

# Private agricultural research in Asia

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**Agricultural research in South and South-east Asia was started by a mix of private companies, commodity groups and governments. In the 1960s and 1970s, government research increased rapidly, commodity groups declined in importance and there were signs of private research growth. Recently, the increased demand for modern inputs and changes in government policy provide greater incentives for private research. Governments can encourage greater private research, but first they have to resolve a number of issues about the role private research should play in their societies.**

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<sup>1</sup>*Impact of Government Regulations on Development of Chemicals Used in Animal Production*, Council for Agricultural Science and Technology, Ames, IA, 1980, p5.

This article brings together the available information on the role of private agricultural research in Asia. The first section reviews the role of the private sector research in the USA and Latin America. Then there is a discussion of the trends in private agricultural research in Asia. The final section raises a number of important issues regarding the role the private sector should play in Asian agricultural research.

There are three types of research institutions that I want to distinguish in this article. The first is the public agricultural research system which is government run and financed through general taxation. The second is research which is controlled and financed by the producers of a commodity sometimes in cooperation with industrial users of the commodity. The third type of research is conducted and financed by individual private companies. These last two types of research are classified as private research in this paper.

## Private sector research in the Americas

The role of the private sector and the trend in its involvement in the USA differ by type of research. The private sector has been dominant in the development of new mechanical technology while the public sector plays a larger role in the biogenetic technologies. Chemical and pharmaceutical inventions were mainly stimulated by the private sector. The relative importance of private and public sector research activities has remained fairly stable in the development of mechanical technology. Chemical inventions and research seem to have declined somewhat in the 1970s after strong growth in earlier decades.<sup>1</sup>

Biogenetic research has shown a long term trend of more private involvement – particularly on the plant side. Before the 1930s and the development of hybrid corn, the public sector did almost all of the research on plant breeding. With the development of hybrid corn and then sorghum, it became possible for seed companies to establish proprietary rights in certain varieties. Thus, they could capture the gains to research from developing new varieties, and they started investing heavily in plant breeding research. The passage of the breeders' rights legislation gave private sector biogenetic research more incentive to do research. Most recently the breakthroughs in the field of recombinant DNA and the US Supreme Court's ruling that a living organism can be patented have induced more private investment in this area.

In aggregate, private research has been expanding steadily since the

1940s. One study reports that private research went from 20% of total agricultural research in the 1950s to 40% in the 1960s.<sup>2</sup> Ruttan estimates that this percentage went from 55% in 1965 to 65% in 1979.<sup>3</sup> This implies a substantial real increase of the private sector expenditure on agricultural research.

The recent increase in private research in plant breeding and biogenetics in the USA has led to considerable discussion about the impact of this research on both public sector research and the generation of agricultural technology in general. The most general issue is the relative importance and the respective roles of the public and private sector. A second issue is the impact of expanded private research on client support of public agricultural research. A third issue is the shortage of biologists and the fear of the public sector that private industry will lure away many of the best biologists. Finally, there is the fear that increased proprietary rights and private research will decrease the flow of scientific information and genetic material, impairing the effectiveness of public and private research.

In the Third World there has been little discussion of the role of the private sector in developing new agricultural technology. Several recent papers which have discussed this question have concentrated on Latin America and have reached very different conclusions. Trigo and Pineiro state that:

In Latin America, and probably in other less developed regions, this process (the increased role of the private sector in agricultural research) has developed beyond what regional and national modernization and development conditions would warrant. This is largely due to the increased importance of multi-national firms operating in these fields.<sup>4</sup>

They say that in most countries in Latin America in the 1960s, the public sector had a monopoly on agricultural research and that this monopoly has been broken down in recent years by increased private sector research by producer groups and private industry. Private research increased due to the modernization of agriculture which increased the size of the markets for agricultural inputs.

They emphasize the negative effects of increased private sector research. The public sector is forced to specialize in producing technology for the small farmers who have little political clout, and so its budget declines. At the same time the private sector is hiring the best scientists away, reinforcing the decline. This leaves a weak public sector servicing the small farmer and the market rather than the government determining the priorities of research and technology.

Papers by Evenson and Evenson<sup>5</sup> and Judd and Evenson<sup>6</sup> take a more positive view of the role which the private sector can play. There is some evidence that for a certain range of inventions, 'private self-interested firms and individuals are superior to the public sector research system'.<sup>7</sup> They suggest that the private sector is a threat to public sector researchers because 'bureaucracies want monopoly power to protect inefficiency in many cases'.<sup>8</sup> Thus, competition from the private sector might have positive effects. They also suggest that the main negative effects would be the loss of trained personnel from the public sector to the private sector.

Governments can provide incentives for private inventive activity. Some LDCs have reformed their legal system to give more patent protection to private sector inventions by local inventors and companies rather than continue to rely on international patent agreements that

<sup>2</sup>James Boyce and Robert E. Evenson, *Agricultural Research and Extension Programs*, Agricultural Development Council, New York, 1975, p 66.

<sup>3</sup>Vernon Ruttan, *Agricultural Research Policy*, University of Minnesota Press, Minneapolis, 1982, p 185.

<sup>4</sup>Edwardo J. Trigo and Martin E. Pineiro, 'Dynamics of agricultural research organization in Latin America', *Food Policy*, Vol 6, No 1, February 1981, p 6.

<sup>5</sup>D.D. Evenson and R.E. Evenson, 'The private sector in agricultural research', Paper presented as seminar at IICA, Costa Rica, 1981. (Available from Yale University Economic Growth Center, New Haven, CT).

<sup>6</sup>M. Ann Judd and R. Evenson, *Resources for Production of Agricultural Growth in the Pacific Basin Region*, Yale University Economic Growth Center, New Haven, CT, 1982.

<sup>7</sup>*Ibid*, p 51.

<sup>8</sup>*Ibid*, p 56.

favour multinationals. The 'petty' patents in Brazil and South Korea seem to have encouraged private inventive activity. If private research does play a greater role, this would allow the public sector to shift its emphasis into two major activities: the conduct of intermediate and basic research with the findings made available to all; and, developing technology as an alternative to the private sector to provide it with competition and undertaking various testing and verification activities designed to curb abuses of the private sector.<sup>9</sup> These activities would complement the research of the private sector and increase its efficiency.

### **Private sector research in Asia**

The first stage in the development of agricultural research in Asia was a combination of research by commodity groups and public institutions with some research by private firms. During the colonial period in the Dutch and British colonies, the commodity groups were particularly important. Tea research was carried out by the Indian Tea Association with little government assistance. Cotton research in British India started in the public sector, but just after the first world war the Indian Central Cotton Committee was set up. This committee had its own research stations and also funded research at public research stations. In the 1930s and 1940s similar committees were set up for almost all of the major cash crops in India. They were financed through a cess that was given legal status by the government, and they had government representatives who headed the committees. The processors, manufacturers, traders and farmers were all represented on these committees.

In Malaya the agricultural department conducted some rubber research after it was formed in 1905, but did not have much success. Plantations and planters' associations went back to doing their own research. They were able to merge the public and private research programmes under the Rubber Research Institute of Malaya in the 1920s.<sup>10</sup> In the Dutch East Indies also, cash crops were studied in a research institute which was separate from the public sector. These institutions were supported by commodity organizations funded by a cess on exports or production. Food grain research in all Asian colonies was supported out of general revenues.

Some small research programmes were also carried out by private sector firms during the colonial period. British American Tobacco Company had applied research programmes on cigarette tobacco in a number of Asian countries including India and Indonesia. Private companies like Imperial Chemical Industries ran fertilizer trials in India. Several large sugar mills did applied research in the Philippines. Some rubber estates continued to do their own research in Malaya. However, research by the commodity groups and the public sector research played the dominant role in India, Indonesia, Malaya and the Philippines.

The second stage in the development of the research system in Asia was the consolidation of the commodity research programmes into the public sector in the 1960s and 1970s. The Indian Council of Agricultural Research took control of the commodity research programmes from the central commodity committees in 1965.<sup>11</sup> They established a near monopoly on biogenetic research in India, although tea, rubber, coffee, and cardamon still remained outside their control. In 1976 the Agency for Agricultural Research and Development took over the Estates Crop Research Institute in Indonesia ending the independent status of research

<sup>9</sup>*Ibid*, p 55.

<sup>10</sup>Ruttan, *op cit*, Ref 3, p 102.

<sup>11</sup>M.S. Randhawa, *A History of the Indian Council of Agricultural Research*, ICAR, New Delhi, 1979, p 76.

on rubber, cocoa and other cash crops. The Philippines Council for Agriculture and Resources Research consolidated its powers in the Philippines in the early 1970s, and Pakistan and Bangladesh Agricultural Research Councils are still trying to establish their control over the various commodity research organizations.<sup>12</sup> These developments were financed and carried out with the assistance of foreign aid.

During the 1960s research by private firms seems to have grown in some countries and declined in others. In India, research on pesticides, fertilizer and probably pharmaceuticals by the private sector grew rapidly. By 1970 most of the large pesticide companies were doing research. This included both field trials and laboratory work on formulation of the pesticides.<sup>13</sup> In contrast, the nationalization of the sugar, jute and cotton industries in Bangladesh meant the end of some small research efforts by sugar mills and the end of support for research by the jute industry and the cotton industry.

A third stage in Asian agricultural research development may be starting. The rise of private sector research induced by modernization that is predicted by Trigo and Pineiro<sup>14</sup> has taken place to a limited extent in Asia. However, the evidence on the rise of producers' groups in Asia is mixed and as yet there is little evidence of a decline of public sector research expenditures.

It seems likely that in the mechanical invention area there has been an increase in the rate of private activity. This has not come as a result of a shift out of public research but as an increase in overall activity in reaction to the increasing use of machinery in Asian agriculture. Thus, in Thailand, the small scale power tillers, which were originally based on Japanese power tillers of the early 1960s, continue to be modified to meet farmers' changing needs. There is also the example of the bamboo tubewell in Bihar, India where experiments by contractors, farmers and a philanthropic organization led to the development of a tubewell more appropriate for the needs and economic conditions of Bihar.<sup>15</sup> In India some of the large tractor manufacturers now have their own research and development divisions which are designing new types of tractors and other implements. Thus, considerable inventive activity is taking place despite weak patent laws. The Philippines have more patent protection and so one would expect considerable inventive activity there.

In India and other large consumers of pesticides such as the Philippines and Malaysia, private research is expanding. In Bangladesh and Pakistan the pesticide distribution system was shifted from the public to the private sector. The increased market has led private companies to be more active in setting out field trials which are partly applied research and partly demonstrations for farmers. The public sector was also involved through research financed by private companies. Research at public stations on the effectiveness of specific pesticides was carried out. There is research by multinationals in LDCs in the area of veterinary medicine. Research is needed to develop vaccines against local virus strains and other diseases which are not important in the USA or Europe. Smith-Kline and other US companies operate laboratories which do this type of research in India.

It is the biogenetic type of invention which seems to be closest to a public sector monopoly at the moment, but has the potential for expansion of the private sector. In the area of hybrid corn there are signs of considerable private sector activity by both multinationals and local firms. In India, multinationals and several local companies are

<sup>12</sup>However, effective commodity organizations in Pakistan and Bangladesh had been replaced by government sector institutions with little responsiveness to the growers soon after Pakistan became independent in 1947. Thus, the recent changes are more power struggles within the public sector than movements from the private to the public sector.

<sup>13</sup>Channing Fredrickson, Personal communication, June 1982.

<sup>14</sup>Trigo and Pineiro, *op cit*, Ref 4.

<sup>15</sup>Edward Clay, 'The economics of the bamboo tubewell', *Ceres*, May-June 1980.

developing hybrid corn. In the Philippines, the San Miguel Beer Company has started breeding hybrid corn for a seed operation and Pioneer is also active.<sup>16</sup> Cargill, Pioneer, Funk Seeds, Dekalb, and Pacific Seed of Australia have seed corn operations in Thailand.<sup>17</sup>

However, expansion in this biogenetic area is dependent on the public sector breeders who have a tendency to protect their monopoly through their power to certify seed. In India, legislation is pending which would require that all seed sold in India be approved by a national seed board. One company in India has not been able to get a single variety certified or approved by the board in the six years that it has been selling corn varieties in India, despite the fact that these varieties have passed the most important test, farmer acceptance. The people who sit on this board are the public sector plant breeders who are competing with the private sector. They have little incentive to approve anything the private sector produces. At the moment, companies are allowed to sell uncertified seed. However, if the proposed laws are passed, their seed operation and most of their research activity will go out of business. This type of uncertainty prevents large scale private investment in research.

The most recent development in the biogenetic area is the joint venture between Sime Darby, the huge Malaysian palm oil, rubber and cocoa producer, and the International Plant Research Institute, a Californian biotechnology company. They plan to set up Asean Biotechnology Corporation which will take over Sime Darby's laboratories and install a small number of US personnel there. They will work with the team of Malaysian researchers who are there at present, on a 'fee-paying basis' for Sime Darby plantations and outside clients.<sup>18</sup>

In contrast to biogenetic research on plants, there is still little private sector animal breeding in most parts of Asia. Little private sector poultry breeding and research is carried out in Asia despite the fact that a hybrid poultry breed has the same type of natural proprietary rights as a hybrid corn variety. However, the public breeder does face increasing competition from the improved hybrid birds which have been produced by private sector breeding programmes in the USA, Canada and Europe. These companies supply grandparents of the commercial broilers or layers to most of the countries of South and South-east Asia to be used in modern commercial poultry operations and they are growing rapidly. In India, this competes directly with the government breeders who provide cheaper but less efficient birds. In Pakistan, public sector breeders have chosen not to compete in the commercial market and instead are concentrating their breeding work on the village multipurpose bird which is mainly a scavenger.

Dairy and beef cattle have apparently not attracted investment by multinationals in either the provision of genetic material or in-country research. In most Asian countries, private farmers, villages or regions have specialized in breeding, selecting and selling the best draught animals and milk animals. In recent years the public sector has been quite active in bringing in new genetic material, particularly for milk animals. The one country that does seem to have a fairly strong private research and development programme for milk animals is India. There the National Dairy Development Board, a farmer-owned cooperative, has an extensive breeding programme using exotic, improved local and crossbred cattle with an effective artificial insemination programme to implement it.

Commodity groups which support research seem to be on the rise in

<sup>16</sup>Robert E. Evenson, Paul E. Waggoner and Paul R. Bloom, *The Agricultural Research System of the Philippines: A Reconnaissance Report*, Economic Development Center, Bulletin Number 81-3, May 1981.

<sup>17</sup>Taki Izuno, Letter, 21 August 1982.

<sup>18</sup>Jeffrey Segal, 'Splitting the bean gene', *Far Eastern Economic Review*, 23 April 1982, p 106.

some countries, but they are generally not as strong as they were in the past. In India, there is the huge National Dairy Development Board (NDDB) and the small Associated Exporters of Onions which partially support the Associated Agricultural Development Foundation (AADF). The NDDB conducts a wide range of research ranging from trials of different fodder varieties and breeding milk cattle to engineering research to develop better equipment for their milk processing and distribution programmes. They also do a substantial amount of social science research and are moving into oilseed and cotton research. The AADF concentrates its efforts on developing better export varieties of onion and storage and shipping facilities.

In the Philippines, commodity groups such as the sugarcane growers, tobacco growers, and coconut growers had considerable power at one time and financed some research. However, their political power became a threat to the government, so they were taken over by the government. Only the fisheries commodity group has remained organized but somewhat independent of the government. In Indonesia there seems to be little interest in reviving private commodity groups to support research. In Bangladesh there have been suggestions by aid donors that the Tea Research Institute be given back to the producers, but this proposal seems to have generated little interest on the part of the government. In Malaysia the recent transfer of oilpalm research from MARDI to the Oilpalm Research Institute of Malaysia, and the continuation of the Rubber Research Institute indicates the continuing influence of these commodity groups.

In addition to input suppliers and commodity organizations, the other type of industry which has financed private research and may increase in size due to modernization are the processing industries. The cigarette and sugar industries have private research programmes in many Asian countries which include chemical, mechanical and biogenetic research. British American Tobacco (now BAT Industries) and its affiliates have applied research programmes in India, Pakistan, Bangladesh, Indonesia and Thailand. These programmes concentrate on agronomic research and ways of cutting the cost of flue-curing tobacco. In Pakistan, it has been able to shift some of the research to the public sector. Sugar mills in the Philippines continue to have strong applied research programmes which gather and screen sugarcane varieties from the Philippines and abroad for use by their growers. These programmes have been growing recently after several years of decline. Several Pakistan sugar mills also have variety testing programmes. However, they do not seem to have grown in recent years. In Pakistan, CPC International has set up a small corn research programme to support the contract growers who provide corn for its wet-milling operation.<sup>19</sup>

### **The role of private research in Asia**

*Should there be more private research in Asia?*

This initial survey indicates that in many Asian countries private sector agricultural research plays a very small role. Furthermore, private research does not expand automatically with the expansion of the market. The question is, should governments encourage private companies to play a larger role in the future? At present there is not enough empirical evidence to answer this question in a definitive manner. The answer will be determined by the answers to the following questions:

<sup>19</sup>Ray A. Goldberg and Richard McGinity, *Agribusiness Management for Developing Countries: Southeast Asian Corn System and American and Japanese Trends Affecting It*, Ballinger, Cambridge, 1979, p 425.

6

is the private sector more efficient at producing some types of technological innovation than the public sector?; can increased private sector research bring society closer to the optimal level of total expenditure on agricultural research?; would more private sector activity make the public sector more efficient either through providing it with some competition or as a means of transforming basic research from the public sector into practical inputs which farmers can use?; is the private sector a more efficient means of transferring technology and/or scientific information between countries than the public sector?; what are the social costs of allowing the private sector to play a larger role in agricultural research?; can increased private sector research bring society closer to the optimal level of total expenditure on agricultural research? The rest of the article will discuss the preliminary evidence available on each of these questions.

#### *Relative efficiency of private and public research*

There are only a few case studies of Asian private research. Therefore it is not possible to conclude that the private sector is more efficient. Sugarcane research in the Philippines is a case that needs further study. The public sector took over most of the sugarcane research from the private sector in the 1970s. However, now the private sugar mills have apparently decided that the public sector will not produce the results they need and so they have strengthened their research programmes. The only LDC case study of private research that was less efficient than the public sector research that I could locate, was the case of bananas in Central America.<sup>20</sup>

An example that has been studied in some detail is tobacco research in Bangladesh.<sup>21</sup> The public sector research programme is carried out by the Bangladesh Agricultural Research Institute (BARI) in north-western Bangladesh which has traditionally been the main area of tobacco production. Private sector research is done by Bangladesh Tobacco Company (BTC) which is 60% owned by BAT industries. The contrast between these research programmes points out the weaknesses of the public research system. The two operations spent about an equal amount of money on agricultural research in the late 1970s, but BTC has been more productive in producing technology which has been accepted by farmers.

BTC has been successful in developing new varieties and cultural practices and these have gained widespread acceptance by farmers. BARI has developed few varieties and these varieties have had little acceptance. There were four reasons for the difference in performance. First, motivation of the institutions and researchers differed. Since BTC controlled 60 to 70% of the cigarette market in Bangladesh, technology which reduced the cost of tobacco production also reduced the price at which they bought tobacco and increased their profits. BARI as an institution had no such incentive. In fact, increased tobacco production and the reduction of imports may lead the government to put less emphasis on tobacco in the future and probably cut BARI's budget for tobacco. The institutional incentives mean that BTC offered promotion or better salaries for improved tobacco production, while BARI offered only personal satisfaction.

Second, BTC researchers were in close touch with both market demand and the farmers. Thus, they knew which problems were really of economic importance – the quality of the leaf produced, reducing the cost

<sup>20</sup>R.E. Evenson, J.P. Houck, Jr and V.W. Ruttan, 'Technical change and agricultural trade: three examples – sugarcane, bananas and rice', in Raymon Vernon, ed, *The Technology Factor in International Trade*, NBER, New York, 1970, p 434.

<sup>21</sup>This case study is based on the author's research while in Bangladesh, 1978 to 1980.

1

of production and recently the cost of flue-curing tobacco. Third, BTC had the flexibility and the resources to focus quickly on problems as they came up. They were not tied to one experiment station; rather, they ran their experiments on land leased from the farmers. When they decided to shift part of their operations to another part of the country, their research programme could come along while the government programme could not move its farm from the North-west. Also, BTC had the capital to try to find new fuels for flue-curing tobacco and to build a laboratory for testing leaf quality. Fourth, BTC has access to a huge collection of genetic material and scientific information through their parent company. On the other hand, the BARI scientists have to travel to Dacca to get any technical journals. Their programme to breed disease resistance is hindered by the lack of disease resistant genetic material. They apparently do not get any genetic material from BTC and have no access to international collections at present.

#### *The impact of private research on public research*

The impact of greater private sector research on the public sector is not clear and as yet I have not been able to find many examples of their interaction in Asia. There are numerous examples of private firms giving grants to universities or public research organizations to finance research on their chemicals or fertilizers. Indian pesticide companies have been active in this type of activity, and this is also going on in Pakistan, Bangladesh, and Thailand. Private cigarette companies in Pakistan provide money to the government tobacco research centre to work on ways of cutting the cost of flue-curing tobacco. A joint PCARR-private ranch beef research project was carried out in the Philippines.

More private sector research, which would inevitably be on the most applied problems, could well mean increased financial and political support for public sector research from these well organized business interests. This support could be particularly important for more basic research which has virtually no constituency in LDCs today but could build up a constituency on some topics if the results could be inputs into private sector research programmes. Kasetsart University in Thailand sells inbred maize lines to anyone who is interested, and Punjab Agricultural University developed a wheat thresher which they have licensed private firms to produce. Unfortunately, the general reaction of the public sector has been to try to block private sector research. This can take the form of not approving private sector crop varieties or of isolating the private sector researchers and institutions from the scientific inputs and contacts that are needed for a successful research programme.

#### *Efficiency of technology transfer by the private sector*

The private sector can also be important in the transfer of agricultural technology even if it does no research in the LDCs. This is obvious in the case of fertilizer, pesticides and pharmaceuticals which are developed and manufactured by multinationals. Likewise, tractors, power tillers and pumps were developed in industrial nations and transferred by trade or production to the LDCs by multinationals. In the area of biogenetic invention, the private sector can play a large role. The role of multinationals in the poultry business was mentioned above. Pioneer has a pool of germplasm for corn which it uses in the countries where it develops hybrids. BAT has a large collection of tobacco germplasm from throughout the world. When BAT subsidiaries in Asia have a particular

8

problem, BAT sends out the varieties that have overcome this problem elsewhere.

The private sector also has networks of information transfer which include the provision of the latest technical material to different branches of the same company and also trade associations and consulting firms through which information is exchanged. Groups like the British Cotton Growers Association of the colonial period moved information throughout the British Empire. Today the private tea researchers are in contact with each other and consulting firms are bringing the expertise of experienced tea scientists from India and Kenya to work on improving the Bangladesh tea research and extension programme. The contrast between the way in which the private sector transfers information, genetic material for plant breeding and new technology which is embodied in mechanical and chemical inputs and the way in which the international agricultural research centres and other international organizations operate, need to be studied.

#### *Social costs of more private research*

The social costs of providing incentives for more private research may be high. First, there are the negative effects on the public research system if the small farmers who do not grow major cash crops are left without a source of improved technology. This could be due to the weakened public support which is translated into lower budgets, and also to the shift of trained manpower to the private sector. This can be avoided by politically astute leadership of the research system. Second, there is the social cost of granting a private individual or firm monopoly rights to a product through a patent, breeders rights or allowing the firm a certain amount of monopoly power over the entire market such as the Bangladesh Tobacco Company case. A third problem is that local scientific inventive activity may be swamped by multinationals.

These last two types of costs can be minimized by proper design of the patent laws so that there is public disclosure of the innovation and some chance for the local inventor. Proper regulation of the monopoly power of the firms and competition by the public sector can keep monopolies under control. Thus, it appears that social costs of increased private research can be held to a minimum by politically astute leadership of the public research system and by careful legislation and regulation of private research. However, this may not be easy to do in many developing countries.

On the other hand, too much public sector research can place an unfair burden on certain groups in society. Since research on some crops primarily benefit a relatively small segment of society, this segment should pay for the research rather than taxpayers as a whole. Thus, if a few large sugarmills are the chief beneficiaries of sugarcane research, they should pay for it.

#### *Private research to increase total research effort?*

The *ex post* social rates of return to public investment in agricultural research in Asia have been high. However, the public sector in some countries is constrained by budgets and is likely to be more constrained in the future. More expenditure by the private sector could bring societies' total expenditure on agricultural research in line with expected returns. This argument would seem to hold true for most of the countries of South and South-east Asia, although a few public systems have recently been

expanding their expenditure so greatly that it is no longer certain that they are underinvesting. It appears that for South and South-east Asia, private research is below the optimum level. In particular, insufficient private sector research appears to be going on in biogenetic research, an area in which private research is important in the USA.

#### *Role of government in encouraging private research*

I would hypothesize that private firms' decision to do a limited amount of research in Asia is an optimal decision in terms of their returns to research. They do not have strong property rights over innovations because of government interventions and the legal system of many of these countries. In addition many of these technologies are not sufficiently location-specific that they require much research in-country to adapt them to local conditions. Thus, local companies find it cheaper to buy the technology from outside and multinationals find it cheaper to do their research in developed countries. Finally, in some countries input supply and agribusiness have been government monopolies. These monopolies have little incentive to improve technology and in general have no mandate to do research.

Some of these conditions can be changed by government policy. More legal protection in the form of patents and plant breeders rights could induce more private research. Increasing the pool of trained manpower in areas like plant breeding can influence the relative cost of doing research in India or the USA. The recent privatization of input supply in Bangladesh and Pakistan should give pesticide companies more incentive to do research.

The general climate for research can be improved. The Taiwanese have set up the Hsinchu Science-Based Industrial Park which seeks to induce high technology firms to invest in Taiwan.<sup>22</sup> While they are primarily seeking firms in the computer and communications fields they specifically have announced their aim to 'lure well-known biotechnology companies to this land within five years'.<sup>23</sup> A science park may not be appropriate for every country, and it may have to be modified substantially if the main aim is to induce local agricultural research. However, it is also clear that governments can do quite a lot to encourage greater participation of the private sector in agricultural research, and probably should do so in South and South-east Asia.

### **Conclusion**

Many of the forces that caused the growth of private agricultural research in the USA and Latin America are at work in South and South-east Asia today. Markets are expanding, breakthroughs in basic science are applicable there, and in a few countries property rights are being changed to give innovators more incentive. However, there is still considerable debate in Asia and in the West about the proper role of the private sector in agricultural research. Even in some of the strong market economies of Asia, public officials are antagonistic towards the private sector in general and private research in particular. These officials can quickly cut off the growth of private sector research if they wish. Thus, there is an important challenge ahead in both the developed and the developing world to determine what the optimal role of the private sector is and then to develop policies that will assist the private sector in playing that role.

<sup>22</sup>The park offers tax breaks, low interest rates, two nearby universities, a large supply of highly trained personnel (especially engineers) who are presently available at wages lower than in the West and Japan, and the promise of more trained manpower on the way.

<sup>23</sup>Geoffrey Murray, 'How Taiwan plans to leap from shoes into software: science park seen as key to a new industrialization', *Christian Science Monitor*, 30 June 1982.