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Feasibility Analysis and Policy Recommendations for Production of Hybrid Rice Seed in Foreign Countries

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Abstract In the economic new normal, production of hybrid rice seed in foreign countries is the necessity for reducing farmland area occupied by seed production, for ensuring national grain security, realizing cost reducing and quality improving of hybrid rice seed, strengthening competitive power at international market, guiding seed industry of China to go out, building transnational seed groups with core competitive power, establishing close relationship with developing countries, promoting the construction of One Belt One Road strategy, serving overall situation of diplomacy, and setting up excellent international image. It is feasible to produce hybrid seed in foreign countries considering (i) high overall national strength of China, (ii) rapid and healthy growth of China's seed industry and increasingly mature hybrid rice seed production technologies, (iii) excellent climatic conditions of foreign host countries of seed production, and (iv) low land and labor price of foreign host countries of seed production. However, there are social and policy risks, technology and trade barrier risks, market, production, and other risks for production of hybrid rice seed in foreign countries. In view of these, it came up with recommendations, including allowing delivering parent seeds of hybrid rice to foreign countries, allowing delivering hybrid rice seed to China, solving the problem of "opening in protection, and protection in opening", and formulating a package of support policies.

Key words Hybrid rice, Production of seed in foreign countries, Necessities, Feasibility, Risk, Recommendations

1 Introduction

Extension and application of hybrid rice have made great contribution to 12 consecutive increase in grain production, ensuring grain security, and solving grain shortage in Asia and Africa. Now, it still plays an utmost role in maintaining global grain security in the 21st century^[1]. Therefore, study on feasibility of production of hybrid rice seed in foreign countries will have great significance for leading China's seed enterprises to go out, taking full advantage of domestic and foreign market and resources, to realize the mode of "production of seed in foreign countries, sales to foreign countries, and back sales to China", and further expanding agricultural opening fields, and promoting implementation of One Belt One Road strategy.

2 Necessity of seed production in foreign countries

2.1 Reducing farmland area occupied by seed production, and ensuring national grain security At present, the hybrid rice planting area of China remains at 16 million ha, and it is necessary to occupy 0.1 million hectare area to produce hybrid rice seeds every year^[2]. If moving this 0.1 million hectare area to other countries, the vacated land will increase several hundred thousand tons to one million tons of grain supply, which is equivalent to commodity grain supply of 4–5 grain production countries, or 1/2 or 1/3 of

highest import volume of rice of China (in 2015)^[3]. Production of hybrid rice seed in foreign countries can reduce the dependency of China's grain on foreign countries, increase China's grain self-sufficiency, and implement the strategic goal of "increasing grain production through soil conservation and technology, and foreign countries", so as to guarantee China's grain security^[4].

2.2 Realizing cost reducing and quality improving of hybrid rice seed, strengthening competitive power at international market

Due to high sci-tech added value and high adaptation ability, China's hybrid rice seeds demonstrate high advantage of yield increase in southeast Asia and Africa. Generally, the yield increase is about 30%–50%. China's hybrid rice is reputed by farmers of importer as "magic rice". Many countries, such as Vietnam, Pakistan, Bangladesh, and Sierra Leone, have purchased hybrid rice seeds from China. According to statistics of Longping High Technology, the hybrid rice planting area in foreign countries has exceeded 3 million ha. According to analysis and prediction of experts, the demand of hybrid rice seed in the whole world is 1.5 million to 2 million tons, the market value of which is 1.2 billion to 1.6 billion USD^[5]. Several years ago, China became the world largest exporter of hybrid rice seed relying on autonomous innovation technology and comparative cost advantages. In recent years, due to constant rise in land and labor price, the production cost of hybrid rice seed shows a rigid rise. After 2008, the rate of increase is up to 20%. This leads to significant decline in export volume and economic benefit of China's hybrid rice seed, and the total export volume of domestic hybrid rice seed drops by 30%–40% compared with past years. For example, the export volume of hybrid rice seed of Hubei Province in 2013–2015 was only one

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half of the highest export volume in 2010. As a large province of export of hybrid rice seed, Sichuan Province once produced about 50% of total hybrid rice seeds of the whole country. In 2015, the total export volume reduced by 41.20% compared with normal years. Not only in export volume, the export benefit also declines substantially. The gross profit ratio of export drops from 15% – 20% higher than domestic market to lower than 50% of average gross profit ratio of domestic market^[6]. Therefore, if transferring the production of hybrid rice seed to adjacent Cambodia, Laos, Myanmar, Pakistan, Bangladesh, taking full advantage of local cheap land and labor resources, and implementing the mode of "production in foreign countries and sales in foreign countries", the seed production cost may be reduced more than one half. In addition, these southeast Asian countries have abundant sunshine and quantity of heat, there is no risk of fertility conversion of two-line seed production, and it is able to ensure quality of two-line hybrid rice seeds. Thus, it is able to greatly raise comprehensive competitive power of China's hybrid rice seed at international market.

2.3 Guiding seed industry of China to go out and building transnational seed groups with core competitive power According to the development history and trend of the world seed industry, seed enterprises are developing towards large-scale, grouping and internationalized direction. Both *Opinions of the State Council on Accelerating the Development of the Modern Crop Seed Industry* and *National Modern Crop Seed Industry Development Plan (2012 – 2020)* clearly set forth that China should realize the objective of 3 – 5 large seed enterprises ranking among top 10 world seed enterprises. To realize such magnificent objective, China's seed industry must rapidly and actively go out and integrate with the world, and actively be devoted to competition of international seed market. It is required to establish large bases and exploit large market in the global range, realize resource consolidation, form the linkage between inside and outside, realize transformation from closed development to opening development, so as to build transnational seed groups with core competitive power and high international competition power. Excellent variety is core competitive power of seed industry. No matter in three-line hybrid method or two-line hybrid method, China takes the first place in the world. Thus, rice hybrid technology can guide China's seed enterprises to go out, especially when transnational giants have not done business in hybrid rice, but just in maize, cotton, soybean, vegetable, flower, and melon and fruit fields. China should take full use of the hybrid rice technology, rapidly make plan for building seed production base in foreign countries, seize the opportunity, constantly expand international market capacity, and make China's seed enterprises obtain higher market status at international market, to promote change of big seed country to strong seed country.

2.4 Establishing close relation with developing countries, promoting construction of One Belt and One Road, serving overall diplomatic situation, and setting up excellent interna-

tional image Hybrid rice seed production is high agricultural biological technology. Through establishing seed bases in foreign countries, especially in countries along the One Belt and One Road, it is able to guide China's new and high agricultural technology and high technological products to enter the international market. This is favorable for raising influence power of China's grain affairs, formulating international rules, and influencing the power of pricing, promoting global extension and application of fine varieties and new agricultural technologies, increasing agricultural production efficiency, increasing the yield and farmers' income, deepening strategic and trade cooperation with developing countries, raising opening level of China's seed industry, taking advantage of domestic and international market and resources, strengthening the cooperation with developing countries in technological innovation, building comprehensive partnership with developing countries, promoting economic and social development of cooperative countries, serving the overall diplomatic situation of China, and setting up excellent international image. In addition, seed production in foreign countries can promote large volume of export of China's new and high agricultural technologies and products, eliminating adverse influence of financial crisis on China's foreign trade and agriculture, and alleviating domestic agricultural development pressure.

3 Feasibility of seed production in foreign countries

3.1 High overall national strength of China Since the reform and opening-up, China's overall national strength has been rapidly increasing. In economic aggregate, China has exceeded many developed countries including Japan and Germany, and has become the world second largest entity. Economic growth rate ranks first, and foreign exchange reserve takes the lead. China has become the engine country of world economic development and an essential stabilizer for pressing the world economic fluctuation. In international social status, China owns higher discourse power and important influence power in handling major international matters. Especially in countries of Association of Southeast Asian Nations, China has created a big country image. All of these create solid foundation and excellent environment for China establishing production bases for hybrid rice seed in foreign countries. Therefore, with the aid of this opportunity, it is highly feasible to develop production of hybrid rice seed in foreign countries.

3.2 Rapid and healthy growth of China's seed industry and increasingly mature hybrid rice seed production technologies Transnational enterprises are subjects for seed industry going to the world, and advanced hybrid rice seed production technology is the key for production of hybrid rice seed in foreign countries. In recent years, China's seed industry develops rapidly and a lot of strong seed enterprises appear, such as Longping High Technology, Fengle Seed, Winall Hi-tech Seed, Hubei Seed Group, and Jingchu Seed, etc. These enterprises have high competitive power, strong foreign market exploitation ability, and have integrated breeding, reproduction and promotion system. They have made

outstanding achievements in seed trade. In hybrid rice seed production technology, there has been deep changes in international development trend. India, Vietnam, the United States and international rice research institutions, as well as Bayer and DuPont Pioneer Hi-bred transnational seed companies, have undertaken many years of hybrid rice breeding and application researches. However, in both three-line hybrid method or two-line hybrid method, China takes the first place in the world. Especially in florescence, anthesis regulation, 920 application, and key production sections for improving seed yield and quality, China owns a lot of core practical technologies and still has powerful competitive edge. At present, it is a precious opportunity to develop China's hybrid rice seed in foreign countries through large export-oriented seed companies with integrated breeding, reproduction and promotion system.

3.3 Excellent climatic conditions of foreign host countries of seed production

In some ASEAN countries adjacent to China, rice production is basically major part of agricultural production, and rice production is mainly located in tropical or subtropical areas. There is only division of rainy season and dry season, and rainy and hot period occurs in the same season. These areas have fertile soil, rich water resources, abundant heat and sunshine. For example, Cambodia belongs to tropical monsoon climate. Its average annual temperature is 29–30°C. It has two seasons: rainy season (May to October) and dry season (November to next April). Cambodia has abundant water resource and the most moist area is in Cardamom Mountains, where the annual rainfall is up to 5000 mm, while the driest area is located in the capital Phnom Penh and central and northern area contiguous to Thailand, with annual rainfall still up to 1200 mm. For another example, in Vientiane Plain of Laos, apart from fertile soil, rich water resources and abundant heat and sunshine, there is no occurrence of typhoon in the whole breeding period of rice. All such superior climatic and ecological conditions are favorable for obtaining high yield and quality of hybrid rice seed production. In 2005, Hubei Jingchu Seed Company made a pilot production of 7 ha rice variety Chuyou 1588 in Mondulkiri Province of Cambodia and obtained the average yield of 3.795 tons, and in the high yield land parcel, the average yield was up to 4.17 tons. In 2013, rice variety Yueyou 735 was planted in 14 ha land in Lahore of Pakistan, with the average yield up to 4.215 tons (in the high yield land, the average yield was up to 4.5 tons), the seed quality reached national standard of China.

3.4 Low land and labor price of foreign host countries of seed production

At present, the rental charge for one hectare land is about 12000–15000 yuan; in Jiangsu Yancheng farms, the rental charge is up to 18000 yuan/hectare; in foreign countries, the rental charge is only 1200–1500 yuan, about 1/10 of that in domestic area. In China, the labor price for employing farmers to plant rice or weed is higher than 150 yuan/day; in foreign countries, the labor price is only 40–50 yuan/day. Thus, the cost price for production of hybrid rice seed in China is generally 16–20 yuan/kg, while it is 6–8 yuan/kg in foreign countries. Obviously, production of hybrid rice seed in foreign coun-

tries has advantages of low material and labor cost, strong market competition, large profit space, and high economic benefits.

4 Risks

4.1 Social and policy risks Social stability of host countries is a primary factor restricting China developing the production of hybrid rice seed in foreign countries. For example, some African countries have suitable climatic and ecological conditions for hybrid rice seed production, but the political situation is not stable, the society is not stable, and policy continuity is poor, thus the production investment may not be recovered, the risk is high. Besides, due to global grain crisis, some countries declared prohibition of export of grain produced in their territory, and some countries neither allow entry of staple grain seed nor allow exit of staple grain seed. In addition, there are risks generated from changes in bilateral relations. For example, since 2014, Sino-Vietnam and Sino-Philippine conflict led to nervous bilateral relation, obstruction of customs clearing procedure for fruits exporting from Vietnam and Philippine resulted in a lot of agricultural products had to be consumed locally and the losses were huge^[7].

4.2 Technology and trade barrier risks With increase in foreign trade of China's hybrid rice seeds, some seed enterprises tried to produce seeds in foreign countries. However, to protect benefits of domestic rice producers, importers often set technology and trade barriers on the ground of global plant quarantine. For example, India clearly specifies that it is not allowed to import China's hybrid rice seeds in batches. Indonesia and Bangladesh impose new requirements for import of rice seeds and set many technology barriers.

4.3 Market, production and other risks (i) Some transnational seed enterprises, such as Bayer, Syngenta, and DuPont Pioneer, have undertaken production of hybrid rice seeds in foreign countries and have sold their rice products in international market. (ii) Some countries like Vietnam, Bangladesh, and Pakistan, start to explore production of local hybrid rice seeds in batches, and boycott export of China's hybrid rice seeds. Besides, multi-channel competition also increases international market risks. (iii) Farm irrigation facilities of seed production bases in foreign countries are poor, and it is difficult to ensure stable yields despite drought or excessive rain, so the production risk is high. (iv) There are production, marketing and management risks in seed production in foreign countries. China is seriously short of interdisciplinary talents good at foreign languages, skilled at hybrid rice seed production, and having command of transnational operation and management. Besides, the production situation, folk customs and industrial policies are not clear. Therefore, there is certain difficulty in formulation of hybrid rice seed production scheme, implementation of scheme, management of production, seed marketing strategies, as well as technical services for subsequent processes. In addition, effective protection of China's intellectual property right also becomes unavoidable risk in production of hybrid rice seed in foreign countries.

5 Policy recommendations

5.1 Allowing delivering parent seeds of hybrid rice to foreign countries

In the context of constantly increasing opening and internationalization, China's agricultural germplasm resources till implement "stringent exit but loose entry" policy. According to original policy of the Ministry of Agriculture, it is prohibited to export parent seed of hybrid rice; two-line hybrid rice seeds are not allowed to export; three-line hybrid rice seeds may be exported after 5 years since the domestic seed examination and approval. Although the Ministry of Agriculture revised this policy: it is allowed to export three-line hybrid rice seeds examined and approved already 3 years and two-line hybrid rice seeds examined and approved already 5 years; it is allowed to export three-line hybrid rice sterile and restorer line seeds, for seed production in foreign countries; it is not allowed to export parent seeds of three-line hybrid rice maintainer line and two-line hybrid rice^[8]. To implement seed production in foreign countries and strengthen international competitive power of hybrid rice seeds, the Ministry of Agriculture should further loosen this policy and cancel the limitation to examination and approval years of hybrid rice seed export and the limitation to export of supporting parent seeds. No matter the three-line hybrid rice seeds or the two-line hybrid rice seeds, foreign countries have obtained basic genetic resources, including prevailing hybrid rice varieties and parent resources. In few years, some foreign countries may completely use these resources to develop excellent hybrid rice seeds suitable for local areas.

5.2 Allowing delivering hybrid rice seed to China According to China's import policy, it is allowed to import seeds of vegetable, flower, and forest seedlings in batches, limit import of grain crop seeds in batches, allow import of rice, maize, soybean and wheat, but limit import of seeds of rice, maize, soybean and wheat. In this situation, the Ministry of Agriculture should formulate policy allowing China's seed enterprises to produce hybrid rice seeds in foreign countries and then deliver hybrid rice seeds to China, and discuss with the Ministry of Commerce to determine proportion of seeds allowed to return to China.

5.3 Solving the problem of "opening in protection, and protection in opening"

In fact, some hybrid rice varieties and their parent resources of China have been brought to foreign countries through many unclear channels. Since they are not examined and approved and registered by competent authorities, their exit is illegal, and it is difficult to obtain protection of intellectual property right, which directly leads to loss of China's seed resources. Therefore, related department should formulate comprehensive plan for intellectual property right protection of hybrid rice, regulate hybrid rice "going out" system, and establish and improve the intellectual property right management system for external cooperation of China's hybrid rice technologies. Besides, it is recommended to actively undertake researches of intellectual property right system, safeguard rights and interests of China's autonomous innovation technologies in hybrid rice through effectively using laws and regulations of intellectual property right of host countries, and

actively explore and gradually establish intellectual property right monitoring and protection mechanism for new hybrid rice varieties and new technology patents in international scope. Besides, it is recommended to adjust small scale or individual operation action of seed enterprises, to form joint effort of seed industry, increase the share of intellectual property right of China in hybrid rice technologies and varieties with the aid of existing international influence, and accelerate the step of hybrid rice "going out", to realize "protection in opening, and win-win in protection". The protection of intellectual property right is to maximize benefits of owners of intellectual property right, rather than prevent development and use of advanced technologies. Thus, it is required to take full advantage of China's autonomous intellectual property right of hybrid rice, realize reasonable development and use of the intellectual property right, maximally convert it into commercial and economic value, and to create wealth for the whole country.

5.4 Formulating a package of support policies The production of hybrid rice seeds in foreign countries involves domestic, financial, taxation, insurance and fiscal policies, Chinese government should make top-down design and provide related guarantee and policy measures. (i) Competent authorities should allocate financial subsidies for production of hybrid rice seeds in foreign countries, include the building of hybrid rice seed production bases in foreign countries into the scope of financial support for agricultural production. (ii) It is recommended to reduce or exempt import tax of hybrid rice seeds, and implement *Policy of Exempting Taxes from Seed Import* (Cai Guan Shui [2011]76) issued by the Ministry of Finance, General Administration of Customs and State Administration of Taxation, to support back selling of hybrid rice seeds. (iii) It is recommended to strengthen investment protection of China's seed enterprises in building hybrid rice seed production bases in foreign countries, including protection of purchase and rent of seed production bases, consular protection, and labor service export protection, and safeguard safety and lawful rights and interests of China's seed production enterprises and employees.

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