Rice Breeding and R&D Policies in Thailand¹

Orachos Napasintuwong
Department of Agricultural and Resource Economics, Faculty of Economics
Kasetsart University, Bangkok, Thailand

E-mail: orachos.n@ku.ac.th

ABSTRACT

Rice is unquestionably an important stable and economic crop in Asia. Rice from Thailand is well-recognized as a high quality agricultural product in the world market, and the quality is significantly influenced by traits of the rice variety itself. Research and development for rice varietal improvement has been one of the important missions of the Thai government, but public investments in rice varietal development is fairly small. Constraints on adopting advanced technology such as transgenic and hybrid rice and limited access to international germplasm for commercial purposes have lessened incentives for investments by the private sector. This paper aims at summarizing the history and current situations of rice breeding in Thailand. Policies and regulations related to access to rice germplasm, research collaboration, and intellectual property rights protection are discussed.

Keywords: R&D, investments, rice, policy, breeding

RICE RESEARCH AND DEVELOPMENT IN THAILAND

History of rice breeding in Thailand

After the Bowring Treaty with England that has opened international trade with foreign merchants in 1855, Thailand’s rice exports expanded and became one of the largest exporters along with Burma and Indochina (Fig. 1). After World War II, while rice exports from Burma and Indochina drastically contracted, Thailand continued to increase its rice exports and dominated

¹ A part of this paper was presented at the 100th Indian Economic Association Annual Conference, Guntur, India. December 27-30, 2017.
the global rice market. Before the late 1970s, the share of rice exports from Thailand did not increase despite the expansion of the global demand for rice due to the entries of China, the U.S. and other exporters in the world market.

Nevertheless, the price of Thai rice during that time was low due to mixed varieties. Some buyers sorted out the long grains and sold them as good quality rice from India (Patna rice) which was prominent during that time, but the short grains were sold as Siam (former name of Thailand) rice (National Center for Genetic Engineering and Biotechnology, 2003). This created a bad reputation for Thai rice. The vision of selecting good varieties for cultivation started in 1907 when King Chulalongkorn commanded the first Rice Variety Contest at the Rice Exhibition (Fig. 2 and Fig. 3). The objective of the contest was to support and improve good rice varieties and to increase the price of Thai rice to be on the same standards as other countries. The subsequent Annual Exhibitions of Agriculture and Commerce in 1910 and 1911 provided a platform for best rice variety contests that led to the promotion of good varieties’ seed production and dissemination. It was found that the winning varieties from subsequent contests were of better qualities, showing that farmers had adopted good quality rice. This created a good collection of rice germplasm for Thailand. The current rice gene bank in Thailand consists of about 24,000 samples. About 20,000 of which are local varieties (Bureau of Rice Research and Development, 2009).
The visionary King Chulalongkorn also initiated an irrigation system in the Central Plains in 1890 which has set the foundation for rice cultivation expansion and rice breeding in Thailand. The irrigation system is presently called “Rangsit canals” in Pathumthani province (Royal Irrigation Department, 2017). The first rice experimental station, Rangist Canal Rice Experiment Station, was initiated by King Chulalongkorn and later established by King Vajiravudh in 1916. During that period, the first King Scholarship student who completed his studies on mapping and agriculture from Cornell University, Mr. Tri Milintasut (Phraya Phojakara), was appointed the first Chief of Rangsit Canal Experiment Station (Fig. 4), which presently is Pathumthani Rice Research Station under the Rice Department (RD), Ministry of Agriculture and Cooperatives (National Center for Genetic Engineering and Biotechnology, 2003). The first step of rice variety
improvement was to collect rice varieties to create genetic diversity, enabling selection, comparison and search for outstanding varieties which are important in the varietal improvement process. The first groups of students who were sent by the King to study modern agriculture in Europe and USA and returned to Thailand have started the rice development program through rice variety selection method. The result was that hundreds of rice varieties were collected between 1916 and 1950s at Rangsit Canal Experiment Station, laying a foundation for modern genetic improvement in the 1960s (Poapongsakorn et al., 2010).

One of the prominent varieties from the collection, PinKaew, was granted best rice prize in 1933 at the World's Grain Contest in Regina, Canada. During the same contest, other Thai local varieties won the second, third and eight other prizes out of 20 prizes given (Plant Genetic Conservation Project Office, 1996). Eight varieties of excellence qualities were selected after three years of experiment, reproduced and officially recommended to farmers in 1935.

Fig. 4. Men examining the rice experiment farm in Pathumthani, 1937
Source: University of Wisconsin-Milwaukee Libraries, 1959

Rice breeding in the past was principally led by the the RD sector along with some collaborative breeding programs with other national and international organizations such as the International Rice Research Institute (IRRI). During the early 1950s, collaborations with United States Department of Agriculture (USDA) and United States Overseas Mission (USOM) Rice Improvement Program have trained 30 Thai scientists for rice variety selection. Subsequently the ‘good rice varieties collection program’ was created. The world- renowned Thai Jasmine rice--Khao Dawk Mali 105 (KDML105), commonly known as Hom Mali rice in the domestic market, was also a product from these trainings. KDML105 and was first discovered in 1945 in Chonburi province. It later spread to Chachoengsao province. Under the ‘good rice varieties collection program’, one of the scientists found that panicle No. 105 from 199 panicles from the collection
at Bangkla, Chachoengsao station had outstanding quality. After selecting and field testing, KDML105 was registered and recommended for cultivation by the RD in 1959.

During the Green Revolution, Thailand started modern rice breeding program after the introduction of IR8 by the International Rice Research Institute (IRRI) in 1966. The first modern variety, RD1, was released in 1969. The early released HYVs such as RD1, RD2, RD3, and RD4 were not popular among Thai consumers due to their inferior cooking quality compared to existing local varieties. To fulfill Thai consumers’ preferences, consequently, improved cooking quality of long-grain rice with a minimum of 7 millimeter length became the norm for rice breeding in Thailand. Two important successes of modern variety developments are RD6 and RD15. RD6, released in 1977, is the first good quality aromatic glutinous rice developed by induced gamma radiation to KDML105, and it is still popular until today. Aside from KDML105, RD15, which was released in 1978, is the only aromatic improved variety considered to be Thai Jasmine rice under Thai Hom Mali rice standard. RD15 was a mutant of KDML105 by induced gamma radiation, and is about two-week earlier maturing and has higher yield potential (3.5 ton/ha) than KDML105 (2.27 tons/ha).

Rice research and development: investments and impacts

Evidences have shown that research investments contribute significantly to the growth of the agricultural sector. Specifically rice research in Thailand has shown positive economic impact as found by Suphannachart (2011) that investments in rice research and the adoption of high yielding rice varieties (HYVs) in Thailand are key factors which influence the Total Factor Productivity (TFP) growth, a proxy for technological change. The returns on investments of agricultural and rice research in Thailand were found to be positive. The rate of return on crop research investments was 29.5% during 1970–2006 (Suphannachart and Warr, 2011). Specifically on rice, the return on investments of a 12 years of research on the development of one of the popular varieties in the irrigated Central Plains—Chainart 1, a brown plant hopper-, white back plant hopper-, rice ragged stunt disease- and blast-resistant HYV released in 1999 was more than 140% (Napasintuwong, 2010). A return on investments of the disease-resistant RD6, a popular good cooking quality HYV glutinous rice with improved blast- and bacterial leaf blight-tolerant traits released in 2007 was 28% to 33% (Meerod, 2011).

Nevertheless, public investments in rice research in Thailand have been minute, and is declining in its importance relative to rice GDP during the past few decades (Fig. 5). This similar trend of declining R&D growth rate of public investments in agricultural research is also found in Asia and in the global context. The share of public researchers on rice R&D in Asian and Pacific region, nevertheless, is higher than other parts of the world at about 15% compared to 4% in Latin America and the Caribbean, and Middle East and North Africa (Beintema et al., 2010). In the past several decades, the breeding efforts of rice in Thailand were primarily done by the RD under Ministry of Agriculture and Cooperatives. In recent years, other public research institutes and universities through funding by national research institutes became more actively involved in rice breeding programs. The university sector focuses more on basic research and many times are partnered with the RD. For example, Riceberry (aromatic deep purple rice) was developed by Kasetsart University in cooperation with Mahidol University and Chiangmai University funded by National Research Council of Thailand aiming at improving nutritional and

---

2 The name of rice variety that starts with RD stands for Rice Department as a developer. The ending odd numbers represent non-glutinous variety and even numbers for glutinous variety. Between 1974 and 2006 when the RD was merged with the DOA, the names of released varieties start with the names of DOA stations.
value rice varieties. The three public universities released Riceberry in 2005. After the mega-flood in the Central region of Thailand in 2011, the cooperative efforts between the Rice Department and National Center for Genetic Engineering and Biotechnology (BIOTEC) under Ministry of Science and Technology successfully released RD51, a flash flood tolerant variety, which was registered in 2013. For example, Gor Kor Mae Jo 2 (glutinous rice) was developed by Mae Jo University in cooperation with the RD and registered in 2015; Hom Mali Gomane Surin (aromatic red rice) developed by the RD and Mahasarakam University was registered with the DOA in 2016. There are very few exceptions that the RD’s registered varieties were developed by Thai companies.

Fig. 5. Rice and agriculture’s public research intensity (%) relative to its GDP.
Source: Poapongsakorn et al., 2010.

**Policies and regulations on rice varietal development in Thailand**

Being the world’s leading producers and exporters of best quality rice, Thailand’s rice germplasm is very protective. *Oryza sativa* L. is one of the controlled plant species under Thailand’s Plant Variety Act (PVA) or the seed law. The PVA was enacted in 1975 and regulates all imports, exports, collections and transit of controlled seeds including rice seeds to require a permit. The importation of paddy rice which can be used as rice seeds is prohibited, but can be requested for approval by the Director General of the Department of Agriculture (DOA) if the purposes are for research or as samples. The exchange of rice germplasm with foreign countries for a study or research is possible, but the agreement of benefit sharing has to be approved by the Director General of the DOA. Nevertheless, paddy rice imports must not be for commercial purposes, and need certificates of non-transgenic (non-GMO) and sanitary and phytosanitary standards (SPS) under Plant Quarantine Act 1964. The importation of rice seeds as foundation seeds or parental line for hybrid rice has to declare the type, quantity, location, and time period of planting or research. In practice, unlike other controlled plant species that seed imports for commercial purposes can be requested on a case to case basis under the condition that it has to pass the risk assessments for SPS from country sources, importation of rice seeds for commercial purposes have never been allowed. Similarly exports of rice seeds from Thailand are also prohibited. As a result, rice seed and germplasm trade may be considered as practically
“prohibited”; thus, foreign companies have no incentives to invest in rice breeding in Thailand. Furthermore, modern biotechnology in rice breeding is limited with few research institutes employing technology such as marker assisted selection, and genetic engineering. The production of transgenic rice is prohibited in Thailand, and research on transgenic rice is limited to closed field experiment only.

At present, nearly all rice varieties grown in Thailand are Open-Pollinated Varieties (OPVs), although there have been initiatives for hybrid rice breeding and hybrid rice seed production by private companies such as Charoen Pokphand (CP), a Thai-parent multinational company, and Bayer, a multinational company, in the past decade. Due to prohibition of rice seed production from imported germplasm for commercial purposes, Bayer has withdrawn the hybrid rice research program from Thailand. CP is the only company that has engaged in research for rice genetic improvement, and successfully registered the first hybrid rice, CP304, on the same day as RDH1 developed by the RD in 2011. The only exception of a public-private partnership between Thai government and foreign company was the development of RD63. RD63 which was developed by the RD under the Kellogg’s medium grain rice pilot program. The program aims at breeding for medium grain rice to support the manufacturing of Kellogg’s products such as Rice Bubbles™ for the Asia Pacific region (Garcia et al., 2015). RD63, was registered and released by the RD in February 2015. Farmers who produce RD63 are contracted for Kellogg’s through its local suppliers.

Rice varieties approved by the RD not only have to have outstanding characteristics but also the value for cultivation and use (VUS) (for recommended suitable areas). Because quality rice production are also specific to good quality varieties, government support programs frequently cover only approved varieties under the RD. Fig. 6 shows that the number of approved varieties (by the RD) has increased over time.

![Fig. 6. Number of approved rice varieties with the Rice Department](image)

Registered varieties by the DOA, on the contrary, only protect the varieties’ names and require basically sources of germplasm and/or history of development in addition to varietal characteristics. The main differences between the approved varieties by of RD and the registered varieties by the DOA are that the first requires more test for VUS. This registration of varieties
by the DOA, however, is required for commercialization of seeds under the Plant Variety Act. Fig. 7 shows that the number of registered varieties by the DOA. Several of these varieties are not approved varieties by the RD. Most of the rice varieties developed by Thai companies or universities are registered under the DOA. Note that between 1974 and 2006, the RD’s research was merged into the DOA.

![Fig. 7. Number of registered rice varieties by the Department of Agriculture](image)

Note: Prior to 2006, the Rice Department functions were under the Department of Agriculture. Source: Plant Varieties Protection Office, 2017

Furthermore, new rice varieties can file for plant breeders’ rights protection and be listed as new varieties under the Plant Variety Protection (PVP) law that came into effect in 1999. At present, because most of the rice varieties in Thailand were developed by public institutes and considered public goods, only few rice varieties were requested for property rights protection under the PVP law. On the one hand, investments by the public sector ensure that released rice varieties have good quality traits and address production problems as well as meeting the market demand. On the other hand, current protective policies on access to foreign rice genetic resources left the private sector with little incentives to participate in commercial rice breeding. This could be a drawback for Thailand on variety development, especially when demand for improved traits such as insect resistance, drought and flood-tolerance and short duration will be increasingly needed to cope with climate change in the future. Furthermore, some desirable traits such as resistance to diseases and pests, tolerance to unsuitable environments existing in wild rice and other living organisms are not possible to be crossed with rice (National Center for Genetic Engineering and Biotechnology, 2003). Because of the prohibition of genetic engineering in open field trials, non-existence of biosafety law and limited access to a wide range of international germplasm from commercial sources, the competitiveness of Thai rice in the future may be threatened.

**CONCLUSION**

Thai rice has set an excellent reputation for quality and taste in the world market. Rice grain quality is influenced significantly by the variety itself. Thailand is fortunate to have a germplasm
collection of good quality rice, and rice breeding efforts in Thailand have been dominated by the public sector with few exceptions from private investments. With constraints to access to foreign rice genetic resources, commercial rice breeding is presently prohibited. Although there are more investments from the private sector especially on specialty rice that can generate profits to breeders in recent years, it is important that the government recognizes the needs for varietal improvements of rice to be able to maintain its competitiveness in the world market, and to ensure food security in the future.

REFERENCES


Date submitted: April 9, 2018
Reviewed, edited and uploaded: April 26, 2018