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# **Building on Success:** **Agricultural Research, Technology, and** **Policy for Development**

Report of a symposium held at Canberra  
14 May 1987

*Editor:* **James G. Ryan**

*Sponsored by the*  
Australian Centre for International Agricultural Research  
Canberra 1987



Dr Fauziah Othman of the Universiti Pertanian Malaysia is part of the joint UPM/University of Queensland team that developed the new food pellet vaccine to combat Newcastle Disease of poultry. This development will reduce poultry losses to farmers which will lead to increased incomes.

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## Symposium Speakers

### **Professor Jock R. Anderson**

Professor Anderson, who is head of the Department of Agricultural Economics and Business Management at the University of New England, Armidale, was Director of the recently completed study of the impact of the International Agricultural Research Centres (supported by the Consultative Group on International Agricultural Research—CGIAR), for which Australia provides some funding. The distinguished international group making the study is about to publish its findings.

Over the past 14 years Professor Anderson has held consulting positions with many international agricultural research centres, as well as with the World Bank. This experience and his position as Director of the impact study places Professor Anderson in a particularly good position to present an authoritative opinion on the impact of the international agricultural research effort on development.

### **Professor John W. Mellor**

Professor Mellor is Director of the International Food Policy Research Institute (IFPRI) in Washington D.C. IFPRI concentrates on the analysis of alternative national and international strategies and policies for meeting the food needs of the world, particularly those of low-income countries and the poorer groups within them. IFPRI is one of the 13 international agricultural research centres supported by the Consultative Group on International Agricultural Research.

Professor Mellor, who was previously Professor of Agricultural Economics at Cornell University, is a recognised world authority on the role of agricultural development in the economic growth of developing countries. He is an original thinker who has published extensively. He has recently involved himself in the argument on whether supporting agricultural development in developing countries creates competitors for U.S. farmers or increases exports of U.S. farm produce by developing new markets—an argument that is also going on in Australia.

### **Dr Kym Anderson**

Dr Anderson, who is currently senior lecturer in economics at the University of Adelaide, has for many years taken a particular interest in the effects of protectionism and other economic policies on agriculture in Australia, Asia and the Pacific, and in their effects on trade. He has held consulting positions with the World Bank, the Food and Agriculture Organization (FAO) and other international centres, as well as with such Australian government agencies as the Bureau of Agricultural Economics, the Department of Primary Industry and the Australian International Development Assistance Bureau. His recent studies of the effects of market liberalisation on economic growth in China, a country that represents a large potential market for Australian food and fibre products, allow him to make an authoritative assessment of how providing agricultural development assistance to China may generate new and expanding markets for Australia.

## Foreword

THERE is a popular perception that because of the apparent adequacy or surfeit of current world food supplies there is less need to sustain investments in agricultural research for development. This perception is dubious for a number of reasons.

Firstly, research and technological change in agriculture are powerful engines of economic growth of which enhanced physical supplies of agricultural commodities are but one manifestation. Technological change in agriculture generates new income streams and economises on resources, thus allowing their transfer to other sectors experiencing demand growth from the new incomes, including the foreign trade sector.

Secondly, the inexorable future growth of population and incomes will continue to generate demands for increased food supplies in future. With the usually long gestation periods before agricultural research can be expected to generate viable new technological options, it is important to maintain current research investments at levels which ensure an appropriate and continuing supply of innovations in the future.

Finally, self-sufficiency strategies based on the attainment of notionally adequate supplies of each major agricultural commodity in individual countries, besides their potential for sacrificing current welfare gains, can also distort the allocation of resources for research in ways that imply future sacrifices.

Against this background ACIAR decided to sponsor this symposium. The three eminent speakers—Professor Jock Anderson, Professor John Mellor and Dr Kym Anderson—were asked to address particular aspects of the subject.

Professor Anderson was asked to examine the impact of agricultural research and technological change on food supplies, farm incomes, employment and consumers in developing countries. Professor Mellor was requested to explore the linkages between technological change/agricultural growth in developing countries and non-agricultural growth, poverty alleviation, human nutritional status and foreign trade. Dr Anderson was asked to address the macroeconomic and trade implications of technological change and agricultural growth in developing countries.

The three papers are included in this publication, along with the commentaries which were prepared by Professor Frank Jarrett, Emeritus Professor Heinz Arndt and Dr Alistair Watson.

Dr James Ryan, Deputy Director of ACIAR, was responsible for organising the Symposium and the scientific editing of this publication. He was assisted in the former by Dr Joe Remenyi, previously Research Program Coordinator with ACIAR (now with Deakin University) and Mrs Pam Chapman, Research Services Officer. Mr Reg MacIntyre assisted with the editing. We are grateful to CSIRO for making available its conference facilities at Limestone Avenue, Canberra, for the symposium.

**J. R. McWilliam**  
*Director*  
*ACIAR*



ACIAR supports a number of projects in the People's Republic of China, including areas such as the effect of chilling on rice production, the control of insect pests, wool production and animal diseases.



## Opening Address

**Hon. Barry O. Jones**  
*Minister for Science, Canberra*

FOR ANYONE who has followed the fortunes of Australian agriculture in recent times, one thing will surely be obvious: whatever the adverse effects of high interest rates, taxes and tariffs on the rural sector, there is one big negative factor over which we have little control—the massive world surpluses of major export commodities.

So why on earth should Australia be involved in assisting rural research in developing countries? Aren't we merely wiping out potential markets for our products by encouraging self-sufficiency in countries where they could be sold?

That, of course, is the conventional, simplistic view. And as I think this symposium will amply show, it is also completely wrong. Give developing countries better technology for crop and animal production, grain storage, and so on, and you don't just increase output. You change their whole economic environment. You fuel the engine of economic growth. You increase the number of jobs. You boost incomes. And that means greater demand—not only for manufactured goods, but for foodstuffs as well.

There is, indeed, hard evidence to support this view. It is provided in Dr Kym Anderson's paper being presented at this symposium. I would like to mention a few of the points raised by him.

He says that between the periods 1961–64 and 1980–83 there were overall annual increases of 3.3% in grain production and 2.5% in meat and milk production in the developing economies. But the interesting thing is that their total food consumption rose by 3.5% a year.

He goes on to use China as a fascinating case study of how this kind of change has taken place. Despite an increase of over 50% in farm production in the 6 years from 1978 to 1984, the country's self-sufficiency actually declined during the same period. In fact agricultural imports rose a massive sevenfold between 1970–72 and 1982–84.

If one extends these trends into the future, it is obvious they have enormous implications for our future potential trade patterns. There is an important message here for today's policymakers.

Of course our contributions to international agricultural research do not only help in boosting demand for our products overseas. They also provide our scientists with information which is valuable in raising the efficiency of our own farm production. I will use the example of our contribution to Thailand's mungbean research as an illustration. Incidentally, CSIRO is involved in this particular program.

Mungbeans, to place them in context, are a new and expanding crop in northern Australia, while in Thailand they are one of considerable antiquity. In assisting the Thais, our scientists are providing the benefit of their expertise in disciplines like physiology, pathology and plant genetics. But the Thais have the advantage of years and years of practical experience with the crop. They also have access to a wide variety of germplasm which is of great potential value to us.

The net result is that our infant mungbean industry is likely to gain considerably from interaction between Thailand's researchers and our own. We can give them the

benefits of our scientific know-how. They can teach us about the practicalities of on-farm production.

And there is an interesting aside about the crop in case you think it just a quaint-sounding health food. In Asia one of the uses of mungbeans is as a source of top quality starch for making noodles. This high value product is added to cheaper cereal starch to enhance its flavour and texture. That could make mungbean starch just the sort of value-added product Australian agriculture is looking for to boost its export earnings.

Another crop Australia is involved with in collaborative research with the Thais is soybeans. Again, we stand to gain from joint research. And once more there is scope for us to exploit specialist markets in Asia. Both soybeans and mungbeans are widely used in confections in Japan, for instance. Soybeans alone are made into 35 different products—surely another value-added marketing opportunity.

Anyone who is still worried about us helping with research in developing countries should perhaps remember that we do have one advantage that we cannot give away. Ours are the benefits of large-scale, mechanised agriculture. As countries develop, so their labour costs climb. But those with a long history of small-scale intensive farming cannot readily switch to the sort of broad-acre agriculture which is our heritage. It has been suggested this gives us a cost advantage which should become increasingly evident as countries to the north ascend the economic ladder.

Of course there is one benefit of international research which scientists find hard to quantify—but many would probably argue is the biggest benefit of all. I refer, of course, to goodwill. Australia is viewed by many developing nations as a friend, and our scientists are playing an important role in helping foster that image. It is one we will not regret in an increasingly competitive trade environment.

In sponsoring and organising this symposium, ACIAR has brought together well-informed speakers on a topic of considerable significance to the future of Australia, as well as the developing countries with which we are collaborating in the scientific field. I am sure there will be much in what the speakers have to say and the discussions that follow to help clarify Australia's objectives and priorities in international research in the years ahead.

This symposium should also assist in examining the rationale for public support for agricultural research in developing countries. It is highly appropriate at a time when funds are in short supply for research at home.



## Impact of Agricultural Research in Developing Countries

Jock R. Anderson\*

### Abstract

Agriculture continues to be a significant force in the economic growth of most developing countries. This role is greatly enhanced through innovations emerging from national agricultural research systems and their international partners, including particularly the centres supported by the Consultative Group on International Agricultural Research. The most spectacular impact of this research was the so-called Green Revolution of the 1960s. Although targetted at developing countries, this plant breeding work also resulted in considerable benefit to industrial nations such as Australia—notably new cultivars of wheat now widely used by the Australian wheat industry. Agricultural research is, of course, much more than the production of crop cultivars and other products. We also see improved agricultural products, enhanced human capital, and more effective institutions serving agriculture. Although investment in research may be inherently risky, and may involve long delays before benefits are realised, there is mounting evidence that such investment in agricultural research provides returns that compare favourably with those from alternative public investments.

IN THE politics of agricultural research there is a difficulty in many nations in identifying effective political support. With the fruits of research having most of the features of a pure public good, those who stand to benefit most may not even know that they are benefiting. Others who may feel that they can benefit, even if only in the short run before their slower-adopting fellow farmers can catch up and compete away the profits of innovation through greater output and reduced prices, may see little reward in standing up and being counted. Special pleading by people in and of the knowledge industries is liable to be distrusted and easily disregarded as coming from potentially self-serving claimants on the public purse.

We in Australia are rather more fortunate in this regard. Visionary politicians, public servants and scholars—these categories not being mutually exclusive—gradually put in place during this century an institutional infrastructure for research that has served the nation well. Earlier ‘battlers’ such as William Farrer had a harder time of it, but did their bit for easing the task of the visionaries.

For agricultural research in particular, farmers too have played a significant role in articulating demand for public involvement in research, in investing in such formal research through industry organisations, and by engaging in continuing inventive activity themselves.

Thus the case for agricultural research as a worthy public and private investment has long since been made, and the major battles fought and, notwithstanding some recent blips, seemingly won. Why then should we be considering today these same issues from a perspective of international development? It seems that, in the spartan environment exemplified by recent Australian budgetary decisions, responsible investors need to review the situation, to consider any fresh evidence, and to be reassured that a ‘good thing’ when done in Australia is, from Australia’s perspective, also a ‘good thing’ in and for the developing world.

### Research, Agriculture and Economic Growth

Economists are not especially well known for harmony of thought but, in fact, are now well agreed on the importance of a healthy agriculture in the economic growth of agrarian societies struggling to modernise and industrialise (for a recent

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review see Throsby 1986). Kym Anderson's paper (this volume) elaborates on this from a trade perspective. Further, observers from many disciplines perceive that a healthy agriculture depends, among many factors, on cost-reducing technological change that, in turn, is fostered through an effective system of agricultural research and technology/information transfer. This is even true for Australia where agriculture now plays a rather minor (one-twentieth of gross domestic product) role in the economy—of course, much greater in exports—but a role that is supported by an elaborate complex of research organisations. The complex is still evolving, as witnessed by the recent establishment of a Bureau of Rural Science. The role of agriculture as a powerful engine of growth is naturally even more important in economies with dominant agricultural sectors, but with often weak research and extension systems (e.g. Johnston and Mellor 1961; Schultz 1964; Mellor 1985)—including some major nations such as China.

The knowledge industries interact with agriculture in complex ways with varying and dynamic links between many of the elements. Research is the process of adding to the body of knowledge. Some knowledge is widely applicable and highly transmissible, and thus the research from which it stems can be conducted almost anywhere, perhaps most easily and effectively in industrial nations such as Australia. Other knowledge is applicable to much more specific circumstances, such as particular natural ecologies, geographic localities, or socioeconomic conditions, and the relevant research must necessarily be conducted within such defined circumstances. The continuum of situations makes valid generalisations about a desirable degree of specificity in agricultural research virtually impossible, and judgment and experience must guide the hand of wise investors in the knowledge industries. Choices within these industries are also difficult, ranging from enhancing the human capital of the farming population through improved elementary education, to pushing the cutting edge of the formal research system further 'upstream' (i.e. placing more emphasis on exploiting recent innovations in basic sciences, for example genetic engineering and biotechnology).

### **Horses for Courses**

In spite of these reservations, however, there are a few rather broad generalisations that can be proposed. The first must be that as nations differ in their agroclimatic features and development infrastructures, the 'ideal' research and development (R & D) systems vary correspondingly and, abstracting from the difficulties in measurement that are implicit, they may well differ even more greatly.

Second, within national boundaries, the extent of socioeconomic and agroecological diversity will strongly influence the intranational 'ideal' deployment of research resources. The challenge faced by many rather small economies arises from the great diversity in these dimensions mismatched by a paucity of resources with which to pursue research-based advances in technology. Taking these rather uncontroversial generalisations together unfortunately means that there are no ready recipes for identifying the ideal or even a reasonable mix of R & D investments. The issue is, nevertheless, significant, and deserving of more research to try to pin down useful guidelines for all concerned—national authorities, international agencies, and the donor community.

### **Impact Assessment**

People who muster the wherewithall to assess the impact of past investments in agricultural research face and, it is to be hoped, address many difficulties in measurement—not to mention grave conceptual problems. One is the 'counter-factual' question of what would have happened without the investment under consideration. Would other agents, perhaps in international agencies, have done the 'needful' sooner or later? Could the nation simply have borrowed what was technologically feasible from neighbours or other nations in somewhat similar ecologies? Could progressive farmers have come up with similar innovations themselves in a few years with a little luck? What contributions were made by private entrepreneurs and companies and what might they have been?

That some of these and the many other such questions cannot be answered very satisfactorily may explain the paucity of studies of the impact of agricultural research on developing countries. But there are several studies from which to draw. I will lean particularly on a 1984–85 impact study which, amongst many things, included reviews of earlier work. While the primary focus of this investigation was on the International Agricultural Research Centres (IARCs) of the Consultative Group on International Agricultural Research (CGIAR or CG for short)<sup>1</sup>, the perspective taken was that of the developing nations themselves and their own national research systems. The results are being published in various forms ranging from short summaries (CGIAR 1985a,b), to separate reports (Lipton with Longhurst 1985), to books short (Anderson et al. 1988) and long (Anderson et al. 1987 on microfiche). For brevity, only a few notes can be extracted here.

### **Impact of Agricultural Research**

Without question, the big 'achievement' of international agricultural research with its national

partners is the profound change in several nations, which is often simply referred to as the 'green revolution.' Agricultural research surely played a preeminent part in the change. The work was being done in several parts of the world, mostly in national programs with varying forms of assistance through effectively benevolent foundations, bilateral and multilateral arrangements, including the fledgling IARCs and, never to be overlooked, innovative farmers.

Disentangling just who did what, and the contributions from rice and wheat breeding and related research vis-à-vis the critical inputs from investments in irrigation and fertiliser is challenging indeed. Even more impossible is imputing shares among the many actors in the research systems noted above. The story understandably varies as it is told in New York, New Delhi, modern Mexico or modern China. There is, at any rate, probably little return to such analytical decomposition, especially in retrospective accounting. The key thing is that the green revolution did happen and we must ask how worthy it all was, and what lessons can be learned for the future.

### **The Green Revolution in a Nutshell**

From the Malthusian gloom of the early 1960s, the green revolution certainly provided the food to support, with increasing decency, the growing millions in Asia and some densely populated parts of Latin America. We found in our impact study, largely through the diligence of Dana Dalrymple (Dalrymple 1985), that more than half of the developing world's rice and wheat area is now sown to the semi-dwarf high-yielding varieties that are the flagbearers of the green revolution. I, for one, can-

not presume to judge whether the world is a better place as a result of this expansion in human carrying capacity but, if the value of a human life is even only a small positive quantity, the numbers involved are so huge that the 'revolution' is a monumental contemplation for all observers, especially those with our material advantages. The distributional aspects of the green revolution have received analytical attention from different ideological positions and, predictably, with quite varied conclusions. Some early observers perceived the green revolution to be very regressive, as larger scale farmers 'creamed off' the advantages of the new technology and demonstrably disadvantaged the later-adopting, usually smaller-scale, farmers. The fate of landless labourers tended to be played down in the early debates except when they concerned mechanisation.

As the 'revolution' proceeded, and the evidence accumulated, the overviews of most such observers changed in tone. For one thing, the adoption processes for technologies that, in most situations, are essentially neutral with respect to size-of-farm, steadily worked away. Thus in the major green-revolution-success areas, adoption of modern rice, wheat, and increasingly also other crops, is very similar across categories of farm size, and of farm ownership and tenure. For another, the linkages elsewhere have been increasingly recognised. The employment effects are an obvious concern and, while there have been technologically inspired substitutions of capital for unskilled labour in some situations, by and large, the green revolution has increased the demand for farm labourers of both sexes absolutely, on a per unit area basis, and sometimes also on the basis of the share of hired labour. Even more significant are the linkage effects, some of which Mellor (this volume) covers in his paper, whereby the fruits of new technology and research are captured, spent and multiplied around an economy and beyond, including increased demand for some agricultural imports from nations such as Australia.

In summary, the additional rice and wheat produced in the irrigated and well managed fields of the developing world has fed many more people, and fed them better, has led to real economic growth, although typically with little significant increase in income levels. Mass starvation has, by and large, been relegated to history or to those few political hotspots where nasty people choose to allow their subjects to suffer and die—but more on this later when I address poverty issues per se. Somewhat less dramatic progress has been made with most other crops, and also with rice and wheat in less favoured and nonirrigated regions. Major gains have, however, been made in particular places

<sup>1</sup> The IARCs supported by the CGIAR are: CIAT, Centro Internacional de Agricultura Tropical (International Center of Tropical Agriculture), Cali, Colombia; CIMMYT, Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center), Mexico City, Mexico; CIP, Centro Internacional de la Papa (International Potato Center), Lima, Peru; IBPGR, International Board for Plant Genetic Resources, Rome, Italy; ICARDA, International Center for Agricultural Research in the Dry Areas, Aleppo, Syria; ICRISAT, International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India; IFPRI, International Food Policy Research Institute, Washington, D.C., USA; IITA, International Institute of Tropical Agriculture, Ibadan, Nigeria; ILCA, International Livestock Center for Africa, Addis Ababa, Ethiopia; ILRAD, International Laboratory for Research on Animal Diseases, Nairobi, Kenya; IRRI, International Rice Research Institute, Manila, Philippines; ISNAR, International Service for National Agricultural Research, The Hague, Netherlands; WARDA, West Africa Rice Development Association, Monrovia, Liberia.

in maize, sorghum, pearl millet, beans and other grain legumes, and a few other food crops. Generally, rather less progress has been made on industrial and beverage crops (exceptions include Malaysia's successes with rubber and oil palm) and on livestock, reflecting variously the less research attention given them and their inherent difficulties for technological improvement.

As an aside, it should be noted that Australia can stand proudly by the record of its agricultural scientists who have worked in these research arenas, including those who have worked in the IARCs in various capacities. Others have had more of a domestic research orientation yet have identifiably assisted researchers, farmers and eventually consumers in developing countries, whether it be in the 'eucalyptisation' of the world, improved species of tropical legumes, better techniques for storing grains, or the thousands of other useful products of Australian research.

It must also be observed that the flow of products has not been all one way. The developing world has, in one way or another, supplied us with a diversity of germplasm ranging from tropical legumes to exotic trees. The IARCs have also helped us in a very direct and practical manner, such as in facilitating development of pigeonpea cropping in Queensland (International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the University of Queensland). Perhaps the largest 'single' benefit that Australia has received is genetic material used in our wheat breeding. The International Maize and Wheat Improvement Center (CIMMYT) is not our only external supplier of wheat genes, but it has been a major source of useful material. Today, notwithstanding the plight of our wheat industry, some 50% of our wheat area is grown to cultivars with some CIMMYT connection, and the gain attributable to the connection is conservatively worth some A\$150 million/year to Australia (Brennan 1986). This benefit certainly dwarfs our modest contribution to CIMMYT's operations and also overwhelms our total contribution to the financing of the IARCs of rather less than A\$10 million/year. Such an outcome confuses the notion of altruism in investment by industrial nations in international research, but Australia has probably been exceptionally fortunate in this regard. Ironically, given the recent parallels drawn between the economic destinies of our nations, the other major analogous non-primary-target beneficiary is Argentina!

To return to the overview of the green revolution, it was indeed the major 'event' in global agriculture of recent decades, and a persuasive demonstration of what can be achieved through agricultural research. There is, however, still a long way to go. Progress will not be fast but we must be prepared to assist in the research work that is so important in

making the world a better place for the inevitable billions of the next century.

### **Beyond Modern Cultivars**

It is all too simplistic to look at agricultural research, especially the internationally supported work, as the generation of new higher yielding ('modern') crop varieties. While this has been, and continues to be, a very important aspect, other research products may, in the long run, prove to be even more significant. One of these is the training of young scientists and technicians, especially from the developing nations. By 1984, the IARCs had given formal training in research methods and crop management to more than 14 000 people. These people, with their enhanced skills and productivity, are critical to future agricultural advancement in the Third World.

The two research products that are most difficult to address are policies and institutions. Within the CG system, two of the younger international centres have primary responsibilities for these products, but many others are also involved. The International Food Policy Research Institute (IFPRI) has, in its short life, been a major and widely appreciated source of independent research-based information on a diversity of issues surrounding such delicate matters as foodgrain pricing policies, food security interventions, and many other issues about which developing countries must make 'hard' decisions. It is arguable that the rewards from co-gent policy research are really huge and that the investment in it appallingly small. If the global community had a more informed view of the costly consequences of such things as (a) the agricultural protection and subsidisation policies in the First World, (b) the heavy-handed controls in the Second World, and (c) typically agricultural 'taxation' cum urban-biased cheap-food policies in the Third World (Peterson 1979; Byerlee and Sain 1986), then the world might not be simultaneously 'drowning' in surpluses generally yet suffering inadequate availabilities elsewhere. There are many actors in the field of policy research, including several other international agencies besides IFPRI and the World Bank (e.g. the International Institute for Applied Systems Analysis (IIASA), illustrated by the analyses of Parikh and Tims (1986)), many national agencies including, closer to home, both the Bureau of Agricultural Economics (BAE) and the Australian International Development Assistance Bureau (AIDAB), and a plethora of others (often based in universities) including, in the Australian context, the Australian Centre for International Agricultural Research (ACIAR).

The second rather different product that poses difficulties in measurement and attribution is the

facilitation of institutional development. Again, most of the IARCs have necessarily had some involvement in developing institutional capacity for research but, in the past decade, much of this role has fallen formally to the International Service for National Agricultural Research (ISNAR). If you believe in self determination for nations generally and developing economies in particular, you'll take no persuading that a national capacity for effectively conducting agricultural research is absolutely vital for what are essentially, at their present stage of development, agrarian nations. But institution-building is easier said than done, and there is still much to be done in this regard in the Third World, notwithstanding the noted achievements in the training of research personnel by the IARCs, and the universities in the industrial countries.

A case in point is Pakistan where the Constitution makes agriculture a provincial responsibility (i.e. in four exceedingly independent 'national states' that jealously guard their rights), while science and technology is a federal responsibility. To complicate matters further, agricultural education is ministerially differentiated from both these responsibilities, and results in the agricultural universities essentially not participating in research and development activities. This situation of ineffective institutional linkages is paralleled in many nations. While politically difficult to address, the impediments to progress must somehow be overcome with energy and urgency.

### Other Issues

The tenor of most of the foregoing may be a little more upbeat than I would wish, and it behooves me to mention some qualifications. Knowledge generation being an essentially uncertain phenomenon means that research is, indeed, a risky business and it is thus unsurprising that the research battlegrounds are littered with decaying corpses. Investors need to be understanding of this reality, while doing their best to minimise casualties and to maximise advance. Again, I find the Australian experience generally encouraging as I observe the track-record of our agencies concerned with the management of state, federal, and international agricultural research.

Many of the national agricultural research systems that must in due course do most of the work are profoundly weak, and can benefit greatly from effective external assistance. We know that multilateral assistance, especially through the CG Centres, is very effective in this regard. It is also remarkably effective in some possibly unexpected ways. There seems to be a significant 'research multiplier' effect at work whereby any given investment in research

on a major food crop in a developing nation by an IARC is, on average, more than matched by the nation itself from its own resources (Evenson 1987).

We have also seen that bilateral assistance, despite its often political orientation, can be effective, but comes up against a severe impediment in the form of a time-bound project orientation and its implicit discontinuities that augur poorly for the long-term institutional support that is necessary for agricultural research. I know that it is difficult for aid agencies to enter into long-run commitments while they must grapple with changing priorities and opportunities, and not always with expanding resources, but I fear that many significant gains are being sacrificed through a lack of sustained follow-up. My suggested generalisation is that, if a research and development project was worth doing as a phase-one effort, it is probably even more worthwhile as a long-term collaborative endeavour.

Let me indulge in a university-oriented illustration of what I could describe as aid/benevolence short-sightedness. Australia has supported many students from the developing world in a commendably generous and supportive manner. My own Department presently has about 60 such scholars. But, as they are eventually repatriated, the process officially comes to a halt. There may be some lingering contact through correspondence between teacher and student or occasional meetings at conferences. The university alumnus associations try to keep track of who's where but, due to a lack of resources, are not too impressive in their efficiency or effectiveness. I would like to see some resources deliberately devoted to sustaining contact between selected AIDAB awardees and their Australian university departments. A criterion in the selection would be the extent of the awardee's involvement in research, and the perceived complementarity of research interests on both sides. The resources could go in large measure to sponsoring travel for awardees back to their Australian university as visiting scholars, and for Australian academic staff to visit and collaboratively work in 'sister' institutions in which the awardees work. Clearly, the administration of all this would be awkward but the benefits, both politically and economically, are potentially great. The same arguments, of course, also apply to any form of aid, especially those with a human-capital building component (which is most of it), but the administrative problems of following up on projects that don't have the 'institutional memory' of universities must be daunting.

Let me note one final but important qualification before I attempt to conclude this brief survey. In spite of my enthusiasm for the social benefits that can derive from investments in agricultural research, I should stress the obvious point that it is by

no means a global panacea. Many serious social ills are virtually untouched by successful agricultural research and, insofar as they relate to the subject of this symposium, most of these are closely connected to absolute poverty. Household food insecurity is a classic ill that usually depends directly on an insufficiency of resources (including human capital) under the command of the household, or what Sen (1981) describes as inadequate 'entitlements.' Technological progress in agriculture is a very blunt instrument for addressing the nutritional and other deprivations associated with poverty, and clearly investments in and policies concerning many things beyond research are required for broad social advancement in the developing world, including the nutritional relief of the half-billion or so people who are seriously undernourished.

### Conclusion

The temptation to be complacent about world food supplies from the vista of surplus grain mountains is understandable, but must be resisted. Feeding the world in 2050 and beyond will require a continuing succession of productivity-enhancing changes that can only come through research, and all that goes with it. In conjunction with further investments in irrigation, agricultural chemical manufacturing capacity and other essential elements of modern agriculture infrastructure, research will continue to play its critical role.

As always, investors will need to be patient, especially because the 'easy' gains have already been made. Growing concerns for environment and sustainability problems in agriculture (e.g. Schuh 1987) mean that the research agenda must grow in scope, complexity and challenge. The more difficult and diverse environments where technological advance is so sorely needed imply even longer lags than the 'normal' 10 to 20 years that pass before significant impact can be realised from an accumulated investment in agricultural research. Australia has a compelling moral duty to apply its professional expertise and, rather than entertain cutbacks of the recent kind, to devote a larger share of its considerable (albeit declining) wealth to furthering the welfare of humanity through this proven means to progress in the developing world.

### References

- Anderson, J. R., Herdt, R. W., and Scobie, G. M. 1988. Science and Food: The CGIAR and Its Partners. World Bank, Washington, D.C. (in press).
- Anderson, J. R., Herdt, R. W., Scobie, G. M., Pray, C. E., and Jahnke, H. E. 1987. International Agricultural Research Centers: A Study of Achievements and Potential. Agricultural Economics Bulletin, Department of Agricultural Economics and Business Management, University of New England, Armidale, N.S.W. (on microfiche, in press).
- Brennan, J. P. 1986. Impact of wheat varieties from CIM-MYT on Australian wheat production. Agricultural Economics Bulletin 5, Department of Agriculture, New South Wales, Haymarket, 56 p.
- Byerlee, D. R., and Sain, G. 1986. Food pricing policy in developing countries: bias against agriculture or for urban consumers? American Journal of Agricultural Economics, 68(4), 961-9.
- CGIAR. 1985a. Summary of International Agricultural Research Centers: A Study of Achievements and Potential. CGIAR Secretariat, World Bank, Washington, D.C.
- 1985b. Annual Report—Consultative Group on International Agricultural Research, 1984. CGIAR Secretariat, World Bank, Washington, D.C.
- Dalrymple, D. G. 1985. The development and adoption of high-yielding varieties of wheat and rice in developing countries. American Journal of Agricultural Economics, 67(5), 1067-73.
- Evenson, R. E. 1987. The International Agricultural Research Centers: Their Impact on Spending for National Agricultural Research and Extension. CGIAR Study Paper Number 22, World Bank, Washington, D.C.
- Johnston, B. F., and Mellor, J. W. 1961. The role of agriculture in economic development. American Economic Review, 51(4), 566-93.
- Lipton, M., and Longhurst, R. 1985. Modern Varieties, International Agricultural Research, and the Poor. CGIAR Study Paper Number 2, World Bank, Washington, D.C.
- Mellor, J. W. 1985. Determinants of rural poverty: the dynamics of production, technology, and price. In Agricultural Change and Rural Poverty: Variations on a Theme by Dharm Narain (J. W. Mellor and G. M. Desai, ed.), Johns Hopkins University Press, Baltimore, 21-40.
- Parikh, K. S., and Tims, W. 1986. From Hunger Amidst Abundance to Abundance Without Hunger. Executive Report 13, International Institute for Applied Systems Analysis, Laxenburg, Austria.
- Peterson, W. L. 1979. International farm prices and the social cost of cheap food policies. American Journal of Agricultural Economics, 61(1), 12-21.
- Schuh, G. E. 1987. Some thoughts on economic development, sustainability and the environment. Proceedings of the Seventh Agriculture Sector Symposium, World Bank, Washington, D.C., January 8-9.
- Schultz, T. W. 1964. Transforming Traditional Agriculture. Yale University Press, New Haven.
- Sen, A. K. 1981. Poverty and Famines: An Essay on Entitlement and Deprivation. Clarendon Press, Oxford.
- Throsby, C. D. 1986. Agriculture in the economy: the evolution of economists' perceptions over three centuries. Review of Marketing and Agricultural Economics, 54(3), 5-48.

## Comment on J. R. Anderson Paper

F. G. Jarrett\*

LET me say at the outset that while a number of issues relating to the Anderson paper can be raised, finding acceptable answers to the problems flowing from such issues is no easy task. I accept the conventional wisdom amongst people concerned with development, especially agricultural development, that agricultural systems that are based on traditional knowledge stocks are unlikely to provide the surpluses which are required for economic development. The need to switch from such traditional systems to science-based systems is by now well established. The linkages between agricultural research and the flow of innovations which will lead to agricultural growth in the first instance—and economic growth consequentially—need no emphasis to the people attending this Symposium. Having said that, however, there are a number of policy issues—and this is after all a policy symposium—which can be raised in the context of the Anderson paper.

The paper starts with the proposition that agricultural research lacks a political constituency. While that proposition may be true for basic food crops, it is not necessarily true for a number of export crops. One has only to cite the funding of agricultural research by levies on growers for a number of export tree crops. These funds, which are often matched by a government contribution, suggest that with respect to the export tree crops such a constituency *does* exist. We have the examples of funded coffee research in Colombia and Kenya, cocoa research in Brazil, sugar in Mauritius, rubber and palm oil in Malaysia, and copra research in Papua New Guinea to suggest that the proposition may need to be qualified. In the context of the International Agricultural Research Centres, it is understandable that a constituency may not exist, primarily because the international centres are in the main concerned with the basic food crops, the exceptions being the two livestock centres and the International Food Policy Research Institute. The benefits of agricultural research in the basic food crops are often diffused widely amongst the community, and are not so obvious to the general public as is the case for exporters, so the basis for a political constituency is also diffuse.

There is still a policy issue relating to the quantum of resources to be devoted to agricultural research and the distribution of whatever resources are available over private and publicly funded research. One may also question the statement in the paper that the battles for agricultural research have been 'fought and seemingly won.' I believe that the battle is still on, and the fact that this Symposium is held in the Headquarters of CSIRO would lend weight to the proposition that the struggle for resources, particularly for agricultural research, is an ongoing one. That view is reinforced by a recent document from the Department of Industry, Technology and Commerce that seems to take a jaundiced view of the role of Australian agriculture. Amongst the many statements arguing for more resources for R&D in manufacturing is one which reads: 'the decline in world demand for Australia's traditional agriculture and mineral export commodities now seems likely to be medium- to long-term duration.' This policy statement hardly seems to square with the view that 'V-Day' has arrived for agricultural research.

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In the specific context of resources that originate in Australia and that are devoted to agricultural research, there is the problem of the allocation of public funds between agricultural research that is directed at Australian agricultural problems, and research that is directed at overseas agricultural problems, particularly in the developing countries. The concern manifests itself in a general view that if the budget for overseas agricultural research grows then it will often be at the expense of research aimed at solving Australia's problems. There is little doubt that although Australia benefits from research done overseas, which has application in Australian agriculture, it is also arguable that the feedback to Australian agriculture of research funded by Australian taxpayers, but directed at overseas agriculture, may be limited. The commodity mix is different and the location-specificity of much agricultural research, particularly on the biological side, might suggest that, if we were taking the view that public funds should be directed at increasing welfare in Australia, then preference should go to research projects which have relatively little spillover to overseas countries. Admittedly this is a partial view and Kym Anderson's paper at this Symposium takes a more general equilibrium view of the potential benefits in second round effects of the gains to Australia of funding research directed at overseas countries.

Once the quantum of resources has been decided on, and the publicly funded component of it is known, there are a number of consequential issues to be addressed. The first of these is the institutional format in which the research is to be conducted. The possible institutions are universities, departments of agriculture, separate research institutes at the national level, and research institutes established at the international level. I believe that the early success of CIMMYT and IRRI resulted in a proliferation of that institutional model without consideration of alternative models which might have been more appropriate in particular developing countries. For example, the French in their overseas agricultural research maintain a much more highly centralised research system with the laboratories based in France, rather than in the developing countries in francophone Africa.

The question of the size of the international agricultural research units is also a matter for debate. The notion of 'minimal critical mass' was used as a basis for arguing that the developing countries could not mount such a critical mass. Measurement of the mass was often very difficult but it was often argued that one had to have an international centre to mount the necessary critical mass. The early achievements of both IRRI and CIMMYT, in the Green Revolution context, were obtained with relatively small core budgets, primarily because the results from the research centres were pervasive in nature. In particular, the lack of sensitivity to day-length meant that the new varieties of wheat could slot into an environmental niche in many countries of the world. As the international centres became subject to pressures to improve on the results they had already achieved—pressures which mounted as the donors wanted more results—the centres engaged in an outreach program. While this undoubtedly helped strengthen many weak national agricultural systems in the developing countries, the size of the budget increased materially.

The decision where to locate a centre is also an interesting issue and in a sense depends on the scientific charter of the international centre. The decision to locate ICRISAT in India with the commodity orientation directed to chickpeas, pigeon peas, sorghum, millet and groundnuts, has meant that India will be the major early beneficiary of any innovations which originate from the centre. Since there is substantial evidence that new innovations are first adopted in the areas immediately around the centre, and since India has some 90% of chickpea production and some 35% of sorghum production in the semi-arid tropics, then both the location and the commodity mix will benefit Indian agriculture in the first instance. There is a question at what stage should the host countries take more of the burden to free up resources for other even poorer areas. However one cannot avoid the comment that scientific institutions once created have a long half-life and go on and on and on.

The international centres' budgets can be broken down into research, extension and training and one question that must arise is the proportion of that budget

devoted to training of scientists for national research institutes. Some years ago I looked at the nationality of fellowship holders in CIMMYT and IRRI and concluded that the majority of such fellows tended to come from the developed countries themselves. Therefore one might well have said so far as Australian scientists are concerned that Australia was doing well by doing good.

I was delighted to see the reference to location-specificity in Anderson's paper, a specificity which arises both from agroclimatic factors and from socioeconomic factors. I have for a number of years argued that such location-specificity, particularly for biological innovations, means that there will have to be a strengthening of the national agricultural systems and more adaptive work in the recipient countries of innovations originating from the centres. However, location-specificity does have implications for research priorities at the international agricultural research centres. Does it mean, for instance, that the international centres should move more towards the basic science end of the research spectrum where new knowledge may have a potentially pervasive influence on agricultural innovations, rather than concentrating on farming systems, which tend to be location-specific.

The last comment that I have to make is in the context of what appears to be the simple goal of increasing food production, a goal which the author emphasises in his treatment of the Green Revolution as the crown jewel of the international agricultural research centres. I am convinced that many donors to the international centres regard increased food production as a non-contentious objective and that any aid for scientific research directed at such an objective is an apolitical activity. Sen\*, for instance, has argued that the study of famines is a more complex issue than simply the non-availability of food. So far as scientific truths are concerned, while they may be apolitical at source, their application in the agricultural science field is to alter the mix of inputs, to change the mix of outputs, to alter competitive relationships between countries (rice importers become rice exporters), to affect the balance of payments and to alter the level and structure of domestic economic activity. Moreover, they often have the consequences of altering personal relationships between landlords, tenants, landless agricultural labourers and the relative returns to men versus women. Such perturbations arising from the application of scientific principles to agricultural innovations hardly seem to merit the adjective apolitical.

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\* Sen, A. K. 1981. *Poverty and Famines: an Essay on Entitlement and Deprivation*. Clarendon Press, Oxford.



Julie Delforce, ACIAR project member, working in Tonga, discusses the Smallholder Farming Systems Research Project with a field officer. This project aims to improve the productivity and incomes of smallholders in the South Pacific.



## Links Between Technology, Agricultural Development, Economic Growth and Trade Creation

John W. Mellor\*

### Abstract

This paper presents the argument that, for the most part, the recent successes in development in the Third World are a consequence of growth in the agricultural sector and that, to build on those successes, it is necessary to further promote growth through increased investment in agricultural technology. It is argued that technological change, and the agricultural research systems that lie behind it, increases the income of farmers and, consequently, their demand for labour-intensive, nonagricultural commodities. The poor, who spend a large part of incremental income on food, respond to the resulting increase in their employment and purchasing power by increasing their demand for food. The link between employment and food demand is shown to cause a significant increase in the demand for food imports in developing countries. This increase in imports from greater employment of the poor highlights the mutual benefits of agricultural growth in the Third World to both developing countries and developed countries which export basic food staples.

### Introduction

THE dramatic turnaround in many countries from food deficits in the 1970s to food surpluses in the 1980s is evidence of the tremendous success in world agriculture in recent years. Global cereal stocks in the mid-1980s are now almost twice as large as in the mid-1970s. In 1985, real world cereal prices were down 30% from 1981, compared to an almost twofold increase between 1972 and 1974. At no time have the prospects for feeding the world's poor been so encouraging.

In recent years, there have been many successes in agriculture in developing countries as well. During the period 1961 to 1983, developing country production of major food crops grew at an average annual rate of 2.7% and consumption at an even faster rate of 3%, compared to a population growth rate of 2.5%.

Yet, in spite of those successes, in spite of the abundance of food in the world, many countries in Africa, Asia and Latin America still face food deficits, not surpluses. More to the point, hunger and malnutrition continue to affect the lives of from one-half to one billion people in the Third World.

Given the abundance of food in some areas, particularly the developed countries, it might be tempting to suggest food trade alone as an answer to the world's continuing food problems. Shipping food from more developed surplus countries to still developing, deficit countries might seem to represent the easiest solution to the world's food problem.

However, the world food problem is not merely a physical distribution problem. More importantly, it is a problem of the distinct lack of purchasing power among the poor in many Third World countries. The poor in Africa, Asia and Latin America now lack the means to buy more food at any price. Redistribution of global food supplies through trade is, thus, an incomplete solution to the world food problem. Food trade between the developed and developing countries must be coupled with ef-

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forts to raise the purchasing power of low-income people throughout the Third World.

This paper explores the links between poverty, agricultural development and commercial trade between developing and developed countries. Two interrelated themes will be discussed. The first is that in low-income countries, development, agriculture and research are inextricably intertwined. The second is that it is in the best interests of developed countries that are major exporters of agricultural commodities to form a partnership with low-income countries to promote the latter's agricultural development.

### Toward a Successful Development Strategy

Any successful development strategy in the Third World should seek to increase the purchasing power of the poor. Necessary to this task is to create employment opportunities for the poor. In the past, two basic strategies have been put forward: (1) a capital-intensive strategy promoting rapid industrialisation as the source of overall growth; and (2) an agricultural-oriented strategy which stresses growth in rural, labour-intensive sectors as the primary engine of overall economic growth.

In general, capital-intensive strategies of development, exemplified by India's Second Five-Year Plan, do not lead to significant increases in employment. Instead, these strategies concentrate resources in large-scale industries, such as steel and heavy machinery, that are intended, but in practice fail, to maximise capital formation and economic growth. Capital-intensive strategies try to minimise employment in the short run to prevent increased consumption of wage (consumer) goods and the consequent diversion of resources away from high-growth capital goods production. Increases in employment are seen only as long-run consequences of the massive growth in capital. Because the supply of capital goods is believed to be the principal constraint to development, little need is seen for increasing agricultural production.

However, as employment grows and the purchasing power of the poor increases, they tend to spend a substantial part of that increased income on food. Elasticities of expenditure on food run as high as 0.62 to 1.06 for the poor in developing countries (Table 1). This increased demand from growth in employment of the poor requires greater supplies of food. If the role of food is neglected in the development process, increased prices will effectively reduce the real incomes of the poor and increase the real cost of labour. The supply of food is, therefore, a critical constraint to sustained growth in employment.

An agricultural strategy of development, on the other hand, promotes employment and increases

**Table 1** Food expenditure elasticities for low-income\* families (source, Alderman 1986).

Country/Region	Urban	Rural
Sri Lanka	0.72	0.86
Thailand	0.62	0.65
Egypt	0.71	0.68
Sudan	0.74	0.84
Indonesia	0.88	0.98
Nigeria		
Funtua	n.a.	0.89
Gusau	n.a.	1.04
Malaysia		
Muda	n.a.	0.88
Brazil	0.83	0.83
Bangladesh	1.06	1.06

\* Low income is defined as the average income of families that consume 1750–2000 calories per capita per day.

the purchasing power of the poor through an emphasis on the production of labour-intensive wage goods, particularly food. Such a development strategy emphasises the widespread dissemination of yield-increasing technological change in agriculture. The sheer size of the agricultural sector in most developing countries, accounting for 40–80% of employment, ensures that technical change in that sector will have important macroeconomic implications. Increased agricultural production boosts domestic food supplies at the same time that it stimulates further rounds of employment growth in the service and urban sectors of the economy. Because of its output and employment linkage effects with the rest of the economy, agricultural growth helps raise access to food supplies for both the urban and rural poor.

### Impact of Technological Change

To grossly oversimplify a complex issue, the proper stimulus to increased agricultural production is improved agricultural technology which results in increasing factor productivity. These productivity gains provide a combination of increased profits to landowners, increased demand for labour and consumer benefits from lower prices. Growth of this kind produces a net increase in national income that serves as an important engine for driving the rest of the economy.

Higher prices, on the other hand, produce growth with decreasing factor productivity (due to classic diminishing returns), resulting in less and less output for additional levels of inputs. Of course, prices must be at profitable levels for the technology to be applied, and if governments have dictated prices downward they may well need to

reconsider such practices if technological change is to be fully effective.

In fact, in the past two decades higher crop yields from improved technology have become the main source of food production growth in the developing world. Between 1961 and 1980 output per hectare of major food crops in the developing world rose by 1.9% annually and accounted for more than 70% of total food production growth. Increases in harvested area, which averaged only 0.7% a year, contributed the other 30% of total production growth in the Third World (Paulino 1986).

The direct effect of technological change in agriculture is an increase in the incomes of landowning farmers. These farmers typically spend a large proportion of their new incomes on locally produced, nonagricultural goods and services such as textile products, transportation and health services, and housing. Production of these goods tends to be far more labour-intensive than in large-scale industry. As a result of the increased incomes of landowning farmers, the rural poor are provided with a wide range of new, nonagricultural employment opportunities.

The more far-reaching implications of increased agricultural production are the results of increased employment of the poor. Greater employment provides greater income, and effectively increases the poor's purchasing power, providing access to more food. The resulting increased demand for food and other nonagricultural goods provides strong, indirect multiplier effects which stimulate new rounds of growth in the economy as a whole. Inexpensive food from increased production helps keep labour costs down and, thus, encourages employment growth in the urban sectors of the economy. The result is a general increase in domestic demand for labour-intensive consumer goods.

Another favourable result of agricultural growth is the increase in foreign exchange earnings obtained both through increased production of exportable agricultural commodities and the growth in those labour-intensive industries in which developing countries possess a comparative advantage. Taiwan is a good example of a country which used an agricultural-oriented strategy of development to create small-scale manufacturing and industrial enterprises that could compete on the world market.

Of course, necessary to this process of agricultural development is the concurrent development of rural infrastructure. In many developing countries new rural roads, drainage systems and delivery systems are sorely needed. It is essential to provide farmers with access to irrigation and other inputs necessary for use with new technology and to provide them with access to markets for their increased output.

## Food Imports and Stages of Development

The initial stages of development are marked by extreme poverty, high death rates and, therefore, low rates of population growth. The effective demand for food at these levels of income and population grows slowly, at a rate that can be met with more effort on a slightly expanded land base.

Later, as development occurs, the population growth rate increases and, more importantly, income begins to grow rapidly. These two forces, combined with the poor's high elasticity of expenditure on food, can produce a rate of increase in effective demand for food that far exceeds all but the most rapid rates of food production growth.

Many countries in a high-growth, medium-income stage of development, therefore, find it necessary to rely on food imports to meet a portion of their surging food demand. A close look at Figure 1 shows that increasing per capita income is the dynamic factor underlying the surge in food imports in the Third World. Between 1966 and

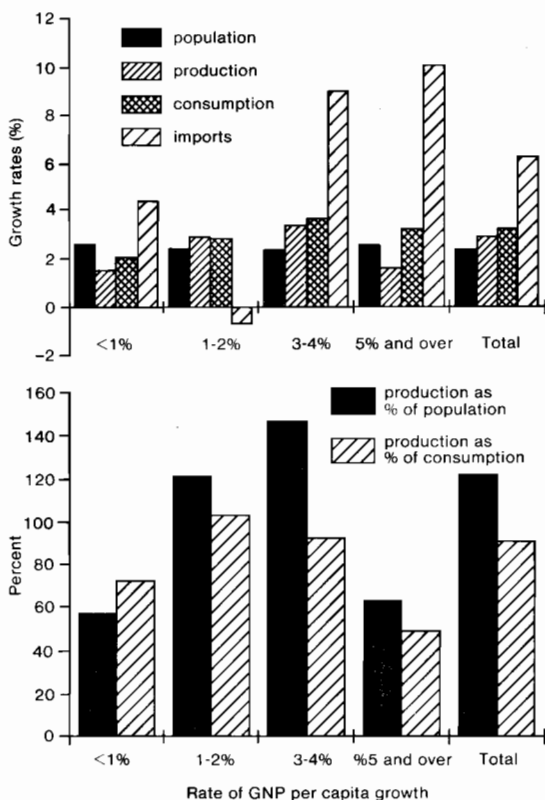


Fig. 1. Growth rates of population, staple food production, consumption and imports in developing countries, 1966-80 (adapted from Mellor and Adams (1986) and Paulino (1986)).

1980, in the fastest-growing countries (over 5% annual increase in GNP per capita), the rate of food consumption growth was over twice the rate of food production growth. Food imports increased at a 10% rate of annual growth for these countries. This is in part due to the inclusion of a number of oil-exporting countries in this fast-growth category. For all developing countries, however, across all levels of GNP growth, food imports still grew at an annual rate of 6.3%, while consumption grew at only 3%.

Even those countries with a high rate of technical progress in agriculture might not be able to meet their rates of growth in food demand. For example, the 24 countries with the fastest growth rates in basic food staples production between the periods 1961-65 and 1979-83 collectively increased their net imports of food staples by 419%, or by 9.6% annually. This level of increase of imports was necessary

despite a 4.3% average annual growth rate of production of food staples (Table 2).

Finally, in the later stages of development, population growth rates decline and growth in income begins to have little effect on the demand for food. Meeting food demand becomes more manageable as food production growth rates become institutionalised at high levels. At this stage, food imports become unnecessary and agricultural surpluses begin to accrue.

### Impact of Livestock Production on Imports

As income rises in developing countries, the relative character of food demand changes. Rising income causes food demand to shift to the more preferred cereals and to highly income-elastic livestock products. The latter, in particular, become

**Table 2** Net imports of food staples in 24 countries with rapid growth in food staple production (source, FAO Production Data, 1961-1983).

	Net food staple imports (000 t)		Annual growth rate (%)	
	1961-65	1979-83	Net imports <sup>a</sup>	Production <sup>b</sup>
Colombia	161 728	681 091	8.3	4.2
Costa Rica	-4 422	-53 892	14.9	4.5
Cuba	947 768	2 079 589	4.5	4.0
El Salvador	92 146	179 499	3.8	4.1
Guatemala	54 837	95 041	3.1	3.3
Indonesia	871 641	1 759 489	4	3.8
Iran	243 639	3 332 452	15.6	4.0
Ivory Coast	54 638	487 363	12.9	3.4
Korea, Dem PR	153 851	215 360	1.9	4.3
Libya	117 219	731 082	10.7	4.2
Mexico	-374 846	5 986 181	—	3.8
Mongolia	-20 195	95 577	—	3.4
Pakistan	750 483	-342 655	—	4.6
Paraguay	69 145	58 366	-0.9	4.7
Philippines	656 305	934 539	2	4.7
Rwanda	-49	20 702	—	4.2
Sri Lanka	787 420	622 612	-1.3	4.6
Sudan	-232 128	-235 756	0.1	3.5
Surinam	-3 621	-60 525	16.9	6.4
Syria	-326 635	559 880	—	3.3
Tanzania	16 408	182 457	14.3	4.7
Thailand	-2 808 116	-10 680 672	7.7	4.3
Venezuela	589 144	2 629 198	8.7	3.3
Zimbabwe	-57 544	-247 743	8.4	3.3
Total	1 738 816	9 029 235	9.6	4.3

<sup>a</sup> Calculations based on mid-points of indicated periods.

<sup>b</sup> Trend growth from regression of the natural logarithm of the annual production values.

Note: Rapid growth countries are defined as those with greater than 3.25% growth in food production from 1961 to 1983. Excluded are China, because of biases in data in the early 1960s, and those countries with an average food production of less than 100 000 t/year from 1979 to 1983. Although there may be questions regarding the quality of national statistics in these countries, especially those in Africa, the trends reflected by their aggregate annual data on production and trade clearly indicate that net food imports of the group have increased much faster than food production.

increasingly important in consumption patterns. Evidence of this fact is the rapidly increasing rate of Third World meat consumption: between 1961-65 and 1973-77 meat consumption in the Third World grew at an average annual rate of 3.4%. As a result, developing countries have been rapidly expanding their imports of livestock products. Between 1961-65 and 1973-79, imports of meat products to developing countries have increased by 79% (Sarma and Yeung 1985).

However, since livestock is a labour-intensive enterprise, it is generally desirable for developing countries to displace these meat imports with domestic production. Accelerated growth of domestic livestock production would, in turn, stimulate the demand for food staples as feed for livestock. In many high-growth, medium-income developing countries, growing demand for livestock feed serves to accelerate the already high demand for cereals.

### Projections

Simple trend projections to the year 2000 of basic food staples imports, including livestock feed, show incremental net imports reaching approximately 40 million t. If adjustments are made for increasing feed to livestock ratios from present levels, which are almost certain to occur, these projections could well increase by another 40 million t (Paulino 1986).

The developing countries are not likely to overcome their dependence on food imports for some time. A rough guess would place the necessary level of per capita income near \$3000 before demand for imports would fall off. The phase of very rapid growth in import demand from developing countries could last for about 40-50 years. While exports from some developing countries, most notably Argentina and Thailand, have increased in recent years, their share in the overall export market is quite small and will continue to be so. Therefore, the bulk of increased food imports to developing countries will have to come from the developed countries.

### Policy Implications

These increased imports mark the unity of interest between food exporters and those developing countries. On the one hand, food exporters are anxious to sell their products on the world market. On the other hand, the developing countries represent the only remaining growth market in the world for basic food staple exports. To ensure continued growth in that market, it is in the interest of the developed countries to nurture agricultural growth in developing countries. To do so, the following steps should be taken:

(1) Increase the purchasing power of the poor through growth in agricultural production brought on by technical change. This can be accomplished only through increased investment in agricultural research and extension in the developing world.

(2) Avoid investment in large-scale capital-intensive enterprises that drain agriculture and employment-intensive, nonagricultural industries of the little capital they need to increase employment. Capital-intensive intermediate goods such as fertilizer and steel and heavy machinery create little domestic employment and can be imported.

(3) Increase investment in rural infrastructure concurrently with increased investment in agricultural research. In many cases, food aid from developed countries will be necessary to undertake these efforts since the employment generated from public works programs on rural infrastructure increases short-term demand for food.

(4) Promote labour-intensive livestock production in developing countries. The potential increase in employment in this sector is extremely high. Again, increased production of livestock in developing countries contributes substantially to those countries' increased imports of basic food staples.

(5) Promote open markets for imports of grain and exports of labour-intensive industries in which developing countries have a comparative advantage.

### Conclusion

Continued success in development requires an active partnership between the developing and the developed world. On the part of developing countries, the first priority is to recognise that increased employment and increased demand for food go hand in hand. An agricultural-oriented strategy of development is the best way to confront that fact. On the part of the developed countries, there must be a commitment to make available the technical and financial resources necessary to insure the success of an agricultural strategy of development. The result of such success could guarantee an adequate level of food for all the world's poor.

### Acknowledgment

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### References

- Alderman, Harold. 1986. The Effect of Food Price and Income Changes on the Acquisition of Food by Low-Income Households. Washington, D.C.: International Food Policy Research Institute.

Mellor, J. W., and Adams, R. H. 1986. The New Political Economy of Food and Agricultural Development. *Food Policy*, 289-97.

Paulino, L. 1986. Food in the Third World: Past Trends and Projections to 2000. Research Report 52. Washington, D.C. International Food Policy Research Institute.

Sarma, J. S., and Yeung, P. 1985. Livestock Products in the Third World: Past Trends and Projections to 1990 and 2000. Research Report 49. Washington, D.C. International Food Policy Research Institute.

## Comment on J. W. Mellor Paper

Heinz W. Arndt\*

THIS paper admirably highlights the three propositions that form the core agenda of this seminar:

(1) Agricultural research can make a major contribution to growth of farm output and income in developing countries;

(2) Growth of food output in developing countries does not necessarily reduce food imports because in the earlier stages of development both the share of agriculture in GDP and the income elasticity of demand for food are high; and

(3) Therefore, concern among farmers in food-exporting countries, such as Australia, about agricultural research aid as a potential threat to their overseas markets is misplaced.

One can only applaud Mellor's authoritative and forceful statement of these three propositions. The fears he seeks to allay are one form of protectionist zero-sum-game thinking which it is the job of economists to counter.

There are, however, two aspects of Mellor's argumentation which I do not find entirely convincing.

The first relates to the evidence he advances for the broad proposition that rapid growth of food production in developing countries has in the last two decades increased rather than reduced their food imports. The statistical evidence is summarised in his Table 2. It purports to show relatively high growth rates of food imports for countries which, over the period 1961-83, have recorded the highest rates of growth of food production.

The data appear to confirm the correlation mainly for three categories of countries: (a) oil exporters (Iran, Libya, Mexico, Venezuela) which were able to use petrodollars to stimulate both food production and food imports; (b) 'basic-needs' oriented economies (Cuba, Mongolia, Tanzania) which become less self-sufficient in food while (if the data can be accepted as reliable) achieving relatively high rates of growth of food production; and (c) some small Latin American countries (Colombia, El Salvador, Guatemala).

Against this, there is weighty contrary evidence: (a) some of the largest food-deficit countries of the Third World have, thanks to the Green Revolution, achieved virtual self-sufficiency in food; India (not shown because it does not rank as a fast-growth food producer), Indonesia and the Philippines (which over the years shown appears to have experienced increased food imports but which has in fact become, on balance, self-sufficient), net importers in some years, net exporters in others; (b) the

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USSR and some other Comecon countries (not shown) whose increased dependence on food imports largely reflects poor agricultural performance; and (c) some countries (Thailand, Zimbabwe, Costa Rica) whose apparent high rate of growth of net food imports in fact records rapid growth of net food exports (negative net imports).

It would be foolish to use the table as evidence against John Mellor's broad case. He is clearly right in pointing out that agricultural growth does not necessarily reduce food imports. But neither does it necessarily increase them. Much depends on what is happening to growth in other sectors of the economy, to income distribution and to the commodity structure of agricultural production and trade.

This leads me straight to my second point, the relevance of Mellor's demonstration of probable growth of developing country demand for food to the world market prospects facing Australia's rural industries; for this relevance depends very much on the commodity patterns of Australian production and developing country demand.

Insofar as Mellor's argument refers to monsoon Asia, and increased developing country demand for food imports of rice, it is largely irrelevant to Australia which cannot significantly increase rice production (without causing severe salination problems in irrigation areas). Developing country demand for wheat and sugar could be more beneficial to Australia, but for neither commodity are developing countries the main importers, and for both world markets seem likely to be depressed by surpluses for some time to come.

Mellor emphasises the high income elasticity of demand in middle-income developing countries for protein foods, such as meat and dairy products, and urges them to meet this growing demand by expanding domestic livestock production which has the advantage of being highly labour-intensive, thus shifting import demand from outputs (meat, dairy products) to inputs (feedstuffs, especially cereals). Such a prescription, if it were followed (which does not in fact seem very likely in Southeast Asia where efforts to expand livestock production have not so far been very successful) would be a lot more encouraging to the USA with its huge potential for additional cereals production, than for Australia which has tended to think of growing East Asian demand for protein food as one of the most promising potential growth markets. It is also worth mentioning that the Australian industry in which fears of strengthening potential competition in export markets through export of technology, or aid in research, have been most strongly voiced is the wool industry, rather than any of the food-producing industries. But Mellor's argument, of course, applies as well to wool.

Let me conclude by repeating that these somewhat niggling comments are in no way intended to weaken John Mellor's case, with which I entirely agree.



A healthy stand of 7-year-old *Casuarina junghuhniana* near Bangkok, Thailand, is part of an ACIAR-funded forestry project. This research has led to significant productivity gains which in turn enhance the incomes of farmers.



## Is Agricultural Growth in Developing Countries in Australia's Interest?

Kym Anderson\*

### Abstract

The commonly held view that agricultural-exporting developed countries such as Australia would lose from agricultural growth in less-developed countries (LDCs) is shown to be based on an incomplete argument. It considers only the effects on LDC agricultural supply, or at best only that and the first-round effects of increased farmer incomes on the demand for tradables. What also needs to be considered is the effect on the demand for nontradables and hence the second-round effects of increased spending by producers of nontradables. When all these effects are considered, the positive correlations obtained between agricultural output growth in LDCs and agricultural imports from developed countries is not surprising. It is then shown that selling or giving away agricultural research and management skills to developing countries can be beneficial to Australia even from a narrow economic perspective.

SINCE the 1960s developing countries have provided the fastest-growing markets for Australia's farm exports. It is therefore understandable that farmers in Australia are concerned, at this time of extraordinarily low export prices, about rapid agricultural growth in developing countries. They see this as reducing developing countries' imports or expanding their exports of food and fibre, thereby lowering Australia's export earnings. Indeed farmers may well feel that part of the *reason* for the currently depressed prices in international food markets is the success of scientists in boosting crop yields in the tropics. As a result, they and others are questioning the wisdom of selling—or, worse still, of giving away in the form of foreign aid via the Australian International Development Assistance Bureau (AIDAB) and the Australian Centre for International Agricultural Research (ACIAR)—Australia's agricultural research and management skills, genetic material from livestock studs, and similar perceived sources of Australia's agricultural comparative advantage.

My task is to address the question of whether this

conventional view—that agricultural growth in developing countries is against Australia's economic interests—is a reasonable one. It turns out *not* to be supported by empirical evidence; in fact there appears to be a strong *positive* correlation between agricultural growth in developing countries and their imports from Australia. The reason has to do with some important demand considerations that are omitted from the conventional argument which focuses only on agricultural supply in developing countries. When these are taken into account, it becomes easier to see why it may well be in Australia's interest to promote agricultural growth in developing countries (see Anderson (1987) for more details).

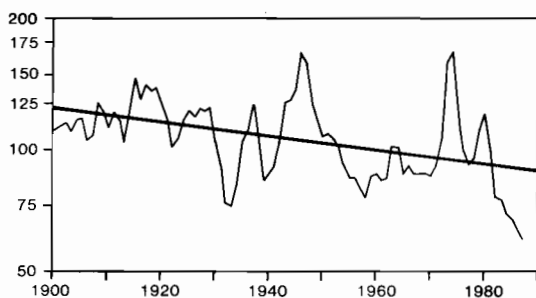
### Is There Empirical Support for the Conventional View?

The common presumption is that if food output expands in a developing country then that country will reduce its imports or expand its exports of food. If the country is a large participant in world food markets, or if this happens in enough developing countries, then international food prices will fall. For both reasons—reduced net imports and a possible fall in the international price—countries

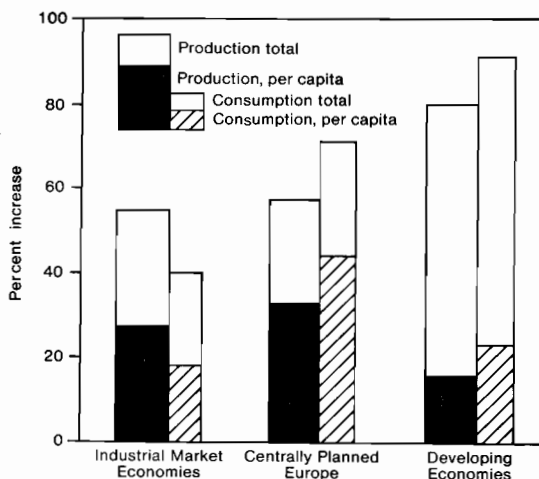
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like Australia could expect to reduce their export earnings, so the argument goes.

There is some concern among our farmers that part of the reason real international food prices are at extraordinarily low levels at present (see Fig. 1) is that developing countries have been so successful in



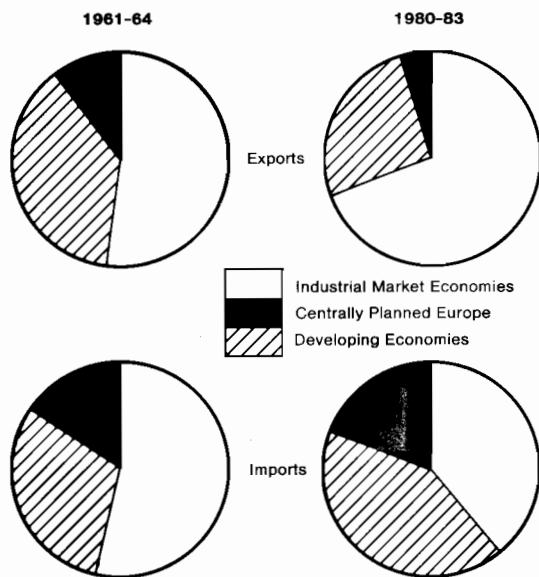
**Fig. 1.** Real international food prices for Australian exports, 1900 to 1987. (An index of export prices in US dollars for cereals, meats, dairy products and sugar, deflated by the US producer price index, with weights based on the importance of each commodity in Australian production in 1977-79. The 1987 value is based on World Bank projections.) (1977-79 = 100). Source: Compiled by the author using price series from the World Bank's Economic Analysis and Projections Department.



**Fig. 2.** Increase in world food production and consumption, total and per capita, 1961-64 to 1980-83. (The percentage by which production (consumption) in 1980-83 exceeded production (consumption) in 1961-64 of grains, meat, milk products and sugar, each valued at their average price in international markets in 1980-82. Source: Tyers and Anderson (forthcoming).

expanding their food output. And there is some basis for that concern: large countries such as China, India and Indonesia have been very successful in raising their production of staple foods, and developing countries as a group have expanded their total food output since the 1960s at a pace 50% faster than that of industrial countries.

However, in developing economies the *demand* for food has grown even more rapidly than the supply. In fact, food consumption has grown at more than twice the pace of food consumption in industrial market economies (Fig. 2), because of faster population growth and faster growth in per capita income (Table 1). As a result, food self-sufficiency has declined in developing economies whereas it has increased in industrial market economies. As Fig. 3 shows, industrial market economies in the early 1960s accounted for a little over half of world food imports and half of world food exports (excluding edible oils and beverages). By the early 1980s, however, they accounted for only one-third of food imports and contributed 70% of food exports. In other words, these high-income countries switched from being slight net importers to massive net exporters of food during those two decades, while the opposite happened for developing countries.



**Fig. 3.** The distribution of world food trade, 1961-64 to 1980-83. (Grains, meats, milk products and sugar trade, measured in US dollars.) Source: Tyers and Anderson (forthcoming).

**Table 1.** Growth in food production, consumption, population and income per capita, 1961-64 to 1980-83 (per cent per year) (Source: Tyers and Anderson forthcoming)

	Food production		Food consumption <sup>a</sup>		Population	Real income per capita
	Grains	Meat and milk products	Total	Per capita		
Developing economies	3.3	2.5	3.5	1.1	2.3	3.7
Centrally planned Europe	2.1	2.9	2.9	1.9	0.9	3.0
Industrial market economies	2.6	1.6	1.8	1.0	0.8	2.8

<sup>a</sup> Grains, meat, milk products and sugar.

Clearly, rapid food production in developing countries *as a group* has been accompanied by rapid increases in that group's food imports. But is this pattern of food demand growth outpacing supply growth simply a response to the decline in international food prices shown in Fig. 1 (a decline caused in large part by protection growth in industrial countries which has generated large surpluses that have been dumped on the international market)? A more stringent test of whether agricultural growth in developing countries is in the economic interests of countries like Australia is to use the data of *individual* developing countries, and examine the correlation between real growth in agricultural value added per capita or per farm worker and real growth in per capita imports from developed countries. Data for such tests have been compiled, for at least 53 developing countries with populations in excess of 1 million, for the period 1970-84, as detailed in the footnotes to Table 2.

From the first set of rows in Table 2 it is evident that agricultural output or productivity growth in developing countries is *not* negatively correlated with those countries' growth in imports from developed countries. On the contrary, the correlations are positive and in some cases statistically significant (with 53 observations, the coefficients are significant at the 5% level if they exceed .27).

While causation cannot be inferred from these positive correlations, these data are certainly not supportive of the conventional argument. That is, agricultural growth in developing countries may well be consistent with Australia's economic interest, in that our exports are growing more rapidly with developing countries with faster rates of agricultural expansion. In addition, there is the possibility that faster agricultural growth has also benefited Australia in the form of lower-priced imports of tropical products such as edible oils and beverages, as well as in the form of any new technologies that may be transferable to Australian agriculture (evidence of which is provided in J. R. Anderson's paper in this report).

**Table 2.** Coefficients of correlation between developing countries' per capita growth rates in agricultural output and imports from developed countries, 1970 to 1984.<sup>a</sup>

	Growth in real per capita imports from:		
	All developed countries	United States	Australia
Growth in real agricultural GDP <sup>b</sup> :			
(a) <b>Total imports</b>			
Per capita	.33	.28	.23
Per farm worker <sup>c</sup>	.22	.24	.09
(b) <b>Agricultural imports<sup>d</sup></b>			
Per capita	.07	.07	.09
Per farm worker <sup>c</sup>	.08	.10	.01

(a) Growth between 1970-72 and 1982-84. The 1982-84 import values are deflated to 1970-72 dollars using the United Nations' index of the unit value of total imports by developing countries and the FAO's index of the unit value of agricultural imports by developing countries.

(b) Available from the World Bank source only for the period 1973 to 1984.

(c) The number of people engaged in agricultural work is obtained from the FAO's Production Yearbook.

(d) Agricultural imports are classified as sections 0,1,2 (excluding 27, 28) and 4 of the Standard International Trade Classification (SITC).

Sources for data: World Bank, World Development Report 1986, Washington, D.C.; Food and Agriculture Organisation, Production Yearbook and Trade Yearbook, Rome, various issues; and the trade data files of the International Economic Data Bank, Australian National University, Canberra (based on United Nations data).

Farmers in Australia, however, are concerned not about our *total* exports to developing countries but simply our *agricultural* exports. Yet even when one's perspective is narrowed to the sectoral interest, as distinct from the national economic interest, the conventional view is found wanting. As the second set of rows in Table 2 shows, the correlations are positive even between agricultural growth in developing countries and *agricultural* imports from

developed countries, including from Australia. And the correlations are positive even using agricultural imports net of each developing country's agricultural exports (not reported in Table 2).

In short, the conventional view that agricultural growth in developing countries is against Australia's economic interest is not supported by empirical evidence. This raises the question: what is omitted from the conventional argument presented earlier that provided the opposite view?

### **Omissions in the Conventional Argument**

The key reason the commonly held view is not supported by the facts is that it is based on an argument that focuses only on developing country supply conditions. That argument omits a number of demand considerations that are especially important in economies where the majority of resources are employed directly or indirectly in agriculture.

When farmers adopt a new technology, their incomes increase. Presumably they will spend that extra income. Part of the increase is spent on extra farm inputs, and the rest is available to spend on consumer items or to invest. Thus the demand for food, for other internationally traded products and for nontradable goods and services will increase (both intermediate and final consumer products). In the case of tradable products other than the ones whose production technology has changed (suppose the latter is staple food), the increased domestic demand is accommodated by a reduction in the country's exports or an increase in its imports of those products, with no change in their domestic production (assuming the producer prices for such products, which are related to international prices, do not change). That is, while the new technology expands the supply of staple food it also has the following two effects on traded goods: (a) it expands the domestic demand for food, which weakens the negative effect of the developing country's net imports of staple food due to the supply expansion; and (b) it expands the domestic demand for and hence net imports of other traded products, which may include other agricultural products exported by Australia.

If all products were internationally tradable, this would be the end of the story: the expenditure increase associated with the two demand shifts could not be more than the increase in farm income due to the new technology, and so the developing country's net imports at given international prices would not be greater than before. This would suggest that the positive correlations in Table 2 are

spurious. They may, for example, simply reflect that countries with rapid agricultural growth happen to be countries with rapid income growth in other sectors, and that the latter is driving up food imports. However, there is a third set of effects omitted from the conventional argument that need to be considered. A substantial share of expenditure is on products and services which by their nature cannot be traded internationally. An increase in farm incomes therefore also increases the demand for nontradables. Since by definition such goods must be produced domestically, this increase in the country's domestic demand for nontradables raises the price of nontradables and attracts resources into the nontradables sector. This has two important effects. One is that less resources are available to produce traded products, so net imports (including agricultural imports) need to be greater because of this effect. The other is that incomes of producers of nontradables rise. That is, the direct income boost for farmers due to the new technology generates an indirect income boost to producers of nontradables. This indirect effect further expands the domestic demand for various traded products and so further increases the country's net imports. (A formal analysis of these effects, in a somewhat different context, is provided by Corden 1984.)

With this more complete analysis it is now possible to understand the reasons for the positive correlations in Table 2 between agricultural output growth and growth in agricultural imports. First, the effects of new farm technology on staple food imports are less than the conventional argument suggests, because that argument ignores the effect of the technology in boosting farm incomes and hence farmers' demands for both staple food and other goods and services, including nontradables. It therefore also ignores the second-round effects of increased incomes for producers of nontradables, which also increase the domestic demand for staple food and other traded goods. Moreover, the conventional argument ignores the possibility that the market for other traded goods, net imports of which are increased as a consequence of technical change in staple food production, may also include agricultural products. It might be, for example, that a new rice technology results in increased net import demand for more luxurious and higher-valued foods such as meat and dairy products and/or for wheat that, after processing into bread, involves less preparation time at home. Or it might simply be that newly adopted intensive livestock techniques expand the demand for feedgrain imports.

For this combination of reasons, together with the obvious fact that higher incomes allow more investment and hence greater economic growth, it is not so surprising that agricultural productivity

growth in developing countries is associated with increased imports, including agricultural imports, from Australia. Nonetheless, one might suspect that agricultural imports would not grow for developing countries whose agricultural growth covers a wide spectrum of farm products. For that reason it is useful to examine the case of China, which has had one of the world's fastest-growing agricultural sectors in the past decade.

### A Case Study: China

Farm output in China increased by more than half between 1978 and 1984. Increases occurred for virtually all commodities produced in China: grain by 5% per year, red meat and sugar by more than 10%, cotton by almost 20% per year, etc. As a result, China's share of the world market for grain, livestock products and sugar rose from 12 to 17% over that period. It might well be imagined that this massive addition to world food supplies contributed significantly to the downturn in world food prices shown in Fig. 1—until one is reminded to think also about the changing *demand* for food in China. As it happens, China's self-sufficiency in these foods actually *fell*, from 100% in 1970–74 to 97% in 1980–84, because domestic demand growth outpaced the growth in supplies (Anderson and Tyers 1987).

Indeed China's agricultural imports have grown almost as rapidly as its total imports: between 1970–72 and 1982–84, China's total imports increased eightfold in nominal terms, and agricultural imports increased sevenfold (Table 3). From developed countries alone agricultural imports increased tenfold, which was even more than total imports. Only for the United States was the increase in agricultural exports to China much less than its total export growth, but that was because of a virtual embargo on non-food exports to China in the early 1970s.

Moreover, even if agricultural output in China

continues to expand at the rapid rates targeted by the government for the next decade or so, it is likely that China will still have to increase its agricultural imports, notwithstanding its small agricultural trade surplus in 1984–85. One series of projections is summarised in Table 4, taken from Anderson and Tyers (1987). The reference case projection incorporates the government's production targets, assumes food prices will be kept at their 1980–82 levels in real terms, and assumes China's population and real national income grow at 1.2% and 6.3% per year to 1995. In that reference case, self-sufficiency falls for all foods shown except rice. This is largely because the effect of assumed rapid income growth on demand outstrips the effect of the assumed rate of technical change in agriculture on domestic food supplies.

Suppose, however, that China's national income were to grow less rapidly than assumed in that reference projection. This would of course reduce the growth in demand for food and other products. But since more than two-thirds of China's workforce is still employed in agriculture, and the farm sector accounts for more than one-third of national income, it is likely that a slower growth in income would be the result of slower growth in farm output. The net effect on food import demand would then depend on the extent to which these two effects, on domestic supply and domestic demand, offset each other. A second scenario is therefore given in Table 4, in which the rate of growth of national income is assumed to be 1 percentage point less than in the reference case (5.3 instead of 6.3% per year, or 16% lower) and food output growth is also reduced by 16%. The net result is that with slower growth, China is projected to reduce its net imports of virtually all these agricultural products, except coarse grains (which increase slightly to help supplement the reduced volume of domestically produced feedgrains available for animals). These results provide further support for the above argument that agricultural output growth in

**Table 3.** China's total and agricultural imports, 1970–72 and 1982–84<sup>a</sup> (current US\$ million per year) (Source: International Economic Data Bank, Australian National University, Canberra).

	Total imports			Agricultural imports <sup>b</sup>		
	1970–72 (1)	1982–84 (2)	(2) ÷ (1) (3)	1970–72 (4)	1982–84 (5)	(5) ÷ (4) (6)
<b>From</b>						
World	1 827	15 194	8.3	558	3 867	6.9
Developed Countries	1 388	12 590	9.1	304	2 985	9.8
United States	212	2 685	12.7	204	1 232	6.0
Australia	68	637	9.4	53	455	8.6

<sup>a</sup> Based on the reported exports of other countries to China, which are more complete than China's import statistics.

<sup>b</sup> Agricultural imports are classified as Sections 0,1,2 (excluding 27, 28) and 4 of the Standard International Trade Classification (SITC).

**Table 4.** China's net imports and self-sufficiency in food products, 1980-83 and 1995 (source: Anderson and Tyers (1987, table 6)).

	Net imports (kt)	Self- sufficiency (%)
<b>Wheat</b>		
Actual 1980-83	12 400	84
Projected 1995—reference	39 500	71
—slower growth	37 100	71
<b>Coarse grain</b>		
Actual 1980-83	1 080	99
Projected 1995—reference	12 200	91
—slower growth	13 400	89
<b>Beef and sheep meat</b>		
Actual 1980-83	-60	108
Projected 1995—reference	190	89
—slower growth	140	91
<b>Pork and poultry meat</b>		
Actual 1980-83	-60	100
Projected 1995—reference	5 400	82
—slower growth	4 390	84
<b>Dairy products</b>		
Actual 1980-83	320	96
Projected 1995—reference	15 480	49
—slower growth	11 000	54
<b>Rice</b>		
Actual 1980-83	-530	100
Projected 1995—reference	-1 400	101
—slower growth	1 470	99
<b>Sugar</b>		
Actual 1980-83	1 090	81
Projected 1995—reference	6 150	64
—slower growth	5 100	65

a developing country can be consistent with agricultural import growth.

### Should Australia Actively Promote LDC Agricultural Growth?

Having established that agricultural growth in developing countries may be associated with a rise in those countries' agricultural imports from developed countries, including Australia, could it be in the latter's economic interest to actively promote such growth? One way to do so is to sell to LDCs our agricultural management and research skills, technological knowledge, genetic material and the like. A more generous way is to give away such items as part of our aid program.

### Selling Skills, Genes, etc. to LDCs

A number of concerns have been expressed about selling what are perceived to be Australia's sources

of agricultural comparative advantage. Wool producers, for example, have long argued for prohibitions or at least limitations on the export of Merino genetic material from Australia. But such concerns are primarily based on the adverse effect of such exports on certain private interests as distinct from the national interest. The only national interest case that might be made is where Australia has some monopoly power in the international market for such genetic material, in which case the optimal export tax would be positive (but certainly not infinite, as with an export embargo) rather than zero. Even then, it would have to be argued that the optimal export tax is above the implicit tax on exports that already is in place by way of tariffs and quotas on imports of manufactures into Australia (Clements and Sjaastad 1984). A recent review of the evidence would suggest that Merino genetic material is unlikely to be deserving on national interest grounds of an additional explicit export tax (Bureau of Agricultural Economics 1986). The situation is simply that much of the reason Australia produces high quality fine wool is that it has high-quality managers of stud and commercial sheep properties: its inherent genetic material today is unlikely to be significantly different from that in South Africa or a number of other countries. If Australian ram prices can be raised by allowing overseas buyers to purchase at auction, then this is to the good and more wool growers should move into the business of producing rams and other genetic material for export. True, the higher ram prices would add a little to the production costs of commercial wool producers, but to the extent that Australian genetic material is superior then buyers will pay for it and Australia will be exploiting more fully its comparative advantage than if it limits such exports.

The same argument can be made about Australia exporting its agricultural research and management skills. Such skills provide an internationally tradable service that is highly valued. Indeed the net export earnings generated by the research and consulting activities of some agricultural scientists would be considerably higher per person than that generated by the average farmer in Australia. Yet Australia does not have a monopoly on such skills, so it is not in the national interest to restrict exports of those skills, especially in the longer run. Indeed if restrictions were imposed, two adverse effects would result. First, scientists would tend to emigrate to countries where they were free to operate internationally, so reducing Australia's export earnings from consulting as well as reducing the number of agricultural scientists in Australia. And second, developing countries would simply turn to countries other than Australia for such skills, so the effects on their economies would be no different than if Australia supplied those skills.

### Giving Away Skills, Genes, etc. to LDCs

This is not the place to argue the pros and cons of providing foreign aid in general (see, for example, the 1984 Jackson Committee Report for such arguments). But given that Australia wishes to spend a particular sum on foreign aid, is it in the national interest to spend that aid on boosting food production in developing countries by providing skills, genes and other perceived sources of Australia's agricultural comparative advantage? The answer is: probably. To see this it is necessary to consider the effects, from both the recipient country's viewpoint as well as Australia's, of tying aid in this way.

The recipient developing country will be largely indifferent to whether the aid is tied or not, provided that country would have otherwise acquired such goods and services anyway (either domestically or from the international market). The reason has to do with the fungibility of aid. The conventional wisdom is that aid in the form of agricultural research and management skills, genetic material, etc. expands the developing country's agricultural potential. This reduces the country's net imports of food (or expands its net exports in the case of a food-surplus LDC), and possibly shifts the international terms of trade against food if the production shift is large enough, thereby harming food exporters such as Australia, it is argued. Apart from the reasons already outlined as to why this conventional argument is incomplete, there is a further question to consider, namely what would have occurred in the absence of that aid? Presumably this developing country would have invested in various development projects which expanded its potential for producing goods in general. If that country in any case would have invested in the particular agricultural project Australia has funded (along with its numerous other investment activities), then the provision of that aid for this part of its investment program simply adds to the country's total investable resources and allows its other resources (including aid from elsewhere) to be diverted to other projects. That is, aid—even tied aid—expands the developing country's production potential in all sectors, not just in the staple food sector.

If aid is so fungible, why should Australia bother to tie it to agricultural projects requiring skills, etc. available in Australia? Presumably part of the reason is simply to ensure those skills are purchased from Australia rather than from other countries.\* As argued above, this does not necessarily mean less of those skills are available to work on Australian problems, since the aid project is likely to be too small to have an impact on the global demand and hence the international price for those skills. It simply means that Australia's excess supply of those

skills would be partly absorbed by the aid project. Tying aid in this way does, however, add a more-specifically and more-visibly Australian image to the aid project, which may be considered desirable for nationalistic reasons. It also provides a means for disseminating information about Australian skills and technology (although more conventional means such as Austrade could probably provide that dissemination service at much lower cost).

### Summary and Policy Implications

The conventional view that agricultural growth in developing countries reduces their agricultural imports, and therefore is against the interests of agricultural-exporting countries such as Australia, is not supported by empirical evidence. The argument on which that view is based is incomplete because it considers only the effects on LDC agricultural supply. What also needs to be considered is the effect of increased rural productivity on per capita incomes and hence on the demand for agricultural and other products. When demand as well as supply conditions are taken into account, especially in the nontradables market, it is not surprising that there is a positive correlation between agricultural output growth and agricultural input growth of LDCs. Moreover, since 60% of Australian exports are non-agricultural, a better index of Australia's economic interest is growth in LDC *total* rather than just agricultural imports from Australia—and the data show LDC agricultural growth to be even more positively correlated with that indicator.

China provides a striking example for illustrating these points. Agricultural output in China increased by 50% between 1978 and 1984. Yet despite that, agricultural exports to China have grown enormously over the past decade. And, according to one set of projections at least, they are likely to continue to be positively correlated with agricultural output growth during the next decade.

It then follows that, if agricultural growth in developing countries is consistent with Australia's economic interests, it pays Australia to actively promote such growth, for example through exporting

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\* Another part of the reason may be a concern that for domestic political reasons, or because of a lack of information on the profitability of different investment projects, a developing country would not invest in a particular high-payoff project that uses Australian goods and services unless aid were tied to that project. In such circumstances it is possible that such tied aid could boost economic growth in that country and at the same time benefit Australia more than if the same amount of aid were given untied.

agricultural research and management skills. Paying for such exports via the foreign aid budget is another way to promote agricultural growth abroad.

Is it possible to say anything about which commodities Australia might concentrate its aid efforts? Wool producers have argued, for example, that Australia should explicitly exclude wool production assistance projects from its aid program, presumably on the grounds that this is more likely to reduce Australia's export prospects than aid for, say, rice production. Such a conclusion is not possible, however, when it is recognised that demand considerations and intersectoral effects need also to be taken into account in addition to direct effects on commodity supply. It would be a brave person who tries to predict the *net* effect on Australian export earnings of any particular form of aid to developing country farmers: the outcome depends among other things on myriad elasticities of substitution in production and consumption both within agriculture and between agriculture and other sectors in the recipient country.

To conclude, three final points about the benefit of providing agricultural assistance to developing countries should be made. Firstly, it need hardly be said that assistance to developing countries is motivated by more than just economic gains to donor countries by way of trade expansion. Many people are prepared to support aid to agricultural projects for humanitarian reasons, because they perceive that this will help the poorest people in developing countries most.

Secondly, further benefits to Australia as well as developing countries might result if the provision of aid-financed improved production technology is accompanied by Australian direct foreign investment in processing and marketing agricultural products. An obvious example is milk. In many developing countries the dairy industry is in its infancy and per capita consumption of this relative luxury is low. Because of Australian aid the recipient country is more likely to be sympathetic to requests from Australian processing/marketing firms to invest in that country. This not only has the direct advantage of earning investment income from that country but also a number of potential indirect advantages. For example, if that Australian firm is better able than a local firm to promote milk products and hence increase the domestic demand for milk, then this contributes to overall milk demand growth and hence benefits Australia's dairy export sector.

And finally, such aid is likely to add to political stability. This is especially true in China, where a

reduction in food self-sufficiency could well lead to a political backlash against the process of general economic reform. The consequences of such a reaction might well include barriers to agricultural imports along the lines of other East Asian countries, with the usual adverse welfare effects not only for China but also for agricultural-exporting countries (Anderson et al. 1986). This makes it even more sensible that Australia should be assisting agricultural development in China especially.

### Acknowledgments

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### References

- Anderson, K., Hayami Y., and Others 1986. *The Political Economy of Agricultural Protection: East Asia in International Perspective*. Sydney, Allen and Unwin.
- Anderson, K. 1987. Does agricultural growth in poor countries harm agricultural-exporting rich countries? Mimeo, University of Adelaide, May.
- Anderson, K., and Tyers, R. 1987. Economic growth and market liberalisation in China: implications for agricultural trade. *The Developing Economies*, 25(2), June.
- Bureau of Agricultural Economics. 1986. *Export of Merino Genetic Material: A BAE Submission to a Committee of Review*. Canberra, Australian Government Publishing Service.
- Clements, K. W., and Sjaastad, L. A. 1984. *How Protection Taxes Exporters*. Thames Essay No. 39, London: Trade Policy Research Centre.
- Corden, W. M. 1984. Booming sector and Dutch Disease economics: survey and consolidation. *Oxford Economic Papers*, 36, 359-80.
- Jackson Committee. 1984. *Report of the Committee to Review the Australian Overseas Aid Program*. Canberra, Australian Government Publishing Service.
- Purcell, R. B., and Morrison, E. (ed.) 1987. *U.S. Agriculture and Third World Development: The Critical Linkage*. Boulder, Lynne Rienner Publishers.
- Tyers, R., and Anderson, K. (forthcoming). *Distortions in World Food Markets*. Cambridge, Cambridge University Press.

## Comment on K. Anderson Paper

Alistair S. Watson\*

KYM Anderson's paper fulfils a number of purposes as it addresses the issues raised by the organisers of this Symposium. It should help to disabuse the audience of the commonplace (and usually wrong) conclusion that Australia, and its farmers, are somehow worse off because of the modest contribution that Australian foreign aid has made to the increase in agricultural output in developing countries. Not that this is likely to be particularly important for those who attended the symposium, who are likely to be predisposed towards recognising the advantages of aid, but to a wider audience who now have had put before them a cogent and straightforward treatment of the relevant theory and important facts that are helpful in making a judgment on this question.

As Anderson points out in his introduction, the conventional argument has a superficial appeal. Farmers are used to being told that their declining fortunes are due to depressed international markets with burgeoning supplies from other countries. Developing countries have expanded their food output—so how can it be that the net economic effect of their success can be favourable to Australia whereas the production and trade policies of Japan, the United States and the European Community are generally agreed to be damaging? Simply put, the clue to this apparent paradox is to realise that *the conventional argument ignores demand considerations* and that increasing agricultural output in developing countries increases income, whereas, in most of the developed world, increased agricultural output achieved through protectionist policies is at the expense of income.

The agricultural sector is so large in countries like China, India and Indonesia that it is almost axiomatic that economic growth requires an increase in agricultural output. All cases of successful economic development have required some contributions from the agricultural sector because economic growth requires an increase in the proportion of a country's annual production which is devoted to capital accumulation. As the greater part of a developing country's population is engaged in agriculture, the agricultural sector must play a large part in the process of increasing the proportion of national income that is saved and invested. In essence, the expansion of the nonagricultural sector has to depend upon an initial increase in farmers' incomes, which generates employment through their expenditure. Farmers benefit in the second round because the newly-employed people spend most of their incremental income increases on food.

The countries that assist this process by providing foreign aid have the potential to share in the gains from economic growth as the additional income is spent. Income elasticities of demand for food are much higher in developing than in developed countries especially for non-staple agricultural products. Kym Anderson has reported plausible empirical confirmation that there is a positive association between agricultural output growth in developing countries and their imports of food from Australia and other developed countries. Reassuring as this is, it would not be the

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end of the argument even if there had been a contraction in imports of food per se—a country like Australia has the potential to benefit from economic growth as well through its exports of other commodities to developing countries.

Perhaps this aspect of the argument could have been developed more in Anderson's paper. When a large country, such as China, starts to grow there are all sorts of opportunities for sales of goods and services for a country such as Australia. Both countries are likely to benefit most if these activities are concentrated in areas of Australia's comparative advantage—in this context, it is hard to envisage a satisfactory aid or trade arrangement that turned its back on the wool industry, which is an area of Australian specialisation *sine qua non*. Nevertheless, it would be a mistake to think of the effects of aid in purely agricultural terms since agricultural aid will spill over into increased demand for other commodities. Sometimes, Australian farmers could have the legitimate complaint that aid, offered by the nation as a whole, has in fact been developed by research systems that have been largely funded by farmers.

An interesting twist to Anderson's paper is to place the economics of foreign aid within the genre of 'booming sector' or 'Dutch disease' economics, which in Australian parlance is the world of Gregory effects. This is because foreign aid, as a gift from outside, can be considered analogously to the increase in income that is made possible by a new mineral discovery or a sharp rise in prices and so on. The economic literature in this field is vast and covers a large range of cases. Whilst, in a typically Australian way, there was a tendency to interpret Gregory's writings (and the contributions of other commentators) in a negative way by concentrating on the adjustment costs for other sectors that such changes bring about, the original paper of Gregory was emphatic on at least one point—that is, the country on the receiving end of a resources boom, a Dutch disease or foreign aid has the *potential* to be better off. The key, of course, is the translation of the increased income into increased output through successive rounds of investment. If the boost to income is dissipated through consumption or investments with low rates of return, then the process need not be as advantageous as it could be to the recipient in the long haul.

Another insight from Anderson's paper is the emphasis on the fungibility of aid which, in economic terms, makes the issue of tied and untied aid somewhat irrelevant, since following any aid the recipient country has additional resources at its disposal 'in all sectors, not just in the staple food sector.'

In conclusion, there would seem to be a further advantage in Australian participation in agricultural aid programs that goes beyond the issues discussed in Anderson's paper. That is, the aid effort adds to Australia's presence and affords some limited protection that our interests will not be ignored in trade negotiations between larger nation states.

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## **ACIAR Technical Reports**

- No. 1. Australian Centre for International Agricultural Research, Grain storage research program, research report 1983-84, 63 p., 1985.
- No. 2. Pastures in Vanuatu. David Macfarlane and Max Shelton. 32 p., 1986.
- No. 3. ACIAR Grain Storage Research Program: research report 1984-85, 85 p., 1986.
- No. 4. Coconut germplasm in the South Pacific Islands. M. A. Foale, 23 p., 1987.
- No. 5. South Pacific agriculture: challenges and opportunities for ACIAR and its research partners. G. J. Persley and P. Ferrar (ed.), 87 p., 1987.
- No. 6. Australian Centre for International Agricultural Research, Grain storage research program, research report, 1985-86. 96 p., 1987.