

Liu Yifei
Shijiazhuang Foreign Language School
Shijiazhuang, Hebei province

Status quo and development suggestion of dryland agriculture mechanization in North China Plain

Abstract

The North China Plain is an important grain producing area in China with excellent agricultural location conditions, but there are still some problems restricting agricultural production such as water shortage and land salinization. By analyzing the status quo of agricultural mechanization in the North China Plain, this paper introduces the application of agricultural machinery in different stages of agricultural production, illustrates the great significance of developing agricultural mechanization, and puts forward reasonable suggestions to break through natural limitations and achieve agricultural modernization.

Key words:

Dryland agriculture, Agricultural mechanization, North China Plain

As the second largest plain in China, the North China Plain has a large population, with a long agricultural history and advantageous geographical conditions, which is of great strategic significance to China's agricultural development. Many kinds of advanced machinery and equipment have been applied in the stages of tillage, sowing, irrigation and harvest in the North China Plain, which has greatly reduced the burden of farming and increased grain yield and production efficiency. However, due to various geographical and social factors, the agricultural productivity still needs to be improved. Therefore, developing agricultural mechanization plays a significant role in further grain production in the North China Plain and comprehensive development of agriculture.

I. Research background and significance

Dryland agriculture, known as the agriculture in arid, semiarid and subhumid drought-prone areas with scarce rainfall and no irrigation conditions, mainly relies on

natural precipitation and adopts a series of technical measures of dryland agriculture to develop drought or drought-resistant and drought-tolerant crops. Mainly distributed in the north of Qinling-Huaihe Line, China's dry land agriculture covers nearly 50% of the country's arable land. The North China Plain is a representative area of dryland agriculture. However, due to its large population and scarcity of land and water, the ecological environment here is relatively fragile, the development of agricultural mechanization is limited, and there is still a great room for improvement on agricultural productivity. Developing dryland agriculture mechanization in North China Plain is conducive to overcoming geographical and humanistic restriction, reducing farmers' burden, improving grain yield and quality, and can make agricultural production more efficient.

Hebei Nonghaha Machinery Group Co., Ltd. is a representative enterprise of agricultural machinery of North China Plain, located in the Industrial park of Shenze County, Shijiazhuang City. It is engaged in agricultural machinery research and development, production and sales. Its sales network covers 19 provinces, cities and autonomous regions. Also, its products have been exported to more than 30 countries and regions. We visited Hebei Nonghaha Machinery Group and had an in-depth conversation with engineers. Related on this, we analyzed the present conditions of dryland agricultural mechanization represented by the North China Plain and put forward practical development suggestions.

II. Status quo of dryland agriculture mechanization in North China Plain

The North China Plain has beneficial geographical conditions for the development of agricultural mechanization. Spanning the seven provinces of Beijing, Tianjin, Hebei, Shandong, Henan, Anhui and Jiangsu, North China Plain is the second largest plain in China, which has a vast area with low and flat terrain and concentrated cultivated land. The main cultivated soil here is yellow tide soil. Besides, the deep fine soil layer and high soil maturity is conducive to deep ploughing and crop root extension. There are many rivers and lakes in the North China Plain, which ease the irrigative water shortage. At the same time, the North China Plain is close to Beijing, Tianjin and other developed areas, which is convenient for the introduction and popularization of advanced agricultural technology. What's more, the North China Plain has a developed industrial foundation, which is beneficial for the production of

agricultural machinery. In conclusion, it is feasible to promote agricultural mechanization in North China Plain.

However, there are also limitations on the development of mechanization in the North China Plain. The North China Plain, which accounts for 40% of the country's arable land, only possesses for 6% of the country's water resources. With the impact of spring drought, there is a serious unbalanced distribution in water and soil resources in North China Plain. Although the North China Plain is the most populous plain in China, in recent years, a large number of rural labor forces have flowed to developed areas dominated by industrial and commercial production, and the cost of labor have continued to rise. Agricultural production in the North China Plain shows the small-scale and smallholder nature, and farmers' arable land is difficult to expand so their production efficiency is low. Therefore, it is necessary to promote agricultural mechanization in the North China Plain.

III. Achievements of agricultural mechanization in the North China Plain

Hebei Nonghaha Machinery Group mainly engages in cultivator, seeder, green fodder harvester, sprinkler and drip irrigation machinery, straw harvester, grain drying equipment and other six categories of more than 80 varieties, and has an annual production capacity of 70,000 sets of various agricultural machinery. It is a leading enterprise of agricultural machinery in China without doubt. The following is an introduction to typical agricultural machinery applications in different stages of agricultural production.

i. Farming stage - rotary tiller

Rotary tiller is a tillating machine which is matched with tractor to complete the tillage and harrowing operations. The use of rotary tiller improves the water retention capacity of the soil, eliminates weeds to a certain extent, reduces pests and diseases, and makes the surface more flat.

Hebei Nonghaha Machinery Group has mastered a mature rotary farming technology, and constantly improve and innovate agricultural machinery. It has developed and applied a variety types of rotary tillers such as 1GQNJS-200, 1GQNJS-250, 1GONJS-300, 1GONJS-330. The most popular tillage machine among

the farmers is the Nonghaha driving rake, which has good soil breaking effect, and does not damage the soil structure stratification or the soil micro-organisms when working. The soil cultivated by it is solid above and soft below, which is good to maintain moisture content. Also, due to the flatness of the soil after cultivation, the seeds can be neatly arranged.

The application of rotary tiller has solved the problem of soil compaction caused by the year-round use of chemical fertilizer, especially for the treatment of the large soil clods that are not easy to break after deep turning. After operation, it can achieve the agronomic requirements of "flat, neat, soft, broken, clean, and moist", which can provide perfect soil conditions for seed emergence.



Figure 1. Nonghaha driving rake

ii. Sowing stage - seeder

Early agriculture adopted the method of "broadcast sowing", the seed spacing is random and uneven, and seeds take root in heaps. The usage of seeder has solved this problem. The seeder and the tractor operate in cooperation, evenly spreading seeds along the straight ditches which are opened by the machine. This way has improved the quality and efficiency of sowing. Here takes the corn seeders as an example.

The original 2BYFSM-2 and 2BYFSM-3 corn no-tillage fertilization and precision seeder is mainly used for single seed precision sowing in untilled or cultivated land, which replaces manual application of furrow fertilization, seeding, soil covering and compaction. It has a copying function so that can float with the terrain to maintain a stable sowing depth, which solves the problem of difficult sowing when the terrain is undulating.

The advanced 2BYFSF-5 corn no-tillage fertilization and precision seeder has been improved from 2-6 rows optional to 3-8 rows optional, which further increases the farming efficiency.

The new 2BMGF-6 corn rotary tillage seeder realizes the connection between the rotary tiller and the seeder, so that the rotary tillage sowing and fertilization are completed at one time, which not only reduces the number of tractors entering the field, but also reduces the operation cost and the burden of farmers' work. Its two driving depth-limited wheels are placed in the front, which better controls the rotary tillage and sowing depth of the rotary tiller, eliminating the ditches created by the two wheels of the rotary tiller and making the field more flat after sowing.



Figure 2. 2BMGF-6 Corn rotary tillage seeder

iii. Irrigation stage – drenching irrigators

Drenching irrigators is an advanced irrigation equipment. The water pressure of the machine is relatively small, so it can reduce the damage to the plants' leaf surface, and it is less expensive than drip irrigator, which is more easily accepted by farmers. It can save more than 30% water per mu than before, which greatly alleviates the agricultural water shortage in North China.

The main drenching irrigators of Hebei Nonghaha Group are 8JP75-300 electric, 8JP75-300 four-speed, and 8JP75-450 (8JP90-330) six-speed and so on. The irrigation frame can rotate 360 degrees without stopping to avoid obstacles such as poles or trees, which eliminate dead ends and is more easily to move. It has strong wind resistance so that can operate normally in 5 ~ 6 wind days, which adapts to the windy

weather of North China in spring.

Among them, the electric drenching irrigators has the most special function. Through the wechat mini program developed by the company, the operation speed, recovery time, precipitation and other operation data of the machine can be monitored and controlled instantly, intuitively and accurately, which ensures the consistent and accurate watering amount in the working area. In the case of sudden shut-down of water and electricity, mechanical breakdown, shorter distance (less than 50 meters) between the sprayer or lower hydropress, the intelligent control alarm system will send three messages and three phone calls to the operator's mobile phone within 15 minutes. It has greatly saved the labor cost and improved the level of agricultural automation.



Figure 3. 8JP75-450 (8JP90-330) six-speed drenching irrigators

iv. Harvest stage - stalk harvester

Stalk can be used for the production of xylitol, fiberboard and so on, and can also be used as an organic fertilizer with high utilization value. Stalk harvesting is a key problem in North China Plain where corn and wheat are widely grown. Stalk harvester can improve harvesting efficiency, reduce stubble and facilitate straw storage and transportation.

Taking the 4G-2.2CH corn stalk harvester as an example, the machine can make the stalk horizontally and neatly laid in the right or right rear of the tractor, which solves the problem of inconvenient collection and storage of corn stalk. It replaces the manual opening, which saves labor and improves work efficiency. The corn stalk it

harvested turned into clean feed without dust, residual mulch or other impurities, which is more healthy for cattle and sheep.



Figure 4. 4G-2.2CH corn stalk harvester

IV. Problems and suggestions of agricultural mechanization in North China Plain

i. Use no-till technology wisely to ensure food quality

The use of no-tillage machinery for sowing is time-saving and labor-saving. It has high precision and efficiency of sowing, and can prevent the loss of moisture, which has been widely used in the North China Plain. However, there are still some disadvantages. After the soil is compacted, the ground temperature becomes lower than usual, which will cause the crop to emerge slowly, and there are even broken seedlings and ridges. Soil is not soft enough and often packs together without cultivate deeply, so that the ability of crops to absorb water and nutrients will be seriously reduced, causing crops to mature more slowly in the later stage of growth, and the maturity and fullness of seeds will become worse. It is also easy to cause plant diseases and insect pests.

Therefore, while using no-tillage technology, rotary tillage or other land preparation measures should be combined with traditional sowing methods in conditional areas to adapt to local conditions, so as to improve production efficiency and ensure food quality.

ii. Promote drenching technology to curb land salinization

At present, field irrigation mainly adopts three ways: flood irrigation, sprinkling irrigation and drip irrigation. Spring precipitation in North China Plain is low, the

temperature rises quickly and the evaporation is strong. In order to alleviate the threat of spring drought to crops, flood irrigation has been adopted for a long time. However, if drainage is blocked, the groundwater and the salinity in it will rise to the surface. In addition, some coastal areas has long overexploited groundwater, so that a large number of sea water goes into the soil, which increased salt content. With the evaporation of water, groundwater salt will also reach the land surface, resulting in salinization. Besides, the impact of sprinkler irrigators hit the crops too hard, which is easy to damage the leaf surface of crops, and the evaporation loss is also great. Although drip irrigators can make water droplets act directly on the root, the technical requirements and installation costs are too high.

In comparison, drenching irrigator supplies water through lower pressure and large drop which sprays the roots of the crops, wisely handled the above problems. Therefore, promoting the use of irrigation machine in North China Plain can save water at the same time to curb land salinization.

iii.Improve the mechanization level of cash crops

Traditional food crops in North China Plain, such as wheat and corn, have a very high degree of mechanization, the mechanization rate of sowing and harvesting in the plain area has even reached almost 100%. However, the mechanization level of some cash crops still needs to be improved. For example, the sowing and picking of vegetables and fruits, as well as the mechanical sowing and harvesting of cotton and other key stages still haven't used machinery on a large scale.

As an important fruit, vegetable, animal husbandry and cotton breeding base in China, the North China Plain has a wide planting area of cash crops, which is of great significance to the overall development of agriculture. We should learn from the experience of mechanization of main food crops, develop new technologies, and vigorously promote relevant agricultural machinery to help the mechanization development of cash crops.

Expanding the scope and frequency of use of advanced agricultural machinery such as no-till seeder, rotary tiller, drenching irrigator and straw harvester can break through the limitations of the natural environment, save production costs, and greatly

improve agricultural production efficiency. Agricultural mechanization in the North China Plain has achieved certain results, achieved the purpose of reducing labor costs to a certain extent while achieving environmental protection, energy saving, safety and reliability. The development of the global informatization has also put forward new requirements for the mechanization of dryland agriculture. Agricultural machinery must develop towards precision, focusing on developing smart agriculture and precise agriculture, and rely on digital technology to form accurate and efficient dryland agriculture technical solutions to promote application, so as to increase productivity and national economic strength.

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