Experience and Problems in Planting Winter Wheat in Reclaimed Wasteland in Xinjiang Oasis

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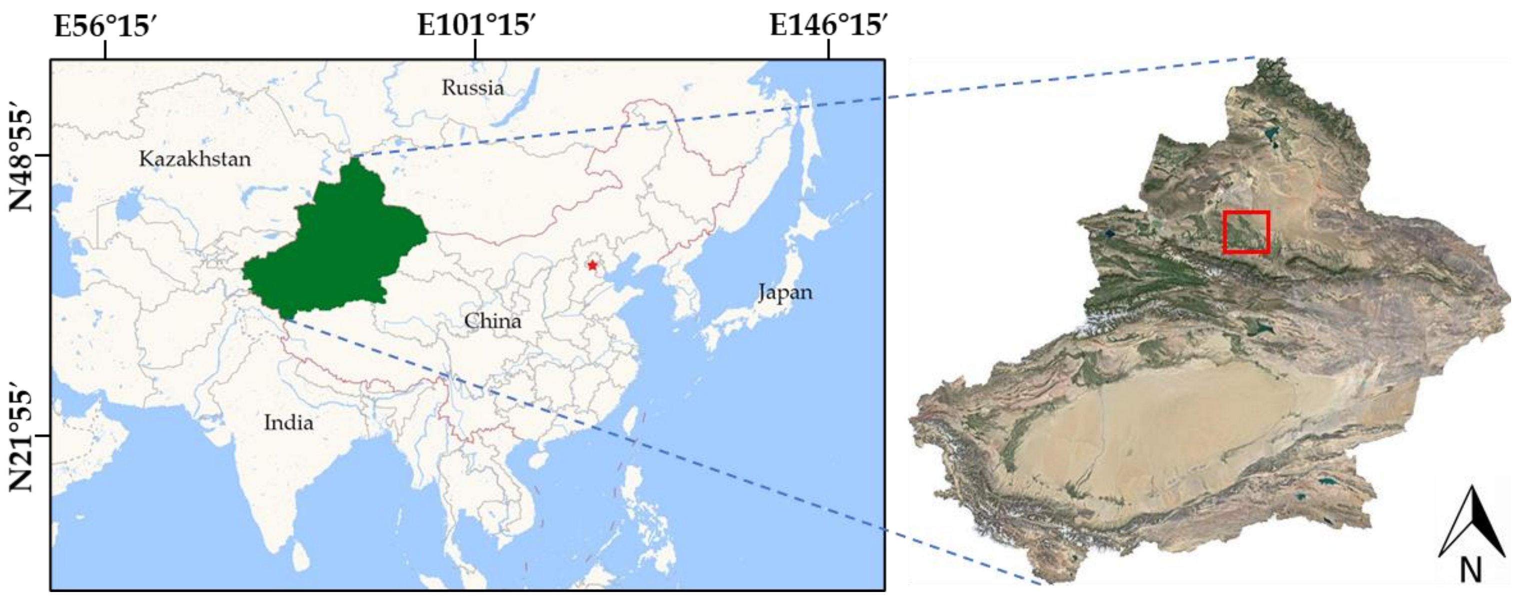
summary

- Xinjiang is located in the northwest of China and in the hinterland of Eurasia. The area is dominated by basins and deserts, with less rainfall and large evaporation. Therefore, most of the agricultural cultivation in this area is developed in piedmont oases.

- Shihezi City is located in the middle of Xinjiang and has a typical continental climate. We have carried out long-term follow-up observation on two cultivated lands near Shihezi. Plots 147 # and 148 # were originally used for planting cotton, but due to the shortage of irrigation and the serious problem of soil salinization, cotton plants in these two plots were eventually abandoned. In 2008, local farmers began to use drip irrigation system to replant wheat on fallow land 147 # and 148 #. The outcome shows some achievements have been made. In 2008, the amount of irrigation on 147 # and 148 # was 360mm-405mm, and the yield was 9676kg/hm^2-8879kg/hm^2.

- After years of reclamation, the agricultural planting in this area has achieved some success, but also brought some problems. Based on the field observation of the region and other relevant research in Xinjiang, we summarized the reasons for the success of agricultural reclamation in the oasis region of Xinjiang, found out the problems restricting the further development of agricultural reclamation, and put forward our suggestions for the future development of agricultural reclamation in the oasis region.

- We hope our research can bring some help to the agricultural reclamation in some similar areas.



Xinjiang province, China is located in the hinterland of Eurasia, belongs to temperate continental climate, with rare annual average rainfall and strong evaporation. At the same time, the region is suitable for the growth of crops due to its abundant light, heat and large temperature difference between day and night, so it has become an important planting area for cotton, grape, wheat and other crops in China.

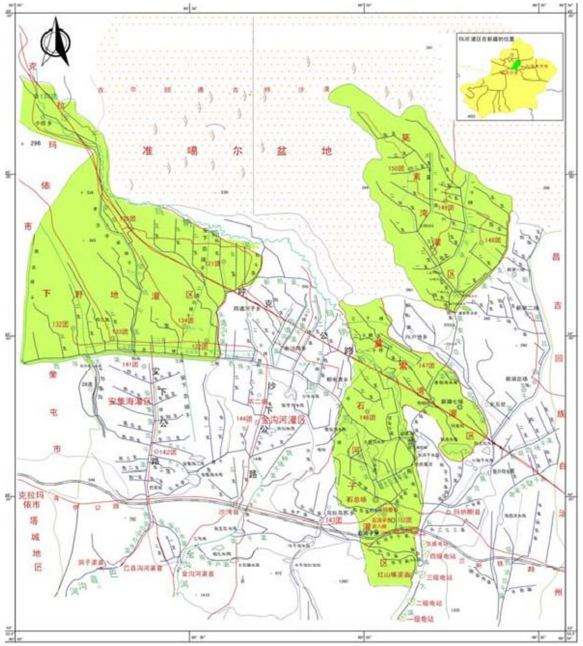
Common crops in Xinjiang

Cotton

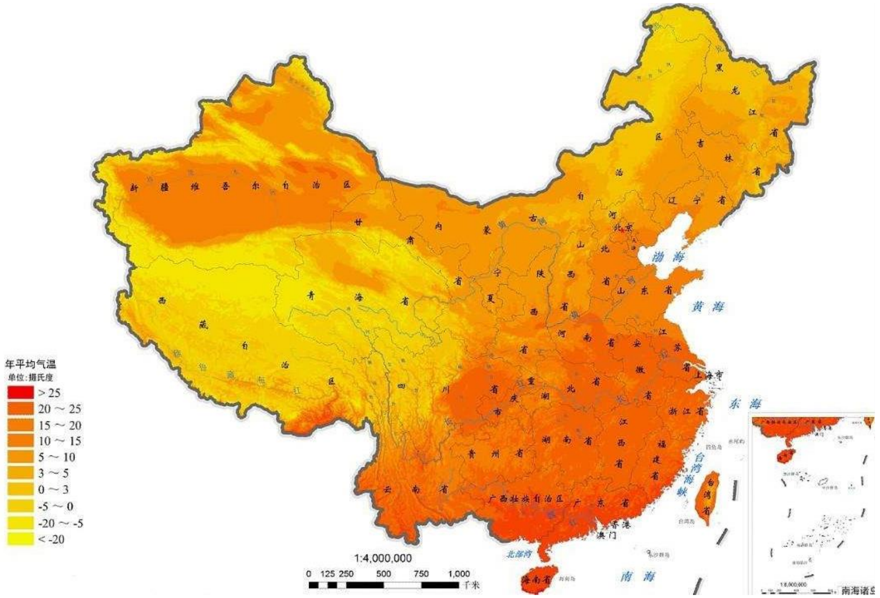
Grape

Wheat

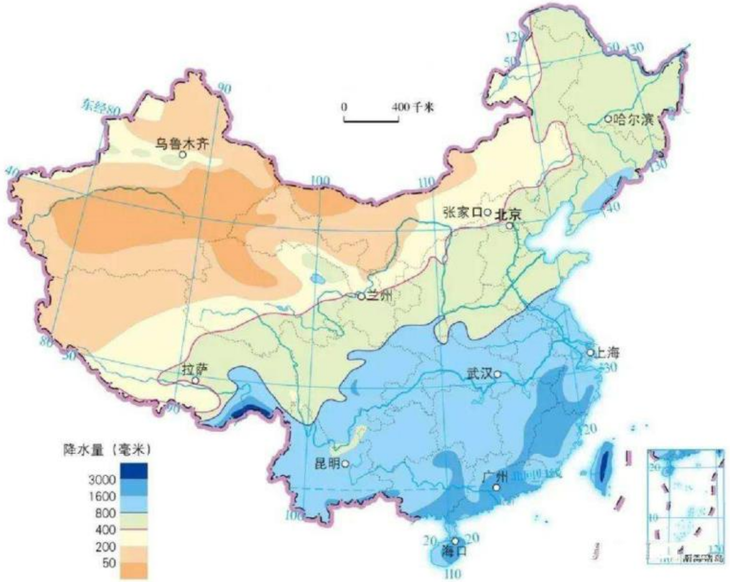
Shihezi-Mosowan irrigation area is located in the Manas River Basin, north of Tianshan Mountain and south of Junggar basin. The agricultural water source in this area mainly comes from the melting water of alpine ice and snow, which is a typical oasis agriculture in front of the mountain. The annual average sunshine hours in this area are 2865 hours, and the accumulated temperatures above 10 ℃ and 15 ℃ are 3463.5 ℃ and 2960.0 ℃ respectively, with an average frost free period of 170 days. The annual average rainfall is 207mm, and the potential evaporation is 1660mm.



The Irrigation Area of Manas River



Annual average temperature

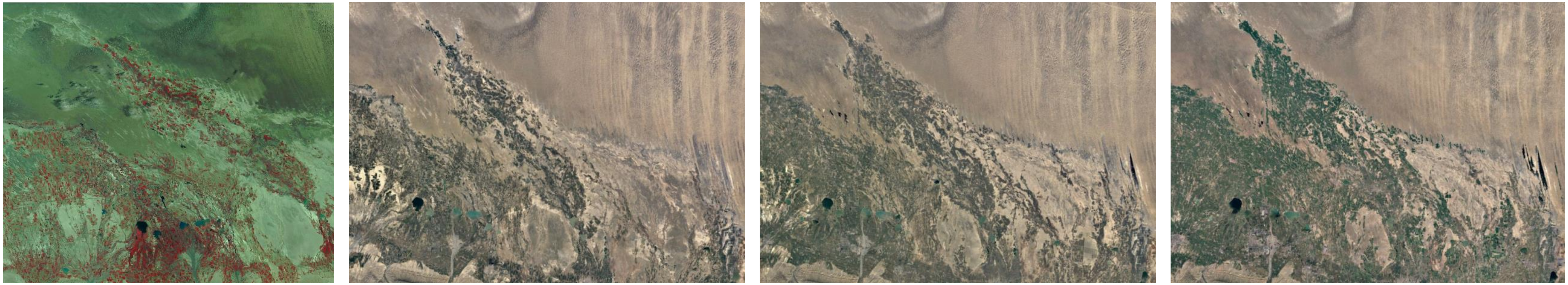


Annual rainfall

According to the local historical records, the area has been gradually reclaimed since the 1960s. So far, it has experienced four stages:

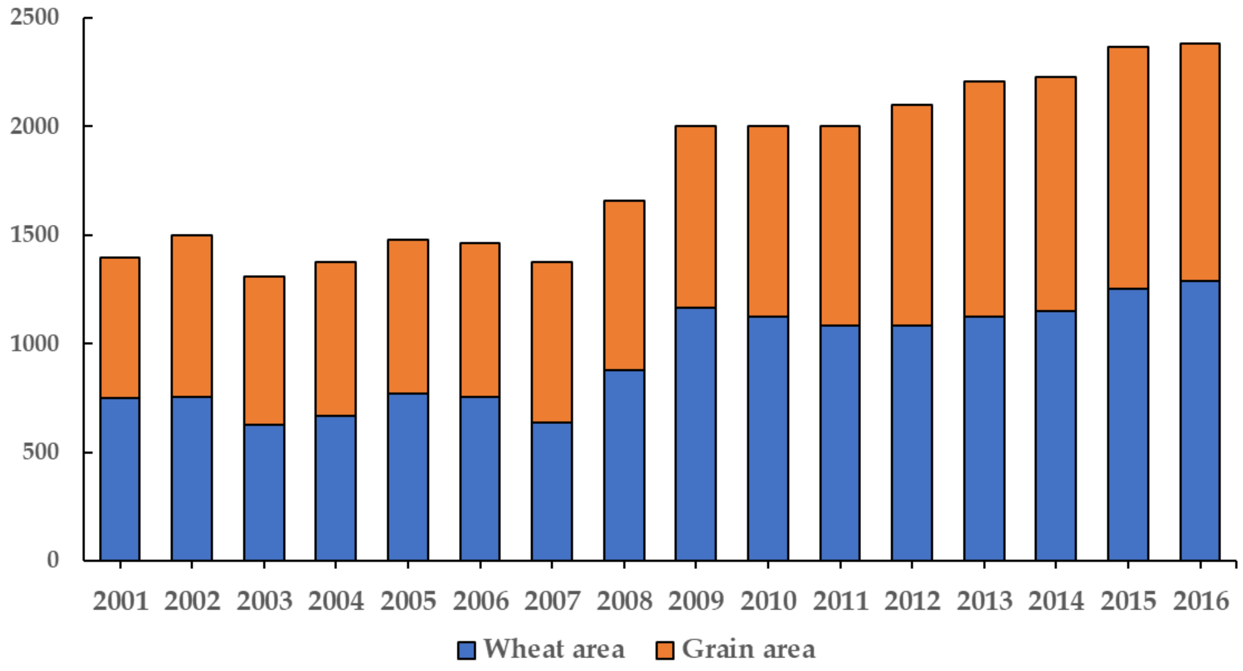
1. Large-scale rapid reclamation;
2. Part of farmland abandoned due to soil salinization
3. Use new technology to repair abandoned land
4. Abandoned land reclamation

Schematic diagram of cultivated land change in Manas River Basin Mosowan irrigation area



1976 1996 2008 2016

Wheat is one of the main grain crops in Xinjiang. By 2016, the wheat planting area in Xinjiang was about 1350 thousand hectares, accounting for 54.4% of the grain planting area in Xinjiang, and the yield was about 7.289 million tons. Due to irrigation water source, climate and other reasons, the main way of wheat planting in Xinjiang is drip irrigation, which covers an area of 1200 thousand hectares.



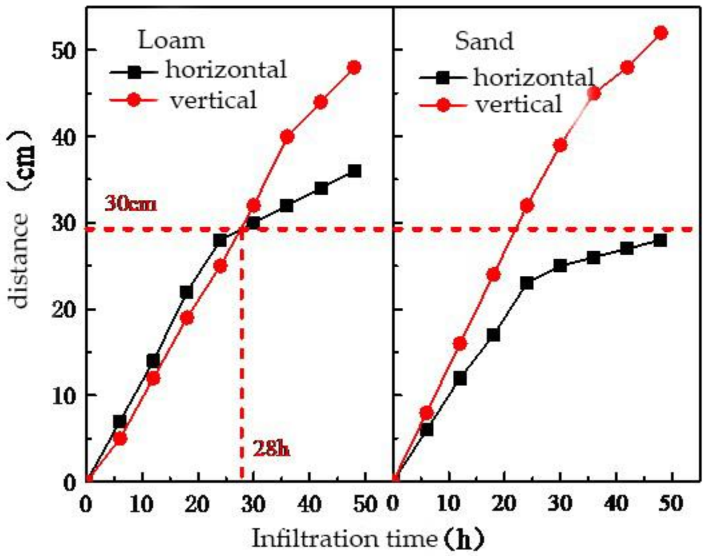
We have carried out long-term follow-up observation on two cultivated lands near Shihezi. Plots 147 # and 148 # were originally used for planting cotton, but due to the shortage of irrigation and the serious problem of soil salinization, cotton plants in these two plots were eventually abandoned. In 2008, local farmers began to use drip irrigation system to replant wheat on fallow land 147 # and 148 #. The outcome shows some achievements have been made. In 2008, the amount of irrigation on 147 # and 148 # was 360mm-405mm, and the yield was 9676kg/hm^2-8879kg/hm^2.

Plots 147 # drip irrigated wheat in 2008

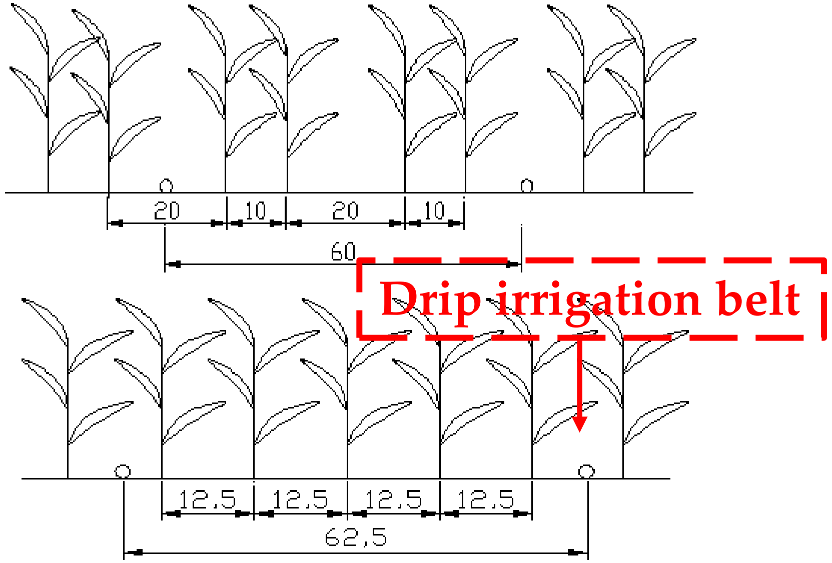
Plots 148 # drip irrigated wheat-maize in 2008

In view of the wheat planting in this area, we have made a lot of relevant research, and deeply explored the reasonable mode of planting wheat on the reclaimed land

①The suitable arrangement mode of drip irrigation wheat capillary was established: the suitable spacing of drip irrigation wheat and replanted crops was 60-70cm, and the arrangement mode was four rows of one tube (Wide row 10cm; Narrow row 20cm; Spacing 60cm) and five rows of one tube (equal spacing 12.5cm: spacing 62.5cm).



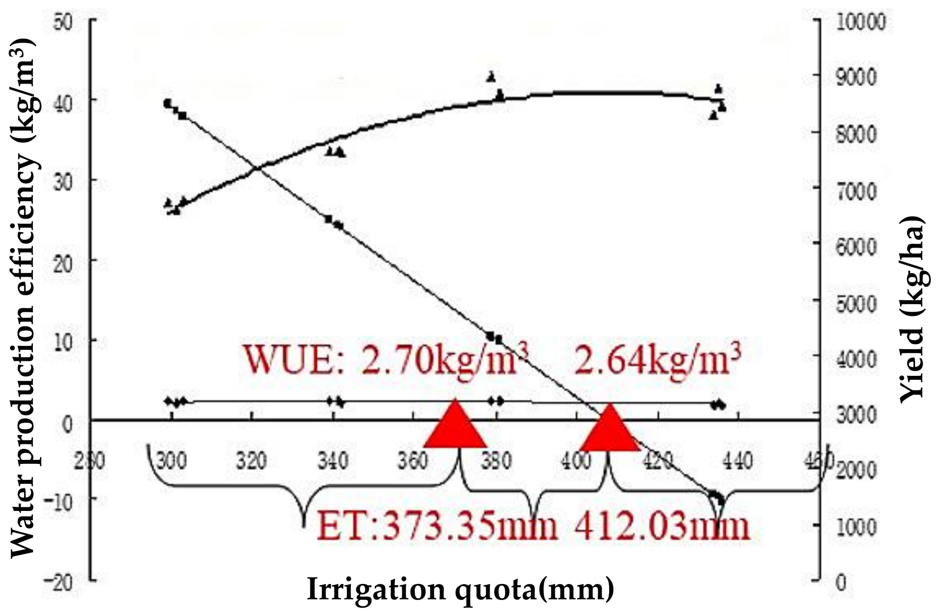
The movement law of wetting front



Layout mode of drip irrigation belt

Soil-column experiment

②The water demand law and irrigation scheme of drip irrigation wheat were clarified: the water demand during the growth period of drip irrigation wheat was 493.97mm-537.51mm. When the irrigation quota is 373.35mm, the maximum water production efficiency is 2.70kg/m³; when the irrigation quota is 412.03mm, the maximum output is 8700 kg/ha, and the water production efficiency is reduced to 2.64kg/m³



The relationship between evapotranspiration and yield, water production efficiency

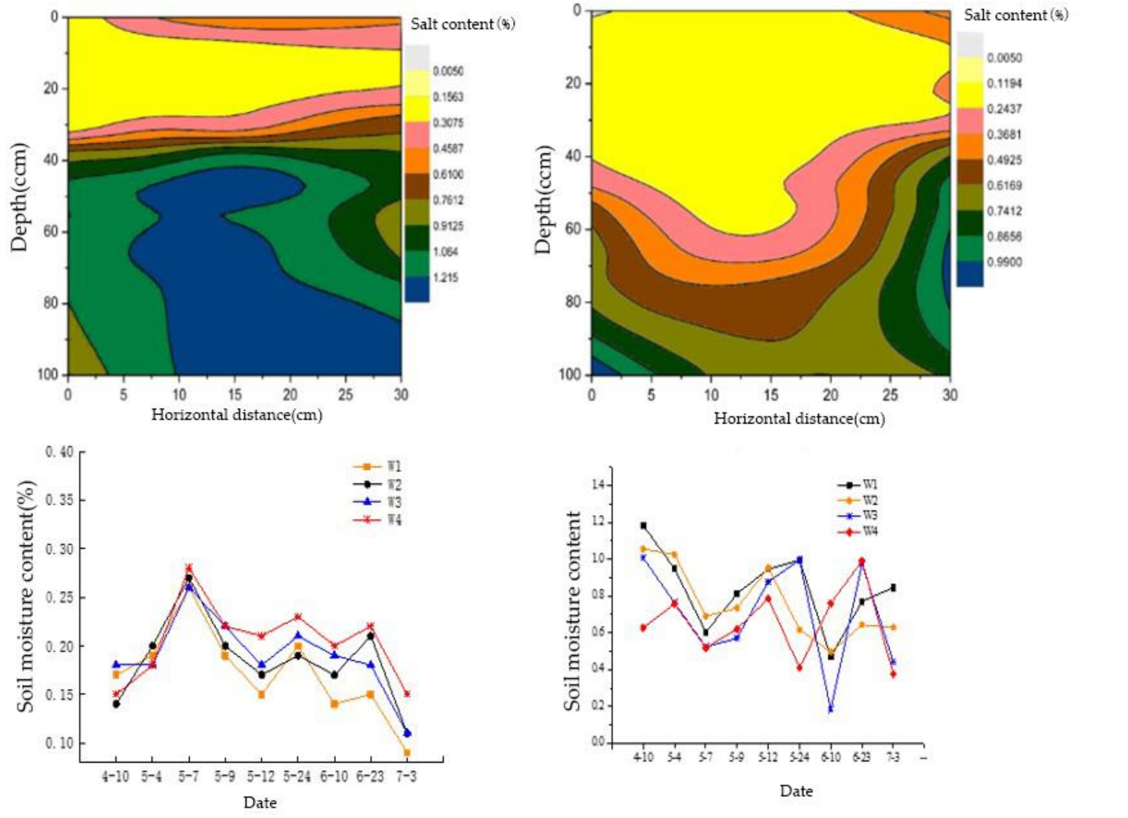
Drip irrigation scheme for wheat						
Growth period	seedling stage	Tillering stage	Jointing stage	Heading stage	Grouting period	Whole growth period
Days/d	13	16	15	16	24	84
Irrigation quota/mm	41.2	61.8	107.94	147.5	53.56	412
Irrigation times	1	1	3	3	1	9
Interval days/d	-	-	5	5	-	-

③The model of efficient utilization of water and fertilizer for drip irrigation wheat and replanted crops was put forward: when the amount of irrigation was 493 mm and urea was 640 kg/ha, the yield of drip irrigation wheat was the highest.

Drip irrigation and fertilization scheme for wheat

Treatment	Irrigation and fertilization amount: Irrigation amount (m^3/hm^2)	N (kg/hm^2)	Yield (kg/hm^2)
W1N1	5400	174.0	6209.98gh
W1N2	5400	278.4	6636.48ef
W1N3	5400	348.0	6990.39bcd
W1N4	5400	382.8	7301.46b
W1N5	5400	452.4	7035.97bcd
W2N1	4950	174.0	6539.21f
W2N2	4950	278.4	6890.42de
W2N3	4950	348.0	7247.56bc
W2N4	**4950**	**382.8**	**7786.74a**
W2N5	4950	452.4	7193.07bcd
W3N1	4500	174.0	5570.70jk
W3N2	4500	278.4	5926.68hi
W3N3	4500	348.0	6434.23fg
W3N4	4500	382.8	6930.10cde
W3N5	4500	452.4	6661.88ef
W4N1	4050	174.0	5095.43l
W4N2	4050	278.4	5580.90jk
W4N3	4050	348.0	5864.29ij
W4N4	4050	382.8	5995.52hi
W4N5	4050	452.4	5542.38k

④ The technical model of water-saving and salt control of drip irrigation wheat and replanted crops was established: drip irrigation wheat can grow normally in light salinized soil (salt content ≤ 6.4g / kg). The suitable irrigation quota of drip irrigation for wheat planted in light salinized soil is 495mm, 11 times of irrigation.



Based on our research results and other scholars' relevant research in Xinjiang, we summarized several factors for the success of planting crops on the reclaimed land in the oasis area of Xinjiang

(1) The reclaimed land was leveled to reduce the difference in land height and improve the uniformity of irrigation.

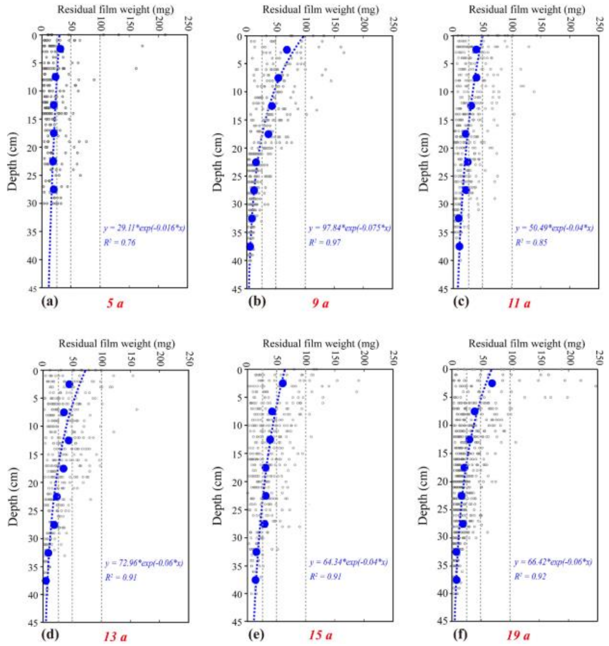
Large area land leveling by machinery can form good structure and surface state of soil plough layer, coordinate water, fertilizer, gas, heat and other factors in soil, and provide suitable basic conditions for sowing, crop growth and field management.

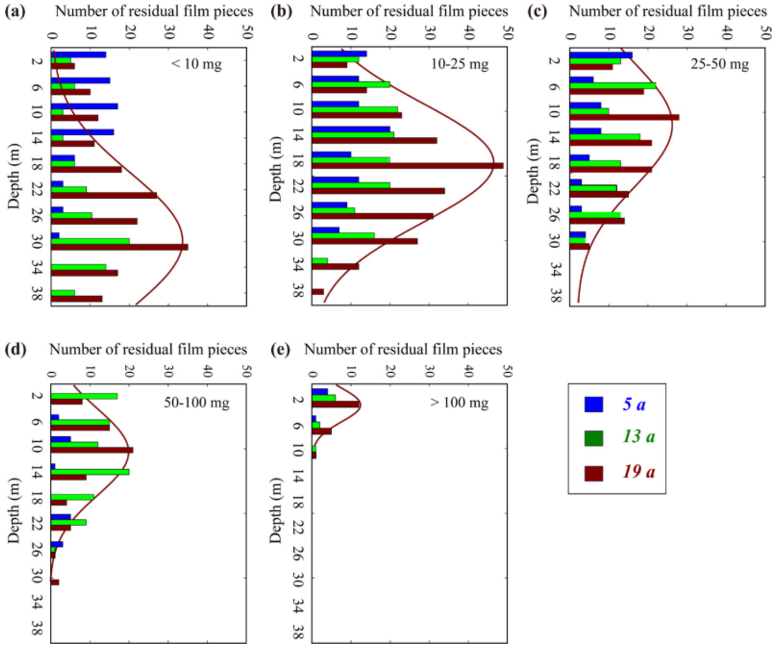
(2) Compared with previous flooding irrigation, the drip irrigation system can better save water and reduces soil salinization; On the other hand, based on drip irrigation system, the application of water-soluble chemical fertilizer has changed the traditional fertilization method in the past and improved the efficiency of using fertilizer.

Through the above measures, the agricultural planting on the reclaimed land in the oasis area of Xinjiang has achieved good results in recent years, the crop output is stable, and the regional food demand is guaranteed.

After ten years of reclamation and cultivation, what has attracted our attention is that there are also problems in plots 147 # and 148 #.

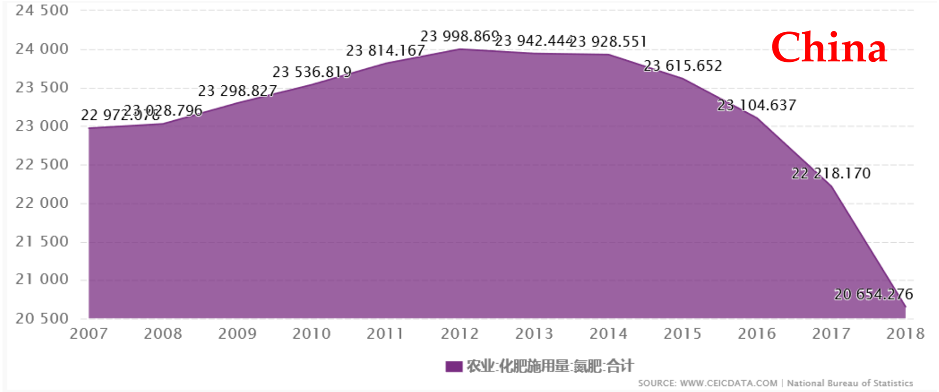
(1) White pollution: In order to reduce soil evaporation brought by local heat, farmers generally use plastic mulching to cover the soil. According to the field observation and our related research, the problem of plastic film residue in the soil is very serious. At present, the density of plastic film residue **increases around 16.37 kg/hm² per year.**

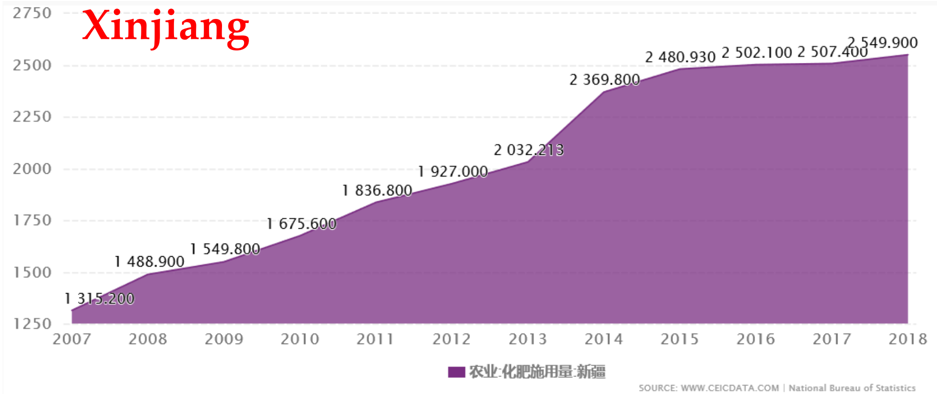




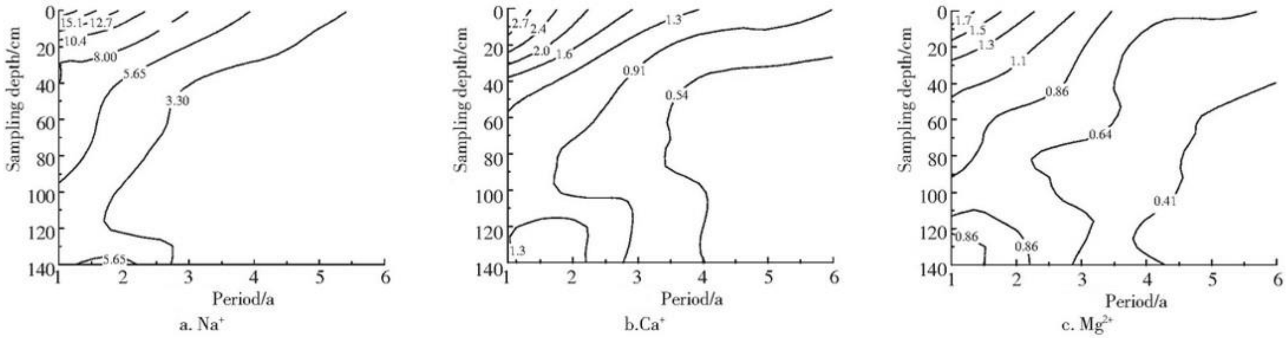
(2) Excessive application of chemical fertilizer causes potential soil pollution: Compared with traditional flood irrigation, the amount of fertilizer applied after the drip irrigation system is reduced, but the amount of chemical fertilizer used is still very large, which causes potential soil pollution.

Agriculture: fertilizer application amount: nitrogen fertilizer (thousand tons)





(3) The problem of soil salinization always exists: the drip irrigation system can effectively reduce the salt on the surface of the soil during the growth cycle of crops, but the salt deep in the soil always accumulates and cannot be effectively excreted.



Relationship between application years of drip irrigation and soil salt cation

Apeople gradually realize the problems, many countermeasures to these problems are also increasing. In our opinion, the more effective solutions at present are:

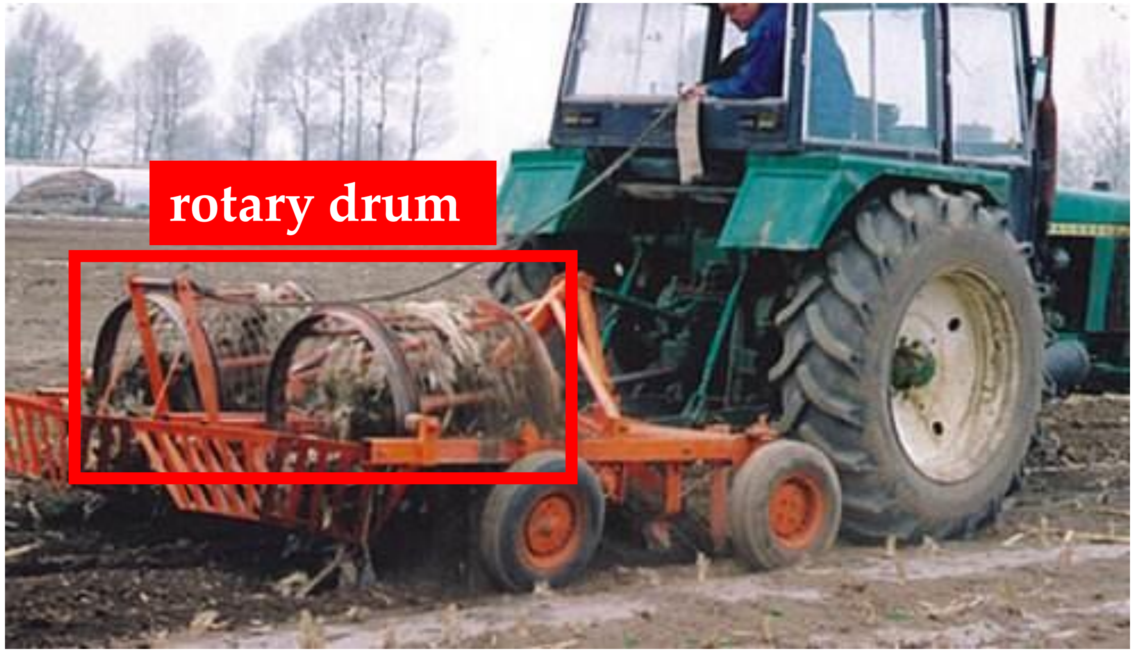
(1) Degradable plastic film: The new plastic film can degrade itself and reduce accumulation in soil.

Biodegradable mulching film is a kind of plastic mulching film which can be degraded by microorganism under natural environment. After bacteria, fungi, actinomycetes and other microorganisms erode the plastic film, the polymer components will be hydrolyzed, ionized or protonated due to the growth of cells, which will cause mechanical damage and split into oligomer fragments. Enzymes secreted by fungi or bacteria decompose or oxidize water-soluble polymers into water-soluble fragments, forming new small molecular compounds until they **finally decompose into CO_2 and H_2O.**

(2) New plastic film recycling machine: improve the recovery rate of plastic film.

Through many years of investigation and practice, it is recognized that mechanical picking up the residual film is an effective measure with high productivity, which is conducive to the harvest rate of more than 85% and the recovered residual film can be reused

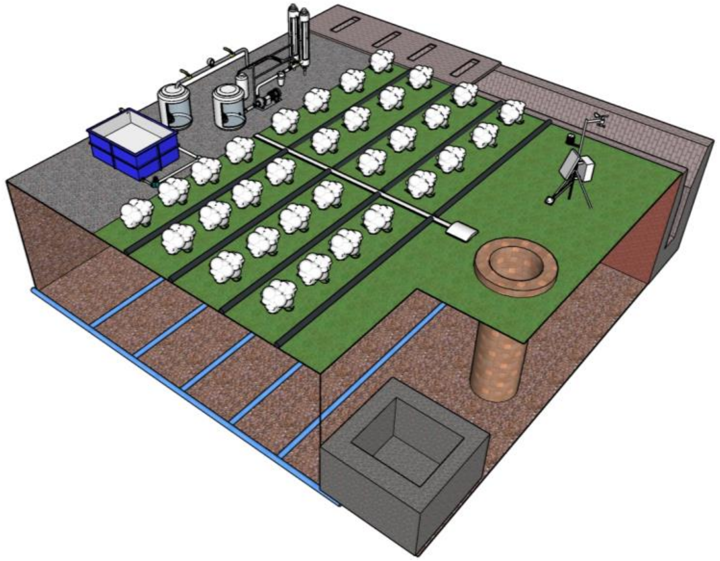
The main working principle of the residual film recovery machine is: shovel the soil into the drum with a shovel plow, screen the residual film with the rolling of the drum, the residual film is wound on the central axis of the drum, and the soil is separated out of the drum, so as to realize the recovery of the residual film.



(3) Optimizing irrigation and fertilization scheme: Through field experiments, find out the most reasonable irrigation and fertilization scheme.

Through field experiment, different irrigation quota and fertilizer application amount were set up to explore the influence of different irrigation schemes on crop growth and yield, so as to find a more reasonable irrigation and fertilizer application scheme and improve the utilization efficiency of water and fertilizer.

(4) Salinization control: Different methods such as using an underground pipe to discharge salt and applying soil conditioners are adopted to control the salinization of land, but different saline-alkali land control measures have their own advantages and disadvantages, therefore, further analysis is needed in practice.



Thank You

If you have any other questions, please feel free to contact us

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