Research on the Mechanized Conservation Tillage for Oasis Irrigation District in Xinjiang

Chen Yongcheng[1] and Hu Bin[2]

ABSTRACT

The paper analyses the characteristics of oasis irrigation in an extremely dry condition, the problems of traditional mechanized tillage methods, and its effects. The necessity, feasibility and latent benefits of mechanized conservation tillage are also discussed. Positive results were obtained through introduction of dry farming such as subsoiling, minimum-till, and no-till sowing and straw-returning farmland done in domestic and overseas areas. The study also brings forward further technical plans suitable for mechanized conservation tillage of oasis irrigated district such as mechanized subsoiling, combined soil preparation and planting, minimum-till and no-till and mechanized soil-purification.

Key words: Oasis, irrigation district, conservation tillage, technical plans

1. INTRODUCTION

Xinjiang, with semi-moist weather, is located northwest of China. It is characterized with gray and brown calcificated infertile soil, with less than 1.5 per cent organic matter. Rainfall is only 145mm per year characterized with strong winds. [1]. Continuous tillage is practiced using moldboard plow which produces negative effects.

First, soil structure is destroyed and organic matter, water holding capacity and resistance of plants to drought as well as rotting are reduced. . Second, conventional tillage decreases soil cover thereby making the soil more prone to sandstorm and erosion. This decreases agricultural production affecting the economy and the living conditions of people. Third, conventional tillage not only requires much energy and high costs, but also makes the soil surface dense and more compact.

Conventional tillage followed by wet tillage, forcible harrow and crude sowing reduces germination rates and seedling survival. Fourth, although the use of film and drip irrigation technique favors the growth of plants and increases water holding capacity, it also causes “white” pollution. The area of Xinjiang totals to 1,010,000 km^2 which is 30 per cent of the whole native wilderness area while 60.9 per cent experiences sandstorms ranging from 4-64 days/year.[1] . Areas wherein soil has been eroded and salinized both amounts to 110,000 km^2, the deteriorated meadow area totals to 51,500 km^2 and fields with low yields caused by the soil deterioration account to 88.1 per cent of the total farmland area. About 5-6 tons/year of plastic film are being used in Xinjiang, 47-57 per cent of this amount which is more than 250,000 tons are left in field,

[1] College of Machinery and Electrical Engineering, Shihezi University, Shihezi 832002, China.

[2] Xinjiang Bingtuan Agricultural Machinery Bureau, Urumqi 830000, China.

lowering the yield.

Farmlands and meadows that are discarded by the locality and Bintuan of Xinjiang amount to 10,000 ha because of water shortage and the sandiness of soil thereby losing 55.500 million. [1] And threatening the sustainable development of oasis agriculture.

With the aid of west exploitation, reforming the conventional tillage pattern, researching on the new mechanized conservation tillage which meets the needs of Xinjiang's irrigated farm and farm tillage, experimentation, demonstration and popularity of use will be some of the important factors of oasis agricultural sustainable development. At present and in the future, the inevitable necessity of continuous healthy improvement of Xinjiang's agriculture and the realization of the main aim of an excellent hill and stream could be attained.

A sustainable development strategy for the nation provides good opportunities to expand conservation tillage in Xinjiang. The government of Xinjiang has taken reforming traditional tillage mode, developing conservation tillage and protecting and building ecosystem as the emphasis of work of agriculture and farm machinery administrative department for a period time. In future, this will objectively favor to promote conservation tillage demonstrations. Promoting conservation tillage is a systems engineering, including agriculture, farming machine, plant protection, management and other aspects. For a long time, the degree of Xinjiang's farming machinery keeps ahead in China, in the course of the expanding and implementing of agricultural techniques. They have specialized organization, perfect system, and agricultural technicians rich in experience. These factors guarantee putting conservation tillage into practice.

I. TECHNOLOGICAL BASIS OF CONSERVATION TILLAGE FOR THE OASIS IRRIGATION DISTRICT IN XINJIANG

Overseas countries attach importance to the research, demonstration and expansion of conservation tillage technique. The United States started to study mechanized conservation tillage in the west dry land as early as the 1930s and 1940s. Up to the present, 70 per cent of farmlands use no-till, minimum-till and subsoiling instead of moldboard plowing; 10-15 per cent of them apply no-till straw covering treatment, which was introduced in irrigated regions by experiments. In Montana of USA, 70-90 per cent of farmlands adopted mechanized conservation tillage to a certain extent, with 25 per cent in Colorado and 50 per cent in Minnesota [2].

The former Soviet Union started to use no-moldboard plough to subsoil or shallow loosening instead of conventional moldboard plow during the 1950s, with about 80 per cent stubble and chopped straw left on the surface, sowing directly in the field with standing stubble. This resulted in an increased yield of 12-59 per cent. Australia, through experiment and research extensively adopts no-till chopped straw covering treatment, and attains the aims of conserving moisture and soil, and increasing yield. The government of Canada establishes the law of abrogating the moldboard plough method in order to guarantee actualizing no-till method. In addition, Brazil, Israel, India, and other countries have also conducted a number of researches on conservation tillage. The mechanized conservation tillage has become one of the basic farming modes in overseas countries [3].

Since the “85 Plan”, some domestic provinces, colleges, scientific research units have carried out systemic research and demonstration on “the system and equipment of conservation tillage in northern dry land”. The total demonstrated and extended area covered 2,250,000 hm^2 in Shanxi province by the China Agriculture University and Shanxi Farm Machinery Administrative Bureau. The conclusion suggests that the use of conservation tillage does result in the reduction of about 60 per cent water runoff and 80 per cent water erosion than conventional tillage; has obvious effects on reducing the wind erosion and restraining the sandstorm; increases the soil moisture conservation capacity for 14-15 per cent, the water use efficiency at 15-17 per cent, the average annual organism capacity of 0.03- 0.06 per cent; increase the yield of wheat and corn for 15-17 per cent, and lowered the cost for 20- 30 per cent [4][5][6] .

Domestic and overseas research has shown that mechanized conservation tillage provides the dependable basis of promoting the technology in Xinjiang. In recent years, Xinjiang made positive and effective research on the system and equipment for oasis irrigation mechanized conservation tillage. It has developed a series of equipment such as: stalk backtracker, combined soil preparation machine, waste film and drip irrigation pipe recovery machine, subsoiler, no-till semi-precision drill [6], and meeting the characters of the different districts such as weather, soil condition in the south and the north of Xinjiang, measures of experimenting and expanding the interrelated technique and equipment has been adjusted according to local conditions.

At present, progress has been made in stalk recovery and comprehensive utilization, combined soil preparation, waste film and drop irrigation pipe callback, no-till seeding and subsoiling etc. Experiments showed that the chopped straw covering technique, which improves the capability of cumulating moisture and heat and conserving moisture of soil, combining with the oasis saving water irrigation technique, can availably advance water use efficiency. Subsoiling and no-till technique improve the soil stratum construction, reduce the labor force, the devotion of machine equipment and energy, increase crop yield and labor productivity. No-till seeding technique can reduce the farming period, wind and water erosion and moisture evaporation in the field surface, increase multiple cropping index, prevent the soil erosion, reduce the sand harm, and repress the sandstorm. In the oasis farmland on the edge of desert, stalk mulch method can effectively reduce the harm such as low germination percentage of cotton, and the phenomenon of sandstorm beating seedlings to die. These explorations serve as the solid foundation for deeply studying, and demonstrating the technique of mechanized conservation tillage for Oasis Irrigation District in Xinjiang.

By introducing the successful experience of dry farming mechanized conservation tillage from domestic and overseas areas[7][8 the approach in mechanized conservation tillage in oasis irrigation areas of Xinjiang was decided on the bases of the following: single-item technique and the combined set techniques put into practice step-by-step, as follow:
Single-item technique

1.1 Mechanized Sub-Soiling Technique

The common subsoiling parts contain: teeth pole subsoiler, arrow shovel subsoiler, inversion trapezoid all-directions subsoiler, etc. Generally working at intervals, the subsoiling depth is 30-50cm. Its function of accumulating water, conserving moisture and boosting yield is very obvious, particularly in the extremely dry and having little rainfall areas, where there is uneven

rainfall and a great deal of evaporation as Xinjiang, and its anti-drought functions are outstanding by storing rain and snow well and conserving the moisture [10]. Popularly, subsoiling every 2-3 years can reduce the machine proceedings; strengthen the function of the protecting farmland. Its economy and social performance is very obvious.

Since the 1990s, Bintuan has already made a number of trails and research on all-directions of subsoiling, which works in wide region, bears little resistance force, has high efficiency, and after its working, a loosed channel comes into being in the bottom, which can not only store water and conserve moisture, but also evacuate waterlogging and alkali. This method is deeply popular for increasing the yield. Besides, with the introduction of the high-power wheel tractor, the problems of tractor power scarcity in the last trails and demonstrations have been resolved. Now this kind of all-directions subsoiler is already a series.

1.2 The Mechanized Combined Harrow-Planting Technique

The mechanized combined harrow-planting technique is a multiple mechanized proceeding technique, which can complete soil preparation, fertilization, seeding, pressing, etc., of the whole ground by subsoiling and plowing once. It reduces the times of the tractor's entering field pressing soil harden, increase working quantity, and can also save time by planting in no-tilled farmland after summer harvest. The combined harrow-planting machine matched with medium-sized tractor has been expanded; multiple combined machines with the big breadth, high speed and efficiency matched with high-power tractor are in experimental and demonstration stages.

1.3 Mechanized No-Till and Minimum-Till Technique

Mechanized no-till and minimum-till technique is a main agricultural mechanized conservation tillage technique. It is mainly applied in mulch planter, which can complete seeding, fertilizing, and pressing, etc., in the machine's one trip, by subsoiling once in no-tilled field (stubble field). The minimum-till (no-till) mechanized operation techniques can lessen the operations, save time, increase accumulated temperature, and have comprehensive effects on reducing cost, increasing benefit and income and improving agriculture for successor planting after harvesting the former wheat crop. This technique applies primarily in successor crop sowing , green manure planting and minimum-till (no-till) forage grass sowing in dryland after the wheat harvesting, in the divisions of the Xinjiang south and some divisions and Bintuan of the Xinjiang north along Tianshan mountain.

1.4 Mechanized Purification Soil Engineering Technique

Film mulch technique has become the key technique applied extensively in agricultural production. It exerts a great developing function, resulting in white pollution because waste film cannot be reclaimed in time. For dissolving its harm, one must make use of mechanized technique for reclamation. Now, successful technique primarily includes film reclaiming in the seedling period, film reclaiming after crop harvest and applying the bio-film that can be dissolved, etc.

1.5 The Mechanized Straw Returning Technique

The mechanized straw returning technique increases the accumulating temperature, avoids the environmental problem of firing straw by returning a large number of straw to farmland on the spot, and represses the soil moisture evaporation, reduces the earth's surface stream runoff, accumulates water and conserves moisture, increases heat and retains temperature, protects the soil surface, improves the soil physical form, boosts water use efficiency, builds the foundation for maintaining the field, and thereby, increasing the soil organism content, improving the soil construction, fostering rich and power, saving water and resisting drought, increasing crop yield and establishing the high and steady yield agriculture [11]. If a big area employing mechanized planting method in Xinjiang Bintuan cannot fertilize the large quantity of muck, the soil organism content is low, so adopting straw mechanized returning technique has more special significance.

2. COMBINED TECHNIQUE PROJECT

2.1 Combined Project of Mechanized Sub-Soiling, Combined Soil Preparation, Precision Drilling and the Straw Returning Technique

The combined technique composes the different principles and effects of all-directions for the subsoiler, combined tillage-plant machine and stalk mulching machine.

The stalk mulching machine chops the straw and mulches the farmland; shallow loosing once a year, subsoil once every 2-3 years; combined soil preparation machine company with mulching film device and precision seeding device; reclaim the waste film before the first irrigation, combined with chemical weed control technique, prevention and control of diseases and pests technique and spray irrigation or under-film drip irrigation technique.

This combined project is applicable for the high requirements of Bintuan division to the quality of soil preparation before sowing and high yield requirements of to the cotton, maize, sugar beet, etc., that uses film.

2.2 Combined Project of Mechanized Sub-Soiling, Mulch Planter and the Straw Mulching Machine

It composes the different principles and effects of all-directions for the subsoiler, mulch planter and the straw mulching machine. Subsoiling is done every 2-3 years. Mulch planter sows directly in straw field that has been treated by the straw mulching machine, adopting medical weed control, prevention and control of diseases and pests technique, and spray or drip irrigation technique. This combined technique project is available for multiple operations.

2.3 Combined Project of Minimum-Till and No-Till Mulch Planting

Mulch planter completes opening ditch, fertilizing, seeding, pressing, etc., in a single trip of the machine in stubble field after harvest, adopting mechanical weeds control, prevention and control of diseases and pests technique and spray or drip irrigation technique. This technique project is available for some areas which experiences ample light, heat, water resource, for successor planting after wheat, in the Xinjiang south and north along Tianshan Mountain, and dry land in front of the mountain and areas planted with forage grass.

2.4 Mechanized Purification Soil Engineering Technique Project

This technique aims at "white pollution" resulting from the use of a large amount of film in Xinjiang. Film can be reclaimed during the seedling period and after crop harvest or applying bio-film that can be dissolved. The corresponding machines for this technique have been developed.

3. CONCLUSION

The oasis agriculture area of Xinjiang is one of the regions where the application of mechanized trailed moldboard plow in wide areas has been implemented for a long time in China. Traditional farming techniques for several decades have caused plough sole harm, descent of the soil organism content, topsoil smashes, serious wind erosion, etc., with the ecosystem environment worsening continuously, seriously influencing sustainable agricultural development.

The mechanized conservation tillage technique is obviously a saving and increment technique, which meets the need of environmental protection and construction of western exploitation. There is a need to innovate the conventional farming mode, study the mechanized conservation tillage technique in accordance with the characteristics of Xinjiang irrigation agriculture and the agriculture cultivation, proceed with experimentation, demonstration and promotion, do further utilization and protection of the water and soil resource, promote sustainable development of the district agriculture and turn the ecosystem environment better while boosting yield and income of the oasis irrigation district of Xinjiang.

4. REFERENCES

[1] Chen Yongcheng, Wang Weixin, Mei Weijiang. Study on conservation tillage for the oasis irrigation district of Xinjiang. The proceedings of Agricultural Reclamation Mechanization Session of Chinese Agriculture Machinery Society. 2003,15-19.

[2] Li Jihong. The application of conservation tillage technique in agriculture production of Xinjiang. Journal of Agricultural Machinery. 2001,7:28-29

[3] Wang Wanzhu, Chen Yongcheng, Liu Yubo. Study on no-till and minimum-till straw mulching technique. Journal of Shihezi University (Nature Science). 2002,6(1): 45-48

[4] Song Shuyou, Bao Yuying, Cun Xuequan. The theories and practices of agriculture engineering for dryland 1995, 270-272. Beijing, Chinese Agriculture University Publications.

[5] Wang Weixin, Kan Za, Tian Xueyan. 2ZBM-6 type stubble no-tillage seeder. Transactions of the Chinese Society of Agricultural Engineering. 2001, 17(3): 174-176.

[6] Shangguan Yong, Ma FengLing. Exploration about mechanization protected cultivation technique. Chinese Agricultural Mechanization. 2002,4: 43-44.

[7] Chen Qien. Applied technique of dryland agriculture. 2002, 119-125.Beijing, Jindun Publications.

[8] Lu Hongmei. Mechanism and application of Subsoiling, no-till, minimum-till and harrow (rotating). Journal of Agricultural Mechanization Research. 2003, 2: 194-195.

[9] Gao Huanwen, Li Wenying, Li Hongwen. Conservation tillage technology with Chinese characteristics. Transactions of the Chinese Society of Agricultural Engineering.