

# ECONOMIC DEVELOPMENT AND TECHNOLOGICAL CHANGE IN RURAL AUSTRALIA: Some Critical Policy Issues

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## Abstract

*The paper discusses the status of the rural economy in Australia, emphasizing that agriculture, and primary industry in general, have historically played a dominant role in national economic development and have occupied a prime position in general economic policy. In this context, rural development policy in Australia has consisted mainly of measures to expand agricultural production through a pattern of capital-intensive technological change aimed at minimizing labor inputs and maximizing land-labor ratios. While leading to very high levels of labor productivity, this approach has failed to prevent the wider rural economy from deteriorating in many communities. It has also been accompanied by a deterioration in the overall economic performance of the agriculture sector itself, despite continued improvements in certain popularly quoted agricultural indicators (such as gross physical production). The paper argues that Australia's rural policies and programs have not taken adequate account of structural changes in the national and international economy. It concludes that improvements in the rural economy will require a new approach which includes: (1) the replacement of "growth in agricultural production" as the main focus of rural policy by a new paradigm concerned with "integrated rural development"; and (2) a new emphasis on technology policy as a tool for ensuring that the pattern of technological practice in agriculture and other rural industries is developed to fit properly the underlying economic conditions.*

## Introduction

The particular combination of demographic, economic, geographical, and social features which typify Australia makes the country an interesting case for comparative studies of rural economic development. While exhibiting the institutional, demographic, and social patterns typical of O.E.C.D. countries (the "developed" or "industrialized" nations), Australia has an economic structure and history similar in some respects to countries outside the O.E.C.D. group. Its economy retains a relatively heavy emphasis on primary industries (agriculture and resource extraction), and it is not located at the "center" in the center/periphery patterns of international investment and trade.<sup>1</sup> In this respect it is not alone. Several smaller middle- and high-income countries are in a similar situation: New Zealand, Eire, Israel, Greece, and

Finland are possible candidates for this category. The economies of peripheral regions in Canada, or Scotland and Wales in the United Kingdom, have similarities to this group.

Despite the similarities of these "middle" economies, there is considerable variety in their economic conditions, as there also is between the "middle" economies and other economies. It follows, therefore, that each country or region should develop unique economic development policies to match its special conditions in any particular period. This is a commonsense principle, but deserves special attention in view of the tendency among some commentators to categorize nations simplistically as either "developed" or "underdeveloped." Despite appealing to common sense, the principle of developing unique economic development policies to match the special conditions of each region during a given period is frequently not applied in practice. Problems now confronting Australia's rural economy have arisen, it is suggested here, from a failure to apply this principle in national and state economic policy.

Primary production, and agricultural production in particular, have been at the center of the economic development policies of Australia. Most policies for rural development, at both the federal and state level, have been based upon the premise that the best way to develop rural communities is by assisting the agriculture sector. This policy emphasis was relatively effective while the agriculture sector was buoyant and expansionist, while Australia held a more obvious comparative advantage in certain primary commodities, and while the real international market price of such commodities (such as wheat, beef, and sugar) remained high.<sup>2</sup>

The declining fortunes of the agriculture sector in recent years, however, combined with long-term modernization of agricultural practice, have led to economic decline in many rural communities and to a search for new approaches to policy for rural development. This paper explores the transformation of Australia's rural economy. The conclusions point to some critical choices facing Australian policy-makers in rural development, and question the wisdom of continuing with traditional agricultural policies as the main thrust of rural policy.

### General Features of Australia's Economy

Australia is well endowed with natural resources and land but is sparsely populated, with an average density of about two people per  $\text{km}^2$ . The land mass (about 7.7 million  $\text{km}^2$ ) is almost as large as that of the United States, yet Australia's population is not much more than 16 million people. Despite the importance of primary industries to the economy, less than 15 percent of the population lives in rural areas,

and about two-thirds live in the eight capital cities.<sup>3</sup> In contrast to the popular "outback" image of Australians, the population is actually highly urbanized.

The annual value of exports in 1984-85 reached just over A\$30 billion,<sup>4</sup> about three-quarters of which was accounted for by primary products. The major customers were Japan (\$8.1 billion), the E.E.C. (\$3.9 billion), and the U.S.A. (\$3.6 billion) respectively. The total value of imports during the same year was also just over \$30 billion, accounted for almost entirely by manufactured and high-value-added products. The major suppliers were the U.S.A. (\$6.8 billion), Japan (\$6.6 billion), and the E.E.C. (\$6.3 billion).<sup>5</sup>

While the export of agricultural commodities remains important for Australian trade, there are reasons for reconsidering the role of agriculture within economic policy. The chief reason, as informed by the statistics presented below, is that during the last three decades the Australian economy has undergone considerable structural change, altering the role of agriculture in the economy.

Tables 1 to 3 summarize these structural changes: the agricultural sector has declined significantly, relative to manufacturing and services, in terms of share of output and employment. Thus, while Australia's economy is still popularly viewed as being driven by primary industry, the contribution of manufacturing to Gross Domestic Product is now about five times larger than that of the rural sector and three times larger than that of mining; and while mining makes a much greater contribution to GDP than agriculture, its relative contribution to total employment is significantly less. Primary products continue to dominate the country's trade, and are crucial to support the imports of technology and manufactured goods used throughout the economy.<sup>6</sup>

The role of primary exports as the dominant sources of foreign exchange for Australia has reinforced the cardinal position primary industry has maintained in Australian economic development policies. Such a policy focus has also been justified on the grounds that Australia holds an international comparative advantage in primary production. During the late 1980s, the manufacturing sector gained increasing attention from policy-makers as a source of export income, but tends to be treated mainly as an adjunct to the primary industries, with the "comparative advantage" argument being invoked to justify this.<sup>7</sup>

### **Australia's Agricultural Sector**

In keeping with the country's low population density, large land mass, and industrialized economy, Australia's agriculture is highly capital-intensive and tends to emphasize broad-acre farming

**Table 1**

*Structural Changes in the Australian Economy:  
Percentage Contribution of Major Sectors to GDP<sup>a</sup>,  
1950-51 to 1982-83*

<u>Year</u>	<u>Rural</u>	<u>Mining</u>	<u>Manufacturing</u>	<u>Services</u>
1950-51	31	2	23	44
1955-56	16	2	28	54
1960-61	13	2	29	59
1965-66	10	2	29	59
1970-71 <sup>b</sup>	7	3	27	63
1962-63 <sup>b</sup>	13	2	27	58
1965-66	10	2	27	61
1970-71	7	4	25	64
1975-76	6	4	23	67
1980-81	6	7	21	66
1982-83	4	7	20	69

**Notes:**

(a) GDP at factor cost at current prices; figures exclude customs duties and imputed bank service charges which cannot be accurately apportioned between sectors.

(b) 1950-51 to 1970-71 figures are classified according to the 1966 Population Census classification. Figures for 1962-63 to 1983-84 are classified on the ASIC basis.

**Sources:** Industry Assistance Commission, *Structural Change in Australia* (Canberra: AGPS, 1977), p. 4; Australian Bureau of Statistics, Catalogue No. 5211.01. Compiled by D.C. Rich in *The Industrial Geography of Australia* (North Ryde: Methuen Australia, 1986).

techniques. The relatively arid climate and light soils over much of the continent have led to the development of special expertise among Australian farmers in dry-land farming techniques, and livestock production is based almost entirely upon rangeland grazing rather than feed-lot systems. Australian agriculture tends towards extensive rather than intensive production methods. In 1986 there were about 174,000 agricultural or pastoral properties, covering about 486 million hectares, or 63 percent of the total land area; only about 10 percent of this land was used for intensive production.<sup>8</sup>

**Table 2**

*Structural Change in the Australian Economy:  
Percentage Contribution of Major Sectors to Total Employment,  
1947 to 1981*

Year	Rural	Mining	Manufacturing	Services	
				Tertiary <sup>b</sup>	Information <sup>c</sup>
1947	16.8	1.8	27.0	38.5	15.9
1954	13.4	1.8	28.2	39.7	17.0
1961	11.1	1.3	27.5	40.4	19.7
1966	9.6	1.2	27.5	39.8	21.9
1971	7.7	1.5	24.2	40.4	26.2
1976	7.5	1.4	21.1	39.8	30.2
1981	6.5	1.5	19.2	39.2	33.6

**Notes:**

(a) Based on 1968 ASIC. Employees whose industry is unknown or unclassified are excluded from percentage calculations.

(b) ASIC divisions D, E, F, G, and L.

(c) ASIC divisions H, I, J, and K.

**Source:** Australian Bureau of Statistics, Census of Population and Housing. Compiled by D.C. Rich in *The Industrial Geography of Australia* (North Ryde: Methuen Australia, 1986).

Charts 1 and 2 indicate the distribution of agricultural activity in 1984-85 over commodity categories (measured by the gross value of production in each category, in Australian dollars). Over half of the output is accounted for by crop production. "Livestock products," accounting for just under one quarter of the value of production, include wool and dairy products. "Livestock slaughtering and other disposables," contributing about the same value-added as "livestock products," consists mostly of beef, veal, lamb, and poultry meat (over half of the beef and veal is exported, mostly to the United States and Japan).<sup>9</sup>

Wheat and barley alone, as indicated in Chart 2, account for over half the value of crop production. About 80 percent of the wheat crop is exported, making the fortunes of the agricultural sector highly exposed to fluctuations in international market prices. Most of the other crops are produced for local consumption. Wool (about 97 percent of

**Table 3***Contribution of Sectors of Australian Economy to Exports,  
1951-52 to 1984-85*

<u>Year</u>	<u>Total Exports</u>	<u>Rural</u>	<u>Mining</u>	<u>Manufacturing and Other</u>
Avg. of three years ended	A\$m	%	%	%
1953-54	1,567	84	7	9
1963-64	2,311	79	7	14
1973-74	5,868	54	24	22
1976-77	9,810	47	30	22
1977-78	12,050	45	30	25
1978-79	14,071	46	28	26
1979-80	18,606	47	25	28
1980-81	18,949	46	26	28
1981-82	19,294	43	29	28
1982-83	21,454	37	35	28
1983-84	24,014	37	35	28
1984-85	29,809	37	37	26

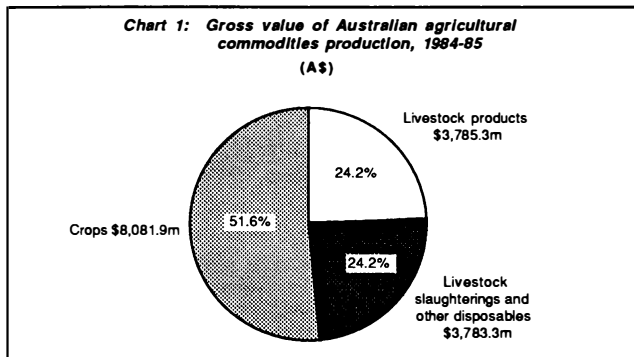
**Source:** Australian Bureau of Statistics and Bureau of Agricultural Economics; Compiled in J. Cribb, ed., *Australian Agricultural Yearbook, 1986* (Melbourne: Publishing and Marketing Australia, 1986).

which is exported) normally represents about 9 percent of Australia's export income. Rising international market prices for wool have recently stimulated a switch in the use of land normally devoted to wheat crops to sheep-grazing for wool production.<sup>10</sup> This has improved the income of the farm sector, but also reflects the continued dependency of the farm sector on fluctuations in international commodity prices.

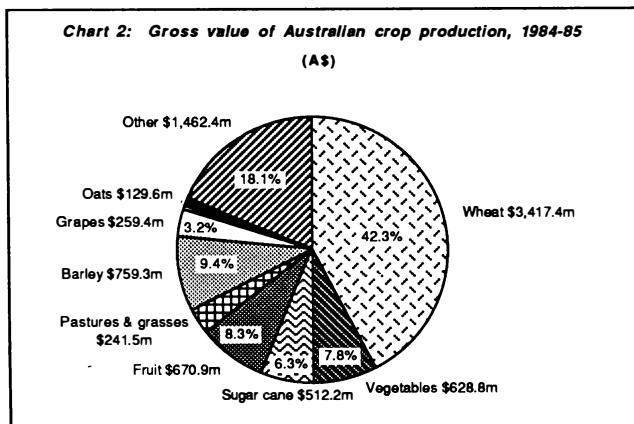
Charts 1 and 2 reveal that Australia's rural output is highly concentrated in a relatively small range of products, and highly dependent upon the international market for rural commodities.

The labor productivity of Australian agriculture, at 256.2 WU/male worker/year in 1980 (one WU is equivalent to one metric ton of wheat) is very high. It is only marginally lower than that of the United States, which is the highest in the world (285.1 WU/male worker/

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Source: Australian Bureau of Statistics, Catalogue No. 7503.0.



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year); the world average in 1980 was 64.9 WU/male worker/year.<sup>11</sup> Australian agriculture also has by far the highest ratio of land-to-labor of any agricultural nation. In 1980 the figure was 1,764.5 hectares/male worker, against a world average of 74.8 hectares/male worker and a United States average of 246.6 hectares/male worker<sup>12</sup>. In short, Australian farms are very large and capital-intensive by international standards, and they are technology-intensive.

In view of such facts, agriculture is almost universally acclaimed in Australia, in both popular and official opinion, as being highly efficient. The Federal Minister for Primary Industries (responsible for agriculture), for example, recently stated:<sup>13</sup>

Primary industries will continue to be crucial to our economic well-being as a source of employment, exports, and wealth. Despite the decline in their terms of trade, intensified international competition, and increasing protectionism in key overseas markets, these industries have demonstrated a capacity to *maintain productivity increases* and remain internationally competitive.

In keeping with this perspective, the Australian government has objected strongly in international fora to agricultural export subsidies by other nations, in the belief that, if international agricultural trade were freer, Australia would stand to gain (due to its high efficiency in agricultural production).<sup>14</sup>

Productivity trends within the Australian rural sector will now be examined. Despite declining terms of trade and a decline in the size of the rural labor force, the increase in physical output of Australian agriculture has not declined. Over the three decades to the mid-1980s, the volume of production increased by over 150 percent; and during the last decade it increased at an average rate of about 2 percent per year.<sup>15</sup> The fact that physical production increases have successfully been maintained for most of the history of Australian agriculture is one reason why both the state and federal governments continue to hold agricultural policy as the center piece of rural policy.

On closer examination, however, it appears that much of the confidence placed by policy-makers in traditional rural policy is supported by selectivity in the reporting and analysis of data. Most of the performance data reported in public debates and official statements in Australia about the rural sector tend to be limited in scope, concentrating on physical production trends rather than economic productivity. When productivity is discussed, attention is almost exclusively focussed on labor productivity alone, rather than financial or total productivity.<sup>16</sup> Some less-frequently cited data provide a more comprehensive picture.

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Longitudinal data taking the cost side of Australian agriculture into account are summarized in Table 4, which covers the period from 1953-54 to 1985-86. A changing impression of Australian agricultural performance emerges as one progresses from left to right across the

**Table 4**

*Production and Productivity Levels in Australian Agriculture, 1954 to 1986*  
(A\$)

Average of three years ended	Gross value of rural production	Farm costs	Net value of rural production	Gross farm product		Index of prices rec'd <sup>b</sup>	Index of prices paid <sup>b</sup>	Ratio of prices rec'd to prices paid
				Current prices	Constant prices <sup>a</sup>			
	(\$m)	(\$m)	(\$m)	(\$m)	(\$m)			
1953-54	2,182	1,136	1,047	1,429	na	37	19	191
1963-64	3,031	1,875	1,155	1,865	4,799	36	24	150
1966-67	3,486	2,250	1,235	2,129	5,231	38	26	147
1969-70	3,645	2,595	1,051	2,087	5,625	37	28	130
1972-73	4,168	2,780	1,389	2,415	5,840 <sup>r</sup>	41	32	129
1975-76	6,154	3,886	2,268	3,911 <sup>r</sup>	6,444 <sup>r</sup>	55	50	115
1976-77	6,757	4,692	2,065	4,209 <sup>r</sup>	7,205 <sup>r</sup>	61	66	92
1977-78	6,972	5,089	1,883	3,967 <sup>r</sup>	7,062 <sup>r</sup>	63	73	86
1978-79	10,225	5,788	4,437	6,427 <sup>r</sup>	8,388 <sup>r</sup>	77	78	98
1979-80	11,768	6,795	4,973	7,448 <sup>r</sup>	7,448 <sup>r</sup>	94	87	108
1980-81	11,539	7,520	4,019	7,158 <sup>r</sup>	6,627 <sup>r</sup>	100	100	100
1981-82	12,625	8,935 <sup>r</sup>	3,690	7,358 <sup>r</sup>	7,708 <sup>r</sup>	99	111	89
1982-83	11,625	9,755 <sup>r</sup>	1,871 <sup>r</sup>	5,890 <sup>r</sup>	6,366 <sup>r</sup>	105	123	85
1983-84	15,309 <sup>r</sup>	10,572 <sup>r</sup>	4,737 <sup>r</sup>	9,006 <sup>r</sup>	8,486 <sup>r</sup>	110 <sup>r</sup>	133	83
1984-85	15,300	11,250	4,050	8,685	8,370	114	141	81
1985-86 <sup>s</sup>	15,100	11,850	3,250	8,270	8,010	116	151	77

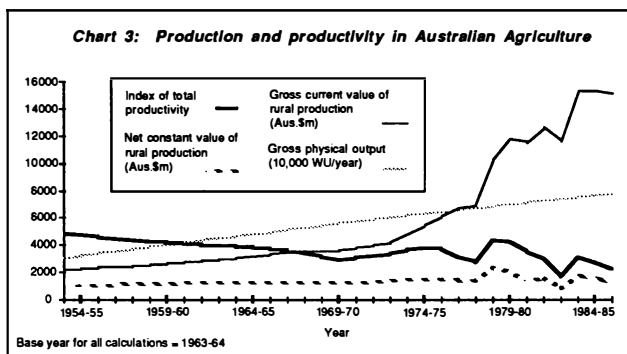
**Notes:**

- (a) in 1979-80 prices.
- (b) Base average 1980-81 = 100.
- (r) Revises.
- (s) Estimated by BAE.
- (na) Not available.

**Source:** Australian Bureau of Statistics and Bureau of Agricultural Economics; compiled in J. Cribb, ed., *Australian Agricultural Yearbook, 1986* (Melbourne: Publishing and Marketing Australia, 1986), p.83.

table. The more the production figures are discounted to take into account operating costs and inflation, the less grounds there are for a sanguine view of the status quo.

Over the three-and-a-half decades covered by Table 4, the gross annual value of rural production increased from \$2,182m to \$15,100m, an increase of almost seven-fold (an average increase per year of just over 6 percent). If production costs are taken into account, however, and the net figures are examined rather than the gross figures, then the increase in the value of rural production over the period (\$1,047m to \$3,250m) achieves only a three-fold increase (an average increase per year of about 3.5 percent). Additionally, gross farm product in constant dollars has not even doubled over the twenty-five years to 1985-86 (an average increase per year of about 2.3 percent). This situation is reflected in the terms of trade for farmers, which are the changes over time in the ratio of prices-received to prices-paid by farmers. As indicated in Table 4, the index of this ratio has changed from 191 to 77 over the 35 years to 1985-86 (a decline of almost 3 percent per year).<sup>17</sup> Chart 3, derived from the data in Table 4, reveals the net performance of the sector over time.



Source: Calculated from Table 4. The index of total productivity was derived by calculating the ratio of *net constant value of rural production* (multiplied by 10,000 for ease of graphical presentation); it is thus a standardized measure of the relative real economic efficiency of agriculture each year. The figures for gross physical output are derived from Table A-4 (p. 457) in Yujiro Hayami and Vernon Ruttan (*Agricultural Development: An International Perspective*, revised and expanded edition; Baltimore and London: The Johns Hopkins University Press, 1985).

The net constant value of rural production in Australia (gross production figures discounted by both production costs and inflation), while fluctuating somewhat, is shown in Chart 3 to have increased by the mid-1980s to only marginally above its magnitude of the mid-1950s (although record peaks were achieved during the 1970s).<sup>18</sup> Over the same period, the index of volume of agricultural production virtually doubled (and had more than doubled during the peak production year of 1978-79).<sup>19</sup> The most striking general trend revealed in Chart 3, however, is that (notwithstanding seasonal fluctuations) the *total productivity of Australian agriculture has actually declined* during the last few decades as physical production volume has increased.

The irony of these figures is that even though policy-makers and agricultural officials may refer to and acknowledge the declining terms of trade, they appear to have failed to take much notice that the unit cost of production in the Australian farming sector has been increasing in *real* terms. In other words, real productivity has actually been decreasing, while the rhetoric of the policy process has conveyed the impression that it has been increasing. Remarkably, this contradiction has largely escaped criticism by commentators on Australian rural affairs.

This irony probably arises because the term "productivity" is commonly used as an abbreviation for "labor productivity"; very rarely are other forms of productivity explicitly analyzed (e.g., capital productivity, energy productivity, information productivity) in agricultural commentaries. Over the same thirty-five-year period considered in Table 4, the number of rural establishments in Australia fell by about 30,000, from over two hundred thousand at the beginning of the period, while the total rural labor force fell to about three-quarters of its 1951-54 level of almost half a million.<sup>20</sup> If labor productivity is the only productivity measure that is used, then these trends can only be interpreted as improvements. The above figures, in contrast, present a different picture: while total physical production, labor productivity, physical-production-per-establishment, and both the gross and net values of rural production (in current prices) have been increasing, *the real net value of production has not improved significantly, and total productivity and the terms of trade for farmers have been declining.*

Although the declining productivity of Australian agriculture has received little attention, some of the symptoms of this decline (e.g., hardship for farming families) have been widely discussed. The policy-makers' failure to openly address the productivity issue, as portrayed here, would appear to arise, not from the lack of evidence, but from the prevalence of a mental outlook which discourages an adequate assessment of the evidence. Two sources of evidence which have

received attention, for example, and which should have alerted commentators to the underlying structural changes at work, are the growth of indebtedness and financial insolvency.

Table 5 summarizes changes in the indebtedness of Australia's rural sector over the two decades leading up to the early 1980s. The table reveals that total institutional indebtedness almost quadrupled over the period, amounting to an average annual increase in indebtedness of almost 18 percent. Indebtedness has been increasing at a much higher rate than has inflation. Total institutional indebtedness had increased to about \$5.9 billion by mid-1984 and has increased substantially since then.<sup>21</sup>

Most Australian farmers have a high level of equity in their properties, but there is a significant group with relatively low equity. With increases in interest rates and significant declines in nominal land values during the last couple of years, particularly in Western Australia, there are significant numbers of farming establishments experiencing serious financial difficulties.<sup>22</sup> A farm was defined by the Australian Bureau of Agricultural Economics as being at risk (in 1984-85) if it had a negative cash margin and an equity level of less than 70 percent.<sup>23</sup> Table 6 indicates the extent of farms-at-risk across the country prior to 1986. It is interesting to observe that the sectors with the highest proportion of farms-at-risk, the dairy industry and horticulture, are also those which are the least export-oriented. This suggests that there are forces *within* the Australian agriculture sector at work here; international factors, while no doubt important influences, are not adequate explanations for the troubles now faced by the rural economy.

### International Context of Australian Agriculture

Two possible explanations for the critical situation now facing Australian agriculture are explored below. The first, and the one most widely cited, is the less favorable international environment. This unfavorable environment is linked to: fluctuations and long-term declines in real commodity prices; increased number of countries competing as agricultural export nations; oversupply of some commodities in the international market; and agricultural protectionism and export subsidies (especially by the European Economic Community and the United States). The second, presented here, is the particular *pattern* of technological change which has been followed in the Australian agricultural industry. Ironically, the latter (which will be argued below as *contributing* to declining productivity) is normally seen as a mitigating factor against the former. This is illustrated by another recent statement from the Federal Minister for Primary Industry:<sup>24</sup>

Table 5

 Rural Indebtedness  
 (Australian \$m)

At 30 June	Major Trading Banks <sup>a</sup>			Pastoral Finance Com- panies	Common- wealth Develop- ment Bank	Life Insur- ance Com- panies	Ex- service Settle- ment	Other Govern- ment- Agencies (including State Banks)	Total Insti- tutional Indebted- ness	Primary Industry Bank of Australia	
	Term Loans	Farm Develop- ment Loans	Over- draft								Total
Average											
1962-66	(na)	(na)	(na)	545	232	60	60	108	185	1,189	-
1966-67	94	21	636	751	285	120	81	92	261	1,590	-
1967-68	113	45	760	918	314	143	97	88	297	1,857	-
1968-69	127	67	745	939	338	162	113	83	318	1,953	-
1969-70	131	79	787	998	349	176	128	80	351	2,082	-
1970-71	122	90	782	994	333	192	129	83	374	2,104	-
1971-72	116	113	733	963	293	202	125	79	432	2,094	-
1972-73	121	215	715	1,051	303	198	117	71	481	2,221	-
1973-74	133	267	761	1,161	371	203	107	61	499	2,402	-
1974-75	122	286	812	1,220	279	232	104	58	554	2,447	-
1975-76	119	324	874	1,317	254	243	96	54	633	2,597	-
1976-77	121	380	896	1,397	200	254	85	49	696	2,682	-
1977-78	122	461	977	1,560	200	280	80	43	797	2,960	-
1978-79	250	586	944	1,780	244	292	70	39	877	3,302	110.7
1979-80	350	715	1,027	2,102	325	212	67	34	932	3,772	215.8
1980-81	469	860	1,199	2,528	325	337	74	32	1,057	4,353	317.1

## Notes:

- (a) Figures for the major trading banks refer to the second Wednesday in July.  
 (b) Excludes equipment finance under hire purchase arrangements.  
 (c) Excludes indebtedness to hire purchase companies, trade creditors, and private lenders.  
 (d) PIBA commenced lending operations in November 1978. The bank is not a direct lender to primary producers. Refinance loans are provided to primary producers through a network of prime lenders comprising banks and other approved institutions. Thus, figures for PIBA refinance loans are also incorporated in lending from other institutional sources.  
 (na) Not available.

**Source:** Reserve Bank of Australia, *Bulletin*, Sydney, December 1981 (and previous issues); Primary Industry Bank of Australia, *Annual Report, 1981*, Sydney. Compiled in Bureau of Agricultural Economics, *Rural Industry in Australia* (Canberra: AGPS, 1983), p.47, Table 19.

**Table 6**

*Proportions of Farms at Risk in Selected Industries, by State,  
1983-84 and 1984-85 (percentages)*

<u>Industry and year</u>	<u>NSW</u>	<u>Vic.</u>	<u>Qld</u>	<u>SA</u>	<u>WA</u>	<u>Tas.</u>	<u>NT</u>	<u>Aust.</u>
<i>Sheep-only</i>								
1983-84	6.3	13.8	7.0	0.4	0.8	3.2	-	7.0
1984-85	6.3	13.8	0.0	0.4	0.8	7.6	-	7.0
<i>Beef-only</i>								
1983-84	0.2	8.7	0.0	0.0	0.0	4.3	10.1	2.3
1984-85	0.6	8.7	0.0	0.0	0.0	4.3	10.1	2.4
<i>Sheep-beef</i>								
1983-84	4.8	0.0	13.2	0.0	4.4	11.9	-	4.4
1984-85	4.8	0.0	13.2	0.0	4.4	11.9	-	4.4
<i>Wheat</i>								
1983-84	4.1	0.0	3.9	3.1	10.1	-	-	4.2
1984-85	7.1	0.0	5.6	12.9	3.8	-	-	5.8
<i>Dairy</i>								
1983-84	6.8	6.9	9.2	3.1	3.1	6.1	-	6.8
1984-85	5.1	8.8	8.2	3.1	3.1	6.1	-	7.4
<i>Horticulture<sup>a</sup></i>								
1983-84	19.3	18.0	na	25.6	na	na	-	21.0
1984-85	33.6	45.6	na	45.4	na	na	-	42.9

**Notes:**

- (a) Excludes the apple and pear industry.  
(na) Not available.

**States:**

NSW	New South Wales	WA.	Western Australia
Vic.	Victoria	Tas.	Tasmania
Qld	Queensland	NT	Northern Territory
SA	South Australia	Aust	Australia

**Source:** BAE Farm Surveys; Economic Planning Advisory Council, *The Medium-Term Outlook for the Rural Sector*, Council Paper #11, January 1986 (Canberra: Office of EPAC), pp. 11-13.

The primary industries are essentially *capital intensive*, relying on productivity increases to offset the long term deterioration in their terms of trade. . . . In adapting to Australia's harsh but fragile environment, the application of technology and *continuing improvements in productivity* have been crucial in developing agricultural systems. . . .

Before analyzing these contrasting views, the international context of the problem will be examined more closely.

It may be argued that the broad post-World War II pattern of movements in the agricultural products markets has been characterized by: (a) rises in absolute output, but with a decline in the relative share of agriculture in national output, employment, and investment; (b) a decline in agriculture's share of international trade, but still with some absolute growth; (c) a fall in the price of agricultural products relative to the prices of manufactures and services; and (d) considerable volatility in agricultural prices and quantities when compared with manufactures and services.<sup>25</sup>

Table 7 compares international agricultural production levels during the first half of the 1980s. All of the countries (or country categories), with the exception of Japan, have experienced growth in total production, with the world growth rate (compound growth rate from 1975 to 1984) averaging about 2 percent per year. The fastest growth in production has occurred in China (5.7 percent per year), followed by South East Asia (4.3 percent per year) and South and Central America (2.7 percent per year). The fastest growth among the industrialized nations has been achieved by Canada (2.5 percent per year). Australia's total agricultural production has increased at an average rate of about 2 percent per year over the last decade.<sup>26</sup>

Thus, from the point of view of rates of increase in gross production, Australia has achieved about average performance by international standards, but has lagged significantly behind the leaders in all three economic categories ("developed," "developing," and "centrally planned").

There has been growth in agricultural protectionism outside of Australia in recent years, with the biggest impact emanating from the European Economic Community and the United States. The Australian Bureau of Agricultural Economics has estimated that in recent years the EEC's Common Agricultural Policy has depressed world agricultural commodity prices by an average of about 16 percent per year, and that during the first half of the 1980s the Policy could have cost the Australian economy about \$1 billion per year.<sup>27</sup>

Table 7

*World Indices of Agricultural Production  
(1976-78 = 100)*

<u>Country</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>Growth Rate (%)<sup>a</sup></u>
<i>Developed</i>	105	109	110	102	111	1.37
US	102	115	115	93	110	1.26
Canada	103	113	119	114	109	2.48
Japan	90	92	94	94	100	-.63
Oceania	98	106	97	115	111	1.47
W. Europe	112	110	113	110	117	1.97
<i>Developing</i>	107	112	113	115	119	2.57
<i>S. &amp; Central America</i>	110	116	115	114	120	2.71
E. Asia <sup>b</sup>	94	99	103	104	108	1.54
S. E. Asia	116	125	125	131	133	4.29
Middle East	103	103	109	110	114	2.04
North Africa	110	105	116	110	116	1.96
Sub-Sahara <sup>c</sup>	108	111	112	108	114	1.92
<i>Centrally Planned</i>	102	103	110	115	117	2.28
USSR	95	92	98	102	101	.63
E. Europe	97	101	104	103	109	.97
China	120	126	140	151	152	5.70
<i>World</i>	104	108	111	110	115	1.99

**Notes:**

- (a) Annual compound growth rate. 1975-84.  
 (b) Excludes Japan and China.  
 (c) Excludes Republic of South Africa.

**Source:** United States Department of Agriculture; reproduced in G. Bond, "World Agriculture," in *Australian Agricultural Yearbook, 1986*, ed. by J. Cribb (Melbourne: Publishing and Marketing Australia, 1986), p.349.

It is reasonable to conclude that growth of total world agricultural production, in the context of protectionist policies, has indeed created greater international competition for Australian producers, leading to

reductions in income for many agricultural enterprises. Does this mean that domestic factors may be ignored? The federal government has acknowledged that increased interest, fuel, and fertilizer costs, when combined with the international factors, have contributed to declining income for many operators in Australia's rural sector (these matters are widely discussed by the rural lobby).<sup>28</sup> Nevertheless, the relationship between these costs and the pattern of technological practice followed by domestic producers has not generally been explored.

### Technology and Productivity in Australian Agriculture

It is difficult to obtain objective information on trends in technology and the rural sector in Australia. No statistics dealing *explicitly* with this topic are published by the Australian Bureau of Statistics, and agricultural economists in Australia appear to have been reticent to analyze the field. Methodologically, the analysis of technological change presents difficulties, as there is a lack of a readily available data series. Nevertheless, some interesting research has been conducted.

The best available empirical work on the subject has been conducted by Roy Powell of the University of New England.<sup>29</sup> Powell attempted an aggregate analysis of technological change and the rural sector in Australia over the five decades to 1970. He encountered obstacles due to the paucity of input/output data for the rural sector and, therefore, the bulk of his work was directed towards improving the available data rather than providing a definitive analysis of technological change *per se*. Notwithstanding the obstacles, he produced an index of technological change in Australian agriculture from 1920-21 to 1969-70. There are some theoretical reasons why these figures ought to be treated with caution<sup>30</sup> but, because they represent the best work currently available, they will be examined briefly here. Salient results from Powell's work are summarized in Table 8.

In short, Powell's work reveals a link between technological change and changes in labor productivity. Table 8 indicates that increases in technological change in Australian agriculture over the half-century to 1970 have been associated with increases in labor productivity.<sup>31</sup> His work reveals the main features of the period to be as follows:<sup>32</sup>

- 1920s: The performance of the rural sector was very poor. Labor productivity fell, despite a significant increase in the capital-labor ratio, and technological change was negative.
- 1930s: There was a rapid improvement in performance without any significant increase in capital input.
- 1940s: The period achieved little more than "standing still" overall, but the decade was dominated by the mid-1940s drought.

Table 8

*Summary of Basic Estimates of Technological Change in Australian Agriculture, 1920-21 to 1969-70*

Period	Final Year Indices Base year = 100			Annual Rate of T.C.	Capital Share	Change in Y/L due to	
	Y/L <sup>a</sup>	K/L <sup>b</sup>	T.C. <sup>c</sup>			T.C.	Incr. K
1920-21 to 1929-30	88	111	78	-2.72	0.17	-25	13
1929-30 to 1939-40	152	102	148	3.96	0.25	49	3
1939-40 to 1948-49	102	99	104	0.47	0.38	4	-2
1948-49 to 1959-60	118	112	105	0.47	0.44	6	12
1959-60 to 1969-70	137	120	112	1.1	0.35	15	22
1920-21 to 1969-70	218	151	142	0.78	0.31	64	54

**Notes:**

- (a) Y/L = labor productivity (output-labor ratio)  
 (b) K/L = capital-labor ratio  
 (c) T.C. = technological change

**Source:** R. A. Powell, *Technological Change in Australian Agriculture, 1920-21 to 1969-70* (Ph.D. thesis, Faculty of Economic Studies, University of New England, 1974), p. 264.

- **1950s:** This was a period of steady development during which the foundation was built for vastly improved performance in the 1960s.
- **1960s:** The best performance of any of the five decades was achieved.

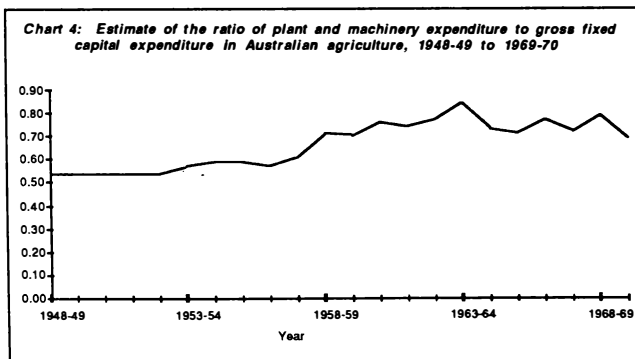
Powell's basis for judging a decade to have been one of high performance was the achievement of high levels in the output-labor ratio

(labor productivity), the capital-labor ratio (degree of capital intensity), and the index of technological change.

Within Powell's model, technological change is, in essence, inferred from any output increase that cannot be explained by increases in capital and labor inputs.<sup>33</sup> This amounts to a rather "catch-all" definition of technological change. The figures are aggregate figures only, and it is not possible to identify exactly what within technological change has led to improved output performance when it has occurred. Powell's work does demonstrate how important it is, however, to distinguish between capital investment and technological change. His research reveals that one should not assume that increasing capital investment in agriculture will automatically lead to improved performance. This contrasts with the tendency among agricultural policy-makers in Australia to treat increasing capital intensity as equivalent to increasing technology-based productivity.<sup>34</sup>

In addition to revealing a general positive relationship between labor productivity and the index of technological change (as defined by Powell, following Solow), Powell's work reveals that the rate of technological change has fluctuated considerably this century.<sup>35</sup>

Chart 4, also based on Powell's work, shows estimates of the changing share of fixed capital expenditure on Australian farms taken up by plant and machinery expenditure.<sup>36</sup> The share of fixed capital expenditure taken up by plant and machinery fluctuated over the two decades



Source: Extracted from a table on p. 176 of R. A. Powell, *Technological Change in Australian Agriculture, 1920-21 to 1969-70* (Ph.D. thesis, Faculty of Economic Studies, Univ. of New England, 1974).

to 1970, but revealed a general upward trend, commencing during the late 1940s at the lower level of just over one half, and rising by the late 1960s to fluctuate around the higher level of about three quarters. While technology includes much more than plant and machinery, we may nevertheless draw evidence from this that the technological component of fixed capital expenditure in Australian farms has been increasing. Given that the capital intensity of Australian farming has, on the whole, been increasing, we may conclude that Australian farming has become more "technology intensive" in recent decades.

Technological change, defined by Powell, includes both changes in "technological intensity" (Chart 4) and changes in the type (or mix) of technology in use (Table 8). Building upon Powell's work, it is possible to conclude further that the reductions in productivity (discussed earlier in this paper) have occurred *concurrently* with technological "advance," rather than due to any lack of technological advance.

It is suggested here that this departure from conventional wisdom about the connection between technological change and productivity has arisen because of the particular pattern of technological change in question; i.e., because of the history of technology choice in the Australian agriculture sector. This suggestion may be explored further by making some international comparisons of trends in agricultural productivity.

### International Comparisons of Productivity

One of the best sources of empirical information on comparative international agricultural productivity is the work of agricultural economists Hayami and Ruttan, who have conducted longitudinal studies of forty-four countries over the two decades from 1960 to 1980.<sup>37</sup> Table 9 was derived from their published work and compares labor productivity, land productivity, and the land-labor ratio between Australia and several major country categories: "less developed countries" (per capita GNP below US\$1,500 in 1980), "middle-stage countries" (per capita GNP between US\$1,500 and US\$6,000 in 1980), and "developed countries" (per capita GNP higher than US\$6,000 in 1980). The "developed countries" are divided into two sub-categories: "new-continent countries" (Australia, Canada, New Zealand, United States) and "other" (Europe and Japan).

Table 9 confirms that by international standards Australian agriculture has very high labor productivity. At the beginning and end of the two decades covered by the table, Australia's labor productivity was higher than the averages for both the developed countries and the "new-continent" developed countries. In contrast, Australia's land productivity is revealed to be exceedingly low relative to all country

Table 9

Comparisons of Agricultural Productivity Between Australia  
and Major Country Groups,  
1960 and 1980

	<u>Developed countries (DC)</u>				Middle- stage countries (MC)	Less- stage developed countries (LDC)
	<u>Australia</u>	<u>Average</u>	<u>New Continent</u>	<u>Other</u>		
<b>Labor productivity</b> (Y/L: WU/worker)						
1960	103.8 (253)	41.0 (100)	97.5 (238)	31.4 (77)	9.9 (24)	4.7 (12)
1980	256.2 (221)	116.1 (100)	240.1 (207)	92.8 (80)	23.9 (21)	6.4 (6)
<b>Land productivity</b> (Y/A: WU/ha)						
1960	0.09 (4)	2.20 (100)	0.48 (22)	3.53 (160)	0.76 (35)	1.04 (47)
1980	0.15 (5)	3.29 (100)	0.70 (21)	5.30 (161)	1.33 (40)	1.61 (49)
<b>Land-labor ratio</b> (A/L: ha/worker)						
1960	1,153.1 (6,199)	18.6 (100)	205.4 (1,103)	8.9 (48)	13.1 (70)	4.6 (24)
1980	1,764.5 (4,999)	35.3 (100)	342.0 (970)	17.5 (49)	18.0 (51)	4.0 (11)

**Notes:**

Data for each country group shown in parentheses are comparisons with the average for developed countries (set equal to 100).

DC: New continent-countries: Australia, Canada, New Zealand, United States.

Other: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Sweden, Switzerland, United Kingdom.

MC: Argentina, Brazil, Chile, Mexico, Greece, Israel, Ireland, Libya, Portugal, South Africa, Spain, Surinam, Taiwan, Venezuela, Yugoslavia.

LDC: Bangladesh, Colombia, Egypt, India, Mauritius, Pakistan, Paraguay, Peru, Philippines, Sri Lanka, Syria, Turkey.

Y = total output (i.e., physical production); L = labor; A = land area;  
and WU = wheat unit (one WU is equivalent to one metric ton of wheat).

Source: Compiled from Table 5-1 (p. 120) and Table 5-2 (p. 123) in Yujiro Hayami and Vernon Ruttan (*Agricultural Development: An International Perspective* [Revised and expanded edition; Baltimore and London: The Johns Hopkins University Press, 1985]).

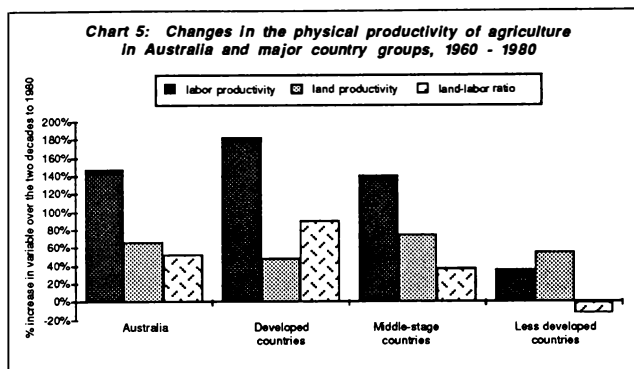
groups. In 1960, Australia's land productivity was only 4 percent of the average for developed countries, 19 percent of the average for new-continent developed countries, and 9 percent of the average for less developed countries; and during the twenty years to 1980 there was no significant change in these ratios.

The extremes in labor and land productivity exhibited by Australia, relative to other countries, are partly explained by the demands of a large land mass, low population, and the consequent large size of farms. As indicated in Table 9, during 1960 the land-labor ratio of Australian agriculture was over 60 times as high as the average for developed countries in general, about 130 times the average for Europe and Japan in particular, and almost 260 times the average for less developed countries. Despite its immense proportions in 1960, the absolute size of Australia's land-labor ratio increased another 67 percent by 1980. The land-labor ratios of developed countries in general also increased during this period, reducing Australia's ratio to about fifty times that of the developed country average and 100 times the ratio for Europe and Japan. The average land-labor ratio for the less developed countries during this period fell marginally, however, to about 0.002 percent of the equivalent ratio for Australia and 11 percent of the average for the developed countries.

The extremely high land-labor ratio in Australian agriculture may be interpreted, of course, as a reflection of the geoclimatic conditions in the continent. Certain patterns of land-use are more appropriate to the environment (and historical circumstances) than others. It is important to realize that the high ratio also reflects a particular pattern of technological practice.<sup>38</sup> Furthermore, it is appropriate to question whether the pattern of technological practice so reflected is determined only by the geoclimatic conditions, or whether alternative patterns might also have been feasible had different criteria and attitudes concerning technology choice been embraced by agricultural operators and policy-makers.<sup>39</sup> Chart 5 provides some clues to how these questions might be answered.

Chart 5 shows differences in the agricultural development patterns followed by Australia and major country groups throughout the 1960s and 1970s. Each agricultural development pattern, in turn, reflects a particular pattern of technological practice. The chart was produced by plotting the movements over time in physical labor productivity, physical land productivity, and land-labor ratios for each country or country group in Table 9. Three distinct development patterns may be observed.<sup>40</sup>

The first, represented by the developed countries group as a whole, takes the form of simultaneously emphasizing increases in labor



Source: Calculated from Table 9.

productivity and the land-labor ratio.<sup>41</sup> This group exhibited the lowest proportional increase in land productivity. However, the average land productivity of the group did increase during the period (by 49 percent) despite already being the highest by a large margin. This development pattern is thus characterized by a pattern of technological change biased towards the substitution of labor by material inputs (especially machinery and energy).

The second development pattern, represented by the less developed countries, takes the form of primarily emphasizing increases in land productivity, followed by some increases in labor productivity. As can be seen in Chart 5, the less developed countries achieved increases in both forms of productivity while actually reducing the land-labor ratio. The increase in land productivity (55 percent) was slightly greater than that of the developed country group (49 percent). This development pattern is thus characterized by a pattern of technological change biased towards the substitution of both labor and material inputs (predominantly chemical and/or biological) for land. The increase in land productivity achieved through that particular form of technological change was sufficient to avoid the potential reductions in labor productivity which, by some orthodox points of view, would be likely to follow from substituting labor for land.

The third development pattern, represented by the middle-stage countries, takes the form of simultaneously emphasizing increases in labor productivity and land productivity, but with most emphasis direc-

ted towards labor productivity. With the exception of exhibiting slightly higher rates of increase in labor productivity and slightly lower rates of increase in land productivity, Australia falls into the same development pattern as this group (despite being one of the new-continent developed countries). This development pattern is thus characterized by a pattern of technological change biased towards the substitution of labor by material inputs (machinery energy, chemicals) and, to a lesser extent, of land by material inputs (chemical and/or biological).

The "middle-stage" development pattern exhibited by Australia, despite being part of the "developed country" group, is partly explained by the fact that, compared with other developed countries, Australia commenced the two-decade period with a higher base-level of labor productivity and a higher base land-labor ratio. The scope for increasing the land-labor ratio through mechanization of agricultural production was probably lower in Australia than elsewhere, because the country's agriculture sector was already highly mechanized. Nevertheless, as the chart shows, technological change in Australian agriculture throughout the period continued the historical pattern of decreasing labor input per unit of land. By this means Australia was able to increase agricultural labor productivity by 147 percent (somewhat less than other new-continent developed countries).

### **Discussion: Implications for Rural Development Policy**

In summary, economic development in Australia has historically been heavily linked to the development of agriculture, despite the existence of a highly urbanized population. This pattern of development has been relatively successful, with the result that agriculture policy, and subsequently primary industry policy in general, plays a cardinal role in the country's overall economic policy. In the main, rural development has been promoted almost entirely by policies to assist agricultural production and marketing. In a sense, therefore, there has until recently been little in the way of distinct rural development policy, only agriculture and primary industry policy.

Technology policy has only recently emerged as a distinct field of policy, but Australia has nevertheless had *de facto* technology policies in place all along, within the framework of agriculture policy. The agriculture sector has been heavily influenced by the extensive system of government-sponsored research, development, and extension in agricultural technology within the state government departments of agriculture, the Commonwealth Scientific and Industrial Research Organisation (which despite its title has emphasized agricultural research), and the universities. The agricultural development pattern of the country has been reinforced, if not partly determined, by the form of agricultural technology which has emanated from this system.

The technological development which has underpinned Australia's pattern of agricultural development has followed a particular pattern: it has been biased towards maximizing labor productivity, land-labor ratios, and total production levels, at the expense of other options. This has had the secondary effect of leading to sharp reductions in the agricultural labor force, which in turn has exacerbated the disparities between rural and urban population levels. Many of the smaller rural communities have suffered severe economic problems in recent years because of the population losses they have experienced. The main policy response to this problem has been to continue with the established pattern in the hope that increased labor productivity and gross production would generate sufficient income to compensate for declining population.

Two macro-level trends point to the need to re-assess Australia's "rural" policy. First, the national economy has undergone structural change, diminishing the relative contribution of agriculture to wealth creation, employment creation, and export income. Second, the economic performance of the agriculture sector has declined over the last three decades, notwithstanding fluctuations in the sector's fortunes. This is revealed in the growth of indebtedness and failures among agricultural enterprises, and, although not widely acknowledged, through a long-term decline in productivity (i.e., total productivity, in real terms).

The evidence presented here suggests that the following factors are salient in explaining the present predicament of the rural economy. First, given the structural changes in the economy, there has been too much attention placed upon agricultural production as the centerpiece of rural policy. Second, there has been a failure to think critically enough about the particular niche in the international political and economic environment to which Australia is most likely best adapted. Because Australia is part of the developed "North," and because the country is thought to have a comparative advantage in rural production, policy-makers have been too ready to assume that highly capital-intensive agricultural production, with its associated bias towards capital-heavy patterns of technological change, is a preferred option for economic development. Third, within agriculture there has been too much reliance on a narrow range of export commodities subject to price volatility in international markets. Fourth, a narrow focus on physical production levels and labor productivity as performance indicators has obscured underlying trends in the rural economy, thereby obstructing the early development of new policies. Fifth, the pattern of technological practice embodied within Australian agriculture has been accompanied by reductions in the productivity of capital which have been sufficient

to offset the large gains in labor productivity and minor gains in land productivity.

### *Suggested Policy Responses Within the Agriculture Sector*

(1) Diversification of the product mix in agriculture away from the traditional emphasis on broadacre production of orthodox commodities (such as wheat, beef, and wool), towards new products (such as new grains, legumes, horticulture, floriculture, silviculture, aquaculture, or the systematic cultivation and harvesting of native flora and fauna). This might help reduce the effects of international market fluctuations and open up new market opportunities. It might also act as a stimulus for innovation in process technologies to solve problems in producing the new product categories.

(2) The application of technology-related programs and policies aimed at altering the biases in technological change within Australian agriculture away from an emphasis on increasing labor productivity, output-per-establishment, and total output, and instead towards increasing capital productivity and productivity in the use of other relevant inputs such as land, raw materials, or energy. The chief aim here should be to increase total productivity and the total real economic surplus, rather than gross production. This shift in policy would require the vigorous application of advanced technologies, but recognizing that "advanced" does not necessarily mean "capital intensive" or "labor-saving."

### *Suggested Policy Responses Beyond the Scope of Agriculture*

(1) Rural policy needs to be broadened in scope to embrace a range of economic sectors, social groups, and infrastructure requirements which are not directly part of agriculture. Both the federal and state governments need to build up rural policy as a field of policy in its own right which overlaps with agricultural policy, but which also embraces other policy spheres with equal seriousness.

(2) The traditional "agricultural development" paradigm which has been the foundation of Australian rural policy needs to be replaced by the "integrated rural development" paradigm. This would involve, among other things: aiming to diversify the rural economy away from reliance upon primary industry to a broad mix of industries; adopting a regional or community focus in planning, rather than a sectoral focus; the expansion of technology policy for rural areas from its present focus on primary industry to include para-agricultural and non-agricultural industries (this could take the form, for example, of a non-agricultural version of agricultural extension); and, taking into account not

only the direct production results when evaluating projects and policies, but their likely broader impacts on the whole local economy in question.

These policy suggestions are tentative only, and require additional investigation before being applied. Together with the material in the body of this paper, however, they indicate the directions in which policy analysis and debate might move in order to adequately confront the current problems of Australia's rural economy.<sup>42</sup>

### NOTES

<sup>1</sup>Some general historical overviews of Australia's society and economy include: C. M. H. Clark, *A Short History of Australia* (2nd. rev. ed.; New York: New American Library, 1980); M. Walker, *Australia: A History* (London: Macdonald, 1987).

<sup>2</sup>The following sources provide useful introductions to the development of Australia's rural economy: F. Wheelhouse, *Digging Stick to Rotary Hoe; Men and Machines in Rural Australia* (Melbourne: Cassell Australia, 1966); S. M. Wadham, *Australian Farming, 1788-1965* (Melbourne: Cheshire, 1967); J. M. Powell, ed., *The Making of Rural Australia, Environment, Society, and Economy: Geographical Readings* (Melbourne: Sorrett Publishing, 1974); R. Bromby, *The Farming of Australia* (Sydney: Doubleday, 1986).

<sup>3</sup>Promotion Australia, *Australia Handbook* (Canberra: Australian Government Publishing Service, 1986), p. 21.

<sup>4</sup>Unless otherwise indicated, all dollar amounts referred to in this article are Australian dollars.

<sup>5</sup>*Ibid.*, pp. 69-71.

<sup>6</sup>The patterns have not altered significantly since 1982-83, with agricultural industries accounting for about 4 percent of the Gross Domestic Product in 1985-86 and the mineral resource sector accounting for about 8 percent during the same year. Australian Bureau of Agricultural and Resource Economics: *Quarterly Review of the Rural Economy*, 10, 1 (March 1988), 97; *Resource Trends* (June 1988), 47.

<sup>7</sup>See, for example: *Longer Term Priorities for the Primary Industries*, a Discussion paper presented to the Economic Planning Advisory Council by the Minister for Primary Industries and Energy, the Hon. J. C. Kerin, M. P. (Discussion Paper 88/10; Canberra: EPAC, September 1988), p. 4.

<sup>8</sup>*Australia Handbook*, p. 81.

<sup>9</sup>*Ibid.*, pp. 82-83.

<sup>10</sup>This switch is being accompanied by an expansion of research and development on new pasture crops for land traditionally reserved for grain production. See, e.g., D. Falconer, et al., "Benefits and Costs of Establishing Medic in the Low Rainfall Wheatbelt," *Journal of Agriculture - Western Australia*, 29, 1 (1988), 3-7.

- <sup>11</sup>These figures are derived from the work of Yujiro Hayami and Vernon Ruttan (*Agricultural Development: An International Perspective*, revised and expanded edition; Baltimore and London: The Johns Hopkins University Press, 1985, p. 84). The world average is calculated from a representative sample of 44 nations.
- <sup>12</sup>*Ibid.*
- <sup>13</sup>Hon. J. C. Kerin, M. P., *Longer Term Priorities*, p. 17.
- <sup>14</sup>*Ibid.*, pp. 9-16. Australia has also used the "Caims Group," an international group in which Australia is a leader, as an avenue for expressing this view (*Caims Group Proposal to the Uruguay Round Negotiating Group on Agriculture*, General Agreement on Trade and Tariffs, Brussels, October 26, 1987).
- <sup>15</sup>*Australia Handbook*, p. 81; J. Cribb, ed., *Australian Agricultural Yearbook, 1986* (Melbourne: Publishing and Marketing Australia, 1986), p. 19.
- <sup>16</sup>This is the author's own observation, but evidence may easily be found in official documents. The annual reports of the state departments of agriculture are typical. The Western Australian Department of Agriculture, for example, annually publishes a table entitled "Principal Agricultural and Pastoral Statistics for Western Australia" (see *Annual Report, 1986*, and other years), with only one line of information out of 54 revealing cost-side figures. The recent report of the federal Minister for Primary Industry (Kerin, *Longer Term Priorities*), as a further example, made repeated reference to the agriculture sector's high productivity, but the figures cited in support of this dealt only with labor productivity (p. 3).
- <sup>17</sup>While record figures for the value of rural production are expected for 1987/1988, the magnitude of rural incomes will, nevertheless, remain about the same, due to the impact of inflation, according to estimates of the Australian Bureau of Agricultural and Resource Economics (J. Cribb, "Farm earnings and exports set for record year," *The Australian*, 8 June 1988).
- <sup>18</sup>Economic Planning Advisory Council, *The Medium-Term Outlook for the Rural Sector*, Council Paper #11, January 1986 (Canberra: Office of EPAC), p. 8, chart 1. Buoyant international prices for wool in 1988 have recently also produced a peak in earnings.
- <sup>19</sup>Bureau of Agricultural Economics, *Rural Industry in Australia* (Canberra: Australian Government Publishing Service, 1983), p. 37, Figure 11.
- <sup>20</sup>J. Cribb, ed., *Australian Agricultural Yearbook, 1986* (Melbourne: Publishing and Marketing Australia, 1986), p. 92, Table 12.
- <sup>21</sup>Economic Planning Advisory Council, *Rural Sector*, pp. 11-13.
- <sup>22</sup>*Ibid.*
- <sup>23</sup>*Ibid.*
- <sup>24</sup>Hon. J. C. Kerin, M. P., *Longer Term Priorities*, pp. 3, 4 (emphasis in original).
- <sup>25</sup>John Freebairn, "Structural Changes in World Agriculture and Australian Agriculture," in *Innovating Our Way Out of the Rural Crisis*, edited by C. D. Kimpton and L. W. Martinelli (Melbourne: Royal Society of Victoria and Australian Institute of Agricultural Science, 1987), p. 7.
- <sup>26</sup>Cribb, *Yearbook, 1986*, p. 19.

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<sup>27</sup>Bureau of Agricultural Economics, *Agricultural Policies in the European Community: Their Origins, Nature and Effect on Production and Trade*, Policy Monograph #2 (Canberra: Australian Government Publishing Service, 1985).

<sup>28</sup>Economic Planning Advisory Council, *Rural Sector*, pp. 14-16: Minister for Primary Industry, *Economic and Rural Policy*, A Government Policy Statement (Canberra: Australian Government Publishing Service, April 1986), pp. 9-14.

<sup>29</sup>R. A. Powell, *Technological Change in Australian Agriculture, 1920-21 to 1969-70*, Ph.D. thesis, Faculty of Economic Studies, University of New England, Armidale, NSW, Australia, 1974.

<sup>30</sup>Powell's model, based on the 1957 work of R. M. Solow ("Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, 39, 3 [1957], 312-320), embodied a number of assumptions which were highly questionable, e.g. that technological change is neutral in its bias towards being either capital-saving or labor-saving, that it is disembodied from factor inputs (land, labor, capital, raw materials, etc.), that constant returns to scale are achieved, and that optimal use is made of all inputs. Powell himself acknowledges these weaknesses in his model (pp. 3-7) but claims that it nevertheless adequately identifies general trends in the rate of technological change (p. 258).

<sup>31</sup>See Powell, *Technological Change*, pp. 261-262.

<sup>32</sup>*Ibid.*, pp. 263-265.

<sup>33</sup>*Ibid.*, p. 5. The actual formula for index of technological change used by Powell (the "Solow" model) is as follows (see pp. 3-7, 258-260):

$$\frac{\Delta A}{A} = \frac{\Delta Y}{Y} - W_k \frac{\Delta k}{k}$$

where	$\frac{\Delta A}{A}$	=	technological change between two time periods
	$\frac{\Delta Y}{Y}$	=	change in output per labour unit between two time periods
	$\frac{\Delta k}{k}$	=	change in capital per labour unit between two time periods
	$W_k$	=	the elasticity of production with respect to capital

<sup>34</sup>With the increase in indebtedness of farm enterprises, however, it has recently been more widely recognized that many operators have become over-capitalized. This is beginning to lead to some questioning of the links between high capital-intensity and supposed high productivity. See G. Ansley, "Get Big or Get Out: Why it Turned Sour," *National Farmer* (Australia), #17 (6-19 September 1984, 24-29).

<sup>35</sup>See Table 10 and Chapter 10 of Powell's dissertation.

<sup>36</sup>Powell's figures draw heavily on the "Australian Sheep Industry Survey" series (ASIS) conducted by the Bureau of Agricultural Economics. The ASIS sample was drawn from a population of between 90,000 and 100,000 farms, about half of which were classified as wheat-sheep farms with important cropping activities.

<sup>37</sup>See Hayami and Ruttan (*Agricultural Development*), cited above.

- <sup>38</sup>The notion that there is a close connection between land-use patterns and technological change has received increasing attention in recent years, with a substantial body of supporting empirical evidence now having been assembled. For a summary of recent research on the spatial impact of "high technology," see M. Castells, ed., *High Technology, Space and Society* (Beverly Hills: Sage Publications, 1985).
- <sup>39</sup>A large body of literature has emerged in the last two decades in support of the view that in both agricultural and non-agricultural industry there is frequently a possibility of choice between alternative technologies with similar degrees of economic viability; non-economic factors are often identified as the decisive reasons for the adoption of a certain form of technology practice in a given place and time. For a review of the literature, see K. W. Willoughby, *Technology Choice* (Boulder and London: Westview Press, forthcoming, 1989).
- <sup>40</sup>The notion of alternative development patterns for different country groups is taken from Hayami and Ruttan (*Agricultural Development*, passim).
- <sup>41</sup>A very similar pattern emerges for the "other" developed countries and "new-continent" developed countries if their data is plotted separately. The same holds for the United States, except that the pattern is even more pronounced (increased  $Y/L = 204$  percent; increased  $Y/A = 45$  percent; increased  $A/L = 111$  percent).
- <sup>42</sup>The relevance of such suggestions is reinforced by the emergence of a similar debate over the U.S. rural economy. See, for example, R. B. Reich, "The Rural Crisis, and What to Do About It," *Economic Development Quarterly*, 2, 1 (1988), 3-8; T. L. Daniels and M. B. Lapping, "The Rural Crisis, and What to Do About It: An Alternative Perspective," *Economic Development Quarterly*, 2, 4 (1988), 339-341; R. B. Reich, "Response to Letter from Daniels and Lapping," *Economic Development Quarterly*, 2, 4 (1988), 342.