FROM RICE IS LIFE TO LIFE IS PROFIT

Trends in Rice Seed Trade in East Asia

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About EARWG

The East Asia Rice Working Group (EARWG) is a network of NGOs, civil society groups, and social movements working on rice and rice trade issues in the region. EARWG provides a platform to facilitate engagement among its network members and develop programs on rice, agriculture, food security and trade.

It seeks to help strengthen farmers' movements by facilitating exchange of information and resources on sustainable agriculture among farmers' groups in the region, promote fairer trading of rice and rice-related products, especially seeds through policy development. Campaigning on rice trade and related issues is also a part of its efforts to help end poverty among women and men farmers.

The EARWG members include representatives of groups from Cambodia, Indonesia, Laos, Malaysia, Philippines, Thailand, East Timor, Viet Nam, and regional organizations, such as SEARICE, SEACON, PAN-AP, La Via Campesina - East and Southeast Asia, and Oxfams in East Asia. We are also hoping to include partners from Burma and China.

Executive Summary

Rice farming is considered the single most important economic activity on earth, being the source of livelihood of more than 250 million people, most of whom live in Asia. Rice is the most important crop in Asia and accounts for as much as 97 percent of the per capita cereal consumption of the people in the region. The importance of rice in the life of Asians cannot be overstated as it is the underlying foundation of the multitudes of cultures in the region.

Rice is largely cultivated by subsistence farmers, with weather as the single most critical factor that determines the level of production. Over the past four decades since the inception of the Green Revolution, however, technological innovations in rice breeding have played an important role in rice productivity. The Green Revolution package of technology involves the use of synthetic chemical inputs such as pesticides and fertilizers, dependence on irrigation, and the use of modern high-response seed varieties. The Green Revolution era has witnessed the doubling of rice yields and production in areas where the ideal farm conditions required by the technology are present and where farmers can afford the costs of farm inputs.

The technology has been criticized for the negative impacts of chemical inputs on the environment and human health, increased dependence of farmers on agro-chemical and seed companies, and for widening the income gap in the rural areas. Beginning in the late 80s, the yields of Green Revolution seed varieties have hit a plateau which is generally attributed to farm intensification that severely depleted soil fertility and pest and disease infestations.

While the Green Revolution was raging in the rest of Asia, rice scientists in China were perfecting the hybrid rice technology which was widely regarded as the reason for the country's rice self-sufficient status and exporting capacity in the face of a burgeoning population. The flagging yield of Green Revolution varieties in the 90s has provided the key motivation for the interest of public research institutions in Asia to shift to hybrid rice. With the

exploding population in developing countries in the region, the search for alternatives to the declining "superstar varieties" is now focused on varieties that yield more in less land areas to feed more people.

While academic studies on hybrid rice claimed steadily increasing adoption of the technology in many countries in East Asia, civil society groups reported no significant increase in the overall hybrid rice area since 2000. While China remains the biggest producer of hybrid rice in the world, the area devoted to hybrid rice in China remains confined to the southeast and south central parts of the country and has been declining since 1997. The decline of hybrid rice hectarage was attributed to the recent advances in conventional breeding that produced promising inbred varieties and even surpassed the yields of the best hybrid rice varieties available in the market.

Despite years of research, hybrid rice technology remains in initial stages in most countries in the region. Thailand, one of the region's leading rice producers, has no market for hybrid rice largely because its edge in the export market is hinged on its well-known jasmine *(hom mali)* varieties that are generally, improved traditional varieties.

Only Vietnam and the Philippines have so far shown major increases in hybrid rice production areas in varying degrees and in particular conditions. Hybrid rice production in Vietnam is confined in the north and still dominated by seeds imported from China. Meanwhile, hybrid rice production in the Philippines is heavily supported by state subsidies.

CHINA

As the birthplace of hybrid rice, China has made impressive advances in the technology. At its peak in 1992, hybrid rice covered 58 percent of the total rice areas in the country, contributing about 15-18 million tons of additional unmilled rice to the total production. While there were individual breakthroughs in increased yield reaching up to 11.2 tons per hectare from a single crop and 23.3 tons per hectare from two croppings, studies on the field performance of hybrid rice varieties in China showed that they only attained an average of 6.9 tons per hectare. The average yield of inbred high yielding varieties is 5.4 tons per hectare, which means a yield advantage of about 27 percent. The actual field performance of hybrid rice varieties is way below the target average yield of 10.5 tons per hectare by 2000 and 12 tons per hectare by 2005.

Ironically, it was in the years following the launching of the "super hybrid rice cultivation program" when China's overall rice production and harvested area began to decline. In 2003, rice harvested areas fell to about 26.8 million hectares. This rose by around 10 percent to about 29.4 million hectares in 2004, which is still below the 30.54 million hectares paddy area in 1999. By the dawn of the 21st century, only about 50 per cent of the total

rice area is planted to hybrid varieties, producing about 103.5 million metric tons of paddy annually. The rest are planted with inbred high-yielding varieties, producing 81 million metric tons.

The decline in hybrid rice areas was attributed to the growing popularity of some newly-introduced inbred rice varieties with higher yields and better traits, and with seeds that cost less than hybrids. New inbred varieties that can grow in higher altitudes have also been introduced commercially and out-competed the older hybrids that can only be grown up to 1,300 meters above sea level.

Hybrid rice research and development in China is primarily initiated and led by public research institutions, many of which have evolved into state-controlled enterprises when the economy shifted to capitalist route. Historically, it is the system of collectivized agriculture and rigid production discipline at the communes that fostered the growth of hybrid rice in China.

With the shift of economic policies to semi-capitalism and the breaking up of rigid communist structures, hybrid seed production is currently facilitated and organized by state-owned seed enterprises. These also engage in field releases and commercialization of hybrid seeds. Majority of these state enterprises operate at the provincial level and engage in domestic and international export of seeds.

Most of the research and development efforts in hybrid rice in China are developed in agricultural universities and public research institutions across the country, especially in the sub-tropical south where rice is grown. However, commercialization and marketing are now in the hands of state-owned seed enterprises, many of which were formerly public research institutions.

The rapid adoption of hybrid rice technology in China can be attributed to the combination of active government promotion for farmers to adopt the technology and the presence of required infrastructures. China's rice areas are nearly all irrigated which is favorable for hybrid rice cultivation. Since the average landholding in China is sufficient only to support subsistence farming, hybrid rice production in China is mainly for family consumption. Profitability in rice production is not a major concern along with the acceptability of the grain to consumers.

The gradual adoption by the Chinese government of the principles of market economy, however, has paved the way for the massive shift from production for household consumption to production for the market. Chinese farmers, including rice farmers, are now encouraged to produce for the open market and get higher price for their products once they reached a production quota aimed at securing the domestic food base. Such economic incentive encourages farmers to choose high-yielding varieties that can command higher price in the market owing from good grain quality, which are not often found in hybrid rice varieties. The emergence of new inbred varieties with higher yields and better grain quality, aggravated by the signs of yield

plateau in hybrid varieties have all contributed to the decline in harvested areas of hybrid rice in recent years.

The nature of the political economy along with the socio-economic and institutional factors explain the phenomenal success of hybrid rice in China rather than its inherent superiority over inbred high-yielding varieties. The experience of China showed that the labor-intensive hybrid rice technology provided a viable opportunity to increase the income of small and marginal farming households in rural areas where labor comes abundant and cheap.

With economic liberalization, consumer preferences have become the single most important determining factor that decides on the fate of any rice variety in the commercial market. Owing from its generally inferior grain quality, the demand for hybrid rice was observed to have declined recently.

The phenomenal success of hybrid rice in China for 30 years has brought to fore the inherent weaknesses of the technology. Its optimum yield seems to have already been breached in recent years. The institutions responsible for its success are being replaced in the light of the rapidly changing political and economic environment.

Ironically, the emergence of better inbred varieties in the midst of the continuing challenge to produce more food with less land devoted for rice due to the massive shift to cash crop production being the reasons for the declining glory of hybrid rice are the same factors that now motivate the government to push the hybrid rice technology to its limits rather than abandon it. The declining trends in hybrid rice adoption and consumer demand are motivating the proponents of the technology in China to promote and commercialize it beyond its borders.

VIETNAM

Motivated by the success in the development and commercialization of hybrid rice in its giant neighbor to the north, Vietnam first ventured into the technology in 1979. While hybrid rice generally surpassed the yield of inbred varieties grown in farmers' field, hybrids had poorer grain quality and were more susceptible to pests and diseases than the popular inbred varieties.

The government revived its hybrid rice research in 1992 with the launching of the National Hybrid Rice Research Program and the establishment of the Hybrid Rice Research Center (HRRC). Hybrid rice adoption has since then increased with full support from the government, from financial requirement to technical capacity building, research and development, training of researchers, and extension and transfer of the technology.

Contrary to the disappointing performance of the hybrid rice varieties earlier introduced from China, the new hybrid rice seeds released by public research institutions or adapted from China have gradually gained wide acceptance among the local rice farmers. Adoption rate is much higher in

the mountainous northern and central regions while high-yielding and good quality inbred varieties promoted by the government remain popular in the southern areas.

Among the reasons cited for the low adoption of hybrid rice among farmers in southern Vietnam were the predominance of larger farmlands and the prevalence of direct-seeding method of crop establishment that reduces labor cost in the sowing stage. Rice farmers in the river delta in the south prefer the less costly cultivation of inbred varieties because the seed rate per hectare is higher under direct seeding and the hybrid rice seeds cost is much higher. On the other hand, hybrid rice is attractive to the small and marginal farmers in the northern and central highlands since higher yields enable them to produce more food for the family from smaller farms.

In a decade, hybrid rice accounts for 18 per cent and 6 per cent of the rice growing areas in the North and in the country, respectively. In 2003, Vietnam is the second hybrid rice producer in the world after China. Areas devoted to hybrid rice production jumped nearly 56 percent annually from 1992 to more than 100,000 hectares in 1996. By 2001, hybrid rice areas in Vietnam occupies nearly half a million hectares, with an average 23.6 percent increase every year since 1997. The leaps in hybrid rice production have also followed the same pattern from 1992 to 2001.

While hybrid rice production and areas planted have increased markedly in a short period of time, the average yield of hybrid rice, however, has shown a constant negative growth rate. Average yield of hybrid rice was reported at 6.3 tons per hectare in 2003, but down to 6.04 tons in 2004. When compared to the national average rice yield of 4.2 tons per hectare, hybrid rice presented an average yield advantage of around 40 percent.

Hybrid rice seed production area increased from 267 hectares in 1996 to 620 hectares in 2000. Seed yield increased from 1.75 tons per hectare to 2.3 tons per hectare, while seed production of hybrid rice rose from 467.5 tons to 1,426 tons in the same period.

Overall figures, however, showed that hybrid rice yields in Vietnam have already declined in the still-limited areas where they are cultivated despite the fact that the technology has not been around for long. This could be attributed to the fact that most hybrid rice varieties released in Vietnam are varieties that have long been commercialized in China where they have already breached their optimum yield ceiling.

At present, only 20 percent of the overall domestic requirements for hybrid seeds in Vietnam are sourced locally. The rest is imported from the southern regions China with similar agro-climatic conditions as the northern provinces of Vietnam. Agriculture officials estimate that Vietnam imports around 10,000-12,000 tons of hybrid rice seeds from China, making it the most lucrative market for Chinese hybrid rice seeds.

Vietnam lacks in stringent regulatory system to monitor the quality of imported hybrid seeds. Complaints from farmers and commune officials on the poor quality of seeds imported from China are common in northern Vietnam but said to have abated in recent years.

The role of provincial and district government structures in the promotion and delivery of hybrid rice seeds to farmers down to the commune level is critical. The local governments control the state-owned seed enterprises that are registered and operate in the localities. These serve as the direct channel of national seed companies that are considered private entities although the government maintains substantial share in the distribution, promotion and selling of hybrid rice seeds to farmers. The local governments also have the discretion and power to offer incentives for farmers to grow hybrid rice seeds, thus benefiting the local seed enterprises in the process.

The public research institutions virtually hold the sole domain of research and development in hybrid rice in Vietnam at present. However, the private sector is encouraged to invest in commercial distribution and importation of hybrid seeds. The government does not give special permits to companies for the importation of hybrid rice seeds since this is already covered in the general permit that allows them to conduct business in Vietnam.

Many farmers in Vietnam encounter serious problems in marketing their produce especially in the north and central regions due to the inferior quality of hybrid rice seeds, particularly in terms of taste. Imported Chinese rice hybrids are generally susceptible to ragged stunt virus and brown plant hopper, particularly, in the south and bacterial leaf blight in the north. The high cost of hybrid seed production at present has been addressed through direct subsidies from the provincial and district government levels and indirect subsidies from the national government in the form of research, development and extension support.

Seed subsidies to hybrid rice farmers from the national government have been removed but the Agriculture Ministry continues to extend direct subsidies to farmers who grow commercial hybrid rice seeds. The ministry extends 60 percent subsidy on the purchase of parental and restorer lines and 40 percent subsidy for the purchase of the required inputs such as gibberelic acid and fertilizers in the poorer mountainous regions in the north. For the delta regions, the government shoulders 20 percent of the cost of parental lines required to grow hybrid seeds and 40 percent of the input costs.

The agriculture extension arm subsidizes the growing of hybrid rice seeds by farming households in about 1,500 hectares of land across Vietnam. To increase the domestic production of hybrid seeds, incentives are also offered to provinces and districts that attain certain targets for hybrid rice seeds cultivation within their areas. The local authorities set aside a significant amount from their local budget to offer as much as 50 percent subsidy

on the costs of parental seeds to encourage local farmers to engage in hybrid seeds production, allow the locality to reach its target and earn incentives from the Agriculture Ministry. These incentives are allotted with a substantial share in the annual budget of Vietnam for agricultural extension.

Yield advantage from hybrid rice remains the main attraction of the technology especially for farmers in the north where the agro-climatic conditions and ragged topography limit the potentials of modern rice varieties. The considerable public investments in promoting hybrid rice among local farmers through aggressive economic incentives undoubtedly triggered the wide adoption of the technology.

Vietnam also has a high ratio of irrigated lands especially in the south and sufficient water sources along the several river deltas. These infrastructures, along with the government's sustained investments in rice breeding in general, helped in buffering the actual costs of hybrid seeds as they become commercially available. The release of new hybrid rice varieties in recent years with better grain quality also contributed to overcome the initial resistance of local farmers to adopt the technology.

It would not have been easy to convince ordinary farmers to shift to hybrid rice production if not for the incentive packages offered by provincial and district governments, especially in the northern regions. While hybrid seeds production is labor intensive, expensive and risky, the incentive schemes offered by local governments for parental seeds, input subsidy and market assurance have encouraged farmers to engage in this knowledge- and skills-intensive technology.

The prevailing political-economic structures in Vietnam also play an important role in the promotion of hybrid rice in the country. The agricultural situation in Vietnam has not changed much in reality, despite the policy reforms. Going with the old practice under the commune system, decisions on the choice of crops are still being made by provincial, cooperative and commune officials rather than by the farmers themselves. This is particularly happening in the northern regions where the influence of the communist regime remains strongly entrenched.

With the commitment of the national government to promote hybrid rice in the north, the cooperatives and communes implemented the decision at the local level. This explains the significant success in the adoption rate of hybrid rice in northern Vietnam where the government political structures at the local level continue to wield strong influence on the peoples' lives. This includes the farmers' decision on their farms which, on paper, should depend on each household. On the other hand, hybrid rice is poorly adopted in the southern regions where the role of communes and cooperatives has minimal influence on the farmers' decisions on farm operations and farmers are relatively free to choose what crop or variety to grow.

INDONESIA

Hybrid rice development in Indonesia largely remains at the research level, two decades after its initial introduction in 1981. The local rice scientists have so far, failed to hurdle the technical challenges in adapting hybrid rice technology to the local conditions.

The slow progress of hybrid rice development in the country was mainly attributed to the lack of commercially available lines. However, some newly introduced CMS lines have been found to be stable and phenotypically acceptable.

The self-sufficiency in rice that Indonesia enjoyed in the past two years also explains the government's lack of motivation to aggressively pursue hybrid rice technology to boost rice productivity. Indonesian rice scientists continue their research and development of new varieties for commercial release along the inbred path. The efforts are aimed at reaching higher yield and better grain quality to ensure long-term food security.

With some pressures, financial support and technical assistance from the Asian Development Bank (ADB), Indonesia re-intensified its research and development efforts in hybrid rice in 1998. The official justification for the renewed interest on the technology was the inspiring successes in the development and commercial use of hybrid rice technology outside China, specifically in India, Vietnam, and the Philippines.

The ADB's "Development and Use of Hybrid Rice in Asia" was implemented in two phases in some countries in Asia with interest in hybrid rice from 1998 to 2004. Under this program, public research institutions released two hybrid varieties in 2002. Five other hybrids were released by private seed companies, mostly using parental lines from China and a few from the national rice research center.

The two public hybrids showed a yield advantage of about 1.0-1.5 tons per hectare over the high yielding inbred check variety in suitable conditions but this edge was not consistently demonstrated in yield trials across locations and seasons. The introduced lines were found to be susceptible to the major rice pests and diseases in Indonesia. It prompted recommendations to disseminate these hybrids only in suitable conditions where the major pests are not endemic.

Indonesia has not been able to establish an efficient seed production and delivery system of hybrid rice seeds. The hybrid rice seeds distribution system proposed by the government remained conceptual and theoretical.

In contrast to the optimistic targets set by the proponents of hybrid rice in Indonesia, it has only covered a total area of 1,500 hectares by 2004. Only 27.3 tons of F1 seeds have been produced on the same year despite the commercial release of 17 hybrid varieties.

Indonesia does not import hybrid rice seeds from China due to the marked difference in the agro-climatic conditions. Thus, most of the hybrid rice productions are in West and Central Java as well as in South Sulawesi

and Sumatra. As a result of the technology's dismal performance, the overly-optimistic conceptual target of attaining 50,000 hectares by 2005 was reduced to 2,500 hectares. Hybrid rice has very low adoption rate and the government was not enthusiastic to invest in the marketing and promotion of hybrid rice.

Apart from the limited distribution of free seeds in 2002/2003, the Indonesian government does not offer any direct incentives to farmers who adopt hybrid rice technology. The proposed incentive schemes that may be adopted to encourage farmers to grow hybrid rice are the use of hybrid seeds as a revolving fund or credit that the farmers can avail and paid after harvest season. However, the government does not seem to be keen in investing on the technology other than the resources allotted for development efforts.

Some policy makers believe that incentives should be given to farmers adopting hybrid rice to promote the technology. However, there are constraints at the national level that prevent the extension of direct incentive schemes. Indonesia's structural adjustment programs imposed by the international financial institutions prescribed the removal of most government subsidies except those that have potentially serious impacts on political stability and national security, such as the support price for the most commonly-used chemical fertilizers.

The government's indirect incentives for hybrid rice producers are the agricultural extension services and training for farmers to learn the techniques and skills required to optimize the benefits of the technology. The government has not allotted any specific budget for the promotion of hybrid rice among Indonesian farmers. The production performance of the technology in the field has not been impressive enough to convince decision-makers of the potentials of the technology.

TIMOR LESTE

Neither the government nor multilateral institutions has formally introduced hybrid rice in Timor Leste. The Ministry of Agriculture, however, conducted limited field trials of some hybrid rice varieties in 2002 to test the local adaptability and performance of these varieties.

In general, the fledgling country lacks the physical and institutional infrastructures required to promote hybrid rice technology among its farmers who mostly depend on subsistent agriculture. A negligible portion of the country's agricultural lands is irrigated and maintenance of these infrastructures is largely dependent on international aid, as most of its development projects.

A multitude of international donor agencies and countries are implementing various agricultural projects in Timor Leste. Some of them are focusing on seeds research and development primarily to improve local food production.

The country imports most of its food, including rice, from Indonesia and Vietnam. Several agricultural development projects involve the importation and distribution of high-response rice seeds from Indonesia for the local farmers to cultivate. Some foreign-funded projects also include the distribution of agricultural chemicals, such as fertilizers and pesticides, to farmers. Imported agricultural chemicals come mostly from Indonesia and even include some internationally-banned pesticides.

Timor Leste still lacks adequate institutional and regulatory frameworks concerning seeds certification and standards, including importation and quarantine. Poor quality rice grains were reportedly imported into the country under foreign-funded food programs implemented by the government. The framework and institutional mechanisms are being drafted by foreign consultants from internationally-funded agricultural development projects. The policy vacuum and the role of foreign-funded projects to formulate the country's seed policies present both an opportunity and threat for Timor Leste's. prospects in defining the future of its agriculture that will provide sustainable livelihoods and food security to its people.

Regional Trends on Seed Policies and Hybrid Rice and in Relation to Trade

The country case studies have adopted similar laws on seeds standards following the guidelines set by the International Plant Protection Convention (IPPC) that member-countries of the FAO have committed to. The general seeds standards provide for basic requirements in seeds management, breeding, selection, production, processing and marketing. These are primarily designed to apply to seeds developed by the formal sector with little room for recognition of seeds developed by farmers. Seed certification requirements limit the selling and dissemination of farmers' seeds to informal channels.

As countries in the region get fully integrated into the international market economy, especially as they become members of the WTO, they are obliged to comply with intellectual property rights (IPR) standard provided in legally-binding commitments such as the Trade Related Intellectual Property Rights (TRIPS) agreement. The TRIPS, among other provisions, require member-countries to adopt the patent system or the Union for the Protection of New Plant Varieties (UPOV)-style plant variety protection in ensuring IPR over plant varieties. Such is the case of Indonesia. Vietnam, on the other hand, was pressured to adopt a UPOV 1991-inspired PVP legislation because of an earlier bilateral free trade agreement with the US and as part of its effort to gain entry into the WTO. China adopted its own PVP law prior to joining the WTO with its membership in the UPOV 1978 Convention, but had to revise its legislation through its Seed Law of 2000 upon accession to the WTO.

Adherence to the 1991 version of the UPOV has limited the countries' power to adopt policies to realize farmer's rights to save, reuse, share, exchange and sell farm-saved seeds as embodied in the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). Adoption of PVP laws patterned after UPOV 1991 defines the limitations on any future privileges that countries can offer to farmers in relation to the use of protected seeds and in the protection of farmer-developed varieties.

Timor Leste is not a member of the WTO and has not yet adopted any PVP law or any IPR legislation. However, it does not have the necessary capacity to develop innovations that would require such protection nor has the political space to define, based on its needs and realities, ways to operationalize the farmer's rights on the seeds.

None of the countries in this study has adopted legislations or even policies to regulate access to biological and genetic resources and the requirements of benefit sharing arising from the commercialization of these resources. China and Indonesia have actively joined a negotiating bloc of countries that is considered mega-centers of biodiversity. Apart from the rhetoric on the need to recognize the rights of source countries over biological resources and the obligation of commercial users to share the benefits from the commercialization of these resources, China, Indonesia and Vietnam have all refused to extend the call for benefit sharing to local and indigenous communities who have nurtured and conserved these resources through millennia.

The countries studied adopted different policy approaches in the area of genetically modified seeds. China, that is the most advanced in the region in terms of research, development and commercialization of genetically modified seeds/crops, has recently adopted legislations addressing concerns on the safety of this technology, including the labeling of genetically modified seeds. Vietnam, silently pursuing research and development in genetically modified crops, has only recently adopted a regulation on biosafety and management of GMOs. Indonesia, still struggling to get into the genetic engineering bandwagon, has adopted biosafety some guidelines some years ago but no attempt so far to provide teeth to these policies. Timor Leste has no biosafety policy since it does not have the capacity yet. Clearly, the status of policies on seeds in these countries is largely dependent on their technological capacity and infrastructures in seeds research and development.

Partnerships Among Actors Pushing for Hybrid Rice

Because of the intensive knowledge and skills and investments required in hybrid rice research and development, public research institutions in East Asian countries that adopted or experimented with the technology since the 80s have worked together. The role played by China in these research collaborations, along with that of IRRI as the provider of international technical

support and network, are critical in all the bilateral partnerships over the decades.

In the case of Vietnam and Indonesia, most of these partnerships were initially bilateral in nature. IRRI provided technical and scientific support and facilitated the procurement of hybrid rice seeds and parental lines from China. In the 90s, as countries in the region revived their interests in hybrid rice, collaboration shifted to more coordinated and regional nature.

The International Task Force on Hybrid Rice (INTAFOHR) was formed in 1995 with the aim of promoting the technology outside China. In 1998, IRRI led a three-year project funded by the ADB, working with a network of countries promoting the development and use of hybrid rice network entitled, "Development and Use of Hybrid Rice in Asia." This was implemented in collaboration with the Asia-Pacific Seeds Association (APSA) and six member countries of the ADB, namely Bangladesh, India, Indonesia, the Philippines, Sri Lanka, and Vietnam. China later joined the network as a collaborating partner.

Each network partner in the ADB project played specific roles in the partnership. IRRI coordinated the project and provided technical backstopping to develop national capacity in hybrid rice technology. It also took full responsibility in sharing germplasm and in providing training and consultancy services to public and private research institutions actively involved in the technology. FAO helped in strengthening collaboration between research and extension work on hybrid rice, raising the awareness of national policymakers to support the development and use of the technology, strengthening hybrid seed enterprise in the public, private and NGO sectors, and providing financial support to the project. APSA, a regional network of public institutions and the private sector involved in seeds development, provided the venue for the discussions on issues affecting the commercialization of hybrid rice technology through regular annual forum. China was actively involved in human resource development, consultancy services, sensitization of policy makers and in the sharing of technology.

The first phase of the ADB project was implemented in 1998 to 2001, with grants amounting to US$1.5 million. The project was a component of a bigger and long-term technical assistance grant of the ADB for the Consultative Group on International Agricultural Research (CGIAR). Impressed by the success of the project, the stronger regional partnership on hybrid rice and the emergence of private enterprises on technology, the ADB funded a second phase of the project, entitled "Sustaining Food Security in Asia Through the Development and Dissemination of Hybrid Rice Technology." It was implemented in 2002-2005 with three new member countries, namely the Republic of Korea, Myanmar and Thailand, joining the network.

International and Regional Financial Institutions and Trade Agreements Promoting Hybrid Rice in East Asia

The ADB and the FAO are the leading international/regional institutions that funded the research, development and promotion of hybrid rice in East Asia.

FAO's financial support for hybrid rice to national programs in Asia and Egypt during the period 1992-2001 amounted to $1.76 million. FAO's funding assistance allowed governments to build infrastructures and develop the technical capacity of public research institutions in research and development. These were mostly focused in the evaluation of hybrid varieties and parental lines developed by China and IRRI, especially in the early 90s. Technical assistance projects in the late 90s involved the strengthening of capacity to develop locally-adapted hybrid rice seeds, setting up demonstration farms to promote the technology to farmers and upgrading of facilities for the production of parental lines. Notably, the funds and technical assistance from the FAO coincided with the intensification of the national hybrid rice programs in Vietnam in 1992, the Philippines in 1998, and Indonesia in 2000.

The ADB's technical assistance for the development and promotion of hybrid rice in East Asia came in the form of a regional program on "Development and Use of Hybrid Rice in Asia" which was implemented in 1998-2001 and its follow up program entitled "Sustaining Food Security in Asia Through the Development and Dissemination of Hybrid Rice Technology" in 2002-2005. Both projects were implemented under the aegis of IRRI as lead coordinator and project holder, receiving the bulk of the ADB.

The ADB and FAO-backed projects on the development and promotion of hybrid rice were implemented at the same time in the case of Vietnam, Indonesia and the Philippines. In these cases, the activities of the projects were complementary and mutually reinforcing following the respective national hybrid rice programs.

Discussion and Analysis of Trends in Hybrid Rice in East Asia State's Role in the Promotion of Hybrid Rice

Economic Viability and Sustainability of National Hybrid Rice Programs

East Asia's history in market economy bears the lesson that direct economic incentives to promote any technology are not sustainable. Countries can only infuse as much investments on subsidies but will not attain the desired effects in the long run. It is caused by the accompanying complications that come with this kind of support in an economic context aimed at encouraging competition among players and among an array of options.

The impact of China's transition from a command-and-control economy to partial liberalization on the trends and development in hybrid rice since the late 90s is a good case in point. The incentives for the promotion of hybrid rice from the 70s to the mid-90s were inherent components of the incentive schemes and production systems in the commune set up for collective production, rather than additional economic incentives for farmers.

As China's commune system gave way to the introduction of a unique approach in embracing the market economy ideology through partial privatization of key industries including the seeds business, economic incentives to promote hybrid rice came in different forms. No direct incentives were extended to farmers planting hybrid rice and the government instead focused its intervention in the market and in the creation of a national seed industry. Spinning off from the public research sector, the national seed industry takes care of the research, development and dissemination of the technology. The impact of this shift on hybrid rice adoption is still not clear from current statistics, but the emerging trend is the decline in the adoption rate of hybrid rice among Chinese farmers.

Like China, Vietnam also has a long history of command-and-control economy and is currently undergoing a process of transition to market economy mode. Unlike China, the history of hybrid rice in Vietnam did not happen under a centrally-planned system but during the transition to economic liberalization. In its effort to be fully integrated into the world economy, the central government of Vietnam had to remove the direct subsidies it extended to farmers producing F1 seeds and cultivating hybrid rice. However, the central hierarchy gave local governments the option to continue extending subsidies to hybrid rice seeds producers using a socialized scheme and only up to a limited time. More than promoting the technology, the motivation for some provincial and district governments to continue offering subsidies for hybrid rice growers stems from the lucrative economic opportunities that such incentive schemes offer. The discipline and top-down mentality ingrained by the commune system on farmers provide the right socio-cultural environment for such scheme to thrive, particularly in the north.

At this juncture, Indonesia is not motivated to extend economic incentives to invest more in hybrid rice technology. Boosted by confidence from the rice self-sufficiency level that it attained in recent years and constrained by its international financial commitments to restrain from extending subsidies that distort the market, there is no indication that the Indonesian government will extend further incentives to promote hybrid rice. If at all, such incentives will have to come from external sources with interest in creating a market for the technology in Indonesia such as the ADB and IRRI. Without these incentives and any serious effort and investments from the government, the future of the national hybrid rice program in Indonesia does not look very promising.

Beneficiaries of the National Hybrid Rice Programs

The political-economic set up in China and Vietnam, both formerly under the command-and-control system and are now undergoing economic transformation, gives opportunity for certain political and economic actors to benefit from the incentive schemes to promote hybrid rice. In China, it is clearly the innovatively-established public seeds enterprises and the public research institutions that set them up who are the clear winners in the country's hybrid rice program under the policy of "partial privatization".

In essence, the Chinese government and taxpayers pay for the research, development and even promotion of hybrid rice that the public seed enterprises sell to farmers at commercial price since all the direct subsidies for hybrid seeds have been removed in the spirit of free competition. Since the central government has limited the participation of purely private enterprises in seeds development and distribution, the benefits from the hybrid rice business actually accrue to the government in a limited sense and primarily to individual officials and personalities who now play the dual-role of public officials and businessmen in China's own blueprint for capitalism.

In Vietnam, research and development in hybrid rice is mainly in the hands of the public sector, while state-controlled enterprises, officially called private seed companies, take charge of the business end at the national level. At the local level, hybrid seeds commercialization is mainly the business of the provincial and district governments that control and operate local seeds enterprises. They distribute and sell seeds directly to farmers.

Under the policy of decentralization, the national government has removed direct subsidy on hybrid rice seeds while local governments are allowed to keep the support in their discretion for a limited time. In the name of assisting poor farmers to benefit from the promises of hybrid rice, local governments offer incentive schemes that in reality benefit themselves. With the removal of all subsidies for hybrid rice scheduled in 2005, purely private seed companies are coming into the picture at the national level. The development of new hybrid varieties from the public sector that yield high and produce good quality grains favored by farmers and consumers presents promising products for the private sector to sell.

In Indonesia, the benefits that the hybrid rice technology brings to any actor remain limited and do not hold much promise in the short-term. The private sector has not invested substantially in research and development of hybrid rice but has jumped into the bandwagon some years ago driven by projects funded by the FAO and the ADB. Except for the funds from international and regional institutions for the development of hybrid rice, the government has not actually invested substantially in the technology. Without public investments in research and development and with the continuing dismal performance of current hybrid rice varieties, the private sector will not put its stake in this business and will continue to wait for future prospects in the sideline.

Impacts of Hybrid Rice Programs

Hybrid Rice and Corporate Interest in the Rice Sector

Trends in Corporate Investments in the Rice Sector

The level of involvement of private corporations in hybrid rice is determined by the policy environment laid down by the government and the commercial potentials of the products developed by the public research sector. In China, the rice sector remains under the control of the government through the public seed enterprises. The subsidies and support given by the government to quasi-public companies keep private investors at bay. Private companies have so far not laid their stake in this business despite the huge domestic market for hybrid rice seeds and the potentials in the export market.

China's hybrid rice market remains a monopoly of the state, through the public seed enterprises that came from the public research sector. It breeds a different form of free competition among public enterprises which could also help lower the price, improve the quality of products and sustain research efforts. From a perspective of serving the public good, the scheme may seem fair and equitable. The public research institutions who developed the hybrid rice varieties are themselves involved in the commercialization and distribution, in a way, plowing back profits to the government. On the other hand, there is an anomaly in an arrangement when government funds are used to develop products that are sold back to the public at market price.

In Vietnam, hybrid rice promotion is happening when former state enterprises have been "equitized" with private sector investments but the control generally remains with the government. Unlike in China where the government maintains a strong hold on the vast pool of farmers who have mastered the science of growing hybrid rice seeds, Vietnam has a more limited network of producers thus its dependence on hybrid seeds imported from China. This gap presents a promising potential for the private sector in which they can play an active role in seeds production. In meeting the domestic demands, the private sector can build more facilities, acquire bigger lands, develop capacity and provide resources for the specific requirements in the production of parental lines. While private companies have started laying their stake in hybrid rice seeds production in Vietnam, they want the government to guarantee the profitability of their investment through exclusive licensing agreement over the use of promising public hybrid varieties.

Unlike in China and Vietnam, none of the national and transnational companies in Indonesia have made any substantial investment in research and development of hybrid rice, with their interest directed at commercial production and distribution. On the other hand, seeds and agribusiness companies will take many years to get hold of Timor Leste. There is no

domestic seeds industry and the domestic demand is weak. For now, the young country has unfortunately become a dumping ground for unwanted and even banned technologies coming from other countries, such as the banned pesticides imported from neighboring Indonesia. The absence of any regulatory framework and capacity makes the country an open playing field for any technology in seeds that come in by way of development aid extended by various donors.

Linkages in Corporate Interests on Seeds and Agri-chemicals

While most seed companies are not currently involved in hybrid rice technology, they are nevertheless increasingly interested in the rice crop which, not too long ago was not even considered commercially viable. Monsanto for instance, is interested in penetrating the rice seed market in Asia. The company is particularly interested in promoting hybrid seeds along with the promotion of direct seeding rather than transplantation for this will create market opportunity for its herbicides business in Asia. This trend, however, is not yet seen in the current realities of hybrid rice in China, Vietnam, Indonesia and Timor Leste.

In China, seed transnational companies have forged joint ventures with national seeds companies in more lucrative crops such as corn, soybeans and cotton, but not yet in rice which remains the domain of public enterprises. In Vietnam, the effort of BioSeeds to venture into commercial production of hybrid rice seeds developed by the public sector is considered as a logical expansion of its interest in hybrid corn.

Due to the long history of hybrid rice research and development in East Asia, especially in China, and the mastery of the science by more and more public research institutions in other parts of the region such as Vietnam and the Philippines, seeds corporations are not substantially investing in research and development but focusing more in marketing and distribution of existing varieties that have good commercial potentials. Corporate attention in hybrid rice is emerging in a context like Vietnam where the policy environment encourages private investment in the hybrid rice industry and where promising varieties with commercially-attractive traits beyond good yield have been developed by the public sector. The presence of these factors means less capital investment on the part of seeds corporations which can in turn offer their marketing resources and distribution network to widely commercialize these varieties. China and Vietnam instituted mature socio-political structures such as the commune that serve as top-down channels for marketing and distribution of seeds as prescribed by the national government. In countries with market economy like Indonesia which has no history of command-and-control system like China and Vietnam, the role of the government in the massive promotion of any technology is crucial.

National Hybrid Rice Programs and the Private Sector/Corporations

Historically, seed industries in developed countries have prospered by developing and selling hybrids. Today, about 40 per cent of the total revenues from commercial seed sales (estimated to total about US$15 billion) are generated through sales of hybrid seeds. It is then likely that the adoption of hybrid rice would make farmers dependent on external sources and thus, would greatly increase the role of the formal seed industries which, except in China, are comprised mainly of the private sector. While this may be theoretically sound and supported by past trends in the hybrid corn seeds industry, the current realities in the development of hybrid rice in East Asia cast some doubts in it.

Hybrid rice in the region is far from being a fledgling technology. And yet, it remains, principally a domain of the public sector, with the private sector's role limited to commercial production and marketing in countries where they are allowed to participate. Mastery of hybrid rice technology is almost exclusively limited to the public sector, with the private sector merely waiting in the wings for viable products to mass produce and sell.

A closer scrutiny of the history of hybrid corn shows the nuanced difference in the way hybrid rice developments are currently unfolding. The promotion of hybrid corn and its ultimate take over by the private sector was greatly facilitated by the crest of the Green Revolution and pushed by top-down, even authoritarian, governments that impose decisions on which agricultural technology to adopt. The current free market ideology under the WTO, on the other hand, limits the capacity of governments to extend direct incentives to promote any technology in the interest of fostering open competition. The inherent difference in the nature of corn and rice as crops also plays a role in determining the direction of how the development of hybrid technology unfolds.

Factors Influencing the Promotion and Trade of Hybrid Rice

Political Pressures: Rice as a Political Crop

The quest for technological solution to the lurking threats of hunger, and therefore political stability, is the main justification of countries that adopted hybrid rice. China led the way under centrally-planned economy where hybrid rice played a key role in increasing rice production that helped keep the social order and propelled the country in its current spot as a leading rice producer.

Vietnam, even as it occupies a safe seat as the world's top rice exporter, is also hounded by the specter of hunger because of its exploding population and the need to keep its competitive edge in the rice export market. Vietnam's interest in the technology is actually specific to the need to provide more food for the poor population in the mountainous regions in the north that share similar agro-ecological conditions as the hybrid rice regions of China.

Political pressures are less evident in Indonesia where the renewed interest on the hybrid rice technology happened at a time when democracy has gained substantial grounds. The interest of the government in the technology became even less enthusiastic as the country attained rice self-sufficiency in recent years with the dismal performance of hybrid rice varieties.

Trade Pressures: Role of Regional and International Trade Agreements

The free market paradigm opens up hybrid rice seeds trade and commercialization to the private sector. The governments encouraged the private sector to invest in bringing the technology to farmers. With the yield plateau currently being experienced in China and lackluster field performance of available hybrid rice varieties in other countries, the private sector is generally not enthusiastic about the prospects of the technology. Those that have put their stake in the business demand guarantees for profit-taking such as exclusive licensing agreements with public institutions that develop promising varieties.

The other aspect of trade regimes that promote seeds developed by the formal research sector including hybrids is the seeds standards adopted by countries in compliance with their international commitments. These standards are basically guided by the so-called DUS criteria (distinct, uniform and stable) as defined in international conventions. These, in practical terms, exclude the seeds selected and developed by farmers that are generally location-specific, have high rates of segregation and relatively unstable. In addition, the seed quarantine rules and certification standards adopted by governments basically exclude farmer-developed seeds from being commercially traded and exported.

Pressures from International/Regional Institutions

The FAO, ADB and IRRI undoubtedly played pivotal roles in the development and promotion of hybrid rice technology in East Asia. The examples of Vietnam and Indonesia clearly illustrate how the financial, technical and political muscles of international and regional institutions shape the development and direction of hybrid rice technology in a country.

The hybrid rice project funded by the ADB which was implemented in the years immediately following the completion of the FAO project, shows that a country need not request for funds and technical assistance for hybrid rice development for those graces to come. Vietnam and Indonesia are part of the network specifically created by IRRI to work with the project and serve as the pilot areas for the development and later, dissemination of hybrid rice in the region. Beyond the technical assistance extended to the member-countries in the network, the ADB project also explicitly aimed for the development of national seed industries that will actively participate in the

promotion and marketing of hybrid rice seeds to farmers. The emergence of private sector companies that engaged in the hybrid rice seeds business is in fact considered by the ADB as one of the major accomplishments of the project, meriting a follow up phase aimed at speeding up the dissemination of the technology in the region.

Regional/International Trade and Movement of Hybrid Rice

Trends in Hybrid Rice Seeds Trade

Official statistics rarely pay attention to the trade in rice seeds which is insignificant compared to the trade in rice grains as a commodity. Rice grain is traditionally traded more than the rice seeds, except when a country or region is in dire need of seeds for planting coming from other areas due to natural or man-made calamities. The introduction of hybrid rice in Asia, however, is changing that.

Since the potentials of the technology may be optimized only if new seeds are used in each planting season, it implies the need for an efficient seed industry that produces sufficient seeds for domestic use. In cases when the domestic requirements for hybrid rice cannot be met by local production, the national seed industry should be able to source out seeds from other countries. This case is similar to Vietnam where at least 80 percent of the hybrid seeds requirements are imported by state-controlled and private seed enterprises from neighboring China where a strong hybrid seeds industry can meet the demand. This would have been the case in Indonesia, too, had it not been for the difference in agro-climatic conditions. Imported hybrid rice varieties from China would be unable to thrive in the warmer and more humid environment of Indonesia.

Interestingly, the agro-climatic factor that deters directly exporting hybrid rice seeds from China to the tropical countries in East Asia is the same reason that motivates private enterprises in the Philippines to engage in hybrid rice seeds development and marketing. These private enterprises are planning to export hybrid seeds to other countries with similar conditions. From these emerging trends, barring agro-climatic, ecological and technological factors, hybrid rice clearly has the potential to give birth to a rice seeds industry in the region that could bring revolutionary changes in the future of rice breeding and development.

The developments and trends in hybrid rice performance and adoption in China would have far-reaching implications in the rest of East Asia. The rate of adoption and contribution of the technology to the overall rice production of China in the coming years are expected to steadily decline. The reasons for this are the yield plateau in most commercially available hybrid rice varieties, continuing challenge on the grain quality of hybrid rice and

the policy to give the farmers their individual responsibility to decide on their farm.

This may not mean the end of hybrid rice technology because hundreds of public enterprises involved in the hybrid rice business in China are interested in expanding their interest on to the export market. The only obvious limitation to this potential is the agro-climatic conditions that would bar Chinese hybrids from growing productively in other areas with more tropical climates. In the short-term, the countries in the Indo-China region at the doorstep of China are the most logical targets for aggressive marketing of Chinese hybrids. Other countries that have achieved some successes in the development of promising locally-adapted hybrid rice varieties, such as the Philippines and India, are already exploring export possibilities in other countries in the region with similar agro-climatic conditions.

Bilateral/Multilateral Partnerships in Hybrid Rice Promotion

Bilateral and multilateral collaborations facilitated by IRRI pushed for the development and dissemination of hybrid rice in East Asia. IRRI facilitated the bilateral arrangements between China and several countries in the region that explored the potentials of hybrid rice technology through transfer of parental lines, trainings and exchanges in expertise in hybrid rice research and development. The INTAHFOR formed the backbone of IRRI's project with the ADB on technical assistance in hybrid rice development and use in several countries in the region, namely Indonesia, Philippines and Vietnam, and later expanded to include Myanmar, Thailand and Korea in the second phase of the project. The project also actively involved the private sector in the seeds business through the participation of APSA in the network. INTAHFOR is a clear example of public-private partnership in seeds research and development. IRRI promoted it in recent years with funding from financial institutions like ADB that promote active private sector participation in agricultural development.

The knowledge- and skills-intensive nature of the hybrid rice technology actually necessitates bilateral and multilateral partnerships to attain the objectives of national programs initiated by the public sector. The state of hybrid rice technology and advancements in China prompted countries and companies interested in adopting the technology to establish bilateral cooperation in research and development with it.

Present and Future Implications of Rice Seeds Trade/Hybrid Rice Development on the Efforts of Small Rice Farmers in Adopting and Promoting Sustainable Agricultural Systems/Initiatives

Trends in Promoting Hybrid Rice Under Organic Farming Systems

There are no specific examples of hybrid rice promotion using organic farming systems in China, Vietnam and Indonesia, although there were some

informal accounts from China some years ago. Rather than being a deliberate strategy to promote hybrid rice under different farming systems, there are techniques in pest control and farm management associated with sustainable agriculture that evolved in the process of adopting hybrid rice technology in some countries. The effectiveness of such technologies in a local area inspired proponents of the technology to promote these in other areas with similar conditions. This was the experience of interplanting disease- and pest-susceptible varieties between rows of resistant hybrids from Yunnan and Sichuan provinces in southern China.

Courses of Actions on Hybrid Rice

Critical Elements for Civil Society Work on Rice Seeds Trade: Lessons from Hybrid Rice Experiences

Cross-border Issues in Hybrid Rice

The importance of looking beyond national borders in analyzing the trends and development in hybrid rice cannot be overemphasized. Developments in China would have impacts on the trends and future development of hybrid rice in other countries in East Asia. With the yield plateau experienced by hybrid rice varieties in China and the development of higher yielding and better tasting inbred rice varieties, public enterprises in China engaged in the hybrid rice business are looking beyond the country's borders to sell their products. Less competition in other countries where hybrid rice technology is still nascent and local rice scientists are unable to overcome the technical hurdles in hybrid rice development are opening up the market for imported seeds coming from China.

China's political and economic muscles in East Asia to sell hybrid rice seeds in countries with which it has forged trading relations, like Laos and the Philippines, cannot be underestimated. Vietnam is a different case because of its long history of relations with China and its shared border and agro-climatic features in the north. All these dynamics and developments should be considered in formulating any campaign surrounding issues in hybrid rice, whether at the national or regional level.

The Policy Environment

Experiences in China and Vietnam have clearly shown that the issues in hybrid rice that civil society organizations need to confront are not just technological but intricately linked with the socio-economic and political contexts in the country where the technology is promoted. The socio-economic and political developments in a country determine how the hybrid rice technology plays out and will impact on peoples' lives.

China has shown how the commune system under a command and control economy has facilitated the introduction and widespread adoption of hybrid rice among farmers who actually have no choice on the seeds that

they use since the decision is made for them by government authorities. Civil society fears the market economy will encourage the control over seeds in the hands of few transnational seeds corporations. Ironically, the experience in China showed that the opening up of the country to market economy weakened the clout of hybrid rice domination over farmers. They now have the choice on seeds to use and crops to grow.

In Vietnam, the revival of the government's fascination with hybrid rice happens at a time when the country was undergoing transition from centrally planned economy to liberalization. Despite this economic transformation and the shift of decision on agricultural production from commune to the households, the commune continues to wield power over farmers especially in the north where the Communist regime is well entrenched. In a free market economy, such political control, however, will lose its old strong power especially with the pressures to remove direct subsidies for hybrid rice.

The issue of government subsidies, however, as an incentive for farmers to adopt the hybrid rice technology should be seen as one of the many components of an overall political push for the technology. While it is true that the role of direct subsidies and economic incentives is crucial in the promotion and widespread adoption of hybrid rice technology, the removal of direct subsidies does not automatically adversely affect the promotion and adoption of hybrid rice technology, as shown in the cases of China and Vietnam. Direct subsidies in the form of seed support and input subsidy are the easiest opportunities for corruption at all levels, thus the reluctance of many government officials to remove it in the guise of altruistic pretenses such as aid for poor farmers, boosting food production, etc. such as what happened in Vietnam in recent years. Pressures from the forces behind market economy for the government to remove these direct subsidies in the name of encouraging open competition in the market and good governance, however, often facilitate the removal of these incentive schemes.

It is very important to note that the political and economic environments that promote hybrid rice are just some of the aspects of the entire debate in hybrid rice. While economic and political policies define the context of hybrid promotion, there are technological and socio-cultural issues that any civil society effort in the technology need to define. Groups working on the issue need to determine the tactical and strategic issues and in order to define the negotiable and non-negotiable elements in a campaign or advocacy effort.

Hybrid Rice and Development of Other Rice Breeding Technologies

Hybrid rice technology is just one of the arrays of modern technologies in rice breeding that are simultaneously being developed in East Asia. Among the most notable are the developments in new plant type (NPT) that in-

volves conventional breeding, and the more controversial developments in genetic engineering and nanotechnology. It is in rice genetic engineering, however, where Asian scientists have made some inroads in research and development that could dramatically shape the future of the rice sector.

Hybrid rice and genetically engineered rice are two totally different technological approaches in rice breeding, but their parallel developments should not be viewed as totally separate and mutually exclusive. As both work on the most important staple crop for the region and are usually done by scientists from the same public research institutions, their interrelated paths and implications should be studied by civil society organizations working on strategic issues in rice.

The recent development in China involving the commercialization of genetically engineered rice is an important case to illustrate this point. Groups working against genetically engineered bacterial-blight resistant rice (BB rice) and Bacillus thuringiensis (Bt) rice argue that there are available technologies, such as hybrid rice, that confer the same traits and deliver the same yields promised by genetic engineering, but do not pose the same threats to human health and the environment as genetic engineering.

There is clearly a need for groups working in the issues in hybrid rice to define the strategic and tactical arguments against hybrid rice and how those link with the campaign against GE rice. This interconnection cannot be avoided since these technologies play out in a context where both are being used as technological options to attain food security and are usually pushed by the same proponents.

The nature of the technologies involved and the fact that there are technology options outside of those produced by the formal research systems, namely technological systems and traditional knowledge evolved by farming communities pose a serious problem. The potential adverse impacts posed by GE rice on human health, the environment and the genetic diversity of rice in East Asia are no longer doubted. More importantly, these potential adverse impacts of GE rice cannot be confined to the country that develops or sells the technology but equally important for the rest of the world that receives the technology and its product because of the inherently hazardous nature of genetic engineering.

Beyond GE rice, the interrelation and links of hybrid rice with other technological breakthroughs need to be carefully considered. While the recent advances in conventional breeding such as NPT could be seen as an opportunity to marginalize hybrid rice in the future, there are already research efforts in China and Vietnam to develop new hybrid varieties that utilize NPT as parentals. This trend clearly shows that technological options are not mutually exclusive and links between these parallel developments needs to be consciously analyzed.

The advances within hybrid rice research and development themselves should merit careful analysis, especially how they affect the tactical and stra-

tegic objectives of any civil society effort in rice seeds trade in general and hybrid rice technology in particular. Careful attention should be paid to the notable advances in public research institutions outside China in the development and releases of hybrid rice varieties that do not only yield higher but possess key traits preferred by farmers and consumers such as resistance to major pests and diseases, and good grain quality. Breakthroughs in the use of NPT as parentals in hybrid rice development are also worth analyzing as this may hold the key to address the most difficult technological hurdles faced by hybrid rice at present such as high seed costs and climate-specificity. All these development may bear considerable influence in the future adoption of the technology among farmers and the long-term direction of rice seeds trade in the region which could work against the interest of small-scale farmers.

Consortium Campaigning and Advocacy

Civil society organizations campaigning against hybrid rice should consider adopting a parallel mechanism to the consortium-type partnerships adopted by public research institutions in the region involved in research, development and promotion of hybrid rice. While these public research consortia often have the backing of international research institutions such as IRRI and multilateral financial institutions such as ADB, civil society organizations can count on their broad network and strong mass base as their principal asset. The East Asia Rice Working Group (EARWG) is one model for a civil society consortium-type vehicle for campaigning and/or advocacy around tactical and/or strategic issues in rice trade issues in general and for hybrid rice technology in particular.

Recommendations in Advancing Sustainable Agriculture in View of the Analysis of Trends in Hybrid Rice

Any civil society campaign or advocacy in rice seeds trade in general and hybrid rice in particular should be anchored on an overall strategy that promotes clear, concrete and viable alternatives to the current paradigms and dominant technologies in rice research and development. The promotion of sustainable agriculture, however, should carefully fit in the analysis of the developments in the region as well as the civil society positions with regard to rice seeds trade and technological options.

Civil society efforts around hybrid rice should be very clear on the elements of hybrid rice that civil society is opposing or fighting against and to which the alternative is sustainable agriculture. The key challenge for civil society is to show the economic viability of sustainable agriculture in providing livelihoods to farmers and ensuring food security.

The issue of technological options should also be addressed. Civil society calls should be more strategically geared towards providing infrastructure, financial and social support to farmers for agriculture to become eco-

nomically viable and sustainable. However, such call involves dilemmas for civil society to address. "Leveling the playing field" in terms of agricultural support to farmers would help realize the farmer's right to decide on farming technologies to adopt in their farms. On the other hand, this may not necessarily benefit the common good or may even be detrimental to the common good such as the case of genetically engineered crops. This requires more thorough studies to prove that some technological options simply cannot co-exist, such as the case of organic agriculture and genetically engineered crops.

With regards to strategies and approaches in advancing sustainable agriculture in a context where the public sector and private interests have joined hands to push for questionable technological options in rice research and development, civil society organizations should be able to clearly define the means to advance their arguments and proposals. How campaigns and policy advocacy can effectively work to deliver clear messages promoting sustainable agriculture, outlining well-founded arguments on issues and developments, and presenting concrete proposals and options, is a challenge that civil society organizations like EARWG need to address.

I.
Regional Overview: Background on Hybrid Rice in East Asia

a. General Overview of Rice Production and Trade in East Asia

Rice plays a vital role not only in the consumption but also in the economy of East Asia. As a staple food, it accounts for a major share of cereal consumption ranging from 67 per cent in the Philippines to 97 percent in Myanmar. In Southeast Asia, it contributes about 30-60 per cent of the total daily calorie intake.[1]

Aside from being the staple food, it is the source of livelihood of about 250 million farmers across Asia. Most of these are subsistence farmers cultivating an area of less than one hectare. In fact, rice farming has been called "the single most important economic activity on earth" as it provides more "employment" than any other industry or agricultural activity.[2]

The value of rice is inextricably imbedded in the culture, tradition and practices of the peoples in Asia. Rice is also widely regarded in the region as a "political crop" in view of the far-ranging impact on political situations of the trends, changes and policies concerning rice prices, supply and demand situation in many rice-producing countries.

The growth of rice production has been in a general slowdown during the last 10-15 years. This was reported to be mainly due to significant decline in yield and area growth rates in the region. For instance, there has been a decline of four million hectares in rice plantings in China since 1991-92. The decrease in rice areas in Japan was 0.38 million hectares and 0.12 million hectares in South Korea.[3]

A large body of literature attributed the overall decline in rice production to the so-called "yield plateau" of most high-yielding varieties promoted during the glory years of the Green Revolution. Also, the demand for rice in the region has been observed to have slowed down primarily because

1. Janaiah et al 2002
2. Barclay, 2004
3. Brookes and Barfoot, 2003

of the increased diversification of diets in more affluent developing countries such as South Korea, Thailand, Malaysia, Singapore and Taiwan.

On the other hand, there are notable expansion of areas under rice cultivation in some countries in the region such as Myanmar with the biggest expansion area at 1.7 million hectares, Vietnam, Indonesia, Thailand and the Philippines. Projection estimates indicate that Asia in general, will continue to have a net surplus of about 16.4 million tons of rice in 2025, despite the population growth.[4]

Thailand, Vietnam and China remain the top largest rice-exporting countries in the world along with the United States, India and Pakistan. From 1991 to 2001, exports from Vietnam increased three-fold while that of Thailand has virtually doubled. In addition, Myanmar has exported 0.5-0.7 million tones more rice during this period despite the trade ban imposed by many European countries on the military regime.

On the other hand, the main rice importing countries in the region are Indonesia, Malaysia, the Philippines and Japan. The current trend is a considerable change from the 70s and the 80s when countries like the Philippines used to export rice while Vietnam was a net importer, especially in the aftermath of its war with the US. In the last couple of years, Indonesia has attained rice self-sufficiency level and even aspires to recoup its former role as a rice exporter.

The significant changes in rice production and trade are generally attributed to weather-related production shortfalls, increasing populations, rising income levels, and the impact of international trade regimes.[5] In recent years, however, technological breakthroughs in rice research were seen as a critical factor that could influence the patterns of rice production and trade in rice-dependent Asia. This analysis largely stemmed from the experience of China where hybrid rice is regarded to have played a pivotal role in its rice self-sufficient status and exporting capacity in the face of a continuously burgeoning population.

In the past, the technological advancements in rice breeding that gave birth to the Green Revolution phenomenon have also been hailed as a determining factor in international rice trade. But as the so-called high-yielding varieties suffered from yield failures and the adverse impacts of high-input farming systems were slowly unmasked, that assertion has lost credence. After all, the Green Revolution technology has failed to make any impact on the most marginalized farming communities where high-input and irrigation-dependent technologies are beyond the reach of resource-poor farmers.

The phenomenal success of hybrid rice in China since the 70s and the fact that the technology was developed and nurtured by Chinese public research institutions have caught the attention of the world gripped with a

4. Sombilla et al, 2002
5. Brookes and Barfoot, 2003

specter of food scarcity in the face of increasing population in developing countries, especially in Asia where one-third of the world's population live. Some analysts look at hybrid rice as the next wave of the Green Revolution technology in the midst of corporate-backed promotion of genetically engineered rice and the humane-face of the so-called Gene Revolution. Some assert that hybrid rice and genetically engineered rice are two faces of the same coin aimed at consolidating corporate control over rice genetic resources that will rob farmers of their traditional rights to seeds.

Rice, for one is traditionally traded internationally as grain for consumption, animal feed and processing, but rarely as seeds for sowing. Modern rice varieties are all inbred varieties with seeds that can be produced locally and can be reused by farmers every planting season. Largely because of the extensive knowledge of Asian farmers in on-farm breeding and improvement of rice, very little rice is traded internationally as seeds that these are not often reflected in official statistics.

In hybrid rice technology, however, hybrid vigor is only optimally expressed in the first filial generation and substantially deteriorates in succeeding generations, thus farmers will have to buy new seeds every planting season. Hybrid technology therefore makes rice seeds production a potentially lucrative industry for agribusiness, thus has the potential to change the landscape of rice production and marketing overtime.

The study will look closely at these assertions and the ensuing debate in the context of Asia by studying the specific experiences of China, Indonesia, Timor Leste and Vietnam in research, development and commercialization of hybrid rice. The succeeding sections of this study will analyze the trends and developments in the introduction of hybrid rice in East Asia, focusing on the real and potential impacts on small-scale farmers in the region. The analysis will focus on the impacts of hybrid rice on the traditional right of farmers to save, use, exchange, share and sell farm-saved seeds, as well as the farmers' right to make decisions in their farms and participation in agricultural development in general. By closely looking at these trends and developments, the study hopes to provide a framework for civil society organizations and farmers' organizations to address the challenges brought by hybrid rice in different contexts and conditions across East Asia.

b. Hybrid Rice and Its Development in the East Asia

The term *"hybrids"* refers to the first generation offsprings of a cross between genetically different parents of the same plant species. Hybrids usually express a phenomenon called *heterosis* (also known as *hybrid vigor*), or the tendency of offsprings to perform better than either of the parents in one or more physical or agronomic traits, particularly in terms of yield. However,

the expression of hybrid vigor substantively decreases in succeeding filial generations, thus reusing hybrid seeds after each harvest is not recommended in all crops. Since its discovery, *heterosis* has been exploited to produce crops with traits that have high commercial value, especially in terms of higher yields.

The development of hybrids in rice did not come as easily as corn and some commercial vegetables, all of which are cross-pollinating crops. Rice is a self-pollinating crop although out-crossing (usually less than one per cent) does occur.[6] Because of its nature, extra efforts must be exerted to transfer the pollens from one variety or line to another in order to produce a heterozygous hybrid. At present, hybrid seed production is based on male sterility systems. The most popular male sterility system used to develop and produce first filial generation (F_1) hybrids is the *cytoplasmic-genetic male sterility* (CMS) system. Other tools like thermo-sensitive genic male sterility (TGMS) and photo-sensitive genic male sterility (PGMS) systems are also available and are currently utilized commercially although not as widely as the CMS system especially in the early years of hybrid rice research and development.

A CMS system, to describe, is a mechanism by which a cytoplasm causes male sterility in rice through an interaction with the nucleus. The system is also known as the *three-line* system indicating that it requires three lines of rice to produce an F_1 hybrid - a CMS line, a maintainer line, and a restorer line. A CMS line is a stable sterile plant with sterility-inducing cytoplasm and acts as the female parent in hybrid seed production. A maintainer line is similar to a CMS line except that it has normal cytoplasm and hence, has viable pollen grains and exhibits normal seed setting. It is used as a pollinator to maintain a CMS line. A restorer line on the other hand, restores the fertility in the F_1 when it is crossed to a CMS line and is used as the male parent.[7]

The TGMS and PGMS systems are also becoming popular as a genetic tool in hybrid seed production. The TGMS lines are sterile lines that revert back to fertility under certain temperature conditions while the PGMS lines regain their fertility under certain photoperiods or day-lengths.

Since these methods do not require a maintainer line and any fertile line can be used a pollen parent, they are called *two-line systems*. The PGMS system is recommended for use in temperate regions where striking day-length differences exist during the rice growing season, whereas the TGMS system is more advantageous under tropical conditions where day-length differences are marginal and temperature differences between low and high altitude are more pronounced.[8]

6. Beachell et al 1938 as cited by Coffman and Herrera, 1980
7. www.philrice.gov.ph
8. Virmani, 1996

Another advantage of this system over the CMS is that the choice of parents in developing heterotic hybrids can be broadened since P(T)GMS genes can be easily transferred into any rice lines with desirable characteristics. In addition, the dominant cytosterility situation of wild abortive (WA) type used in the CMS system, can be avoided ensuring that no negative effects will result from this sterile cytoplasm.[9]

Scientists are trying to develop another system referred to as the *one-line system* for hybrid rice seed production. This system will make use of a mechanism in plant called *apomixis* or the production of gametes without fertilization. Apomictic plants are capable of producing seeds asexually, that is, without the union of male and female reproductive cells. Therefore, the seeds are clones of a single parent plant.[10]

The goal here is to fix heterosis in rice hybrids so that no segregation and subsequent decreases in yield will occur even if farmers use the reproduced seeds from generation to generation. Researches are currently being conducted to incorporate apomictic genes into the rice hybrids but have so far yielded no confirmed report of apomixis in rice. Notably, public rice research institutions, including the International Rice Research Institute (IRRI), do not devote as much resources in studying apomixes in rice as they do for hybrid research and development.

The demonstration of heterosis in rice has been observed as early as 1926.[11] However, hybrid rice research began in China only in 1964 and began to bear fruit in the 70s.[12] This intensified after the discovery of a male sterile plant in a wild rice population. After identifying the genetic mechanism controlling male sterility in rice, the first CMS line was developed in 1972. The first commercial hybrid rice was developed and was made available to Chinese farmers in 1976.[13]

At the time the first hybrid rice were made commercially available in China, however, East Asian countries were dazed with excitement over the breakthroughs in rice breeding coming out from the newly established IRRI under the optimistic banner Green Revolution. The Green Revolution technology introduced the modern high yielding varieties which, like the promising hybrid rice, were touted as the solution to increase rice production in the region and stem the tide of Communist insurgency resulting from rice shortages in the rural areas across the region.

IRRI developed and released the first "miracle rice", code-named IR-8 in 1966. It brought significant yield increases in rice production with an average yield of around 10 tons/hectare. IR-8's genetic potential has been so

9. Yuan, 1998
10. Kuyek, 2000
11. Jones, 1926 as cited by Virmani, 1996
12. Virmani and Kumar, 2004
13. Pingali et al, 1998

dramatic that it has never been surpassed by subsequent modern varieties developed by IRRI.[14]

Rice yields from a series of high-yielding varieties dramatically increased in the 60s to the 80s. Complemented by massive support and assistance from national and international agencies, rice production in Southeast Asia rose from about 50 million tons in 1966 to about 140 million tons by 1999 with an annual growth rate of 3.2 per cent, even outpacing the 2.2 per cent annual increase in population growth.[15]

In the 80s, however, the growth in rice production and yield slowly declined in many countries in the region, leading many rice experts to believe that the so-called "miracle rices" have reached their "yield plateau" which is the optimum yield potential that a variety can deliver over time within specific agronomic conditions. The fact that the Green Revolution has failed to reverse hunger and food insecurity in many countries in East Asia despite the hype over "miracle rices" and millions of dollars poured by the international donor community on IRRI's rice breeding efforts, governments and IRRI were pressured to find other breakthroughs to increase rice production and break the rice yield barrier. This time, all their attention focused on hybrid rice, having performed phenomenally in China for over three decades while the Green Revolution was raging in the rest of the region.

The developments in hybrid rice in China encouraged IRRI to explore the potentials and challenges of the technology outside China. In collaboration with the Chinese Academy of Agricultural Sciences (CAAS), IRRI organized training courses on hybrid rice technology as early as 1980 and 1981 to train scientists from several Asian countries.[16] The next few years have been an assessment of the potential of this new technology particularly in irrigated environments outside China.

The first commercial hybrid rice outside China and developed by IRRI was released in Vietnam in 1993. This has been subsequently followed by limited releases in India and the Philippines.[17]

Because of the need to develop their own hybrid lines, many countries have initiated their own hybrid rice research activities. By 1998, the Asian countries that carried hybrid rice research in their agricultural programs include Korea, Philippines, India, Indonesia, Republic of Korea, Vietnam, Malaysia, Thailand, Japan, Sri Lanka, Bangladesh and Pakistan.

Governments' interests on hybrid rice intensified as the Green Revolution varieties suffered failures from pests and disease infestations, erratic weather patterns, soil degradation and the massive reduction of government support to agricultural programs in general as a result of the structural ad-

14. Kuyek, 2005
15. Janaiah et al 2002
16. Yuan et al 1987
17. Virmani, 1998

justment programs imposed by international financial institutions. The rapid industrialization of agriculture in East Asia from the 80s to the present also affected the delivery of the promises of the Green Revolution varieties as high-value commercial crops became the priority of government agricultural problems and rice areas were converted to industrial crops and other uses. The search for an alternative to the declining "superstar varieties" is now focused on varieties that produce more in less land areas to feed more people.

c. Review of Studies and Existing Literatures on the Status of Hybrid Rice Policies and Trends Across East Asia

Most of the countries in Asia that adopted hybrid rice cited the need to provide food for the expanding population as their main reason for adopting the technology. The projection was an increase by 50 million people annually in the region's population in the next few years and this means more mouths to feed.[18] Since rice remains the staple food of Asia, it is therefore imperative to utilize technologies that would ensure more food that concretely translates to more rice.

More than two decades after the first discovery and development of hybrid rice in China, the technology has been widely tested and acknowledged in the region. In East Asia, the Philippines and Vietnam are the leading countries in the region in terms of commercialization and releases of local hybrid rice varieties. Other countries like Myanmar, Indonesia, Thailand and South Korea, are starting their evaluation and assessment of the technology but notably slow in promotion and adoption.

National governments are already pouring out resources for investments in research, training and facilities specifically for hybrid rice. For instance, Indonesia's national allocation for hybrid rice research increased four times to Rp.15 billion while that of Vietnam augmented from US$13,000 per year in 1999-2000 to US$70,000 for research and development and US$589,000 for seed production in 2001.[19] The Philippines' budget for research and commercialization of hybrid rice has also dramatically increased from barely PHP8 million in 1998 to PHP171 million in 2001.

The Asian Development Bank that funded a regional program on research, development and promotion of hybrid rice in 2001 in Myanmar, Indonesia, Philippines, Thailand and Vietnam, intends to increase hybrid rice area in Asia (excluding China) to about two million hectares by 2006-2007, as cited by Sombilla et al in 2002. Table 1 (next page) sums up the status of hybrid rice research and development and its adoption and commercialization in several countries in East Asia.

18. Sombilla et al 2002
19. ibid.

Table 1. Status of Hybrid Rice Technology in Some East Asian Countries

Country	Hybrid rice research and development	Hybrid rice adoption and commercialization
Vietnam	Appropriate hybrid rice varieties being developed locally, mostly public sector initiative.	Active private-sector involvement in seed distribution. Hybrid rice sees are mostly imported.
Philippines	Local hybrid rice varieties developed and cultivated. Strong government support in research and technology development and commercialization.	Increasing participation of private sector in seed production and dissemination. Strong government support in technology dissemination and adoption.
Myanmar	Strong government support to strengthen hybrid rice research for the development of appropriate varieties. Human resource development through training.	Primarily public-sector responsibility. Commercialization pending development of high-quality varieties and reduction of seed production cost.
Indonesia	Appropriate hybrid rice varieties being developed for wide-scale cultivation in on-farm trials.	Limited private-sector involvement. Imported seeds for on-farm trials.
South Korea	Japonica hybrid rice varieties from new restorer lines being developed for testing on experimental farms. Hybrid rice varieties to be further improved for better eating quality.	On-farm demonstrations to be established primarily by the government.
Thailand	Restarting hybrid rice research and development for appropriate varieties	Dialogue between government and private sector to be conducted

Adopted from Sombilla et al,2002

While academic studies on hybrid rice claimed the steadily increasing adoption of the technology in many countries in East Asia, reports from the Genetic Resources Action International[20] indicated there is no significant increase in the overall hybrid rice area in East Asia since 2000. China remains the biggest producer of hybrid rice not only in the region but also in the world but the area devoted to hybrid rice has been declining since 1997 and remains confined to the southeast and south central parts of the country. Chinese scientists attributed the decline of hybrid rice hectarage to the recent advances in conventional breeding that produced promising inbred varieties even surpassing the yields of the best hybrid rice varieties available in the market.

Despite years of research, hybrid rice technology still remains in initial stages in most countries in the region such as Malaysia, Indonesia, Lao PDR and Myanmar. GRAIN noted that there is no market for hybrid rice in Thailand, one of the region's leading rice producers, largely because Thailand's edge in the export market remains to be its well-known jasmine (hom mali) varieties that are generally improved traditional varieties. Only Vietnam and the Philippines have so far shown major increases in hybrid rice production in varying degrees and in particular conditions. Yet hybrid rice production in Vietnam is confined to the North and still dominated by seeds imported

20. GRAIN, 2005

from China. Meanwhile, hybrid rice production in the Philippines is heavily supported by state subsidies. Table 2 shows the production of hybrid rice in Asia.

Table 2: Production of Hybrid Rice in East Asia

Country	Area cultivated with hybrid rice (ha)			Hybrid rice as % of total rice area
	1997	2001	2003	2003
China	17,708,000	15,821,000	15,210,000	52%
Vietnam	187,000	480,000	600,000	8%
Philippines	500	90,000	107,000	3%
Burma	0	10,000	unknown	-

Adopted from GRAIN, 2005

II.
Issues in Hybrid Rice

A number of issues confronting the hybrid rice technology range from technological to socio-economic, that are at the center of current debates on the merits of the technology across East Asia and even in the international scientific circles. A general overview of these debates and the different facets of the issues involved are presented in this section.

a. Technological Debate

The technological debate surrounding hybrid rice revolves around questions inherent in hybrid technology itself as applied to rice. A number of these issues are raised on hybrid technology in general as applied to any crop, while some are specific to rice with its unique nature as a self-pollinating crop.

Debate on hybrid vigor

One major critique on hybrid rice is the genetic basis of producing the technology itself. Although the phenomenon of heterosis has been extensively exploited in other crops and the occurrence of superiority of the hybrids over their parents in many crops is evident, the scientific explanation of heterosis remains unresolved. Some scientists doubt the existence of heterosis particularly in self-pollinated crops like rice. Jean--Pierre Berlan of the Institut National de la Recherche Agronomique in France for instance, believes that while rice may demonstrate some hybrid vigor, this phenomenon is actually *inbreeding depression*. Berlan concludes that stable inbreds resulting from repeated backcrossing and use as parents of hybrids suffer from inbreeding depression that when they are crossed, they are able to recover and hence, the resulting progeny or the hybrids appear to surpass the yield of their parents.[21]

21. Kuyek, 2005

Another study that questioned the soundness of using hybrid rice over inbred rice is that of Ntanos and Rousakis in 2003 following the suggestion of Fasoulas in 1993. The study said inbred vigor may be more advantageous than hybrid vigor or heterosis in self-pollinated crops with a low load of deleterious genes. They were able to prove that heterosis in rice is fixable by producing superior recombinant inbred lines from commercial F_1 hybrids with yielding ability and quality equal to or higher than the F_1 hybrids. Ntanos and Rousakis concluded that hybrid rice can be used only as an intermediate step for breeding even better inbred cultivars but not as a breeding goal itself. This result contradicted the study of Virmani in 1996 suggesting that heterosis is not fixable as demonstrated by the less recovery of heterosis in doubled haploid lines and the insignificant increase in rice grain yield resulting from conventional pedigree breeding during the past three decades.

Labor-intensive technology

In terms of utilization of the technology, the use of the CMS system in producing hybrid seeds is widely acknowledged as labor intensive. In fact, hybrid rice seed production requires about 30 per cent more labor or 100 workdays per hectare than the seed production of improved varieties. n North Vietnam for example, F_1 seed production needs 400 to 500 workdays per hectare.[22]

The labor-intensive requirement in hybrid rice multiplication and production means additional costs for farmers involved in seed production, especially in countries like Malaysia and Indonesia where the rural wage rates are high. On the other hand, the same situation might be advantageous for countries with high land-labor ratio like Vietnam and China as this could create rural employment opportunities and additional income for farmers. But the logical end result for both situations is higher costs of seeds sold in the commercial market, thus increasing the input costs for farmers using hybrid seeds.

Knowledge intensive technology

Aside from being labor-intensive, hybrid rice seeds development is also complex and knowledge-intensive. In seed production, for instance, the planting time of both male (pollen parent) and female (seed parent) plants must be carefully planned to synchronize with the flowering period to ensure successful pollination and attain higher yield. This is usually done by determining the maturity period of the two parents and planting the parent that matures longer ahead of the other parent. It is worth noting that for a hybrid rice production to succeed, a sufficient number of pollen grains must be deposited in the stigma lobes of each spikelet of the seed (male sterile) parent.[23]

22. www.fao.org
23. Virmani et al 2002

A specific number of rows are also required for both male and female plants and the ratio would depend on the weather, management practices in the particular area where the seeds are produced and even the parental lines used.[24] Because of the knowledge and rigor involved in hybrid rice seeds production, the older and educated farmers in Vietnam have adopted the technology more than the others. They have the patience and rigor to go through the meticulous steps involved in the breeding process.[25]

Risk of cytoplasmic uniformity

At present, despite the identification of various new CMS lines in rice, none are as effective and as responsive as the wild abortive (WA) type. Hence, rice breeders tend to deploy this CMS system more frequently than other CMS lines. Zhou (1994) as cited by Virmani (1996) observed that 87.9 per cent of the commercial hybrids in China are still based on the CMS-WA cytoplasm. Since these hybrids share common genetic heritage, they are vulnerable to catastrophic diseases or pest epidemic.

Recent history on the devastation of hybrid crops due to pest susceptibility of uniform parental lines raised alarm on this danger in hybrid rice. The Texas-cytoplasm for male sterility associated with susceptibility to *Helminthosporium maydis* in hybrid maize resulted to the southern maize blight epidemic in the 1970s that entirely devastated the North American maize crop.[26] To avoid the same fate, IRRI scientists are working to develop CMS lines possessing diverse cytoplasmic and nuclear backgrounds from wild and cultivated rice.[27]

The availability of restorer lines is another issue on the soundness of the technology. Although fertility restoration is not a constraint in developing commercial rice hybrids in *indica* rice, it is a problem in japonica rice. Most *japonica* rice are non-restorers and therefore, require restorer gene(s) to be incorporated into them from indica rice. However, this entails a long breeding process, and consequently, the genetic diversity of *japonica* restorers is limited only to the resulting lines. Thus, heterosis in japonica would be weaker compared to *indica* rice hybrids.[28]

Irrigation dependence

Hybrid rice cultivation is designed for irrigated environments. In fact, Pingali et al (1998) emphasized that the size of irrigated rice area and the availability of labor are the two major factors that determine the demand for hybrid rice technology in any country. The experience of China clearly illustrates this assertion, where hybrid rice is grown exclusively in irrigated area and where the shift from conventional varieties to hybrid seeds, from the point of view

24. www.philrice.gov.ph
25. Hossain et al 2003
26. Pingali et al 1998
27. Virmani, 1996
28. ibid

of farmers in irrigated areas, involves only a change in seed types without requiring much change in farming systems.

Cultivating hybrids in upland or rain-fed rice ecosystems would not only mean changing the seed, but also the type and quantity of inputs used and the cultivation practices. This implies fundamental alteration of the entire farming system.[29]

Notably, irrigated areas comprise only a small portion of the total riceland in many countries in East Asia. Unless existing irrigation facilities are improved and new ones are built, this technology will not be advantageous for the majority of farmers particularly those in marginal areas and in upland ecosystems.

On the other hand, some studies in Egypt revealed that hybrid rice exhibited better heterosis in unfavorable soil and climatic conditions such as saline soils and upland ecosystem than in favorable irrigated rice conditions. In fact, hybrid rice surpassed the yields of inbred varieties by 35 percent under saline conditions.[30]

Yield plateau

There were observations in recent years that the yield level from hybrid rice has already stagnated, particularly in China where it was first introduced and widely commercialized over the past three decades. This could be an indication that the yield plateau for hybrid rice has already been reached. Unless new methods and materials are developed and adopted, the technology, like the high yielding varieties of the Green Revolution era may no longer be viable in the future.[31]

b. Economic Concerns

Beyond the questions on the inherent nature of hybrid rice technology, the concerns on the multi-faceted spheres affected by the technology and its products once it is released into the environment and adopted by farmers are equally controversial. The key economic concerns on hybrid rice are outlined in this section.

Location-specific performance

Hybrid rice technology is promoted as a viable option to increase rice yields globally largely because of the reported average yields that are about 20-25 per cent higher than the inbred high yielding varieties, thus contributing towards higher on-farm productivity.[32] However, the value of these yield increases seems to vary depending on location.

29. Pingali et al 1998
30. www.fao.org
31. Yuan, 1998
32. Virmani et al 2002

A farm-level study conducted in the Jiangsu province of China during the 1984 crop season showed only 15-16 per cent yield advantage of hybrid rice varieties over their inbred counterparts.[33] On the other hand, a comparison of the average yield of hybrid rice and conventional rice varieties grown in China from 1981-1990 showed as much as 29 to 49 per cent yield advantage of hybrids over inbreds.[34]

Lower net returns

Increases in yield and production, however, do not automatically translate into higher net profits across different contexts and conditions as shown by several studies conducted and actual experiences of farmers in the field. A study in Bangladesh showed that cultivating hybrids was more profitable than inbreds but the difference was not statistically significant. In India, the use of hybrids resulted to lower net returns despite the fact that hybrids yielded higher than the inbreds, largely due to the significantly higher cost of hybrid rice seeds. These experiences are in contrast with the conclusion of Hossain et al (2003) that hybrid rice cultivation is substantially more profitable compared to inbred high yielding varieties.

Poor grain quality

One major reason for the low net returns from hybrid rice production, that is a key drawback in hybrid rice seed dissemination and utilization, is the inferior quality of grains from hybrid varieties compared to inbreds. As one Chinese rice breeder admitted, it is very difficult to a develop rice variety that yields high and has good grain quality since these two traits have conflicting relations in genetics.[35]

Inferior quality grains – with poor eating quality, not aromatic, tasteless and poor storage quality – obviously command lower price in the commercial rice market. In Vietnam, for instance, hybrid rice sells around 3-5 per cent lower than inbred varieties in the local grains market. A study conducted in Vietnam revealed that 42 per cent of the sampled households do not use hybrid rice for human consumption but as feeds for livestock, especially for pigs. Of the 52 per cent who sold hybrid rice in the domestic market, 51 per cent admitted that they deliberately sold their produce using an inbred name to avail of the higher price paid for inbred varieties. However, in some countries like the Philippines, public research institutions and private companies have already developed hybrid rice varieties with comparable or better eating quality than other popular inbreds available in the market.[36]

33. He at al, 1987 as cited by Virmani, 1996
34. Yuan et al 1994 as cited by Virmani, 1996
35. Jiang, 2006
36. www.philrice.gov.ph

High seed costs.

Rice cultivation using hybrid rice seeds is much more expensive than using inbred materials. Hybrid seeds cost at least five times higher than ordinary rice seeds and even certified varieties. In Vietnam, for example, hybrid seeds are sold at US$1.21 per kilogram as compared to only US$0.22 per kilogram for the inbreds. Proponents of hybrid rice argue that the high seed costs is compensated by the fact that hybrid rice cultivation requires less seed rate, which is about 39 kilograms per hectare compared to the 109 kilogram per hectare requirement of inbred seeds.

However, seed cost is only a small component of the total costs of rice production. A more substantial expense that conventional rice farmers incur in production is the cost of chemical fertilizers. Comparatively, hybrids require more fertilizers than inbreds, as observed in Vietnam. The fertilizers used in hybrid cultivation accounted for about 16 per cent of the total cost of cultivation and 11 per cent of the gross value of output, that is around 14-19 per cent higher than in inbred cultivation.[37] In China, however, despite the high production costs of hybrid rice cultivation, the high yielding ability of hybrids allowed increased production from the same piece of land which enabled Chinese farmers not only to meet their grain quota but also to generate a surplus that can be sold in the open market at favorable prices.[38]

Another reason for higher cost of hybrid seeds production than inbred varieties is gibberellic acid (GA_3) that is an essential input in F_1 seed production. It is expensive and largely imported from countries where the substance is produced in commercial quantities. GA_3 is sprayed using a knapsack sprayer on the parental lines as part of the management system to improve panicle exertion and increase the relative height of the pollen parent over the seed parent. Spraying begins when 5-10 per cent of the rice plants are at the heading stage and lasts for two to four consecutive days.

In China, hybrid rice seed producers use very high dosage of GA_3 at 150-300 gm/ha to ensure high seed yields. Since China produces GA_3 domestically, the price of the substance is relatively cheaper at US$0.30 per gram compared to other countries that import this substance at more than US$1.00 per gram.

The high cost of GA_3 is a major limiting factor for seed growers outside China where the average dosage has to be reduced to only 45-50 gm/ha to reduce the production cost. The International Task Force on Hybrid Rice (INTAFOHR) has in fact, identified this problem and has recommended policy interventions, giving particular attention to the pricing, local manufacture of GA_3 and/ or substitution with alternative chemicals.[39] So far, none of these measures has contributed to significantly reduce the market price of GA_3.

37. Hossain et al, 2003
38. Pingali et al 1998
39. Virmani et al 2002

Higher labor costs

Hybrid seeds production requires additional labor for extra farm operations such as thinning and row planting, supplementary pollination, filling gaps, rouging, GA3 application, manual harvesting, threshing and cleaning. In the Indian states of Andhra Pradesh, Karnataka and West Bengal, the additional labor required in growing hybrid seeds actually constituted about 48 per cent of the total cost of hybrid rice seeds.[40] This explains the significant difference in the price of hybrid rice seeds compared to inbred varieties.

On the other hand, proponents boast about the potential growth of a local seed industry resulting from the contribution of seed companies in the commercialization of hybrid rice which is seen as an opportunity to create additional rural employment.

c. Socio-Cultural Impacts

Outside of the economic sphere where the most immediate and obvious concerns on hybrid rice are found, there are a number socio-cultural issues that confront the technology as well, especially as it begins to be widely promoted in many countries in East Asia.

Impact on the traditional rights of farmers to save and reuse seeds

Since rice is a self-pollinating crop, inbred rice varieties that are traditionally used by farmers can be used year after year without necessarily observing segregation and experiencing decreases in yield. As their forefathers have done through generations, farmers can therefore rely on their own resources to multiply, select and reproduce inbred rice seeds.

In contrast, hybrids do not truly breed when reused repeatedly and lose the yield advantage in subsequent generations. This shift in practice has long-term and far-reaching implications on on-farm seed production with farmers having to buy new F1 seeds every season to maintain the optimum performance of hybrids.

This trend might lead to the rice farmers' total dependence on commercial seed companies for their seeds. This will, in the process, surrender their traditional right to save, reuse and exchange seeds that are already enshrined in binding international agreements recognizing Farmers' Rights.

Curtailment of on-farm rice breeding Hybrid rice system, in all its aspects and implementation, does not recognize the invaluable role of farmers in the development of new varieties. For thousands of years, rice breeding has been the domain of farmers in Asia. It is in their process of collecting, selecting, exchanging, conserving and experimenting with rice plants that they have developed and bred over 100,000 varieties with different characteristics suited for varying conditions and ecosystems.

40. Janaiah and Hossain 2000 as cited by Virmani et al 2002

The advent of hybrid rice with the massive promotion by governments supported by the financial and technical resources of international institutions and agribusiness replicated what the world has witnessed in the Green Revolution era. The farmers will be effectively forced to stop their traditional practice in on-farm breeding and selection and will eventually have to depend for seeds developed by formal plant breeders and commercialized by seed companies. Dependency in almost all aspects of rice farming, from seed supply to the processing and marketing of the harvest might also lead to monopoly of the rice seed industry by agro-seed companies that are largely controlled by their narrow profit motives.[41]

41. Pandey, 1994

III.
Country Case Studies on Hybrid Rice in China, Vietnam, Indonesia, Timor Leste

To closely analyze the trends and developments in the introduction of hybrid rice in East Asia, the study will focus on four countries in the region where the technology has been or is being introduced and adopted, at different stages and under different conditions. The four countries were selected largely based on an initial assessment of the status of hybrid rice promotion in East Asia, and to some extent, based on the available resources for the research and the presence of reliable resource persons in the countries under study.

The four countries selected for the study are China, Indonesia, Timor Leste and Vietnam. China was a logical choice for any case study in hybrid rice since it is where the technology was developed, widely adopted and made a phenomenal contribution in the country's rice production. Vietnam was chosen to represent that group of countries in East Asia that aggressively adopted hybrid rice as a strategy to increase food production with the push coming from within the public research institutions as well as from China, its giant neighbor to the north. Indonesia was selected as a representative of a country that is cautiously going into research, development and promotion of hybrid rice. Its overall rice security strategy is still heavily dependent on conventional breeding legacy of the Green Revolution. Timor Leste, on the other, represents the group of least developed countries in East Asia still suffering from the devastation of the war for independence. It has openly embraced external assistance from a multitude of development agencies each bringing its own brand of farming systems, including hybrid rice technology, to help Timor develop as a newly-independent state.

Notably missing in the country case studies is the Philippines where hybrid rice is being tightly embraced by the government as a key technological option to increase rice production, thus, pumping the government's scarce resources to subsidize seed prices and provide the required infrastructures. In many ways, the Philippines is in the same league as Vietnam in its aggressive push for hybrid rice with some interesting differences that

will be noted in the case analysis included in this study. The case of the Philippines has been closely analyzed by the research team of the Southeast Asia Regional Initiatives for Community Empowerment (SEARICE), a core member of the East Asia Rice Working Group (EARWG) that has commissioned this research.

CHINA: Where All Roads in Hybrid Rice Begin

a. Overview of the National Rice Sector

Like most of Asia, rice is the predominant grain crop in China. It is primarily grown in the semi-tropical south of the Qin Ling range that includes the biodiversity-rich Yunnan province, widely held as an important cradle of origin of rice in East Asia. Unlike most countries in the region, China's lowland rice areas are almost 100 per cent irrigated where 97 per cent of the total area employs the labor-intensive seedling transplantation with two or three cropping seasons per year.

Rice cultivation in China's rice granary south is generally done only once a year because of the nearly temperate climate, especially in the highly elevated areas in the southwest. Rice farming is generally characterized by heavy fertilizer use – both organic and inorganic – that, along with abundant irrigation, delivers high yields to most Chinese farmers. The highest grain yields in the country come from the south which includes the Sichuan basin and the lower Jiang (Yangtze River) valley.[42] High rice yield is an imperative for this vast country with limited fertile lands. Thus, the average land holding is relatively small that rice production at household level is mainly for family consumption.[43]

Despite the phenomenal rice yields, rice production in China has shown a decreasing trend in the last 10 years. It soared from about 178 million tons in 1994 to 202.8 millions tons in 1997, owing primarily to active government intervention including the control of volumes of grain in domestic markets. But it has consistently declined in the next few years with only 186.7 million tons in 2004.

The decline has been partly attributed to the decrease in harvested areas shortly after China acceded to the World Trade Organization (WTO). The government allowed domestic prices to fall to world price levels in order to facilitate enhanced global competitiveness.

In 1999, the rice paddy area harvest was about 30.54 million hectares. It fell to about 26.8 million hectares in 2003 and picked up to about 29.4 million hectares in 2004. About 15 million hectares or more than 50 per cent of the total rice area were planted to hybrid varieties, producing about 103.5

42. http://www.new-agri.co.uk/02-1/countryp.html
43. Janaiah et al 2002

million metric tons of paddy annually. The rest were planted to inbred high-yielding varieties, producing 81 million metric tons. The average yield of hybrid rice varieties is 6.9 tons per hectare that is about 27 percent higher compared to the average yield of inbred high yielding varieties at 5.4 tons per hectare.[44]

Rice export volumes from China have also widely fluctuated over the last 10 years. From 3,803,838 tons in 1998, the exported milled rice gradually decreased to 2,097,901 tons in 2002.[45] In contrast, rice imports have surged high from only 106,570 tons in 1992 to 404,659 tons in 2003 (FAOSTAT data, 2004).

The policy reforms allowing farmers to make their own decision on the crops that they want to grow have resulted to massive shift from the cultivation of rice to commercial crops that command higher prices in the market, thus resulting to the overall reduction of rice production over the past decade. While China remains a net exporter, with its rice import representing only about 20 percent of its total rice exports in 2002, the decline in rice production has already raised alarms to the government. It offered 10 billion Yuan ($1.2 billion) in subsidies in 2004 to farmers who grow rice and other grains.[46]

b. State Policies on Seeds

China has a mature body of policies and legislations governing seeds and its seed industry. These shaped the country's rice sector agenda in general and its hybrid rice program in particular. A general discussion of these policies is provided in this section.

Seeds Standards

The standards for selection of varieties for breeding, seed production, and the management and use of seeds in China are defined under the Seed Law of 2000. This serves as the blueprint of principles that governs all seeds-related concerns in the country.

The law aims to protect and rationalize the use of germplasm material; safeguard the legal rights of variety selectors, seed producers, managers and users; improve seed quality; provide an impetus to the seed industry; and to promote the development of crop production and forestry.[47] The law mandates the local government bureaucracies to adopt their respective seed development plans and to allocate funds to support breeding and selection of high quality varieties. It reinforces the objectives of the policy on plant variety protection set out in an earlier and more specific law, and outlines the safety evaluation requirements for genetically modified seeds.

44. Virmani et al 2002
45. FAOSTAT data, 2004
46. BBC News, 19 November 2004
47. Seed Law of China, 2000

The Seed Law defines the responsibilities of the provincial governments and other government instrumentalities in evaluating the quality of seeds before they are commercially released. It provides the general guidelines and standards in certification, production, processing, packaging and marketing of seeds. It specifies that genetically modified seeds must be clearly labeled as such, complete with information on safety measures that need to be adopted. The general requirements in ensuring seed quality are also provided in the law, including the policy on liability and redress arising from poor quality seeds.

Access and Benefit Sharing

China is a signatory to the Convention on Biological Diversity (CBD) and has adopted a number of laws on biological diversity conservation and utilization to operationalize its commitment under this international agreement. It is a member of the Like Minded Groups of Mega-Diverse Countries, an informal bloc of 17 countries considered as centers for mega-diversity of biological and genetic resources. It was formed to consolidate their bargaining power in the negotiations on access to and benefit sharing (ABS) arising from the commercialization of biological and genetic resources under the CBD.

As a member of the Like Minded Group, China works for the adoption of a legally-binding international agreement that will compel industrialized countries and users of biological resources coming from biodiversity-rich countries to give a fair and equitable share of benefits from the commercialization of products derived from these resources. Among the members of the bloc, China has one of the strongest views in opposing the recognition of the rights of local and indigenous communities for a share in the benefits arising from the commercial use of biological resources, insisting that this right is reserved for the state.

Intellectual Property Rights on Seeds

China's patent law was enacted as early as 1984 and has already undergone two amendments, first in 1992 and then in 2001 as part of its compliance with its WTO commitments. China also acceded to the 1978 Act of the *"International Convention for the Protection of New Plant Varieties"* (UPOV) on 23 March 1999. It was followed by the enforcement of Decree No.13 in April 1999 created to regulate the protection of new varieties of plants.[48] Decree No. 13, otherwise known as the *Regulations of the People's Republic of China on the Protection of New Plant Varieties*, guarantees breeders' exclusive rights over their protected variety, and unless otherwise authorized, prohibits others from producing or selling for commercial purposes any propagating material of the protected variety.

The weak enforcement of majority of intellectual property rights (IPR)

48. http://www.cnpvp.net/old-www/PVP_in_China.htm

laws in China is seen as a major constraint limiting private sector research in the country. IPR in relation to the protection of new plant varieties, in contrast, is considered to have gained optimal legal and policy support.[49]

As a member of the UPOV, China has put in place legal remedies for the effective enforcement of breeders' rights. In 2000, the Supreme People's Court released explanations on issues regarding resolution of disputes on rights on new varieties of plants, to facilitate the handling of such cases by people's courts at various levels.

The Ministry of Agriculture has also set up law enforcement pilot regions in 10 agricultural production areas including the provinces of Sichuan, Hunan and Shandong. As of 2004, Chinese local courts have addressed at least 100 cases involving infringements of plant breeders' rights or PBRs.[50]

Aside from the PVP, the rights of breeders to their new plant varieties are also protected in China's Seed Law issued in 2000 that is also governed by the newly created IPR Affairs Center under the Ministry of Science and Technology. Moreover, again, as part of its legal obligations to the WTO, China abolished its law on Seed Management Regulations that gave monopoly powers to local seed companies and discriminated against foreign companies.[51]

Farmers' Rights

China has not yet signed nor ratified the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) that enshrines the principle of farmers' rights to seeds as a legally-binding commitment that Parties must respect and operationalize. Article 27 of China's Seed Law of 2000, however, provides for exemption to farmers in obtaining seed management licenses and allowing them to sell their surplus production of conventional seeds to the local markets. The provincial authorities were ordered to adopt their own administrative guidelines to operationalize this mandate.

Biosafety

The Seed Law of 2000 recognizes the need to adopt strict safety measures for genetically modified seeds, and requires the appropriate labeling of such seeds when sold commercially. In June 2001, the Chinese government announced that it would require labels for GMO-containing products in response to concerns about the presence of GMO food in the nation's import basket, particularly that of soybean. The policy pronouncement came as a surprise since the country has been commercially cultivating transgenic cotton since 1999 and has made considerable investment in agricultural genetic engineering.[52]

49. Pray, 2000
50. China Daily 01/24/2005
51. Huang and Rozelle, 2002
52. ibid

c. State of Hybrid Rice Grain and Seed Production in the Country

i. Development of Hybrid Rice in the Country

Hybrid rice technology originated in China. Although as early as 1926, heterosis in rice was already reported,[53] it was Professor Yuan Long Ping and his team who spearheaded the research in hybrid rice in Hunan Province in 1964.

The research efforts intensified in 1972 after the discovery of a single male sterile plant in a wild rice population. Massive cultivation of hybrid rice followed after its first field release in 1976 with much government promotion and encouragement for farmers to switch from conventional modern varieties to hybrids.

It should be noted that at this time, China was still under a centrally-planned economy run by the Communist Party with the commune system serving as the backbone of collectivized agricultural production. Under the collective system, each commune is expected to meet a production quota. Thus, the commune leadership decided on the farming system to adopt, crops and varieties to plant, including amount of inputs in the production. The system of collectivized agriculture and the rigid production discipline at the communes fostered the growth of hybrid rice in China.

Based on the accounts of the pioneers of hybrid rice in China, led by Professor Yuan Long Ping, the development of hybrid rice in China followed four phases.[54] The first phase from 1975 to 1979 was considered the *experiment, demonstration and extension phase*. It was during this period when the first set of hybrid rice was developed and initially released to cover about 5 million hectares. It had an average yield of 4.7 tons per hectare, which at that time was already 20 per cent higher than the yield of inbred varieties.

The second phase, covering the period from 1980 to 1981, was termed as the *adjustment stage*. The area devoted for hybrid rice remained the same but average yield increased slowly to 5.3 tons per hectare as more hybrids were developed with disease-resistant traits.

The period 1982 to 1985 marked the *continuous development phase*, with more farmers adopting rice hybrids and the area covered increasing to nearly 10 million hectares. The average yield of hybrid rice also increased to around 5.9-6.5 tons per hectare. At this time, IRRI started to collaborate with hybrid rice scientists in China and in the process developed short-duration hybrids.

The area devoted to hybrid rice further increased to 17.6 million hectares yielding an average of 6.6 tons per hectare during the *rapid and steady development phase* from 1986 to 1991. More hybrid rice varieties resistant to pests were developed and released during this period.

53. Jones 1926 as cited by Ntanos and Roupakias, 2003
54. Yuan et al 1994 as cited by Virmani 1996

By 1991, the area cultivated to hybrid rice in China was estimated to be around 17 million hectares, representing 55 per cent of the country's total rice land area. It contributed two-thirds of the total rice production of the country in that year and 20 per cent of the total rice production worldwide.[55] By 1992, about 58 per cent of the total rice area was planted to hybrid rice contributing about 15-18 million tons of additional unmilled rice in the country.[56]

Six years later, the government launched the "super hybrid rice cultivation program" with an optimistic target average yield of 10.5 tons per hectare by 2000 and 12 tons per hectare by 2005.[57] These targets, however, were not achieved. Sichuan, located in the southeast, is the largest hybrid rice-growing province in China and with three million hectares with 95 per cent of the total rice area in the province devoted to hybrids. It attained an average yield of only 7.5 tons per hectare in actual field conditions. But there were individual breakthroughs reported in terms of increased yield, with the highest yield recorded for hybrid rice from a single crop at 11.2 tons per hectare while 23.3 tons per hectare from a double crop or two croppings.[58]

ii. Status of Research on Hybrid Rice

Despite the continuous promotion and use of hybrid rice in China, public and private research institutions consistently conduct the research activities to derive full benefits from hybrid rice breeding. While majority of the hybrid rice in China is based on the CMS system or the three-line method, Chinese scientists are currently looking for new methods and materials for developing hybrid rice.

The two-line system has gained inroads and is becoming to be more widely used in parts of China where the climate is conducive for this temperature-sensitive method, such as Yunnan. Its altitude is high and the climate is evenly cooler for most of the year.

The level of hybrid rice yield has stagnated for years, leading some scientists to believe that these hybrids have already reached their yield plateaus and unless new methods or materials are invented or adopted, continuous yield declines would be expected. Chinese rice scientists are now racing against time for alternative hybrid breeding approaches such as the two-line method, using either PGMS or TGMS system, as well as the one-line method or the apomixis system.

One critical aspect in developing the two-line system or P(T)GMS lines for commercial use is the temperature for inducing male sterility. The critical temperature must be relatively low with mean temperature of 23°C

55. Virmani,1996
56. Janaiah et al 2002
57. Xinhua News Agency, 2003
58. Yuan, 1998

in the temperate zone and 24°C in the sub-tropics. The sterile pollen is not induced to become fertile even during the hot season.

After years of research, several P(T)GMS lines were developed in China. As early as 1998, 20 P(T)GMS lines belonging to either *indica* or *japonica* types or both were already registered. Experimental tests and commercial piloting in China reported that the best two-line hybrids have surpassed the yields of the three-line hybrids by around 5-10 per cent. Inspired by these results, China is now aiming to replace at least 70 per cent of its current three-line hybrids with two-line hybrids.[59]

On the other hand, some rice lines with low frequencies of apomixis were found but their frequencies are too low at only around 1-5 percent for any practical use in breeding. To overcome this technical hurdle, some Chinese scientists are now targeting to transfer the obligate apomixis gene from wild grasses, such as *Pennisetum* to rice lines through a combination of genetic engineering and conventional breeding to develop the one-line system of rice hybrids (Yuan, 1998).

Other research areas that are being explored by rice scientists in China to go around the technical hurdles in the development of better-yielding hybrid rice varieties are the development of inter-subspecific (e.g. *indica/japonica, indica/javanica, japonica/javanica*) as well as distant (inter-specific and inter-generic) hybrids. Like the one-line system approach, the objective in these streams is to raise the current level of heterosis. The inter-subspecific hybrids are particularly aimed to incorporate the good eating quality of *japonica* or *javanica* rice types to the currently available commercial *indica* types that have poorer eating quality than the former two. While these research approaches still depend on conventional breeding techniques, molecular markers to identify and transfer valuable novel genes for high yield potential and good grain quality from wild species are being used to develop elite distant rice hybrids (Yuan, 1998).

iii. Domestic Distribution and Regional/International Trade on Hybrid Rice Seeds

In China, hybrid seed production are generally facilitated and organized by the state-owned seed enterprises that are also engaged in the field releases and commercialization of hybrid seeds. Most of these state enterprises operate at the provincial level and engage in domestic and international export of seeds.

In Yunnan province alone, that is the third or fourth largest province growing hybrid rice in China, there are at least 140 public companies producing and selling hybrid rice seeds and fiercely competing with each other.[60] Prof. Yuan Long Ping himself, considered as the "father of hybrid rice",

59. Yuan, 1998
60. Lu, 2006

heads the biggest public enterprise established in 1998. It is involved in research, development and marketing of hybrid rice in Hunnan province in the southwest, where virtually all rice lands are planted to hybrid rice.[61] There are also dozens of private seeds enterprises operating at the national level that sell hybrid rice seeds to the domestic and international markets.

Most of the research and development efforts in hybrid rice in China came from and continue to come from the laboratories of agricultural universities and public research institutions across the country, especially in the sub-tropical south where rice is grown. However, commercialization and marketing are now in the hands of state-owned seed enterprises, many of which were formerly public research institutions.

The gradual opening up of China to the market economy that reached maturity at the turn of the century when the country acceded to the WTO was largely responsible for these institutional changes. The early years of hybrid rice introduction relied on the efficient top-down adoption by farmers under the commune system of collectivized production. The central government's Ministry of Agriculture initially took over this function in the transition period from the old command-and-control system to the current "individual responsibility" set up that basically means partial privatization.[62]

As China selectively embraced the most appropriate aspects of trade liberalization, privatization of enterprises that used to be run by the state was adopted with a mix blend of decentralization, liberalization and state intervention. The birth of so-called public enterprises from the research arms of public research institutions is a very interesting case in point as illustrated by an example from Yunnan province.

Yunnan Jin Rui Seeds Co. Ltd. is the biggest producer, distributor and exporter of hybrid rice seeds in Yunnan province. The company is also engaged in the development and marketing of hybrid corn, vegetables, flowers and traditional herbal medicines but the biggest part of its business is hybrid rice that it sells, both as grain and as seeds.

It was established in 2000 by the Cereal Crop Research Institute (CCRI) of the Yunnan Academy of Agricultural Sciences (YAAS), immediately after the national government issued a decree allowing the establishment of public enterprises in broad sectors and industries including seed marketing. The Institute has been in the forefront of research and development of hybrid rice in Yunnan province since the 70s, and is responsible for dozens of hybrid rice varieties released in the province.

Jin Rui Seeds was set up specifically to work with the Institute in research, development and commercialization of hybrid rice and other major crops. Upon its establishment, the company has taken over all the research and development efforts of the Institute related to hybrid rice.[63] Jin Rui

61. Jiang, 2006
62. Stiglitz, 2002
63. Lu, 2006

Seeds has since set up four subsidiary companies to take care of its core businesses, the biggest of which is the *Huayun Two-Line Hybrid Rice Subsidiary Company* which takes care of the hybrid rice business.

Unlike the so-called public enterprises in most market economies, state enterprises in China like Jin Rui Seeds do not actually operate independently from the public institution or agency where they came from or in partnership. Despite their claims that they are independent companies, Jin Rui Seeds, for example, is headed by the Director of the Cereal Crop Research Institute of YAAS who also sits on the company's board. The 50 research staff of Jin Rui Seeds are all personnel of the Institute who are also shareholders of the company. YAAS is a major shareholder in Jin Rui Seeds, and is represented in its Board together with a representative of the national government.

The government provided the initial capital of Jin Rui Seeds through YAAS, that Jin Rui Seeds is paying regularly. About 5-10 percent of the firm's profits go directly to the Academy's coffer. It justifies the arrangement where the Institute provides technical and scientific support to the supposedly independent company. The rest of the Jin Rui Seeds' profits are revolved by the company to support the bulk of its research and development efforts, marketing and infrastructure development to improve the quality of its product lines.

The Director of Jin Rui Seeds admits that this arrangement, in a way constitutes a form of government subsidy for a public enterprise involved in hybrid rice production. However it does not make the sector attractive for private companies to compete in.[64] Monsanto is in Yunnan province but only in hybrid corn production and marketing.

To produce the hybrid rice seeds that Jin Rui Seeds sells in Yunnan and exports to neighboring provinces and other countries, the company works with smaller public enterprises operating in 129 counties and 16 prefectures in the province. These, in turn work directly with farmers in seeds growing mostly using the two-line system (Lu, 2006).

Company technicians regularly visit the fields where farmers grow the hybrid seeds to monitor the techniques, planting conditions and the quality of seeds. Most farmers growing hybrid seeds for the company have long experiences in this endeavor that the technicians do not have problems in teaching the required techniques and maintaining quality.

The company also continues to train farmers on the new techniques and skills required in growing hybrid rice. Many farmers in Yunnan have, in fact, adopted local innovations to overcome the laborious and rigorous requirements in growing hybrid rice.[65] These factors all contribute to the good reputation earned by Jin Rui Seeds for having "guaranteed quality hybrid seeds", which its head claims to have "even better quality than the

64. ibid
65. Jiang, 2006

seeds produced by Luang Rong Ping's company in Hunnan province" (Lu, 2006).

In addition to the facilities of the Institute/YAAS, Jin Rui Seeds has its own research facility in the 26.7 hectare land outside Kunming where its technical staff conducts their breeding and research efforts. It also has its own factory and laboratory facilities for seed processing and quality inspection. It recently imported a state-of-the-art seed processing equipment from Denmark worth RMB 1.5 million with a processing capacity of 3-5 tons of seeds per hour.

Through its local partner enterprises, the company produces hybrid rice seeds with farmers in some 333.3 hectares across Yunnan province. It maintains four marketing bases in the biggest rice-growing provinces in southern China, namely, Szechuan, Hubei, Chongquing and Yunnan as key distribution points of its hybrid seeds (Lu, 2006). The company primarily sells five varieties (all bearing the name "Yunguang": one *japonica* and four *indica* varieties) of good quality hybrid rice seeds which its top official claims to have very high yield and very good eating quality.

Apart from the domestic market, Jin Rui Seeds also exports four hybrid rice varieties in the international market, particularly to the neighboring countries that border Yunnan in the south, namely, Vietnam, Laos and Myanmar. In 2004, the company even exported hybrid rice seeds to Bangladesh. By September 2006, it hopes to export to the Philippines that is also a target destination for the seeds produced by the company of Prof. Luang Rong Ping in Wunnan (Lu, 2006). The company also sets its eyes for export expansion in Indonesia and Malaysia in the near future.

In 2005, Jin Rui Seeds claimed to have exported 500 tons of hybrid rice seeds to Vietnam, and around 20 tons to Myanmar. It also exported hybrid rice seeds to Laos that were planted in 50,000 mu of land in the northern part of the country to replace opium production, in addition to the deal with the provincial government in Savannakhet farther down Laos (Lu, 2006). Jin Rui Seed's hybrid rice varieties are considered ideal for the topography of northern Vietnam and northern Laos, as well as the Irrawady Plains of Myanmar, since these are suited for high altitude ecosystems up to 1,900 meters above sea level.

iv. Impact and Contribution of Hybrid Rice in Overall Rice Production and Trade

It was reported that during the entire phase of the development of hybrid rice in China from 1976 to 1995, China was able to increase its production from 129 million tons to 200 million tons. The most vocal proponents of hybrid rice in China claimed that farmers growing hybrid rice obtained more than 30 per cent yield advantage over conventional pure-line varieties.[66]

66. Yuan, 1998

Reports from the actual planting of hybrid rice in field conditions in China, however, did not look to be as optimistic. While there are individual breakthroughs in increased yield, the highest yield recorded for hybrid rice from a single crop was at 11.2 tons per hectare while 23.3 tons per hectare from a double crop or two croppings (Yuan, 1998). The average yield of hybrid varieties in China fared way below the exceptional figures trumpeted by the proponents.

A study on the field performance of hybrid rice varieties in China showed that they attained an average of 6.9 tons only per hectare while that of inbred high yielding varieties is at 5.4 tons per hectare, which means the yield advantage of hybrid rice is only about 27 percent.[67] The actual field performance of hybrid rice varieties at less than 7 tons per hectare was way below the target average yield of 10.5 tons per hectare by 2000 and 12 tons per hectare by 2005.[68] A rice scientist at the Yunnan Academy of Agricultural Sciences who has been doing researches on hybrid rice since the 70s and prides himself as a student of Prof. Yuan Longping, realistically placed the actual yield advantage of hybrid rice at around 5-10 percent as compared to inbred varieties.[69]

Hybrid rice steadily covered vast areas of the total rice lands across China over the past 30 years, primarily due to the massive government promotion of hybrid rice facilitated by the old command-and-control economic system. By 1991, the area cultivated to hybrid rice in China was estimated to be around 17 million hectares, representing some 55 per cent of the country's total rice area. It contributed two-thirds of the total rice production of the country in that year and 20 per cent of the total rice production worldwide.[70]

By 1992, about 58 per cent of the total rice area was planted to hybrid rice contributing about 15-18 million tons of additional unmilled rice in the country.[71] Six years later, the government under the leadership of Prof. Yuan Longping launched the "super hybrid rice cultivation program" with optimistic targets that have yet to be achieved long past the set timelines.

Ironically, it was in the years following the launching of the "super hybrid rice cultivation program" when China's overall rice production and harvested area began to decline. In 2003, rice harvested areas fell to about 26.8 million hectares but rose by around 10 percent to about 29.4 million hectares in 2004, still below the 30.54 million hectares paddy area in 1999. By the early years of the 21st century, only about 50 per cent of the total rice area was planted to hybrid varieties, producing about 103.5 million metric tons of paddy annually while the rest are planted to inbred high-yielding varieties, producing 81 million metric tons. In Yunnan province, hybrid rice cultivation dropped estimatedly from 5 million mu (around one-third

67. Virmani et al 2002
68. Xinhua News Agency, 2003
69. Jiang, 2006
70. Virmani,1996
71. Janaiah et al 2002

of a million hectare) in 2000 to only around 4 million mu (around a quarter of a million hectare) at present.[72]

Some Chinese rice scientists attributed the decline in hybrid rice areas to the growing popularity of some newly-introduced inbred rice varieties with higher yields and better traits, seeds that definitely cost less than hybrids (Jiang, 2006). Furthermore, new inbred varieties that can grow in higher altitudes have been introduced commercially and out-competed the older hybrids that can be grown at only certain altitudes or only up to 1,300 meters above sea level. Some areas in China, particularly in the mountainous Yunnan province, have rice grown in altitudes of up to 2,700 meters above sea level.[73]

v. Impacts of and Issues on the Hybrid Rice Program

The rapid adoption of the hybrid rice technology in China can be attributed to the combination of active government promotion for farmers to adopt the technology and the presence of infrastructures required to optimize the benefits offered by the technology. Aside from the old centrally planned economy that later gave way to partial privatization and opened up the market economy to thousands of public enterprises engaged in seeds production and distribution, China's rice areas are nearly all irrigated which is favorable for hybrid rice cultivation. Also, since the average landholding in China is sufficient only to support subsistence farming, hybrid rice production in China is mainly for family consumption and thus, profitability in rice production and acceptability of the grains to consumers are not among the major concerns.

The gradual adoption by the Chinese government of the principles of market economy that has matured at the turn of the century also paved the way for the massive shift from production for household consumption to production for the market. Chinese farmers, including rice farmers, are now encouraged to produce for the open market and receive higher price for their products once they reached a production quota aimed at securing the domestic food base.[74] Such economic incentive encourages the farmers to choose high-yielding and good grain quality varieties that could fetch higher price in the market, which are not often found in hybrid rice varieties. The emergence of new inbred varieties with higher yields and better grain quality than hybrid rice varieties, aggravated by the signs of yield plateau in hybrid varieties have all contributed to the decline in harvested areas devoted to hybrid rice in recent years.

The labor-intensive nature of hybrid rice technology may be a limiting factor for other countries with scarce and high cost of labor. The experience of China, however, showed that it can instead provide a viable opportunity to

72. Jiang, 2006
73. Dai, 2006
74. Stiglitz, 2002

increase the income of small and marginal farming households in rural areas where labor comes abundant and cheap.

As Janaiah et al (2002) has concluded, the nature of the political economy along with the socio-economic and institutional factors, indeed, explained the phenomenal success of hybrid rice in China rather than its inherent superiority over inbred high-yielding varieties. The trends in recent years marked by the stunted growth which later led to the steady decline in the areas under hybrid rice cultivation tend to prove this conclusion. This is especially true, after the introduction of policy reforms in the early 1990s that brought gradual but steady socio-economic and political transformation in the country.

With economic liberalization, consumer preferences have become the single most important determining factor that decides on the fate of any rice variety in the commercial market. Owing from its generally inferior grain quality, the demand for hybrid rice has been observed to have declined recently. In some pilot regions of reforms like the Zheijang province in the eastern part of China, where farmers are now free to choose what crops to grow, majority have indicated that they would rather buy good quality rice from other parts of the country than depend on their early maturing but poor-tasting local varieties which are mostly hybrids.[75]

In a closer analysis, hybrid rice in China has fallen victim to its own success. Its phenomenal success for 30 years in the world's most populous country has brought to fore the inherent weaknesses of the technology. Its optimum yield seems to have already been breached especially in recent years.

The rapidly changing political and economic environment removed the institutions responsible for hybrid rice's success. Its declining glory in China and the emergence of better inbred varieties in the midst of the continuing challenge to produce more food with less land devoted for rice because of the massive shift to cash crop production are the same factors that now motivate the government to push the hybrid rice technology to its limits rather than abandon it.

d. Description and Analysis of the National Hybrid Rice Program

i. National Policy on and Rationale of Hybrid Rice

The main rationale of promoting hybrid rice in China with direct policy intervention from the government is to increase the domestic rice production to feed the increasing population in the urban and rural areas.[76] The introduction and promotion of hybrid rice has been an explicit component

75. http://www.new-agri.co.uk/02-1/countryp.html
76. Janaiah et al 2002

of the regular five-year national agricultural development plans of the world's most populous country since the mid-70s.

While the rest of Asia were singing praises to the bounty in rice harvests brought by the high-yield inbred varieties under the banner of the Green Revolution, the Chinese government was pushing hybrid rice aggressively among its farmers from the time of the commune system of collectivized production to the gradual opening up of the country to the market economy. The government invested heavily in building irrigation canals and systems across the vast country, thus providing the most important infrastructure necessary to grow hybrid rice in massive proportion. Communally-built and maintained irrigation systems have bore fruit for China, covering nearly all of its lowland areas.

The opening up of China to market economy also brought forward a new justification to pursue the hybrid rice program apart for the increasing domestic rice production. With the emergence of market-inspired incentive systems for farmers to produce more in their farms, the higher yield attraction of hybrid rice provides a motivation for farmers to earn additional income from selling their surplus to the open market. In the transition years from centrally-planned economy to market economy, the Chinese government offered a dual-pricing system to encourage farmers to produce more beyond the production quota set at the household level.[77] The out-quota produce that goes directly to the open market receives higher prices, thus encouraging farmers to produce more for them to earn more.

The policy of "partial liberalization" that gave birth to thousands of public enterprises, such as the successful Yunnan Jin Rui Seeds discussed in a previous section, added another economic incentive for public research institutions to develop better rice varieties, whether hybrid or inbred. The climate of open competition that the gradual liberalization policy adopted by the Chinese government since the 90s represents both as a threat and opportunity for hybrid rice. Public enterprises now fiercely compete with each other, and thus more motivated to produce better quality hybrid seeds. In a liberalized set up, public enterprises can contract out the growing of hybrid seeds to farmers who can earn more in the process.

On the other hand, the open competition policy entails an equal playing field to both hybrids and inbreds provided by the government. That "equally playing field" comes in the form of research grants and initial capital for start-up state enterprises engaged in the seeds business. In a level playing field, farmers now have a choice which crops or varieties to grow in their farm, which puts the more expensive and poor grain quality hybrid varieties to a disadvantage compared to the cheaper and better tasting new inbred varieties in the market.

77. Stiglitz, 2002

The deteriorating image of hybrid rice among farmers in China, as can be gleaned from the declining yields and harvested areas of rice in general and hybrid rice particular in recent years, has already sounded alarm bells for the Chinese government. To arrest the decline, the government has offered 10 billion Yuan ($1.2 billion) in subsidies in 2004 to farmers who grow rice and other grains.[78]

Specific to hybrid rice, the government, under the advice of the most high-profile proponent of hybrid rice in China, Professor Yuan Rongping, embarked on a "super hybrid rice program" in 1998 to develop higher yielding and better grain quality hybrid rice varieties. The launching of the program coincided with the setting up of a public enterprise in Hunan province specializing in the research, development and marketing of hybrid rice seeds led by Professor Yuan himself. The company is now the biggest firm that sells hybrid rice seeds in China, but the targets set by the "super hybrid rice program" at 10.5 tons per hectare by 2000 and 12 tons per hectare by 2002 are yet to be attained.

Some rice scientists in China expressed their discomfort over the hype on "super hybrid rice" tagged by the most vocal proponents and sensational journalists on the upcoming varieties of hybrid rice that promise higher yield and better quality. A rice scientist in Yunnan who has been involved in the development of hybrid rice at the Yunnan Academy of Agricultural Sciences says that the label gives unrealistic expectations on the promises of the new varieties, most of which are still being developed and will become obscure in 5-10 years from the time they are released in the fields just like any other modern varieties.[79]

ii. Promotion and Incentives Extended by Government to Seed Researchers and Seed Producers

As discussed extensively in previous sections, the production system in China under the centrally-planned economy in the 70s and the 80s was primarily responsible for the wide adoption of hybrid rice in the first two decades since its introduction. The farmers were grouped into communes to which land and quotas for grain production were assigned.

Under the commune system, most rice farmers were required to grow hybrid rice varieties promoted by the government to boost rice production. The local government agencies provided the required inputs and technical assistance and ensured that the farmers implemented the decision. Hybrid seeds were provided free to farmers by the government. Fertilizers and pesticides were also subsidized.[80] Both the supply and procurement of the grains were handled by the state. Since it was the government that actually bears the cost and the farmers have no other choice, the cost of hybrid seeds was not considered a constraint for the large-scale adoption of the technology.

78. BBC News, 19 November 2004
79. Jiang, 2006
80. Lin, 1991 as cited by Janaiah et al 2002

With China's carefully planned and measured integration into the global economy in the 90s, the context in which hybrid rice plays out has changed, although not necessarily to its detriment. As discussed above, the economic incentives adopted by the government to replace the security provided by the commune system have attracted farmers to produce more beyond their household production quota.

Farmers can now buy hybrid rice seeds in the open market side by side with a diverse array of inbred varieties, and make their choice on which varieties to sow in their rice fields. At RMB 12-15 per kilogram, compared to the RMB 3 per kilogram of ordinary inbred varieties, the cost of hybrid rice looks formidable for a poor rice farmer in rural China, unless its yield and cost advantages are obvious. While the national and local governments initially subsidized the costs of hybrid seeds in the transition years of market reforms, such subsidies are said to have been completely withdrawn in the late 90s.[81]

Up to the late-90s, some provincial governments even offered such incentives as 50 percent subsidy for the price of hybrid rice seeds to support farmers in the process of the transition to market economy (Jiang, 2006). At present, some provincial governments still maintain some kind of subsidies for all farmers not just to hybrid rice farmers. Such is the case in Yunnan where the government allots a subsidy for agriculture of RMB 100 million every year in the form of support prices for fertilizers and pesticides (Jiang, 2006). In addition, agricultural technicians of the government generally advise farmers to grow hybrid rice because of the yield advantage, less seeds requirement and the fact that the required skills, farming practices and knowledge are already mastered by Chinese farmers.

Hybrid rice proponents claim that rice farmers in China still prefer hybrid rice seeds over inbreds because of its proven economic advantages. The farmers only need 2 kilograms of hybrid seeds per mu compared to 5 kilograms of inbreds. They are assured of at least 10 percent yield advantage in hybrid rice despite the fact that it costs five times more.

This explanation, however, does not shed any light on the lack of economic logic behind the farmers' decision to choose hybrid seeds that cost five times more while obtaining a mere 10 percent yield advantage in return. A more plausible explanation may be found in the socio-political reality in present day China. The long decades of commune living has ingrained in Chinese farmers the discipline of following orders from authorities and the indoctrination from agricultural technicians that hybrid seeds are best guarantee for better production.

A decade in the market economy would not bring complete transformation to China's institutions as well as the mentality of its people especially in the rural areas where communication and information still largely comes

81. Jiang, 2006; Lu, 2006

from and controlled by the local authorities. The real judgment on the fate of hybrid rice in China will come as the country marches on to complete liberalization and full privatization. At present, farmers that use hybrid rice do not bear the costs of irrigation systems since these are provided by the government and limited subsidies for chemical fertilizers and pesticides persist.

Beyond the "hidden subsidies" that farmers growing hybrid rice continue to receive in the form of irrigation facilities and technical training from government technicians, the more substantial incentives and subsidies enjoyed by the technology are actually found in the research and development phase (Lu, 2006; Jiang, 2006). The bulk of China's research and development efforts in hybrid rice continue to come from the public research sector, as shown in the case of Yunnan. Even public enterprises, such as the Yunnan Jin Rui Seeds, receive direct support from the central and local governments. After all, the seed capital of public enterprises was provided by the government, which in the case of Jin Rui Seeds came directly from the Yunnan Academy of Agricultural Sciences. But Jin Rui Seeds is plowing back a portion of its earnings to the Academy.

More importantly, the officers and the bulk of the research and technical staff of these public enterprises are employees of the public research institution where these enterprises came from and continue to be attached to. In sum, the government of China provides the resources for research and development on hybrid rice which are now sold to farmers by public companies mostly set up by public research institutions. This privilege, however, is also enjoyed by public enterprises engaged in the development and distribution of inbred rice varieties. The economic rationale for this scheme is for the public enterprises to earn from the business of developing and selling seeds, return the initial capital provided by the government, revolve their profits to expand and build assets, and later become totally independent from the government. This set up typifies China's own model of gradual privatization.[82]

e. Roles of Different Actors in Research, Production, Distribution, Promotion and Use of Hybrid Rice Grain and Seeds

i. The Public Sector

The agricultural input sector in China is dominated by state-owned enterprises and other government organizations that facilitate most of the marketing, importation, production, or research in the agricultural input industry.[83] In the domestic seeds market, these public enterprises dominate

82. Stiglitz, 2002
83. Pray, 2000

nearly 100 per cent of the production of commercial seeds. By law, the government-owned seed companies must supply hybrid seeds of the major field crops.[84]

Three major national research institutes in China focus on breeding and biotechnology in rice and spearhead rice research activities in the country. These are the China National Rice Research Institute (CNRRI) in Zhejiang, the National Hybrid Rice Engineering Technical Centre (NHRETC) in Hunan and the Institute of Genetics and Developmental Biology (IGDB) in Beijing. These agencies are active at the provincial level and coordinate with agricultural universities as well as seed companies. They are considered to be the most capable rice research institutes in China in terms of resources and scientific expertise.[85] These three institutes are all involved in the research and development of hybrid rice since the 70s, but are also slowly moving to the development genetically engineered rice in recent years. The NHRETC in Hunan comes under the tutelage of the "father of hybrid rice", Prof. Luan Rongping.

The Chinese Academy of Agricultural Sciences (CAAS) is also heavily involved in the research and development of hybrid rice at the national level, with some of the best hybrid varieties developed by some of its luminaries. The CAAS links directly with the provincial academies of agricultural sciences, such as the Yunnan Academy of Agricultural Sciences that has institutes specializing on the development of hybrid rice varieties. The public research institutions that invested and continue to invest in hybrid rice research and development are naturally those in the provinces of China where rice is primarily grown, mostly located in the southern regions, such as Jiangxi, Szechua, Hunnan, Hubei, Guangxi and Yunnan). With the national directive allowing the establishment of public enterprises spinning off from public research institutions in the late 90s, nearly all provincial academy of agricultural sciences and public agricultural research centers in these provinces have established their own seeds companies engaged in research, development and marketing of both hybrid and inbred rice seeds.[86]

ii. Role of the Private Sector

Since most of the enterprises engaged in the rice seeds business is owned and controlled by the government, it is not surprising that the private sector has very little contribution to agricultural research and technology transfer in this particular sector. This is, in fact, the general profile of agricultural research and development in China. In 1995, for example, private research expenditures for agriculture in China were estimated at only $11-16 million compared to the $480 million of public research expenditures, which is considered small relative to private research investments in other parts Asia.[87]

84. Pray, 2000
85. Brookes and Barfoot, 2003
86. Jiang, 2006
87. Pray, 2000

As part of the government's effort to cushion the national economy from the adverse impacts of rapid shift to full liberalization and privatization, private companies in China are not allowed to invest in seeds production unless they operate as joint ventures with local enterprises with the majority shares owned by Chinese entities. Strategic industries such as food crops are primarily left under the control of the government, through public enterprises, although still following the market economy-inspired rules and schemes.

Giant agribusiness companies, such as Monsanto and Syngenta, however, are slowly gaining inroads in China's agriculture mainly through join ventures. Monsanto, for example, has substantial investment in China on the seed production of such commercial crops as corn and cotton. Despite this policy instituted in the 90s, there were reports that the Chinese government had exclusively licensed its hybrid rice technology to *Cargill Seeds* and *Ring-Around Products Inc.* It was later acquired by Occidental Petroleum, which then later merged into Cargill/Monsanto in the late 70s. However, the licensing contract was later terminated in 1992 due to difficulties encountered by the companies in commercializing the hybrids either because of their poor adaptability in the tropics and/or because of the poor seeds quality.[88]

iii. Role of Research Institutions

Apart from the public research institutions at the national and provincial levels, IRRI also played an important role in the development and use of hybrid rice technology for the tropics since 1979. Chinese rice hybrids performed excellently in areas with irrigation and adequate rainfall in the subtropical parts of the country. However, IRRI's initial experiments and screenings in the late 70s showed the Chinese rice hybrids were not suitable in the tropics and exhibited poor grain quality compared to the popular inbred high yielding varieties grown in tropical countries.

IRRI researchers then concentrated in developing parental lines suitable in the tropics using the CMS (three-line) system widely used in China at that time. Within a decade, commercially usable CMS and restorer lines, including some elite hybrids were identified and shared with national agricultural research centers in other parts of Asia for evaluation and utilization. From 1993-1998, IRRI released hybrids for commercial cultivation in the Philippines, India, and Vietnam. Several seed companies in Asia were also provided with IRRI-bred parental lines for further evaluation and research.[89]

88. Pandey, 1994
89. Virmani et al 2002

VIETNAM: Promoting Hybrid Rice in China's Doorsteps

a. Overview of the National Rice Sector

Being the dominant staple crop in the country, rice has a special place in the Vietnamese economy. It accounts for 92 per cent of grain production, 45 per cent of agricultural output, and an estimated 7.5 per cent of Gross Domestic Product (GDP).[90]

Rice occupies nearly 60 per cent of the land areas in Vietnam planted with agricultural crops. It is grown on 4.2 million hectares to 6.7 million hectares every year, varying depending on weather patterns, as a result of increased cropping intensity.[91] Nearly 85 per cent of the lands allocated to food crops are currently utilized for rice cultivation that contributes 90 per cent of total food output.[92]

An average Vietnamese get and estimated 80 per cent of carbohydrates and 40 per cent of protein intake from rice.[93] In 1998, 65 per cent of the households cultivated at least some rice in their available lands while 17 percent of household spending (including home consumption) was used to buy rice. In addition, about 5-6 per cent of the government's national budget is allocated to investments in agriculture where more than half of this total goes to the maintenance and expansion of irrigation systems that mainly serve rice cultivation.[94]

Aside from feeding its people, rice is an important export earner for Vietnam as well. From 1993-2002, Vietnam was the world's second largest exporter of rice by volume, or fourth largest as measured by value. Since 1996, Vietnam has exported at least three million tons of rice annually that accounted for 11.1 percent of the total Vietnamese export earnings in that period. The share of rice in the total export earnings of the country, however, sharply declined to 3.6 percent in 2003 due to a combination of factors that affected Vietnam's overall agricultural performance in general, namely, erratic weather patterns, conversion of rice lands to the cultivation of cash crops such as soybeans and corn, shift of land use to aquaculture that fetches higher prices in the export market, and the declining price of rice in the international market (Haughton et al 2004).

The overall national rice production of Vietnam has shown an increasing trend. From barely 22.8 million tons of paddy produced in 1993, it rose to 34.5 million tons in 2003, registering an impressive 50 percent increase in a decade. Over the same period, yield grew from 3.48 to 4.63 tons per hectare posting a 33 percent increase while the area planted to rice rose by 13.5 percent.[95]

90. GSO 2004 as cited by Haughton et al 2004
91. Hoan, 1998
92. Hossain et al 2003
93. Luat, et al 1995
94. Haughton et al 2004
95. FAOSTAT 2004 data

The increase in harvested area was attributed mainly to the practice of double- and triple-cropping, particularly in the Mekong River Delta in the southern part of Vietnam. This was made possible by massive public investments in irrigation as well as the economic reforms instituted by the government during this period. Furthermore, production in 2003 amounted to 300 kilogram per capita that is more than sufficient to satisfy the domestic needs, enabling the country to export a sixth of its total rice harvests that year.[96]

The Red River Delta located in the north and the Mekong River Delta in the south are considered the two most important rice-growing regions in Vietnam that contribute 19 percent and 51 percent respectively, of the total rice output in 2003. The densely-populated and comparatively poor Red River Delta sometimes generates a net surplus during favorable harvest seasons. However, Mekong Delta has consistently provided the bulk of the export surplus (Haughton et al 2004). In general, the northern provinces have two cropping seasons while the southern provinces have two to three cropping seasons every year, allowing farmers to produce substantive surplus for the domestic and export markets.[97] The country's has a very diverse rice ecology, with 40 per cent irrigated, 31 per cent rainfed lowland, 14 per cent deepwater, 8 per cent floating and 7 per cent upland.[98]

b. State Policies on Seeds

Seeds Standards

The enforcement of regulations on seeds certification and quality standards in Vietnam is part of the mandate of the provincial and district authorities. The national seed policy basically follows the international seed and quarantine standards that primarily place a commercial premium and general preference for seeds developed by formal institutions. In recent years, there were some flexibilities adopted by the government for farmer-developed varieties with commercial potentials by allowing local certification processes that would enable their commercial adoption within specific districts and provinces.

Access and Benefit Sharing

Vietnam is a signatory to the CBD, but has not adopted any legislation on the regulation of access to and benefit sharing arising from the use of biological and genetic resources found within its territory. A proposed law has been drafted by the Ministry of Science, Technology and Environment way back in 1999, but has not been acted upon by the National Assembly.

96. Haughton et al 2004
97. Hoan and Nghia, 2002
98. Hoan et al 1998

Intellectual Property Rights

The National Assembly of Vietnam recently passed the IPR Law of Vietnam that revised and puts together in one piece of legislation the different types of IPRs governing various applications. The IPR Law adopted in November 2005 includes a chapter on plant variety protection (PVP) that basically follows the template set by UPOV 1991. The adoption of the law, consistent with the provisions of the TRIPS, is seen as part of Vietnam's effort to convince the WTO to accept its application for membership. The provisions on PVP are in compliance with Vietnam's commitment to its bilateral trade agreement with the United States signed in 1999 in which Vietnam has agreed to adhere to the provisions of UPOV 1991 and exert every effort to become a member of the UPOV.

Farmers' Rights

Vietnam is not a party to the ITPGRFA and thus not obliged to respect and operationalize farmer's rights as defined in the treaty. The PVP chapter of the new IPR Law, however, includes a provision on farmers' rights that gives limited concession for farmers to save and reuse seeds from protected varieties as long as such is done for personal and non-commercial purpose within the land where they have been granted user's rights by the government. The concession is an optional privilege provided in UPOV 1991. Vietnam is currently applying for membership in UPOV 1991.

Biosafety

The central government has adopted a Decree on labeling and commercialization of products from genetically modified organisms in September 2005. The Decree provides the general guidelines on the testing and commercial releases of GMOs in the country, focusing mainly on the technical Biosafety requirements.

c. State of Hybrid Rice Grain and Seed Production in the Country

i. Development of Hybrid Rice in the Country

Motivated by the reported success in the development and commercialization of hybrid rice in China, its giant neighbor to the north, Vietnam started its first venture into the technology in 1979 through initial researches conducted by the Vietnam Agricultural Science Institute (VASI). Since China and Vietnam have similar climatic conditions, particularly the northern part of Vietnam and the southern provinces of China, the government introduced several varieties and promising combinations of hybrid rice from China for field testing in the 80s. While hybrid rice generally surpassed the yield of inbred varieties grown in farmers' field, hybrids had poorer grain quality and were more susceptible to pests and diseases than the popular inbred varieties. Hence, the hybrid rice varieties imported from China failed

to impress the Vietnamese farmers during the 1980s. The maiden experience of hybrid rice in Vietnam was therefore a failure.

Not to be discouraged by the lack of success of the initial releases of hybrid rice, Vietnamese research institutions continued to pin their hopes on the technology in the 90s, looking at it as a viable option to address the concerns on yield plateau of the Green Revolution varieties introduced by IRRI after the war with the US has ended. The government revived its hybrid rice research in 1992 with the launching of the National Hybrid Rice Research Program and the establishment of the Hybrid Rice Research Center (HRRC). With full support from the government, from financial requirement to technical capacity building, research and development, training of researchers, and up to extension and transfer of the technology, hybrid rice adoption has since then increased.

In ten years' time, hybrid rice accounts for 18 per cent and 6 per cent of the rice growing areas in the North and in the country, respectively. In 2003, Vietnam is the second hybrid rice producer in the world after China. Table 3 shows the increases in terms of area and production of hybrid rice in Vietnam in two periods, from 1992-1996 and from 1997-2001. Rice areas devoted to hybrid rice production jumped nearly 56 percent annually from 1992 to more than 100,000 hectares in 1996. By 2001, hybrid rice areas in Vietnam occupies nearly half a million hectares, enjoying an average of 23.6 percent increase every year since 1997. The leaps in hybrid rice production have also followed the same pattern over a ten year period, from 1992 to 2001. Meanwhile, it is important to note that while hybrid rice production and areas have increased markedly in a short period of time, the average yield of hybrid rice however has shown a constant negative growth rate.

Table 3. Hybrid Rice Development in Vietnam: 1992-1996 and 1997-2001

	Year		Growth Rate	Year		Growth Rate
	1992	1996	(%)	1997	2001	(%)
Area (ha)	11,340	102,800	55.5	187,700	438,700	23.6
Ave. yield (t/ha)	6.66	6.58	-0.2	6.35	5.85	-0.2
Production (t)	75,525	677,172	55.3	1,191,895	2,763,711	23.4

Quach Ngoc An 2002 as cited by Bui chi Buu (http://clrri.org/en/new/hybridrice04.htm

ii. Status of Research on Hybrid Rice and the Pivotal Role of Public Research Institutions

Hybrid rice research in Vietnam was initiated for the first time in 1979 at the Vietnam Agricultural Research Institute (VASI) after the phenomenal successes of the technology in neighboring China. Later, research efforts were extended at Hau Giang in the Mekong River Delta Region and at the Cuu Long Delta Rice Research Institute (CLRRI) in 1983. The general objectives

of the initial researches were: to develop suitable rice hybrids possessing a yield potential that is significantly higher than and grain quality comparable to the best available inbred rice varieties in irrigated areas in the Red River Delta and Mekong River Delta; to package the seed-production technology in a form suitable for the country; to develop agronomic management practices for optimizing yield of hybrid rice; and to study the economics of hybrid rice cultivation and seed production.[99]

Initial research results in the Red River Delta showed that hybrid rice introduced from China produced more than the inbreds in the farmers' field. However, they are more susceptible to insect pests and diseases and have poorer grain quality than the farmers' varieties. As a result, while rice farmers in the north planted hybrid rice and reaped higher yields, the grain fetched a lower price in the market compared to popular high-yielding inbred varieties. While the initial attempt on hybrid rice did not succeed and received lukewarm reception from farmers, agricultural extension officials found the experience has in many ways helped in shortening the time for research and development on hybrid rice in Vietnam in the following decade.[100]

In 1992, the government revitalized its hybrid rice program and established the National Hybrid Rice Research Center (HRRC) in 1994 with an exclusive mandate on hybrid rice development, directly under the supervision of VASI. The centre was granted a five hectare-land for experimental purposes at its headquarters and another 4.5 hectare land in the Ba Vi area in north, with good isolation conditions suited to CMS line multiplication in the spring season. It also has a few F_1 seed farms contracted to farmers in Hai Phong and at the extension centre in Thai Binh Province in northern Vietnam. The center initially received funding and technical support from the Food and Agriculture Organization (FAO), particularly, for staff training and upgrading of the hybrid rice research facilities.[101] From the national government, the HRRC receives an average annual budget of around VND 2 billion.

Following the revival of interest of the Vietnamese government on the hybrid rice technology, national rice breeders at VASI, prior to the establishment HRRC, obtained 40-50 hybrid varieties from China and conducted adaptability trials in 37 locations from the northern to the central highlands of the country having similar agro-climatic conditions with China where the seeds originated.[102] HRRC took these adaptability trials and further development work on the most promising varieties when it was established in 1994. These resulted to the commercial release of 3-4 varieties by the mid-90s.

99. An, 2002
100. Nguyen, 2005
101. FAO, TCP/VIE/6614(T)
102. Nguyen Tri Hoan, 2005

The need to increase rice production in the poorer northern regions of Vietnam that could not wait from long years involved in research and development for local hybrid varieties justified the direct importation of hybrid seeds from China. In succeeding years and in the medium-term, as HRRC developed its skills and knowledge in hybrid rice development, local hybrids were developed from parental lines coming from China. Researchers explain that the strategy is based on a cautious effort to select from a diverse pool of parental lines, focusing on the objective to breed for good quality grains. They believe that the only way for hybrid rice to succeed in Vietnam is to develop varieties with good grain quality apart from high yields.[103]

With more and better trained human resources involved in hybrid rice research and development and facilities, Vietnam was able to develop and implement multi-disciplinary programs involving breeding, genetics, seed production, plant pathology, entomology, rice chemistry, and biotechnology. The primary breeding goals included the development of high yielding varieties with good seed productivity, early maturity of 100-110 days to suit Vietnam's cropping season, longer grains compared to the bold grained Chinese hybrids, and resistance to major insects such as brown plant hopper and major diseases such as bacterial leaf blight and sheath blight.[104]

CMS lines from China were tested for adaptability and stability of sterility. The adapted CMS lines were crossed to available restorers and elite lines in Vietnam. By 2002, four hybrid rice have been officially released from the facilities of HRRC for large-scale hybrid rice commercial production while several other hybrids were still being studied for F_1 seed production and further evaluation before releasing them for commercial cultivation. In addition, another four hybrids with high yield and good eating quality were selected during the conduct of the International Rice Yield Trials for two years at four locations in Vietnam. The research and development efforts on these hybrid rice varieties were supported by the Asian Development Bank (ADB) under its technical assistance project, "Development and Use of Hybrid Rice in Asia" that started in 1998 and ended in 2004.

At present, HRRC is developing more hybrid rice varieties, using parental lines from China and developed locally, with a combination of high yields, good grain quality and resistance to bacterial blight. Already released commercially are the varieties *HYT 100* and *HYT 92* that are highly favored by farmers because of their aromatic and slightly sticky grain traits which could even be potentially grown for export in the near future (Nguyen Tri Hoan, 2005). HRRC have forged partnership with a national seed company and provincial seed enterprises to widely commercially produce and market these two varieties.

Despite the successes in the development hybrid rice varieties suited to the conditions and farming systems in Vietnam, the development of variet-

103. Nguyen Tri Hoan, 2005
104. Hoan and Nghia, 2002

ies possessing a combination of qualities like good grain quality, tolerance to pests and diseases and early maturity, remains a challenge for the HRRC. In particular, hybrids that are resistant to major diseases such as bacterial leaf blight and sheath blight are very much needed since current hybrids are only blast resistant but susceptible to other important diseases.[105]

Recently, rice scientists at Hanoi University of Agriculture developed the first two-line hybrid rice named *Viet Lai 20*. This was released as a national variety by the Ministry of Agriculture and Rural Development in 2004. The new hybrid variety was reported to have acceptable grain qualities and resistance to bacterial leaf blight.[106] Most of the current research and development efforts in hybrid rice in Vietnam are focused on improving the grain quality, particularly the taste and general eating quality, of new hybrid varieties.

Local researchers were motivated by the recent research breakthroughs in China and the Philippines where new hybrid rice varieties were developed with good grain quality. This targeted breeding agenda is in response to the complaints of farmers on the poor grain quality of most commercially-available hybrid rice varieties which sell lower in the local markets. Researchers hope that in the future, the new hybrid varieties will be developed with better grain quality that will not only contribute to providing sufficient food for the population in the northern and central regions of Vietnam that suffer from rice deficit for most of the year. It should also boost the potentials of northern farmers to export rice.[107]

Another research area that Vietnamese rice researchers are currently exploring is the development of hybrid varieties that thrive in marginal conditions. Recent field studies conducted by the HRRC showed that certain hybrid rice varieties performed very well in adverse agro-climatic conditions especially in saline areas where some have yields of as much as 6 tons per hectare.[108]

Agriculture officials estimate that Vietnam invests around the equivalent of US$1 million every year to support the infrastructures, research, development, extension and overall requirements of the country's hybrid rice program.[109]

iii. Hybrid Rice Seed Production and Delivery System

At present, only 20 percent of the overall domestic requirements for hybrid seeds in Vietnam are sourced out locally. The rest is directly imported from neighboring China where the southern regions that produce hybrid seeds have similar agro-climatic conditions to that in the northern provinces of

105. Hoan and Nghia, 2002
106. Buu 2004
107. Tran, 2005
108. Nguyen Tri Hoan, 2005
109. Tran, 2005

Vietnam. There are no available statistics on the actual volume and value of hybrid seeds imported by Vietnam from China, but one big public seed enterprise in Yunnan province, Jin Rui Seeds, claim to have exported 500 tons of hybrid seeds to Vietnam in 2004 alone.[110] So far, Vietnam seems to be the most lucrative market for hybrid seeds produced in China. With the lack of stringent regulatory system in place to monitor the quality of imported hybrid seeds into the Vietnam, complaints from farmers and commune officials on the poor quality of seeds imported from China are common in northern Vietnam but said to have abated in recent years.

Aside from developing and releasing hybrid varieties, the HRRC has also taken responsibility for developing and transferring hybrid seed production technologies. The center developed a technology package for large scale-seed production of hybrids, but has limited capacity to distribute and commercialize hybrid rice varieties to farmers in the country. The head of HRRC recognizes this inherent limitation in the capacity of the institute and the government, in general. Ensuring the efficient delivery of new hybrid rice varieties to the farmers requires the marketing skills and resources of the private sector.[111]

Since importation of seeds from China is costly and quality is often not guaranteed, the Vietnamese government has encouraged local seed production activities. Under this scheme, seed production is mainly done by trained farmers in the provinces under the close supervision of HRRC technical personnel or extension specialists. A system for purifying parental-line seeds is also currently being developed to solve the problem of low purity of CMS lines. In addition, the government has also formulated seed certification standards for hybrid rice in the country to control seed quality. However, many small farmers are generally reluctant to produce hybrid rice seeds locally because of high risks involved, very high financial requirement, lack of proper warehouses and storage space for unsold seeds, and the unavailability of pure CMS lines.[112]

The role of provincial and district government structures in the promotion and delivery of hybrid rice seeds to farmers down to the commune level is critical. The local governments exercise control over state-owned seed enterprises that are registered and operating locally. The local enterprises serve as the direct channel of the national seed companies that are considered private entities where the government maintains substantial share, in the distribution, promotion and selling of hybrid rice seeds to farmers. The local seed companies that are closely tied to and controlled by the provincial and district bureaucracy, virtually operate as the local distribution arms of the national seed enterprises. This the same local set up that represents the national seed companies when they engage in hybrid seeds production ar-

110. Lu, 2006
111. Nguyen Tri Hoan, 2005
112. Hoan and Nghia, 2002

rangement with local farmers. Interestingly, the same local structure also has the discretion and power to offer incentives for farmers to grow hybrid rice seeds, thus benefiting the business arrangement itself in the process.

At present, Vietnam's strategy is to concentrate seed production in the south while massively promoting hybrid rice cultivation in the north. Since farmers in the south generally adopt the direct seeding method, the government has provided modified rice drum seeders to facilitate the sowing of the seeds to address the concern on increased labor requirement during the planting stage.[113] To intensify the local production of hybrid seeds and thus reduce dependence on seeds imported from China, the agricultural extension department of MARD has set up model hybrid rice farms both in the northern and southern regions of the country for the purpose of demonstrating the techniques in growing hybrid rice and to showcase the potential benefits, especially in terms of higher yields. With these efforts, the government hopes to supply at least 70 percent of the domestic requirements for hybrid seeds by 2010.

iv. Domestic Distribution and Regional/International Trade on Hybrid Rice Seeds

The seed yield of hybrid rice in Vietnam ranges from 1.5 tons per hectare for autumn harvests to about 2.4 tons per hectare for the spring harvest. While increases in average seed yield have been observed, domestic seed production is still not sufficient for distribution at the local level to cope with the local demand. Farmers in the north often complain of unsteady seed supply or difficulty in buying hybrid seeds during planting season. To meet the local demand for hybrid rice seeds, the government permits public enterprises and the private sector seed companies to import hybrid seeds from China to meet the deficits.

There are no official statistics on the actual volume and value of hybrid rice seeds imported by Vietnam from China annually, but agriculture officials put it at around 10,000-12,000 tons representing some 80 percent of the total domestic requirements for hybrid seeds every year.[114] One public enterprise in Yunnan province engaged in hybrid seeds production and trade, Jin Rui Seeds, claim that the company exported a total of 500 tons of hybrid seeds to Vietnam in 2005.[115] Some observers estimate that the government of Vietnam spends around VND 20 billion every year to import hybrid rice seeds from China.[116]

In 2001, about 12,000 tons of the total 14,400 tons seeds sown by Vietnamese farmers were imported from China. Meanwhile, the gap between local seed requirements and seed production has gradually decreased in

113. Buu, 2004
114. Nguyen, 2005; Tran, 2005
115. Lu, 2006
116. Nguyen Ngoc Trinh, 2005

recent years. By 2003, the seed requirement of Vietnam for hybrid rice was about 16,000 tons of which about half (8,400 tons) was imported from China. The government is aiming for self-sufficiency in hybrid seeds production by producing about 24,000 tons of seeds within the country by 2005.[117] Table 4 shows the area and yield of F1 hybrid rice seed production in Vietnam from 1992 to 2004.

Table 4. Area and Yield of F1 Hybrid Rice Seed Production in Vietnam, 1992-2004

Year	Area (ha)	Yield (kg/ha)	Output (ton)
1992	173	302	52.25
1993	154	541	83.64
1994	123	484	59.53
1995	101	972	98.17
1996	267	1,751	467.52
1997	410	2,200	902.00
1998	340	2,200	750.00
1999	455	1,700	773.00
2000	620	2,300	1,426.00
2001	1,450	1,700	2,400.00
2002	1,600	2,400	3,840.00
2003	1,700	2,050	3,485.00
2004	1,500	-	-

Source: MARD, cited in Nguyen Tri Hoan, "Success on Development of Hybrid Rice in Vietnam, 2004

While the research and development in hybrid rice in Vietnam is virtually the sole domain of public research institutions at present, the commercial distribution and importation of hybrid seeds are shared with the private sector. Fledgling seed companies that came from state-owned enterprises, dominate the hybrid rice seeds business in Vietnam in partnership with their counterparts in China.

The national seed companies operate locally through their local channels at the provincial and district levels, through local state-owned seed enterprises that are registered with MARD. The local counterparts of the national seed companies distribute and sell hybrid seeds to farmers down to the commune level.[118] The government does not give special permits to companies for the importation of hybrid rice seeds since this is already covered by their permit that allows them to conduct business in Vietnam.

Agriculture officials in Vietnam admit that complaints of farmers on the grain quality of hybrid seeds from China persist, but the hybrid varieties imported in recent years have improved qualities that make them more

117. Hossain et al 2003
118. Tran, 2005

acceptable to local farmers and consumers.[119] More than the quality of the grain, complaints in recent years were more on the quality of the hybrid seeds imported from China which in some cases have failed due to poor quality. The government has acted on these complaints and the private seeds companies responsible for the importation of poor quality seeds were made liable and required to compensate the farmers.

v. Contribution of Hybrid Rice in Overall Rice Production and Trade

From a mere 100 hectares in 1991,[120] the land area devoted to hybrid rice production in Vietnam has jumped to 600,000 hectares in 2003, mostly located in the Red River Delta in northern Vietnam.[121] Average yield of hybrid rice was reported to be 6.3 tons per hectare in 2003 and down to 6.04 tons in 2004. Compared to the national average rice yield of 4.2 tons per hectare, hybrid rice presented a yield advantage of around 40 percent on the average.

The area for hybrid rice seed production also increased from 267 hectares in 1996 to 620 hectares in 2000. Seed yield increased from 1.75 tons per hectare to 2.3 tons per hectare, while seed production of hybrid rice rose from 467.5 tons to 1,426 tons in the same period. Table 5 shows the steady increases in area and yields of hybrid rice in Vietnam from 1992 to 2004.

Table 5. Area and Yield of Hybrid Rice Commercial Production in Vietna, 1992-2004

Year	Annual		Spring Season		Summer Season	
	Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)
1992	11,094	6.22	1,156	7.20	9,938	6.10
1993	34,648	6.75	17,025	7.02	17,623	6.50
1994	60,077	5.84	45,430	6.26	14,647	4.54
1995	73,503	6.14	35,598	6.35	33,905	5.91
1996	127,713	5.85	60,416	6.71	67,327	5.07
1997	187,700	6.35	110,802	6.56	77,000	6.14
1998	200,000	6.50	120,000	6.70	80,000	6.30
1999	233,000	6.47	127,000	6.50	106,000	6.43
2000	435,508	6.45	227,615	6.50	207,893	6.37
2001	480,000	6.44	300,000	6.60	180,000	6.30
2002	500,000	6.30	300,000	6.50	200,000	6.00
2003	600,000	6.30	350,000	6.45	250,000	6.00
2004	577,000	6.04	350,000	6.45	277,000	5.40
2005	-	-	360,000	6.57	-	-

Source: MARD, cited in Nguyen Tri Hoan, "Success on Development of Hybrid Rice in Vietnam", 2004 (source: Report Hybrid rice production - Department of Agriculture, MARD 26 June 2005)

119. Nguyen, 2005
120. Hoan and Nghia, 2002
121. GRAIN, 2005; Nguyen, 2005

At the national level, average rice yield in Vietnam increased from 2.13 tons per hectare in 1975 to 2.9 tons per hectare in 1998 and 4.2 tons per hectare in 2000. Yield of up to 11 tons per hectare per year in two to three croppings were reported in some provinces.[122] Rice production, on the other hand, has increased from 15.9 million tons in 1985 to 32.7 million tons in 2000, with an average increase of more than one million tons of rice each year. Rice exports have been estimated to be 3-4 million tons annually.

In terms of yield, official figures show (see Table 3) that hybrid rice has an actual field performance yield advantage of at least 1 ton per hectare over their inbred counterparts in 2001. The difference was, in fact, higher in 1996 and 1997 when the average yield of hybrid rice varieties, mostly imported from China, was even more than double that of inbreds. The figures show hybrid rice yield in Vietnam has even declined in the still-limited areas where they are cultivated despite the fact that the technology has not even reached a decade-old in the country. This could be explained by the fact that most hybrid rice varieties released in Vietnam are varieties that have long been commercialized in China and may have already breached their optimum yield ceiling.

The contribution of hybrid rice in the overall rice production and trade of Vietnam is still far from significant, while its hectarage and production grew impressively over a ten year period since the revitalization of the government's interest on the technology in 1992. Hybrid rice accounts for 18 per cent and 6 per cent of the rice growing areas in northern Vietnam and in the country, respectively, in 2001. But its share in the total rice production of the country in that year is about 9 percent only.[123] There are no available data on the volume of hybrid rice exported by Vietnam in a given period.

An analysis of the rice industry in Vietnam in 2004 by Haughton et al revealed that nearly 60 per cent of the growth in rice output between 1993 and 1998 may be attributed to conventional factors like irrigation and fertilizers. At least nine out of ten rice farmers in Vietnam used chemical fertilizers, making Vietnam as one of the highest consumer of inorganic fertilizer in the whole of Southeast Asia.[124]

The remaining segments of the overall output growth in rice is attributed to improvements in management, water control, and in the choice of seeds used. Through the promotion of hybrid seeds, Vietnamese authorities hope to increase the value of the contribution of seeds used in the overall output growth in rice, despite the fact that hybrid rice technology does not in any way alter the inorganic fertilizer-dependent farming systems in Vietnam and even intensifies its use in many cases.

122. Hoan and Nghia, 2002
123. An, 2002
124. Nielsen, 2003

vi. Impacts of and Issues on the Hybrid Rice Program

Because of the inferior quality of hybrid rice seeds compared to inbred seeds particularly in terms of taste, many farmers in Vietnam encountered serious problem in marketing their produce especially in the north and in the central regions where the country's vast rice areas are located.[125] The Chinese hybrid rice adapted in Vietnam to augment the scarcity of locally-produced seeds, were susceptible to ragged stunt virus and brown plant hopper especially in the south and bacterial leaf blight in the north, adding to the woes of farmers who opted to plant hybrid seeds.

Another issue is the high cost of hybrid seed production which, at present, is resolved by the subsidies provided by the government, specifically from the provincial and district levels. These are in the form of direct subsidies and indirect subsidies from the central government through research, development and extension support. If the government withdrew the direct subsidies, the selling price of hybrid rice may increase to compensate for the costs involved in providing all the inputs requirements in producing hybrid seeds.

Being largely dependent on hybrid rice seeds imported from China that supplies at least 80 percent of the needs for domestic hybrid seed, the most concrete issue facing the promotion of hybrid rice in Vietnam is the monitoring of the quality of seeds being sold commercially. Complaints from farmers and local governments on poor seeds quality that resulted to crop failure and severe losses in income opportunities were common in areas where hybrid rice is produced. The Department of Agriculture under MARD is responsible for addressing these complaints and ensuring that the seed company that imported the seeds from China would compensate those affected or would otherwise be legally liable. The importing company then runs after the company in China that produced the seeds to pay for the compensation being demanded by the complainants in Vietnam.

In a recent case in Hat Tay during the 2004-2005 planting season, the seed company and its Chinese partner were pressured by the government to compensate local farmers and authorities for poor quality seeds in the tune of VND 3-4 billion. It was roughly equivalent to the annual budget of MARD for agricultural extension.[126]

To address the problems on the poor quality of hybrid seeds, MARD has invested in training agricultural technicians on seed quality monitoring, even sending some staff to IRRI to acquire the necessary skills. Stricter guidelines were imposed in regulating the entry of imported hybrid seeds as well as monitoring the quality of those that are approved for commercial releases. The evaluation and approval of potential hybrid varieties for commercial release in Vietnam falls under the mandate of the Department of

125. Hossain et al 2003
126. Nguyen, 2005

Agriculture which is also under MARD (Tran, 2005). Technicians do random sampling from imported batches and test them in the field to assess the quality of seeds. MARD officials noted that the investment seemed to have paid off since there are much less complaints on poor hybrid seeds quality in recent years compared to the earlier years of hybrid rice adoption in Vietnam.

An emerging serious problem in the research and development of hybrid rice in Vietnam is the increasingly stringent application of intellectual property rights (IPR) on seeds in China that equally applies to hybrid rice seeds. Since Vietnam depends on Chinese hybrids for at least 80 percent of its annual domestic requirements of hybrid rice seeds and virtually all the parental lines that research institutions use in hybrid rice development, this policy development has grave long-term implications on the country's hybrid rice research agenda. The director of HRRC lamented that the new hybrid rice varieties coming from their northern neighbor which have good grain quality, such as the variety *Dei Zhu 527*, is protected by plant breeders' rights (PBR) in China.[127] This particular variety sells higher in the local market, at VND29,000 (US$1.90) per kilo, and would require a licensing agreement with the PBR owner for any entity to use its parental lines.

To protect the promising hybrid rice varieties that it has developed, namely *VN 20* and *TH3-3*, HRRC has applied for plant breeders' rights under Vietnam's law. The head of HRRC defended the move as an important form of protection over the products of public sector research against infringement and misappropriation and not for the economic benefit of the institute.[128] He also explained that PBR on hybrid varieties can help encourage private sector investment in further research and development in hybrid rice, and can also facilitate the transfer and exchange of technology among public research institutions and private companies engaged in the business.

d. Description and Analysis of the National Hybrid Rice Program

i. National Policy on and Rationale for Hybrid Rice Promotion

The national rice policy of Vietnam is focused in ensuring food security for the country's growing population, especially for the poor, most of whom live in the central and northern highlands. As in many Asian countries, food security in Vietnam is traditionally equated with rice self-sufficiency. While the surplus rice in the Mekong River Delta in the southern portion of Vietnam is allotted for export, a large number of provinces in the central and northern regions suffer from food deficit throughout the year. Rice deficit in the northern region even reaches up to 1.0-1.5 million tons annually that is ironic for a country that exports at least 3 million tons of rice to the world market every year.

127. Nguyen Tri Hoan, 2005
128. ibid.

Underdeveloped infrastructure and transportation system hindered the movement of rice from surplus to deficit area and increased the cost of distribution of food.[129] This situation was actually used by the government as a main justification to launch its national hybrid rice program in 1992, specifically aimed at achieving self-sufficiency in food at the provincial level for the remote and mountainous regions and for the provinces with small average size of farms in Vietnam.

Hybrid rice is widely regarded as a readily available option to increase rice production by about 15-20 per cent. Through the promotion of hybrid rice in the poorer northern provinces, the region is expected to reduce its dependency on rice surplus from the southern region that could then be secured for the export market. This explains why the north and central parts of Vietnam have large adoption rate of hybrid rice among the farmers.

At present, hybrid rice is cultivated in all 24 provinces in the northern regions and majority of the provinces in the central highlands.[130] Because of the topographic features of the central and northern regions of Vietnam, with vast mountainous areas peopled by diverse ethnic communities, most of the hybrid rice varieties developed by Vietnamese scientists, and even those adapted from southern China that shares similar topography, are suited for upland conditions that enjoy sufficient rainfall and fairly cool climate throughout most of the year.

The Ministry of Agriculture and Rural Development (MARD) of Vietnam has developed a hybrid rice development plan that aims to cover at least 500,000 hectares of hybrid rice areas by 2005 and will eventually double to 1 million hectares in 2010.[131] By 2002, this earlier target has already been surpassed, according to official statistics. Table 6 (next page) presents the distribution of areas and the average yield per hectare of hybrid rice production in Vietnam.

The draft hybrid rice development plan has already been submitted by MARD to the National Assembly that has yet to approve the blueprint and allot resources for its implementation.[132] Among many proposals, the policy prescribes the removal of all direct subsidies for hybrid rice production by 2006, including those that are currently offered by provincial and district governments. However, it proposes the continuation of subsidies for hybrid rice seeds production to further increase domestic production and reduce dependence on imported Chinese hybrids.

While still not officially adopted, the proposed program is claimed to have already attained some of its targets. By 2004, hybrid rice cultivation in the country is right on target at more than 600,000 hectares. Attainment of the 1 million hectare target by 2010 is mainly anchored on a multi-faceted strategy involving intensive training of agricultural technicians, extension

129. Hoanh et al 2002 as cited by Hossain et al 2003
130. Hossain et al, 2003
131. Hoan and Nghia, 2002
132. Nguyen, 2005

Table 6. Distribution and Average Yield of Hybrid Rice in Vietnam, 2002

Province	Annual		Spring Season		Summer Season	
	Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)
Nam dinh	97,062	-	52,480	7.29	44,300	-
Thanh hoa	96,400	6.71	68,400	6.80	28,000	6.50
Nghe an	59,000	6.10	53,000	6.13	6,000	5.80
Ninh binh	45,326	5.90	23,750	6.20	21,576	5.60
Ha nam	31,080	5.90	14,300	6.00	16,780	5.80
Hai phong	17,100	6.35	8,700	6.40	8,400	6.30
Thai binh	28,200	64.4	15,500	7.00	12,700	6.00
Phu tho	35,000	53.6	19,000	5.50	16,000	5.20
Yen bai	21,000	6.20	12,000	6.50	9,000	5.80
T. quang	18,550	5.74	9,550	5.75	9,000	5.74
Noi khac	51,614	6.10	23,370	6.45	28,244	5.90
Total	**500,000**	**6.30**	**300,000**	**6.50**	**200,000**	**6.00**

Source: Department of Agricultural Extension, MARD, Vietnam

workers and farmers in growing hybrid rice seeds, setting up of numerous demonstration farms that set as model to encourage farmers to adopt the technology, and the extension of subsidies that come in different forms including direct subsidies on seeds and inputs and other economic schemes.

MARD officials interviewed for this study in July 2005 clarified that the draft hybrid rice development plan, yet to be approved by the National Assembly, only serves as a guide for government agencies involved in hybrid rice development and promotion. The targets, they say, have been reviewed and the 1 million mark by 2010 is not being seriously pursued anymore even if the performance by 2005 has been quite encouraging. Because of the decentralization policy of the government and the removal of the subsidies from the national government, the decision on targets in hybrid rice coverage and incentive schemes now primarily rests on the provincial and district governments.[133] There is an on-going debate among the decision-makers at the national level on whether or not there is a need to expand the current area for hybrid rice production in view of the public investments required in pursuing these targets while recognizing that there is a need to increase rice production for food security and to earn from rice exports.[134]

ii. Promotion and Incentives Extended by Government to Seed Researchers and Seed Producers

All government support services for the research, development and promotion of hybrid rice in Vietnam are centralized at the HRRC. The govern-

133. ibid.
134. Nguyen Ngoc Kinh, 23 July 2005

ment has provided 100 per cent financial support to HRRC on a "pay-back" policy to improve its seed production infrastructures. The "pay-back" scheme operates by providing every farming household with 5 kilograms of seeds and 50 kilograms of chemical fertilizers as loans in-kind. Farmers then have to pay their loans in the form of paddy rice after harvests. The government has also provided a 30 per cent subsidy in the form of free parental line seeds and GA3 to farmers involved in hybrid seeds production, as well as support for the procurement of chemical fertilizers to reduce the cost of production of hybrid seeds.[135]

Apart from credit support, HRRC also produces, purifies and distributes seeds of parental lines to public and private seed companies, farmers' cooperatives and provincial cooperatives, for the production of hybrid seeds (F_1). Parental lines seeds are priced at about US $2.5 per kilogram. In addition, HRRC provides technical assistance to the seed companies, farmers' cooperatives and communes and enters into written contracts with entities involved in seed production to guarantee the quality of hybrid seed produced at the local level. In return, seed companies and farmers pay fees to the HRRC for the technical services rendered. In fact, from 1999-2002, the VND1.9 billion initial capital provided by the government to HRRC as financial support for the seed production program has already generated VND 2.5 billion from the sales of parental seeds and fees for the technical services provided by HRRC. In the contract that it signed with hybrid seeds growers, HRRC is obliged to pay compensation to seed producers/ cooperatives in cases of failures in seed production.

In terms of direct government subsidies to farmers who have adopted hybrid rice, the national government, through MARD, used to extend subsidies on hybrid rice seeds until recently. The subsidies on hybrid seeds coming from the national government used to follow a socialized scheme that gives priority support to farmers in the poorest areas adopting the hybrid rice technology. Under the socialized seed subsidy scheme that was adopted in 2000, hybrid rice farmers in mountainous regions receive 100 percent subsidy on seeds from the government while those in poor areas in the central highlands receive 50 percent subsidy and the farmers in other areas get a 30 percent subsidy on hybrid seeds.[136] After two years, however, the seed subsidy scheme from the national government was removed largely because of feedbacks received by the national government on corruption and unsustainability of the arrangement.

In 2003, the national government issued a decree removing all direct subsidies in hybrid seeds through national agriculture extension system but did not prevent the provincial and district governments from offering such subsidies to farmers in their respective jurisdictions in the spirit of the de-

135. Virmani et al 2002
136. Nguyen, 2005

centralization policy adopted by the government of Vietnam in the late 90s. Agriculture officials admitted that there reluctance of the local governments to remove direct subsidies to farmers planting hybrid rice is understandable because of the political and economic benefits that it brings to their constituents, as well as to some corrupt officials. The national government, on the other hand, continues to extend subsidies to farmers on the costs of chemical fertilizers and pesticides, on top of the support on irrigation facilities. The agricultural extension department of MARD also subsidizes the production of hybrid seeds at an average rate of VND5.5 million per hectare that comes in the form of seeds, fertilizers, training of farmers and technicians, and the establishment of demonstration/model farms.

While seed subsidies from the national government to hybrid rice farmers have been removed, the MARD continues to extend direct subsidies to farmers who grow hybrid seeds for commercial release. In the poorer mountainous regions in the north, the agricultural extension office gives 60 percent subsidy on the purchase of parental and restorer lines and 40 percent subsidy for the purchase of the required inputs such as gibberelic acid and fertilizers (Nguyen, 2005). For the delta regions, the government shoulders 20 percent of the cost of parental lines required to grow hybrid seeds and 40 percent of the costs of inputs. All in all, the MARD's extension arm supports the efforts of farming households in about 1,500 hectares of land across Vietnam to grow hybrid rice seeds that it later distributes to farmers who adopt the technology. To increase the domestic production of hybrid seeds, MARD also offers incentives to provinces and districts that attained a certain target (usually, 100 hectares) for hybrid rice seeds cultivation within their jurisdictions.[137] The local authorities, in turn and upon their discretion, set aside a significant amount from their local budget to offer as much as 50 percent subsidy on the costs of parental seeds in order to encourage local farmers to plant hybrid and will allow the locality to reach its target and earn the incentives from MARD. These incentives are allotted with a substantial share in the total budget of MARD for agricultural extension every year amounting to about VND 5-7 billion.

Incentives schemes are not only limited to farmers involved in hybrid rice seeds production and adoption of the hybrid rice technology. The government, through MARD, also provides incentives in the form of cash reward to researchers and rice breeders involved in the development of commercially viable hybrid rice varieties (Nguyen, 2005).

137. Nguyen, 2005

iii. Response of Farmers to the National Hybrid Rice Program Over the Years

From the disappointing performance of the first hybrid rice varieties introduced from China in the late 70s that yielded well but have poor grain quality, the hybrid rice seeds in the Vietnamese market now released by the public research institutes or adapted from China have gradually gained wide acceptance among rice farmers in Vietnam. Adoption rate, however, is much higher in the northern and central regions but not as much in the southern areas where high-yielding and good quality inbred varieties promoted by the government remain popular.

One reason cited for the low adoption of hybrid rice among farmers in southern Vietnam is the predominance of larger farmlands and the prevalence of direct-seeding method of crop establishment that reduces labor cost in sowing stage. Because hybrid rice seeds cost much higher than the inbred varieties and the seed rate per hectare is higher under direct seeding, rice farmers in the river delta in the south prefer the less costly cultivation of inbred varieties. For the same reasons, hybrid rice is attractive to the small and marginal farmers in the northern and central highlands of Vietnam because the higher yields enables them to produce more food for the family from much smaller land holdings.[138]

The acceptance by Vietnamese farmers of hybrid rice in the years following the revival of government's effort on the technology has increased due to a number of factors. The higher yield offered by hybrid rice, that has around one ton per hectare yield advantage over inbred varieties in Vietnam, remains the main attraction of the technology especially for farmers in the north where the agro-climatic conditions and topography limit the potentials of most rice varieties. With the climatic factor crucial in growing hybrid rice, its wider acceptance in the sub-tropical condition in the north is understandable.

The considerable investments poured by the government in promoting hybrid rice among local farmers through aggressive economic incentives undoubtedly facilitated the wide adoption of the technology in recent years. The release of new hybrid rice varieties in recent years with better grain quality, both coming from the public research institutions in Vietnam as well as those imported from China, has also contributed in breaking down the initial resistance of local farmers to adopt the technology.

The improvement of overall living standards in Vietnam over the past decade has also contributed in allowing farmers to choose over farming technologies available in the market, in addition to the increased public investments in agricultural infrastructures and services. Vietnam has a high ratio of irrigated lands especially in the south and sufficient water sources along the several river deltas in its territory. The presence of these infra-

138. Hossain et al 2003

structures, along with the government's sustained investments in rice breeding in general, helped in buffering the actual costs of hybrid seeds as they become commercially available to farmers.

Still, the difference in the price of hybrid seeds compared to inbreds is very substantial, between five to ten times. The argument that the less seed rate requirement of hybrid seeds, at 30 kilograms per hectare compared to the 80-100 kilograms per hectare in inbred varieties, on top of the attraction of a minimum additional ton per hectare in harvest, could not easily convince ordinary farmers to shift to hybrid rice production if not for the incentive packages that come with the technology.

Farmers are also encouraged to grow hybrid rice seeds for the domestic market largely because of the incentive packages offered by provincial and district governments, especially in the northern region. While hybrid seeds production is labor intensive, expensive and risky, the incentive schemes offered by local governments such as 50 percent support price for parental seeds, input subsidy and market assurance, have encouraged farmers to engage in this knowledge- and skills-intensive endeavor in 1,500 hectares across Vietnam by 2004.

F_1 hybrid production in the country averages 2.5 tons per hectare but sells at 5 to 10 times more than ordinary inbred varieties. While inbred varieties sell at about VND 4,000-4,500 per kilogram in local markets, hybrid seeds fetch around VND 25,000-30,000 per kilogram at times when there is sufficient supply and up to VND 40,000 per kilogram in times when the supply cannot meet domestic demands.[139] The potential to earn more income from their small farms, added with the offers of attractive incentive schemes from the local governments and the technical support from national government agencies, all contributed to the attraction of hybrid rice seeds production among farmers in Vietnam.

iv. Role of the Public Sector

The government of Vietnam has allocated substantial human and financial resources for hybrid rice development and promotion mainly through the National Hybrid Rice Research Program launched in 1992 aimed solely for hybrid rice research and development activities in the country. The program then evolved into the present-day HRRC in 1994 under the supervision of VASI which was also given the responsibility to coordinate all hybrid rice research and seed production programs at the national level. The HRRC's main task is to coordinate activities of the extension agencies at the provincial level in charge of development of hybrid rice production program. It also coordinates with the universities and the public sector seed companies engaged in research, training and seed production.[140]

139. Nguyen, 2005
140. Hossain et al, 2003

The annual budget of the HRRC since its inception averages around VND 2 billion, the bulk of which goes to compensation for researchers and technicians, upgrading facilities, setting up trials and field experiments, securing parental lines, etc.[141] As the main backbone of Vietnam's hybrid rice research and development program, HRRC currently has 36 staff, that includes three PhD's, one professor and six MSc's. The HRRC receives an annual average budget of VND 2 billion from the central government to implement its mandate in research and development of hybrid rice.

Apart from the HRRC, several academic institutions and agricultural universities in Vietnam are also involved in hybrid rice research and development. Hanoi Agricultural University, for example, has recently released commercial hybrid varieties. As discussed lengthily in previous sections, the MARD, specifically its Department of Agriculture and Department of Agricultural Extension, is also directly involved in the promotion, extension, monitoring and regulation related to hybrid rice.

The HRRC, as the backbone of Vietnam's national hybrid rice program, is envisioned to become an independent income-generating public enterprise. Already, the government is starting to recoup its investments in establishing the center especially from HRRC's business in selling parental lines to farmers, cooperatives and private companies that engage in hybrid rice seeds production. The institute sells parental lines at around VND4,000 per kilogram for the female lines and half that price for male lines which growers can only use for one or two seasons.[142] The effort earns substantial income for the center especially since its capital investments, including the salary of its technical personnel, are paid for by the government.

While the public sector in Vietnam has made substantial investment in the research, development and extension in hybrid rice production, officials acknowledge the inherent limitations of the government in performing these functions, especially in the distribution and commercialization of hybrid rice seeds which require an efficient system. This assessment has motivated HRRC to enter into commercial distribution partnerships with the private sector.

In an initial agreement with the Southern Seeds Company, a former state-owned enterprise that has been equitized in recent years, HRRC will provide the parental lines of several promising *HT* hybrid rice varieties with good grain quality, high yield and resistance to bacterial blight while the company will produce the F1 seeds, market the seeds and distribute them to farmers through its vast network of local seeds enterprise.[143] The profit sharing arrangement resulting from the agreement is, however, unclear. To ensure that the partner company will not unscrupulously profit from the commercialization of these varieties that resulted from public sector research,

141. Nguyen, 2005
142. Nguyen Tri Hoan, 2005
143. ibid

HRRC officials claim that they explicitly stated a ceiling price for the commercial sales of the varieties to farmers.

v. Role of the Private Sector

Private companies, that are primarily national enterprises, are engaged in hybrid rice seeds distribution, importation and commercialization. In a limited scale, these companies are also involved in the production of F1 hybrid seeds using parental lines that they purchase from HRRC or import from China through their business partners. However, it is in the importation of hybrid rice seeds form China that comprises the bulk of business of national seed enterprises in hybrid rice.

Since the seeds produced by HRRC and other public research institutions are inadequate to meet the requirements for hybrid rice seeds at the local level, the government allows the importation of seeds by private sector seed companies to meet the local demand. As of 2002, there are three private seed companies engaged in hybrid rice seed business in Vietnam namely the T*rang Nong Seed Company, Southern Seed Stock Company,* and the Hung Nong Seed Company. Aside from importing solely from China and distributing seeds in the local market, these companies are also involved in the domestic production of hybrid seeds in a smaller scale. Since these private enterprises do not have their research and development efforts in hybrid rice, considered as a capital-intensive venture, they have not developed their own parental lines that specifically suit the local conditions and practices. Thus their involvement in the nascent hybrid rice industry is primarily limited to the importation seeds from China and distribution to the domestic market through their local conduits that connect directly to the provincial, district and commune governments. The three biggest private enterprises all have business partners in China that source out hybrid rice seeds that are then exported to Vietnam, while a minor component of their business involves the sourcing of parental lines from China which they use in domestic hybrid seeds production, while some are sourced out from HRRC. This limited production of hybrid rice seeds are done by companies in partnership with local cooperatives or directly with farmers at the commune level.

A study conducted by Hossain et al 2003 reported that nearly 41 per cent of the farmers in Vietnam obtain their seeds from the private sector companies engaged in seed production. On the other hand, about 18 per cent obtained their seeds from the cooperatives, 17 per cent from the public research institutions, and the remaining portion from other traders whose seeds are directly imported from China. It should be noted at this juncture that the private seed companies in Vietnam involved in hybrid seeds production and distribution are national firms that started off as state-owned enterprises that were later privatized when Vietnam adopted the *doi moi*

(liberalization) economic development strategy in the early 90s. The government still maintains about 20-50 percent stakes in these national companies that are envisioned to become fully private in the coming years. The full privatization for national and provincial seed companies recently started in 2003-2004 under the government restructuring program and in preparation for Vietnam's accession to the WTO.

At the provincial and district levels, the seed industry is still dominated by state-owned enterprises with only a few privately-owned businesses engaged in seed production and distribution. Largely because of the involvement of the government in establishing these so-called private enterprises and the substantial stake that it maintains in their current operations, they continue to dominate the seeds industry, particularly in rice which is considered a strategic agro-industry in Vietnam. The provincial and district seed enterprises are closely linked with the national seed companies whose products they distribute locally. Local seed companies are authorized by the government to source out seeds from the domestic market and even export directly. The role and functions of the local seed companies are mandated in a Decree issued by the National Assembly in 2004.[144]

While transnational agribusiness companies have already established their presence in Vietnam in recent years, none so far has significant share in the hybrid rice seeds business. Syngenta, for example, has expressed interest in collaborating with HRRC in the development and distribution of hybrid rice seeds but none has materialized so far. Bio-Seeds, a multinational agribusiness company primarily engaged in hybrid corn production in Vietnam since 1992, has started doing its own field trials on some hybrid rice varieties developed by HRRC that it hopes to distribute in the future if the company sees the profitability of such venture. Initial trial production by BioSeeds of HRRC hybrid varieties in 3-4 hectares have began in 2006 and the company expects to start marketing hybrid seeds shortly. Following its long experience in regional marketing of hybrid corn seeds, BioSeeds has made a proposal for exclusive production and marketing of particular hybrid rice varieties, called "One hybrid variety, One company strategy" developed by HRRC based on the assessment that it would not make business sense for any private company to develop hybrid varieties that are also being produced by other entities targeting the same market.[145] The company's Managing Director explained that exclusivity does not automatically result to monopoly, especially in countries like Vietnam where there are adequate state mechanisms to prevent private monopolies in strategic industries like agribusiness.

The interest of BioSeeds in hybrid rice seeds venture is a logical shift for a regional multinational company that specializes on hybrid corn that targets basically the same farmers in most cases. The company also has a long

144. Phu Tuc Commune, 2005
145. Jaisimha, 2005

experience in hybrid rice seeds development in India where it has commercially released several varieties, one of which has even been released recently in the Philippines.[146] It has built a wide seeds distribution network for hybrid corn seeds in Vietnam since 1992 that it hopes to tap in marketing promising hybrid rice varieties developed by HRRC. Its top official is very optimistic about the potentials of the hybrid rice seeds industry in Vietnam because of the farmers' wide acceptance that presents a lucrative market, and the presence of new hybrid varieties that possess superior grain quality. It even projects that it can even targeting the export of outstanding hybrid seed varieties to other countries in the region in the medium-term.

The national and local seeds companies in Vietnam have formed under the umbrella of Vietnam Seeds Association (VSA), that currently does not have foreign and transnational seed companies in its membership. VSA is a member of the Asia-Pacific Seeds Association (APSA), a regional network of seed companies including transnational seed corporations.

vi. Farmers and Farmer Organizations

The dramatic reforms in agricultural policy in 1988 have changed the policy environment of rice in Vietnam. Under Decree 10, households rather than commune were recognized as the main production units in agriculture. Prior to this, a contract system of farming, similar to the system operating in China since 1978,[147] was practiced in Vietnam where farmers were obliged to enter into a contract with a designated cooperative to produce a specific level of output on their land, then sold to the state for a fixed price. The cooperative would, in turn, deliver the required inputs to the farmers. Land use and crop choice decisions were made by the government, through the commune, without considering farmers' preferences and local market conditions.

Despite policy reforms, however, the agricultural scenario in Vietnam has not changed much in reality. Going with the old practice under the commune system, decisions on the choice of crops are still being made by provincial, cooperative and commune officials rather than by farmers themselves.[148] This is especially true in the northern provinces of Vietnam where farmers' cooperatives and communes still play an important role in farmers' decision on farm operations. Since the national government has committed to promote hybrid rice in the north region, the cooperatives and communes implemented the government decision at the local level. This explains the significant adoption rate success of hybrid rice in northern Vietnam where the government political structures at the local level continue to wield strong influence on peoples' lives, including decision on their farms that, on paper,

146. ibid
147. Haughton et al 2004
148. Nielsen, 2003

should now depend on each household. In contrast hand, in regions where the role of communes and cooperatives has minimal influence on farmers' decisions on farm operations and farmers are relatively free to choose what crop or variety to grow, such as the case in South Vietnam, hybrid rice was poorly adopted. Studies concluded that most farmers in South Vietnam are not convinced on the economic superiority of hybrid rice over the existing inbred varieties.[149]

The persistence of top-down decision-making in communes in Vietnam to this day was clearly demonstrated by commune and cooperative leaders in Ha Tay province (located just outside Hanoi) in an interview conducted for this study in July 2005. When asked about the performance of hybrid rice in the commune, the officials sang endless praises to the merits of hybrid rice being high yielding, cost-efficient, requires much less seed rate and less chemical pesticides, with very good grain quality, and even claiming that it is easy to plant and fetches higher price in the local market.[150] The local officials also claimed that they have not encountered any problem in planting and marketing hybrid rice since it was first introduced in the area in the 90s. Some of them even attributed the higher living standards in the commune to the benefits brought by hybrid rice. The agricultural technicians from MARD and district officials who were present in the meeting looked amused at this unquestioning praise heaped on hybrid rice, with some of them correcting that hybrid rice actually commands less price in the local market and reminding the local officials about some recent problems encountered by a neighboring commune on the poor performance of hybrid seeds imported from China. The MARD officials cautioned the researcher about the over-enthusiasm of some village officials in northern Vietnam to implement the national program on hybrid rice, a lingering attitude that they inherited from the top-down system in old Vietnam.

The officials of the cooperative in Ha Tay interviewed for the study claimed that despite the removal of all direct subsidies on hybrid rice production (including subsidies from the local governments since the commune is considered well off), local farmers continue to buy hybrid seeds because of the advantages that the technology provides especially the substantial yield advantage over inbreds, suitability to the agro-climatic conditions in the locality and longer storage life.[151] They also attest that the local consumers in Ha Tay prefer hybrid rice because it is easier to digest and the god quality is retained even if it gets cold. The cooperative even enters into regular contract with the provincial seed company to import hybrid rice seeds for distribution to its members. The contract indicates the quantity, quality and specific hybrid varieties that the cooperative wants to buy in cash without receiving any support from the government. With its long experi-

149. Hossain et al 2003
150. Phu Tuc Commune, 2005
151. Phu Tuc, 2005

ence in planting hybrid rice since the early 90s, farmers in the commune have not encountered any problem with the quality of hybrid seeds that they import from China or sourced out locally.

The high praises heaped by cooperative officials in Phu Tuc Commune in Ha Tay province are actually tapered down by agriculture officials and other seed industry observers. An official of the Vietnam Seed Association (VSA) explained that the economic efficiency of hybrid rice is not as high as originally expected with a maximum yield advantage over inbreds ranging only at 15-20 percent that does not provide much profitability to farmers.[152]

INDONESIA: Cautious and Externally-Pushed Adoption of Hybrid Rice Technology

a. Overview of the National Rice Sector

Rice is considered the backbone of Indonesian agriculture. As a staple food, it provides 66 per cent of the calorie requirements of the country's 204 million people.[153] It is the major source of income of millions of Indonesians and occupies 75 per cent of the cultivated area. Irrigated lowland devoted to rice accounts for about 5 million hectares, the third largest in the world next to China and India. Most of the irrigated land is distributed in the densely populated area offering high labor availability.

Rice production in Indonesia increased steadily from 12.3 million in 1970 to 25.8 million in 1985 owing to the wide adoption of high yielding varieties promoted by the government under the Green Revolution, as well as the implementation of a special intensification program characterized by high application of chemical inputs to obtain maximum yields. This tremendous production increase made Indonesia self-sufficient in rice since 1984.[154] However, paddy production and yields have exhibited stagnant trends in the past decade. From an average yield of 4.35 tons per hectare and paddy production of 46.64 million tons in 1994, the figures barely increased to 4.58 tons per hectare and 53.1 million tons respectively, in 2004.[155]

In a complete reversal of trends in the previous decade, there was a drastic increase in rice importation in Indonesia within the following ten-year period, from 1993 to 2003. FAO recorded about 24,318 tons of imported rice in 1993 which soared to as much as 4.75 million tons in 1999.[156] However, the figure went down to 1.63 million tons in 2003, and the country has since become rice self-sufficient. Recently, in an effort to pressure the provinces to further increase rice production, the government has declared a rice import ban throughout the country except for two provinces that were

152. Nguyen Ngoc Kinh, 2005
153. Krishnaiah, 2002
154. Suprihatno and Satoto, 1998
155. FAOSTAT data 2004
156. FAOSTAT data 2004

devastated by the December 2004 tsunami. The ban expires on 30 June 2005, unless the government decides to continue the policy.[157] As the country's rice production meets the domestic demand of its burgeoning population, rice exports have consistently declined over the past five years. Indonesia has attained rice self-sufficiency level in 2004/2005 and has even started to export rice to the Middle East in limited scale.

As an important commodity in Indonesia, rice also enjoys subsidies from the government by means of input support and price protection. Despite being an active party to the General Agreement on Tariffs and Trade (GATT) since 1960 and an important force in the negotiations for the Uruguay Round (and later in the WTO) where countries agreed to fully liberalize trade, Indonesia has maintained highest tariffs on rice at 180 per cent. The government has kept its policy of extending subsidy to farmers for the purchase of chemical fertilizers since the 70s. To cushion the poor from the devastating impact of the depreciation of the Indonesian rupiah that pushed food prices up as a result of the financial crisis in 1997, the government introduced the so-called Special Market Operations for rice, under which rice was sold at 60 per cent of the market price.

b. State Policies on Seeds

Seeds Standards

Indonesia has, generally a well-established seed system for conventional inbred varieties of rice. About 60 per cent of the total rice cultivation area, mostly in irrigated lowlands, uses certified seeds. Two state-owned companies, PT. Sang Hyang Seri and PT. Pertani, produce about 80 per cent of the certified seeds of rice marketed in Indonesia and the rest is produced by some public seed farms and some private seed growers. The seed inspection and certification agency, which has an office in each district, conducts the seed certification process.[158]

Access and Benefit Sharing

Indonesia is a signatory to the CBD and has adopted a national law on biodiversity conservation in 1996. The country has no specific law on regulation of access to and benefit-sharing arising from the commercial use of biological diversity, but is a member of the Like-Minded Group of Mega-Diverse Countries in the CBD that is pushing for an international regime on access to biodiversity.

Intellectual Property Rights

Indonesia adopted its Patent Law in 1991. The Law prohibits patents for inventions *"on a production process or product of food and drink(s), including products in the form of raw material made by chemical processes with the aim to*

157. http://www.riceland.co.th/news.html
158. Suwarno et al 2003

produce food and drink for human and for animal consumption; an invention on a new species or variety of plant or animal or any other process that can be used to cultivate plants or animals, including products thereof", which means that new plant varieties cannot be patented.[159]

However, Indonesia adopted a Plant Variety Protection Law in 2001 as part of the country's compliance to the Agreement on Trade Related Intellectual Property Rights (TRIPS) of the WTO and as a result of pressures from the terms of the structural adjustment programs imposed by the International Monetary Fund (IMF) in the late 90s following the crippling financial crisis in 1997. Without signing on to the UPOV, the country patterned its PVP Law after the 1991 Convention of the UPOV that provides stringent intellectual rights protection on protected varieties. The law provides a token concession to farmers by allowing them to save, reuse, share and exchange seeds from protected varieties in their own landholding that is optionally provided in UPOV 1991.

Farmers' Rights

The country is not a signatory neither a party to the ITGRFA although the public research sector has been pressuring the National Assembly to ratify the agreement.

Biosafety

Indonesia is party to the Cartagena Protocol on Biosafety that governs the transboundary movement, handling and management of genetically modified organisms. The government has adopted regulations governing genetically modified organisms but has not legislated those policies. Indonesia's biosafety regulation basically outlines the requirements and processes for the experimental research and development efforts involving GMOs, as well as commercialization that has so far been limited to the local commercial cultivation of *Bt* cotton in South Sulawesi some years ago and has since stopped due to commercial failure.

c. State of hybrid rice grain and seed production in the country

i. Development of hybrid rice in the country

The development of hybrid rice in Indonesia started with the introduction of Chinese cytoplasmic male sterile (CMS) lines in the country in 1981 by IRRI. Subsequently, IRRI-bred CMS lines were periodically introduced. Majority of the Chinese CMS lines did not perform well in the fields as they were susceptible to major tropical pests and diseases, particularly sheath blight. The IRRI-bred CMS lines, although observed to be resistant to some

159. IPPD,1996

major pests and diseases, have shown poor combining ability, low out-crossing rate, and unstable pollen sterility.[160]

Largely because of these technical challenges that local rice scientists have so far failed to hurdle, work on hybrid rice in Indonesia remains at the academic or research level two decades after its initial introduction into the country. The slow progress of hybrid rice development in the country was mainly attributed to the lack of commercially available lines although some newly introduced CMS lines have been found to be stable and phenotypically acceptable. This slow progress of hybrid rice research has discouraged the government of Indonesia from pouring additional investment on this technology option.

The self-sufficiency in rice enjoyed by Indonesia in the past two years also explains the lack of motivation on the part of the government to aggressively pursue hybrid rice technology to boost rice productivity. While many of the high-yielding inbred varieties released by IRRI and the national agricultural research system are already observed to be experiencing yield plateau in the fields, the current rice yields and the grain quality offered by these varieties are still sufficient to meet domestic demands. Conscious of the need to develop new varieties with higher yield and provide better grain quality, Indonesian rice scientists continue their research and development efforts to develop new varieties for commercial release, but more along the inbred path.

ii. Status of research on hybrid rice

Hybrid rice research in Indonesia began in 1983, with the initial objective of exploring the prospects and problems of using this technology that has worked wonders in populous China. But due to the largely technical problems cited in the previous section, progress in hybrid rice research in the country has been considerably slow, with most research activities focusing only in the evaluation of introduced hybrids and parental lines from IRRI, China and other countries. With disappointing results from the field evaluation of these varieties, the government has drastically reduced the budget for hybrid rice research since 1993 (Suprihatno and Satoto, 1998). However, with some pressure, financial support and technical assistance from the Asian Development Bank (ADB), the government decided to re-intensify its research and development efforts in hybrid rice in 1998. The official justification for the renewed interest on the technology was the inspiring successes in the development and commercial use of hybrid rice technology outside China, specifically in India, Vietnam, and the Philippines.

With the financial and political backing of the ADB's "Development and Use of Hybrid Rice in Asia", that was implemented in two phases in a

160. Suprihatno and Satoto, 1998

few countries in Asia with interest in hybrid rice from 1998 to 2004, the government released two hybrid varieties introduced in 2002. IR 58025A/IR53942 and IR58025A/BR827-35, locally named *Maro* and *Rokan*, respectively, were officially released. Both were developed by the Indonesian Institute for Rice Research (IIRR) from parent lines provided by IRRI through the ADB's hybrid rice project. The releases of IIRR-developed hybrids were prominently announced by the President of Indonesia himself during the National Rice Week in March 2002. Five other hybrids, *Intani 1, Intani 2, Miki 1, Miki 2,* and *Miki 3,* were released by private seed companies, mostly using parental lines from China and a few from IIRR.

Although the two hybrids, *Maro* and *Rokan*, enjoyed a yield advantage of about 1.0-1.5 tons per hectare over the high yielding inbred check variety IR64 in suitable conditions, this edge was not consistently demonstrated in yield trials across locations and seasons. The public researchers themselves who did the evaluation on these introduced lines admit that these new hybrids are susceptible to the major rice pests and diseases in Indonesia, including brown plant hopper (BPH), bacterial leaf blight (BLB), and rice tungro virus (RTV). It prompted recommendations to disseminate these hybrids only in suitable conditions where these major pests are not endemic.[161] Many other hybrids from IRRI, China and the Philippines have been selected awaiting further field evaluation before release.

The development of CMS lines more suitable to conditions in Indonesia is in progress while rice researchers are also exploring the potentials of another promising technology approach in increasing yield potential using the new-plant-type (NPT) lines. Indonesian scientists have been doing research on NPT in collaboration with IRRI that have shown promising results in terms of yield and said to be at par with hybrid rice varieties. They envisioned the use of NPT lines to produce promising hybrid rice varieties in the near future.[162] Because of the diversity of the agro-ecosystem in Indonesia and the need to continuously increase rice production to cope with the increasing population, national researchers believe there is a need to maximize the potentials of available technologies and not be limited to a single option.

At present, there are 17 hybrid rice varieties that have been commercially released in Indonesia since 2002, that is quite an impressive progress since the government's interest in hybrid rice development was revived only in 1998. The IIRR, the public research institution principally responsible for research and development on hybrid rice in the country, has released another two varieties, *HPA-3* and *HPA-4*, in 2004, along with several other new varieties from the private national and transnational seed companies (Las, 2005).

161. Suwarno et al, 2003
162. Las, 2005

iii. Hybrid rice seed production and delivery system

Since hybrid rice technology is nascent in Indonesia and would not have been seriously explored by the government had it not been for ADB's initiative, efficient seed production and delivery system of hybrid rice seeds has yet to be established. The Ministry of Agriculture has proposed a seed system for seed production and quality control of hybrid rice produced by the public sector, following the seed system for conventional inbred varieties with specific modification based on the specific requirements of the technology. The elements and flows of this proposed seed system are largely anchored on the role of the public sector as key provider of the breeder seeds, the parental seed lines and hybrid seeds to growers and even directly to farmers, as shown in Figure 1 below. The existing seed inspection and certification system set up under the Department of Agriculture will also be tapped to ensure the quality of the seeds released for commercial use. The proposed system does not expound on the role that the government expects that private seed enterprises will play in hybrid seeds production and distribution beyond those developed in the public sphere, but it could be safely assumed that they will primarily be in the marketing and distribution of hybrid rice seeds to farmers.

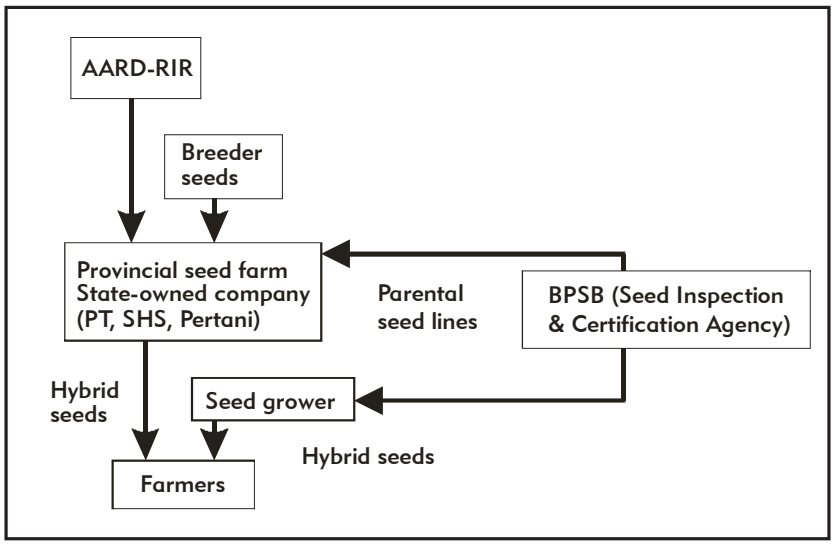

Fig.1 System of seed production and quality control for publicly-developed hybrid rice (Suwarno et al 2003)

The hybrid seeds delivery and distribution system proposed by the Ministry of Agriculture has remained conceptual and theoretical, so far since none of it has been implemented. In contrast to the optimistic targets set by the proponents of hybrid rice in Indonesia, it has only covered a total area of 1,500 hectares by 2004 while only 27.3 tons of F1 seeds have been produced in the same year despite the commercial release of 17 hybrid varieties in all (Las, 2005). Indonesia does not import hybrid rice seeds from China because of the marked difference in the agro-climatic conditions. Chinese

hybrid varieties are not feasible to grow productively in any part of the country.

Most of the current hybrid rice production is in West and Central Java as well as in South Sulawesi and Sumatra. As a result of the technology's dismal performance, the overly-optimistic conceptual target of attaining 50,000 hectares by 2005 has in fact been revised to 2,5000 hectares due to the very low adoption rate and the lack of enthusiasm on the part of the government to invest in the marketing and promotion of hybrid rice technology in the country.[163]

d. Description and Analysis of the National Hybrid Rice Program

i. National Policy on and Rationale for Hybrid Rice Promotion

Under the aegis of the ADB project, the Ministry of Agriculture of Indonesia drafted a plan for the mass planting of hybrid rice in the country by 2009. Hybrid rice seeds are expected to grow in over 1 million hectares of rice fields over the next four years, up from the 1,500 hectares in 2005.[164] With this target in mind, the government launched its active promotion of hybrid rice in 2004.

The rationale of this policy stemmed from the fact that rice is not only a staple and an economic crop in Indonesia, but also a political crop, and therefore increasing rice production to support food security is always given high priority in the agricultural development of the country. The rice requirement by 2025 would be about 68.8 million tons for the estimated population of 265 million.[165]

The government must therefore make serious efforts to increase productivity using innovative technologies, especially in view of the observations that the yields of the modern inbred varieties commercially available have reached a plateau. Rice productivity levels have started to decline. Current efforts to incorporate desired characters such as resistance or tolerance to biotic and abiotic stresses as well as the development of effective crop management systems, however, do not necessarily increase the yield potential of a variety neither do these directly contribute to boosting rice production. Inspired by the successful experiences of China and IRRI in hybrid rice development, and later of Vietnam and India, rice scientists in Indonesia urged the government to reinvigorate its efforts to develop and use hybrid rice to address the concerns on rice productivity to feed its big population especially in the future.

163. Soekirno, 2005
164. http://www.riceland.co.th/news.html
165. Suwarno et al 2003

ii. Nature of the National Hybrid Rice Program

The hybrid rice breeding program adopted by the government in 1998 as a vehicle for Indonesia's renewed attention on hybrid rice followed step-wise strategies aimed at surmounting the technical hurdles encountered by the local rice scientists in the early 80s when hybrid rice was initially evaluated in the country (Suwarno et al, 2003). In the short term, the activities under the program largely echoed the approach adopted in the 80s focusing on the evaluation of introduced hybrids for their yielding ability and other desirable characteristics to identify the superior ones for release. The main sources of these introduced hybrids were still IRRI and China. For the medium term, the strategy involved the identification of restorer lines among the breeding materials developed in Indonesia to develop more adapted hybrids with the existing introduced CMS lines. In the long term, Indonesian rice scientists are looking at the development of CMS lines with the genetic background of locally-developed and more adapted breeding lines for developing rice hybrids suitable for Indonesian conditions.

The program for developing cultivation areas for hybrid rice began in 15 districts considered as the major rice-growing areas of the country. The main criteria in selecting the sites were fertility of the soil, adequacy of irrigation facilities, no major pests endemic to the area, and responsiveness of local farmers to the new technology.

Despite the long gap between the initial research and development efforts that started in 1983 and the promotion and extension phase that began in 1998, Indonesian rice scientists are optimistic that the set target will be achieved. The government has began its information and education program in 2002-2004 to increase the awareness of farmers on the advantages of growing hybrid rice, as well as encouraging the private sector to invest in the technology especially in the production of hybrid seeds that is seen as the biggest obstacle in the widespread adoption of hybrid rice in the country. The costs, skills and labor involved in hybrid rice seeds production, that primarily limits the volume of seeds to be grown locally every year, has bloated the price of commercial hybrid seeds to ten times the price of ordinary inbred varieties per kilo (Las, 2005). The prevailing climate in West Java, where most of the local hybrid rice seeds are grown, in addition to the low level of purity of parental lines, has also contributed to the low yield of F1 hybrid seeds production at 1-1.7 tons per hectare that is less than half of the average F1 seeds yield in Vietnam or China. To increase the yield of F1 seeds, researchers at the IIRR are proposing to find more suitable areas in East Java where the climate is more appropriate for the production of F1 seeds, and to work more in purifying the parental lines obtained from IRRI.

iii. Promotion and Incentives Extended by Government to Seed Researchers and Seed Producers

Under the ADB program, Indonesia has targeted to increase the hybrid rice area to at least 50,000 hectares in the wet season of 2004-2005. To achieve this, the government plans to extend various support services to encourage farmers to adopt the technology. For a start, hybrid seeds were provided for free to the farmers during the dry season of 2002 and wet season of 2002-2003 but have since stopped.[166] Private companies that ventured into hybrid rice seeds production also distributed limited amount of free seeds to farmers in an effort to entice them to adopt the technology. The government also plans to provide and distribute pesticide to farmers for free in areas where these are needed. The regular subsidies extended by the government to Indonesian farmers in general, such as the support price for chemical fertilizers, will also benefit farmers who adopt hybrid rice technology.

The IIRR has also set up several demonstration fields to allow farmers to compare the performance of hybrid varieties with inbreds. Extension officers are being trained to guide farmers on hybrid rice cultivation that will then be supervised on site by trained technician to monitor the quality of seeds.

Apart from the limited distribution of free seeds in 2002/2003, the Indonesian government does not offer any other direct incentives to farmers who adopt hybrid rice technology.[167] There have been several proposals on possible incentive schemes that may be adopted to encourage farmers to grow hybrid rice such as the use of hybrid seeds as a revolving fund or credit for farmers to avail and paid after the harvest season,[168] but the government does not seem to be keen to pour out more investments in promoting the technology other than the resources allotted for development efforts. Agriculture officials observed that while there are policy makers who believe that incentives should be given to farmers adopting hybrid rice in order to promote the technology, there are constraints at the national level that prevent any direct incentive scheme from being adopted. It should be noted that Indonesia's structural adjustment programs imposed by the international financial institutions prescribed the removal of most government subsidies except the ones that have potentially serious impacts in ensuring political stability and national security. Among the subsidies that the government has been allowed to keep is the support price for the most commonly used chemical fertilizers such as urea, NPK and phosphate, receiving almost 30 percent subsidy on the total costs from the government.

The only incentives offered by the government for hybrid rice producers are the agricultural extension services and training for farmers to learn the techniques and skills required to optimize the benefits of the technology.

166. Suwarno, 2003
167. Las, 2005; Soekirno, 2005
168. Suwarno, 2003

The government has not allotted any specific budget for the promotion of hybrid rice among Indonesian farmers largely because the production performance of the technology in the field has not been impressive enough to convince decision-makers on the potentials of the technology.[169]

e. Roles of Different Actors in Research, Production, Distribution, Promotion and Use of Hybrid Rice Grain and Seeds

i. Role of the Public Sector

The government of Indonesia takes an active role in pushing for the development of hybrid rice technology in the country. Research institutions and government agencies under the Ministry of Agriculture such as the IIRR, the Central Research Institute for Food Crops, Directorate of Seed Development and the Directorate of Food Crop Production are directly involved in the implementation. IIRR is responsible for the research and development activities while the other agricultural agencies share the tasks in extension and promotion of the technology. Agriculture officials interviewed for the study admitted that the government agencies involved in the hybrid rice program do not have the capacity to produce seeds and distribute them to farmers, thus the government is counting on the active participation of the private sector.

Under Indonesia's policy to encourage public research institutions to commercialize the products of their research, the IIRR generates income from the selling of parental lines and breeders' seeds of hybrid rice to local growers and seed companies that produce hybrid rice seeds for the commercial market. The institute has entered into commercial licensing agreement with Syngenta and Dupont for the use of the parental lines that it developed to grow hybrid rice seeds that technicians from IIRR monitor regularly to ensure the quality of seeds.

The FAO and the ADB were instrumental in the development of hybrid rice in Indonesia. The complementary technical assistance programs and funding provided by these two multilateral institutions from 1998 to 2004 provided the strong push for the country to seriously venture into hybrid rice, despite the earlier misgivings to invest in the technology. The crippling effects of the 1997 financial crisis have also adversely affected the funding status and potentials of public research institutions in the country. This provided another motivation for the public sector agencies to adopt hybrid rice technology with the funding already being offered by international development agencies and the opportunity to collaborate with rice scientists from neighboring countries.

The ADB's technical assistance project on "Development and Use of Hybrid Rice in Asia", that was anchored in Indonesia by the Department of

169. Soekirno, 2005

Agriculture, provided for the training of scientists and technicians in hybrid rice research and development as well as the basic facilities required in these efforts. The program also allowed Indonesia to optimize the benefits of learning from research partners in the collaborating countries such as the Philippines, Vietnam, India, Pakistan and Bangladesh, and IRRI.

The FAO, on the other hand, sponsored a 20-month long Technical Cooperation Program project entitled "Strengthening the Development and Use of Hybrid Rice in Indonesia" that ran from April 2000 to November 2001. The technical endeavor aimed to train Indonesian hybrid rice researchers, seed production supervisors, seed growers and farmers to carry out research and development activities on a sustainable basis; to undertake on-farm trials and demonstrations and evaluation of hybrid rice varieties with the participation of farmers to validate the technology under farmers' field conditions, both economically and technically; and to formulate a medium-term program for sustainable development and use of hybrid rice in Indonesia.[170] The activities of the project were implemented in five provinces, namely West Java, Central Java, East Java Bali and West Nusa Tenggara, under the coordination of the Directorate of Seed Development (DSD) and in collaboration with the Research Institute for Rice (RIR), rice seed farms of the provincial governments, seed control and certification agencies, and private and public seed companies

ii. Role of the Private Sector

While the public sector in Indonesia plays a pivotal role in the research, development and introduction of hybrid rice in the country, it was the private sector that produced the first commercially released hybrid rice variety in Indonesia. *PT Bisi Indonesia,* a private national seed company, partnered with *Charoen Pokhpand (CP)*, a Thai agribusiness corporation with diverse regional interest, to develop and commercially release *Intani-1* and *Intani-2* in 2001 - marking the debut of hybrid rice varieties in Indonesia's seeds market. The joint venture was formed primarily for the development and marketing of hybrid corn in Indonesia, but later went into exploring the commercial potentials of hybrid rice. *Intani-1* became obscure shortly after its release to the market and has since ceased to exist in the Indonesian seed market because it was not profitable.[171] Local farmers who observed the field performance of the variety noted that it has much less panicles than the best local varieties and was very susceptible to pests such as the brown plant hopper.[172]

Following the high-profile release of the IIRR's hybrid rice varieties in 2002, several private seed companies in Indonesia jumped into the hybrid

170. Krishnaiah, 2002
171. Las, 2005
172. Warsiya, 2005

rice bandwagon but largely limited to the production and marketing of hybrid seeds. Among the companies that ventured into hybrid rice seeds production in the country were *Bayer, Syngenta, Mitsui* and *Dupont,* as well as smaller national players such as *P.T. Bisi Indonesia, Kariana Gabras* and *PT Bangor Pusaka*. All these companies are primarily involved in the production and marketing of hybrid corn and vegetables as their main business, while most are also engaged in the marketing and distribution of chemical inputs domestically. None of these private entities went into research and development of parental lines but instead relied on the parentals developed by IIRR from IRRI materials or directly imported from China. Agriculture officials noted that the interest of these companies in hybrid rice is merely exploratory and their investments are not as substantial as what they are pouring into other hybrid crops such as corn and vegetables.[173] Table 7 presents the profile 17 hybrid rice varieties released in Indonesia.

Table 7. General Profile of Hybrid Rice Varieties Commercially Released in Indonesia

No.	Variety Name	Developer	Year Released	Ave. Yield (tons/ha)
1	Intani 1	PT BISI	2001	8.70-11.20
2	Intani 2	PT BISI	2001	8.36-9.90
3	Miki 1	Mitsui CH	2001	4.50-6.00
4	Rokan	Min. of Agriculture	2002	9.24
5	Maro	Min. of Agriculture	2002	8.85
6	Miki 2	Mitsui CH	2002	4.50-7.00
7	Miki 3	Mitsui CH	2002	4.50-7.50
8	Long Ping 1	PT Bangun Pusaka	2002	6.59-9.11
9	Long Ping 2	PT Bangun Pusaka	2002	6.80-10.11
10	Hibrindo 1	PT SGP, Salim Grp	2003	9.32
11	Hibrindo 2	PT SGP, Salim Gro	2003	9.26
12	Batang Samo	PT KNBM	2003	10.50
13	Batang Kampar	PT KNBM	2003	9.90
14	Hipa 3	Min. of Agriculture	2004	11.67
15	Hipa 4	Min. of Agriculture	2004	10.43
16	Manis 4	Mitsui CH	2004	10.14
17	Manis 5	Mitsui CH	2004	9.87

Source: Directorate for Seeds Development, Ministry of Agriculture, 2005

At the height of the government's promotion of hybrid rice in 2002-2004, most of these companies offered limited amount of free hybrid rice to farmers in West Java to entice farmers to adopt the technology. In some areas in Indramayu province, some agricultural technicians of PT Bisi-Indonesia gave out free hybrid rice seeds to farmers in exchange for the purchase of pesticides and fertilizers distributed by the company.[174]

173. Soekirno, 2005
174. Warsiya, 2005

TIMOR LESTE:
An Open Playing Field for Hybrid Rice Technology

a. Overview of the National Rice Sector

Rice is the preferred staple crop in Timor Leste while coffee is considered the primary economic crop and maize and cassava as the predominant subsistence crops. Rice is ranked third in production volume after maize and cassava and fifth in total area planted.[175]

The annual consumption of rice in this newly-independent republic was estimated at 78,000 tons in 2001. It was much higher than the overall national rice production that averages around 50,000 tons in good harvest years. About half of the rice consumed domestically is imported from other areas, especially from the former power center, Indonesia, and in later years, from sources of cheaper rice such as Vietnam and China.

Rice farmers comprise about 26 percent of the population although the proportion of net sellers is considerably less than this, clearly indicating that the crop is primarily produced for home consumption like any other food crop in the country.[176] Rice areas are concentrated in Viqueque, Bobonaro, Manatuto, Baucau, Oe-cusse and Covalima districts. The agronomic conditions in Timor Leste – mainly characterized by mountainous and erosion-prone landscapes, poor soils and variable rainfall – are generally not considered well-suited for rice cultivation.[177] Like other crops, rice cultivation in the country is mainly done under traditional agricultural production system.

Rice production in Timor Leste has been fluctuating in the last 10 years. The national production has been in a continuous decline from 52,600 tons of paddy rice in1996 to as low as 33,580 tons in 1999. It was mainly attributed to the civil strife that wracked the country during that period. However, the last three years following the declaration of independence of Timor Leste from Indonesia marked a steady increase in rice production. Area harvested to rice has also exhibited the same trend over this period while paddy yield decreased slightly from 3.4 tons per hectare in 2001 to 3.27 tons per hectare in 2003.[178]

The consumer needs were largely imported despite significant efforts in the primary and construction sectors in Timor Leste since it was annexed by Indonesia and over the years since its independence.[179] Small-scale trade in local rice exists in local markets at the village, sub-district and district levels where rice is mostly sold by cans or glass with weights ranging from 150-750 grams per glass or can. The low national production coupled with

175. FAO/WFP 2003 as cited by OXFAM, 2004
176. da Costa, 2003
177. Timmer, 2001
178. FAOSTAT 2004 data
179. da Costa, 2003

high demand for consumption in rice make regular imports from the world market the cheapest and most effective way to ensure regular supply primarily in the urban areas.[180] The rural population, on the other hand, depends on root crops as the main staple crop throughout the year, punctuated by rice during traditional feasts and good harvests.

In 1992, the country imported about 38,000 tons of milled paddy rice, which later increased by almost 50 percent in 1999.[181] In 2001, cheap rice from Vietnam accounted for 57 percent of the overall imported rice supply, while 35 percent and 8 percent came from Indonesia and Thailand, respectively.[182] Prior to 1999, Indonesia was the primary source of imported rice in Timor Leste, with rice importation facilitated by Budan Urusan Logistik (BULOG), the Indonesian buffer stock body responsible for maintaining domestic rice stock supplies.

The civil upheavals in 1999 and the eventual independence of Timor Leste led to the cessation of the import services from the central government. Other sources like traders, the donor community and even smugglers took over this role in providing the domestic supply for rice in Timor Leste. In his study of the food supply status in nascent republic, da Costa (2003) suggested that about 30,000 tons of rice in 2001 may have been sourced out through smuggling. Locally-produced rice, on the other hand, is being retailed at marginally lower price than the imported rice in the domestic market, mainly because there is no steady supply coming from the surplus of rice farmers.

While farmers used to enjoy government subsidies in the form of fertilizers and price support under Indonesian rule, the aid-dependent government of Timor Leste does not have the means to provide these support services subsidies. Thus, it adopted a free market-based agricultural system that leaves local produce competing with imports from other countries.

In mid-2003, the National Logistic Center (CLN) was created under the auspices of the Ministry of Agriculture, Forestry, and Fisheries (MAFF), to establish and maintain a national stock of staple foods, particularly rice, and provide a buffer against bad harvests or sudden price increases. CLN buys unmilled rice from farmers, mills it, and finds distributors and buyers for this. The purchase price of paddy ranges from 11-13 cents a kilo and milled rice are sold at 23 cents a kilo, considered sufficiently competitive against the price of imported rice. To sustain the scheme, CLN received a grant of US$17,660 from the USAID as support for office equipment and transport, in addition to the start-up loan from a German donor agency.

In East Timor, similar work on rice and other crops are also taking place. In 2000, the Australian Center for International Agricultural Research (ACIAR) in cooperation with five CGIAR centers (IRRI, CMMYT, CIP,

180. Timmer, 2001
181. FAOSTAT 2004 data
182. da Costa 2003

ICRISAT and CIAT) and government and relief agencies had launched the Seeds of Life project. The objective is to assess plant varieties for local growing conditions through the conduct of on-farm trials of selected varieties of rice and five other crops.[183] IRRI in particular is responsible for introducing new improved varieties.

Regional Trends and Development in Hybrid Rice

Regional Trends in Seed Policies and Hybrid Rice and in Relation to Trade

Most countries in East Asia have adopted similar laws on seeds standards following the guidelines by FAO, particularly the International Plant Protection Convention (IPPC) that member-countries of the FAO have committed to. The general seeds standards provide for basic requirements in seeds management, breeding, selection, production, processing and marketing – as exemplified by the laws adopted by China, Vietnam and Indonesia. The standards and criteria set under these laws are designed primarily to apply on seeds developed by the formal sector such as public research institutions and the private sector, with little room for those seeds informally developed by farmers and communities to be accommodated. Seed certification requirements limit the selling and dissemination of farmers' seeds (referred to as "conventional seeds" in China's Seed Law of 2000) to informal channels. Timor Leste is expected to adopt similar standards in the future as the necessary infrastructures and capacities are put in place with the guidance of the various international development agencies that are currently assisting the new republic in the formulation of its agricultural development agenda and policies.

As countries in the region get fully integrated into the international market economy, especially as they become members of the WTO and regional trade agreements, they were obliged to comply with standards in intellectual property rights (IPR) agreed in these legally-binding commitments. Foremost among these international agreements that countries have to comply with is the TRIPS that, among other provisions, require member-countries to adopt the patent system or the UPOV-style plant variety protection in ensuring intellectual property protection over plant varieties. Such is the case of Indonesia. Vietnam, on the other hand, was pressured to adopt a UPOV 1991-inspired PVP legislation recently because of an earlier bilateral trade agreement with the US and as part of its effort to gain entry into the WTO. China adopted its own PVP law prior to joining the WTO following its membership in the UPOV 1978 Convention, but had to revise its legislation via its Seed Law of 2000 upon accession to the WTO. None of these

183. Lawrence, 2004

countries has adopted the patent system to protect intellectual rights over innovations in seeds.

Adherence of these countries to the 1991 version of the UPOV has limited their power to adopt policies to operationalize farmer's rights to save, reuse, share, exchange and sell farm-saved seeds as embodied in the ITPGRFA. While none of the countries studied have acceded to the ITPGRFA that does not bind them legally to its provisions, their adoption of PVP laws patterned after UPOV 1991 has already determined the limitations on any future privileges that they can offer to farmers in relation to the use of protected seeds and in the protection of farmer-developed varieties. Only Timor Leste, that is not a member of the WTO nor applying to become a member, and has not yet adopted any PVP law, or any IPR legislation for that matter, for the simple reason that it has not built the necessary capacity to develop innovations that would require such protection, has the political space to define how it wants to operationalize farmer's rights as appropriate to its needs and realities.

While all countries in East Asia are parties to the CBD, very few has adopted legislations or even policy on the regulation of access to biological and genetic resources and requirement of benefit sharing arising from the commercialization of these resources. In fact, none of the countries scrutinized for this study has adopted such legislations although China and Indonesia have actively joined a negotiating bloc of countries considered as mega-centers of biodiversity in the CBD. Aside from the rhetoric on the need for the world to legally recognize the rights of source countries over biological resources and the obligation of industrialized countries and commercial users to share the benefits from the commercialization of these resources, China, Indonesia and Vietnam have all refused to extend the call for benefit sharing to local and indigenous communities who have nurtured and conserved these resources through millennia. A closer analysis of the political context of these countries, however, would reveal that their view on the sole right of the state to share those benefits should be expected from governments with long history of top-down and authoritarian approach.

While the countries studied shared commonalities in the laws that they have adopted pertaining to conventionally developed seeds, they adopted vastly different policy approaches in the area of genetically modified seeds. China, that is the most advanced in the region in terms of research, development and commercialization of genetically modified seeds/crops, has recently adopted legislations and policies that address concerns on the safety of this technology. Its Seed Law of 2000 includes provisions on the labeling of genetically modified seeds based on the recognition that strict safety measures have to be adopted regarding these products, yielding to consumer pressures from countries where it exports products as well as learning from its long experience in developing genetically modified crops. Vietnam, si-

lently pursuing research and development in genetically modified crops, has only recently adopted a regulation on biosafety and management of GMOs. Indonesia, still struggling to get into the genetic engineering bandwagon, has adopted biosafety some guidelines some years ago but no attempt so far to provide teeth to these policies. Timor Leste has no biosafety policy since it does not have the capacity yet.

From the analysis, it becomes clear that the status of policies that countries adopt concerning seeds is largely dependent on the state of the technological capacity and infrastructures that they have with regards to the different aspects of seeds research and development.

Partnerships Among Actors Pushing for Hybrid Rice

Since the initial introduction of hybrid rice technology in East Asia, public research institutions in different countries that initially adopted or experimented on the technology in the 80s have worked together in a collaborative manner. Because of the intensive knowledge and skills and investments required in hybrid rice research and development, collaboration is an indispensable approach in any national strategy. The role played by China in these research collaborations, along with that of IRRI as the provider of international technical support and network are critical in all the inter-national partnerships in the whole of Asia over the decades.

The research partnerships in hybrid rice research and development in East Asia, and the key roles played by China and IRRI, can be traced from the 80s when countries in the region first dabbled with the technology by evaluating and doing field trials of hybrid rice varieties from China in the different local conditions. Most of these partnerships were bilateral in nature and facilitated by IRRI that provided the technical and scientific advice in the experiments as well as facilitated the procurement of hybrid rice seeds and parental lines from China. Such was the case in Vietnam and Indonesia. The need for more coordinated and broader research partnerships became clearer in the 90s, when countries in the region revived their interests and made fresh investments in hybrid rice technology. These countries were at that time searching for higher yielding rice varieties in the face of the yield plateau affecting the Green Revolution inbred varieties and inspired by reports of the phenomenal success of the technology in China.

In 1992, participants at the Second International Symposium on Hybrid Rice held at the headquarters of IRRI in Los Baños, Philippines proposed the establishment of an International Task Force on Hybrid Rice (INTAFOHR) with the primary objective of promoting the technology outside China. The proposal was later endorsed by several countries in various international discussions organized by IRRI and the FAO and was finally formed in 1995. In 1998, IRRI led a three-year regional project funded by the ADB working with a network of countries promoting the develop-

ment and use of hybrid rice network entitled "Development and Use of Hybrid Rice in Asia". The project was implemented in collaboration with the Asia-Pacific Seeds Association (APSA) and six member countries of the ADB, namely Bangladesh, India, Indonesia, the Philippines, Sri Lanka, and Vietnam. China later joined the network as a collaborating partner in 2000.

Each network partner in the ADB project has specific roles to play in the partnership. IRRI was tasked to coordinate the project and provide technical backstopping to the member countries to develop their capacity in hybrid rice technology. It also took full responsibility in sharing germplasm for free and in providing training and consultancy services to the public and private research institutions actively involved in the production of the technology.

FAO's responsibilities were to strengthen collaboration between research and extension work on hybrid rice, sensitize policymakers in the member countries to support the development and use of the technology, and strengthen hybrid seed enterprise in the public, private and NGO sectors. It has also provided financial support to the project in the form of technical cooperation projects to some major countries with hybrid rice research and seed production, such as Vietnam as discussed in the case study.

APSA, a regional network of public institutions and the private sector involved in seeds development, organized regular annual forum that provided the venue for the discussions on issues affecting the commercialization of hybrid rice technology. China was actively involved in human resource development, consultancy services, sensitization of policy makers and in the sharing of technology.[184]

The establishment of an effective regional collaboration on hybrid rice in Asia that functions as a working group under IRRI's Irrigated Rice Research Consortium (IRRC) and the coordinated international hybrid rice trials particularly in member countries are among the most important achievements of the network. The group provided NARES personnel (researchers, seed growers and extension workers) training on the technology – from hybrid rice breeding to seed production and cultivation. In return, the national governments of member countries strengthened their national hybrid rice program with increased investment from national funds. For instance, Indonesia renewed its interest in hybrid rice and increased four times its national allocation to Rp 15 billion. Vietnam's budget support increased from $13,000 per year in 1991-2000 to $70,000 for research and development and $589,000 for seed production in 2001. In addition, the network also serves as venue for the release of new rice hybrids from IRRI to national programs.[185]

184. Virmani et al, 2002
185. ibid.

The first phase of the ADB project was implemented in 1998 to 2001, receiving grants amounting to US$1.5 million. The project was actually a component of a bigger and long-term technical assistance grant of the ADB for the Consultative Group on International Agricultural Research (CGIAR) called the Second Agriculture and Natural Resources Research at CGIAR Centers (TA5766). Duly impressed by the successes of the project, the stronger regional partnership on hybrid rice and the emergence of private enterprises on technology, the ADB approved a follow up project, that was considered a second phase, entitled "Sustaining Food Security in Asia Through the Development and Dissemination of Hybrid Rice Technology." This was implemented in 2002-2005 . Three new member countries, namely the Republic of Korea, Myanmar and Thailand, joined the network's second phase.

Apart from the public-private/regional-national partnerships in hybrid rice research, development and dissemination, APSA also proposed for the creation of a consortium of smaller seeds companies in the region to help them bear the costs involved in developing or sourcing parentals for hybrid rice. Under APSA's proposal, each company in the consortium pays a membership fee to get exclusive rights to IRRI's hybrid rice lines for a certain period of time. IRRI however, rejected the industry's proposal due to its longstanding policy against exclusive licensing agreements involving the products of its research as an international public research institution. IRRI was reported to be considering an alternative arrangement to APSA's proposal.[187]

International and Regional Financial Institutions and Trade Agreements Promoting Hybrid Rice in East Asia

The ADB and the FAO are the leading international/regional institutions that have funded the research, development and promotion of hybrid rice in East Asia. FAO started funding technical assistance projects in some countries in the region since 1992. ADB, on the other hand, financed a two-phase regional project for a network of countries involved in research, development and dissemination of hybrid rice under the coordination of IRRI in 1998-2005.

FAO's financial support for hybrid rice to national programs in Asia and Egypt during the period 1992-2001 amounted to $1.76 million.[188] The combined funds that it provided for the hybrid rice programs of Vietnam, Myanmar, Bangladesh, Indonesia, Philippines and Egypt, however, paled in comparison to the US$6.55 million that it provided for India's national hybrid rice program 1991 to 2002. Table 8 summarizes the FAO's support to the national hybrid rice program in 1992-2002. Hybrid rice also took a promi-

187. GRAIN, 2005
188. Virmani et al 2002

Table 8. FAO support to the national hybrid rice programs (1992-2002)

Project	Country	Period	Budget (US$)
FAO/TCP/VIE/2251	Vietnam	May 1992-Dec.1993	259,000
FAO/TCP/VIE/6614	Vietnam	July 1996-Dec.1998	296,000
FAO/TCP/MYA/6612	Myanmar	Mar.1997-Mar.1999	221,000
FAO/TCP/BGD/6613	Bangladesh	May 1997-Apr.1999	201,000
FAO/TCP/PHI/8821	Philippines	Jan.1998-Dec.2000	275,000
FAO/TCP/INS/8921	Indonesia	Jan.2000-Dec.2001	257,000
FAO/TCP/EGY/8921	Egypt	Sep.1999-Dec.2002	248,000
FAO/TCP/IND/91/008 & IND/98/140	India	1991-2002	6,550,000

Source:(www.fao.org)

nent role in FAO's agenda in 2004 during the celebration of the "International Year of the Rice" when it highlighted the potentials of the technology in the world's quest for solutions to hunger and poverty.

FAO's funding assistance to the national hybrid rice programs allowed governments to build infrastructures and develop the technical capacity of public research institutions in research and development that were mostly focused in the evaluation of hybrid varieties and parental lines developed by China and IRRI especially in the early 90s. Technical assistance projects in the late 90s involved strengthening of the countries' capacity to develop locally-adapted hybrid rice seeds, setting up demonstration farms to promote the technology to farmers and upgrading of facilities for the production of parental lines.

Notably, the infusion of funds and technical assistance from the FAO perfectly coincided with the intensification of the national hybrid rice programs in the recipient countries. This is true in the case of Vietnam in 1992, the Philippines in 1998 and Indonesia in 2000. Since FAO's technical assistance and funding support are extended to member-countries that made such request formally, it may be said that the international funding allowed the requesting government to finance the hybrid rice programs that they have formulated rather than being totally driven by funds coming from the international community.

The ADB's technical assistance for the development and promotion of hybrid rice in East Asia came in the form of a regional program on "Development and Use of Hybrid Rice in Asia" that was implemented in 1998-2001 and its follow up program entitled "Sustaining Food Security in Asia Through the Development and Dissemination of Hybrid Rice Technology" in 2002-2005. IRRI acted as the project holder and coordinator of the two programs that involved a network of ADB-member countries, such as, Indonesia, Philippines and Vietnam from East Asia in the first phase, and later joined by Myanmar and Thailand in the second phase. The bulk of the ADB grant actually went to IRRI as the lead implementor, coordinator and

holder of the project providing overall technical backstopping and coordination for the project.

Vietnam, for example, only received a total of US$45,000 from the ADB/IRRI project for the implementation of its national activities for the whole duration of the first phase, from 1998-2001, and another US$23,750 for the second phase activities implemented in 2002-2005.[189] The project funds from the ADB allowed Vietnam to work on advanced evaluation of hybrid rice varieties from China, develop locally-adapted hybrid varieties using parental lines from IRRI, strengthen the technical capacity of HRRC, build the required infrastructures for the production of parental lines, and train technical personnel in the production of hybrid seeds.

Unlike the FAO technical assistance project that was directly and formally requested by the recipient countries from the FAO, the ADB project came under the aegis of IRRI as lead coordinator and project holder. In fact, according the ADB project reports, these hybrid rice projects actually came under a major technical assistance program of the ADB for the CGIAR in which IRRI was a member. As the major player in the project and the resulting network, IRRI presumably got the biggest slice of the project funds. Apart from the international assistance coming from IRRI as the world's center of excellence in rice breeding, the ADB project also boasted of APSA's involvement and the emergence of active private sector involvement in hybrid rice seeds production in the recipient countries as a result of the project.[190]

Based on official records, the ADB and FAO-backed projects on the development and promotion of hybrid rice were implemented at the same time in the case of Vietnam, Indonesia and the Philippines. In these cases, the activities of the projects were complementary and mutually reinforcing following the blueprint in the respective national hybrid rice programs and plans of these governments. It is not surprising that the intensified implementation of the hybrid rice programs in these countries happened during the period of 1998-2005 when the ADB and FAO projects were being implemented at the same time. The small amount that went to Vietnam under the ADB projects may be explained by the fact that the government has already received substantial funds for technical assistance and capacity building from the FAO for six years prior to the period of implementation of the ADB projects. In the ADB projects, the FAO was explicitly included in the network created under the project and was tasked to coordinate the technical assistance requirements of the member-countries.

189. Nguyen Tri Hoan, 2004
190. ADB, 2002

IV.
Discussion and Analysis of Trends in Hybrid Rice in East Asia

a. State's Role in the Promotion of Hybrid Rice

i. Economic Viability and Sustainability of National Hybrid Rice Programs

The region's history in the market economy clearly bears the lesson that direct economic incentives to promote any technology are never sustainable in any context. Countries can only infuse as much investments on subsidies but will never attain the desired effects in the long run because of the accompanying complications that generally come with that kind of support in an economic context aimed at encouraging competition among players and among an array of options.

The impact of China's transition from a command-and-control economy to partial liberalization on the trends and development in hybrid rice since the late 90s is a good case to illustrate this point. The incentives for the promotion of hybrid rice from the 70s to the mid-90s were part of the incentive schemes and production systems in the commune set up for collective production. Under the commune system, the government decides and provides for the inputs while farmers produce collectively to meet a certain quota for a particular period. Farmers under the old set-up in China do not make decisions on the crops and seeds that they use. The government does and provides for all the production requirements. Thus, the promotion and dissemination of the hybrid rice technology was not an additional economic incentive for farmers but was channeled through the commune. The decision of the central government to adopt hybrid rice was based on the impressive performance of the technology in boosting rice production within China's specific agro-climatic conditions at a time when the government's top priority was feeding its burgeoning population.

As China attained food self-sufficiency and became a mega-exporter in the world market in the era of global trade liberalization, the commune system gave way to the introduction of a unique approach in embracing the

market economy ideology through partial privatization of key industries including the seeds business. Minus the commune system, the new agricultural development approach has shifted to farmers' "individual responsibility" with farmers producing for their households first and for the market next.[191]

Economic incentives to promote hybrid rice come in different forms under this different economic system. The government has restrained itself from offering direct incentives to farmers planting hybrid rice and has instead focused its intervention in the market and in the creation of a robust national seed industry spinning off from the public research sector to take care of the research, development and dissemination of the technology. The impact of this shift on hybrid rice adoption is still not clear from current statistics, but some trends are emerging in the decline in the adoption rate of hybrid rice among Chinese farmers.

In a market economy where competitions among players and products are encouraged, hybrid rice varieties have to slug it out with the rice varieties currently in the market based on commercial price, yield advantage, labor requirements, input costs and overall cost efficiency. In a market economy, the farmers make the decision on the crops and seeds they plant and the government's role is limited to providing the policy climate that allows farmers to make choices.

The government of China continues to provide indirect economic incentives for the hybrid rice technology through the support it gives to the public research institutions that gave birth to so-called public seed enterprises that develop and sell hybrid rice seeds. However, in the final analysis, the end-users will judge the technology based on the cost-efficiency and advantages that it offers. Despite the indirect subsidies from the government at the research and development end, hybrid rice seeds are still five fold more expensive than inbreds. The yield of hybrid rice is declining in recent years, and the quality is poorer than the best inbreds. These are the main criteria with which any rice technology will be judged by farmers and consumers. As the old top-down habits from the commune wear off over the years and unless new breakthroughs in hybrid rice research and development emerge to address the key concerns on the technology, the world will soon witness the final judgment of Chinese farmers on hybrid rice.

The case of Vietnam is another interesting case on how incentives to promote the hybrid rice technology work and play out in a unique political-economic context. Like China, Vietnam also has a long history of command-and-control economy and is currently undergoing a process of transition to market economy mode. But unlike China, the history of hybrid rice in Vietnam did not happen under a centrally-planned system but during the transition to economic liberalization. The timing of the introduction of

191. Stiglitz, 2002

hybrid rice in Vietnam is an important factor that determined the economic incentives that the government offered to develop and promote the technology. In its effort to be fully integrated into the world economy, the central government of Vietnam had to cease in its initial attempt to provide direct subsidies to farmers producing F1 seeds and cultivating hybrid rice.

As a concession and to go around the pressures coming from the proponents of economic liberalization, the central hierarchy gave local governments the option to continue extending subsidies to hybrid rice seeds producers using a socialized scheme and only up to a limited time. The motivation for some provincial and district governments to continue offering subsidies for hybrid rice growers is clearly not limited to their interest in promoting the technology but because of the lucrative economic opportunities that such incentive schemes offer. This is a logical motive for local officials under a set up where the provincial and district governments themselves have controlling stake over local seed enterprises that produce, import and distribute hybrid seeds to farmers. Every subsidy extended by the provincial or district governments to farmers who grow hybrid seeds for the local market equally benefit the local seed enterprises that sell these seeds to farmers at the commune level. This self-serving scheme also motivates local officials to promote hybrid rice among local farmers to expand the market for the hybrid rice seeds imported by the public seed enterprises that they control. The discipline and top-down mentality ingrained by the commune system on farmers provided the right socio-cultural environment for such scheme to prosper. The fact that hybrid rice has not gained popularity in more Westernized and liberal South, aggravated by agro-climatic factors and prevailing farming system, tend to support this observation.

The scheduled pull out of all forms of direct subsidies for hybrid rice production from local governments may not severely affect the business of the local seed enterprises that source out at least 80 percent of the hybrid rice seeds that they sell domestically from China. But it will shape the sustainability and independence of Vietnam's hybrid rice future. Without the subsidy for local production of hybrid rice seeds, the country will have to virtually depend solely on China to meet the domestic demands. As farmers in Vietnam begin to assert their independence from the old local hierarchical structures and without any promising breakthrough in hybrid rice research that address the key issues in the technology, hybrid rice technology will have to prove its worth in the face of the impressive performance of inbred varieties that have helped Vietnam attain rice self-sufficiency and income from rice exports.

At this juncture, Indonesia is not motivated to extend economic incentives to promote neither invest more in hybrid rice technology. The disappointing performance of introduced hybrid rice varieties in the field, the failure of national rice scientists to hurdle technical obstacles in developing

economically viable and locally-adapted hybrid varieties, and the questionable cost-efficiency of the technology have all contributed to the lackluster performance of the technology in Indonesia. Boosted by confidence from the rice self-sufficiency level that it attained in recent years and constrained by the international financial commitments to restrain from extending subsidies that distort the market, there is no indication that the Indonesian government will extend further incentives to promote hybrid rice other than what it has already invested in the technology in the past decade. If at all, such incentives will have to come from the generosity of international and regional bodies with interest in creating a market for the technology in Indonesia such as the ADB and IRRI, but not from the coffers of the national government. Without these incentives and any serious effort and investments from the government, the future of the national hybrid rice program in Indonesia does not look very promising at all.

ii. Who Benefits from the National Hybrid Rice Programs

The current political-economic set up in China and Vietnam, that are both formerly under the command-and-control system and are now undergoing economic transformation, gives opportunity for certain political and economic actors to benefit from the multitude of incentive schemes to promote hybrid rice. In close scrutiny, these actors may not even include the farmers who are in the first place the prime target for the promotion of hybrid rice.

In China, the clear winners in the hybrid rice program at this stage when the policy of "partial privatization" is being implemented are the innovatively-established public seeds enterprises and the public research institutions. Researchers and scientists who have gained national and international prominence from their lifetime achievements in hybrid rice research and development are now reaping the economic benefits that come with their fame by occupying the top posts in so-called public seed enterprises. Unlike in typical market economies where public researchers would be obliged to resign in their government post once they occupy positions in private companies, the researchers and scientists enjoyed the best of both worlds in China. Respected rice researchers act as directors and officers of public seed enterprises while performing their usual tasks in the public research institutions developing the hybrid rice varieties that their fledgling companies sell to the domestic and export markets. As an added incentive, the government provides the start-up capital to their company and continues to provide the technical and scientific support required to keep the company's cutting-edge position in the cut-throat seed business. It should be noted that this market economy-inspired incentive scheme is not unique to hybrid rice but has generally swept China's public research sector as the country embraced capitalism.

In essence, the Chinese government and taxpayers pay for the research, development and even promotion of hybrid rice that the public seed enterprises sell to farmers at commercial rate since all the direct subsidies for hybrid seeds have been removed in the spirit of free competition. In recognition of the strategic character of the seeds industry, the central government of China has limited the participation of purely private enterprises in seeds development and distribution, thus benefits from the hybrid rice business actually accrue to the government in a limited sense and primarily to individual officials and personalities who now play the double-role of public officials and businessmen in China's blueprint for capitalism.

A shadow of China's current scheme in research, development and promotion of hybrid rice technology is unfolding in Vietnam although may not be as matured and sophisticated. In Vietnam, research and development in hybrid rice remains with the public sector, but state-controlled enterprises, that are officially called private seed companies, take charge of the business end at the national level. The local scene, however, shows that hybrid seeds commercialization is mainly a business of the provincial and district governments that control and operate local seeds enterprises that distribute and sells seeds directly to farmers.

While China has removed virtually all the direct subsidies for hybrid rice since the past decade, Vietnam maintains a schizophrenic attitude on the subsidy issue with the national government. It ordered the removal of direct subsidy on hybrid rice seeds but allowed the local governments to continue such support in their discretion in the name of decentralization although this too will have to be removed. Not surprisingly, few local governments would resist the temptation of using public funds to extend subsidies to a scheme that will in the end benefit themselves since they control and even operate the local seed enterprises that deal with farmers who grow hybrid seeds and also sell hybrid seeds for other farmers to sow. In the name of assisting poor farmers to benefit from the promises of hybrid rice, local governments in Vietnam offers incentive schemes that in reality they themselves will benefit.

With the removal of all subsidies for hybrid rice scheduled this year, purely private seed companies are coming into the picture at the national level. Multinationals like BioSeeds, with long experience in doing business in Vietnam and wide marketing networks all over the country, are starting to pay attention to the potential economic benefits from hybrid rice. Without further investments from the government to develop mechanisms for wider dissemination of the technology and with pressures coming from international agencies to create a robust seeds industry doing business in hybrid seeds, the government of Vietnam actually welcomes active private sector role in promoting the technology.

In Vietnam's effort to provide conducive economic and political environments for private investments to pave the way for its entry to the WTO, the timing is perfect for private seeds companies to play a lead role in the country's hybrid rice industry. The emergence of new hybrid varieties that yield high and produce good quality grains favored by farmers and consumers from public sector facilities in the country presents promising products for private sector interests to sell especially since they have not shown any interest in investing in research and development themselves. The presence of enterprising local seeds business controlled by provincial and district governments actually reinforces this trend towards more vigorous promotion of hybrid rice in Vietnam in the near future.

In the case of Indonesia, the benefits that the hybrid rice technology brings to any actor remain limited and do not hold much promise in the short-term. The private sector has not invested substantially in research and development in hybrid rice but nevertheless jumped in the bandwagon some years ago primarily driven by projects funded by the FAO and the ADB. Except for the foreign funding assistance infused by international and regional institutions for the development of hybrid rice in the country, the government has not actually made much investment in the technology. Without public investments in research and development and the dismal performance of commercially-available hybrid rice varieties, the private sector will not put its stake in this business and will continue to wait for future prospects in the sideline in the coming years.

b. Hybrid Rice and Corporate Interest in the Rice Sector

i. Trends in Corporate Investments in the Rice Sector

From the case studies analyzed in this report, the level of involvement of private corporations in the hybrid rice industry is clearly determined by the policy environment laid down by the government and the commercial potentials of the products developed by the public research sector.

In China, rice is considered a strategic industry that should remain under the control of the government through the public seed enterprises. The government subsidies and support to these quasi-independent companies actually keep the private investors at bay. The government encourages competition among players in the industry, but only among public enterprises. With full backing of the government given to public enterprises that makes the market uncompetitive for private companies, none has so far laid their stake in this business despite the huge domestic market for hybrid rice seeds and the potentials in the export market. The only opportunity available for the purely private companies, especially foreign entities, to participate in the hybrid rice business is to engage in joint ventures with public enterprises. Even then, there is little room for such joint ventures to prosper

since public companies do not require additional investments that have already been provided by the government neither the technological competence which the public researchers doubling as businessmen have mastered over the decades.

For all intents and purposes, hybrid rice in China remains a sole monopoly of the state, especially if we will broaden the definition of "state" to include the public seed enterprises that sprouted from the laboratories of the public research sector. While this may not be seen as sound in the context of the market economy paradigm since it discourages private investment, it also breeds a different form of free competition among public enterprises which could also help lower the price, improve the quality of products and sustain research efforts. The scheme may also look fair and equitable from a public good perspective because it is the public research institutions themselves who developed those economically viable hybrid rice varieties and who are now involved in their commercialization and distribution, in a way plowing back a part of the profits to the government coffers. On the other hand, there is an anomaly that some would perceived in an arrangement when government funds are used to develop products that are sold back to the public at market price.

Hybrid rice promotion in Vietnam happens in a context where the country has adopted it own type of partial liberalization following the footsteps of China but more market economy in tendencies. Former state enterprises have been "equitized", with private sector investments but the control generally remains in the hands of the government which continues to own shares in these companies. Vietnam is more open to joint ventures with the hard-core private companies, including multinationals like BioSeeds and transnationals like Syngenta, which have the resources, marketing capacity and vast network to distribute and commercialize the hybrid seeds developed by the private sector. Unlike in China where the government maintains a strong hold on the vast pool of farmers who have mastered the science of growing hybrid rice seeds, Vietnam has a more limited network of producers thus its continued dependence on hybrid seeds imported from China. While HRRC has developed the capacity and acquired the facilities to produce the parental lines, private companies and cooperatives still import even preferred parental lines from China implying short domestic supply and limited choices. This gap presents a promising potential for the private sector to play an active role in seeds production to meet the domestic demands through investments in building more facilities, acquire bigger lands, develop capacity and provide resources for the specific requirements in the production of parental lines.

While private companies such as BioSeeds have started to put their stake in hybrid rice seeds production in Vietnam, other transnationals like Syngenta waiting in the wings, they want a guarantee from the government

to ensure the profitability of their investment through such proposals as exclusive licensing agreement over the use of HRRC's promising varieties. The private sector argues that it does not make any business sense for several corporations to produce the same varieties for the same market, thus they want to contract more with the developer of product that awards exclusivity. This proposal has put the back of the HRRC to the wall. The government in general has no capacity neither the resource to disseminate and commercialize hybrid seeds to farmers and has repeatedly stressed the need for the private sector to play that role. It cannot expect a handful of national seed enterprises controlled by the government to play that role since hybrid rice seeds is just a tiny portion of their thriving interests in seeds and their geographic focus is in the lucrative south. Thus, the offer of companies like BioSeeds to lend its marketing muscle to the government's research and development efforts in hybrid rice sounds too attractive to resist. The HRRC, however, is constrained by its strictly public nature from granting exclusive license to private companies with interest to commercialize the institute's research products, but this may have to be resolved soon as Vietnam strives to prove that hybrid rice is indeed a viable technology option to attain food security for its population in the poorer northern regions.

In Indonesia, seeds and agri-business corporations are clearly waiting in the wings for any commercially viable hybrid rice varieties that may come out from the labs of the public sector. Like in China and Vietnam, none of the national and transnational companies in Indonesia have made any substantial investment in research and development of hybrid rice, and their interest seems to be directed at commercial production and distribution. This seems to be a logical business approach in a crop like rice that is primarily produced for domestic consumption and does not have any strategically important industrial use that could increase its value. Seeds corporations direct their investments in research and development on industrial crops that command higher prices and higher demands in industries globally, and would rather leave consumption crops like rice in the hands of the public research sector. Corporations often come into the picture of consumption crops in the commercialization stage where they can use their existing resources and marketing networks to promote and sell viable products developed by the public sector.

It will take many long years for seeds and agribusiness companies to take hold in Timor Leste. A domestic seeds industry needs to be developed first, and this is what the Seeds of Life Project of the Australian Government wants to achieve in the long-run. For the meantime, the young country is unfortunately becoming to be a dumping ground for unwanted and even banned technologies coming from other countries such as the banned pesticides imported from neighboring Indonesia. The absence of any regulatory framework and capacity makes the country an open playing field for

any technology in seeds that come in by way of development aid extended by various sources.

ii. Linkages in Corporate Interests on Seeds and Agri-chemicals

It is also worth noting that although current efforts of other seed companies are not directly involved in the hybrid rice technology, they are nevertheless increasingly interested in the rice crop that, not too long ago, was not even considered having a commercial value. In 1991, Syngenta /Myriad Genetics announced the first complete genomic map of rice containing information of the genetic constitution of the crop. Other companies like *Orynova*, a joint venture between Zeneca LTd. and Japan Tobacco, are also involved in gene transformation technology and in the Golden Rice initiative with the IRRI (Brookes and Barfoot, 2003). Monsanto for instance, is interested in penetrating the rice seed market in Asia, particularly promoting the hybrid seed (along with the promotion of direct seeding rather than transplantation) since this will create market opportunity for its herbicide business in Asia. None of these trends, however, are playing out in the current realities of hybrid rice in China, Vietnam and Indonesia.

In China, seed transnationals have forged joint ventures with national seeds companies in more lucrative crops such as corn, soybeans and cotton, but not yet in rice. It remains the domain of hundreds of public enterprises in the country that fiercely compete with each other. In Vietnam, the current move of BioSeeds to venture into commercial production of hybrid rice seeds developed by the public sector is considered a logical expansion of its interest in hybrid corn where it has built a good reputation in Vietnam. The company's interest in hybrid rice cannot be considered a tentative business venture because of its successes and experience in research, development and commercialization of hybrid rice in India. And yet, BioSeeds, knowing the inherent flaws of hybrid rice as a technology and as a commercial product, insists on playing it safe by collaborating with HRRC only under exclusive marketing arrangements in order to protect its market interest and ensure returns to its investments.

Because of the long history of hybrid rice research and development in East Asia, especially in China and the mastery of the science by more and more public research institutions in other parts of the region such as Vietnam and the Philippines, seeds corporations are not substantially investing in research and development but focusing more in marketing and distribution of existing varieties that have good commercial potentials. Corporate attention in hybrid rice is emerging in a context like Vietnam where the policy environment encourages private investment in the hybrid rice industry and where promising varieties with commercially-attractive traits beyond good yield have been developed by the public sector. The presence of these factors means less capital investment on the part of seeds corporations

which can in turn offer their marketing resources and distribution network to widely commercialize these varieties.

Corporate investments in hybrid rice are determined by the presence of these key factors: a policy environment that protects private investments and ensure a competitive market that does not unduly favor public enterprises; good products with promising commercial potential domestically and for the export market; and a big market that is willing to adopt hybrid rice technology. In a closer analysis, the direct subsidies provided by governments to promote hybrid rice is but secondary motivation for companies to go into hybrid seeds business. As the Managing Director of BioSeeds has put it, government subsidy on hybrid seeds makes doing business in hybrid seeds easier for companies, but it is not a critical factor.[192]

In Indonesia agribusiness corporations, both nationals and transnationals, have tentatively invested in the development of hybrid rice seeds using introduced parental lines but they have so far been lukewarm to marketing due to the currently small market for the technology in Indonesia. Their investment on the technology, however, constitutes a very tiny portion of their overall interest in the seeds market and agricultural inputs. The government has not invested as much as Vietnam on the promotion and distribution of hybrid rice seeds, and instead focused on the development of adapted varieties using parental lines provided by IRRI. Without adequate investment and incentives, the technical hurdles in development of hybrid rice in the country will limit any further progress in producing viable hybrid rice varieties. Without commercially feasible products from the public sector, the private seed companies waiting in the wings have nothing to market. The only other opportunity for hybrid rice to be promoted actively by the private sector in Indonesia is to link the technology with their business in agricultural chemicals. *PT Bisi-Indonesia* seems to be experimenting on this potential in some parts of Indonesia.

In countries with market economy like Indonesia that has no history of command-and-control system like in China and Vietnam, the role of the government in the massive promotion of any technology is crucial. This is especially true, in cases when the technology involved is as expensive, knowledge and skills-intensive as hybrid rice and would require strong assistance from government field technicians.

iii. National Hybrid Rice Programs and the Private Sector/Corporations

Historically, seed industries in developed countries have prospered by developing and selling hybrids. Today, about 40 per cent of the total revenues from commercial seed sales (estimated to total about US$15 billion) are generated through sales of hybrid seeds.[193] It is then likely that the adoption

192. Jaisimha, 2005
193. Sehgal 1992 as cited by Pingali et al 1998

of hybrid rice would make farmers dependent on external sources other than their own resources. It would greatly increase the importance of the formal seed industries that, except in China, are composed mainly of the private sector.

In addition, the future growth path of the hybrid rice industry can be foreseen by examining how the hybrid corn industry expanded through the years since its emergence more than 50 years ago. Pingali et al (1998) noted the similarities in terms of evolution and developments between the two.

Most national hybrid rice seed industries are beginning to emerge into the seed industry cycle. As was true in the case of hybrid corn, the emergence stage is characterized by the domination of the public sector in the research and seed production activities while a few private seed companies engage in experimentation using the germplasms developed in the public breeding programs. However, as the demand for hybrid seeds increases and the industry becomes profitable, private seed companies tend to dominate the market while the public sector gradually vanishes. In addition, as competition in the seed industry intensifies, private companies will come under increasing pressure to differentiate their products from those of their competitors and eventually come up with propriety hybrids that can be sold on an exclusive basis. This situation could lead to concentration where only a few companies dominate the seed industry. This scenario is currently happening in the corn seed industry worldwide.

While this assertion may be theoretically sound and supported by past developments in the hybrid corn seeds business the current realities in the development of hybrid rice in East Asia cast some doubts in it. Hybrid rice in the region is far from being a fledgling or start up technology. It has a 30-year history in China and more than a decade already in some countries in the region. And yet, the technology remains principally a domain of the public sector, with the private sector's role limited to commercial production and marketing in countries where they are allowed to participate.

Mastery of hybrid rice technology is almost exclusively limited to the public sector, with the private sector merely waiting in the wings for viable products to mass produce and sell. Even in countries that encourage private sector investments in hybrid rice, such as Indonesia and Vietnam, the business has attracted very little serious attention and much less investments from the agribusiness and seeds companies. This reluctance could be explained by the technical obstacles in developing the technology as explained in an earlier section in this study, the high costs involved which contributes to its high commercial price, and the recent technological developments in hybrid rice where yield plateau in many areas were observed. The breakthroughs in research and development in inbred rice seeds, such as the excitement over the new plant type (NPT) technology that could match the yield of the best hybrids, are all contributing to the reluctance of the private sector to pour out resources into the technology.

A close scrutiny of the history of hybrid corn shows the nuanced difference in the way hybrid rice developments are currently unfolding. The promotion of hybrid corn and its ultimate take over by the private sector was greatly facilitated by the crest of the Green Revolution when national governments and international agencies combined their resources to pour out investments and incentives to promote hybrid corn varieties and high-yielding inbred in rice. Hybrid corn promotion also coincided at a time when the political situations in many countries across East Asia were dominated by top-down and even authoritarian rule where decisions on which technology to adopt lies in the hands of the central government.

The current free market ideology under the WTO, on the other hand, limits the capacity of governments to extend lucrative incentives to promote any technology in the interest of fostering open competition. The stark difference in the nature of corn and rice as crops also plays a role in determining the direction of how the development of hybrid technology unfolds. While corn is a cross-pollinating crop that makes hybridization easily possible, the self-pollinating nature of rice as a crop presents the first and most difficult technological obstacle that researchers needed to hurdle in developing hybrids which have far-reaching implications on how the technology has evolved in the specific context of East Asia.

c. Factors Influencing the Promotion and Trade of Hybrid Rice

i. Political Pressures: Rice as a Political Crop

A serious analysis of the developments in hybrid rice introduction East Asia reaffirms the assertion that rice is no doubt a political crop. As the major staple of the people in the region that constitutes a substantial portion of the world's total population, the importance of rice in the economic, social-cultural and political life in East Asia is unquestionable. Thus, any technological innovation in rice could potentially bring far-reaching implications in the lives of people in this part of the world. East Asia's recent experiences in hybrid rice bear this out.

The quest for technological solution to the ever-present threats of hunger, and therefore political stability, is the main justification of countries that adopted hybrid rice. China led the way under centrally-planned economy where hybrid rice played a key role in increasing rice production that helped keep the social order and propelled the country in its current spot as a leading rice producer. Vietnam, even as it occupies a safe seat in the world's top rice exporter, continues to be hounded by the specter of hunger because of its exploding population and needs to keep its competitive edge in the cut-throat international market, thus the justification to invest in hybrid rice. Vietnam's interest in the technology is actually specific to the need to provide more food for the poor population in the rugged regions in the north

that shares similar agro-ecological conditions as the hybrid rice regions of China. The historical and political ties of north Vietnam with China is also a factor that influence the decision to adopt the technology and primarily depend on China for seeds that are sold domestically.

Political pressures are less evident in the case of Indonesia where the renewed interest on the hybrid rice technology happened at a time when the strongman-rule of Suharto was already weakening and the democracy movement has gained substantial grounds. The initial disappointments in testing the efficacy of the technology in the early 90s also overclouded whatever political pressures were pushing the government to adopt hybrid rice, especially in the face of increasing rice production using high-yielding inbred rice varieties. The interest of the government in the technology became less enthusiastic even more as the country attained rice self-sufficiency in recent years as hybrid rice varieties introduced commercially failed to perform.

ii. Trade Pressures: Role of Regional and International Trade Agreements

There are no direct or explicit requirements in any international or regional trade agreements specific to hybrid rice. However, the free market paradigm opens up hybrid rice seeds trade and commercialization to the private sector and encouraged by governments to invest in bringing the technology to farmers. But with the yield plateau currently being experienced in China and lackluster field performance of available hybrid rice varieties in other countries in East Asia, the private sector is not enthusiastic about the prospects of the technology in most of the region. Those that decide to put their stake into the business, demand such guarantee for profit-taking as exclusive licensing agreements with public institutions that develop promising varieties, before they make any substantial investments.

Apart from the free market economy that gives natural edge to the bigger and better funded agribusiness and seeds companies, there are other aspects of current international trade regimes that promote hybrid rice seeds, especially over inbred varieties developed by the informal sector. The seeds standards adopted by countries in compliance with their international commitments under the auspices of the FAO allow explicit bias for seeds developed by the formal research sector including hybrids. These standards are basically guided by the so-called DUS criteria (distinct, uniform and stable) set in international conventions, that in practical terms exclude the seeds selected and developed by farmers which are generally location-specific, have high rates of segregation and relatively unstable. In addition, the seed quarantine rules and certification standards adopted by governments basically exclude farmer-developed seeds from being commercially traded and exported.

iii. Pressures from International/Regional Institutions

The FAO, ADB and IRRI undoubtedly played pivotal roles in the development and promotion of hybrid rice technology in East Asia. The examples of Vietnam and Indonesia clearly illustrate how the financial, technical and political muscles of international and regional institutions shaped the development and direction of hybrid rice technology in a country. It was the funds and technical assistance provided by the FAO that made the country's first serious exploration of the potentials of hybrid rice all through the 90s. While it may be argued that the FAO only acceded to the request of the Vietnamese government to extend that financial assistance, it cannot be denied that the plans of the government would not have materialized without FAO's resources. IRRI also played an important role in the FAO project as the main source of parental lines in the initial experiments on hybrid rice conducted by the Vietnamese government as well in training local researchers and providing the overall technical guidance to the national hybrid rice program.

The hybrid rice project funded by the ADB that was implemented in the years immediately following the completion of the FAO project, shows that a country need not request for funds and technical assistance for hybrid rice development for those graces to come. Vietnam and Indonesia are part of the network specifically created by IRRI to work with the project and serve as the pilot areas for the development and later, dissemination of hybrid rice in the region. Beyond the technical assistance extended to the member-countries in the network, the ADB project also explicitly aimed for the development of national seed industries that will actively participate in the promotion and marketing of hybrid rice to farmers. The presence of ASPA in the consortium helped in providing the direction for private sector participation in hybrid rice dissemination and the complementation of public sector development efforts with the commercial interests of private seed companies in the network. The project also facilitated access of the private sector to the parental lines at IRRI and the public research centers in the consortium. The emergence of private sector companies that engaged in the hybrid rice seeds business is in fact considered by the ADB as one of the major accomplishments of the project, meriting a follow up phase aimed at speeding up the dissemination of the technology in the region.

d. Regional/International Trade and Movement of Hybrid Rice

i. Trends in Hybrid Rice Seeds Trade

There are scant statistics available to serve as basis in projecting the future trends in the regional or international trade in hybrid rice seeds. Official statistics actually rarely pay attention to the trade in rice seeds that is insignificant compared to the trade in rice grains as a commodity. This may be

attributed to the fact that the unmilled or paddy rice that is being traded are the same seeds that may be planted in the rice fields in the recipient area/country. In rice, it is the grain that is traditionallly traded, except in dire circumstances when a country or region needs seeds for planting coming from other areas because of a natural or man-made calamity. Such was the case of Cambodia following the Pol Pot regime and in Aceh after the massive tsunami in December 2004, when international development agencies had to import seeds form other countries to give out to farmers and revive rice cultivation for long-term food security.

The introduction of hybrid rice in Asia, however, is changing that. Since the potentials of the technology may only be optimized if new seeds are used each planting season, it implies the need for an efficient seed industry that produces the seeds for domestic use. In cases when the domestic requirements for hybrid rice cannot be met by local production, the national seed industry should be able to meet the demand by sourcing out seeds from other countries. This is clearly the case in Vietnam where at least 80 percent of the hybrid seeds requirements are obtained by the state-controlled seed enterprises from neighboring China where a strong hybrid seeds industry can provide more than adequate supply. The similarities in the agro-ecological conditions in the hybrid rice production areas in Vietnam and China have made it possible for this import supply arrangement to work, at least for now. This would have been the case in Indonesia too had it not been for the difference in agro-climatic conditions which render it unfeasible for hybrid rice varieties from China to thrive in the warmer and more humid environment of Indonesia. That does not stop the public research centers and the private sector in Indonesia, however, from relying on the parental lines developed in China in the development of locally-adapted varieties.

Interestingly, the agro-climatic factor that deter directly exporting hybrid rice seeds from China to the tropical countries in East Asia is the same reason that motivates private enterprises in the Philippines engaged in hybrid rice seeds development and marketing to target the export of hybrid seeds to other countries sharing the same conditions such as Indonesia. From these emerging trends, barring the agro-climatic, ecological and technological factors, hybrid rice clearly has the potential to give birth to a rice seeds industry in the region which could create revolutionary changes in the way rice breeding and development would unfold in the future.

The developments and trends in hybrid rice performance and adoption in China would have a far-reaching implication in the rest of East Asia. With the ominous signs of yield plateau in most commercially available hybrid rice varieties, added to the continuing challenge on the grain quality of hybrid rice and the policy giving individual responsibility to farmers in making farm decisions, the rate of adoption and contribution of the technology to the overall rice production of China in the coming years are expected

to steadily decline. This may not mean the end of hybrid rice technology, however. The hundreds of public enterprises involved in the hybrid rice business in China have began to set their eyes on the export market for the past few years in countries where the adoption rate of the technology is increasing and commercial prospects are promising. The only obvious limitation to this potential, however, is the agro-climatic conditions that would bar Chinese hybrids from growing productively in other areas with more tropical climates. In the short-term, the countries in the Indo-China region which are right at the doorstep of China are the most logical targets for aggressive marketing of Chinese hybrids. Vietnam tops the list of targets with active government promotion of the technology, vast number of farmers that are eager to adopt a technology promoted by local bureaucrats and the presence of enterprising local government-controlled seed companies that wants to profit from importing hybrid seeds from the north. Chinese public seed enterprises have also started advancing to the northern areas of Laos as well as the fertile Irrawady plains of Myanmar where the military government is aggressively promoting hybrid rice technology.

Other countries that have achieved some successes in the development of locally-adapted hybrid rice varieties with promising grain quality and better yields, such as the Philippines and India, are also set to go beyond the potentials of the domestic market by exploring export possibilities in other countries in the region sharing similar agro-climatic conditions. Some private seeds enterprises in the Philippines, for one, are training their sights on Indonesia as a potential market for the seeds that they produce locally.

ii. Bilateral/Multilateral Partnerships in Hybrid Rice Promotion

Bilateral and multilateral collaborations facilitated the development and dissemination of hybrid rice in East Asia. These partnerships, however, did not seem to have spontaneously developed based on the needs or demand for the hybrid rice technology at the national level. All the bilateral and multilateral collaborations on hybrid rice in the region are notably facilitated by IRRI in the same way that it played a pivotal role in the promotion of Green Revolution in Asia in some decades ago.

IRRI facilitated the bilateral arrangements between China and several countries in the region that explored the potentials of hybrid rice technology. The parental lines and hybrid varieties from China that were used in Vietnam and Indonesia were accessed through the help of IRRI which also provided parental lines that it developed. Many of the initial trainings and exchanges in expertise in hybrid rice research and development were extended by China in partnership with IRRI.

By holding international symposia and conferences on hybrid rice, IRRI aimed at generating the interest of governments on hybrid rice technology by highlighting the success of the technology in China. It was through these

international information sharing and exchange vehicles that the International Task Force on Hybrid Rice (INTAFOHR) was formed in 1995 under the coordination of IRRI. The INTAHFOR formed the backbone of IRRI's proposal to the ADB for a technical assistance project on hybrid rice development and use in several countries in the region, namely Indonesia, Philippines and Vietnam. The network later expanded to include Myanmar, Thailand and Korea on the second phase of the project implemented in 2002-2005. The project was not exclusive for public research institutions but also actively involved the private sector engaged in the seeds business through the participation of APSA in the network. INTAHFOR is a clear example of public-private partnership in seeds research and development being promoted by IRRI in recent years which receives full backing from financial institutions like ADB that promotes active private sector participation in agricultural development.

The knowledge- and skills-intensive nature of the hybrid rice technology actually necessitates bilateral and multilateral partnerships in order to attain the objectives of national programs initiated by the public sector. The fact that the technology originated and fully developed in China almost exclusively also requires countries interested in adopting the technology to establish bilateral cooperation in research and development with China. Even private companies that would not want to invest heavily in doing research on hybrid rice research from scratch for business reasons would have to connect one way or the other from where the technology has been mastered and perfected. The few private companies in Indonesia, Vietnam and the Philippines that have so far ventured into hybrid rice production have relied on parental lines from China or have outright imported seeds from there for domestic distribution in countries where they operate. With the common problem of private companies in sourcing out good quality and profitable parental lines, APSA even proposed the creation of a regional consortium of smaller seed companies to address this problem. This proposal, however, has yet to materialize.

It may be said that issues in hybrid rice are regional in nature, as can be gleaned from the extensive partnerships between and among countries and even with the private sector, with full financial and technical backing from the ADB, FAO and IRRI. With China blazing the hybrid rice trail, public and private seeds companies alike are now looking beyond national borders in promoting their hybrid rice seeds. Be that as it may, the issues concerning national hybrid rice programs need to be seen in relation to the developments in the region in order to address them in a more strategic way.

e. Present and Future Implications of Rice Seeds Trade/Hybrid Rice Development on the Efforts of Small Rice Farmers in Adopting and Promoting Sustainable Agricultural Systems/Initiatives

i. Trends in Promoting Hybrid Rice Under Organic Farming Systems

There are no specific examples of hybrid rice promotion using organic farming systems in China, Vietnam and Indonesia, although there were some informal accounts of such in China some years ago. However, there are no available statistics nor official confirmation on these reports was obtained in the course of conducting this study. In all these countries, proponents and adopters alike recognize the importance of disciplined farm management in growing hybrid rice, and even more so in producing hybrid seeds. High costs of inputs, such as gibberelic acid, fertilizers and pesticides, are among the key factors why hybrid rice seeds costs several folds higher than inbreds.

Rather than being a deliberate strategy to promote hybrid rice under different farming systems, there are techniques in pest control and farm management associated with sustainable agriculture that evolved in the process of adopting hybrid rice technology in some countries. The effectiveness of such technologies in a local area inspired proponents of the technology to promote them in other areas with similar conditions. In Yunnan province in southwestern China, for example, the interplanting of disease- and pest-susceptible varieties between rows of resistant hybrids has spread to cover some 260,000 hectares in the province and another 330,000 hectares in the neighboring province of Sichuan (IRRI, 2005). According to IRRI scientists who have documented the technique, farmers now interplant about 90 different traditional varieties with modern hybrid to effectively control pest while at the same time conserving the rich diversity of rice genetic resources in that region. In Vietnam, where the techniques in integrated pest management (IPM) have been widely adopted by farmers especially in the North, hybrid rice varieties are cultivated using IPM techniques in pest control.

V.
Courses of Actions on Hybrid Rice

a. Critical Elements for Civil Society Work on Rice Seeds Trade: Lessons from Hybrid Rice Experiences

Cross-border Issues in Hybrid Rice.

The analysis of the experiences of China, Indonesia, Timor Leste and Vietnam underlines the importance of nuanced understanding of the context, dynamics and forces that determine how hybrid rice is promoted and adopted at the local, national and regional levels. The importance of looking beyond national borders in analyzing the trends and development in hybrid rice cannot be overemphasized. As explained in previous sections, developments in China would have impact on the trends and future development of hybrid rice in other countries in East Asia. With the yield plateau experienced by hybrid rice varieties in China and the emergence of higher yielding and better tasting inbred rice varieties, public enterprises in China engaged in the hybrid rice business are looking beyond the country's borders to sell their products. There is less competition too in other countries where hybrid rice technology is still nascent and local rice scientists are unable to overcome the technical hurdles in hybrid rice development, thus opening up the market for imported seeds coming from China. The use of China's political and economic muscles in East Asia to sell hybrid rice seeds in countries with which it has forged trading relations, like Laos and the Philippines, cannot be underestimated. Vietnam is a different case because of its long history of relations with China and its shared border and agro-climatic features in the north. All these dynamics and developments should be considered in formulating any campaign surrounding issues in hybrid rice, whether at the national or regional level.

Technological breakthroughs in and outside China in the near future that will allow scientists to hurdle the technical obstacles in further hybrid rice development would help shape the future of the technology in the region. Civil society should also carefully follow the developments in the com-

mercial front to make sure that advocacy and campaign plans are still relevant in view of the changes in the configuration of realities and dynamics among actors.

The Policy Environment

Government policies to promote hybrid rice as a technological option to increase overall rice production may either encourage investments and active role for the private sector, as can be gleaned from the trends in Vietnam and the Philippines, or may hinder the entry of the private sector with stronger government role in varied forms, as in the case of China where public enterprises have pivotal role in the research, development and promotion of hybrid rice which translates to continued control by the government over the seed industry while using market economy-inspired schemes that promotes competition among public enterprises. Understanding these dynamics would allow civil society to grasp the potential weaknesses and the extent of strength of the forces behind hybrid rice promotion in a given context.

Experiences in China and Vietnam have clearly shown that the issues in hybrid rice that civil society organizations need to confront are not just technological but intricately linked in the socio-economic and political context in the country where the technology is promoted. The socio-economic context and political developments in a country determine how the hybrid rice technology plays out and impact on peoples' lives. While there may be debates on whether or not technologies like hybrid rice are neutral, the context where the technology is applied strips it of any neutrality. China has shown how the commune system under a command and control economy has facilitated the introduction and widespread adoption of hybrid rice among farmers who actually have no choice on the seeds that they use since the decision is made for them by government authorities. Even with the transition from state control to partial privatization and collective system to personal responsibility have failed to destroy old habits deeply ingrained through decades of indoctrination and political disempowerment that even without the subsidies from the government, farmers continue to use hybrid rice seeds despite of the higher price. Ironically, while it is the market economy that civil society fears will encourage the concentration of control over seeds in the hands of few transnational seeds corporations, the China case shows that the opening up of the country is also weakening the clout of hybrid rice domination over farmers who now have the choice on which seeds to use and what crops to grow. The declining statistics of hybrid rice hectarage and adoption rate in China in recent years tend to prove this.

In Vietnam, the revival of government's fascination with hybrid rice happens at a time when the country was undergoing transition from centrally planned economy to the liberalization. Despite this economic transformation and the shift of decision on agricultural production from commune to the households, the commune continues to wield power over farm-

ers especially in the north where the Communist regime was well entrenched. In a free market economy, such political control, however, will lose its old strong power especially with the pressures to remove direct subsidies for hybrid rice.

The issue of government subsidies, however, as an incentive for farmers to adopt the hybrid rice technology should be seen as one of the many components of an overall political push for the technology. While direct government subsidies in the form of support price for seeds and chemical inputs are the most obvious forms of economic incentives adopted by governments, there are far more sophisticated and subtle but more strategically entrenched incentive mechanisms that should be carefully analyzed such government resources that directly go to research and development efforts specifically for hybrid rice, enabling environment for both public and private enterprises to invest on hybrid rice development and distribution. While it is true that the role of direct subsidies and economic incentives is crucial in the promotion and widespread adoption of hybrid rice technology, the removal of direct subsidies does not automatically adversely affect the promotion and adoption of hybrid rice technology, as shown in the cases of China and Vietnam. Direct subsidies in the form of seed support and input subsidy are the easiest opportunities for corruption at all levels, thus the reluctance of many government officials to remove it in the guise of altruistic pretenses such as aid for poor farmers, boosting food production, etc. such as what happened in Vietnam in recent years. Pressures from the forces behind market economy for the government to remove these direct subsidies in the name of encouraging open competition in the market and good governance, however, often facilitate the removal of these incentive schemes. This is what happened in China and what is currently happening in Vietnam.

Why the market economy defenders in the aggressively-liberalized economic context like the Philippines have failed to push the government to remove the direct government subsidy on hybrid rice remains a puzzle for civil society organizations to figure out. A logical guess is that this scheme is part of the aggressive push from China, the only giant trading partner of the Philippines that can potentially challenge the hegemony of the neo-liberal forces in the US on Philippine decision-makers, under its agricultural trading agreement with the Philippines. The prominent role played by the "father of hybrid rice", Professor Luan Rongping, in promoting hybrid rice in the Philippines under the starry-eyed admiration of the Philippine president, is an unmistakable symbol of the strong interest of China in exporting hybrid rice to receptive neighboring countries. This push becomes even stronger with the declining glory of hybrid rice in China itself which could create a glut on hybrid rice seeds produced by hundreds of fledgling public enterprises that spun off from enterprising public research institutions bankrolled by the central government.

It is very important to note that the political and economic environments that promote hybrid rice are just one aspects of the entire debate in hybrid rice. While economic and political policies define the macro context in which the technology plays out, there are technological and socio-cultural issues that any civil society efforts in the technology need to define. Groups working on the issue need to determine which of these issues and arguments are tactical (i.e., short-term approaches leading towards a particular goal) and which are strategic (i.e., long term and far-reaching approaches that directly leads to the goal) in order to define what are the negotiable and non-negotiable elements in any campaign or advocacy work. Without this preparatory effort, any campaign or advocacy work would be without any clear mission and efforts would be limited to tactical objectives that are aimless and unsustainable.

Hybrid Rice and Developments Other Rice Breeding Technologies

The hybrid rice technology is just one of the many modern technologies in rice breeding that are currently being simultaneously developed in East Asia. Among the most notable are the developments in new plant type (NPT) which involves conventional breeding, and the more controversial developments in genetic engineering and nanotechnology. It is in rice genetic engineering, however, where Asian scientists have already made some inroads in research and development that could dramatically shape the future of the rice sector in the world. In fact, China is already in the verge of allowing the first commercial production of GE rice in East Asia (Iran claims to be the first country in Asia that allowed large-scale production of GE rice containing gene from the soil bacterium *Bacillus thuringiensis* since 2004.)

Hybrid rice and genetically engineered rice are two totally different technological approaches in rice breeding. Hybridization utilizes conventional breeding technologies, while genetic engineering is advancement in modern biotechnology that allows manipulation at the genetic level and often involved the introduction of unrelated genes into the rice genome. The difference in the nature of these two technologies also brings different sets of issues and implications for the future of the rice sector in East Asia. However, the parallel developments in these two technological approaches in rice breeding should not be viewed as totally separate and mutually exclusive. As both work on the most important staple crop for the region and are usually done by scientists from the same public research institutions, their interrelated paths and implications to each other should be studied by civil society organizations working on strategic issues in rice.

The recent development in China involving the commercialization genetically engineered rice is an important case to illustrate this point. While the country has greatly benefited from the potentials of the hybrid rice technology, resulting from the different factors discussed in the case study, many public research institutions as well as public seed enterprises have ventured

into research and development efforts in genetically engineered rice since the 90s. These development efforts have already matured and are due for commercialization in the coming years. The first of the series if GE rice that is ready to hit the market is the bacterial-blight resistant rice (BB rice) engineered with genes from a wild rice. Notably, many commercially-released hybrid rice varieties in China are known to have resistance to bacterial blight. The developers of BB rice have filed a number of applications with the biosafety authorities in China for the commercialization of the varieties since 2004 but the body has prolonged its deliberations on the applications. While the national biosafety committee deliberates on the application, illegal commercial releases of BB rice have been reported and monitored by Greenpeace in Hubei province in southwestern China in 2005. Greenpeace, together with a host of international environmental organizations, leads a high-profile campaign against the introduction of genetically engineered crops into the environment, especially in centers of origin and diversity of crops such as rice in China. In the BB rice case, it argues that there are available technologies that confer the same traits and deliver the same yield promised by genetic engineering, which do not pose the same threats to human health and the environment as gene manipulation. Among these technologies is hybrid rice.

The BB rice case in China is an example of how civil society organizations can use hybrid rice to argue against a clearly damaging technology like genetic engineering. However, there is no agreement, neither any discussion on this among civil society groups working against GE rice and hybrid rice. This lack of complementation and interface could be attributed to the fact that it is not clear to civil society groups working against hybrid rice what are the strategic and tactical issues in the technology that they are fighting against or campaigning for. The groups working on GE rice, however, are very clear on the strategic and tactical lines, but have no coordination with hybrid rice groups on how their arguments on the merits of hybrid rice over GE rice can affect the arguments of the former.

There is clearly a need for groups working in the issues in hybrid rice – many of whom are also working against genetic engineering in rice – to define the strategic and tactical arguments against hybrid rice and how those link with the campaign against GE rice. This interconnection cannot be avoided since these technologies play out in a context where both are being used as technological options to attain national food security and are usually pushed by the same proponents. In an even playing field where each technological option is given equal chance and opportunity to compete with each other, it should not be a problem for various options to exist side by side. However, the nature of the technologies involved and the fact that there are technology options outside of those produced by the formal research systems, namely technological systems and traditional knowledge evolved by

farming communities, these developments pose a serious problem. The potential adverse impacts posed by GE rice on human health, the environment and the genetic diversity of rice in East Asia are no longer doubted. The only question now is how these impacts will play out in the real world and when. More importantly, these potential adverse impacts of GE rice cannot be confined to the country that develops or sells the technology but equally important for the rest of the world that receives the technology and its product because of the inherent nature of genetic engineering. These arguments should be weighed carefully in any civil society campaign surrounding hybrid rice and seeds trade.

Beyond GE rice, the interrelation and links of hybrid rice with other technological breakthroughs need to be carefully considered. While the recent advances in conventional breeding such as NPT could be seen as an opportunity to marginalize hybrid rice in the future, there are already research efforts in China and Vietnam to develop new hybrid varieties that utilize NPT as parentals. This trend clearly shows that technological options are not mutually exclusive and links between these parallel developments needs to be consciously analyzed. Side by side, the development in China where research successes in hybrid rice can be used as an argument against GE rice should be a point that needs to be carefully discussed especially on how it affects overall arguments and campaigns in hybrid rice.

The advances within hybrid rice research and development themselves should merit careful analysis, especially how they affect the tactical and strategic objectives of any civil society work in rice seeds trade in general and hybrid rice technology in particular. Careful attention should be paid to the notable advances in public research institutions outside China in the development and releases of hybrid rice varieties that do not only yield higher but possess key traits preferred by farmers and consumers such as resistance to major pests and diseases such as the tungro virus and rice blast, and good grain quality. Among the most promising varieties that are already in the market are the *mestizo* rice lines released by the Philippine Rice Research Institute (PhilRice) and the *HYT 100* released by the HRRC of Vietnam. Breakthroughs in the use of NPT as parentals in hybrid rice development are also worth analyzing as this may hold the key to address the most difficult technological hurdles faced by hybrid rice at present such as high seed costs and climate-specificity. All these development may bear considerable influence in the future adoption of the technology among farmers and the long-term direction of rice seeds trade in the region which could work against the interest of small-scale farmers.

Consortium Campaigning and Advocacy

Civil society organizations campaigning against hybrid rice should consider adopting a parallel mechanism to the consortium-type partnerships adopted by public research institutions in the region involved in research,

development and promotion of hybrid rice. While these public research consortia often have the backing of international research institutions such as IRRI and multilateral financial institutions such as ADB, civil society organizations can count on their broad network and strong mass base as their principal asset. The technical obstacles in hybrid rice technology, such as the difficulties in developing and maintaining parental lines, have also motivated the private seed enterprises in the region to work in consortium formations.

Unlike the formal partnerships of public research institutions, multilateral institutions and the private sector for the research, development and dissemination of hybrid rice which are strategic in nature, regional civil society consortium may decide to be collectively motivated by tactical objectives working around specific campaign issues in hybrid rice. One obvious issue for tactical campaigning is the issue of using public resources to develop hybrid rice varieties that will primarily benefit the private sector, especially agribusiness corporations. This particular issue goes beyond the more limited issues of government incentives to promote hybrid rice among farmers. The case of China shows that even without direct incentives, hybrid rice remains popular among farmers due to the long history of the technology in the country and the continuous investment of the government in research, development and commercialization of the technology through the public seed enterprises created by public research institutions. The same is true in Vietnam to some extent, with much support coming from international institutions to sustain research and development efforts. Indonesia is classic case of how foreign funds have driven a country to adopt the hybrid rice technology. Even with funding for hybrid rice coming from the FAO, ADB and IRRI, national governments still need to put up taxpayers' money as counterparts for this project, thus the use of public funds for a technology that would benefit the private seeds company most would be one interesting tactical issues to focus on.

The East Asia Rice Working Group (EARWG) is one model for a civil society consortium-type vehicle for campaigning and/or advocacy around tactical and/or strategic issues in rice trade issues in general and for hybrid rice technology in particular. With thorough planning based on a careful analysis of the rice situation in the region, the presence of civil society members coming from the most important countries in East Asia in the network, with strong and broad bases among small-scale rice farmers at the local level, is the most important resource of the group that could match the strength of any consortium pushing for hybrid rice at the regional level.

b. Recommendations in Advancing Sustainable Agriculture in View of the Analysis of Trends in Hybrid Rice

Any civil society campaign or advocacy in rice seeds trade in general and hybrid rice in particular should be anchored on an overall strategy that promotes clear, concrete and viable alternatives to the current paradigms and dominant technologies in rice research and development. Already, civil society movements, such as EARWG, are working for the advancement of sustainable agriculture models as a proven technological option in rice research and development that would directly benefit small-scale rice farmers that comprise the bulk of the population that depend on rice as food and source of livelihood. The promotion of sustainable agriculture, however, should carefully fit in the analysis of the developments in the region as well as the civil society positions with regard to rice seeds trade and technological options.

First and foremost, civil society efforts around hybrid rice should be very clear on what is it about hybrid rice that civil society is opposing or fighting against to which the alternative is sustainable agriculture. If civil society groups, such as EARWG, define that the heart of the issue in hybrid rice is it technological, then they should be able to demonstrate that sustainable agriculture requires less labor, less inputs and less costs and is more cost-efficient than hybrid rice. That sustainable agriculture works based on time-proven traditional knowledge farming systems developed by farming communities over millennia, and is adapted to local conditions, needs and capacity are no longer a debate. In fact, a number of governments in the region have repeatedly claimed that they believe in the merits and benefits of sustainable agriculture, although none has really translated such pronouncements into coherent policies. The outstanding question posed on sustainable agriculture is "can it ensure food security?". Civil society's answer is a resounding yes, but how to go about it remains largely unanswered as far as the proponents of dominant technology options are concerned. For one, the argument that sustainable agriculture works only in small-scale, labor-intensive and household-based farming systems need to be seriously rebutted.

The issue of technological options needs to be addressed. Civil society calls to governments should be more strategically geared towards providing infrastructure, financial and social support to farmers for agriculture to become economically viable and sustainable, rather than extending preferential incentives to farmers who adopt a particular technology. While this may be a sound and logical call, civil society organizations working on this issue need to acknowledge the dilemma involved in such demand. "Leveling the playing field" in terms of agricultural support to farmers would imply the farmer's right to decide on farming technologies to adopt in their farms, which may not necessarily benefit the common good or may even be detrimental to the common good such as the case of genetically engineered crops.

While fighting against dominant and emerging rice technologies that may have adverse impacts on health, the environment and the interest of small-scale farmers, civil society should be prepared for a stalemate scenario where they will be pushed to accept a compromise that allows all these technological options to co-exist. This requires more thorough studies to be conducted to prove that some technological options simply cannot co-exist, such as the case of organic agriculture and genetically engineered crops.

With regards to strategies and approaches in advancing sustainable agriculture in a context where the public sector and private interests have joined hands to push for questionable technological options in rice research and development, civil society organizations should be able to clearly define the means to advance their arguments and proposals. Decisions on whether campaigns that rely on the strength of a critical mass base or policy advocacy anchored on the need to work within the existing political-economic systems should both. It should be noted that these main approaches are not mutually exclusive, and could in fact be mutually reinforcing if carefully planned on the basis of defined tactical and strategic objectives. How campaigns and policy advocacy can effectively work to deliver clear messages promoting sustainable agriculture, outlining well-founded arguments on issues and developments, and presenting concrete proposals and options, is a challenge that civil society organizations like EARWG need to address.

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