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Policies for Private Agricultural Research in Asian Developing Countries

INTRODUCTION

Public research in developing countries in Asia continues to grow, but in many countries the rate of change has slowed and it is lower than growth in agriculture. In Asia, private sector research grew twice as fast as public research (see Table 1). Using a new set of data on private research, this paper identifies the policies that encouraged growth in private agricultural research in the developing countries of Asia from 1985 to the late 1990s and suggests a few others which might have helped. This can provide guidance to policy makers in other developing countries who must develop agricultural science and technology policies in the shadows of globalization and the emergence of 'Life Science' corporations.

TABLE 1 *Growth of public and private research in Asia (millions of 1995 US$)*

	Public 85	Public 95	Growth (%)	Private 85	Private 95	Growth (%)
India	206	348	69	26	56	116
China	403	485	20	0	16	infinite
Indonesia	62	81	31	3	6	118
Malaysia	44	64	44	14	17	18
Philippines	17	38	113	6	11	69
Thailand	67	127	89	11	17	64
Pakistan	n.a.	n.a.	n.a.	2	6	138
Total	800	1 142	43	62	128	99

Sources: Case studies.

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RESEARCH METHODS AND SOURCES OF DATA

To identify the key policies we conducted interviews with scientists and officials of private firms and governments, sent out mail surveys in some of the larger countries, and collected published statistics in seven countries in South and East Asia: India, Pakistan, Thailand, Indonesia, Malaysia, the Philippines and the People's Republic of China. The first six were chosen because they had been the subject of an earlier study conducted by Pray in the mid-1980s. China was added because of its size and importance. The authors visited each country, except for Pakistan, for several weeks over the period 1996 to 1998, conducting personal interviews with 70 to 80 in total. In Pakistan, consultants were commissioned to conduct the survey. Because the number of countries is so small, use is made of tabular and graphical analysis rather than econometric methods.

STYLIZED FACTS ABOUT PRIVATE AGRICULTURAL RESEARCH IN ASIA

Between 1985–7 and 1995–8, private sector R&D grew in real terms in all of the countries in our sample (Table 2). In four cases – India, Pakistan, Indonesia and China – research more than doubled in size in ten years. The largest amount of private research is in India, where investment was about $55 million a year in the mid-1990s. The next largest amounts of private research expenditure are in Thailand, Malaysia and China. For the entire region, the agricultural chemical industry conducted the most private research ($47 million), followed by the agricultural processing and plantation industries ($41 million) and the seed industry ($16 million) (Pray and Fuglie, 1999). Relative to the size of China's agricultural economy, the investment in private research is particularly small there – less than one-hundredth of 1 per cent of agricultural GDP on private research (last column of Table 2). In contrast, in Thailand and Malaysia, firms spent about one-tenth of 1 per cent.

GLOBAL FORCES AFFECTING PRIVATE AGRICULTURAL RESEARCH IN ASIA

To identify the impact of policies on private research it is important first to examine the importance of factors largely beyond the control of ministries of agriculture or of science and technology ministries. These factors are the changes in aggregate demand for food and fibre and the changes in the global input supply industry.

Growth in consumer demand for food

The economic models of R&D expenditure by firms indicate that large markets induce more private research (Griliches, 1957). Increased demand for agricul-

TABLE 2 *Private agricultural R&D expenditure, growth and research intensity*

Country	Private R&D expenditure* (million 1995 US$)		Increase in R&D (%)	Private research intensity (private R&D as % of ag. value added)	
	1985–7	1995–8		1985–7	1995–8
China	0.0	11–16.0	infinite	0.000	0.009
India	25.7	55.5	116	0.026	0.059
Malaysia	14.1	16.6	19	0.173	0.150
Thailand	10.6	17.4	64	0.124	0.095
Indonesia	2.8	6.1	118	0.010	0.018
Philippines	6.2	10.5	69	0.059	0.064
Pakistan	2.4	5.7	138	0.019	0.036
Total	61.8	123–8	99–107		

Note: *Adjusted to 1995 prices using US implicit GDP deflator.

Sources: Expenditure from 1985 Asian countries from Pray and Echeverría (1991); 1995–7 authors' survey. Research intensity calculated using Agricultural GDP data from World Bank (1987, 1997), *World Development Report*, Washington, DC: World Bank.

tural production in Asia at a time when investments in traditional sources of growth (land expansion, irrigation, additional agricultural labour and public research) were slowing down or declining led to an increase in demand for private research. In addition, demand for higher-value agricultural commodities – meat, fruits and vegetables – was growing particularly fast. Demand for more agricultural goods leads to demand for more modern inputs. As sales of modern inputs grow, private input firms and plantations raise their expectations about the future returns to research.

There is a closer relationship between growth of private agricultural research and growth in agricultural gross domestic product (GDP). Research intensity (research expenditure as a percentage of agricultural GDP) remained roughly constant from the mid-1980s to the mid-1990s in Thailand, Malaysia and the Philippines (Table 2). Thus research and production were growing at roughly the same rate, which suggests that the growth in value of agricultural production could account for most of the growth in private research in these cases. In the other four countries, research grew more rapidly than production. Thus increases in demand (as measured by value of production) can account for only part of the increase in research. In these countries we have to find other explanations for growth in private agricultural research.

Growth in the international supply of agricultural technology

The supply of science and technology from outside Asia has increased since 1995 for three reasons. First, the promise of agricultural biotechnology has turned into large sales of commercial products in the Americas. Second, there has been considerable consolidation of the biotech firms, seed firms, agricultural chemical firms and food and feed firms into large multinational 'Life Science' firms. Third, declining or stagnant demand for agricultural inputs in the USA and Europe have made the growing markets of countries of Asia look very attractive relative to US firms' traditional markets. Asia, in particular, appears promising because of the rapid growth in demand for modern inputs, especially for labour-saving items such as herbicides and machinery.

Two prominent examples of these trends are provided by Monsanto and DuPont. Representatives of both firms reported that, since 1985, their firms have made major policy decisions to expand into Asia and other developing countries. Monsanto's US investments in biotechnology, chemical and seed companies and research have led to more investments in Asian markets. In 1985, they did not sell seed in Asia and were not among the market leaders in Asian pesticide sales. Now they have bought into the seed industry in all seven countries, have expanded their herbicide sales greatly, and are making major investments in research in India. DuPont was not in the Asian seed industry until its recent purchase of Pioneer Hi-Bred which has a presence in all of these countries. DuPont is also investing in a major research facility in India.

These multinationals provide new technological opportunities, increasing the efficiency of research of Asian firms and Asian affiliates of the multinationals, and they provide new sources of money to finance research and technology transfer. Two types of evidence show the multinationals' importance for Asian research. First, foreign firms make up about half of the research that is conducted in the seven countries included in this study (Pray and Fuglie, 1999). They perform the majority of the private research in all countries except India, Pakistan and Malaysia. Second, foreign firms are concentrated in the industries where private agricultural R&D has been growing fastest – chemicals, livestock and seed – and play a small role in private plantation and machinery research, where R&D growth has been slower.

A small but growing trend in industry structure is the purchase of technology-based companies in industrial countries by emerging multinational corporations (MNCs) from developing countries. A pioneer in this area was the Thai firm Charoen Pokphand, which has extensive business interests in Southeast Asia, China and the USA. It has a long history of joint ventures in Asian countries, with DeKalb for seed and Arbor Acres for poultry genetics. It then decided to purchase the US broiler breeding company Avian Farms to give it another source of poultry genetics.

COUNTRY POLICIES AND PRIVATE AGRICULTURAL RESEARCH IN ASIA

In addition to the global forces described above, policies undertaken in individual Asian countries have also influenced incentives for private agricultural research and technology transfer.

Market liberalization and competition policy

The major policy change that stimulated more private research in Asia was input market liberalization, which eliminated public sector monopolies, reduced regulations, allowed imports, reduced restrictions on foreign direct investment and reduced subsidies for public sector input firms. The countries in which private research intensity grew fastest – China, India, Pakistan and Indonesia – all had major liberalization programmes during this period. China allowed foreign firms into the seed, pesticide, feed and agricultural machinery industries with Chinese joint-venture partners starting in the late 1980s. Before then, a few poultry genetics firms had been the only foreign ones allowed to sell technology in China. In India, the government gradually reduced restrictions on the foreign input firms, particularly in the seed industry but also in pesticides and agricultural machinery where foreign firms had been restricted to being minority partners in joint ventures. In the 1980s, both Pakistan and Indonesia reduced the role of the public sector in supplying subsidized inputs to farmers. In addition, Pakistan had a strong policy of privatization and liberalization after 1988. None of these countries eliminated, or even substantially reduced the size of, the government corporations in the agricultural input industries, but they did 'level the playing field' by reducing subsidies and eliminating monopoly powers of state-owned enterprises.

Intellectual property rights

Firms do not conduct research unless there is a way to capture some of the resulting benefits and turn them into profits. In Asia, input firms have primarily used technical means of protecting their intellectual property. Seed companies protect new plant varieties by only producing hybrids. Chemical companies protect new pesticides or pharmaceuticals by keeping the process of production secret and by making chemicals that are difficult to reproduce.

Almost all the research by private seed firms in Asia is on hybrid corn, hybrid sunflowers and hybrid vegetables which farmers and other seed firms cannot easily copy. Recent investments in research on normally self-pollinated crops – cotton, soybeans, rapeseed and rice – are due to new methods for capturing some of the benefits from research. Hybrids of rice and rapeseed have been developed. Some 'Life Science' firms can capture benefits from genetically engineered soybean and rice varieties because they will increase sales of their herbicides. China is the one place where *Bt* cotton has been commercialized. This is due in part to the fact that the Chinese joint venture

partner is the government owned company which has the provincial monopoly on cotton seed.

In the countries in our survey, growth of private research was not closely associated with stronger legal protection for intellectual property rights (IPRs). China, Malaysia and Thailand made improvements to their patent laws. Research intensity grew in China but declined in Malaysia and Thailand. India and Pakistan, which had very limited changes in IPRs during this period, had the fastest growth in research intensity.

Appropriability of enough of the benefits from research to pay for further research is clearly important for firms. However, in Asia, the passing of stronger patent laws has not stimulated much research as yet. Anecdotal evidence suggests that the main problem now is enforcement of the patent laws.

Investments in public agricultural research

Public and private research can be either substitutes or complements. If public research institutions develop and disseminate technologies similar to those developed by private companies, public research could discourage the private sector from investing in new technology. However, public research can serve to provide important 'upstream' science and technology for private firms to adapt into product innovations. Public research institutions and universities also reduce the cost of research inputs for private companies by expanding the available pool of scientific and technical personnel or by providing contract research and field testing services for private firms.

Public research appears to have been an important force in stimulating private R&D in Asia. It certainly provided basic technology such as downy mildew-resistant corn in Southeast Asia and downy mildew-resistant pearl millet in India. These breakthroughs then facilitated the development of local hybrid seed industries. A survey of Indian private plant breeders found that the Indian public research system has been a major source of breeding material for cotton and sorghum, while the International Centre for Research in the Semi-Arid Tropics (ICRISAT) has been a major source of germ plasm for pearl millet (Pray *et al.*, 1998). In China, the two best known emerging local private plant breeding firms are evolving out of provincial hybrid rice and hybrid corn research programmes (Pray and Fuglie, 1999).

In addition, public research is providing technology to improve benefit appropriability by seed companies. Hybrid rice is now the focus of much private research in India and some private research in the Philippines, Pakistan and Thailand. This has been stimulated by the work of the International Rice Research Institute (IRRI) and of national government programmes, which developed hybrid rice technology for the tropics. In addition, hybrid rapeseeds were developed by an Indian university and a European firm.

Public research has also been very important as a source of scientists for private research. Almost all Asian private sector plant breeders first worked in government research institutes and/or international agricultural research centres. This is not surprising because there is virtually no other source from which to hire trained scientists. The important point is that firms are likely to

invest more in research in countries where there are many well-trained agricultural scientists.

Public and private research expenditures and research intensities are positively related in the Asian countries in our sample. In addition, Table 1 shows that in all countries both the public and the private sector grew. However, the countries with the most rapid growth in public research – the Philippines and Thailand – had lower than average growth of private research and countries with slow growth in public research (China and Indonesia) had high growth of private research.

Other policies

In recent years Asian research systems have started to offer special subsidies and tax benefits to encourage private research. Our interviews with private companies did not find any evidence that either the tax policies or the research parks have had an important impact on private research. Most of these policies have just been established. Thailand has had R&D tax credits for a number of years, but none of the firms we interviewed were aware of them or took them into account in their research investment decisions. However, in the 1980s, the Thailand Board of Investments introduced incentives for the seed industry, including a ten-year tax holiday for new seed companies, a waiver of import duties on research equipment and materials, and permission for foreign companies to own agricultural land for research purposes. Some firms acknowledged that this was an important incentive for them to invest in seed processing and research in Thailand.

To protect farmers and consumers from health and environmental hazards, from fraud due to information asymmetries and from potentially harmful plant and animal diseases, governments have developed an extensive set of regulations on new plant varieties, seed and animal imports, pesticides, agricultural machinery and food. Some of these regulations can have an important impact on R&D.

Establishing a clear and consistent regulatory regime for agricultural inputs can encourage private companies to undertake research. For example, few international companies are willing to do research on transgenic plants unless a country has some system for government regulation of testing, because the adverse publicity of such activity in the absence of an approved regulatory framework would be too great. However, there can be a problem of balance since excessive regulation reduces the amount of private research by adding years of work and tens of thousands of dollars of research. Differences in regulations for testing genetically engineered plants in the field have meant that private agricultural biotechnology research is being conducted in Thailand, China and India, not in the Philippines. International chemical firms have also reported that, in the past, differences in regulations led companies to test and market chemicals more rapidly in Thailand than in India, even though it was a smaller market. However, recent changes in the way the Indian regulatory system works have increased firms' interest in doing research in India.

CONCLUSIONS

This new set of data on private research in seven Asian developing countries indicates that changes in the demand for inputs, the breakthroughs in biotechnology and the expansion of multinational life science companies are stimulating more private research in Asia. Analysis of the country case studies also indicates that policies have had an important impact on the amount and growth of private research. In Asia, liberalization, public research and, under certain circumstances, intellectual property rights and regulations can stimulate private R&D. However, these policies will have little impact on private research unless a country meets certain prior conditions, has passed through some minimum stages of development and has some key policies in place.

The first requirement for private research is a large and growing demand for agricultural products so that farmers demand modern, improved, inputs. Traditional agriculture or agriculture which does not have effective demand for modern inputs because infrastructure is inadequate or because policies discriminate against the farm sector will not attract private research. In countries where land rather than labour is the key constraint and adapted, modern technology is not readily available, public investments in research and some means of supplying inputs may be required. In small countries or niche markets private research may not develop or supply the needed technology; hence public research will continue to be important.

The second requirement is that private firms be allowed to supply agricultural inputs and operate plantations in a competitive market. Obviously, if there is a state monopoly of input supply, private investment will not grow. If public monopolies of input supply are turned into private monopolies, welfare losses are likely to increase. Allowing foreign investment and trade in the input industry is an important way of increasing competition and increasing a country's access to technology that has been developed and commercialized elsewhere in the world. Other policies that are needed are competition regulations to ensure that no local or foreign firm has too much market power.

When these conditions are in place, intellectual property rights and regulatory frameworks can be an important stimulus to private research. With rights protection, firms will have the ability to capture some of the benefits from research even in competitive markets. Firms will then choose to invest in developing improved inputs or management practices for which there is both potential demand and technological opportunity based on local public and private research or research done elsewhere. Finally, with intellectual property rights in place, tax subsidies for research or research parks may be important stimuli to further research. There was little evidence of the benefits of the latter types of policy in the seven countries studied here, but their effectiveness should be tested.

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