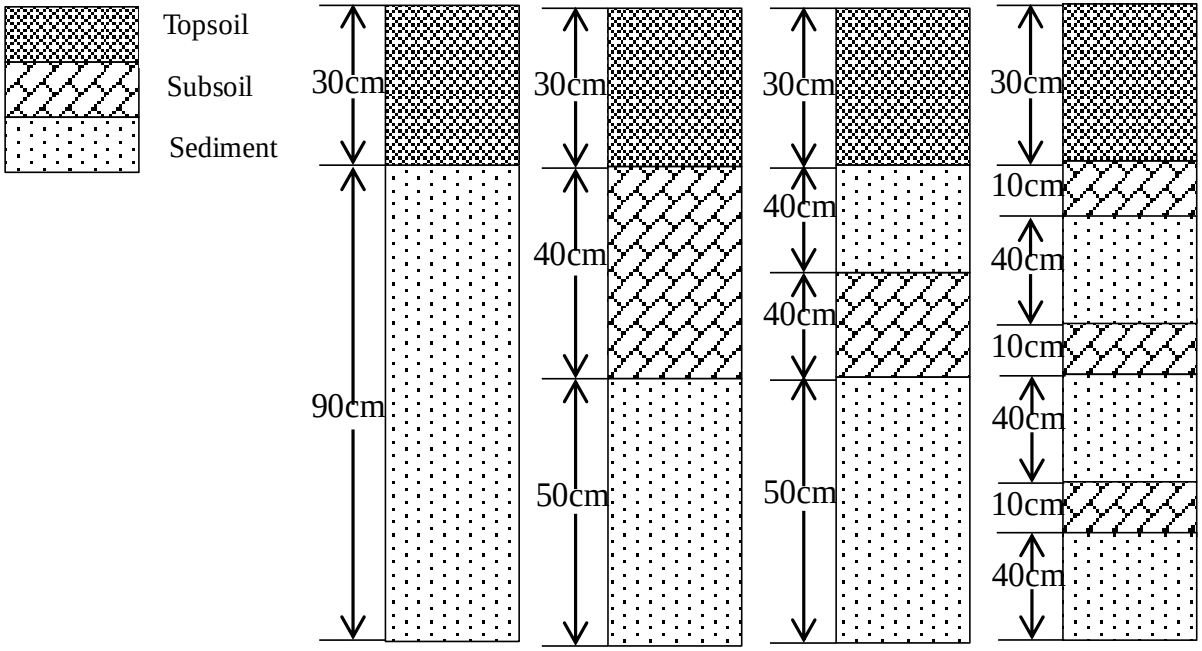
Grow bad (not enough thickness of covering soil)

4. Some countermeasures for improving the soil productivity

- **increase the thickness of soil covers --- about 70cm**
- **use better sediments with high silt and clay contents**
- **improve filling process for long time depositing so that much more silt and clay contents could stay at the filled sediments**

4. Some countermeasures for improving the soil productivity

- **new soil reconstruction**



- **soil amendments**

矿山生态安全教育部工程研究中心
Engineering Research Center of Mining Environment & Ecological Safety, Ministry of Education

土地复垦与生态重建研究所
Institute of Land Reclamation and Ecological Restoration

THANK YOU FOR YOUR ATTENTION!

QUESTIONS OR COMMENTS

Welcome to Institute of Land Reclamation & Ecological Restoration, China University of Mining and Technology (Beijing), and Engineering Research Center of Mining Environment & Ecological Safety, Ministry of Education

National Key Technology Research and Development Program (2012BAC04B03)

中国矿业大学（北京）
China University of Mining & Technology, Beijing