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The Philippine Hybrid Rice Program: A Case for Redesign and Scaling Down

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PHILIPPINE INSTITUTE FOR DEVELOPMENT STUDIES
Surian sa mga Pag-aaral Pangkaunlaran ng Pilipinas

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Abstract

Promotion of hybrid rice has been the central goal of the government's rice production program since 2001. Yet, farmers' adoption rate has remained low (about 5% of total rice area) despite concerted efforts and massive subsidies. Evidently, most rice farmers do not find the currently available hybrid rice varieties to be economically superior to inbred varieties. At farmers' level, their yield advantage has not compensated for the higher cost of seeds, labor, and other inputs usually required by hybrid varieties. Unlike inbred varieties which can be grown by farmers, hybrid varieties need to be purchased every cropping season. While some hybrid varieties may be suited to irrigated areas with developed market infrastructure, demand by farmers has not been sufficiently large and concentrated for private seed companies to be commercially viable.

The highly subsidized approach of the program has been not just ineffective but costly in terms of wasting scarce budgetary resources, compromising the government's regulatory functions, promoting corruption, and distorting farmers' choice of varieties. The government should remove the present system of subsidies on hybrid seeds and related agricultural inputs which are all private goods in nature. The public sector's role in hybrid rice should by now be limited to basic and strategic research on hybridization, conventional breeding, and research and extension in hybrid-related cultural and other management practices.

I

Introduction

The promotion of hybrid rice has been the centerpiece of the Arroyo administration's (GMA) rice production program since 2001. Government efforts to encourage hybrid seed production and adoption by farmers actually began in 1998. These early efforts focused on intensified research, short-term and season-long training programs on hybrid seed production, and large-scale technology demonstrations in 11 top rice-growing provinces. Despite no clear evidence that the hybrid rice technology was more profitable than the best available inbreds at the farm level nor that a hybrid rice seed industry would be commercially viable, the government embarked on a nationwide Hybrid Rice Commercialization Program (HRCP). Thus far, the program has relied mainly on massive subsidies to promote hybrid seed production and adoption by farmers.

From 2001 to 2005, approximately 10 billion pesos have been spent directly and indirectly in implementing this program. Except for the budgetary support on irrigation and price stabilization, nearly all national government expenditures for the rice industry have been allocated to the hybrid rice program. Most local government agricultural staff in rice areas was mobilized to promote and distribute hybrid seeds.

Yet, the estimated adoption rate of hybrid rice, eight years after its introduction in 1998, is only about 5 percent of total rice area, and all hybrid seeds continue to be distributed for free or sold at highly subsidized prices. Evidently, most rice farmers are still not convinced of the economic superiority of hybrid rice to be willing to pay the full cost of hybrid seed production and distribution such that a hybrid rice seed industry can be commercially viable.

Given the current fiscal crisis, the poor state of infrastructure, and the severe underfunding of education and health services, it is imperative to evaluate the design, conduct, and performance of the hybrid rice program. The first section presents the role of government in varietal improvement and the Asian experience in hybrid rice technology. The second section analyzes the program design and structure of subsidies. The third section evaluates the performance of the program in terms of trends, provincial patterns, and sustainability of farmer adoption, as well as the yield and profit advantage of the hybrid over inbred varieties. The fourth section explains the budgetary cost and distribution of benefits of the program. Finally, specific recommendations to strengthen the government's program in rice variety improvement are presented.

Hybrid Rice and the Asian Experience

Hybrid technology is based essentially on the phenomenon called "heterosis" where hybrid vigor is observed in the seeds produced from crossing two widely different parental lines. Heterosis is the yield advantage or the difference in yield performance of such a cross or hybrid seed (F1) over that of its best parent. The crop produced from the hybrid seeds (F2), however, loses its hybrid vigor. Thus, farmers cannot reuse or save seeds from a hybrid crop because yields would drop sharply. Depending on the yield and other advantages or disadvantages of a hybrid crop and the cost of seed development, production, and distribution, a commercially viable private hybrid seed industry performing the full range of functions—research and development, seed production, and marketing—can emerge. This is because breeders have a natural or biological protection (property rights) against uncompensated use of their hybrid crosses, and the seed market is potentially large as farmers will have to buy hybrid seeds (F1) each crop season to obtain its yield advantage.

Hybrid seeds first became commercially viable for corn in the United States where adoption spread rapidly across the country in the 1930s (Griliches 1957). Hybrids now dominate the corn industry, with the private sector at the forefront in research and development, seed production, and marketing. The early and greater success of the hybrid technology in corn can be explained mainly by its biological characteristics as a cross-pollinated crop. Because the male and female flowers are physically separated, cross-pollination is easy to control, resulting in a relatively low cost of seed production. Moreover, heterosis in corn is very pronounced, as high as 100 percent of the best open-pollinated varieties in the US during the 1930s and about 50 percent in the developing countries in the mid-1990s (Morris 1998).

Varietal Improvement in Rice

Except for rice in China, the success of hybrid seed development in corn and other cross-pollinated crops could not be duplicated in rice, wheat, soybeans, and other self-pollinated crops where conventional plant breeding has proven to be the more economical method of varietal improvement.[1] As a self-pollinated crop, the essential genetic identity of a rice variety remains the same through several generations of cultivation, allowing farmers to save and reuse seeds from own cultivation many times over without any significant deterioration in yields and other characteristics. Thus, conventionally bred new rice varieties (inbreds) can be more quickly and cheaply disseminated. Furthermore, the cost of seeds for farmers is generally low. While additional care may be required by farmers in growing their own seeds, its opportunity cost remains at the margin just equal to the price of the grain. Even the premium that will have to be paid by farmers to purchase new varieties or periodic replacements of existing varieties is relatively small as inbred seeds can be produced at a much lower cost than hybrids (Sikap/Strive Foundation and Philippine Rice Research Institute 2005).

In contrast to hybrids, once new inbreds are introduced, they are easily reproducible. Limiting or excluding others from their use is virtually impossible. In other words, inbred seeds have public good characteristics. The private sector will underinvest in conventional breeding of self-pollinated crops, as the cost of varietal development embodied in their seeds cannot be fully recovered from the initial sales of seeds of new varieties to farmers. Consequently, the public sector has been the main source of funding for varietal improvement in rice, and usually subsidizes, at least in part, the cost of promotion, seed production, and distribution of inbred rice varieties.

Large-scale hybrid seed production by hand emasculation, which is a practice in corn and other cross-pollinated crops, is not possible with self-pollinated crops like rice which is characterized by tiny florets. The most effective method of hybridization involves the more complicated process of (a) locating a cytoplasmic male-sterile (CMS) female plant—the A line; (b) crossing this with a maintainer line—the B line, to produce a sterile offspring (AXB) with desirable genetic traits; and (c) crossing these seeds with a "restorer" line R to produce F1 seeds (AXR) with normal self-fertilizing

[1] In Asia, conventional breeding of rice first succeeded in Japan during the Meiji period from 1868 to 1900. It was followed by the development of the "ponlai" japonica varieties for subtropical conditions in Taiwan in the 1920s. Semidwarf, fertilizer-responsive, high-yielding varieties (or modern varieties) were developed independently in China by 1964 and at the International Rice Research Institute in the Philippines in 1966 that led to the so-called Green Revolution in rice in Asia.

power. Indian scientists were actually the first to report on the existence of cytoplasmic male sterility, indicating the possibility of developing hybrids for rice (Sampath and Moharty 1954).

In the early 1970s, the International Rice Research Institute (IRRI) also conducted rice hybridization research, but management soon doubted its commercial feasibility (Janaiah 2002). Similar efforts in Japan and the US at about the same time produced hybrid rice varieties that had 10 to 15 percent yield advantages (Carnahan et al. 1972; Barwale 1993). However, these were not profitable since the price premium of existing high quality inbreds was higher than the yield advantage of hybrids, while the latter were more susceptible to diseases and required higher labor inputs.

Hybrid Rice in China

Hybrid rice research began in China in 1964 under Professor Yuan Long-Ping. It made a technological breakthrough in 1970 with the discovery of a wild male sterile line. Through concerted nationwide efforts, the first hybrid rice variety was released in 1976. Farm-level studies reported hybrid rice to have a yield advantage of about 15 percent over the current high-yielding inbred varieties (He et al. 1987; Lin 1994). There was no significant difference in material costs and labor use, but eating and milling quality were generally lower, particularly with the hybrid rice varieties introduced in the early period.

Diffusion rate of hybrid rice varieties rose to 58 percent by the early 1990s, but since then, adoption rate has declined to slightly less than 50 percent by the late 1990s (Huang 2002). Several factors favored the rapid adoption of hybrid rice in the initial years. First, under a centrally planned system, the government can directly influence farmers' behavior. Second, nearly all rice areas (97%) are irrigated and transplanted, and the production environment and crop establishment method are conducive to hybrid rice adoption. Third, until the late 1980s, rice quality was not a major concern under the quota system of marketing rice as farmers were obliged to sell a portion of their rice production at a low fixed price regardless of grain quality. A significant proportion of rice production continued to be directly fed to livestock in which grain quality is not important. Finally, hybrid rice research and development, seed production, and distribution, which were all performed by the public sector up to the 1990s, have been heavily subsidized, although no rigorous quantification can be found in the literature.

On the other hand, the leveling off and eventual decline in the spread of hybrid rice by the early 1990s was due in part to technical difficulties in developing hybrids for Japonica varieties grown extensively in northern China (Virmani and Kumar 2004). In addition, the demand for better quality rice increased as household incomes improved, and the ratio of quota sale to the government decreased, whereas the success of breeding for high quality hybrids was quite limited. By the early 2000, adoption rate has risen as some success has been reported in the development of high quality hybrid rice as incentives for breeding increased.

Research and development of hybrids continue to be primarily conducted by public research institutions, but the proprietary rights for seed production and distribution are either sold to private seed companies or retained and profits from own seed operations shared between the scientists and the research institutions. The scientists who develop any new hybrid variety typically receive 30 percent of the value of the proprietary right. The remainder of the proceeds is allocated for research, including the further development of superior inbred varieties to raise the productivity potential of hybrid rice breeding. The question is whether or not these new inbreds are directly released to the public, or just kept for the sole use of the research institution in its own hybrid rice development. The latter case would be costly to society as some of these new inbreds may be economically superior compared to existing and even future hybrids.

Hybrid Rice in the Tropics

Encouraged by the Chinese technological breakthrough, IRRI in the late 1970s resumed research on hybridization, specifically aimed at developing hybrid rice for tropical conditions, as Chinese-bred varieties were found to be highly susceptible to pests and diseases in this production environment. Since 1990, parental lines bred under this program have been used in several Asian countries to develop hybrid rice varieties suited for local conditions. The increased interest in hybrid rice research and production programs was motivated by the deceleration of rice productivity growth and the widely held belief that the productivity potential of existing modern varieties has been exhausted in the region by the late 1980s.

Hybrid rice research and adoption

Table 1 summarizes the current status of hybrid rice research and adoption in Asian countries. In the nine countries having research programs on hybrid rice, only five, including China, have reported some farm-level adoption. In India, more than 20 hybrid rice varieties have been released since the initiation

Table 1. Status of hybrid rice research and adoption rate in Asian countries

	Year research initiated[a]	Year of first hybrid release	Adoption rate	
			Area planted (000 ha)	% of total rice area
China	1964	1976	15,000 (2000)	50[b]
India	1990[c]	1994	560 (2004)	1.4
Vietnam	1992	1992 [d]	500 (2002)	10
Philippines	1993	1993	175 (2004)	4
Bangladesh	1997	2001[e]	60 (2004)	0.5
Indonesia	1998	-	-	-
Sri Lanka	1996	-	-	-
Myanmar	1997	-	-	-
Thailand	2001	-	-	-
IRRI	1979			

[a] Year of mission mode R&D initiated.

[b] Hybrid rice adoption reached a peak of 54% in 1991/92 but declined since then.

[c] India actually engaged in hybrid rice research earlier (Janaiah 2002) than China, but discontinued and restarted in1990.

[d] Seeds mostly imported from China.

[e] Seeds imported from China and India.

Source: Adapted from Janaiah and Hossain (2003).

of hybrid rice research in 1990. The country's private seed industry participated vigorously in hybrid rice research and development, seed production, marketing, and international trade due to the potentially large market, as half of its 40 million hectares of total rice area is irrigated. The government provided tax breaks to seed companies, strong support to research and development, and technology promotion activities including massive demonstration trials and subsidized credit programs.

By 2005, more than a decade after the first hybrid rice variety was released, only 570,000 hectares were planted to hybrid rice. This constituted 1.4 percent of total rice area and less than 3 percent of irrigated area. Moreover, increases in crop area planted to hybrid rice were reportedly achieved largely by transferring promotion efforts to other states. Many farmers who initially grew hybrid rice for one or two seasons eventually dropped out from hybrid rice cultivation (Janaiah 2002). Indeed, Griliches' (1957) adoption study of hybrid corn across the United States considered the hybrid technology commercially viable only in states where adoption rates have reached 10 percent. Below this, the hybrid technology may be technically available, but not necessarily commercially viable. In other words, the farmers may still be at the trying-out stage of the new technology.

The first locally bred hybrid rice variety in Bangladesh was first released in 2001. However, private seed companies were allowed to import about 600 tons of hybrid rice seeds from India and China for the 1999 boro season, in response to the shortage of rice seeds after the devastating floods in the 1998 monsoon. By 2004, adoption rate of hybrid rice in the country remains insignificant, about 0.5 percent of total rice area and 1 percent of irrigated area.

Hybrid rice adoption in Vietnam has steadily risen to 10 percent by 2002. This is concentrated in the north and central regions where farmers' cooperatives and state farms are heavily subsidized and strongly influenced by government directives. In these low-income regions, grain quality is not a major concern because a high proportion of rice production is for own family consumption and feeds as input to backyard livestock production. The agroecological, political, socioeconomic, and institutional features are also similar to southern China, the main source of its hybrid seed supply. In South Vietnam, where the exportable rice surpluses are produced, hybrid rice adoption has been minimal.

The first hybrid rice variety in the Philippines was released in 1994, though rice farmers did not plant hybrid varieties in any significant area until a nationwide production program began in late 2001. After five years, adoption rate has reached only 5 to 6 percent. Later sections will show that these increases were driven mostly by rising budgetary allocations as all hybrid seed supply continue to be highly subsidized. Furthermore, hybrid seed adoption has not been sustained. Farmers frequently shift back to the use of inbred varieties after one or two seasons of trial planting.

Yield and profit advantage at farm level

In the early 2000, IRRI economists organized a four-country study in Asia to evaluate the economic performance of hybrid rice at the farm level (Janaiah and Hossain 2003). Table 2 summarizes the estimated yield, price, cost, and net return comparisons between the sample of hybrid and inbred rice farmers surveyed in India, Bangladesh, and Vietnam. Similar data for the Philippines are presented in Table 3.

Table 2. Percentage difference in yield, price, gross returns, total cost, and net profits between sample farmers growing hybrid and inbred rice varieties in India, Bangladesh, and Vietnam

	Yield (t/ha)			Percent difference			
	Hybrid	Inbred	% difference	Price	Gross returns	Total cost	Net profit
India							
1994 / 95	6.3	5.6	12	-8	2	12	-5
1997 / 98	6.9	5.9	16	-11	2.6	19	-5
2000 / 2001	6.8	6.0	13	-7	-2	18	-15
Bangladesh							
1999 boro	6.4	5.6	14***	3	16**	23***	9
Vietnam							
Wet 2000	6.1	5.0	22**	.5	16**	8	42***
Dry 2001	6.3	5.2	21***	-3	17**	8	37***

Source: Adapted from Janaiah and Hossain (2003).

Legend:

*** Significant at 1%

** Significant at 5%

* Significant at 10%

No asterisk means difference is not statistically significant.

Table 3. Comparison of performance between hybrid (*Mestizo 1* and *JinYou*) and inbred varieties among 154 sample farms in Isabela and Cagayan, crop year 2000/2001

	WS 2000			DS 2001				
	Hybrid *(Mestizo 1)*	Inbred	% difference	Hybrid *(Mestizo 1)*	Inbred	% difference	Hybrid *(Jin You)*	% difference
Yield (t/ha)	5.2	4.9	6	5.9	5.1	17***	3.5	-32***
Price (P/kg)	7.2	7.2	-	8.1	8.1	-	8.1	-32***
Gross returns (P/ha)	37,696	35,609	6	48,417	41,449	17***	28,165	-32***
Total cost (P/ha)	20,544	16,578	24**	22,260	18,495	20***	19,636	6**
Net returns (P/ha)	17,152	19,031	-10	26,158	22,954	14	8,529	-63***

Source: Adapted from Casiwan et al. (2003).

Legend:

*** Significant at 1%

** Significant at 5%

* Significant at 10%

No asterisk means difference is not statistically significant.

Except for Vietnam, these studies indicated that, in general, hybrid rice cultivation was not profitable to farmers despite varying levels of subsidies. Among the five states studied in India over three cropping years, the yield advantage of hybrid rice over inbred varieties was in the order of 15 percent (Janaiah 2002). Since the selling price of hybrid rice was lower and cost of production higher, average net return was a little less than the popular inbred varieties grown in the same areas.

The results were essentially the same in Bangladesh for the boro season of 1999 (Hossain et al. 2003). Average yield of the hybrid seeds imported from India and China was also about 15 percent more than the high yielding inbred varieties. No significant difference in net returns was found even though the market price of hybrid rice was assumed to be slightly above inbred varieties based on farmers' perception, because the cost of production was more than 20 percent higher.

The Philippine study evaluated the performance of hybrid rice on farmers' fields in two favorable rice-growing provinces (Casiwan et al. 2003). In the wet season of 2000, the average yield of *Mestizo*, the publicly bred hybrid variety being promoted at that time, was not statistically different from the inbred varieties. However, the cost of production was significantly higher, leading to negative though still insignificant difference in profits. The same variety performed better in the dry season with a significantly higher yield advantage of 17 percent. But due to the higher cost of seeds and labor, the net return advantage was not statistically different from zero. Not surprisingly, the cultivation of Jin You, an imported Chinese hybrid variety released to farmers without adequate field testing nor approval by the National Seed Industry Council, failed miserably. Average yield and net returns were 32 percent and 65 percent, respectively, less than inbred varieties. Although *Mestizo* was supposed to have better eating quality than ordinary rice, the study did not observe any premium in price because of the lower head rice recovery of hybrid rice.

The yield advantage of hybrid rice reported in the Vietnam study was slightly above 20 percent, which is even higher on the average than the farm-level experience in China (Hossain et al. 2003). The difference in average cost of production (8 percent higher for hybrids) and selling price (3 to 5 percent discount for hybrids) was relatively small. Consequently, the estimated net return advantage of 40 percent was quite high, which would explain, at least in part, the steadily increasing adoption rate of hybrid rice in the northern and central Vietnam. Whether and to what extent government subsidies affected the estimated net return advantage was not quantified in any of the country studies.

Based on these four country studies, Janaiah and Hossain (2003) concluded that the presently available hybrid rice technology cannot help reverse the decelerating trend in rice productivity in the Asian tropics. More research is still required to raise yield advantage and improve grain quality of hybrid rice. Following the earlier evaluation of the Asian tropical countries' potential for hybrid rice development based on labor supply and irrigated area (Lin and Pingali 1994), the authors pointed out that only Vietnam in Southeast Asia and Bangladesh in South Asia may have good prospects for hybrid rice adoption because labor cost in these countries is low and the proportion of irrigated area relatively high in these countries.

Evidence from scientists' trials

Yield advantage of hybrid rice measured by comparing yields of farmers growing hybrid vs inbred varieties cannot be solely attributed to varietal difference. Farmers typically grow hybrids in areas with better production environments in terms of water control, topography, soil conditions, and so forth. They also tend to apply more fertilizers, agricultural chemicals, and labor inputs on hybrid compared to inbred varieties. While comparison of profitability instead of yields corrects for differences in application of inputs that can easily be valued, other important factors are still not taken into account.

Peng et al.'s (2003) analysis of results of scientists' trials in various locations in tropical Asia provides estimates of yield advantage of hybrid over inbred varieties that minimize attribution problems due to differences in production environment, input application, cultural practice, and quality of management. Table 4 summarizes the mean standard heterosis (yield advantage) computed from various breeders' and agronomic replicated yield trials in five tropical Asian countries over 15 years. Among the 155 breeders' trials conducted in the wet and dry seasons from 1986 to 1999 in India, Philippines, Vietnam, Pakistan, and Malaysia, estimated yield advantage averaged 23 percent.

The more relevant results, however, are based on agronomic trials because these are usually conducted on farmers' fields and use input levels closer to farmers' practice. In contrast, breeders' trials are conducted in experiment stations which typically have more favorable growing conditions and apply higher levels of inputs and management. Based on 25 such trials

Table 4. Mean standard heterosis of hybrid rice varieties based on breeders' replicated yield trials in five Asian countries, agronomic trials in India, and agronomic trials in the Philippines (in percent)

	Mean standard heterosis[a]
Breeders' trials[b]	23.4
Agronomic trials, India[c]	16.4
Agronomic trials, IRRI and PhilRice[d]	5.1

[a] Yield advantage over inbreds

[b] Based on 155 trials in India, Philippines, Vietnam, Pakistan, and Malaysia in dry and wet seasons from 1986 to 1999.

[c] Based on 25 trials conducted in dry and wet seasons from 1993 to 1999 in India.

[d] Based on 44 trials conducted in dry and wet seasons from 1004 to 2001 at IRRI and PhilRice.

Source: Peng et al. (2003).

conducted in India for both seasons from 1993 to 1999, average yield advantage was only 16 percent. In the Philippines, the average yield advantage from 44 similar trials also for both seasons from 1994 to 2001 dropped even further to 5 percent. These generally low yield advantages of hybrid rice found in agronomic trials coupled by its lower quality, higher fertilizer and other input requirements, and greater susceptibility to certain pests and diseases is consistent with the lack of farmers' acceptance of the hybrid rice technology in most tropical Asian countries.

II

Program Design and Conduct

Earlier government efforts (1998-2000) to promote hybrid rice production were limited in scope, targeting only 11 provinces as priority areas for piloting the hybrid rice technology. Research and development in breeding and seed production were intensified, including the collaborative undertakings with IRRI, UPLB, and selected Chinese hybrid rice institutions. The Philippine Rice Research Institute (PhilRice) began conducting both season-long (17 weeks) and short-term (4 days) training programs on hybrid seed production for potential seed growers, seed inspectors, seed analysts, seed coordinators, and extension workers. In 1999, a course on parental line (AXB) production was also introduced. The Farmers Field School programs being implemented nationwide added training modules on hybrid rice cultivation in their curriculum.

Large-scale (20 hectares) techno-demo farms were established in the priority provinces to convince farmers that hybrids are more productive than the best inbreds in the area. PhilRice and IRRI supplied most of the hybrid seeds used in the techno-demo trials. Seed growers initially hesitated to produce hybrid seeds because of the high capital requirements, laborious and technically difficult production process, and the uncertainties about the market size of hybrid seeds. As the shortage of hybrid seeds constrained the expansion of the program's coverage area, the government imported 60 tons of Chinese-bred hybrid seeds (*Jin You*) to supplement the local supply of hybrid seeds. Unfortunately, this variety proved to be highly susceptible to pest and disease infestation resulting in crop failures.

Despite the questionable economic performance of available hybrids at the farm level, even in irrigated areas considered favorable to hybrid rice adoption, the HRCP was made the centerpiece of the government's rice production program in 2001. For the program to succeed, however, a private hybrid seed industry must potentially be commercially viable on the supply side. On the demand side, there should be a sufficiently large and concentrated market for hybrid seeds among farmers at a price that covers the full cost of seed production and distribution, as well as the cost of research, development, and promotion. Crucial to the program's success, therefore, is the existence of hybrid rice varieties that are not just technically available, but commercially viable in the country.

The HRCP was faced with the twin tasks of developing a commercially viable private hybrid rice seed industry; and creating a sufficiently large market for hybrid seeds among rice farmers historically growing inbred varieties and generally using their own seeds. To accomplish these, however, the program did not simply focus on the purely public sector roles in hybrid rice development such as research and development in breeding, seed production, and hybrid rice-related cultural management, technology promotion, varietal regulations, and so on. Instead, the strategy adopted was to make hybrid seed production and hybrid rice cultivation artificially profitable through a structure of subsidies that is massive in scope and geographic coverage and quite prolonged in time. In fact, up until the wet season of 2004, the public sector directly performed many functions of a hybrid seed industry.

Promoting the Hybrid Seed Industry

The private seed industry has had an early interest in hybrid rice. In the early 1980s, Cargill Inc, one of the largest multinational agribusiness companies, collaborated with China to develop hybrid rice for the tropics, but was unsuccessful in producing commercially viable hybrid rice seeds (Virmani 1998). By 1988, the seed division of its Philippine-based company started a hybrid rice breeding program, even before PhilRice began testing some CMS and maintainer lines developed at IRRI in 1989. In 1996, Hyrice, a small local seed company involved in hybrid corn also undertook hybrid rice breeding research in collaboration with PhilRice. Soon after, another multinational agribusiness company, Aventis Crop Science, Philippines, Inc., began testing the performance of imported hybrids developed by its parent company in India.

With the government's strong interest in exploring the potentials of hybrid rice by 1998, a new local company, SL Agritech Corporation (under the umbrella of the Filipino-Chinese owner's Sterling Group of Companies involved mainly in paper products), sought the assistance of Prof. Yuan Long Ping's research institution in China to develop hybrid rice varieties suited to local conditions. It has actively engaged the government in its activities, such as initially using public lands in Laguna for its research activities, naming its hybrid seeds the "Gloria" rice after President Gloria Macapagal Arroyo during the 2004 presidential election season, and leading the local lobby for the expansion of the hybrid rice program.

The government launched the HRCP with only one hybrid rice variety, *Mestizo 1*, approved for nationwide release by the National Seed Industry Council (NSIC) back in 1997.[2] A year later, *Mestizo 2* and *3* were added to the program after their approval for nationwide release. All these three varieties were bred by IRRI, an international public research institution that permits free access to its parental lines. In 2002 and 2003, four proprietary (privately bred) hybrid varieties were also included in the program on the basis of provisional accreditation issued to satisfy the precondition for government support since the standard criteria of the NSIC for varietal release have not yet been met. These were *Bigante* of Bayer (formerly Aventis) which is imported from India, *Magilas* bred and produced by Monsanto (formerly Cargill), *SL8* of SL Agritech, and *Rizalina 20* of Hyrice. It was only in mid-2004 that *Bigante, SL8* and another Monsanto variety (*MRH005*) were approved by the NSIC for release in specific irrigated locations.[3] The *Magilas* variety was withdrawn from the market after only one season due to serious pest and disease problems.

Incentives for Seed Suppliers

Hybrid seed production did not actually prosper until 2001, after a wide variety of direct and indirect incentives were granted. Because of the availability of publicly bred varieties, the government sought the participation of seed grower cooperatives, state colleges and universities (SCUs), and individual farmers in producing the supply of hybrid seeds for the program. Private seed companies poised to supply proprietary hybrid varieties were also initially involved in producing the *Mestizo* varieties.

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[2] Two other hybrid varieties which were approved earlier for specific locations, i.e., *Magat* (1994) for Cagayan and Bicol and *Panay* (1998) for Mindanao, were included in the program.

[3] All the three varieties are recommended for irrigated lowlands. *Bigante* is particularly suited in Nueva Ecija, Cagayan, Bohol, and Isabela, especially during the wet season and for areas of similar growing conditions as the National Cooperative Trial (NCT) sites; *SL8* is suited in Nueva Ecija, Bohol, and Bukidnon during the wet and dry seasons and similar growing conditions as these NCT sites; and *MRH005* is suited in Nueva Ecija, Cagayan, General Santos City, Bohol, and Bukidnon for both seasons and similar growing conditions as these NCT sites.

Direct grants and other incentives

Several forms of direct subsidies were given. Aside from free training programs and other forms of technical assistance, seed growers received free parental lines and gibberellic acid (GA3) up to 2004. Many seed growers also benefited from direct cash grants of P5,000 to P10,000 per hectare for the initial two to three seasons. There was also the advance seed payments in the early years and subsidized credit from PhilRice, LandBank, and Quedancor. In some areas, free muriate of potash was also distributed.

Among seed suppliers, SL Agritech obtained a number of unique incentives. It was initially selected to supply parental seeds of *Mestizo 1*, without undergoing any public bidding.[4] It was also exempted from agrarian reform regulations that prohibit the purchase and ownership of 40 hectares of rice lands for its research center in the rapidly urbanizing, high-priced Laguna province.[5] The Philippine Export Import Credit Agency (PHILEXIM) seriously considered approving its application for a 300 million peso loan guarantee, despite the fact that the only hybrid seed market so far is heavily subsidized by the government itself.

Seed procurement, target setting, and market share allocation

The most valuable incentive for seed suppliers has been the government procurement aspect of the program which guarantees the market for hybrid seeds at a fixed price that is supposed to cover production cost and a reasonable profit margin. Every season, the Department of Agriculture (DA) sets the target area for hybrid rice cultivation and then estimates seed requirements based on the recommended seeding rate of 20 kilograms per hectare. That target is determined after consultative meetings between the DA's regional field units (RFUs) and the municipal and provincial agricultural offices (MAOs and PAOs) of the local government units (LGUs) directly involved in the hybrid seed distribution.

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[4] Subsequently, seed cooperatives successfully produced parental lines after training programs were conducted.

[5] The choice of Laguna as research site is surprising. The province does not seem to be a favorable area for hybrid rice cultivation as evidenced by its low adoption rate. The bulk of the company's seed production is in Davao Oriental and other areas in Mindanao where growing conditions are favorable throughout the year. The highest adoption rate and thus the biggest potential market for hybrid seeds is in Kalinga, Isabela, and other northern Luzon provinces where adoption rates of hybrids and size of rice areas are relatively high.

The aggregate supply targets, however, are clearly influenced by the budgetary resources available for seed procurement, and not so much by the level of farmer demand, as evidenced by the consistently low rate of target accomplishment reported in the next section. Interviews with the heads of LGU agricultural offices confirm their limited voice in setting supply targets. Furthermore, up to the wet season of 2005, the distribution of the target supply among the various accredited cooperatives, seed companies, and other seed growers is likewise administratively determined, in part based on the suppliers' capacity to deliver and other factors not explicitly defined. Note that the allocations across seed suppliers would correspondingly establish the market shares of the various hybrid varieties, since seed companies supply their own proprietary hybrid seeds, while the cooperatives and other seed growers produce the publicly bred *Mestizo* varieties. In effect, the market shares of the different hybrid varieties are also based largely on government allocation decisions and not on farmers' preferences and seed suppliers' competitiveness.

The Memoranda of Agreements (MOAs) are then executed between the government and suppliers of hybrid seeds. This guarantees the sale of their allocated amounts at a fixed price of P125 per kilo or P2,400 per bag of 20 kilos. At the beginning of the cropping season, the suppliers deliver the hybrid seeds to the various distribution points across the country, mainly RFUs, PhilRice stations, and PAOs, according to government instructions. Based presumably on the seed orders from the MAOs, the hybrid seeds are delivered or picked up from distribution points where the public sector absorbs the cost of the additional transport cost. To some extent, the MAOs may order the specific variety and sometimes even from the specific supplier preferred in their locality; but many of them complain about the lack of variety choice in the program.

Interestingly, the two multinational companies (Bayer and Monsanto) historically involved in the seeds and agrochemical industries opted to market their own seeds through private dealers. Unlike the SL Agritech, cooperatives, and other seed growers, these companies only receive half of the procurement price (P65 per kilo or P1,200 per 20-kilo bag) on their allocated amounts based on the stated rate (50 percent) of seed subsidy to hybrid rice adoptors. However, field visits indicate that many MAOs are also involved in the distribution of their hybrid seeds; mainly because they are in direct contact with farmers and responsible for the distribution of the other agricultural inputs accompanying hybrid seeds availment.

Starting 2005 dry season, the system of seed subsidy and distribution was changed. Instead of procuring the hybrid seeds, the government simply guaranteed the seed suppliers a certain portion of the selling price, while the remainder is to be collected from farmers. The "guaranteed" price was officially lowered to P87.50 per kilo or P1750 per 20-kilo bag, and then this was reduced further to P65 per kilo or P1,300 per 20-kilo bag in the following 2005 wet season. In addition, suppliers are now required to market their seeds directly to farmers, or indirectly through private dealers or LGU units, eliminating the cost of additional transport, storage, and marketing risk previously shouldered by the government. Seed suppliers are then paid the guaranteed price only for the quantities sold according to the signed masterlist of farmers who availed of hybrid seeds (whether or not these were directly distributed by the LGU agricultural units) and attested by the heads of MAOs, PAOs, and RFUs.

The practice of executing MOAs between the government and individual seed companies or cooperatives that stipulate the specific amount of seeds that will be procured was stopped. But the government continued to set the target supply based on the budgetary allocation and distribute this to seed suppliers, effectively providing some assurance that the guaranteed price will be paid up to the allocated amounts as long as the necessary documentations are submitted. It should be pointed out that while the guaranteed price to seed suppliers was being reduced, the target supply or the budgetary allocation for seed subsidy was increasing.

Government payments to seed suppliers and selling price to farmers actually varied depending on the source of funds. For example, a month after the start of the 2005 dry season, the DA introduced a "rehabilitation program" in Regions 2, 3, and 5, to assist farmers who suffered from typhoons at the time of planting. Under this program which supported about 40 percent of seeds distributed in these regions in that season, the guaranteed price to seed suppliers was raised to P2,075 per 20-kilo bag, correspondingly lowering the selling price to farmers. In many cases, provincial or municipal governments as well as Congressmen have allocated their own DA/foreign grant funds, or Priority Development Assistance Funds to pay part or all of the cost of hybrid seeds that farmers are supposed to shoulder. In these cases, seed suppliers effectively received up to the original procurement price of P2,400 per 20-kilo bag.

Incentives for Farmers and LGU Staff

Apart from training, techno-demo farms, and other extension activities, the selling price of hybrid seeds are heavily subsidized to induce farmers to grow hybrid rice. In addition, price discounts on chemical fertilizers, free distribution of various soil ameliorants and agricultural chemicals, and other incentives were linked to the availment of hybrid seeds. The LGU agricultural personnel involved in the hybrid seeds distribution to farmers were also granted P2,000 monthly allowance as incentives. However, these have been given only intermittently. Another incentive is in the form of a commission per bag of hybrid seeds distributed and/or paid for by the farmers.

Seed subsidies

At the beginning of the program in 2001, the hybrid seeds were sold to farmers at 50 percent of the procurement price, i.e., at P1,200 per 20-kilo bag; half of the price to be paid in cash and the remainder after the harvest. When fully paid in cash, the price was lowered to P1,000 per bag. The MAOs deduct a commission of P200 per bag from the full payment by farmers. The net revenues collected from seed sales were remitted to PhilRice, which as a government corporation can retain its earnings and allocate these to further hybrid seed-related procurement, research, training, or for any other purpose approved by its Board of Trustees.

From the wet season of 2003 to the end of 2004, most hybrid seeds were distributed on a plant-now-pay-later scheme. Farmers pay the P1,200 only after harvest, even though the risk of nonrepayment is high as experienced in the collection of credit from hybrid seed sales in the previous seasons. The fact that this scheme was introduced suggests that farmers' demand for hybrid seeds was much less than expected; and more liberal terms were necessary to encourage wider adoption.

The government has not released any official data on repayment rates, but interviews from the LGUs and national levels clearly indicate very low collections from farmers at the end of each season. Penalties were not imposed against nonrepayment. Moreover, farmers were allowed to avail of new supply of hybrid seeds the following season on the same plan-now-pay-later scheme. Under this scheme, therefore, hybrid seeds were essentially being given free to farmers.

In the 2005 dry season, as the government reduced the guaranteed price to seed suppliers, the system of distribution and the official selling price of hybrid seeds were also changed. Suppliers now sell hybrid seeds directly to farmers or indirectly through private dealers or LGU agricultural offices. For the publicly bred hybrid varieties (*Mestizo 1, 2,* or *3*), the selling price was pegged at P650 per 20-kilo bag to be paid in cash as the plant-now-pay-later-scheme was abolished. From the proceeds, the LGU agricultural units retain P100 per bag as commission, and the remainder remitted directly to seed suppliers. This price was further lowered to P350 per bag for hybrid seeds distributed later in the season under the "Rehabilitation Program." During the following wet season, the selling price was raised to P1,100 per 20-kilo bag.

Private companies selling proprietary varieties were allowed to set their own price and incentive payments to LGU staff. SL Agritech priced *SL8* at P1,200 per bag (P850 to be paid upon purchase and the remainder after harvest). Incentive payments to LGU staff were higher, ranging from P175 to more than P200 per bag. However, in early July, amidst the wet season planting, the company dropped its selling price to P550 per bag to reverse the slow rate of sales and minimize inventory carryover to the next season.

As mentioned in the previous section, the selling price to farmers also differed depending on the source of funding used to procure hybrid seeds or guarantee the minimum price received by suppliers. When LGUs or Congressional pork barrel funded the hybrid seeds, these were usually given free to farmers since the seed suppliers have already been paid the full procurement price, including what should have been paid by the farmers. There are no available data on the proportion of hybrid seeds funded from these sources, though rapid appraisal of LGU agricultural offices indicates that this is significant.

Other input subsidies

Aside from the seed subsidies, a wide variety of additional incentives were granted to further induce farmers' adoption of hybrid rice. These range from cash prizes to top yielders to provision of different combinations of subsidized agricultural inputs across municipalities and provinces as presented in Table 5. This list is not exhaustive, but it is indicative of the extent and the instruments of additional incentives utilized by the government to promote hybrid rice adoption particularly in crop year 2003/2004.

Cash prizes, travel opportunities, and other benefits were given by the government or private companies to farmers who attain exceptionally high yields. Occasionally, barangays/municipalities which reach the targeted adoption rates were recognized and granted community prizes such as solar dryers. In late 2003 and early 2004, nearly all hybrid rice growers were entitled to a P500 discount on chemical fertilizers for every bag of hybrid seeds availed and in a few municipalities the rates of subsidies were even higher. In addition, varying amounts and/or combinations of zinc sulfate, organic fertilizers, foliar fertilizer, and soil conditioners were distributed free for every bag of hybrid seeds obtained by farmers. Since hybrid rice is susceptible to bacterial leaf blight (BLB), farmers received one sachet of BLB Stopper for application during seedbed preparation as a preventive measure (and bigger amounts are sold through the RFU/LGU in case of actual BLB infestation). In the case of Region 2, another chemical, Kocide, was provided free to hybrid farmers who suffer from pest and disease infestation. These additional incentives effectively paid farmers an equivalent of about P1,000 per bag just to grow hybrids, even though most of them did not even have to pay for the hybrid seeds itself under the plant-now-pay-later scheme or when LGU and Congressional pork barrel funds were used to supplement payments to seed suppliers.

Problems in Program Design and Conduct

There are at least six major problems in the program's design which raised government cost, induced inefficiencies in resource allocation, and promoted corruption.

Government performing private sector roles

The government performed functions that are properly private sector roles. Total supply of hybrid seeds, market shares of various suppliers and hybrid varieties, distribution of supply across major locations, and the procurement and selling prices of hybrid seeds were largely determined by the government and not by market competition among seed suppliers and rice farmers as they respond to real demand and supply factors. As a result, the area planted was consistently below targets and also significantly lower than the equivalent of the seeds procured or paid a guaranteed price by the government. Farmers frequently complained about late deliveries, poor quality of seeds, and lack of variety choice. Carryover inventories of hybrid seeds across seasons were large. Given their bulky and perishable nature, the costs of additional transport, storage, and wastage shouldered by the government were consequently high. Moreover, opportunities for rent seeking (or corruption) were created.

Anomalies in seed payments

It had been very difficult to ensure that the government pays the procurement or guaranteed price only on hybrid seeds that farmers actually bought and planted, particularly after 2004. Prior to 2005, procurement payments were made upon submission of audited delivery receipts from any of the distribution points (RFU, LGU agricultural unit, or PhilRice). However, during the 2002/2003 crop year, the equivalent quantity of seeds required for the reported area planted to hybrid rice was about 25 percent lower than the quantities of hybrid seeds actually procured.[6] Evidently, some payments were made before the conduct of audit procedures. These payments have included, in part, the poor quality seeds delivered at distribution points but were either returned by farmers or remained undistributed. The difference may also have reflected significant rates of seed wastage caused by the high levels of carryover inventory and their inefficient handling and storage at government locations not equipped to handle the task of seed distribution.

Under the new system, anomalies in seed payments are likely even greater. While it is relatively easy to produce signed masterlists of farmer beneficiaries authenticated by the heads of the concerned MAOs, PAOs, and RFUs, the cost of proper auditing at the farm level is prohibitive. Not surprisingly, allegations are widespread that seed suppliers have received the government support or guaranteed price despite irregularities such as padding of seed sales, distribution of poor quality seeds, and so forth. The difference between the quantities of hybrid seeds actually planted and those paid for by the government would likely be greater under this system, especially in the 2005 dry season when little systematic audit procedures were in place. Although the number of bags of hybrid seeds subsidized by the government in recent years have not been made public, the fact that independent estimate of percentage of area planted to hybrid rice by the Bureau of Agricultural Statistics (BAS) is only about half the figure reported by the HRCP as shown in the subsequent section, clearly indicates serious problems in controlling anomalies in seed payments.

Ensuring that revenues collected from farmers are fully remitted to the government or to the seed suppliers has been equally problematic. Prior to 2005, the MAOs were accountable for remitting the payments for hybrid

[6] This is based on comparison of the number of bags of hybrid seeds distributed as reported by the HRCP and the number of bags paid for by the government through PhilRice.

seeds purchased by farmers to PhilRice. Because the seeds were mostly distributed on a plant-now-pay-later (and on a partial credit basis in 2001 and 2002), it was not easy to determine whether and to what extent the apparently low repayment rate was due to nonpayment of farmers or the nonremittance of payments by the MAOs.[7]

Since 2005 dry season, it has become even more difficult to monitor the actual payments of farmers for the hybrid seeds and the revenues from sales now remitted directly to seed suppliers. Informal interviews with various seed suppliers reveal that many MAOs have either not remitted or only partially remitted the expected revenues from seed sales to farmers. This may be due, as before, to the nonpayment by farmers or the nonremittance of payments by the MAOs.

Seed growers who are able to produce at least 0.8 ton per hectare may still remain in business despite low collections from farmers because the guarantee price remain relatively high, especially for those who benefit from additional funds from LGUs or Congressional pork barrel. At the same time, seed suppliers will not strongly complain against any anomalous practice such as bias in promoting specific hybrid varieties, delayed, or nonremittance of seed payments. This is because of the fear that agricultural officials may not distribute their seeds to farmers nor endorse the masterlist of farmers directly purchasing from the seed growers or private dealers.

Regulatory functions compromised

The government's critical regulatory functions with respect to varietal release and seed quality were frequently compromised in the conduct of the program. A number of new hybrids were procured and distributed even without passing the standard criteria of the National Seed Industry Council (NSIC). This happened in the case of *Jin You* imported from China that were distributed only after a few trials and the three new hybrid rice varieties (*Magilas, Bigante,* and *SL8*) granted temporary accreditation in 2002/2003 after failing to meet the standard criteria for NSIC approval just so these varieties can be administratively eligible for government procurement and distribution. Not surprisingly, *Jin You* and *Magilas* turned out to be highly susceptible to diseases in the farmers' fields and had to be withdrawn from the market. In

[7] One well-known case occurred in a Bulacan municipality where collections from farmers for several bags of *Bigante* were not remitted to the seed company.

mid-2004, *Bigante* and *SL8* were formally approved by the NSIC for distribution in specified locations. Yet these varieties are being subsidized even outside the recommended areas.

The incidence of poor quality seeds (low germination rate, high impurities, etc.) being delivered to LGUs, planted by farmers, and paid for by the government has been pervasive.[8] Presumably, defective seeds are to be replaced by the supplier. But, replacement often came too late for the current crop and some of them were paid for by the government before auditing procedures were completed. Even if some cost of poor quality seeds were shouldered by the suppliers, the additional cost incurred by the government in addressing this problem and the production foregone by the farmers when poor quality seeds have to be returned and replaced, or have already been planted can be quite substantial.

It may be argued that the program should have allocated sufficient budgetary resources for adequate field inspection and laboratory analysis, as well as imposed the necessary penalties against delivery of poor quality seeds. Whereas the cost of effectively regulating seed quality may be reasonable for the relatively small amounts of marketed seeds of inbred varieties, it would be prohibitively high in the scale needed for hybrid varieties. For hybrid seeds of corn and other crops marketed by the private sector, self-regulation has been the norm since seed companies protect their market shares by ensuring high quality of their seeds. In the case of hybrid rice, most seeds are sold to the government than directly to farmers. Thus, hybrid seed suppliers have little incentive to self-regulate even after 2004, because the government has continued to pay for a high proportion of the price of hybrid seeds.

Except for the production risk faced by seed growers, all the costs of risk were borne by the government (e.g., failure to sell all procured seeds and

[8] For example, in Davao del Sur during the 2004 dry season, only 50 out of the 300 bags of *SL8* delivered to the province without necessary inspection tags were planted by farmers because of poor germination rate, a common problem elsewhere at that time. Apparently, *SL8* requires a different process of seedbed preparation; but the supplier was not penalized for failing to inform the farmers about the appropriate method when the new variety was first introduced. In the same season, 100 out of the 400 bags of *Mestizo 1* hybrids delivered in a municipality of Pampanga were also defective and post audit procedures revealed that these have been paid by the government. In the wet season of 2004, uneven stands of *Mestizo 3* due to seed impurities were prevalent in a number of municipalities in Isabela. As recent as the dry season of 2005, 500 bags of *SL8* delivered in a municipality of Nueva Ecija were returned due to poor germination rates.

poor quality of seeds) and by the farmers (e.g., poor quality seeds, low yield, insect and disease problems, and others). While the shift in seed policy from government procurement to gradually transferring marketing functions and reducing price guarantee to seed suppliers are steps in the right direction, the problem of poor quality seeds continued to be widespread.

Questionable rationale of input subsidies

Subsidies on agricultural inputs listed in Table 5 cannot be justified on efficiency nor equity grounds. These inputs are private and not public goods in nature. Their free distribution will lead to misallocation of resources. The

Table 5. Sample of different combinations of additional incentives provided to farmers per bag of hybrid seeds availed, dry and wet season, 2004

	Case 1[a]	Case 2[c]	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
Fertilizers								
Inorganic	₱500 discount	₱500 discount	1 bag (₱700)	₱500 discount	Buy 1, take 2 (₱700)	₱500 discount	2 bags (₱1400)	-
Organic	-	-		-	-	2 - 4 bags (₱600)	-	8 bags (P1400)
Zinc Sulphate	10-15 kg (₱375)	-	3 kg (₱125)	5kg (₱125)	-	-	-	-
Foliar	-		-	-	-	1-2 bottles[d] (₱900)	-	-
Soil conditioner	-	-	1-3 kg[d] (₱175)	1-3 kg[c] (₱175)	1-3 kg (₱175)	1-3 kg[c] (₱175)	-	-
Chemicals								
BLB Stopper	-	1 sachet (₱80)	1 sachet (₱80)	1 sachet (₱80)	1 sachet (₱80)	1 sachet (₱80)	1 sachet (₱80)	1 sachet (P80)
Kocide	1 bottle (P300) [b]	-	-	-	-	-	-	-
Others								
	Multipurpose pavement / 200 bags distributed							
	Cash prizes to top yielders (farmers) and top adoption rates (municipalities)---------------							

[a] Incentives in Region II during dry and wet seasons of 2004.
[b] Provided to those affected by bacterial leaf blight. Initial allocation to 20 percent of planted area to hybrid rice.
[c] Commonly found in Mindanao, Kalinga, and other areas.
[d] Observed in some municipalities (e.g., those in Leyte and Bataan).
Source: Survey of Municipal Agricultural Offices.

appropriate public sector role for these agricultural inputs, if any, is the conduct of research on proper methods and rates of input application, technology demonstrations, training, and other extension activities. Subsidizing any cost of learning that may be warranted at the initial stages of technology introduction, however, does not apply to chemical and organic fertilizers which have long been known to rice farmers.

Among soil management-related inputs, promoting and subsidizing the use of foliar fertilizers and soil conditioners on rice are highly questionable on scientific and economic grounds. Foliar fertilizer is usually recommended for broad leaf plants such as fruits and vegetables, but not for crops with a low leaf area index such as rice because most of the nutrients from its application drop to the ground. For rice, it is more economical to apply ordinary chemical fertilizers directly on the soil rather than to use foliars which are much more costly per nutrient content. Likewise, the application of soil conditioners to increase the water-holding capacity of the soils is obviously unnecessary for irrigated and favorable rainfed areas where rice is grown on flooded conditions.

Many rice areas have been found to be zinc deficient, and at least in Region 2 results of soil tests were supposed to screen potential beneficiaries for the free distribution of zinc sulphate. The issue is why such subsidy was granted only to hybrid rice adoptors, and not to farms with the greatest deficiency, nor perhaps to the poorest among them. Similarly, why were the funds for the rehabilitation program during the dry season of 2005 allocated only to hybrid rice adoptors, and not shared equally among typhoon victims regardless of variety choice? Or if funds were limited, why was priority not conferred on the poorer farmers?

Scientific studies have convincingly shown that bacterial leaf blight (BLB) cannot be economically, nor effectively controlled by pesticide application (Mew and Vera Cruz 2001). Hence, Farmers Field Schools nationwide teach farmers to adopt BLB-resistant varieties as the most effective and environmentally safe method of preventing the onset of that disease based on integrated pest management (IPM) principles. Indeed, PhilRice posters (Appendix A) detailing control measures against BLB specifically warn farmers against the use of any kind of chemicals. Ironically, the HRCP promotes hybrid rice varieties that are often susceptible to BLB, and simultaneously encourages pesticides use by distributing these for free or facilitating their sale at government agricultural offices.

It should be emphasized that most of these subsidies tend to benefit the wealthier rather than the poorer farmers. First of all, hybrid rice is adopted mainly by farmers in irrigated and favorable rainfed areas, with greater capacity to finance higher cash costs, and located in areas with more developed market infrastructure. Larger or politically influential farmers can avail of higher amounts of hybrid seeds, and accordingly receive more of the free agricultural inputs as incentive. Under the plant-now-and pay-later scheme, farmers did not even have to pay for the hybrid seeds to avail of the subsidies on fertilizers and other inputs. There is also no assurance that the subsidized fertilizers and other inputs are used solely on hybrid rice cultivation since larger farmers typically grow both hybrid and inbred varieties (BAS 2004).

Interestingly, most of the subsidized agricultural inputs were linked to hybrid seed distribution at the execution stage, but the planning of the seed subsidy program is clearly separate from the subsidies on other inputs. In fact, nowhere in the literature describing, monitoring, or evaluating the program and performance of hybrid rice had the existence of the subsidies on fertilizers and other agricultural inputs reported. Yet, interviews with LGU agricultural offices consistently mention the linkage of hybrid seed distribution with provision of other agricultural inputs. Whether and to what extent these additional incentives do reach the intended farmer beneficiaries is, of course, another question.

Effective cost of hybrid seeds much higher

The effective cost of hybrid seeds procured and distributed by the government is much higher than the price directly paid to suppliers. Table 6 shows an estimate, prior to 2005, of the effective cost of the hybrid seeds per 20-kilo bag procured by the government from cooperatives and SL Agritech in comparison with Bayer which opted to market its hybrid seeds and simply receive half of the procurement price. Aside from the procurement cost of seeds, estimates of PhilRice's direct distribution cost, salaries of LGU personnel involved in the program, cost of inspection, and cost of seed wastage are added to the procurement cost of seeds to estimate the effective cost of government purchase and distribution of hybrid seeds from cooperatives and SL Agritech. This amounted to P5,100 per bag, which was much higher than the total cost of the privately produced and distributed hybrid seeds by Bayer Crop Science. The latter also received government subsidy, but only at P1,200 per bag. These are apart from the cost of

Table 6. Effective cost of hybrid seeds distributed by the government excluding any amount collected from farmers prior to 2005 (₱/20-kg bag)

	Cooperatives, SL Agritech	Bayer
Seed procurement /field production cost	2,400	1,200
Direct distribution cost of PhilRice	300[a]	
Distribution/promotion cost	1,500[b]	
Cost of inspection	100	
Cost of wastage	800[c]	
Subtotal	5,100	1,200
Other incentives (fertilizer and others)	1,000[d]	1,000
Total (excl R&D)	6,100	2,200

[a] Excludes salaries of personnel and other indirect cost of PhilRice involvement.

[b] Based on conservative assumption that 1200 agricultural technicians (ATs), (i.e, 2 ATs per municipality for a total of 600 municipalities) are involved in hybrid seed distribution.

[c] Assume 25 percent of hybrid seeds procured end up not being planted because of germination and purity problems based on difference between the quantities of seeds planted and procured mentioned.

[d] See Table 5 for details.

additional incentives which is conservatively estimated at P1,000 per bag of hybrid seeds distributed.

Excessive subsidies distort varietal choice of seed growers and farmers

The government's singular focus on hybrid rice, accompanied by excessive subsidies, has distorted varietal choices of seed growers and farmers between inbreds and hybrids, as well as among hybrid varieties. Since 1994 when the first hybrid variety was introduced, 55 new inbred varieties have been approved for release by the NSIC in contrast to only eight hybrid varieties. From 1998 when the government first decided to institute a hybrid rice program, the NSIC has approved 27 new inbred varieties compared to only six hybrids. However, nearly all government extension and production support efforts were concentrated on hybrid rice, even though hybrid seeds are basically private goods whereas inbred seeds have public good characteristics that justify government involvement in their promotion, seed production, and distribution.

The structure of subsidies artificially raised profitability of hybrid seed production and rice cultivation vis-à-vis inbred varieties. Aside from direct subsidies at the initial stages of the program, the government guaranteed seed growers a price that will ensure the supply of hybrid seeds required to achieve target areas of the HRCP, regardless of farmers' level of demand. Despite the reduction in the guaranteed price starting the 2005 dry season, hybrid rice production and distribution has remained profitable to major seed suppliers obtaining relatively high yields. Without these excessive subsidies, production of new inbred varieties would have been greater and their market price lower, increasing farmers' adoption of new and more profitable inbreds.

By distributing hybrid seeds at less than the full cost of research, production, and distribution, farmers have been induced to plant hybrid seeds that may be less socially profitable than inbred varieties. Farmers' choice among different hybrid varieties has also been distorted, because availability of specific varieties at the local level has been determined largely by the national government's deployment strategy; rather than by market demand and supply factors. As the suppliers of hybrid seeds assumed more marketing functions since the 2005 dry season, the MAOs, PAOs, and RFUs began to have stronger influence on the local availability of specific varieties. Their choices, however, do not necessarily reflect those of the farmers. Instead, these are very likely influenced by the differential incentives provided by seed suppliers, not just in terms of official commissions, but gifts in kind, travel grants, and other forms of rents. Under the current system, seed suppliers have become highly dependent on the cooperation of officials in these offices. They have a major influence on what hybrid varieties to distribute in their respective localities as well as from which supplier to get. Furthermore, these officials have to sign the masterlists of farmers availing of hybrid seeds needed to collect the government price guarantee which accounts for a greater proportion of revenues from seed sales than payments of farmers.

III

Program Performance

Hybrid rice adoption is generally better suited to irrigated and favorable rainfed lowland conditions, where yield advantage over inbred varieties may be expected to more than compensate for the higher cost of seeds and other inputs. It would be more profitable in areas with developed market infrastructure and among farmers with greater financial capability and education. This is because of the importance of marketing cost in the prices of hybrid seeds and other cash inputs and the management or knowledge-intensive nature of hybrid rice cultivation.

Hybrid rice is also expected to be more popular during the dry season when pest and disease problems are typically less, and cost of risks from typhoons and other harsh weather conditions are minimal. However, in many parts of Panay Island and Central Luzon, where direct seeding is commonly practiced especially in the dry season, the yield advantage of the transplanted hybrid rice would likely be less valuable than the benefits from the savings on labor cost, possibility of growing a second crop, and other advantages of a shorter cultivation period.

This section evaluates the performance of the program by analyzing the trends and patterns of hybrid rice adoption, examining whether and to what extent farmers have adopted hybrids on a sustained basis, and comparing yields and profitability of hybrids and inbred varieties at the farm level.

Patterns of Hybrid Rice Adoption

Until 2004, the only available estimates of area planted to hybrid rice are based on the field reports submitted by the MAOs to the Department of Agriculture (DA). These estimates are likely to be somewhat overstated. Many municipalities simply derive the area planted from the number of bags of hybrid seeds distributed. It was assumed these are all planted and farmers follow the recommended seeding rate of 20 kilos per hectare, even though several studies have already shown that farmers generally apply 10 to 20 percent higher seeding rates (BAS 2004; Sikap/Strive Foundation and PhilRice 2005). As discussed in the previous section, a significant amount of hybrid seeds reportedly distributed may not have been actually planted because of poor germination rates. Some farmers may have obtained several bags of seeds to benefit from the additional incentives such as fertilizers. Still, it cannot be assumed that these were all planted nor be paid under the plant-now-pay-later scheme.

National level

Table 7 shows by season the target areas of the program, reported areas planted to hybrid rice, ratios of target accomplishment, and ratios of reported area planted to hybrids to the official estimates of total harvested area based on the Rice and Corn Production Survey (RCPS) of the Bureau of Agricultural Statistics (BAS). Starting 2005, the BAS began to estimate adoption rate of hybrid rice varieties from the RCS as shown by the figure in parenthesis for the dry season of that year.

The target area increased sharply from 20,665 hectares in the 2001 wet season to more than 200,000 hectares in the 2005 wet season. Although the reported area planted has also been rising steadily over time, these have been consistently much below the target area, averaging only about 50 percent in the earlier seasons and climbing to about 70 percent more recently. This low accomplishment rate reflects the government's over optimism about the profit advantage of hybrids and confirms earlier observation that target areas were set not so much on the basis of perceived demand by farmers but on the size of the budgetary resources allocated to the program.

The limited demand for hybrid seeds by farmers is clearly revealed by comparing the reported area planted to hybrid varieties to total rice area. In 2004, when seed subsidies and additional incentives were at the highest, adoption rate reached only a low 5 percent. By that time, hybrid rice was already being promoted and heavily subsidized nationwide for at least six seasons. The apparent doubling of adoption rate to 11 percent in the 2005 dry season after the plant-now-pay-later scheme was abolished is highly doubtful. Padding of names and quantities of seeds in the masterlist of farmers was found to be widespread under the new system of seed subsidy and distribution while delivery of poor quality seeds continued to be a problem. In fact, the RCPS of the BAS found that the rate of hybrid rice adoption during that season was only about 5 percent, just half of the adoption rate estimated from the area planted reported by the HRCP.

Table 7. Target area of the Hybrid Rice Commercialization Program, area planted to hybrid rice, and percentage of area planted to target area and to total rice area

	Dry season	Wet season
Target area (has)		
2001	-	20,665
2002	13,087	31,699
2003	49,629	93,687
2004	92,706	182,625
2005	251,060	224,820
Area planted to hybrid (has)		
2001	-	5,472
2002	7,078	21,301
2003	25,521	54,691
2004	77,982	131,790
2005	186,329	138,709
% of target area		
2001	-	26
2002	54	67
2003	51	58
2004	84	72
2005	74	62
% of total rice area		
2001	-	0.2
2002	0.4	0.9
2003	1.6	2.3
2004	4.7	5.5
2005	10.9 (5.0)	5.8

Figure in parenthesis is estimated percentage of total rice area using hybrid seeds based on the first semester Rice and Corn Production Survey of the Bureau of Agricultural Statistics.

Sources: Target and planted area of hybrid rice (F1) from the Department of Agriculture.
Total rice area from the Bureau of Agricultural Statistics.

It is not surprising that the estimated adoption rate based on HRCP reports dropped to 5.8 percent the following wet season. This could be due to improved auditing procedures on the sales of hybrid seeds, but may also reflect a declining trend in adoption rate. It should be emphasized that all of the hybrid seeds distributed continue to be highly subsidized. Hence, area planted to hybrids expanded not so much due to rising demand of farmers, but to increases in the budgetary allocations for the seed subsidy and correspondingly to the target area of the program.

Provincial level

As mentioned earlier, adoption rate below 10 percent may simply indicate farmers are still trying out the technology. Meaning, hybrid rice varieties may be technically available, but not yet commercially viable. While adoption rate may continue to be low at the national level, it is important to examine whether or not this may be higher in irrigated and other areas suitable to hybrid adoption. Since disaggregated data on area planted to hybrids are only reported by province, this section analyzes patterns of hybrid rice adoption in relation to the rate of irrigated area and the size of rice area across provinces.

Table 8 presents the contribution to total rice area, the rate of irrigation, and the trends in adoption rate of hybrid rice from 2001 to 2005 wet seasons in provinces where adoption rate reached 10 percent or more for at least two

Table 8. Percentage contribution to total rice area, of irrigated area, and hybrid rice adoption among the top 15 hybrid rice adoptors ranked according to their contribution to total rice area

Province	Contribution to total rice area	% area irrigated	Percent adoption to hybrid rice								
			Wet 2001	Dry 2002	Wet 2002	Dry 2003	Wet 2003	Dry 2004	Wet 2004	Dry 2005	Wet 2005
Philippines	100	68	0.2	0.4	0.9	1.6	2.3	4.7	5.5	10.8	5.8
Isabela	5.7	96	1.4	1.4	1.4	3.2	5.6	8.3	21.0	25.0	11.1
Cagayan	3.9	72	0.5	0.4	0.6	1.4	2.4	4.6	18.5	19.0	19.5
Ilocos Norte	1.5	83	0.1	0.3	1.0	1.8	2.5	23.4	6.7	17.6	6.1
Nueva Vizcaya	1.4	97	0.6	0.2	0.5	1.2	1.3	4.2	6.5	17.4	16.0
Agusan del Sur	1.0	66	0.1	0.1	1.4	1.4	2.6	8.3	6.4	13.7	25.9
Davao del Norte	0.8	96	0.6	1.0	11.2	4.9	9.2	13.4	16.7	33.5	13.1
Kalinga	0.8	96	3.7	3.0	7.2	10.3	17.3	32.9	39.8	49.2	41.7
Davao del Sur	0.7	93	0.6	3.1	7.2	36.9	20.6	22.3	9.9	41.8	20.5
Zambales	0.6	67	0.4	1.7	2.4	5.1	4.8	4.2	20.1	13.7	4.6
Southern Leyte	0.4	80	0.3	0.2	0.9	1.4	0.5	3.2	9.2	10.4	19.5
Quirino	0.3	88	0.7	0.2	0.7	1.2	3.2	6.0	16.6	24.6	16.2
Misamis Oriental	0.1	94	-	1.5	11.8	6.1	6.4	10.3	12.3	16.5	10.1
Zamboanga City	0.1	73	0.0	0.4	6.1	6.1	15.3	14.9	16.7	32.0	6.8
Siquijor	0.0	86	-	-	1.1	-	0.2	2.4	16.2	3.2	11.3
Camiguin	0.0	99	-	-	4.9	-	4.5	9.1	19.1	13.8	15.2

* Percentage adoption to hybrid rice is computed using the HRCP reported area planted to hybrid seeds as ratio to respective official estimate of total rice harvested by the Bureau of Agricultural Statistics.

Sources: Department of Agriculture; Bureau of Agricultural Statistics.

seasons (Appendix Table A).[9] Except for Agusan del Sur and Zambales, rice areas in all of these provinces are nearly all irrigated. Only 15 out of the more than 70 provinces which planted hybrid rice had adoption rates that exceeded 10 percent for two or more seasons.

Among those provinces listed, only two provinces experienced relatively high rates of adoption for five seasons. Adoption rate in Kalinga steadily increased from 10 percent in the dry season of 2003 to nearly 50 percent in the dry season of 2005. This is the highest ever attained by any province, although adoption decreased to 40 percent in the succeeding season. Davao del Sur, which is perhaps the most favorable rice area in the country because of the high rate of irrigation and the absence of typhoons, obtained the highest rate of adoption in the early years of the program—37 percent in the dry season of 2003. This has declined over the years except for the unusually high adoption in the dry season of 2005. Among the top 15 rice-growing provinces contributing about half of total rice area, only Isabela and Cagayan have had adoption rates above 10 percent, averaging 18 percent over the last three seasons.

The relatively high rates of hybrid rice adoption are concentrated in Region 2 and the neighboring province of Kalinga, accounting for 35 to 40 percent of total hybrid seeds distributed. Similarly, the Davao region has relatively high rates of adoption, but only about 5 percent of hybrid seeds are grown in its small rice area. Outside the major rice-growing provinces of Isabela and Cagayan, those with significant rates of hybrid rice adoption have generally small rice areas, contributing 1 percent or less to the total. In these provinces, adoption rates may be higher than others because the quantity of free hybrid seeds and other incentives funded by grants to LGUs or the Congressional pork barrel would likely be distributed more equally or randomly across administrative units than total rice area. It is interesting to note that in several provinces with high rates of irrigation such as Pampanga and Tarlac, hybrid rice adoption remains low mainly because direct seeding is commonly practiced to save on labor cost. Adoption of hybrid seed is also very low in the predominantly rainfed areas of Panay Island where direct

[9] Unlike the national level estimate cited earlier, adoption rates of hybrid rice by province based on the RCPS of the BAS for 2005 dry season are not yet available. It should be noted, however, that as with the national estimate of adoption rate based on HRCP reports, provincial estimates shown in both tables would also be biased upwards, though the rate of overstatement would differ across provinces.

seeding is widely practiced to save time and residual water supply for a second crop of rice to be planted.

Drop-out Rates

Although there are provinces where adoption rates have been relatively high, a relevant question is whether and to what extent farmers' shift to hybrid varieties has been sustained. Farmers who are convinced about the economic superiority of hybrid rice are expected to continue growing hybrids after one or two seasons of trial plantings. To examine this question, the masterlists of farmers availing of hybrid seeds were collected from a sample of municipal agricultural offices across 12 selected provinces. In each municipality, the names of farmers are compared from one season to another and the drop-out rate of farmers in season "t" that did not use hybrids in the following "t+1" season. The availability of the masterlist of farmers for each season differed across the sample municipalities. But often, data for earlier seasons were not kept because of the small number of farmers who planted hybrid seeds, and the failure of the hybrid rice crop in the initial years of the program. Nonetheless, the patterns of drop-out rates among these sample municipalities are quite instructive because provinces with low and high adoption rates are well represented.

In Table 9, frequency counts of municipalities across the range of drop-out rates by season are presented (Appendix Table B). In general, most farmers who planted hybrid rice in the previous season reverted back to growing inbreds in the following season. Drop-out rates averaged 75 percent and ranged from 67 percent in the wet season of 2003 to 86 percent in the wet season of 2004. The lowest of the drop out rates were still relatively high at around 30 to 33 percent. In some municipalities, nearly all farmers who adopted hybrids stopped growing them in the following season such as in Magsaysay, Davao del Sur in the wet season 2003 and in Lubao and Floridablanca in the dry season of 2004. Indeed, in the sample municipalities of Davao del Sur and Davao del Norte, all of the farmer adoptors in the wet season of 2004 did not grow hybrids in the succeeding 2005 dry season. On the average, only about 12 percent of municipalities had drop-out rates below 50 percent. Another 24 percent of municipalities experienced drop-out rates ranging from 50 to 70 percent, and among the remaining two-thirds of municipalities, more than 80 percent of farmers who tried hybrids went back to using inbreds.

It is important to note that provinces with the highest hybrid rice adoption also experienced high drop-out rates, such as Isabela, Kalinga, Davao del

Table 9. Distribution of sample municipalities by drop-out rate (in percent)[a]

	Dry 2002	Wet 2002	Dry 2003	Wet 2003	Dry 2004	Wet 2004
No. of municipalities	8	18	25	37	48	38
Drop-out rate in next season						
91 – 100	13	33	40	8	10	50
81 – 90	-	22	16	14	19	21
71 – 80	38	22	24	24	19	13
61 – 70	13	6	8	24	21	13
51 – 60	13	11	8	11	17	0
50 below	25	6	4	19	15	3
Average drop-out rate	68	80	80	67	69	86

[a] For example, the figures under Wet 2004 refers to percentage of farmers in the season who did not grow hybrid rice in the succeeding dry season of 2005.

Source: See Appendix Table B.

Sur, and Davao del Norte. In a few cases, farmers grew hybrid rice only in the dry season, and in some rainfed areas, only in the wet season. This finding is all the more disturbing since the hybrid seeds were practically free in 2003 and 2004 and many farmers were actually being given additional incentives for growing hybrids. Until the present, many farmers continue to receive hybrid seeds without having to pay for them, either because of additional subsidies through LGUs or Congressional pork barrel funds or nonpayment of the farmers' share of the price of hybrid seeds. Clearly, the majority of farmers have not been convinced about the economic superiority of growing hybrid rice versus the best yielding inbreds.

Green Revolution Experience

The Green Revolution experience illustrates that farmers are quick to adopt new varieties when these are more profitable than existing ones. The modern rice varieties (MVs) introduced in 1966 spread rapidly, covering half of total rice area by 1970. Indeed four years after its first release, adoption was generally 100 percent complete in irrigated areas where MVs are most suitable (IRRI 1971). As new generations of MVs were developed, adoption rate rose to 80 percent by the early 1980s and to more than 90 percent by the 1990s, leaving mostly just the upland areas being planted to traditional varieties. This is because the new MVs incorporated more desirable traits—better grain quality, greater insect and disease resistance, shorter growth duration, and more tolerance to drought, flooding, and other abiotic stresses.

It should be pointed out that government promotional efforts in the late 1960s were primarily extension activities and some free distribution of one or two kilos of the modern variety inbred seeds to farmers joining training programs. Public expenditures for irrigation also increased sharply in response to the higher returns to investments resulting from the MV introduction. However, the massive subsidies on credit and fertilizers under the Masagana 99 Program were provided only in the early 1970s. These were justifiably aimed at (a) hastening farmers' recovery from the widespread tungro infestation and series of bad weather years that reduced total rice production by 20 percent in the early 1970s; (b) easing the adjustment cost of the land reform program instituted in 1972 which removed landlords as the main source of farm credit; (c) protecting farmers from the sharp increase in fertilizer price due to the oil crisis in 1973; and (d) ensuring adequate domestic rice production as world rice prices rose nearly four-fold in 1973/74. In fact, Herdt and Capule (1983) showed that the Masagana 99 Program did not accelerate the rate of MV adoption and concluded that input subsidies were not necessary to promote adoption of new varieties as long as these were economically superior to existing varieties.

Yield and Net Return (Profit) Advantage

In order to understand why adoption rate of hybrid seeds remain low and farmers often revert back to using inbred varieties after one or two seasons of trial planting of hybrids, the economic performance of hybrid compared to inbred rice varieties at the farm level has to be examined. Farmers shift to new varieties when expected profits are higher than those being presently grown. In turn, the increase in expected profits depends on the yield advantage of the new varieties. Other factors include differences in the price of seeds, seeding rates, grain quality or price of output, susceptibility to pests and diseases, tolerance to abiotic stresses, growth duration, yield stability, requirements for other inputs, and so forth.

The only countrywide data comparing yields of hybrid to inbred rice varieties are collated by the DA based on field reports of the MAOs (Table 10). Reported yields of hybrid rice averaged 6 tons per hectare. The yield advantage of hybrid over inbred rice varieties was in the order of 1.5 tons per hectare or about 30 percent. Accuracy of these data is doubtful for at least two reasons. First, no systematic farm survey with a common methodology across municipalities was utilized to derive yield estimates. Second, given the monetary incentives provided to the MAOs staff for implementing the program, yield reports was likely to be biased upwards.

There are only two independent farm-level studies that evaluated the economic performance of hybrid versus inbred rice varieties. First is the survey of more than 4,000 hybrid and inbred rice-growing farmers conducted by BAS in 15 provinces for the 2003 dry and wet season of 2003 (BAS 2004). Although this survey has a relatively wide geographic coverage, its analysis was limited to yield comparisons. The second study involved fewer samples. But it is a more detailed evaluation of the yield and profit advantage of hybrid over inbred rice varieties for both seed growers and farmers in five provinces over four seasons (Sikap/Strive Foundation and PhilRice 2005).

The two studies relied on simple cross-section comparisons of yields, price, cost, and profits or net returns between hybrid and inbred farms. The differences observed cannot be solely attributed to hybrid seed adoption because many other factors that may affect yields and profitability are not taken into account. Although some efforts have been made to sample hybrid

Table 10. Reported national average yields of hybrids and inbreds (certified seed) in irrigated areas by the Department of Agriculture and LGUs

	Average yield (t/ha)		Yield advantage	
	Hybrid	Inbred	(t/ha)	(percent)
Wet 2001	5.5	4.3	1.2	27
Dry 2002	6.8	4.4	2.4	55
Wet 2002	5.8	4.5	1.3	30
Dry 2003	6.1	4.6	1.5	32
Wet 2003	6.0	4.6	1.4	32
Dry 2004	6.1	4.7	1.4	29
Wet 2004	5.6	4.6	1.0	21

Source: HRCP, Department of Agriculture.

and inbred rice farmers who have similar characteristics, farmers who grow hybrids would likely be endowed by more favorable agroecological conditions and socioeconomic characteristics. For example in the BAS study, the ratio of irrigated area (80%) and farm size (2.4 hectares) were higher among hybrid seed users than those growing inbreds (65% and less than 2 hectares). Also, farmers do not usually plant hybrids in their whole farm. Within their farms, these would likely be grown in the more productive parcels, receiving greater care and higher fertilizer and other inputs. Moreover, the early adoptors are expected to be more progressive in terms of education, financial capability, and so forth. Despite the attribution problem, these studies are useful in understanding why adoption rate of hybrid rice remains low.

BAS study

Table 11 shows the average yields of hybrid rice in 15 selected provinces in the wet and dry seasons of 2002 and 2003 reported in the BAS. In general, average yields of hybrid rice in this study—about 4.2 tons per hectare—are significantly lower than those reported by the DA (6 tons per hectare). Average yields varied widely across provinces ranging from only 1 ton per hectare in Iloilo to 6.3 tons per hectare in Kalinga in the dry season and from 2.7 ton per hectare in Agusan del Norte to the highest of 5.3 ton per hectare in Kalinga in the wet season. The relatively low average yield in Iloilo is consistent with the minimal rate of hybrid rice adoption in the province and others in the Panay Island.

Contrary to the DA estimates of yield advantage, the average yields of hybrid seeds in the BAS study were significantly higher than inbred varieties only in three out of the 15 sample provinces. In most cases, there was no statistical difference in yields between hybrid and inbred varieties even though yield advantage may seem high because of wide variations in farm yields for both hybrid and inbred seed adoptors. In some provinces, hybrid varieties even had lower average yields than inbreds. With one exception, yield advantage is statistically significant only when the difference in average yields between hybrids and inbreds reach 1 ton per hectare or more. According to IRRI studies, this is the threshold at which hybrids become more profitable than inbred varieties as the value of the yield advantage surpass the higher cost of seeds and other inputs in hybrid rice cultivation (Virmani 2004).

Table 11. Average yields of hybrid rice and yield advantage of hybrid over inbred rice varieties based on survey of farms by the Bureau of Agricultural Statistics on selected provinces, crop year 2002/2003

	Average yield (t/ha)		Yield advantage			
			(t/ha)		(percent)	
	Dry 2002	Wet 2003	Dry 2002	Wet 2003	Dry 2002	Wet 2003
Kalinga	6.3	5.3	1.74	1.05	38***	25***
Isabela	5.8	5.0	0.64	-21	13	-4
Nueva Vizcaya	3.5	4.2	-	-	-	-
Laguna	4.0	4.6	-0.28	1.02	-6	29*
Quezon	2.9	3.1	-0.28	.09	-9	3
Mindoro Oriental	5.5	5.6	1.70	1.86	45***	50
Albay	5.7	4.8	0.49	.42	9	9
Camarines Sur	4.6	4.3	0.71	.53	18	14
Iloilo	1.0	4.4	-2.35	-.75	-70	-14
Bohol	3.3	4.3	-0.06	.63	-2	17
Negros Oriental	3.6	3.5	0.56	.70	18	25
Leyte	4.3	4.2	1.04	.64	32***	18**
Davao del Norte	4.2	4.2	-0.13	-.02	-3	-.6
Agusan del Sur	4.7	3.6	0.06	.50	-1	16
Agusan del Norte	2.6	2.7	0.22	.01	-8	.4

Source: Bureau of Agricultural Statistics (2004).

Legend:

*** Significant at 1%

** Significant at 5%

* Significant at 10%

No asterisk means difference is not statistically significant

Sikap/PhilRice study

It is important to relate the patterns in yield advantage between hybrid and inbred varieties (Table 12) to the gains in net returns (Table 13) found in the five study provinces over four crop seasons reported by the Sikap/Strive Foundation and PhilRice (2005). Note that the sample farmers changed from one season to the next, because many of the sample of hybrid adoptors shifted back to growing inbreds. Thus no trends can be inferred from the changes in yield advantage nor net return over time.

The yield advantage was statistically significant in one or two seasons in Isabela, Nueva Ecija, Iloilo, and Davao del Sur. But these are only about 15 percent, way below the 20 to 30 percent found in the DA reports. Relatively high percentages of yield difference in three seasons were observed in Davao

Table 12. Average yield of hybrid rice and yield advantage of hybrid rice over inbred rice varieties based on a sample of farmers surveyed in five provinces from the 2002 wet season to the 2004 dry season

	Isabela	Nueva Ecija	Iloilo	Davao del Sur	Davao del Norte
Average yield of hybrid rice (t/ha)					
Wet 2002	5.6	2.0	4.0	6.7	5.8
Dry 2003	6.2	5.9	4.7	6.2	5.6
Wet 2003	5.8	5.9	5.2	5.9	4.9
Dry 2004	6.1	6.3	4.7	5.0	4.6
Yield advantage					
(t/ha)					
Wet 2002	.71	-1.82	-.79	.76	1.53
Dry 2003	.87	.29	.61	.78	.93
Wet 2003	.38	.85	.31	-.12	.32
Dry 2004	.23	.30	.60	-.22	.72
(percent)					
Wet 2002	16*	-48	-2	13	36*
Dry 2003	16**	5	15**	15	20*
Wet 2003	7	18**	6	-2	7
Dry 2004	4	5	15**	-4	25**

Source: Sikap/Strive Foundation and PhilRice (2005).
Legend:
*** Significant at 1%
** Significant at 5%
* Significant at 10%
No asterisk means difference is not statistically significant

del Norte. In nearly all cases, however, the differences in average yields between the hybrid and inbred rice varieties were only less than a ton per hectare, the threshold at which hybrid varieties can be expected to be more profitable than inbreds.

While the yield advantage of hybrids in the three major rice-growing provinces were statistically significant for a number of crop seasons, it was only one season in Isabela which showed significantly higher net return of hybrid over inbred varieties. In all four crop seasons, hybrid adopters in Nueva Ecija and Iloilo did not have significantly higher net returns than inbred growers, which may explain the generally low rate of hybrid seed adoption in these two provinces. On the other hand, the average net returns of hybrids were significantly higher in three crop seasons in Davao del Sur and Davao del Norte despite the yield difference of less than a ton per hectare. Highly

Table 13. Percentage difference in net revenue between hybrid and inbred rice varieties based on a sample of farmers in five provinces from wet season of 2002 to dry season of 2004 (in percent)

	WS 2002	DS 2003	WS 2003	DS 2004
Isabela	30	44*	12	4
Nueva Ecija	-20*	3	28	1
Iloilo	-14	2	-19	29
Davao del Sur	28**	35**	13	39**
Davao del Norte	53**	52**	-2	61**

Source: Sikap/Strive Foundation and PhilRice (2005).
Legend:
*** Significant at 1%
** Significant at 5%
* Significant at 10%
No asterisk means difference is not statistically significant.

questionable is such a result for Davao del Sur in the dry season 2004 when the yield advantage was reported to be slightly negative.

The attribution problem in cross-section comparison of net returns is more serious than of yields because there are many other factors besides variety choice that affect the value and cost of production such as differences in tenure, method of crop establishment, input subsidies, and so forth. Apart from the attribution problem, it should be noted that these estimates do not include other relevant costs such as the opportunity cost of cash outlay and implicit rental on land. Also, these estimates reflect financial net returns and not social rates of returns which value the output and inputs at their social opportunity costs, i.e., without the effects of policy instruments that distort prices faced by farmers.

IV.

Program Cost and Distribution of Benefits

Budgetary Cost of the Program

Accounting for the direct and indirect budgetary cost of the hybrid rice promotion program is difficult and not straightforward. The only source of funding for the hybrid rice program that can be explicitly documented is the planning budget of the so-called GMA Rice Program, one of the DA's banner programs and funded as a lump sum allocation under the Office of the Secretary (OSEC). However, the DA has the flexibility to reallocate resources within its relatively large pool of lump sum funds approved by Congress to increase the allocation for the rice program. In addition, other funding sources within the department such as commodity and other foreign grants, surpluses of government corporations under its jurisdiction, and other grant-like budgets of certain agencies within the Office of the Secretary can easily be realigned.

Outside the DA, several sources of funds have been used to support the HRCP. In early 2004, about P500 million of the Agrarian Reform Funds have been allocated to the program. Since 2003, many LGUs and Congressmen utilized their own resources, DA funds, foreign grants, and the Priority Development Assistance Funds to subsidize hybrid seeds and other related agricultural inputs.

Table 14 presents the estimated amounts spent for the hybrid rice program by source of funding from 2001 to 2005. These estimates should be viewed as broadly indicative of the budgetary costs and the shares of the various fund sources, and not as exact amounts of government expenditures. In most cases, the data on actual expenditures for seeds, other inputs, and related activities are not made public. On the other hand, expenditures related to the hybrid rice program are not specified in the publicly available financial reports.

The GMA Rice Program budget allocated under the General Appropriations Act (GAA) constitute the largest source of funds totaling more than P6 billion over five years. This estimate is based on the total allocation for the rice program less the provision for inbred seeds. This includes the procurement of hybrid seeds, support to seed growers, subsidies for other

Table. 14. Estimated budgetary outlays for the Hybrid Rice Commercialization Program from 2001 to 2005 by source of funding[a]

Source	P (billion) [b]
DA GMA Rice Program	6.47
LGU	
Personnel	1.20
Procurement/distribution	0.75
PDAF (Congressional pork barrel)	1.00
DAR	0.50
Total	9.92

[a.] Excludes FAO grants and revenue collections from hybrid seed distribution to farmers spent on HRCP related activities.
[b.] See text for methodology used for estimation.

inputs, research and development, techno-demo farms, salary supplement for LGU staff, and other operational expenses) as detailed in Appendix Table C. The amount actually released and spent may be lower than the GAA allocation. This possible overstatement may be compensated by the omission of funds from other sources that cannot be documented. Examples are the FAO grants used for seed procurement by a few LGUs, credit subsidies, and the revenues derived from farmers' seed payments deposited at PhilRice. This amount may be spent also for hybrid rice-related inputs or activities upon the approval of its Board of Trustees.

The local government's contribution is primarily in terms of the time devoted by its agricultural staff in seed distribution, farmers' training and technical assistance, and program planning, monitoring, and reporting for the hybrid rice program. Based on conservative assumptions of the number of municipalities (600), agricultural technicians (2 per municipality), and annual gross compensation per staff (P200,000), the annual indirect cost for LGU personnel only sums up to P240 million, or about P1.2 billion over the past five years.

The LGUs have also procured hybrid seeds and other agricultural inputs for distribution to farmers, funded partly by DA grants. Although there is no budget in the GAA that specifies such an allocation, the P750 million reportedly transferred to the various LGUs in 2004 for that purpose may have been realigned from the lump sum funds and other budget items (PCIJ

2005). Since there is no other basis for estimating LGU financial contribution for the purchase of hybrid seeds and other agricultural inputs distributed free to farmers under the program, only that amount is listed, though additional budgets have likely been provided in other years. Some progressive municipalities and cities with higher internal revenue allotment funds have also used their own resources as a token of support to the national program.

The Priority Development Assistance Fund (PDAF) or the congressional pork barrel is another budgetary source which has been used to procure agricultural inputs for distribution to farmers. In 2003, close to P400 million of the PDAF was disbursed for agricultural-related inputs. This includes hybrid seeds, fertilizers, foliars, soil conditioners, and others. In 2004, the amount as of August has already reached nearly P300 million. Assuming conservatively that about P200 million of the PDAF is allocated annually for the hybrid rice program, this source of funding would have contributed a billion pesos over five years. Finally in early 2004, P500 million of the Agrarian Reform Funds were diverted to the DA for the hybrid rice program, presumably earmarked to fund the distribution of hybrid seeds and other subsidized inputs to agrarian reform beneficiaries. Thus far, the hybrid rice program has cost the government approximately P10 billion.

Distribution of Benefits

The fact that most rice farmers have chosen to grow inbred varieties, even after trying hybrid seeds for one or two seasons, clearly indicate that the target clientele is not the major beneficiary of the HRCP. The relatively few rice farmers who may have sustained the adoption of hybrid seeds would generally be the irrigated and larger farmers. The comparison of the estimated costs and returns of hybrid and inbred seed production as well as the hybrid rice cultivation in Table 15 revealed that hybrid seed growers or companies benefit most from the program and not the rice farmers.

The first column show the average costs and returns of hybrid seed production based on estimates submitted by the five cooperatives in Isabela and Kalinga assuming yield of one ton per hectare for 2004. All the other estimates of costs and returns were obtained from the Sikap/PhilRice study in the five provinces. It is clear from the comparison that as early as 2003 and at the procurement price of P120 per kilo or P2,400 per 20-kilo bag, hybrid seed production has become highly profitable for many growers. Net returns average P60,000 per hectare when yield of one ton per hectare is attained. In contrast, inbred seed growers gain only about P30,000 to P35,000, while

Table 15. Profitability of hybrid and inbred seed production and rice production (P/ha)

	Seed production			Rice Dry 2004	
	Hybrid		Inbred [b]	Hybrid	Inbred [b]
	(1)[a]	(2)[b]			
Yield (kg/ha)	1,000	735	4,977	5,355	4,993
Gross revenue	120,280	100,329	67,689	48,098	41,762
Cost of production c	55,095	47,220	32,340	28,209	26,925
Gross revenue - cost of production	63,185	63,109	35,324	19,889	14,838
Cost per kilo		63	65	7	

[a] Average of cost and returns data of cooperatives assuming average yields of F1 seeds of 1 t/ha for Isabela (ISGMPC for Dry 2004, Roxas for Wet 2004, and San Manuel for Wet 2004), Cagayan (CSPMC for Wet 2004), and Kalinga (Tabuk for Dry 2004).

[b] Based on sample of farms in 5 provinces (Isabela, Nueva Ecija, Iloilo, Davao del Sur, and Davao del Norte) reported in the Sikap/Strive Foundation and PhilRice (2005) study.

hybrid rice farmers gain only P15,000 to P20,000. Even when yields of hybrid seed production is only about 700 kilos per hectare, net return is quite high at around P50,000 per hectare.

In fact, the sensitivity analysis reported in the 2001 study of S.R. Francisco et al. found that at an average yield of 500 tons per hectare and procurement price of P120 per kilo, net returns from hybrid and inbred seed production will be equal. Evidently, hybrid seed production has become highly profitable at the procurement price set when the program started, which has not been adjusted until the dry season of 2005. The level of management and financial capital required for seed production, especially of hybrids, is undoubtedly higher than rice cultivation. These wide disparities in net returns reflect the lack of competition and consequently, the excessive subsidies received by hybrid seed suppliers in the HRCP.

Table 16 presents the estimated changes in the market shares of the different hybrid rice varieties. Whereas the three publicly developed *Mestizo* varieties produced primarily by cooperatives dominated the hybrid seed supply in the early part of the program, the share of *SL 8* is now about equal to them by 2005. Since SL Agritech is the sole supplier of *SL8*, it is now the single biggest supplier of hybrid seeds in the market.

Table 16. Hybrid rice seeds procured/subsidized by variety, source, and season of seed production (in bags)[a]

	Wet 2003	Dry 2004	Dry 2005
Cooperatives	30,201	146,962	99,221
Mestizo 1	26,064	89,259	58,009
Mestizo 2	-	1,219	1,395
Mestizo 3	4,137	56,484	39,817
SL Agritech	29,138	48,087	93,611
SL8	29,138	48,087	93,611
Bayer Crop Science	9,098	17,211	20,164
Tisoy	582	2,266	
Bigante[b]	8,516	14,945	20,164
Monsanto	2,126	-	-
Magilas	2,126	-	-
Total	70,563	212,260	212,996

[a] As of August 2004.

[b] *Bigante* which comes in 15 kg/bag is considered equivalent to the 20-kg bag for all others.

Sources: PhilRice (Wet 2003 and Dry 2004 seed procurement); Department of Agriculture (Dry 2005 seed distribution).

It is important to note that *Bigante*, which is imported from India and receives the lowest price guarantee from the government, can maintain a market share of about 10 percent. This suggests that hybrid varieties may be developed elsewhere under similar tropical production environments; and after intensive field trials within the country, the seeds of the best performing varieties may be produced in other countries with lower cost of production.

Imported hybrid seeds can compete in the local market for a number of reasons. First, trade policies which have raised domestic rice price by about 70 percent above the landed cost of imported rice have defended a similarly higher local cost of rice production compared to most developing Asian countries (David 2003). That margin or implicit tariff, coupled by zero tariff on imports of seeds, would more than cover the total cost of hybrid seed importations from countries that can produce rice at world prices. In fact, the Philippines would even be less competitive in hybrid seed production compared to rice cultivation. This is because the former is more labor-intensive and the country's labor cost is significantly higher than India, China, Indonesia, and other Asian countries exporting rice.

Second, the most favorable areas for seed production are located in the northern part of the country namely, Kalinga, Isabela, Cagayan, as well as in the southern end specifically the Davao area. Given the country's geographic characteristics, poorly developed infrastructure, and well-known monopoly rents pervasive in the shipping industry, internal transport is relatively high. On the other hand, the importation of seeds saves internal shipping cost because of the presence of several international ports across the country.

Finally, the cost of storage and wastage due to seasonal imbalance in demand and supply of hybrid seeds can be minimized. In general, the dry season is more favorable to both hybrid seed and rice production. But due to the greater risks of pest and disease infestation and weather problems in the wet season, farmers' demand for hybrid seeds is usually low relative to the supply of fresh hybrid seeds produced from the previous dry season. Consequently, the carryover inventory of hybrid seeds between the dry and wet season rice crop tends to be large. The cost of storage, including the losses due to quality deterioration, is quite considerable.

V

Conclusion

Despite concerted efforts and massive subsidies incurred in the promotion of hybrid rice, there is no strong evidence that currently available hybrid varieties are already commercially viable in the country as similarly concluded by the recent studies in other tropical Asian countries led by Janaiah and Hossain (2003). While currently available hybrid seeds may be suited in some areas with irrigation and developed market infrastructure, the market demand has not been large and sufficiently concentrated for private seed companies to achieve economies of scale.

The highly subsidized approach adopted in the HRCP incurred not only direct and indirect financial cost to the government. Equally costly are the inefficiencies arising from the distortion of farmers' choice between hybrid and inbred rice varieties, and among hybrid varieties. It created opportunities for corruption that weakened the quality of governance. Moreover, the government's preoccupation to meet distribution targets inadvertently compromised its regulatory functions aimed at protecting the interest of farmers and taxpayers in general. Even when the problems of unsuitability of varieties and poor quality seeds became apparent, these were not adequately addressed.

While some government subsidies may be justified at the initial stages of hybrid rice introduction, these should have been limited to supporting research and development, training and other extension activities. For infant industry argument, the costs of learning and risks involved in trying out the hybrid technology by seed growers and rice farmers may be initially subsidized but for only one or two seasons among representative farmers for demonstration purpose. As discussed earlier, even the research to develop hybrid crosses and promotional activities to market hybrid seeds are more efficiently performed by the private sector. The public sector's role in hybrid rice should by now be limited to basic and strategic research on hybridization, conventional breeding, and research and extension in hybrid-related cultural and other management practices. It should be emphasized that further varietal improvements in hybrid rice depends critically on the rate of achievement in conventional breeding of superior inbreds suited to local conditions which is a key ingredient to successful hybridization (Virmani 1998).

It is imperative that the government quickly phase out the present system of subsidies on hybrid seeds, fertilizers, chemicals, and other agricultural inputs which are all private goods. The country cannot afford to further waste scarce public resources on making hybrid rice artificially profitable, especially since investments in infrastructure, education, and health are very low. A modest research and development effort in hybrid rice can be maintained at PhilRice, mainly to keep abreast with international developments in this field.

Public sector research and development efforts must be focused on inbred varieties. Furthermore, resources must be urgently allocated to develop an efficient inbred rice seed system with modest regular subsidy. The private sector will not allocate optimal levels as inbred seeds have public good characteristics. The current ad hoc system of government inbred seed procurement and distribution is also inefficient and prone to corruption (dela Cruz 2002). Reforming the current system may consider the establishment of a revolving fund, and an operational system that ensures accountability and efficiency.

Appendix A

Paano maiiwasan ang bacterial blight (BLB)

- Panatilihing malinis ang bukid.
  Sa panahon ng paghahanda ng lupa, tanggalin lahat ng pasyo, dayami, raton, o supang sa palayan. Ang mga ito ay pinamamahayan ng *bacteria*. Lalo na kung hinayaan ang mga ito sa palayan. Ugaliin ang regular na pagtanggal ng mga damo upang mawala ang posibleng kahaliling tirahan o "*alternate host*."

- Siguraduhin na madaling patubigan o patuyuin ang punlaan at mga pinitan.
  Panatilihin ang dalawa o tatlong sentimetrong lalim ng tubig - maiiwasan nito ang pag-apaw ng tubig na maaring magkalat ng sakit. Ang *bacteria* ay kumakalat sa ibang palayan sa pamamagitan ng tubig irigasyon.

- Maglagay ng tamang dami ng abono netrohino.

  Ang paglalagay ng sobrang dami ng netrohino ay pabor sa pagkalat ng *bacterial leaf blight*. Mas mainam ang hati-hating aplikasyon keysa isahang aplikasyon.

- Pahingahin ang lupang pinagtataniman at hayaan itong matuyo (*fallow period*).
  Matapos ang anihan, araruhin ang lupa para mailantad ang mga bacteria na maaaring naninirahan at nabubuhay sa ilalim ng lupa. Hayaang matuyo ang lupa sapagkat namamatay ang *bacteria* sa maiinit at tuyong kondisyon.

- Iwasan ang paggamit ng kung anu-anong kemikal.
  Ang bacteria ay madaling magkaroon ng resistensya laban sa mga kemikal na pamatay-bacteria. Sa ngayon, wala pang kemikal ang inirerekomendang gamitin laban sa bacterial blight.

Source: PhilRice.

Appendix Table A. Contribution to total rice crop area, ratio of irrigated rice crop area, and adoption rate of hybrid rice by province ranked by adoption rate during wet season 2004 (in percent)

Province	Contribution to total rice area	Ratio of irrigated rice area	Adoption rate of hybrid rice								
			Wet 01	Dry 02	Wet 02	Dry 03	Wet 03	Dry 04	Wet 04	Dry 05	Wet 05
Philippines	100	68	0.2	0.4	0.9	1.6	2.3	4.7	5.5	10.8	5.8
Nueva Ecija	6.1	83	0.2	0.2	1.2	1.2	1.3	9.1	4.5	20.2	7.1
Iloilo	5.9	54	-	0.0	0.2	0.1	1.3	0.3	1.2	0.1	0.4
Isabela	5.7	96	1.4	1.4	1.4	3.2	5.6	8.3	21.0	25.0	11.1
Pangasinan	5.4	66	0.2	0.3	0.3	1.3	0.7	2.8	3.3	14.2	5.5
Cagayan	3.9	72	0.5	0.4	0.6	1.4	2.4	4.6	18.5	19.0	19.5
Camarines Sur	3.2	72	0.0	0.2	0.5	0.9	0.9	2.1	2.2	13.2	3.4
North Cotabato	2.8	74	0.2	0.1	0.3	0.6	2.7	3.2	2.8	5.0	3.1
Tarlac	2.8	90	0.2	0.1	0.7	4.5	2.6	5.7	3.5	8.2	2.4
Capiz	2.7	27	-	0.0	0.2	0.2	0.3	0.1	0.6	0.2	0.9
Leyte	2.6	64	0.5	0.3	0.5	0.6	0.9	2.5	5.5	8.8	11.6
Sultan Kudarat	2.5	89	0.1	0.4	0.6	0.3	4.9	2.1	8.3	4.2	4.8
Negros Occidental	2.5	75	-	0.2	0.6	0.1	0.5	0.1	0.5	0.7	0.4
Maguindanao	2.5	32	0.0	0.1	0.2	0.2	2.0	4.0	3.6	7.9	1.0
Palawan	2.0	40	-	-	0.1	0.0	1.4	1.5	1.0	0.5	0.3
Oriental Mindoro	1.9	73	-	-	0.5	0.9	3.2	4.2	6.1	8.7	9.9
South Cotabato	1.9	90	0.2	0.0	0.3	0.3	3.7	0.7	4.3	2.0	1.9
Zamboanga del Sur	1.9	68	0.0	1.7	1.3	1.4	3.4	10.4	6.5	25.2	5.6
Bulacan	1.8	72	0.1	0.1	0.3	0.6	0.6	3.7	5.4	8.1	9.2
Antique	1.7	53	-	-	0.0	-	0.4	0.3	0.8	0.0	0.1
Pampanga	1.6	95	0.2	0.1	1.1	1.4	1.1	4.0	8.1	9.3	3.6
Occidental Mindoro	1.6	62	0.1	0.2	0.7	0.9	4.8	16.2	4.4	11.7	13.1

Appendix Table A (continued)

Province	Contribution to total rice area	Ratio of irrigated rice area	Adoption rate of hybrid rice								
			Wet 01	Dry 02	Wet 02	Dry 03	Wet 03	Dry 04	Wet 04	Dry 05	Wet 05
Lanao del Sur	1.6	29	-	0.1	1.5	1.7	3.8	3.6	1.7	6.1	3.0
Ilocos Norte	1.5	83	0.1	0.3	1.0	1.8	2.5	23.4	6.7	17.6	6.1
Bukidnon	1.5	97	-	0.2	1.4	1.6	3.3	4.8	5.2	7.9	12.5
Nueva Vizcaya	1.4	97	0.6	0.2	0.5	1.2	1.3	4.2	6.5	17.4	16.0
Bohol	1.4	47	-	0.0	1.8	1.8	3.8	6.4	4.7	7.5	4.8
Quezon	1.3	53	-	0.1	0.3	0.0	2.5	1.7	4.7	0.7	2.1
Lanao del Norte	1.3	79	0.6	0.2	1.0	0.4	0.8	2.5	2.1	2.0	1.2
Albay	1.1	77	0.0	0.2	0.5	1.0	1.7	3.7	3.9	13.2	8.7
Masbate	1.1	7	0.0	-	-	-	0.0	0.3	0.2	1.4	0.7
Ilocos Sur	1.1	49	0.4	1.7	1.5	3.7	2.4	10.1	7.3	20.8	5.7
Aklan	1.1	48	-	-	0.0	0.2	0.2	0.4	0.7	1.1	1.5
Sibugay Province	1.1	55	-	0.5	0.9	3.4	8.3	14.9	6.4	18.1	6.8
Agusan del Sur	1.0	66	0.1	0.1	1.4	1.4	2.6	8.3	6.4	13.7	25.9
Western Samar	1.0	10	0.0	0.1	0.0	0.0	0.2	0.5	0.7	0.9	0.6
Northern Samar	1.0	9	-	-	0.0	-	0.2	0.2	0.6	1.2	1.4
Sorsogon	0.8	71	0.0	0.2	-	0.0	0.6	2.6	3.9	6.0	8.0
Zamboanga del Norte	0.8	41	-	0.8	9.0	6.5	1.8	5.0	1.5	6.9	7.1
Davao del Norte	0.8	96	0.6	1.0	11.2	4.9	9.2	13.4	16.7	33.5	13.1
La Union	0.8	58	0.3	0.2	2.0	1.1	2.5	13.2	5.9	8.0	4.2
Kalinga	0.8	96	3.7	3.0	7.2	10.3	17.3	32.9	39.8	49.2	41.7
Bataan	0.7	100	0.7	1.5	0.3	1.3	1.1	5.6	2.7	8.2	2.5
Surigao del Norte	0.7	65	0.3	0.0	0.5	0.6	0.0	1.7	2.7	4.2	-
Davao del Sur	0.7	93	0.6	3.1	7.2	36.9	20.6	22.3	9.9	41.8	20.5

Appendix Table A (continued)

Province	Contribution to total rice area	Ratio of irrigated rice area	Adoption rate of hybrid rice								
			Wet 01	Dry 02	Wet 02	Dry 03	Wet 03	Dry 04	Wet 04	Dry 05	Wet 05
Comval Province	0.6	86	-	0.0	2.0	0.9	1.9	3.0	5.1	9.0	17.3
Zambales	0.6	67	0.4	1.7	2.4	5.1	4.8	4.2	20.1	13.7	4.6
Laguna	0.6	97	0.0	0.2	0.9	1.6	3.1	11.2	5.2	15.7	3.7
Batangas	0.6	58	-	-	0.1	0.6	1.4	1.4	1.3	6.9	1.3
Surigao del Sur	0.6	72	0.0	0.1	2.6	0.8	0.5	2.1	6.7	8.7	9.6
Agusan del Norte	0.6	68	0.1	0.4	1.1	1.7	1.2	2.2	1.7	6.8	13.3
Aurora	0.5	89	-	-	0.4	0.7	0.6	1.9	2.0	8.6	6.9
Negros Oriental	0.5	82	-	0.0	2.5	2.1	1.4	0.7	2.5	3.9	1.0
Apayao	0.5	80	-	-	1.6	2.5	3.4	4.1	4.5	19.2	4.5
Guimaras	0.4	22	-	-	-	-	1.0	-	1.6	1.1	0.3
Southern Leyte	0.4	80	0.3	0.2	0.9	1.4	0.5	3.2	9.2	10.4	19.5
Abra	0.4	75	-	-	0.6	2.0	1.1	4.2	4.5	15.1	0.9
Sarangani Province	0.4	59	1.4	-	0.4	1.6	1.0	1.2	2.7	5.9	5.6
Marinduque	0.4	22	-	-	0.1	0.0	0.3	0.1	1.0	1.5	1.3
Misamis Occidental	0.4	96	0.6	0.5	2.5	1.9	3.2	4.9	8.7	6.3	4.6
Davao Oriental	0.4	65	1.8	7.7	8.2	1.8	2.3	3.1	4.1	6.3	8.7
Romblon	0.4	44	-	-	0.0	-	0.8	-	0.8	3.2	1.8
Biliran	0.4	94	0.1	0.1	1.2	1.8	0.4	5.2	1.4	3.1	1.6
Camarines Norte	0.4	73	0.0	-	0.2	0.1	1.0	3.1	3.8	4.8	2.7
Cavite	0.4	80	-	-	-	0.4	3.8	2.6	4.0	4.8	1.3
Eastern Samar	0.4	11	-	-	-	-	-	0.8	0.6	1.2	0.0
Quirino	0.3	88	0.7	0.2	0.7	1.2	3.2	6.0	16.6	24.6	16.2
Ifugao	0.3	93	-	-	-	0.6	1.5	2.9	5.3	14.0	0.6

Appendix Table A (continued)

Province	Contribution to total rice area	Ratio of irrigated rice area	Adoption rate of hybrid rice								
			Wet 01	Dry 02	Wet 02	Dry 03	Wet 03	Dry 04	Wet 04	Dry 05	Wet 05
Davao City	0.3	40	-	-	-	1.9	0.4	0.7	0.8	4.2	-
Catanduanes	0.3	45	0.0	-	-	0.1	0.0	-	0.2	3.2	1.5
Rizal	0.2	88	-	-	0.0	0.2	9.7	5.3	9.9	10.5	4.3
Mt. Province	0.2	84	-	-	-	-	-	1.5	0.6	1.8	-
Misamis Oriental	0.1	94	-	1.5	11.8	6.1	6.4	10.3	12.3	16.5	10.1
Benguet	0.1	87	-	-	-	-	-	0.8	-	3.3	-
Zamboanga City	0.1	73	0.0	0.4	6.1	6.1	15.3	14.9	16.7	32.0	6.8
Cebu	0.1	94	-	0.1	0.2	1.9	1.4	2.4	1.6	8.2	2.6
Sulu	0.1	-	-	-	-	-	-	-	-	-	-
Basilan	0.0	27	-	-	-	0.4	-	-	-	-	-
Tawi-tawi	0.0	-	-	-	-	-	-	-	-	-	-
Siquijor	0.0	86	-	-	1.1	-	0.2	2.4	16.2	3.2	11.3
Camiguin	0.0	99	-	-	4.9	-	4.5	9.1	19.1	13.8	15.2

* % adoption to hybrid rice is computed using the HRCP reported area planted to hybrid seeds as ratio to official data on rice area harvested by the Bureau of Agricultural Statistics.

Sources: Department of Agriculture; Bureau of Agricultural Statistics.

Appendix Table B. Ratio of farmers in the specified season who dropped out of using hybrid rice in next season in selected municipalities in 11 provinces (in percent)

	Dry 2002	Wet 2002	Dry 2003	Wet 2003	Dry 2004	Wet 2004
Kalinga						
Tabuk				79	77	99
Cagayan						
Penablanca					33	93
Isabela						
Alicia				42	59	98
Aurora				54	68	
Cauayan City			75	54	70	88
Mallig				68	66	88
San Mateo				69	56	95
San Manuel			94	60	53	
Santiago City					48	89
Echague					76	92
Roxas					64	
Nueva Ecija						
Talavera	50	88	98	58	95	76
Muñoz				40	80	76
Sta. Rosa					70	63
San Leonardo					40	72
Gapan		92	82	80	75	
Tarlac						
Gerona					82	63
Tarlac City			96	93	99	94
Pura				50	65	67
Pampanga						
Lubao		71	91	72	97	
Mabalacat			71	71	55	
Floridablanca				67	97	
Guagua				73	90	92
Magalang	56			82	75	89
Bataan						
Abucay		78	100	46	56	35
Mariveles		60	57	32	86	
Balanga City	100	67	86	33	81	75
Pilar			100	33	88	67
Dinalupihan		100	71		70	
Bulacan						
San Miguel		94	100	86	75	88
San Rafael				70	60	76
San Ildelfonso		90		84	81	92

Appendix Table B (Continued)

	Dry 2002	Wet 2002	Dry 2003	Wet 2003	Dry 2004	Wet 2004
Mindoro Oriental						
Calapan City		46	52	66	35	81
Naujan					74	98
Mindoro Occidental						
Rizal		80	[b]	65	83	83
Sorsogon						
Gubat					52	94
Irosin					30	87
Sorsogon City					89	84
Zambales						
Botolan			76	88	40	
Iba	65	82	68	71	63	99
Palauig		94	79	87	25	97
Davao del Sur[a]						
Hagonoy	71	52	66	72	76	98
Digos City	50	88	78	70	80	100
Matanao	80	78	94	92	83	100
Magsaysay	73		98	100	60	100
Davao del Norte						
Asuncion		80	79	61	66	100
New Corella		92	85	74	65	100
Sto. Tomas		93	94	64	100	100

[a] Excludes farmers who procured through irrigator's associations and cooperatives.
[b] One farmer only.
Source: Masterlist of farmers availing of hybrid seeds from respective municipal agricultural offices.

Appendix Table C. The Department of Agriculture's budgetary allocation for the GMA Rice Program (Pmillion)

	Total	Production Support			R&D	Extension	Salary Supplement	Others
		Hybrid seeds	Other seeds	Others				
2001	1342	322	190	14	25	124	155	512
2002	1443	424	168	118	16	47	268	402
2003	1642	289	211	442	10	24	219	447
2004	1719	551	114	355	5	39	200	455
2005	1522	785	118	210	39	114[a]	-	256

[a] This includes the financial support to Philscat's testing of Chinese hybrids.

Source: GMA Rice Program, Department of Agriculture.

Appendix Table D. Estimated costs and returns of hybrid rice seed (AxR) production per hectare in selected cooperatives (₱/ha)

	Isabela			Cagayan	Kalinga
	ISGMPC (Dry2004)	Roxas (Wet2004)	San Manuel (Wet2004)	CSMPC (Wet2004)	Tabuk (Dry2004)
Gross revenue	105,200[a]	130,000[b]	105,200[a]	117,000 [a]	144,000[c]
Cost of production	43,250	60,474	56,178	57,218	58,356
Estimated land rental[d]	20,000	20,000	20,000	20,000	30,000
Net return	41,950	49,526	29,028	39,782	55,644

[a] Assuming yield of 1 t/ha, but 800kg/ha valued at ₱120/kg and 1150 kg/ha of R line valued at ₱8/kg for San Manuel. Figure for ISGMPC simply assumes the same as San Manuel. Figure for CSPMC assumes 2000 kg/ha of R line valued at ₱10.50/kg.

[b] Assuming average yield of one t/ha and price of hybrid seed (F1) at procurement of ₱120/kg. Included also is 1 t/ha of R line valued at ₱10/kg.

[c] Assuming average yield of 1.2 t/ha and price of hybrid seed (F1) at procurement of ₱120/kg

[d] Based on interviews of seed growers.

Source: Isabela Seed Growers Multipurpose Cooperative, Roxas Hybrid Seed Growers Multipurpose Cooperative, San Manuel Multipurpose Cooperative, Cagayan Seed Development Multipurpose Cooperative, Tabuk Seed Growers Multipurpose Cooperative.

References

Barwale, B.R., editor. 1993. *Hybrid rice: food security in India*. India: MacMillan.

Bureau of Agricultural Statistics (BAS). 2004. *Assessment of farmers' performance in the GMA-rice program and nonprogram areas*. Quezon City, Philippines: Department of Agriculture.

Carnahan, H.L., J.R. Erickson, S.T. Tseng and J.N. Rutger. 1972. Outlook for hybrid rice in USA, p. 603-607. In *Rice breeding: outlook for hybrid rice in USA*. Laguna, Philippines: International Rice Research Institute.

Casiwan, C.B., S.R. Francisco, M. Hossain, J. Narciso, E. Cabrera and F.C. Hidalgo. 2003. Hybrid rice cultivation in the Philippines: early farm-level experiences. *Economic and Political Weekly*. June, 38(25):2502-2508.

David, C.C. 2003. Agriculture. In *The Philippine economy: development, policies, and challenges*, edited by A.M. Balisacan and Hal Hill. New York: Oxford University Press.

Dela Cruz, A.M. 2001. The structure, conduct, and performance of the rice seed industry. Unpublished report of the Philippine Institute for Development Studies funded by the Bureau of Agricultural Research, Department of Agriculture.

Francisco, S.R., C.B. Casiwan and A.B. Mataia. 2001. Socioeconomic analysis and policy formulation on hybrid rice technology. In *Philippine Rice R&D Highlights 2000*. Nueva Ecija, Philippines: Philippine Rice Research Institute.

Griliches, Z. 1957. Hybrid corn: an exploration in the economics of technological change. *Econometrica* 25(4):501-522.

He Guitong, X.Z. and J.C. Flinn. 1987. A comparative study of economic efficiency of hybrid and conventional rice production in Jiangsu Province. *Oryza* 24:285-296.

Herdt, R.W. and C. Capule. 1983. *Adoption, spread, and production impact of modern varieties in Asia*. Laguna, Philippines: International Rice Research Institute.

Hossain, M., T.T. Uk, and A. Janaiah. 2003. Vietnam's experience with hybrid rice. *Economic and Political Weekly* 38(25):2523-2529.

Hossain, Mahabub, A. Janaiah, and M. Husain. 2003. Hybrid rice in Bangladesh: farm-level performance. *Economic and Political Weekly* 38(25):2518-2522.

Huang, J.K., S. Rozelle, R. Hu and N. Li. 2002. China's rice economy and policy: supply, demand, and trade in the 21st century, p. 33-58. In *Developments in the Asian rice economy*, edited by M. Sombilla, M. Hossain and B. Hardy. Laguna, Philippines: International Rice Research Institute.

International Rice Research Institute (IRRI). 1973. *Changes in rice farming in selected areas in Asia*. Laguna, Philippines.

Janaiah, A. 2002. Hybrid rice for Indian farmers: myths and realities. *Economic and Political Weekly*. 37(42):4319-4328.

Janaiah, A. and M. Hossain. 2003. Can hybrid rice technology help productivity growth in Asian tropics? Farmers' experiences. *Economic and Political Weekly*. 38(25):2492-2501.

Janaiah, A., M. Hossain and M. Husain. 2002. Hybrid rice for tomorrow's food security: can the Chinese miracle be replicated in other countries. *Outlook on Agriculture* 31(1):23-33.

Lin, J.Y. 1991. The household responsibility system reform and adoption of hybrid rice in China. *Journal of Development Economics* 36(2):353-372.

______. 1994. Impact of hybrid rice on input demand and productivity. *Agricultural Economics* 10(2):153-164.

Lin, J.Y. and P.L. Pingali. 1994. Economic assessment of the potential for hybrid rice in tropical Asia, p. 131-142. In *Hybrid rice technology: new developments and future*, edited by S.S. Virmani. Laguna, Philippines: International Rice Research Institute.

Mew, T.W. and C.M. Vera Cruz. 2001. Bacterial leaf blight of rice. In *Encyclopedia of Plant Pathology*, edited by O.C. Maloy and T.D. Murray. New York: John Wiley & Sons, Inc.

Morris, M.L., editor. 1998. *Maize seed industries in developing countries*. London and Mexico: Lynne Rienner Publishers and CIMMYT.

Peng, S.B., J. Yang, R.C. Laza, A.L. Sanico, R.M. Visperas and T.T. Son. 2003. Physiological bases of heterosis and crop management strategies for hybrid rice in the tropics, p. 67-77. In *Hybrid rice for food security, poverty alleviation, and environmental protection*, edited by S.S. Virmani, C.X. Mao, B. Hardy. Proceedings of the 4th International

Symposium on Hybrid Rice, 14-17 May 2002, Hanoi, Vietnam. Laguna, Philippines: International Rice Research Institute.

Philippine Center for Investigative Journalism. 2005. Billions of farm funds used for Arroyo Campaign. *Investigative Reports*. 25 August. Manila, Philippines.

Sampath, S. and H.K. Moharty. 1954. Cytology of semi-sterile rice hybrid. *Current Science* 23:182-183.

Sikap/Strive Foundation and Philippine Rice Research Institute (PhilRice). 2005. *Midterm impact assessment of hybrid rice technology in the Philippines: Final Report*. Nueva Ecija, Philippines: Philippine Rice Research Institute.

Sombilla, M. 2004. Policy recommendations for the long-term implementation of hybrid rice commercialization program. Unpublished paper. International Rice Research Institute, Los Baños, Laguna.

Virmani, S.S. and I. Kumar. 2004. Development and use of hybrid rice technology to increase rice productivity in the tropics. *International Rice Research Notes* 29(1):10-20.

Virk, P.S., G.S. Khush and S. Peng. 2004. Breeding to enhance yield potential of rice at IRRI: the ideotype approach. *International Rice Research Notes* 29:5-9.