Devote Major Effects to Push the Application of Conservation Tillage in China

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ABSTRACT

Conservation tillage is a modern farming technology which can be used instead of traditional dryland tillage to support the Chinese government's agricultural programme at all levels. The application of conservation tillage has resulted in benefits to the economy, society and environment. To further strengthen extension and application of conservation tillage in China, there is a need to take a series of measures to intensify work, and constantly improve working methods.

Conservation tillage, which originated in 1930s in America, has been extended and applied to over 70 countries recently. It has been a dryland agricultural technique with the widest application areas and resulted in best effects worldwide. According to statistics, the application areas of conservation tillage is 169 million ha, which accounts for 11 per cent of the total arable lands all over the world. Conservation tillage, which employs zero or minimum-tillage, and utilizes crop straw cover to reduce soil, wind, and water erosion, improve soil fertility and the ability of the crop to resist drought.

Since the introduction of conservation tillage into China, the government has provided support for its application at all levels resulting in scientific research breakthroughs. Conservation techniques have been maturing and experiment, demonstration, and extension areas have been expanded. Effects of conservation tillage have been realized; social concepts have been promoted; and environmental conditions have been improving.

In order to promote the harmony between humans and nature, and facilitate the sustainable development of agriculture, major efforts should be made to push for the extension and application of conservation tillage in China.

Keywords: Conservation tillage, extension and application

1. SIGNIFICANT EFFECTS ACHIEVED IN THE EXTENSION APPLICATION OF CONSERVATION TILLAGE IN CHINA

Before the 1980s, China conducted experimental research on no-tillage, subsoiling, straw cover, etc, and attained success. In the 1990s, with funds from the Ministry of Agriculture (MOA), the China Agricultural University cooperated with relevant departments of Australia and conducted long-term experimental research on conservation tillage in Shanxi province.

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After over 10-years of experimental research, more than 10 middle-and small-size suitable machines for conservation tillage have been developed. Further, the experiment, demonstration and extension of conservation tillage have made significant breakthroughs in at least one crop per year in various regions. The experiments also demonstrated that conservation tillage, which could effectively conserve soil and water, enhance soil fertility, improve soil structure, control sediment transport from farmlands, decrease agricultural production cost and increase farmer's incomes, and is suitable for the national situation of China.

In 2002, the government's central finance set up special capital to promote the experiment and extension of conservation tillage. Aimed at the construction of two conservation tillage belts around Beijing and Tianjin regions, and wind and sand regions of northwest China, 38 demonstration counties of conservation tillage have been set up in Beijing, Tianjin, Hebei, Inner Mongolia, Liaoning, Shanxi, Gansu, and Shaanxi, indicating that the demonstration and extension of conservation tillage has been in the new development stage in China.

Since 2003, about 30 million yuan per year has been allocated by the central finance to support the extension and application of conservation tillage in China. Driven by the central capital, a series of provincial demonstration regions and experimental sites have been built in Beijing, Tianjin, Shanxi, Hebei, Inner Mongolia, Liaoning, Jilin, Shandong, Henan, Shaanxi, Gansu, Ningxia, Qinghai, and Xinjiang. By the end of 2006, a total of 167 national demonstration counties and 262 provincial demonstration counties for conservation tillage have been set up in the 15 provinces, municipalities and autonomous regions of northern China, covering a total application area of 1.36 million ha for conservation tillage. Ownership for no-tillage planters totaled 32,800 with other complementary matching machines totaling 33,700 sets.

Results of the more than ten years of research and demonstration showed that the functions of conservation tillage in conserving soil water, enhancing soil fertility, controlling sediment transport, decreasing erosion, protecting environment, saving cost and increasing effects, increasing farmer's incomes, etc, were significant and could not be substituted by other tillage modes. The social, economic, and ecological benefits of conservation tillage are as follows:

(1) Economic benefit is considerable. Conservation tillage abandons mouldboard ploughing, and adopts combined mechanized operations, therefore reducing 2-3 operations in one crop production, decreasing by about 20 per cent of operation cost and effectively improving benefits from farming. Further, conservation tillage achieves stable and increased crops yields, therefore improving farmers' incomes. According to the yields data collected from 14 kinds of crops in the 10 monitoring sites of MOA, 13 kinds of crops showed increased yields under conservation tillage management. Conservation tillage increased yields of maize, wheat, millet, and bean by 4.1 per cent, 7.3 per cent, 11.2 per cent, and 32 per cent, respectively. In annual double cropping regions, conservation tillage resulted in 1515 Yuan/ha of economic benefit, while in annual one crop regions, the improvement was 652.5yuan/ha. In Beijing, 118,000 ha of farmlands adopted conservation tillage in 2006, resulting in 80 million Yuan increase in farmers' incomes.

(2) Preliminary ecological benefits shown. Straw cover and no-tillage improved soil structure, increased soil organic matter, decreased water evaporation and enhanced the ability of

conserving water and fertility, therefore realizing sustainable utilization of farmlands. The data collected from field monitoring and wind tunnel simulation in Wuchuan, Songshan of Inner Mongolia and Fengning of Heibei showed that straw cover reduced sediment transport from farmlands by 60 per cent, 54.4 per cent, and 48 per cent and large areas application could effectively control dust storms. Furthermore, straw cover could also increase soil water storage by 16 to 19 per cent and water use efficiency by 12 to 16 per cent, respectively.

When conservation tillage was applied on annual double cropping areas, irrigation water could be reduced once for each crop which translates to a total of 15,000 m3/ha irrigation water savings for the production of two crops in a year. For example, if conservation tillage is applied in all the 6.7 million hectares of farmlands in Beijing, about 100 million cubic meters of irrigation water would be saved every year, which is close to the total amount of water the Huairou Dam can hold. Straw cover increases soil fertility. The soil organic matter in wheat fields could be increased by 0.01-0.03 per cent per year and soil organic matter in maize field could be enhanced by 0.02-0.06 per cent per year. In addition, straw cover reduced the emission of CO_2 and mitigated the green gas effect, thereby effectively preventing atmosphere pollution caused by straw burning.

(3) Social benefits have been striking. The complete implementation of conservation tillage changed the traditional tillage mode, built farmers' consciousness of scientific farming and environmental protection. Further, conservation tillage promoted the advancement of agricultural scientific techniques and structural adjustment and optimization of agricultural machinery, so some advanced and practicable, economic and safe, energy-saving and environment-friendly new machinery have been developed, extended, and applied. This has enhanced the promotion of modern agriculture in the countryside.

Statistics in 2006 showed that the total application areas of conservation tillage in China was over 1.3 million hectares, which decreased top soil loss by 12-24 million tons; sediment transport from farmlands by 200-400 thousand tons; emission of CO_2 by 3.2-3.6 million tons; and the loss of SOM, N, P, K by 0.76-1.44 million tons; improved water use efficiency by 12-16 per cent; and soil organic matter by 0.03 per cent; reduced diesel oil use by 40-60 thousand tons; saved labor inputs by 80-100 million days accounting for about 0.4 million labor; decreased production cost by 0.32-0.6 billion Yuan; and increased grain yields by 0.4-0.72 million tons; farmers' incomes by 0.72-1.32 billion Yuan; and total economic benefits by 1.04-1.92 billion Yuan.

2. GOOD CONDITIONS FOR THE EXTENSION AND APPLICATION OF CONSERVATION TILLAGE FORMED IN CHINA

Since the introduction of conservation tillage into China, the techniques have been maturing, good effects have been observed, and the condition for accelerating the technology's extension has been better. The favorable conditions for the extension and application of conservation tillage are as follows:

2.1 Conservation Tillage is Receiving More Attention from the Government

During the past years, the Party Central Committee, Council State and relevant departments

have paid great recognition and attention to the development of conservation tillage. In 2005, the No.1 Document of the Central Committee “Reform Traditional Tillage, Develop Conservation Tillage”, and “Circular of the State Council on Accomplishing the Recent Work Focus on Building a Resource Efficient Society” (No. 2005-21) places conservation tillage as an important task for accelerating the development of a resource-efficient society and led to “The programming for the construction of conservation tillage demonstration project”.

The “Decision of the State Council on Further Strengthening the Prevention and Control of Desertification” (No. 2005-29) took conservation tillage as one of the important measures to control desertification. Combined with the other four national ministries, the National Development and Reform Commission issued “Policy Outline for Chinese Water Conservation Technologies” and put forward the policy of “Extend conservation tillage actively”. The MOA took the “Extend Conservation Tillage” as one of the 15 major projects for farmers. In 2006, the No.1 Document of Central Committee, “Continuously implement conservation tillage demonstration project” and MOA took conservation tillage as the main contents of “Nine Important Activities” for promoting new socialism in the countryside.

Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Shaanxi, Qinghai, and other areas successively issued governmental files, which brought conservation tillage into the schedule for agricultural development of each province and made the development programming to provide support to conservation tillage. Many counties also issued formal files to accelerate the development of conservation tillage. The positive effects of conservation tillage gradually struck the hearts of the people. Conservation tillage also got the recognition and support from all levels of governments and relevant departments. Conservation tillage was considered an important period of development opportunity in China.

2.2 Technical Systems are Becoming More Perfect

Based on the technical experts’ experiments and farmers’ practices, some mature technical systems of conservation tillage have been summarized to guide its technical extension. There are two kinds of conservation tillage modes consisting of all year no-tillage and no or minimum tillage in annual two crops areas of northern China. Examples of these modes are harvesting wheat in summer with straw cover, subsoiling if necessary, no-till seeding maize (or combining maize no-till seeding and subsoiling), harvesting corn in fall with straw chopping (or standing stubble mulch), and no-till seeding wheat (or strip-rotary-till seeding wheat). In one crop a year area, i.e., Loess Plateau, there are four main technical modes: straw cover and no-till planting (after harvest, straw cover, no-till, fallow, no-till planting next crop); subsoiling with straw cover and no-till (harvest in summer, straw cover, subsoiling, summer fallow, no-till seeding in autumn or next year); no or minimum tillage for small cereals (harvest in summer, straw cover or standing stubble, no-till, winter fallow, no-till seeding in next spring, harvest in next summer); all year no-tillage with straw cover in two crops a year areas (wheat harvest in summer, straw cover, no-till seeding maize, maize harvest in autumn, straw chopping cover or standing stubble, no-till seeding wheat); and all year no-till and straw cover.

In the cross areas of agriculture and pastoral region in Northwest China, the main technical modes are straw cover and no-till seed, standing stubble and no-till seed, straw cover and no or minimum-till seed, and pasture no or minimum-till. In west oasis agricultural areas, the main

technical modes are permanent raised-beds, straw cover and no-till plant, and crop rotation under conservation tillage. In cold ridge farming area of Northeast China, the main technical modes are straw cover (standing stubble) and minimum-till seed and ridge tillage with conservation tillage. In southern rice areas, the main modes are as follows: no-till for one of early-rice (middle-rice) and late-rice or no-till for both early and late-rice in double-rice areas; no-till for one of rice and wheat (cole, potato) or no-till for both rice and wheat (cole, potato) in the rice-wheat, rice-cole and rice-potato rotation areas.

Further, relevant national departments also organized experts to conduct research on weed and pest control under conservation tillage management, weed growth role, and synthetically controlled, the mechanism of conservation tillage's effects on soil fertility and crop growth, crop growth control, water coupled fertilizer and soil quality, etc, and continuously monitoring the long-term application effects, so as to resolve the problems in the extension and application and provide the extension programme with the technical supports.

2.3 Personnel Abilities are Promoted

MOA founded the technical expert group consisting of experts in cultivation, soil and fertilizer, plant protection, agricultural machinery, and management to provide advices for government policy and guidance for the extension of technology and conduct of research for technical development. Many research teams such as China Agricultural University, Chinese Academy of Agricultural Sciences, Northwest Agriculture and Forestry University, Huazhong Agricultural University, Jilin Academy of Agricultural Sciences, have been formed to track the development of conservation tillage in the world and solve the problems of technical extension in China, which has made some achievements and supplied the technical support for application and extension of conservation tillage.

Fifteen provinces (autonomous regions, municipalities) and 530 counties which are the locations for the extension projects of conservation tillage in northern China all have set up expert groups to train technicians, extensionists and farmers and promote the application of conservation tillage. Through training and practice, the understanding of local extensionists on conservation tillage has improved and the abilities of farmers to implement the technology have increased. Over the past five years, the extension projects of conservation tillage covered more than 2 million farmers properly trained on the technology. According to the survey in project areas, 60 per cent of farmers and 80 per cent of tractor drivers have basically mastered the key points of conservation tillage and operation criterion and used methods of key machinery.

Through more than 20 years of research and five years of technical extension, China has initially developed the complete research system and high capacity research teams, established an extension team in field production, and trained a large number of farmers who can understand conservation tillage, master the key points and operate machinery, which generated enough resources for further promotion of technical extension.

2.4 Machinery Quality Has Been Getting Better

China has made progress in the development of row-following no-till planter, strip-rotary-till direct seeding planter, and ridge tillage for corn planter, no-tillage planter for small cereals

after the introduction of techniques, and technological breakthroughs. MOA has recommended 10 kinds of wheat no-tillage planters and 19 no-tillage corn planters to the community, supported and guided extension and application of conservation tillage equipments, and conducted training on the technology.

The production enterprises of no-tillage planters developed from the original 20 to the more than 100 at present. Some foreign enterprises have started to engage in conservation tillage equipment market of China.

In 2006, the survey results from China's agriculture machinery testing centers which covered 95 project counties in 13 provinces which implemented conservation tillage demonstration projects (municipalities and autonomous regions) showed that the overall quality evaluation of no-till planters was "good (applicable)" and "common (basically applicable)". This result accounted for more than 95 per cent. In the evaluation of no-till maize planters, the evaluation results of "applicable" for no-tillage maize planter accounted for 80 per cent and the total "applicable" and "basic application" accounted for 100 per cent. This finding indicated that the current no-tillage planters are basically recognized by farmers and meet their requirements. It also means that the bottleneck restricting the development of conservation tillage has been eased.

2.5 Social Service Has Been Developing

As the technology matures and market demands expand, local departments have formed conservation tillage service modes with regional characteristics suitable to the local conditions, which promoted the application of conservation tillage and provided experiences for establishing and promoting a long-term mechanism.

Professional service organizations for conservation tillage, which maintains large agricultural machinery, professional services team, and agricultural machinery operation services, have rapidly developed. Through cross-regional operations, orders, contract services, leasing services, and developing social and market-oriented operations, these organizations increased the operation areas and drivers' benefits, and accelerated the popularization and application of conservation tillage. The operation mode, which takes the farm machinery families as the main parts and develops social and market-oriented services, shows a vigorous vitality in the demonstration areas for conservation tillage.

3. PROMOTE THE MOMENTUM OF WORK AND ACCELERATE THE EXTENSION OF CONSERVATION TILLAGE IN CHINA

Conservation tillage is a change from the traditional tillage, so there are evident difficulties of changing traditional tillage custom which has lasted for several thousand years. Encouraging achievements have been reached but the gaps are still significant. Currently, the extension and application of conservation tillage in China are in the key period. Gradually promoting the momentum of work and improving work methods are the key issues.

3.1 Strengthen the Role of Support and Instruction from the Government

Conservation tillage is an advanced agricultural technique with significant economic,

ecological, and social benefits. Its long-term benefits are greater than the short-term and the social benefits are greater than farmers' individual benefits. The government, which is in charge of social management and public service, has the responsibility and obligation to push the extension and application of conservation tillage.

With government support, conservation tillage in the United States, Canada, Brazil, and Australia has been extended in large areas. The experiences in and outside of China showed that the extension of conservation tillage depended on government support, including support for scientific research, demonstration, extension and the purchase of agricultural machinery. The conservation tillage technique and machinery will gradually be developed and improved and new problems will be met in the future for the technology's extension. The government then should support the research on conservation tillage techniques and machinery, continuously set up special projects to support experts and technicians who can perfect suitable technical system for local areas and instruct farmers' on best practices. There is a need for the government to help enterprises with the development of suitable machinery and ensure that relevant agronomic measures are taken.

Conservation tillage is mainly adopted by the farmers, so government should support the demonstration and extension of conservation tillage; improve farmers' situation, and train technicians and farmers. As a result, technicians can instruct about the practices and farmers can use the technique. Demonstration areas should be set up to persuade and convince the farmers to practice conservation tillage. The application of conservation tillage should adopt new machinery, improve or abandon old equipment, build ecology-restoration mechanism, and assist farmers to buy or update machinery through subsidy.

3.2 Strengthen the Leading Role of Demonstration Project

Project demonstration areas should be set up to develop main technical modes and mature machines and train technician teams for the extension of techniques. Demonstration projects should be set up in the region with basic good agricultural machinery which is a requirement for conservation tillage. Such demonstration projects should be recognized by local governments and provided with enough technicians. The demonstration project funds, which should concentrate on propagation, training farmers, and the conduct of comparative experiments, should be used scientifically. The funds should culture farm machinery contractors and assist them to buy or improve machinery. Based on the acceptance of farmers, the government should decide on the different support mechanisms for different stages. Further, the government should mobilize the local enthusiasm, drive local fund inputs, encourage local experiments and demonstration, and put the national demonstration projects with significant effects in local project areas.

3.3 Strengthen the Role of Interest-Driving Mechanism

The beneficiaries of conservation tillage are the most enthusiastic groups to push for the application of this technique. The stakeholders of conservation tillage include government, enterprises, farmers, tractor drivers, and technicians. The support from the government can be obtained by propagating the positive effects of conservation tillage on an improved environment and promotion of sustainable agricultural development. Farmers' enthusiasm can be mobilized

by propagating positive effects of conservation tillage on enhancing soil fertility, saving cost, and increasing yield and income. Enterprises need to recognize the potential market during the course of extending and implementing new machinery. The participation and recognition of tractor drivers can be realized from increased benefits by increasing their operation areas and machine use efficiency. Further, the government can increase the enthusiasm of technicians by providing funds and proper commendation, and push for the formation of a good environment for conservation tillage.

3.4 Strengthen the Support Role of Mature Techniques

After over 20 years of research and six years of demonstration and extension, some mature technical modes and lines suited to local conditions have been formed. The application of these effective and feasible techniques should be accelerated. In the areas with mature conditions, the application of these techniques can be done by the whole village, township and county. The application effects should be used to stabilize farmers' self-confidence and attract more participants. The relationship between research and extension should be properly handled, which means that importance should be attached to both research and extension. Acceptable practices by farmers should be adopted to demonstrate and teach other farmers, and accelerate the popularization of techniques. The information dissemination platform with online column, seminars and experience-sharing sessions should be constructed to strengthen technical exchanges, promote information sharing, and expand the application effect for outcomes.

3.5 Strengthen the Combination of Agricultural Machinery and Agronomy

Conservation tillage involves the fields of farm machinery, cultivation, soil and fertilizer and plant protection, etc. Thus, it should be emphasized that conservation tillage is a combination of agricultural machinery and agronomy, engineering, and bio-technology, and the use of systematic opinions to tap on their advantages and solve the problems in the most economic way. In the implementation of conservation tillage, problems such as weed management, pest control, straw disposition, and planting under no-tillage, will be encountered. Some problems can be easily solved by agronomic methods and some could be easily done by machinery. Agricultural machinery departments should take the full advantages of agronomic experts, consult with them, and construct expert groups involving agronomic experts, so as to strengthen the push for the application of conservation tillage through cooperation.