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China, Factor 2: Water Scarcity

China: The application and popularization of water saving agriculture of wheat in Hebei province

Abstract

Water resources are becoming increasingly scarce in Hebei, which is a province of China. Developing water saving agriculture and improving utilization of water resources have become a necessary demand for the sustainable development of agricultural production. The essay focuses on the subject of water saving agriculture of wheat, specifically. By probing the achievements and existing problems of water saving agriculture of wheat by data analysis and field investigation, some feasible suggestions are discussed for future development and provide experience and reference for the development of water saving agriculture in water-deficient areas.

Key words

Wheat, Water saving agriculture, Hebei

I. Necessary application of water saving agriculture of wheat in Hebei province

Water and food security have been two worldwide issues for a long time. China is the most populous developing country in the world, which uses 7% of the world's land and 8% of the fresh water to feed 22% of the world's population. In recent years, with a continuously increasing population, global warming, and serious ecological environment issues, which includes the scarcity of water resources, China is facing enormous pressure and challenges in the aspects of water resources and food security. Particularly, water consumption in agriculture accounts for more than 70% of the total water usage in China, but the utilization rate of water resources is only 30-40%. The grain productivity per stere of water is only 0.85 kilogram, which is less than half in comparison with developed countries and that seriously restricts the development of modern agriculture in China.

We have visited the Hengshui Wheat Water Saving Project Area in Hebei Province, the Shengpeng Specialized Cooperative for Grain Planting in Shenze county, Shijiazhuang, Hebei Nonghaha Machinery Co., Ltd., the Agricultural Science Institute of Gaocheng District, the Agriculture Department of Hebei Province and the Agriculture Bureau of Shenze county, the leaders of Shengpeng Cooperative, the person in charge of Hebei Nonghaha Machinery Co., Ltd., the professor of Hebei Agricultural University, and the agricultural science and technology personnel Shenze county, carrying out in-depth exchanges and discussing the future direction about water saving agriculture of wheat.

Through the investigation, it has been found that Hebei province is not only one of the largest agricultural provinces and 1 of 13 major grain producing areas in China with a large population, but also one of the most water-scarce provinces in China. With congenital shortage, the annually available water resources in the province is about 16.8 billion stere and per capita water resources is 307 stere, which is 1 in 7 of the national average. Due to the small amount of water resources and the large amount of water consumption, the groundwater in Hebei province is seriously overdrawn, forming seven groundwater funnels exceeding 1000 square kilometers, which has become the largest groundwater funnel area in the world. The main crops in Hebei province are wheat and corn. Wheat planting area is stable at about 34 million mu and its yield is about 14 billion kilograms. The total water consumption of wheat accounts for 49% of agricultural water consumption and about 34.3% of the total water consumption of the whole society, so wheat is regarded as a huge agricultural water consumptive crop. Considering the significance of Hebei wheat production in China's wheat supply, it is particularly essential to achieve zero or negative growth of total agricultural water usage under the presupposition of keeping wheat yield without decreasing.

II. Current situation of water saving agriculture of wheat in Hebei province

Hebei province began to carry out comprehensive control in the groundwater areas and promoted the pilot construction, where “four retrenchments and one increase” policy was adopted in wheat production to ensure grain stability and water saving.

i. Implement structural water saving and construct an agricultural planting system which is suitable for developing using appropriate water. First, the wheat production area should change the planting pattern, put seasonal lie fallow into practice and reduce the planting area of winter wheat in the non-dominant area of planting wheat, so as to reduce the water consumption in agriculture. Besides, it is necessary to replace wheat with trees, hydrophyte and forage crops and so on, which takes advantage of changing crops to adjust the agricultural structure and save water from the fountainhead.

ii. Implement engineering water saving and construct efficient farmland irrigation systems. By improving the utilization of water resources, the government could build water system connecting and efficient irrigation project, at the same time popularize sprinkling irrigation, drip irrigation, micro irrigation and other irrigation systems. Currently, 2.37 million mu has already irrigated high-efficiency and water-saving, which offer equipment support for water saving agriculture of wheat.

iii. Implement agronomic water saving and construct advanced and applicable agricultural technology support system. Firstly, generalize water-saving and drought-resistant wheat with fine ground preparation, straw returning to the field, suppression after sowing, timely late sowing, soil moisture irrigation and many other agronomic water saving technology in winter wheat growing areas where groundwater is overdrawn. It has totally popularized 17 million mu field with the reduction of 850 million stere water usage for agriculture. Secondly, as the support of integral control of water and fertilization, the central and local governments have invested more than a billion in funds to establish a water-fertilizer integrated irrigation system like sprinkling irrigation and drip irrigation in different regions. Correlative policies that subsidies will be 800-1500 yuan per mu according to different irrigation methods are promoted of 950 thousand mu in total.

iv. Implement mechanism water saving and construct long-term management and operation systems. On the basis of “divide water resources by land and into fields”, reformation of water price should be put by the government, establishing a “use more spend more, use less spend less, no use earn allowance” mechanism to warm up farmers’ enthusiasm for saving water.

v. Increase substitute water resources and establish a scientific agricultural water security system. Improving the water diversion projects of the Yellow River has added 490 million stere of additional water sources and the south-to-north water diversion project has added 180 million stere, which helped relieve the serious shortage of groundwater in Hebei province.

One of the pilot areas that assessed by a third institution in 2017, has formed an agricultural groundwater pressure extraction capacity of 1.5 billion stere, which was introduced by the responsible person of the Hengshui Wheat Water Saving Project Pilot in the Heilongjiang Port area in Hengshui. Its shallow and deep groundwater level generally shows the tendency of rising or slowly decreasing. The comprehensive production capacity of grain has been consolidated and agricultural planting has gradually changed from extensive water and fertilizer management mode to accurate and quantitative modern irrigation mode, which helps to achieve the goal of saving water and produce stability. The average yield of wheat per mu in the project area is 446.8 kilograms, which is much higher than the average level in Hebei province.

III. Existing problems in water saving agriculture of wheat in Hebei province

In order to understand water saving agriculture in depth, the Shengpeng Specialized Cooperative for Grain Planting in Shenze, Shijiazhuang, Hebei (hereinafter to be referred as Shengpeng Cooperative) is selected in the process of visiting Shenze. Shengpeng Cooperative was founded in 2015 and consists of 70-80 people, of whom 7-8 are shareholders and the rest are land members. Through land transfer, a total of 500 mu of land is used to mainly plant winter wheat and produces an annual income

of about 850 yuan per mu and total income of 425 thousand yuan. Shengpeng Cooperative has three long-term employees with annual income of 30-35 thousand yuan. The cumulative investment in basic water-saving irrigation equipment of which the government subsidizes 50%-80% depending on the type is more than 2 million yuan.

Shengpeng Cooperative mainly uses Shimai-15 and Yingbo-700 provided by the government, which takes 240 days to harvest with a yield of 400-450 kilograms per mu. It actively implements integral control of water and fertilization and agronomic water saving technology, which generalizes subsoiling and suppression after sowing and use buried telescopic sprinkler irrigation equipment. Also, training about the prevention of wheat diseases and pests, the use of water-saving irrigation equipment and agricultural water-saving supporting technology is frequently organized to spread technology in the countryside and help farmers adapt to the water saving agriculture of wheat. Water saving wheat production has the achievement of saving water, fertilizer and employment at the same time and protect land resources, which provides the possibility of increasing production while simultaneously using less labor, promoting the sustainable development of water-saving agriculture of wheat.

Taking a consultation, the staff of the Agriculture Bureau of Shenze county, the members of Shengpeng Cooperative and the person in charge of Hebei Nonghaha Machinery Co., Ltd. reflected some puzzles in water saving agriculture of wheat, which they have continued to think about.

i. Most of the land doesn't carry out land transfer, so land scale cannot be guaranteed and water saving irrigation equipment cannot be popularized. During the period of reform and opening up, China implemented household contract responsibility system and the policy of "work and production contracted to households", so large plots of land were divided into small plots run by individual farmers. In 2014, the central government began to implement a nationwide land transfer policy, which encouraged farmers to transfer land to form large-scale land and scale production. The higher level of agricultural production systematism is very effective to popularize the production of agricultural machanisation on a large scale and to popularize the application of new technology on a larger scale. Most farmers support this policy, but there are still some farmers who are unwilling to carry out land transfer because of traditional ideas, personal interests and other reasons. Therefore, the scale of land cannot be guaranteed. During the visit, it was found that apart from the 500-mu land used by Shengpeng Cooperative through land transfer, most other farmers in Shenze didn't carry out land transfer. There are ridges separating the land between each household, which waste the land resources and increases the difficulty of developing water-saving agriculture. These particular farmers need time to agree with this policy. The water saving irrigation equipment needs to be used on a large scale of land to produce economies of scale, which is not applicable to small plots of land. Land decentralization limits the generalize of water-saving irrigation equipment, which then limits the application and popularization of water saving agriculture of wheat.

ii. Water saving wheat varieties are not widely used. Most of the water saving wheat varieties used by some farmers, such as Shimai -15 and Yingbo -700, are provided by the government. The farmers don't have a clear understanding of the advantages of water saving wheat varieties compared to common wheat varieties. Taking the farmers in Shenze as an example, though planting water saving wheat can save water and reduce agricultural spending, what they care the most is whether the water saving wheat varieties can guarantee or increase the yield while saving water. At present, the water saving varieties they use haven't got a clear supporting yield data, and other characters may not meet the need of production. Farmers have uncertainty about using water saving wheat varieties.

iii. The consciousness of saving water is currently weak. Raising the consciousness of saving water is an essential guarantee to promote the sustainable development of water saving agriculture. The consciousness of water-saving in a society is an important measure of a social civilization. The average education level of farmers in Shenze is senior high school and below, which means that the whole education level is lower, so their ability to accept the idea about saving water and water saving irrigation equipment is weaker. Traditional flood irrigation is similar to border irrigation and may lead

to secondary salinization of land, which farmers don't know. Besides, using buried telescopic sprinkler irrigation equipment must be purchased and maintained, which increases agricultural spending and requirements for technology compared with flood irrigation. One of the reasons why people's consciousness of saving water is weak is that water saving production of wheat doesn't directly improve the profit. Combined with the feature of large water demand in wheat growing process, farmers aren't obliged to know too much about modern water saving irrigation system, which is another reason that people's consciousness of saving water is weak.

iv. Water saving wheat has little sales and the price is low. Having no policy of broadening the market for water saving wheat or subsidies for purchasing water saving wheat, farmers spend more and get less profit by using water saving wheat varieties and water saving irrigation equipment. A member of Shengpeng Cooperative told that wheat sales have been poor and the purchase price is low in recent years. In addition, the leaders of Shengpeng Cooperative said they haven't got wheat processing factories in Shenze. The chain of wheat production is too short that most of the wheat is sold directly without further processing. As a result, the profits of farmers are also reduced.

v. Agronomic water saving technology and the usage of water saving irrigation equipment lack proper training and water saving technology still needs to be further improved. Farmers in the cooperative have mastered elementary water saving technology through the training of Shengpeng Cooperative. However, farmers who don't participate in Shengpeng Cooperative did not receive the training, so they lack water saving technology. Current water saving technology still has some defects. For instance, sprinkler irrigation equipment has dead angle and the amount of irrigation water can't be definite in different seasons and years. These technologies still need deeper improvement and innovation to better adapt to agricultural production.

vi. Although wheat production saves water, fertilizer, land and employment, its electricity consumption per unit water is quite large. According to scientists' research, the effective utilization of water and fertilizer in Israeli agricultural production, which uses drip irrigation, can be maintained at an astonishing 80%-90%, saving 50%-70% water and 30%-50% fertilizer. The following data was collected and can be seen in Table 1:

Table 1 statistical table of wheat's spring watering

	Border irrigation				Buried telescopic sprinkler irrigation			
	Water consumption stere/mu	Time hour/mu	Electricity kilowatt hour/mu	Cost yuan/mu	water consumption stere/mu	Time hour/mu	Electricity kilowatt hour/mu	Cost yuan/mu
First irrigation	100	2-2.5	15	9.15	60	1.5	25	15.25
Second irrigation	80	2	15	9.15	60	1.5	25	15.25
Employment	Each well with 1-2 people irrigate the land, night inaptitude, the cost of labor per mu watering about 20 yuan.				Each person can easily manage 4-5 machine wells at the same time, no impact at night, basically no labor costs.			
Land	Ridges occupy 7%-10% of land				No			
Single well control area	The single well control area is 50 mu according to one wheel filling period of 7 days.				The single well control area is 100 mu according to one wheel filling period of 7 days.			

Shengpeng Cooperative uses sprinkler irrigation equipment, obviously saving water consumption, land and employment cost, but the electricity cost is significantly increasing. How to save electricity while saving water, enlarge the source of power and reduce the cost of electricity have become a difficult problem for the leaders and members of Shengpeng Cooperative.

IV. Recommendations in water saving agriculture of wheat in Hebei province

i. Strengthen the propaganda in all aspects of water saving agriculture of wheat. Firstly, the government should strengthen the propaganda in land transfer to let farmers fully understand its advantages and compare the income of farmers who have carried out land transfer to others who haven't to improve farmers' sense of identity to the land transfer policy. Secondly, water saving wheat varieties should be advertised to farmers. It's essential to widely collect their opinions and reflect them to the local Agricultural Science and Technology Institute in order to improve water saving

wheat varieties. Also, enhancing their consciousness of saving water, knowledge of modern water saving agriculture and the superiority of water-saving irrigation equipment need to be publicized.

ii. Set up a special group responsible for the implementation of water saving agriculture of wheat. First, there is a need to raise subsidies, which are given to the implementation of land transfer policy and the usage of water saving irrigation equipment in an effort to carry out the circumstance of policy propaganda and financial allowance. Second, the data about water consumption and the yield of water saving varieties should be investigated and provided, associating farmers' profits with saving water and using water saving varieties to improve their sense of identity and enhance their consciousness of using water saving varieties. Third, reformation of water price requires deeper implementation in Hebei province, making reward and punishment measures adapted to local and strictly implementing them. Besides, to extend wheat's industrial chain and increase its value, wheat further processing should be encouraged to develop in conditional counties and cities. Furthermore, developing water saving technology training and activities that technicians go to the countryside to guide regularly provide technical support for water-saving production of wheat. In addition, there ought to promote the use of sustainable development of electric energy such as solar panels and biogas power generation, providing enough clean energy for water saving irrigation equipment to use.

iii. Develop and popularize the remote monitor and control system for water saving production of wheat. This will take advantage of detection device placed in the land to measure soil moisture content and plant's demand for water, which can help determine how much water to irrigate. The remote monitor and control system, which can control the usage of water saving irrigation equipment, will improve the utilization of water resources considerably and fully meet the water need of crop growth. After the development, the whole system may improve appropriately to reduce the cost and improve the utilization.

Conclusion

Currently, agriculture and rural area are undergoing transformation with all kinds of new types of agricultural businesses using scale management. New crop varieties and new technologies are continuously popularized, and modern agriculture, scale agriculture and facility agriculture are growing rapidly. The construction of water saving agriculture and dissemination of water saving agricultural technology are facing the above-mentioned transformation challenge and opportunity. It is urgent to develop the research and popularization of water-saving agriculture of wheat in Hebei province, which is short of water resources. Great achievements have been made in structural water saving, agronomic water saving, engineering water saving and mechanism water saving now. However, because of the immaturity of the land transfer mechanism and the poor awareness of saving water, it's still arduous to be used in practical application. Effort ought to be made the promotion and implementation of water saving production of wheat and the development and application of remote monitoring system to help the sustainable development of agricultural production.

Strengthening the research on water saving agricultural technology, promoting the development of productivity by scientific and technological innovation and establishing and consummating the modern water saving agricultural technology system, which is suitable for national conditions of China will become one of the essential strategic measures to further the sustainable development of water saving agriculture in China. Water saving production of wheat has been a national key agricultural project and the development of water saving agriculture of wheat can be seen as an epitome of water saving agriculture in China. Utilizing the existing science and technology, wheat production capacity is maintained by water-saving technology to actualize the survival and the development win-win, which not only provides the experience and the reference for the agricultural development of other water shortage areas in China, but also provides a vivid example for the development of water saving agriculture around the world. Developing water saving agriculture and realizing sustainable development is the direction of agricultural development in China. Moreover, it's the goal of agricultural development in the world.

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