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Rural Resources, Scientific Research, and Rural Development: An Australian Perspective

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In advanced economies rural geography has undergone a rapid expansion in the 1980s somewhat akin perhaps to the rapid growth in urban geography that characterized the 1960s. Rural geographers have widened their horizons from systematic economic, population, and land-use planning topics to embrace a wide range of social and welfare issues, so that rural geography now presents a more integrated approach and felicitous balance than marked its miscellany a decade ago. In particular, agricultural geography, which in the 1970s tended to be disregarded in the reaction to its earlier pre-eminence, has undergone some resurgence, though it continues to receive slender treatment in most standard texts on rural geography. At times it might appear that the pendulum has swung from a former preoccupation with agriculture to a current predilection for rural policy and multi-purpose land-use planning.

It is not the aim of this address to review the field of rural studies, which has recently been attempted elsewhere;[1] nor is it to set agricultural geography within a broader conceptual compass, useful though such an attempt might be. Rather is it to examine two seemingly disparate but related themes that tend to get short shrift—if indeed any shrift at all—in almost all geographical literature. The first theme, which is essentilly a small subset of the much larger theme of this Congress, is the contribution made by scientific research and new technology to the development of rural resources, and the second is the spatial appraisal of agricultural capital, which latterly in advanced economies has grown rapidly due to inter alia technological inputs. I shall illustrate these themes by reference to Australia, the first by citing research in the natural sciences on rural resources and the second by a case study.

1. Scientific Research

Scientific research, innovation, and technological change are fundamental to national economic and social policy promoting rural

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1) Cloke, P.J., 1980, New emphases for applied rural geography, *Progress in Human Geography*, 4, 181-217.
Cloke, P.J., 1985, Whither rural studies?, *Journal of Rural Studies*, 1, 1-9.

development. Geographers, rural sociologists, agricultural economists, and other social scientists have long studied aspects of innovation in agriculture, and in particular agricultural geographers have long analyzed selected aspects of rural technical change. In recent decades, following upon the excellent pioneer work on innovation adoption by sociologists and psychologists, geographers have made a major contribution to our understanding of rural development through research on the spatial diffusion of agricultural innovations. Over the past decade behavioural studies have yielded new insights into the diffusion process by setting it within a decision-making context.[2] While traditional studies in agricultural geography have revealed long-term upward trends in rural productivity, only fleeting reference is made to the part played in these trends by scientific research on which innovation, technological transfer, and rural development depends. Standard texts on both rural and agricultural geography, even recent geographical texts on rural resource management, are virtually silent on the nexus between research and development.

Accordingly I shall first examine, with special reference to Australia, the returns to rural research in the natural sciences, the impact of

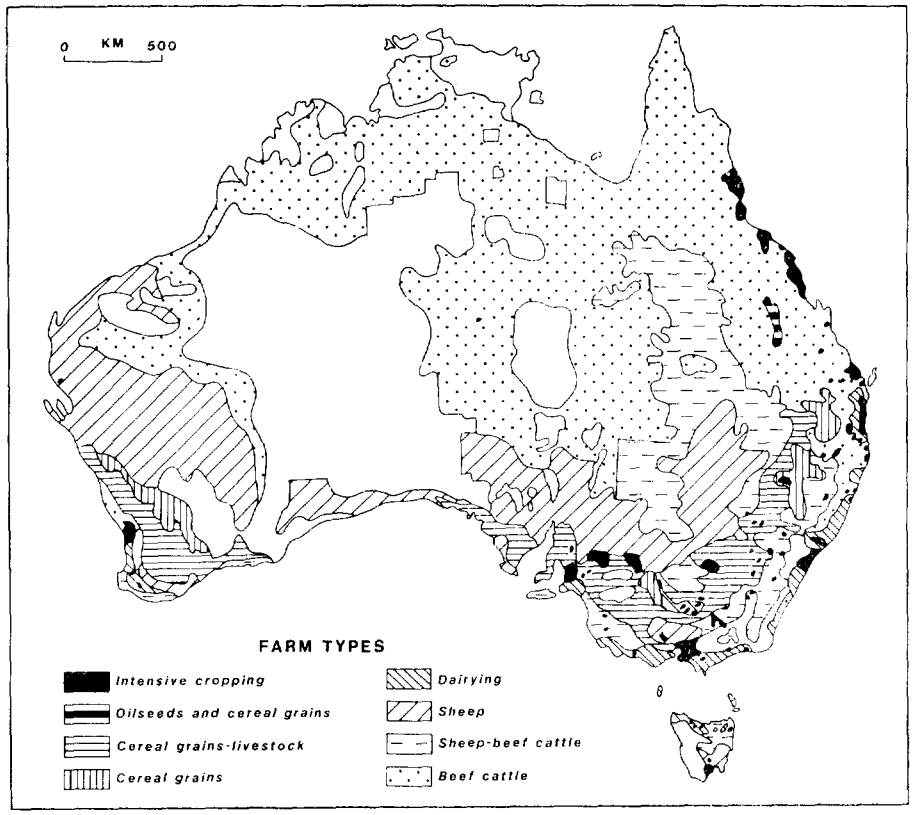

Fig. 1. Farm types in Australia. *Source*: Division of National Mapping, 1982.

2) Ilbery, B.W., 1985, *Agricultural Geography: A Social and Economic Analysis*, Oxford University Press, Oxford.
Brown, M.A., 1981, Behavioural approaches to the geographic study of innovation diffusion: problems and prospects, *in* Cox, K. and Golledge, R., eds., *Behavioral Problems in Geography Revisited*, Methuen, New York, 123-144.

research on resource development, and the nature and significance of some recent research on land resources. Australia furnishes a particularly pertinent perspective, for in the nineteenth century the settlement of its harsh, largely infertile and alien environment by European immigrants early necessitated experimentation, and ever since federation the need for continuing research on rural problems has been widely accepted. Today, despite recent reorientation of much national research and government incentives promoting R and D in manufacturing industry, the intensity of rural scientific research is almost certainly greater than for manufacturing or for the economy as a whole,[3] and compares favourably with expenditures on rural research in other western countries. Moreover, Australia's rural industries rank among the most efficient in the world, involving low inputs of labour and high inputs of capital per unit output, and yielding exceptionally high prouductivity per working (Fig. 1). An important factor in this achievement has been the moderately high level of continuing investment in scientific research and the widespread application of research findings.

(1) Returns to Rural Research

Nevertheless, the few Australian studies that have attempted to measure the retuns to rural research have considerable limitations. Studies of individual projects have yielded internal rates of return for sugar-cane research of 50 percent, and for pasture improvement research in the cereal-sheep belt ranging regionally from 22 to 68 percent[4] but studies analyzing specific projects tend to focus successes and ignore failure. A study of all the research carried out by the CSIRO Division of Entomology from 1960 to 1975 gave an internal rate of return of 19 percent but much of this benefit derived from the success of a single project involving the biololgical control of skeleton weed[5]. Hastings[6] attempted to analyze the returns to rural research in aggregate for Australia but while making allowance for weather variations, notably drought, he was unable to separate out the long-term effects of improved farmer education, and established merely a positive relationship between scientific research and aggregate productivity. By contrast, American studies have shown that for four separate periods the internal rates of return for all agricultural research in the United States ranged from 34 to 51 percent.[7]

Whatever may be the rates of return in Australia, it may be safely concluded that the returns to rural research are substantially higher than the returns to many publicly funded inves-

3) Australia, 1974, *The Principles of Rural Policy in Australia: A Discussion Paper*, Report to the Prime Minister by a Working Group, Australian Government Publishing Service, Canberra, 108.

4) Duncan,R.C., 1972, Evaluating returns to research in pasture improvement, *Australian Journal of Agricultural Economics*, 16, 153-168.
Evenson, R.E., Houck, J.P., and Ruttan, V.W., 1970, Technical change and agricultural trade: three examples-sugar-cane, bananas, and rice, *in* Vernon, R., ed., *The Technology Factor in International Trade*, Columbia University Press, New York.

5) Marsden, J.S., Martin, G.E., Parham, D.J., Ridsdill Smith, T.J., and Johnson, B.G., 1980, *Returns on Australian Agricultural Research*, The joint Industries Assistance Commission—CSIRO benefit-cost study of the CSIRO Division of Entomolology, Commonwealth Scientific and Industrial Research Organization, Canberra.

6) Hastings. T., 1981, The impact of scientific research on Australian rural productivity, *Australian Journal of Agricultural Economics*, 25, 48-59.

7) Arndt, T.N., Dalrymple, D.G., and Rattan, V.W., eds. 1977, *Resource Allocation and Productivity in National and International Research*, Agricultural Development Council/University of Minnesota Press, Minneapolis.

tment projects, notably the Murray-Darling irrigation schemes. In 1976 the Industries Assistance Commission recommended that aggregate public funding of rural research and development be maintained at its 1976 level in real terms but since then in real terms it has declined.[8] Recently, independent assessors have concluded, having regard to numerous considerations, that there is a prima facie case of under-investment in rural research in Australia.[9]

(2) Impact on Resource Development

Certainly substantial gains in rural productivity, whatever the precise extent, are attributable to research. Australia exports between two-thirds and three-quarters of its agricultural output, wool and wheat together accounting for one-half of the exports. Since Australia is the world's largest exporter of wool and the third largest exporter of wheat, an increase in the output of these commodities can significantly depress world prices for wool and to a lesser extent for wheat. But in general additional agricultural output resulting from research, as evidenced by the greatly expanded wool clip following the spread of myxomatosis and the decimation of the rabbit population in the early 1950s, has continued to be sold overseas with substantially augmented returns. At the same time, most research in Australia has sought to increase yields per hectare or per animal rather than to develop labour-saving machinery, and despite the vital role farm mechanization has played in the past and must continue to play in the future, agricultural engineering research represents no more than one per cent of the total expenditure on rural research.[10] Thus the fairly steady decline in the input of farm labour over recent decades stems less from the direct input of research than from the high cost of labour relative to other farm costs. In the absence of scientific research, costs would have risen faster than actually occurred, thereby accelerating the exodus of labour from the rural sector.

Most of the successful rural research in Australia has increased the productivity of existing agricultural land or has enabled hitherto unused land to be developed. An essential prerequisite for agricultural progress throughout this century has been, and will continue to be, an expanding regional knowledge of how to grow better plants and produce better animals.[11] Foremost among the achievements in plant breeding, given a largely postoral economy, has been the development of new pasture plants, notably subterranean clover (*Trifolium subterraneum L.*) in southern Australia. In the third quarter of this century the area under sown pasture quadrupled, accounting for nearly one-half the increase in livestock numbers and wool production.[12] Many other crops, notably wheat, oats, and sugar, have long comprised locally bred varieties, though for some other plants breeding programs have been inadequate or too long delayed. The sheep industry early developed on the basis of the

8) Industries Assistance Commission, 1977, *Financing Rural Research*, Commonwealth Government Printer, Canberra.

9) Jarrett, F.G. and Lindner, R.K., 1982, Rural research in Australia, *in* Williams, D.B.,ed., *Agriculture in the Australian Economy*, Sydney University Press, Sydney, 83-105.
Stoeckel, A., 1986, Australian agriculture: what is the future?, *Quarterly Review of the Rural Economy*, 8, 153-166.

10) Australia, 1974, *op. cit.*, 111.

11) Donald, C.M., 1982, Innovation in Australian agriculture, *in* Williams, D.B., ed., *Agriculture in the Australian Economy*, Sydney University Press, Sydney, 55-82.

12) Vere, D.T. and Muir, A.M., 1986, Pasture improvement adoption in southeastern New South Wales, *Review of Marketing and Agricultural Economics*, 54, 19-32.

Merino, a breed of Spanish origin more tolerant of high temperatures than British breeds. But only recently have tick-resistant, heat-tolerant Zebu or part-Zebu cattle (*Bos indicus*) been widely adopted in coastal and adjacent parts of Queensland, while British-European breeds (*Bos taurus*) continue to dominate the beef and dairying industries. In the postwar years the development of the Ninety Mile Plain in South Australia and the Esperance country of Western Australia, to cite only two prominent examples of new land brought into production, has been a direct response to successful biological research in these regions.

Since the additional rural profitability generated by successful scientific research is capitalized into the value of land, the realization of a capital gain arising from research confers benefits on marginal farmers forced into other occupations. In effect, such farmers receive a 'golden handshake' not enjoyed by manufacturing firms displaced by technological change. Moreover, because the incomes of farmers remaining on the land are generally higher than they would have been in the absence of technological innovation, research assists the adjustment process by increasing the funds available to buy out those forced to quit farming.

(3) Research on Land Resources

One area of rural scientific research in which geographers have made a distinguished contribution but one which, so far as I am aware, has never been subjected to cost-benefit analysis is rural land use research. This area aims at fostering improvements in the use of land and water resources, and at providing authorities responsible for national and regional land use decisions with better methods of collecting, processing, and using data on resources. In the early postwar years the Commonwealth Scientific and Industrial Research Organization (CSIRO) established an international reputation for its pioneer reconnaissance resource surveys in northern and central Australia. This outstanding achievement has been followed by the development of quantitative, computer-based models of land evaluation for a wide range of potential alternate uses, such as agriculture, forestry, conservation, and recreation. In other research institutions Hill and Kelly[13] have developed a method for applying the digital analysis of Landsat imagery to updating the land systems data derived from the postwar surveys. Meanwhile, to cite an example of CSIRO's current work, Laut[14] has used data not only from the land systems surveys and Lansat but also from topographical and geological maps to evalute the difficulties landscape imposes on livestock mustering throughout northern Australia. The degree of difficulty in livestock mustering is then incorporated with probable livestock numbers, mustering costs, livestock turnoff, and transport costs to model the implications of current government policy on livestock disease control in northern Australia aimed at eradicating bovine brucellosis and tuberculosis by 1992.

Rural land management research as distinct from land use research seeks to investigate the environmental and social implications of alternate management methods in agricultural, pastoral, and forest areas, and to develop methods for processing, evaluating, and communicating information to assist decision makers. In this respect it is in the management of Australia's arid rangelands with their vast spatial scales and

13) Hill, G.J.E. and Kelly, G.D., 1986, Integrating Landsat and land systems for cover maps in southern inland Queensland, *Australian Geographical Studies*, 24, 235-243.

14) Laut, P., 1986, Land evaluation for bovine tuberculosis eradication in northern Australia, *Australian Geographical Studies*, 24, 259-271.

low land values that satellite imagery and computer models have outstanding utility. In central and mid-northern Australia the low returns from grazing limit the prospects for treating eroding areas, which make up a third of the arid zone; but grazing needs to be regulated to maintain an adequate vegetation cover. Pickup and Smith[15] are developing techniques to recognize the attributes of eroding systems and to model their behaviour over space and time. Such models aim to integrate soil dynamics, animal behaviour, and vegetation response into a management system for use by arid land managers.

2. Farm resources

In recent decades the application of scientific research and new technology to agriculture in advanced economies has been a vital component of farm investment and rural development. Agricultural geographers have examined many aspects of the resultant changes in farming systems, notably the intensification of agriculture, the increase in farm size, and the movement of labour out of farming. In this address no reference will be made to labour as a farm resource, since labour resources in agriculture have been extensively studied by geographers[16] However, scant geographical analysis has been made of the growth in farm capital and at the same in rural indebtedness as well as of changing land values and the return to farm capital. These neglected aspects of farm resources in advanced economies are discussed by reference to Australian agriculture.

To gain some insight into the spatial manifestations of farm capital in Australia, it is necessary to employ data derived from the sample farm surveys undertaken by the Bureau of Agricultural Economics (BAE). Until the 1980s the BAE undertook industry surveys from time to time but in no year were all the major industries covered, the data from various surveys were not readily comparable, and some industries were never included. After 1980 the BAE amalgamated specific industry surveys into a single, broadly based, annual survey, which not only provides coverage of almost all the major farm types but ensures a high degree of consistency in the results. In 1983～84 the BAE changed substantially its sample design and industry coverage by adopting the Australian Standard Industrial Classification (ASIC) used by the Australian Bureau of Statistics in reporting agricultural and manufacturing statistics. Accordingly the annual surveys now cover wheat and other crops, mixed crop-livestock, sheep, beef, sheep-beef, dairying, and horticultural industries. On this basis final data are available for only 1983～84, a year following a disastrous drought, and 1984～85, a generally buoyant year in the pastoral industries, an average year for grain growing in eastern Australia, and a record year for cereal grains in Western Australia. It was decided to use the 1984～85 data which are available in published form only by state and industry type[17] Some additional data for that year are also available for sugar, tobacco, rice, and cotton growing, the only industries omitted being tropical fruits and vegetable production.

15) Pickup, G. and Stafford Smith, D.M., 1987, Integrating models of soil dynamics, animal behaviour, and vegetation response for the management of arid lands, *Australian Geographer*, 18, 19-23.

16) Scott, P., 1981, *Australian Agriculture: Resource Development and Spatial Organization*, Akademiai Kiado, Budapest, 49-55, 67-69.

17) Bureau of Agricultural Economics, 1987, *Farm Surveys Report*, Australian Government Publishing Service, Canberra.

(1) Farm Capital

Australian agiculture is highly capitalized, and whether measured by capital per labour unit or per unit of output is considerably more capital intensive than manufacturing industry. Modern farms in order to expand productivity require increasingly inputs of working capital, capital for equipment, and developmental capital. In recent decades the growth in average farm capital contrasts sharply with the decline in the area of agricultural land, in the size of the agricultural workforce, and especially in the number of hired workers. Farmers have substituted capital for labour in response to rising wage levels, and increasingly employ contract labour for specialized operations. By investing in technology farmers have sought to expand their businesses, boost output, and increase efficiency. The scale of farm capital is thus a valuable index to the size of farm businesses.

Average farm capital including land tends to be lowest in the intensively farmed, high-rainfall or irrigated country in southeastern Australia, and to be highest in parts of the wheat-sheep belt and throughout the expanse of vast pastoral holdings in the north and northeast (Fig. 2). Inputs of less than $ 500,000 per fam typify dairying in Victoria and Tasmania, Australia's premier dairying states, and tobacco farming at Myrtleford in northeastern Victoria and Mareeba in north Queensland, while inputs of less than $ 250,000 characterize fruit farms; the lowest inputs of all are to be found in viticultural

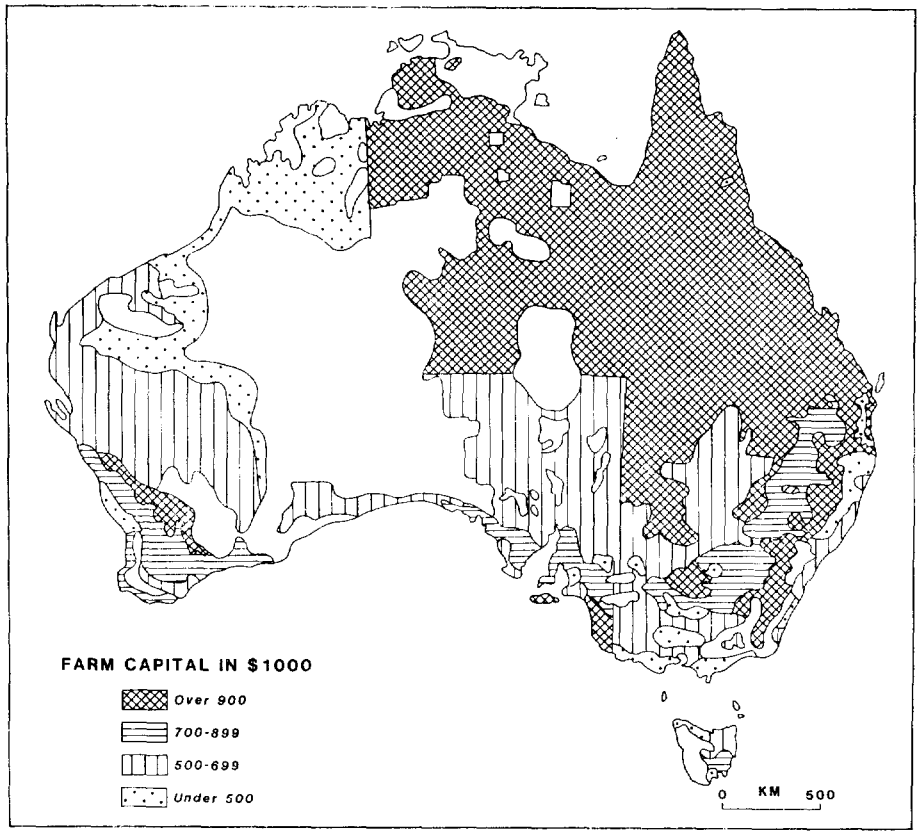

Fig. 2. Capital input (including land) per rural property, 1984~85. *Source*: Bureau of Agicultural Economics, 1987.

regions, notably on irrigated properties along the River Murray in South Australia. Sheep farms tend to have inputs just below the national average for all farm types of $650,000, while dairy farms in Western Australia have substantially higher inputs. Farm types with generally above-average inputs are, in ascending order, beef, cereal, cereal grains, and sheep-beef properties but the average capital input on beef-cattle farms varies widely among the states. The pastoral holdings of northeastern New South Wales and Queensland have an average input exceeding $1 million, the modern, highly mechanized, and irrigated cotton farms along the Namoi Valley in northern New South Wales have an average input approaching $2 million, and the cattle stations of the Northern Territory have an average input of nearly $2.5 million.

Company ownership dominates the pastoral industry in the Northern Territory, where land is held in long-term leases that are bought and sold virtually freehold. The southern drier region around Alice Springs has a predominance of single-leasehold owner-occupied stations that exhibit the most favoured central region lying between lats. 15° and 20°S and including the western Barkly Tablelands is now dominated by multileaseholding Australian Companies; and the wetter northern region focussed on Darwin has the largest concentration of foreign-owned leaseholds which also occur to a lesser extent in the central region.[18] Foreign ownership, which includes increasingly Southeast Asian and Middle East interests as well as traditional British and American interests, and Australian companies each hold nearly one-fifth of the leasehold area of the Northern Territory. Foreign ownership accounts for 5 per cent of rural land in Queensland, the state with the second highest ratio. Significantly the adoption of Townsville stylo (*Stylosanthes humilis*) an annual pasture legume, in the beef cattle industry of the Northern Territory in the sixties occurred mainly on company-owned leases.[19] Thus in 1969, of an estimated 52,000ha under Townsville stylo on 138 properties, no less than 19,700 has, or 38 percent, was located on only 16 foreign-owned leases, and 11,900ha, or 23 per cent, on 17 leases owned by Australian companies. Unfortunately the innovation proved disappointing because the legume required sophisticated levels of pasture husbandry and herd management without precedent in the Territory cattle industry.

A similar situation regarding pasture improvement prevailed in the pastoral industry of northwestern Queensland. In 1984 pastoralists with whom I discussed research potential and innovation adoption attributed the slow spread of Townsville stylo in north Queensland to the high level of management required, and claimed that the capital needed for water, fencing, and yards was beyond the resources of most owner-occupiers. They also claimed that in some places where pastures had been improved, increased stocking rates had caused land degradation. However, one pastoralist on the Gulf of Carpentaria had found it cheaper to improve pasture than to buy more land, and cheaper to use plastic piping to facilitate rotational grazing than extend fencing. Many pastoralists held that in their experience pasture was not the limiting factor in stocking rates; the main limitations were water and handling facilites, namely fences and yards. Suggestions were made for new technology, notably simple, cheap wind/solar

18) Rawling, J., 1987, Capital, the state and rural land holdings: the example of the pastoral industry in the Northern Territory, *Australian Geographer*, 18, 23-32.

19) Mollah, W.S., 1987, Townsville stylo, a pasture innovation for Northern Territory beef cattle production, *Austratian Gographical Studies*, 25, 26-40.

devices to supplement imported power, electronic monitoring of watering points to reduce the frequency of inspection, and cheap fire-resistant fencing. Clearly pastoralists attach more importance to agricultural engineering research than the one per cent accorded it in national rural-research expenditure.

(2) Rural Indebtedness

In recent decades the increasing need for additional farm capital has necessitated supplementing internally generated funds and the proceeds from off-farm investment with loans from banks, government agencies, pastoral finance companies, and other sources. The year 1984~85 saw by far the greatest increase in the level of institutional rural indebtedness in Australia's history. In that year despite high interest rates, the amount grew by no less than $1,310 million, or by 22 per cent, to total $7,327 million on 30 June 1985. At that date the average farm debt for all farm types surveyed expressed as a percentage of farm capital was 10.6. A year later, when the level of institutional indebtedness had risen by $808 million to $8,135 million, the ratio was 11.7 per cent. Annual changes in farm indebtedness not only for the rural sector as a whole but more especially from region to region reflect variations in seasonal conditions, the economic situation, and in the capital and credit needs of specific farm enterprises.

Nevertheless, as Figure 3 shows for 1985, the level of farm indebtedness tends to be higher

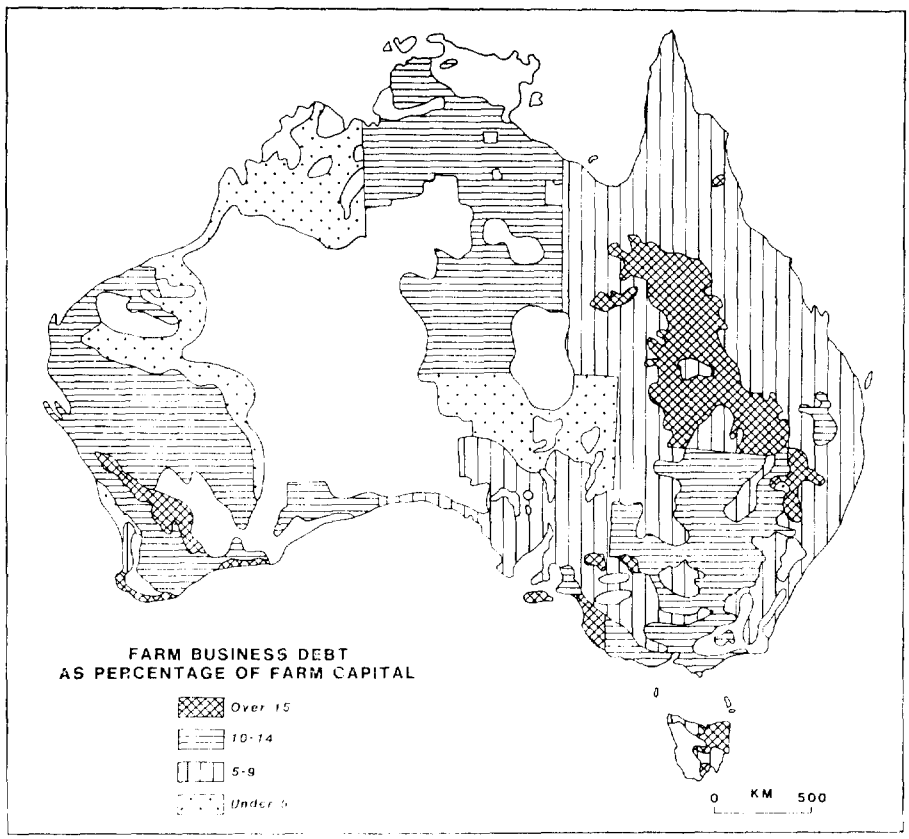

Fig. 3. Farm business debt as a percentage of farm capital per rural property, 1984~85.
***Source*: BAE, 1987.**

in the higher rainfall regions of southern Australia, where the average level of capital input pet farm and therefore of asset backing for loans is lower but where annual fluctuations in output also tend to be lower (cf. Figs. 2 and 3). The highest ratios of debt to farm capital tend to occur among horticultural properties which also have the lowest capital input; in the Sunraysia irrigation area of New South Wales and in the Goulburn Valley of northern Victoria the ratios exceed one-quarter. In many other, more intensively cropped regions high levels of farm indebtedness coincide with modest levels of capital input, notably among rice farms in the Murrumbidgee Irrigation Area (MIA) and tobacco farms in Victoria and Queensland, but high levels of farm debt also coincide with substantial capital input on extensive cereal-grain farms in northern New South Wales, Queensland, and Western Australia. The lowest ratio of debt to capital—a mere 2 per cent—is a feature of the irrigated cotton farms in northern New South Wales. Some pastoral properties, particularly in central Queensland and the Northern Territory, combine high levels of indebtedness with high capital inputs but despite considerable fluctuations in annual cash flows these properties, many of which are company controlled, have outstanding ability to service debt. It should be stressed however that Figure 3 portrays debt-capital ratios averaged per property; farms vary widely in their level of indebtedness, and in 1985 some 28 per cent were debt free.[20]

Even so it is pertinent to note in this context the comments made by Queensland pastoralists on new technology, some of which are reported above. In 1984 they contended that the pastoral zone-and perhaps other agricultural zones as well—require first and foremost low—cost technology. Research findings that require high inputs of capital or management expertise might well have poor acceptability. Since many pastoral properties have their own infrastructure services for power generation, water supply, and plant maintenance, and since staff are required to handle a range of services, technological innovation needs to be simple to apply and reliable. External maintenance causes delays and added costs. It is in fact ironic that the pastoral zone has long exhibited a generally inverse relationship between property development and profitability.

(3) Rural Land Values

Since the farmer's equity is a key factor in his ability to secure loans, the patterns of farm capital and farm debt need to be viewed in the light of trends in farm-resource values. Foremost among these trends are movements in rural land values, a major component of farm capital, especially in the cereal-sheep belts and the higher-rainfall regions of southeastern and southwestern Australia[21]. For BAE surveys market land values are assessed by the Commonwealth Development Bank, which provides finance to the rural setor for specified putposes, and the Reserve Bank of Australia. From time to time market values depart widely long-term trends in economic rent but they reflect changes in agricultural productivity, farm profitability, and economic prospects.[22]

From 1976 to 1981 rural land values in Australia tended to rise on average by some 20 per cent a year, from 1981 to 1983 they remained

20) Australia, 1986, *Economic and Rural Policy: A Government Policy Statement*, Australian Government Publishing Service, Canberra, 38.

21) Scott, P., 1981, *op. cit.*, 60.

22) Scott, R.H., 1986, *The Value of Land in Australia*, Centre for Research on Federal Financial Relations, Research Monograph No. 47, The Australian National University, Canberra,

more or less constant, and then from 1983 to 1985 they resumed their upward climb, only to peak in mid-1985 and fall.[23] These national trends, which should be discounted for inflation (averaging 10 per cent a year in the late 1970s and early 1980s and just under 10 per cent in the mid-1980s), mask significant differences among the states. In the Northern Territory real land values (i.e. allowing for inflation) peaked in 1980, fell to 1982, and have since been rising. In other regions of extensive pastoralism values peaked in Western Australia in 1983, and in New South Wales and South Australia in 1984; in Queensland they continue to rise. In the mixed crop and livestock farming regions real land prices flattened out in New South Wales from 1981 to 1985 before declining, peaked in South Australia in 1982, in Queensland 1983, and in Victoria and Western Australia in 1984. These differences among the states in land-value trends in turn hide considerable intrastate variations resulting from inter alia differential movements in the cost-price relationships of farm enterprises.

Within this context may be seen the spatial pattern of changing real land values from 1985 to 1987 (Fig. 4). In the Northern Territory, corporate interests and buoyant beef prices prompted a significant rise in land prices, amounting to almost 20 per cent or twice the rate of

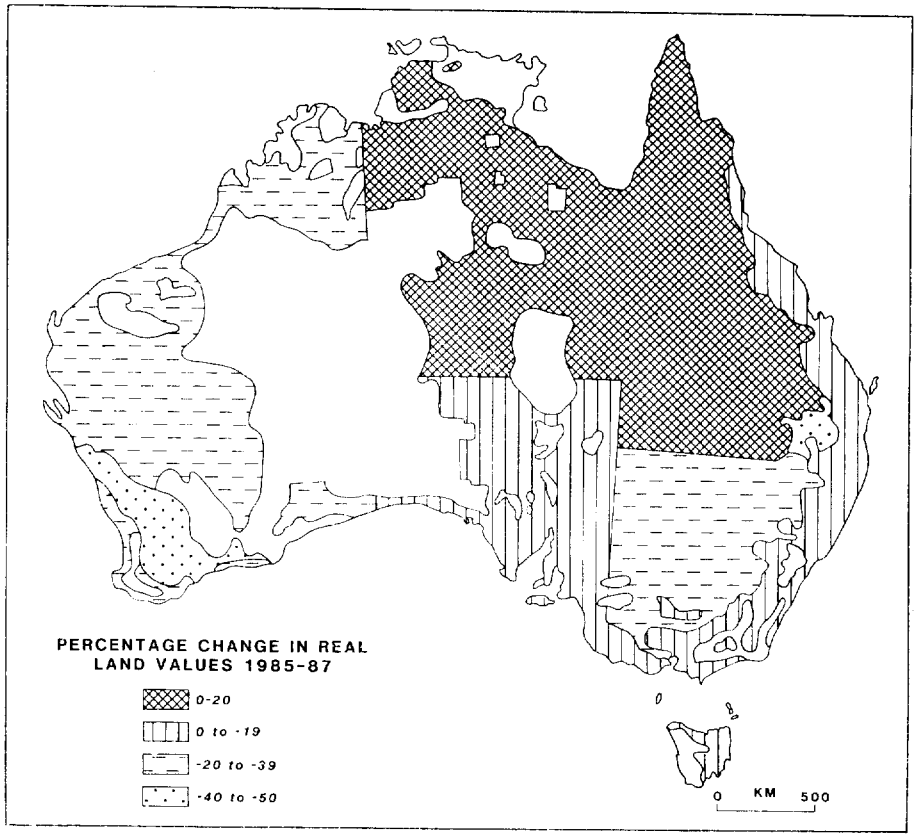

Fig. 4. Percentage change in real land values, June 1985 to June 1987. ***Source*****: BAE, 1987.**

23) Hall, N. and Backhouse, M., 1987, Performance of the farm sector, *Farm Surveys Report*, Australian Government Printing Service, Canberra, 1-20.

increase in central and western Queensland. By contrast, regions of mixed crop and livestock farming and cereal-grain growing in southern Queensland Western Australia experienced a dramatic fall in values, amounting to nearly 50 per cent; the fall reflects the low and uncertain returns from wheat and to a lesser extent other cereal grains over this period. Substantial but less striking falls occurred in the inland pastoral regions of southestern Australia and in Western Australia, while modest declines characterized the higher rainfall regions of southeastern and eastern Australia. These trends and their spatial manifestations help to explain inter alia not only the constraints on many farmers to obtain additional funds for financing farm operations but also why farmers in financial dificulty may be reluctant to sell their farms in times of economic downturn. On the other hand, low land prices enable other farmaers enjoying good returns and servicing small debts to expand farm size and gain economies of scale. In mid-1987 record land purchases by companies and owner-occupiers alike in the cereal-sheep and cereal-grain belts, at least in Western Australia, heralded a possible turning-point in the movement of land prices[24]. Even in the drier, riskier, cereal-grain belt, properties were being sold, chiefly for grazing in response to high wool prices rather than cropping.

(4) Returns to Capital and Mangement

Short-term changes in land values can have an important bearing on farm performance. While most farms perform more or less consistently on various criteria, others exhibit sharp contrasts between farm income and investment returns[25]. Thus in 1984～85 the Northern Territory cattle stations returned the highest average farm income ($60,000) of any farm-type region but the rate of return on capital and management together with rent and interest was 1.8 per cent not allowing for capital appreciation, and −1.4 per cent including capital appreciation; the real rate taking inflation also into account was −5.7 per cent, among the lowest regional rates recorded. From 1985 to 1987 real land values in the Northern Territory showed the greatest regional increase, on mid-1987 estimates for 1986～87 average farm income was projected to be $98,000, and the real rate of return no less than 12.3 per cent, the highest regional rate in Australia. This example also illustrates vividly the returns to very large scale achievable in northern Australia and the fluctuations that can occur in pastoral returns.

In 1984～85 the real return furnished by the resources employed in the farm business revealed both marked regional variation and graphic illustration of acute economic pressure on Australian agriculture. A wide variation in the real rate of return characterized pastoral regions, regions with similar pastoral farm type, and horticultural regions, while all regions of grain farming and mixed crop and livestock farming, except cereal-sheep farming in southeastern Queensland, gave negative returns, though none strikingly so (Fig. 5). Many cereal-sheep and specialist grain farmers who responded to the cost-price squeeze in the past decade by purchasing machinery and additional land were facing difficulty in servicing their debt. In general, eastern Australia, except for the cereal-sheep belt, performed better than the rest of the country, except for cattle grazing in northern South Australia and dairying near Adelaide. Yet even in eastern Australia, aside from central Queensland sheep-beef farms and horticulture in

24) *The Australia*, 7 August 1987.

25) Campbell, D., 1981, Some issues in the assessment of farm performance, *Quarterly Review of the Rural Economy*, 3, 47-57.

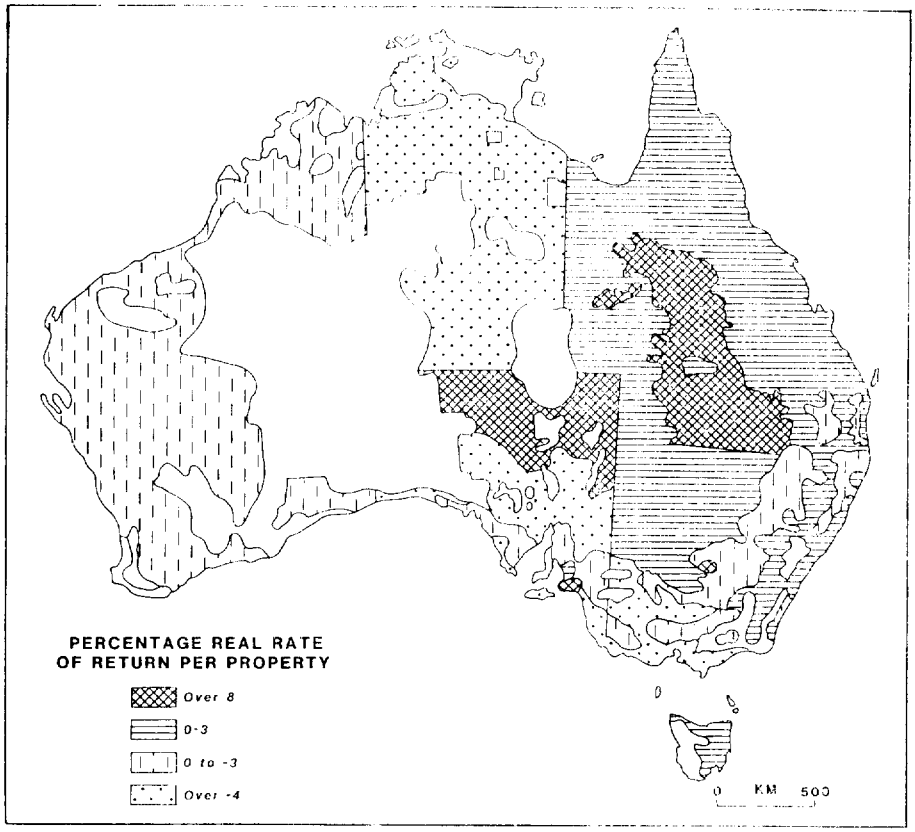

Fig. 5. Real rate of return to capital and management, including interest and rent, allowing for capital appreciation and inflation, per rural property, 1984~85. ***Source*****: BAE, 1987.**

the MIA, no region returned a rate greater that 8 per cent (no region had a rate between 4 and 7 per cent). In 1984~85 the average rate of return for all farms surveyed was −1.1 per cent.

3. Conclusion

In Australian agriculture, therefore, the level of capital input is generally high, indebtedness has recently shown record growth, real land values over most of the country have fallen sharply, and the real rates of return to capital and management are generlly negative. In such circumstances it may be contended that an increase in rural research and technological development would increase productivity and reduce costs. Several recent studies have indicated numerous opportunities for cost-saving technological innovation[26]. In the sheep industry, for example, savings of about $7,500 per farm per year could resut from the elimination of internal

26) Johnston, B. and Girdlestone, J., eds., 1983, *Implications for Future Research of Recent Developments and Trends in Agriculture*, A report prepared jointly by the Bureau of Agricultural Economics and the Commonwealth Scientific and Industrial Research Organization, Canberra.
Heussler, J.H.S., 1985, *The Role of Rural Research in Australia, 1985~2000: A Discussion Paper*, Commonwealth Scientific and Industrial Research Organization, Canberra.

and external parasites[27]. But the potential for cost saving is not sufficient justification for invoking expensive research, since many other factors also affect the choice of projects and the scale of research. Certainly formidable problems confront research managers in the selection of projects having the greatest potential for medium-term solution and for yielding the highest returns, as evidenced by the remarkably successful CSIRO research on skeleton weed which at one stage was almost abandoned. Notwithstanding these and other considertions, the current economic situation within the rural sector in Australia is symptomatic of the need for fundamental long-term adjustment, which will stem, at least in part, from successful scientific research, thereby increasing still further the demand for farm capital.[28]

This address has focussed on two facets of the rural scene vital to its future development: agricultural research and capital input. Although Australia presents many agricultural features more akin to those of Canada and the United States than to much of the Pacific region, some features at least have wider implications. Corporate interests with substantial assets are not only assuming ever growing significance but play a key role in both innovation adoption and land-price movements. Owner occupiers of farms look to rural research to provide simple, cheap, and reliable new technology rather than technology requiring high levels of capital input and/or management expertise. In the present economic climate it is scarcely surprising that recently introduced government policy, requiring rural industries to increase their levels of research funding in order to gain additonal matching public funds, has not been an unqualified success.[29] Certainly abundant scope exists for inter alia in-depth analyses of the economic payoff to new technology, into the adoption of new technology within a range of farm types and under varying economic conditions, and finally into the role of capital in rural systems undergoing structural change and adjustment.

27) Beck, A., Moir, B., and Meppem, A., 1985, The cost of parasites to the Australian sheep industry, *Quarterly Review of the Rural Economy*, 7, 336-43.

28) Jarrett and Lindner, 1982, *op. cit.*, 105.

29) Australia, 1986, *op. cit.*
Stoeckel, 1986, *op. cit.*

農業資源의 科學的 硏究 및 農村開發 : 오스트레일리아의 事例

Peter Scott*

이 연구는 지리학에서 크게 관심을 모으지 못해왔던 농촌의 자원과 개발에 관한 것으로 크게 두 부분으로 분석되었다. 그 하나는 과학적 연구와 새로운 기술의 발달이 농촌자원 개발에 미친 공헌이고, 다른 하나는 기술개발에 투입되는 농업자본의 지역적 분포에 관한 것이다. 이러한 사항들과 관련하여 오스트레일리아는 특별한 관심을 갖게 한다. 이나라에서는 19C초에 대단히 불리한 환경에 정착하기 시작한 유럽인들이 당면한 농업문제에 대하여 연구하지 않을 수 없었으며, 그 이후로 오늘날까지 국가적인 많은 연구와 정부의 장려정책이 제조업의 R & D에 우선권을 주고 있음에도 불구하고, 농촌문제에 관한 연구의 정도는 제조업보다 더 클뿐 아니라 기타 경제 전체에의 것보다 더 크다. 또한 이것은 기타 서방 국가에서 농업문제 연구에 들이는 투자와 비교할 때 더 큰 비중을 가지고 있다. 농촌문제 연구의 성과를 측정하는 조사는 지금까지 거의 없었으나, 이러한 농촌연구는 다른 어느 공공기관에 의한 연구비 지출에 대한 성과보다 상당히 높은 것으로 결론을 내려도 좋을 것이다. 더우기 오스트레일리아에서는 농촌문제 연구에 대한 자금지원이 미흡한 실정이다. 오스트레일리아에서 여러 성공적인 농촌문제 연구들은 기존 농촌 토지 이용의 생산성을 크게 증가시켰거나, 또는 사용되지 않던 토지를 개발하는데 크게 도움을 주었다.

지리학자들은 농촌문제 연구에 크게 공헌하여 왔지만, 비용—수익성 분석에서 아직 검토되지 않은 분야는 농촌 토지이용에 관한 분야이다. 오스트레일리아에서는 광범위한 지역에 걸친 토지의 다양한 이용 가능성에 대하여 평가할 수 있는 계량적 분석을 통한 모델을 개발하여 농촌토지 이용 연구를 발전시켜 왔다. 이와 관련된 분야는 초지 관리에 관한 연구로, 인공위성 자료와 콤퓨터를 이용한 모델을 사용하여 광대한 지역에 펼쳐진 방목지의 관리에 크게 이용되고 있다.

노동력에 대한 자본비율, 또는 생산량에 대한 자본비율로 볼때, 오늘날의 오스트레일리아의 농업은 자본이 고도로 집약되어 있으며, 제조업에서보다 상당히 더 자본집약적이다. 농업에 투자된 평균 자본이 최대치를 보이는 곳은 집약농과 강우량이 많은 오스트레일리아 남동부 지역이고, 최저치를 보이는 곳은 중앙부와 북부의 광대한 목장지대에 펼쳐진 밀과 면양지대이다. 더 많은 농업자본이 다양한 재원에 의하여 투자되어야 할 필요성이 있다.

농가채무는 일반적으로 강우량이 많은 오스트레일리아 남동부에서 최대인데 이 지역은 농업생산량의 변동이 대단히 적은 지역이다. 그러나 이나라 전 농가의 약 1/4은 농업채무가 전혀 없다. 농가의 자산정도는 농가 부채를 상환할 수 있는 능력 평가에 중요한 요소이기 때문에 농촌의 토지가격은 상당한 중요성을 갖는다. 농촌토지가격은 1985~1987년기간의 최고기가격 상승으로 목장토지가격이 크게 증가한 반면, 자금난을 겪고 있는 다른 지역에서는 토지가격이 거의 45%나 하락하였다. 그러나 이러한 자금난 지역에서도 농부들은 농토를 매각처분하기를 꺼려하

편집자 註 : Peter Scott은 현재 International Geographic Union의 회장으로 재직하고 있으며, 이 논문은 특별기고로 1987년 8월 서울에서 열린 제16차 태평양 과학대회(Pacific Science Congress)에서 지리학 분야를 대표하여 강연한 것입니다.

는 한편, 이들 지역의 토지가격이 대단히 낮은 장점 때문에 높은 수익성을 갖는 농부들은 토지를 매입하려고 할 것이다. 이러한 단기간의 토지가격변동은 토지자본과 토지관리에 따른 수익률에 영향을 줄 것이다.

이 논문에서는 앞으로의 오스트레일리아 농촌발전에 농업연구와 자본투입의 중요성에 관해서 살펴보았다. 오스트레일리아는 농업의 여러면에서 비록 미국이나 캐나다와 유사한 점이 많지만, 어떤면에서는 더 폭넓은 점을 제시해 준다. 기업적 농업이 중요한 위치에 있는것 이외에도, 새로운 기술혁신과 농촌토지가격 경향에도 이들 기업은 중요한 역활을 하고 있다. 오스트레일리아의 농업부문과 관련된 현재의 경제적 여건을 보면, 농촌문제에 관한 과학적 연구와 이에 따른 농업자본의 수요가 증대되어야 되는 근본적이고, 또 장기적인 대책을 필요로 하는 징후가 보인다. 농업연구에서 정부의 자금지원을 받기 위해서는 민간부문에서의 연구를 선행조건으로 하는 새로운 정책이 성공을 거두고 있는 것은 놀라운 일이 아니다. (번역 황만익 : 서울대학교 지리교육과 교수)