INTERNATIONAL SCIENTIFIC CO-OPERATION, TECHNOLOGY TRANSFER AND AID: ASEAN COUNTRIES, AUSTRALIA AND NEW ZEALAND*

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This paper considers the scope for beneficial scientific co-operation and technology transfer among ASEAN countries, Australia and New Zealand in the light of differences in the development status of these countries, their proximity to one another, their resource endowments and other factors. Australian official science and technology aid in the ASEAN region (which of necessity involves some co-operation between the donor and aid recipients) is considered as well as recent initiatives of the Australian Department of Science to promote fully co-operative ('non-aided') R & D in the region. Two examples of regional co-operation in R & D are considered briefly, namely the development of a malaria vaccine and giant clam farming.

Keywords: ASEAN, Australia, economic development, international scientific co-operation, international technology transfer, New Zealand, R & D, science and technology aid, technological dependence

INTRODUCTION

The economic progress of mankind can be attributed in large measure to scientific and technological development, and it is hoped that this development will continue. Yet, scientific and technological progress and its translation into economic and other gains does not depend on faith alone. It requires resources, effort and sacrifice. Since resources are scarce, we should carefully assess the way in which they are used. The use of resources for one purpose, such as a particular scientific project, is usually at the expense of other alternatives forgone. Not only individual nations but also groups of nations are subject to constraints imposed by their limited resources. While international co-

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operation in science and technology can significantly reduce the resource constraints experienced by individual nations, it cannot eliminate resource scarcity. Any co-operation in scientific and technological activities by ASEAN countries (Indonesia, Malaysia, Singapore, Thailand, the Philippines and Brunei[1]), Australia and New Zealand needs to take account of the type of limited resources available to each and the increased productivity that is likely to result from their co-operative or joint use. This requires that the countries concerned establish the extent of the scope for their beneficial co-operation and determine priorities.

However, we should not look upon this as a cut-and-dried or static exercise. To do so would be to ignore the importance of search, experimentation and motivation in human behaviour and endeavour. We often have to discover possibilities, including scientific and technological opportunities, and this calls for a degree of entrepreneurship. The ingredient of enthusiasm is a fragile but important component in our endeavours. Rational comprehensive models of decision making are useful but are too mechanical to capture all aspects of human endeavour.

The proximity of the ASEAN countries, Australia and New Zealand means that they have a number of common interests. The political stability of each has potential consequences for the others. Their proximity to one another has trade advantages for them in terms of transport costs and the economic development of each is likely to stimulate, through greater trade, the development of other countries in the region. They have a joint interest in promoting political stability and economic development in the region.

The countries in this group differ considerably in their economic characteristics, as is indicated in Table 1. The combined GDP (gross domestic product) of Australia and New Zealand (about $US190,000m in 1981) is almost equal to that of the ASEAN countries (about $US199,000m) in 1981. However, the combined population of the ASEAN countries exceeds that of Australia and New Zealand several fold so that, except for Singapore and to some extent Malaysia, per capita incomes in ASEAN countries are low. Comparative statistics for GDP, population levels and per capita GDP are set out in Table 1, but, of course, are subject to qualifications. Despite the disparity in the GDP of these countries. the difference is much less than comparison with larger developed economies, such as those of the USA, Japan or West Germany, would reveal.

BENEFITS OF SCIENTIFIC AND TECHNOLOGICAL INTERACTION AMONG LDCs AND DEVELOPED COUNTRIES

In the grouping of countries under consideration, some are relatively

TABLE 1

Some Comparative Aspects of the Economies of Australia New Zealand and ASEAN Countries

Country	GDP[1] (1981) $US'000m	Annual GDP[2] growth rate %	Population[3] 1983 (millions)	Annual average growth rate of population %	Per capita[4] GDP 1984 $US
Australia	163.8	3.3	15.37	1.4	11,553
New Zealand	25.2	2.0	3.20	1.5	8,253
Singapore	12.9	8.5	2.50	1.5	6,512
Malaysia	24.2	7.8	14.86	2.5	1,990
Thailand	36.8	7.2	49.46	2.5	894
Philippines	38.7	6.2	52.06	2.7	867
Indonesia	86.1	7.8	159.40	2.3	661

Sources:

1. Based on Department of Trade and Resources, *Survey of Major Western Pacific Economies,* Australian Government Publishing Service, Canberra, 1983, Table 9.
2. Based on World Bank, *World Development Report 1983,* Oxford University Press, New York, 1984.
3. *International Financial Statistics,* 38, 2, February 1985.
4. Estimated on the basis of growth rates.

developed (such as Australia) and others are less developed (such as Indonesia) as can be seen from Table 1. A number of scholars and policy-makers have attempted to generalise about the benefits from increases in the flow of science and technology from more developed to less developed countries. These views need to be considered in assessing relations among Australia, New Zealand and ASEAN countries. Two polar views exist:

1) A number of neo-Marxists, institutionalists and neo-mercantilists argue that science and technology flows from developed countries are to the disadvantage of LDCs. They are variously seen as means of economic exploitation, as means of global political domination, and as giving rise to structural problems in LDCs (less developed countries) which hinder their economic development. This group argues that the best policy for LDCs is to dissociate themselves from developed countries or at least engage in selective de-linking. While the disassociation view was given attention at the United Nations Conference on Science and Technology for Development, the selective de-linking view seemed to be most favoured.[2]
2) At the other extreme is the view that LDCs are bound to gain as a result of a greater flow of science and technology and from more developed countries. The 'integrationist' school of world development argues that the best way for developing countries to progress is to rely on the benefits of international co-operation. Morehouse claims that:

> Most policy initiatives in recent decades have assumed that the best way to attack inequities within and among nations through the international system has been to increase the flow of technology in the form of skills, knowledge, and hardware from North to South. [Truman stated this policy in 1949 in his inaugural presidential address] . . . It has been the cornerstone of not only U.S. but other industrialised-country development policies, as well as those of multilateral institutions, ever since.[3]

Two different policy prescriptions emanate from the disassociation hypothesis but fall short of advocating complete disassociation of LDCs from developed countries. These include:

(a) The recommendation for initial complete disassociation of LDCs from developed countries followed by selective re-linking. The Chinese case has been put forward as an example of this.

(b) Continuing but selective linking. Each LDC should only import science and technology in specific fields which it nominates after establishing its priorities. Morehouse suggests that:

> Selective de-linking does not, of course, involve technological

> isolation of the Third World, which would obviously be foolish in view of the overwhelming dominance of industrialised countries in virtually all areas of modern technology. It does mean carefully targeted technology acquisitions on the initiative of developing countries rather than the present system of indiscriminate North-South technology flows . . .[4]

Some versions of this approach, as indicated by Morehouse, recommend that, to the extent that the LDCs become involved in international co-operation and technology transfer, they should try to depend on one another rather than on developed countries. It is not clear in what light the more developed countries in our region, such as Australia, New Zealand and Singapore, should be seen in terms of this theory. Are they less innocuous than the central developed countries? Does the fact that they are second or third level powers mean that they should be seen in a different light?

It has been suggested by Parry that technology transfer from Australia (and presumably also New Zealand) to developing countries is more appropriate for developing countries than transferring technology directly from central developed economies.[5] Australia acts as a useful filter and modifier of technology from larger advanced economies. It modifies process and product technologies for its smaller market and these become more approporiate to the economic conditions facing LDCs. Karunaratne also accepts this thesis,[6] but Hill and Johns are more critical of it.[7] In any case, there is a wide range of technology in Australia and not all of it is likely to be appropriate to LDCs. Much of Australian agricultural technology, for example, is designed for low labour intensity in use, and much of it is indigenous technology rather than filtered technology from other economies.

Karunaratne is critical of the disassociation strategy for developing countries and feels that Australia should not be put in the same basket as larger more developed countries. He says:

> Some economists, befuddled by the complexity of issues involved in technology transfer to developing countries, maintain an aloofness and others suggest that donor countries would be wise to down-play technology transfer to developing countries. For example, it has been argued that increasing the elasticity of supply of technology by fairer and freer transfers would undermine the capacity of developing countries to build an indigenous technological capability. The argument seems to condemn developing countries to languish in their underdevelopment and is of no value to a country such as Australia which is committed to third-world development.[8]

He sees technological transfer to developing countries as a positive sum game in which both the donor or source of the technology, as well

as the receiver, benefit. Karunaratne therefore appears to support the optimistic integrationist view.

It seems unwise to generalise to the extent that has occurred on the basis of mixed evidence. Science and technology and its transfer are not homogeneous, even in developed countries. A range of different effects and consequences can follow depending upon what piece of science and technology is being transferred to a developing country. This suggests that some selectivity is required. An important question then becomes whether existing mechanisms of selection are adequate. If not, can they be improved *in practice*. This requires some consideration of methods and institutional means of scientific and technological transfer.

METHODS AND INSTITUTIONAL MEANS OF SCIENTIFIC AND TECHNOLOGICAL TRANSFER

There are a variety of ways in which science and technology can be transferred between nations. It may be transferred embodied in traded products, through books and publications, via informal contacts and observations, by means of specifications and blueprints, through formal personnel exchange arrangements and through interchange of individuals in education. However, the transfer of much scientific and technological information is not a simple process. It is increasingly recognised that to be successful, it requires considerable effort on the part of both the transferor and the recipient.

Pack, in summing up contributions to a special issue of *The Annals of the American Academy of Political and Social Science on* 'Technology transfer: new issues and analysis' says:

> The characteristic features of the required knowledge are that it is not easy to specify in blueprints or manuals . . .; it is difficult to negotiate about, since so much of it is tacit and thus a 'fair' price is difficult to define; and that recipients of technology cannot be passive but must undertake purposive action to increase the ability to identify their needs, to learn about those technologies that might be particularly useful, and, especially to operate them successfully.[9]

He emphasises that technology transfer is not free, but involves hard work and substantial monetary costs both by the transferor and the recipient. Free *availability* of technology or scientific knowledge is not a recipe for its transfer.

A number of alternative institutional possibilities exist for scientific and technological co-operation and transfer. It may be arranged by privately owned companies. It can be via direct investment (as in the case of many multinational enterprises), by licensing to indigenous

enterprises, supplied through consulting services, or arranged through a joint business venture. Alternatively, it can involve government to government arrangements or arrangements through semi-autonomous research bodies of the government. Other possibilities include transfer or co-operation through private individual contacts, through voluntary organisations and through tertiary educational/research institutions. Technology transfer and scientific co-operation may be on a bilateral basis, or by joint agreement between countries or parties therein, or arranged through international agencies on a multilateral basis. Australia, for example, contributes funds to the Consultative Group on International Agricultural Research (CGIAR) which supports a number of important agricultural research centres, most of which are located in developing countries; for example, the International Rice Research Institute in the Philippines.

Karunaratne claims that:

> In a global context the importance of commercial technology transfers to developing countries (TTDC) far outweighs non-commercial transfers. However, because Australia is a technological dependency, aid programmes are major TTDC vehicles. Nevertheless, Australian transnational corporations do undertake commercial TTDC, generally using wholly or partly owned subsidiaries; joint ventures with developed country entrepreneurs or governments; licensing agreements and turn-key projects.[10]

The actual type of institutional arrangement used for technology transfer and scientific co-operation can be expected to influence the success of the venture and the distribution of benefits from it. The fact that research institutes associated with CGIAR are mostly located in LDCs seems advantageous in the agricultural field.[11] Different arrangements may be appropriate for different types of technology and research.

FACTORS CONDUCIVE TO SCIENTIFIC CO-OPERATION AMONG ASEAN COUNTRIES, AUSTRALIA AND NEW ZEALAND

A number of factors may favour scientific and technological co-operation among ASEAN countries, Australia and New Zealand for common gain. The proximity of these countries is one factor favouring their co-operation. (However, it might be noted that the proximity factor also applies to Japan.) Proximity reduces the potentially considerable cost of communicating and co-operating. For a number of countries in the grouping, the use of English reduces communication costs.[12]

Some research and technological problems are common to several countries in this region. For example, a large portion of Australia is located in the tropics and some of the crops grown there are also grown in ASEAN countries. A number of the marine species inhabiting Australian tropical waters are also common to ASEAN countries. Joint research by countries on common problems can avoid wasteful duplication of effort and reduce the cost of research. Joint research may also enable comparative advantages to be more effectively exploited; for example, Australia and New Zealand may principally be able to supply skilled manpower and specialised equipment for a research project whereas an ASEAN country may be able to supply suitable field sites for the project and less skilled staff. Supporting staff may be supplied in ASEAN countries at a fraction of their cost in Australia and New Zealand.

Australia and New Zealand may wish to reduce their health risks or other possible environmental spillovers or side-effects from ASEAN countries by supplying suitable technologies to those countries. This may include reductions in risks to human health (e.g., from malaria) as well as risks to plants and animals (e.g., foot-and-mouth disease). Both the donor and the recipient of the technology stand to gain. Mutual gain may occur indirectly through international trade. The donor of technological aid may be able to import cheaper or better quality goods from the recipient country after adoption of the new technology. A technology developed for or transferred to a country may increase the returns of producers in the country concerned and also lower the cost of its exports. If the supplier or donor of the technology is also an importer of the exports of the technology recipient, it may gain from the technology transfer.

A donor may find it profitable to subsidise the introduction of a technology to an overseas country because early introductions, if successful, provide a demonstration effect for later potential adopters. Early adopters may encourage laggards to demand the technology. This may lead to flow-on demand for non-subsidised equipment either embodying or essential to the technology. All parties may gain from this strategy for transferring technology.

Some of the technological and scientific aid given by New Zealand and Australia in the region is given with a view to maintaining political stability in the region. Some is also given for purely humanitarian or philanthropic reasons.[13] Most of Australia's scientific and technological interaction with ASEAN countries appears to have been in the form of aid. There seem to be four possibilities in relation to technological and scientific aid: (1) both the donor and the recipient may gain; (2) the recipient may gain and the donor may lose; (3) the donor may gain and the recipient may lose; (4) both the donor and the recipient may lose. Possibility (1) may be most satisfactory and (4)

least satisfactory. There is no reason to suppose that possibility (3) is the most frequent outcome in practice as a number of neo-Marxists claim.

AUSTRALIAN SCIENCE AND TECHNOLOGY AID IN THE ASEAN REGION

Australia provides considerable scientific and technological aid (in relation to its assistance expenditure) to ASEAN countries and most of this necessarily involves co-operation, even if the funding is mainly from Australia. Bodies involved in such aid include the Australian Development Assistance Bureau, the International Development Program of Australian Universities and Colleges, the Australian Centre for International Agricultural Research, CSIRO's Centre for International Research Co-operation and the Australian National Commission for UNESCO.[14] More recently, as discussed below, the Department of Science, through its Regional Science and Technology Program, has attempted to break away from donor-type science and technology to joint projects involving joint contributions and funding in Southeast Asia.

It has been estimated that if budgetary assistance to Papua New Guinea is excluded, just over a half of official Australian Development Assistance Expenditure is for projects having a substantial science and technology component. In 1980-81, this amounted to $159m out of a total expenditure of $315m. Of the $55.5m spent on overt training and technical assistance under bilateral development assistance, 64 per cent went to ASEAN countries. Of the $30.2m provided for goods and services of a technological nature, 41 per cent went to ASEAN countries and 56 per cent to Southeast Asian countries.[15] In general, Australian official technological and scientific assistance for development is concentrated on Southeast Asia (mostly ASEAN countries), South Asia and Oceania. Together these areas account for over 90 per cent of the science and technology (S & T) component of Australian official development assistance.

Approximately two thirds of Australian development assistance of an S & T type is on a bilateral basis and the remainder is given on a multilateral basis. The main international institutions administering such aid are the International Development Association, the Asian Development Fund, the United Nations Development Fund, the Consultative Group on International Agricultural Research (CGIAR), the Commonwealth Fund for Technical Co-operation, the International Fund for Agricultural Development, the International Centre for Living Aquatic Resources Management (ICLARM) and the International Fertilizer Development Centre (IFDC).

A considerable proportion of the science and technology component of Australian development assistance is used to strengthen

research capabilities in recipient countries.[16] At least 8 per cent is directly used for this purpose, but taking into account the fact that bodies such as CGIAR have most of their associated research institutes located in developing countries, much Australian multilateral aid also assists research effort in LDCs. Most of Australia's direct assistance for strengthening the technological capabilities of developing countries goes to ASEAN countries.

ASTEC has suggested that:

> despite the lack of precise data, it seems clear that Australian support for research, both bilateral and multilateral, has been largely for agricultural research. In the bilateral programs the bulk of past expenditures in support of agricultural research and a significant part of current expenditures have gone towards the establishment of the Animal Husbandry Research Institute in Bogor, Indonesia.[17]

ASTEC concluded that Australian emphasis on agricultural S & T development aid was appropriate given Australian expertise in agriculture and given that "agriculture continues to have a most important role in almost all of those countries with which Australia has bilateral relationships under the assistance program."[18] However, ASTEC suggested that some change in components of this aid should be considered, particularly since some of the ASEAN countries are now more industrialised than in the past. It sees some virtue in increased emphasis on aid in the health and energy fields. It concludes (and this conclusion still seems applicable to the current situation):

> There is a need to review the present balance between the various elements of science and technology in Australia's assistance program to identify those fields of Australian science and technology which are, at present, under-represented in the program but which have a considerable potential to contribute to the social and economic objectives of developing countries. As Australia provides assistance in mutual consultation with developing countries, such a review would need to be conducted in association with these countries.[19]

It has been suggested that the relative importance of agriculture is declining in ASEAN countries and more consideration should be given to the transfer of industrial technology. It is pertinent to note that any move towards greater concentration on 'aid' for manufacturing technology and some tertiary technology and 'know-how' is likely to require a greater input from Australian private firms and transnational corporations. Greater use of joint ventures, licensing, franchising and so on may be appropriate. In many respects, the role of governments in this development interaction would be a purely facilitative one. It is also possible that as agriculture becomes more commercialised in ASEAN countries and individuals

migrate from rural area, Australian agricultural production techniques (modified) will become more appropriate to these countries.

The Jackson report (*Report of the Committee to Review the Australian Overseas Aid Program,* 1984) emphasises the need for firmly establishing priorities in relation to Australian aid to Southeast Asia and small South Asian countries. The committee recognises that Australia cannot effectively aid all LDCs and that there are significant administrative costs in attempting to distribute aid widely, as well as adverse geo-political consequences for Australia. Basically the committee supported the current geographical distribution of aid, but suggested less involvement in bilateral aid for African countries and a relatively greater emphasis on aid for countries situated in waters adjacent to Australia; that is, in the South Pacific and Indian Oceans. The committee established four categories for Austalian aid:

(i) Countries eligible for *all* forms of support. These should be Papua New Guinea, the South Pacific and Indian Ocean Islands. These countries should be the main focus of support.

(ii) Southeast Asian countries and smaller countries of South Asia (Burma, Nepal, Bhutan and Sri Lanka) should be given significant aid, but only for their priority development sectors and those areas in which Australia can contribute particular strengths. Selectivity is important.

(iii) The larger South Asian countries (China, India, Pakistan and Bangladesh) are placed in category III. Country programming should be at a very general level and sectors of concentration involving Australia should be even more carefully selected.

(iv) It is recommended that other developing countries receive no new bilateral project assistance, although they will still be eligible to receive some aid, such as food aid and technical and research co-operation. Nevertheless, the exceptions would not be such as to upset the broad geographical concentration of aid on New Guinea, the South Pacific and Indian Ocean Islands, Southeast Asia and, to a lesser extent, South Asia.

This suggested pattern of distribution has been defended by Jackson and by Lim (who were both members of the Jackson committee),[20] and criticised by Eldridge and by Stent.[21] It is not my purpose to debate the matter here. However, it is clear that if the Jackson report is followed up, there will need to be a greater emphasis on priority assessment in Australian development aid, particularly in relation to Southeast Asia, and this will have flow-on effects for the science and technology component of Australian aid.

Professor Lim has summarised the approach of the Jackson committee in the following way:

> The approach taken by the Jackson Committee to produce an effective Australian aid program is to first make it more focused by country, sector and instrument of delivery, so that the aid effort is not dissipated by doing too many things in too many ways and in too many places, with scant regard for the modest size of Australia's aid budget and for its comparative advantages. Focussing the aid program by sector and instrument of delivery is especially important in those large LDCs where the Australian input is relatively insignificant as it helps to make the most of Australia's contribution at the margin.[22]

The importance of establishing priorities is difficult to deny. However, the difficulty of establishing appropriate priorities and translating these into workable criteria should not be underestimated, especially in the science and technology field. It calls for considerable research effort, ingenuity and exchange of information and views among the countries concerned. Furthermore, some flexibility in the statement of priorities is needed to allow for changing circumstances.

There are difficulties in establishing formal priorities. Australia may have a comparative advantage in a particular field of S & T, but this field may not be very appropriate to countries in its immediate area of concern. Comparative Australian advantage in a particular S & T field (e.g., wool growing) is not a sufficient test of the desirability of giving development aid in this field. There may be S & T fields in which Australia does not have a comparative advantage which are nevertheless significant for LDCs with which Australia is concerned and for which S & T aid is not available from other sources. It may then be appropriate for Australian S & T aid in this field to be afforded a higher status than S & T aid in an area in which Australia has a comparative advantage but which is of little value to recipient LDCs. The matter is complex because a number of variables have to be considered simultaneously. The abilities of the donor have to be matched against the demands or needs of the recipients of aid. In other words, supply side and demand factors must be simultaneously considered. Furthermore, possible complementarities from co-operation in the S & T field need to be taken into account.

The Jackson report suggests that Australian aid should be directed towards the economic development of recipient countries, but this is not to be equated with simple growth of GDP. The multidimensional attributes of economic development make it more difficult to draw up a set of priorities. At this stage we do not have a short, definitive and practical list of relevant priorities. In depth and innovative work is required to establish such priorities.

S & T INTERACTION ON A JOINT BASIS

With the economic development of ASEAN countries, the scope for joint S & T projects among ASEAN countries, Australia and New Zealand is expanding. ASEAN countries are now in a better position to contribute skilled personnel, funds and resources to research projects of common concern. There may be more scope for S & T projects in which all parties gain. The potential for such co-operation is being explored by the International Policy and Programs Branch of the Department of Science in its Regional Science and Technology Program, which aims to enhance Australian S & T interaction with countries in Southeast Asia and the Soutwest Pacific. The Program aims:

> (1) "to increase the visibility of and demand for Australia's S & T capabilities in the S.E. Asian/S.W. Pacific region, (2) to promote co-operation in S & T between Australia and the region through the preparation of proposals for co-operative R & D in fields of mutual interest."[23] It has been emphasised that this is not an aid program, but one depending upon co-operation "with each party contributing to a mutually beneficial goal".[24]
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> [The main] "emphasis will be given to joint projects in applied sciences of interest to Australian scientific industries [and] co-operating agencies will be expected to provide the funds, facilities and personnel for joint projects. The Department's role will be to bring the agencies together and assist them to identify areas for co-operation."[25]

The role of the Department of Science is one of facilitation. The final decision on project partners will be left to co-operating companies and institutions.

Four areas of Australian expertise have been selected for emphasis under this Program: (1) applied microelectronics (2) scientific instrumentation (3) remote sensing, and (4) biomedical technology. Emphasis therefore is on technologies other than those directly related to agriculture. The scheme is in its early stages, but there already appears to be the chance of viable joint projects being agreed to with Malaysia on microelectronics and scientific instrumentation, and with Indonesia on remote sensing.[26]

REGIONAL R & D INTERACTION FOR PARTICULAR PROJECTS

There are several Australian-associated R & D projects which involve, or could profitably entail, co-operation with ASEAN countries. It is possible only to touch upon a couple of recent ones here, namely efforts to develop a malaria vaccine and research aimed at developing technology for the farming of giant clams (tridacnids). The decision of

the Australian government to support the development of a malaria vaccine should benefit ASEAN countries and other LDCs. Mutual benefits are possible although substantial commercial benefits to Australia are not anticipated at this stage.[27] The vaccine is being developed jointly by the Walter and Eliza Hall Institute of Medical Research in Melbourne, Biotechnology Australia Pty. Ltd., the Queensland Institute of Medical Research and the Commonwealth Serum Laboratories. In this work, there has been close collaboration with the Papua New Guinea Institute of Medical Research at Madang. One can foresee that Australia could obtain gains from sales of the vaccine or the technology required to produce it, anti-malaria protection for its citizens abroad, an insurance if malaria should be introduced to northern Australia, and a foothold on methods for developing vaccines against strains of malaria not covered in the initial programme. This expertise could be shared with ASEAN countries on a co-operative basis which may be able to assist in the extension of vaccines to malaria strains not covered in the initial research. It would be an advantage to ASEAN countries to share in this expertise. The availability of the vaccine will help to reduce suffering in ASEAN countries and other LDCs and should add to economic productivity.

Another project of potential economic value to ASEAN and Pacific countries, and providing scope for their international co-operation, is the project for the mariculture of giant clams (tridacnids). This project is funded by ACIAR (The Australian Council for International Agricultural Research), and involves co-operatiave research between James Cook University of North Queensland and institutions in the Philippines and a number of Pacific islands. All countries in the region with tropical waters, including Australia, stand to benefit from the mariculture of clams. The successful mariculture of clams could add significantly to the incomes of coastal dwellers and economically assist some of the lowest income earners in neighbouring countries. The project would seem to promise benefits of the type associated by the Jackson report with economic development. It would use, or is using, Australian and ASEAN resources and expertise, and also resource contributions from the Pacific Islands, and is thus a co-operative project.

One could catalogue and explore other cases, such as microprocessors, food technology, materials handling and processing and alternative sources of energy, in which S & T co-operation would be worthwhile or is at present occurring. Various new (as well as pre-existing) biotechnology fields may also provide scope for co-operation. Each of these fields requires an in-depth study in itself as far as possibilities and priorities for co-operation are concerned. However, we do need *in-depth* studies. Just as the natural sciences and technology cannot progress without adequate resources, it is a folly to

think that adequate policy formulation can be achieved on the cheap. An adequate examination of the prospects and possible priorities, say, for alternative energy technology and biotechnology in relation to co-operation among Australia, New Zealand and ASEAN countries would be a major exercise in itself.[28]

FURTHER PERSPECTIVES AND CONCLUSION

This paper has been written primarily from the perspective of Australia. Ideally one should also undertake a similar exercise for New Zealand and for each of the ASEAN countries. Individual papers given at the ASEAN Interaction component of ANZAAS do address these matters from the perspective of individual countries such as New Zealand, Malaysia and the Philippines.[29]

There may be areas of scientific and technological interaction where Australia and New Zealand would be wise to co-ordinate their efforts or engage in some projects jointly with ASEAN countries. New Zealand and Australia have expertise in a number of similar fields and some differences in relative S & T strengths. New Zealand's strengths are not purely confined to agriculture and coniferous forestry. New Zealand has, for example, significant skills in food processing, the production and use of electric fencing and the management of alpine areas. These latter skills have, for instance, been put to use in Nepal, where New Zealand has helped to train local Sherpas in park management and devised a management plan for Sagarmatha (Mt. Everest) National Park. Being a small country, however, New Zealand may not wish to spread its S & T co-operation too widely and may continue to wish to concentrate its interaction on the islands of the South Pacific.

It needs to be remembered that ASEAN countries have opportunities to interact with many countries other than Australia and New Zealand — for example, with Japan and the USA. Given that interaction requires the use of some resources by ASEAN countries and has flow-on resource implications, they must decide the extent of their interaction in S & T with different countries and the S & T areas in which they will interact with each. One could see a case for an approach not unlike that of Japan in the Meiji period.

A selective approach by ASEAN countries towards international interaction in S & T may not be unfavourable to Australian and New Zealand involvement. The S & T capabilities of Australia and New Zealand may, in many cases, accord more closely with the scale and nature of operations envisaged in ASEAN countries than, say, that of the USA or Japan. Australian and New Zealand technology may be less 'high-tech' and more compatible with local skill and factor proportions than more 'advanced' technology from the USA and Japan.

Whether a selective approach is administratively workable within the social context of the ASEAN countries is, of course, another question. In the case of Australia, there is a danger of government international S & T aid and transfer being unco-ordinated, and some possiblity of competition and duplication of effort by different public bodies. This arises from the fact that different government departments and bodies are involved; for example, the Department of Foreign Affairs (through ADAB and ACIAR) and Department of Science (through its International Policy and Programs Branch and CSIRO). There is a need to monitor the overall Australian effort even though it may be undesirable to centralise administration of it.

ASEAN countries, Australia and New Zealand should take greater steps to evaluate their prospects and priorities for co-operating in scientific and technological development. The recommendations of the Jackson report in favour of selectivity add weight to the importance of establishing these priorities as far as Australian development aid to ASEAN countries is concerned. I am optimistic that there are many S & T projects in which the ASEAN countries, Australia and New Zealand can co-operate to their common advantage. Not all of these projects will involve development aid — many, and probably an increasing number, will involve international commercial co-operation and exchange.

NOTES AND REFERENCES

1. Brunei joined ASEAN in 1985 and is not taken into account in the statistics given in this paper.
2. V. Rittberger, *Science and Technology in a Changing International Order: The United Nations Conference on Science and Technology for Development,* Westview Press, Boulder, Colorado, 1982.
3. W. Morehouse, 'Technological autonomy and disassociation in the international system: an alternative economic and political strategy for national development' in Rittberger, *op. cit.,* p. 52.
4. *ibid.,* p. 54.
5. T.G. Parry, 'The multinational enterprise and two-stage technology transfer to developing nations', *Research in International and Business Finance,* 2, 1981, pp. 175-92.
6. N.D. Karunaratne, 'Australia and technology transfer to developing countries', *Economic Activity,* 27, 2, 1981, pp. 2-12.
7. H. Hill and B. Johns, 'The transfer of technology to western Pacific developing countries', *Prometheus,* 1, 1, 1983, pp. 60-83. *cf.* C.A. Tisdell, 'Technological change and transfer in the Pacific: the position of Australia and Japan', *Australian Outlook,* 39, 1, 1985, pp. 39-43.
8. Karunaratne, *op. cit.,* p. 9.
9. H. Pack, 'Preface', *Annals of the American Academy of Political and Social Sciences,* 458, 1981, p. 7.
10. Karunaratne, *op. cit.,* p. 4.

11. M. Alauddin and C.A. Tisdell, 'Bangladeshi and international agricultural research', *Agricultural Administration,* 21, 1986, pp. 1-20.
12. *cf.* D.J. Teece, 'Technology transfer by multinational firms: the resource cost of transferring technology know-how' *Economic Journal,* 87, 1977, pp. 242-61.
13. D. Lim, 'The Jackson report on Australian aid: the underlying framework', *Australian Outlook,* 39, 1, 1985, pp. 19-22.
14. For more information see 'ASEAN-Australia interaction: summary of areas of science and technology interactions', paper for ANZAAS 1985 prepared by International Policy and Programs Branch, Department of Science, Canberra, 1985.
15. ASTEC (Australian Science and Technology Council), *Australian Science and Technology in International Co-operation and Development Assistance,* Australian Government Publishing Service, Canberra, 1982.
16. For a different view, see Karunaratne, *op. cit.*
17. ASTEC, *op. cit.,* p. 39.
18. *ibid.,* p. 47.
19. *ibid.,* p. 48.
20. R.G. Jackson, 'Australia's foreign aid', *Australian Outlook,* 39, 1, 1985, pp. 13-18; Lim, *op. cit.*
21. P. Eldridge, 'The Jackson report on Australia's aid program: political options and prospects'; and W.R. Stent, 'The Jackson report: a critical review', *Australian Outlook,* 39, 1, 1985, pp. 23-32, 33-8.
22. Lim, *op. cit.,* p. 21.
23. International Policy and Programs Branch, *Scientific Industries Steering Committee Report on Activities to 30 June 1985,* Department of Science, Canberra, 1985.
24. 'ASEAN-Australia interaction: summary of areas of science and technology interactions', paper for ANZAAS 1985 prepared by International Policy and Programs Branch, Department of Science, Canberra, 1985, p. 9.
25. *ibid,* p. 10.
26. International Policy and Programs Branch, *Scientific Industries Steering Committee Report on Activities to 30 June 1985 op. cit.,* p. 6. See also Department of Science and Technology pamphlets *Applied Micro-electronics in Australia, Scientific Instrumentation in Australia, Remote Sensing in Australia* and *Biomedical Technology in Australia,* undated.
27. *Weekend Australian,* 15-16 June 1985, p. 3.
28. For an indication of some of the factors that would need to be considered see K. Hoffman, 'New technologies and the Third World: challenges and opportunities in renewable energy and biotechnology', *Development and Change,* 16, 1, 1985, pp. 3-4; *idem.,* 'The commercialisation of photovoltaics in the Third World: unfulfilled expectations and limited markets', *Development and Change,* 16, 1, 1985, pp. 5-38; M. Kenney and F. Buttel, 'Biotechnology: prospects and dilemmas for Third World development', *Development and Change,* 16, 1, 1985, pp. 61-92.
29. Relevant papers presented at the Science and Technology Workshop, ASEAN Interaction, ANZAAS, Melbourne, 1985 include Q.L. Kintanar, 'Science and technology for development: ASEAN aspirations'; Fong Chann Onn, 'Technological co-operation between ASEAN and Australia-New Zealand: issues from Malaysian case studies'; and C.M. Palmer, 'Co-operative development of science and technology in ASEAN, and Australia and New Zealand: constraints and problems: a review'.