

## Mini Review

# A Mini Review on Chinese Hybrid Rice Seed Market in Pakistan: An Economical and Social, Far-reaching Challenges and Future Prospects

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**Abstract.** The production of rice (*Oryza sativa* L.) contributes significantly to Pakistan's food supply and foreign exchange revenues. It produces about US\$2 billion in foreign exchange annually and is planted on almost three million hectares each year. There is an urgent need to boost productivity per unit area in light of the increasing population rise. Since the 1980s, when hybrid rice (HR) was successfully discovered and commercialized, China's rice production has expanded significantly. HR has been adopted in certain Asian nations up to this point, including Pakistan, India and Bangladesh. Within a few years, HR occupied 20% of Pakistan's entire rice-growing land. The article examines the current state of China's marketing of HR seeds in Pakistan, analyses the development and use of seeds, reviews HR export trends, extensive detail on business trends, prospects and upcoming challenges.

**Keywords:** rice in Pakistan, chinese rice hybrids, seed business, future opportunities, challenges

## Introduction

According to the Economic Survey of Pakistan (EPS) from (2020-2021), the agriculture industry provides 19.3% of Pakistan's GDP and employs 42.3% of the labour force. It contributes significantly to growth in other industries and serves as a key foundation for the currency market. A significant portion of Pakistan's agricultural export revenue comes from rice and which is consumed on a daily basis World Agricultural Production (USDA, 2020). It is the first food export each year and the second-most significant staple crop after wheat.

The area under rice cultivation in the 2019-20 crop year is around 3,034 million hectares, an increase of 8% from the 2,810 million hectares in the 2017-18 crop year. When compared to the previous year the output increased by 2.9% to 7,410 million tonnes from 7,202 million tonnes (EPS, 2019-2020) as a result of an increase in the area under cultivation, primarily as a result of rising domestic demand for rice (EPS, 2020-2021). Demand for agricultural products rises as a result

of rapid population expansion. As a result, new technologies like biotechnology and rice hybridization, which can boost agricultural production, are becoming increasingly popular.

**Trend in hybrid rice (HR) cultivation by province and agro-ecological zones.** Major rice-producing provinces in Pakistan include Sindh and Punjab in particular. All of Pakistan's Balochistan, KPK and Sindh provinces, cultivate coarse (IRRI type) as well as HR. Punjab provinces is famous for Basmati rice, however, half of the province (lower Punjab) is also considered good for extra-long grain and HR. In each part of the country, different edaphic variables contribute to the growth of rice crops. From the tropical region of the Arabian sea in Sindh to the high-altitude portions of the mountainous KPK, there are places with noticeably erratic temperature fluctuations and moderate to high precipitation (Akhter and Haider, 2020). However, there are four distinct agro-ecologies in which it can be grown (Fig. 1) (Yamd *et al.*, 2020).

Zone I, which includes a number of districts in Khyber Pakhtunkhwa province (KPK), including D.I. Khan,

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Swat, Malakand, Dir and Banu which is located in the state's northeastern mountainous regions. Rice farming is primarily centred in the summer due to the sub-humid climate and monsoon's average rainfall of 750-1000 mm (Akhter *et al.*, 2014). Other approved varieties including IR-6, KS-282, KSK-133 and KSK-434 are also grown in the lowlands of KPK. Imported HR types with excellent yields and cold tolerance have become more widely grown in recent decades.

Zone II contains the region between Chenab and Ravi. The climate is subtropical and humid, with annual rainfall averaging between 400 and 700 mm. Since rice has a relatively long growing season, basmati rice, sometimes referred to as fragrant rice, can be produced with greater success. The agricultural area planted with Basmati varieties has grown dramatically over the past three decades as a result of rising global demand and price increases. This area is also home to the "Kalar Tract," a well-known high-quality Basmati rice growing region. This region contains the Gujarat, Lahore, MB Din, Sheikhpura, Gujranwala, Sialkot and Sialkot Basmati supreme quality area. Due to its superior quality and distinct Basmati flavour, Basmati rice produced in these areas is regarded as premium and is more expensive on both domestic and international markets. In addition to coarse varieties like KS-282, KSK-133 and KSK-434 and cultivated HR varieties, there are several different types of basmati rice, including Basmati 370, Super Basmati, Basmati 385, Basmati Pak, Shaheen Basmati, Basmati 2000 and Basmati 515 (Akhter *et al.* 2014). During the monsoon season, seasonal flooding poses a serious threat to rice production (Haider *et al.*, 2018).

Beginning on the west bank of the Indus river and extending through a greater portion of Sindh province to various districts of Balochistan province are the rice fields of Zone-III, a subtropical environment with 100 mm of rainfall on average. The annual rice crop is irreparably harmed by the hot, dusty weather during the rice harvest. Heat-tolerant rice cultivars are encouraged for trendy cultivation as the region has primarily been settled for the cultivation of medium-long grain rice varieties (Akhter *et al.*, 2014). Cultivation of indigenous varieties is recommended including IR-6, DR-83, DR-92, DR-82, Sarshar, Sada Hayat and Shahkar as well as other imported Chinese hybrids with high yields and heat tolerance. HR can be grown in this region which includes the districts of Larkana,

Jacobabad, Nasirabad, Jaffarabad and Shikarpur. Due to increased foreign trade in high-yielding foreign seeds by domestic and international agricultural enterprises, rice farming has expanded dramatically in recent years. Due to the strong climatic attributes, this region has tremendous potential for the development of HR. Some HR types, however, they are not preferred by rice farmers due to their lower quality and as a result, their price is lower in both domestic and foreign markets.

The Indus delta, along with significant outflows and a basin, is located in Zone-IV. The climate is primarily tropical and dry, which is ideal for the growth of HR varieties and sticky rice. This region's climate is thought to be the best for the development and maintenance of HR and its parental lines. Due to high humidity and ideal temperatures, locations in the districts of Gularchi, Badin and Thatta are particularly well suited for HR. The production of rice in this area is severely hampered by severe drought and salinity (Akhter *et al.*, 2014). Rice cultivators grow varieties like Shua-92, IR-6, Shadab, Khushboo-95 and HR.

**HR development and adoption in Pakistan.** Although newly developed rice varieties have improved grain and cooking quality, Pakistan's rice yields are still considerably lower than those of other countries that produce rice. Due to genetic constraints that have lowered the yield of inbred lines, rice breeders have now come to the conclusion that there is no more room for the expansion and development of inbred varieties (Akram *et al.*, 2007). Other advanced techniques,



Fig. 1. Pakistan rice production zones.

including HR technology, should be used in addition to traditional breeding methods. Since China revealed its achievement in HR culture and development in 1976, this HR technology has been recognized all over the world (Kueneman, 2006). With the rapid expansion of HR seed commercialization after the 1980s, HR production in China significantly improved (Yang *et al.*, 2006).

R&D initiatives in the HR field were started in both the public and private sectors as a result of a successful HR culture in a particular area of Pakistan. With the initial goal of estimating foreign and local genetic material for use in HR breeding programs and assessing surviving hybrids for yield, adaptability and grain quality, the Rice Research Institute, Kala Shah Kaku, established in 1926 and working under the Ayub Agricultural Research Institute, Ministry of Agriculture, Punjab, began a project in the public sector. The HR breeding program was then started using screening material with the goal of creating parental lines, such as CMS, maintenance and restoration lines (Akhter *et al.*, 2008). About 800 HR varieties were successfully tested between 1993 and 2006 for traits such as grain yield potential, agroclimatic adaptation and hybrid benefits. The outcomes of all these tests revealed that when compared to the approved KS-282 coarse-grained lines used as controls, all these exotic hybrids had hybrid superiority ranging from 8 to 142%. Some of these exotic hybrids have outperformed existing varieties, however, in the Punjab region, where Basmati and fine grain rice types are preferred, these hybrids have not been widely adopted due to their inferior cooking quality (Akhter *et al.*, 2007). Despite the fact that these HR types offer higher yields, community acceptability is hampered by reduced net income due to worse cooking quality and lower market prices.

Guard Agricultural and Services Pvt., a private company in Pakistan, imported Chinese HR varieties for testing and marketing in upper Sindh under the direct supervision of Chinese experts. As a result, the mass cultivation of two HR types, GNY-53 and GNY-50, imported from China's Longping High Tech, was authorized (Akram *et al.*, 2007). At that time, Chinese seed enterprises like Winall High Tech and Hubei Province Seeds began operating in Pakistan to expand their HR (HR) seed market. Chinese hybrids are therefore dominating the HR seed market in Pakistan and growing in popularity. Pakistan's rice production business has entered a new age as practically all HR types are now

imported from China. Due to the popularity of these hybrids, the ratio even approaches 40-60% in Sindh and Balochistan after a few years of expansion (Yang and Hu, 2018) (Table 1). The HR sector is anticipated to grow beyond an area of 1.2 million hectares in the coming years, and the overall demand for HR grains may reach 20 million Kg/year.

**Analysis of gross margin (GM) and variable cost (CV) of HR cultivation in comparison to other local cultivars.** Maximum yields for HR have been estimated to reach around 195 mounds per hectare worldwide, while the approved raw variety IRRI-6 (151 mounds/ha) the Basmati fine-grained variety Basmati-2000 (91 mounds/ha) and rosi (94 mounds/ha) all have comparably lesser production potential. Compared to the upper Sindh areas (190 mounds/ha) and Balochistan (185 mounds/ha), HR growers in Sindh's lower regions produced more HR per hectare (about 227 mounds/ha). The total variable cost of cultivating various rice varieties, as determined by adding the total cost of factors and the total cost of labour, was measured for the analysis of gross margin (GM), which is the derivative of the variance of total revenue and total variable costs (VC). When compared to other regions where common varieties, such as Basmati-2000 (Rs.48,432/ha) and Rosi (Rs.48,446/ha) were grown, HR (hybrid rice) farmers obtained the highest GM (Rs.56,742/ha), while the gross profit margin of IRRI-6 rice farmers recorded the lowest (Rs.40,964/hectare).

The target rice producing areas in lower Sindh have a higher GM (Rs.70,167/ha) than those in upper Sindh (Rs.55,758/ha) and Balochistan (Rs.51,693/ha), according to the average GM of HR per cultivated area. There was no discernible difference between the yield of HR and other significant crop types when comparing variable cost (VC) to average total cost. The HR agri-

**Table 1.** Production of HR in different provinces of Pakistan, indicating the proportion of HR to total rice-growing areas in (ESP, 2020-21)

Province (1000 ha)	Rice area (1000ha)	HR Area	Ratio (%)
Punjab	2030	61	3
Sindh	780	360	46
Baluchistan	160	47	29
KPK	70	3	4
<b>Total</b>	<b>3040</b>	<b>471</b>	<b>16</b>

cultural areas had the highest CV (Rs.43,986/ha), while Rosi variety had the lowest CV (Rs.30,428/ha). However, it was shown that there was a statistically significant difference in the average total income earned from the cultivation of HR (Rs.100,728/ha) and other local cultivars (IRRI-6 Rs.78,983/ha, Basmati-2000 Rs.81,370/ha and Rosi Rs.78,874/ha) ( $P \geq 0.05$ ).

Compared to other local cultivars, HR significantly affected yield. However, because seeds and chemical fertilizers are so expensive, the cost of production is quite high. Furthermore, due to inferior grain quality in comparison with eating and food preferences, the average market price of HR is lower. However, given the great yield potential of HRs even in Pakistan's marginal lands, growing HRs results in a considerably better net profit than growing other local cultivars. Due to favourable seasonal and meteorological conditions, HR farming has been demonstrated to be more profitable in the lower Sindh areas than in the higher Sindh regions as well as in Balochistan. Small-scale rice farmers are discouraged from utilizing this cutting-edge technology since the cost of obtaining HR seeds is comparatively greater than that of other conventional rice varieties (Khushk *et al.*, 2011).

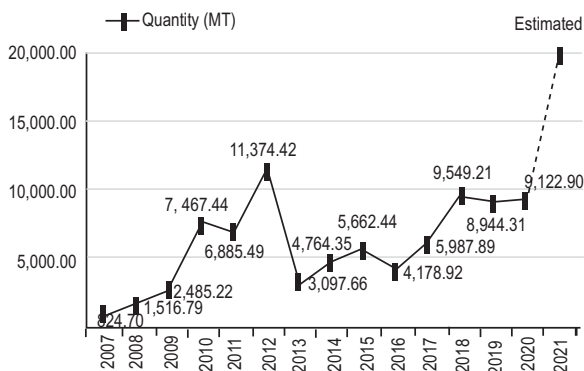
**Overview of Chinese HR seeds export to Pakistan.**

The first commercially licensed HR seeds were planted in China in 1976 and as a result, the annual HR cultivation area in China reached its peak in 1995 at nearly 20.89 million hectares or roughly 68% of the total rice area in China (Zhong *et al.*, 2016), while the commercialization of HR began in Pakistan in 2007 with the importation of 642 tonnes of hybrid seeds from the HR seed firm Longping Pvt. Ltd. in China, the local release of the HR-designated varieties GNY-50 and GNY-53 and the importation of 182 tons of hybrid seeds from 3 other Chinese companies. The benefits mentioned previously have caused the farmed area to progressively grow each year. Due to their high yield potential and value, hybrid seeds are primarily imported from China, with less than 1% of them being produced domestically. The amount of imported HR grains reached its highest level in 2012 with a total volume of 11374.42 tonnes, an increase of more than 13 times from the year's commencement. The entire number of HR imported into Pakistan in 2020 is 9122.90 tonnes, an increase of more than ten times from the initial year. The highest forecast for the upcoming decade is 20 times higher than it was in the initial year. Figure 2 depicts the pattern of Chinese imports of rice seeds from 2007 to 2030.

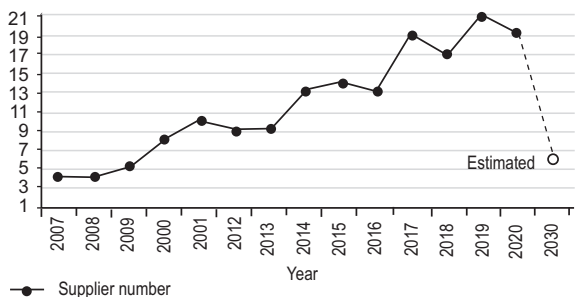
In 2007, just four Chinese companies—Longping Hi-Tech, Winnall-Tech, Hubei Provincial Seeds and Anhui Longping Seeds—exported HR seeds to Pakistan. HR exports to Pakistan reached their highest level in 2012 at 11374.42 tonnes and in 2019 the top 4 suppliers made for 21 of the total providers. From 2007 to 2030, Fig. 3 depicts the trend of Chinese HR seed entrepreneurs in the Pakistan market.

**Review of top suppliers of HR seeds from China.**

Since HR seed trading began in Pakistan, Longping High-Tech Ltd. has been one of the earliest suppliers in China, as previously stated. The increased demand for HR in Sindh and Balochistan due to their better-earning potential has increased the amount of HR exported to Pakistan during the past 10 years. However, it is not viable to export as much as is needed for HR in the Pakistani market due to political instability and a challenging HR market environment. In contrast to



**Fig. 2.** Quantities of HR seeds in million tonnes imported from China to Pakistan during fourteen years (2007 to 2020) and estimated export upto 2030 depending on previous and current scenario.



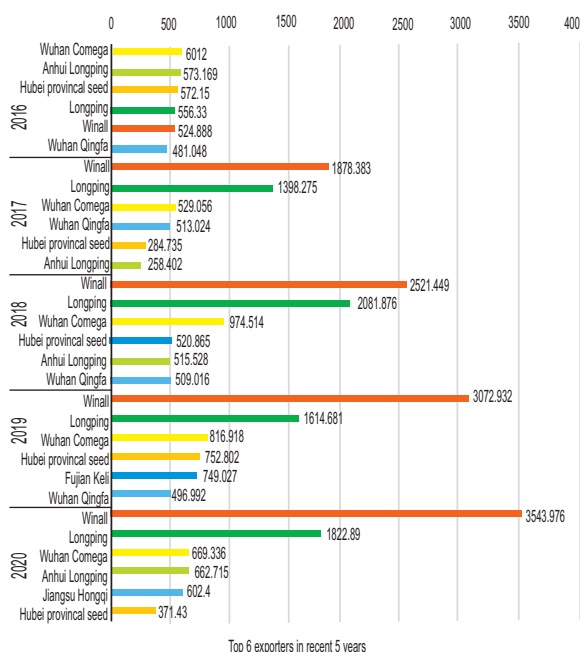
**Fig. 3.** HR seed key suppliers from China for Pakistan market.

the status of Pakistan in the field of HR seeds, the country has not exported as many HR seeds over the previous five years (Fig. 4) as to meet the demand of HR in country.

Winall, a pioneer in HR research and innovation, was the first HR seed firm to be listed on SSE Star Market. It has dominated the Pakistani market for HR seeds for the past five years, and it exports considerably more seeds than its nearest rival, Longping HT Pvt. Ltd. According to Fig. 5, its market share for the overall HR seed market in Pakistan in next five years is expected to be approximately 40%. The export volume and replacement market share of HR seeds to Pakistan is accounted for by the 3 to 6 suppliers. In comparison to the top suppliers, the general competitors are substantially lower (Fig. 4). With the remaining 70% of the market share concentration in the top two suppliers, Winall and Longping, it can be inferred that in the ten years to come, the ranking of suppliers may change to 30% of the market share.

### Result and Discussion

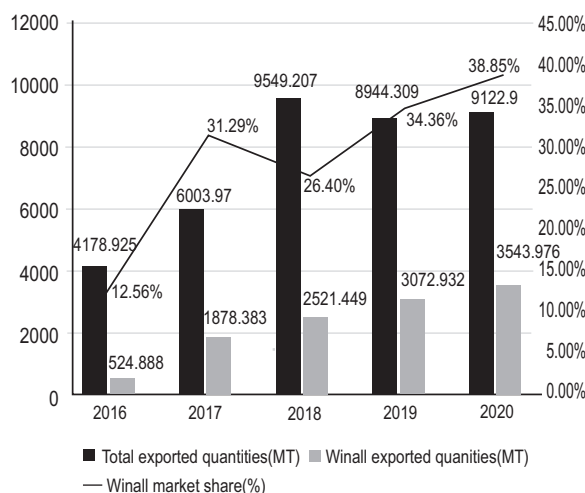
**The future opportunity of HR seeds export to Pakistan.** In recent years, agricultural research and development have seen significant cooperation between



**Fig. 4.** Recent five years exports volume for top six hybrid seeds exporters from China.

China and Pakistan. R&D in the area of agricultural research has increased since the 2013 opening of the China-Pakistan Economic Corridor (CPEC, 2019), a flagship project of the belt and road initiative. The Presidents of China and Pakistan met more than three times in 2019 and focused on enhancing and extending the CPEC project in order to achieve the vital objectives of raising peoples' standards of living, constructing industrial parks, and boosting agricultural cooperation (CPEC, 2019). During their official visit to China in March 2020, Beijing and Islamabad agreed to increase their bilateral cooperation in research, technology and agriculture (BR, 2020). With the above-mentioned scenario, the prospect for hybrid seed firms in Pakistan's market is quite promising and optimistically forecasts future growth of 20 million tonnes (MT) over the next ten years due to the yield advantage of HR seeds over local varieties and the future HR technology of China. However, even with optimistic market estimates and the global seed industry's consolidation, there will be stiff and fierce competition.

**Challenges in HR export to Pakistan. HR seeds quality issues for export to Pakistan.** Seed quality is crucial to sustaining agricultural production. However, in contrast to the native poplar types in Pakistan and its rice export partners, the hybrid varieties shipped to the Pakistani market contain short seeds with very low amylose content. Rice exports have turned into a particularly complicated topic for Chinese providers due to distinct dietary habits and seed quality (Shahzadi



**Fig. 5.** Recent five years seeds exports and win all exporting performance.

*et al.*, 2018). Due to the difficulty of HR seed quality certification in China, all major seed suppliers—and even small seed suppliers—have recently had to deal with conflicts over the quality of their products. In contrast to seeds that arrived in Pakistan with unsatisfactory inspection findings by Pakistani customs, primarily because of poor germination, HR seeds depart from Chinese customs to Pakistan with certified quality references. Chinese seed businesses have tried to implement a number of production, packaging and shipping innovations to address these quality issues. However, it appears that the issues have not entirely gone away, as occasional quality issues still exist.

**Impact of climate change on HR adoption.** Over the past ten years, extreme climate events including storms, floods and repeated droughts have wreaked havoc on agriculture, notably rice farming. The most harmful natural occurrences in recent years, such as flooding brought on by recurring floods, salinization brought on by low water levels and hot weather, have reduced the fertility of rice plants and reduced rice yield. The area where rice is grown has been reduced to a restricted region with enough water and good weather because of global warming and dramatic weather changes. Huge greenhouse gas emissions, like those of nitrous oxide and methane, contribute to climate change. To achieve this, active measures to increase flexibility and lessen the effect of rice production on climate change will be needed.

**Risks in currency exchange rate.** The US dollar currently rules the world of international trade. One of the greatest dangers in the exchange of human resources between China and Pakistan is the exchange rate. Typically, Chinese HR seed vendors send their Pakistani customers invoices in US dollars, while paying the growers in Chinese currency *i.e.* Chinese Yuan. In the same way, Pakistani importers receive orders in US dollars and issue PKR (Pakistan Rupees) invoices to their clients, who are primarily farmers and suppliers. The US dollar dominates the seed trade and because of volatility in the PKR to USD conversion rate and the requirement that it be done twice as part of the trade agreement, doing business in this sector can be highly risky. For instance, the Chinese currency's exchange rate to the US dollar increased by about 6% from 7.0 in January 2020 to 6.6 in November 2020 (<https://www.xe.com>). In the event that Chinese exporters pay hybrid seed producers in local currency in January at the start of seed production then ship hybrid seeds to

Pakistani importers in November or December in USD bills, this would result in exporters losing 6% of their net profit. On the other hand, businesses based in Pakistan imported HR seeds from November to December 2019 and paid their Chinese supplier in USD at the corresponding exchange rate of 155 before selling the seeds to local farmers in April and May of the following year using local currency (*i.e.*, PKR) at an exchange rate of 166, resulting in a 7% devaluation. This indicates that by importing seeds from China and selling them in the Pakistani market, the HR seed importer has lost a percentage (7%) of its net profit margin. When every factor is considered, the exchange rate seriously jeopardizes the HR trade between China and Pakistan. If commercial enterprises are permitted to issue bills in local currency, these risks can be reduced by the intervention of the relevant authorities on both sides.

## Conclusion

Due to its yield advantage over other local inbred lines, HR has been shown in numerous studies to be much more productive and profitable. Since the initial HR export to Pakistan, the acreage being cultivated has dramatically increased every year. By importing locally adaptable hybrid varieties, more and more businesses are now getting into the HR market. Due to its propensity to grow in challenging environments, climatic resilience and high yield, the HR production area is growing and has covered a significant area in all provinces of Pakistan.

Due to cheaper prices compared to importing HR from China, local hybrid seed production has also produced enormous potential to begin research and development in HR technology. This has also had an impact on the adoption of HR in Pakistan. In Pakistan, where the agroclimatic conditions are stable and beneficial, numerous Chinese and local businesses have launched research on the development of HR. Despite the substantial yield production advantage of HR adoption and cultivation in Pakistan, the adoption percentage each year is much lower than what is needed as a result of a variety of factors, including poor seed quality, a lack of export markets, high input costs, unstable trade currency exchange, climatic factors and competition from local high quality exportable inbred varieties.

More efforts are still required to produce HR domestically that is of a superior cooking and eating quality that satisfies both local and international market criteria.

Given the current situation, it is best to produce long-grain, high-yielding and early-maturing hybrids of rice to boost overall output in Pakistan and improve export revenue by sending hybrid rice to potential worldwide rice-importing countries.

**Conflict of Interest.** The authors declare that they have no conflict of interest.

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