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farm policy

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farm policy

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by HENRY P. SCHAPPER.

Farmers, Scientists and Economists

Still closer co-operation between farmers, scientists and economists will enhance the prosperity of Australian agriculture whatever the price of wool, whatever the cost of superphosphate, whatever the weather conditions, and whatever the political situation. This article summarises the opening address to the Sixth Farmers' and Scientists' Joint Conference in which the author outlined a number of policy suggestions for integrating and furthering the common aims of farmers, scientists and economists.

The volume of Australia's agricultural production has barely kept pace with the growth of the nation's population during the last five decades. It has not kept pace with the national income or with the demand for imports. For the future it seems that if import demands are to be satisfied the volume of non-agricultural exports must continue to increase faster than agricultural exports.

The male work force on Australian farms has remained about the same as it was in 1921 and the female work force on farms has declined. Thus full employment of an increasing population implies the need for employment outlets in non-farming occupations. It is this need which is likely to determine the sources of future increases in export earnings rather than the comparative economic advantage of Australian exports of agricultural output alone.

Agriculture's role in the economy as almost the sole source of export earnings already has declined to that of a major source, and it may be expected to continue to decline further. Even so, inadequate increases in export earnings are likely to be one of the major bottlenecks to faster national economic growth, and agriculture will continue to be the main source for a long time to come. As in the past, its precise contribution will be strongly influenced by foreign and local market conditions for its output and of its inputs, and by the adoption by farmers of technological developments as they emerge from advances in the agricultural sciences and engineering. However, Australian agriculture will continue to be influenced, and possibly become

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dominated, by the relatively new set of economic and social forces of industrialisation in Australia. These may be expected to be both competitive with and complementary to agriculture.

Implications of Advances in Farm Technology

Despite an unchanged farm male work force there has been a twofold increase in the volume of agricultural production from 1921 to 1961. This is the net result of the interaction of the adoption by farmers of, and their investment in, technological advances, social investment in irrigation, railways, roads and land settlement, farmer investment in land improvement, and changes in agriculture's national and international terms of trade. Each of these factors also is the net result of numerous social and economic forces. For instance, technological advances in agriculture are the outcome of investment in the scientific research and development undertaken by governments, universities and private companies in this and in other countries, and of the inventiveness and ingenuity of numerous experimenting and innovating farmers. I have often thought it is a pity that there is no way of giving formal recognition to farmers for technical developments made by them. I suspect that agricultural scientists and technologists sometimes get more credit than is justified for what are in fact farmer-scientist observations and developments. I suspect also there is a wealth of undeveloped ideas and of farm technology held by numerous farmers throughout Australia worth continual and organised exploitation by Departments of Agriculture.

Wide adoption of these advances by farmers is partly the result of the work of the extension service of Departments of Agriculture and of private companies; it is partly the result of formal agricultural education given at agricultural colleges, of tax incentives and of prices and credit conditions favourable to investment in agricultural productivity.

Social investments in irrigation appear to be the result of widely held views that public works of this sort are necessary for the economic development of Australia; that intensive agriculture is superior to extensive agriculture; that unused water resources should be developed; and that money from outside sources spent within a State is money well spent on national account.

Other social investments in Australian agriculture such as roads, railways, comprehensive water schemes and settlements are also the result of political pressures to satisfy sound and unsound economic and social demands. Farmers' investment in land improvements have been due to easy access to large tracts of land, to the development of a technology permitting a wide labour-land ratio and to adequate finance and favourable income expectations.

The land resource situation in Australia, and the technological and economic conditions in agriculture, do not lead to the expectation that the farm work force will increase greatly from its forty-year-old level. It may even be a necessary condition for the continued prosperity of Australia's farmers that the tens of

millions of acres of land suitable and still available for agricultural and pastoral use are developed in the coming decades without substantial increase in the farm work force. Continuing research and development in agricultural science and technology as a major source of improvements in input-output ratios would be required, however.

The Scientist

Not everybody who uses scientific methods is a scientist. I define the pure scientist as one who researches within or from the pattern of concepts acknowledged by the relevant scientific community to be the appropriate base for further development of these concepts. This immediately marks off the inventor, the engineer, the technologist, none of whom is primarily concerned with the further development of this pattern of concepts. The scientist, and it is the pure scientist of whom I am speaking, is concerned simply to develop an increasingly detailed and refined understanding of nature. Unlike the applied scientist and the technologist he is not application-directed. He does not attempt to extend knowledge towards social usefulness. Rather, he endeavours to extend knowledge from the existing pattern of concepts or from the body of theory which constitutes his particular science.

This has both philosophical and policy implications. The major philosophical point which emerged from Darwin's theory of evolution, for instance, was that natural selection alone was responsible for the process of biological development from primitive beginnings, but towards no goal. Until Darwin's theory, evolution was thought of as a goal-directed process; the unfolding of a pre-existing plan of life. The biological scientist no longer seeks the plan of life. He seeks further understanding of life from what is currently scientifically acceptable, though what is accepted is often an obstacle to further understanding. The pure scientist is not a problem-solver in the sense of the applied scientist, who is a user rather than a developer of science. However, there is a two-way interaction between developer and user, between pure science and applied science and between science and technology.

The implication for policy, of the distinction between the developments in science and their absorption in applied science and technology, is that technological progress is dependent upon and demands social investment in scientific progress. Understandably, science is increasingly governmentally sponsored and an expanding activity of national governments. Thus policy-makers have the problem of determining the suitable level of investment in scientific research. Although the pure scientist himself is not application-directed, it is possible to direct social resources into particular fields of pure science and into their associated technologies; witness the recent advances in nuclear physics and nuclear weaponry. What is the right level of investment in science and which sciences should have priority for development are problems to which policy-makers, scientists and economists are paying increasing attention, and to resolve them is not easy.

These problems are further complicated by a necessary feature of science, namely the freedom of each scientist to communicate with his relevant independent scientific community. This is the only acceptable source of judgement as to the value of his scientific findings. This scientific community is undefined and therefore the final communication in science must be open publication. This inadvertently ensures that scientific findings sooner or later cross national boundaries; in fact, it is sooner. Consequently a country investing more heavily in pure science research could subsidise, in the first round of the application of findings, another country, whose research resources are more heavily involved in technological development. Some persons believe this to have been the case of Britain vis a vis that of U.S.A. for many decades up to the present.

A further difficulty for policy-makers is that the pattern of concepts in science need not be right to be useful. This point is sometimes not understood by farmers whose life experiences require that they should trust only the evidence of their senses rather than the workability of elaborate concepts. Consequently and understandably they are inclined to emphasise the application of pure science with its seemingly more immediate promise of solving a problem, than development in science for which no such promise can truthfully be given. This has important implications for the allocation of agricultural industry research funds. Where farmers are represented on allocating committees they tend to take the scientist members' word for the appropriateness of allocation. However, they should insist on clearly understanding the problems their funds are to be spent on to ensure that the fundamental research that is undertaken with their funds is required for the advancement of agricultural technology, not for the advancement of science.

Finally, international economic competition is increasingly competition—as is war — between national technologies. How Australia should participate in this competition, and what national policies of scientific research and technological development it should adopt, and to what extent it should formally become involved in international scientific policies, are questions already looming up for national consideration.

The Economist

Unlike farmers and scientists it is conceivable that economists can be done without! They would be unnecessary under two sets of conditions. One is when society is so affluent there would be no need to economise. But the world is a poor place and will remain so for many a long long-run. The second set of conditions under which economists would be unnecessary are those of perfect competition, under which all enterprises submit passively to market processes. This is never likely to occur in the real world. It seems we are stuck with economists.

It is widely believed that economists seldom agree among themselves or with other people. It is often stated that, had they been consulted or listened to, many now profitable dams, irrigation projects, ports and harbour works, many miles of now useful roads and

railways and many now prosperous regions and settlements would never have been built and developed. Had there been any economists at the time, and had they been listened to, we may never have had the Group Settlement Dairy Scheme in Western Australia. This scheme attempted to establish dairy farming in what is probably the most hostile dairying environment in the world, with the result it is now probably the highest cost butter-fat production region in the world and forever may well continue to be so. Those who point to this as a successful pioneering venture refer only to the few thousand acres of pasture and few thousand cattle, not to the thousands of families who never made it because it was economically impossible. With reference to the many projects which have turned out successfully without the work of economists, there is always the question of whether these same successes could have been obtained at less cost—or whether alternative projects may have been even more successful.

It is commonly thought that economists should unquestioningly accept as right the economic goals and policies of the government of the day, and that they have no business to make value judgements, nor to join the debate as to how society ought to use its resources. Some economists also think their function is to agree with government, and they will rubber stamp almost any government proposal. Just as the agricultural scientists have their Lysenkos, so the economics profession has its tame economists. No one, and I repeat, no one, has yet demonstrated publicly that the Ord River Project is or is likely to be an economically sound expenditure of public money. It does not necessarily follow from this the project should not be built. But those economists who point out what the Ord will cost the community in teachers not trained, in classrooms remaining over-crowded, in schools foregone, in dairy farm reconstruction not undertaken, in pleuro-pneumonia not eradicated and in the social and economic advancement of aborigines not expedited, to give a few examples, are doing just what economists are supposed to do. Rather than criticism and condemnation, they should receive the community's thanks.

It is widely believed that economists' thinking is blighted by theories which the practical man with commonsense knows to be wrong. The practical man knows he must balance his budget almost every year. It is his commonsense which leads him to the wrong conclusion that so must the nation.

The main reason for these beliefs about economists is that it is not widely realised that one of their important functions is to help the community to avoid wasteful public investments. Another important reason is that economists sometimes are wrong.

Economists are interested in the size of national incomes, how much is produced by particular states, regions, sectors, industries and classes in an economy. They study the composition and the distribution of production, the ups and downs of wealth-creating activity, the expansion and contraction of particular industries and occupations, the influence of trade between countries and between regions within a country, the influence of various arrangements

between employers and employees, the influence of the form of organisation of producing units, and of technology and of government on the amount, composition and distribution of production. They see a region, a state, a nation or the whole world as sets of resources; as soils, water, coastlines, minerals and mines, roads and buildings and as persons able and willing to work at teaching, toothpulling, satellite watching, farming, roadmaking, researching, building and beer-serving. Many of these resources have different uses, though only one at a time. For instance, Carnarvon land may be used for beans or cotton; Kimberley pastoral land for livestock or non-use; labour for road-mending or house-building. There is assumed to be a best use, an optimum use at any one time. This is the one that is expected to give most satisfaction to the community. There is no easy way of determining optimum use, though politicians especially are prone to thinking it is easy. Of all people, economists only are specifically trained to minimise the error and waste in finding out the best way to use resources, though they too sometimes turn out to be wrong.

It is often thought that economics is inferior to the natural sciences, and economists and their findings should therefore not be taken seriously. Certainly there are important differences between the social and natural sciences in objectivity, verifiability, measureability, accuracy, constancy and predictability. But the real question is whether the natural sciences are substitutes for the social sciences. Are they a satisfactory alternative? The answer is no, though this is not to conclude that there is no room to improve our respective scientific endeavours. The fact is there is no one better than economists for the things economists are trying to do.

In recent decades agricultural economists have successfully worked out, in theory, how in practice the organisation and operation of individual farmer's sets of resources can be optimised. This is not yet widely realised despite the popularity of farm management advisory services. Most farm management advisers are improvers rather than optimisers. Few farmers or advisers are aware of this distinction though practical means of calculating the size of the gap between improvement and the farmer's own optimum are known. For this to be done practically, farm management service laboratories need to be established.

There is a need also for agricultural scientists and agricultural economists formally to cooperate. This is being done informally on a small scale in some States in agricultural extension and it needs to be done also in agricultural research and in farm management.

National Science Policy

Now, I should like to turn to a number of policy matters implied in what I have said so far. There is a need to formally develop a national science policy. I do not suggest that a rigid policy be blue-printed but that studies now be undertaken to act as guide lines for policy-makers.

It would be timely and relevant for the Australian Academy of Science to initiate with a couple of economists a

study suggesting appropriate levels of investment for the development of particular sciences which are considered to be of importance for Australia, bearing in mind the work of scientists overseas. The Academy has already prepared a submission to the Vernon Committee of Economic Enquiry but this dealt with applications of science rather than development in the sciences. It would be important to have economists closely associated with this proposed study to ensure that the community's resources for science will be used to satisfy the community's scientific needs. The temptation for the scientists, unrestricted, to use social resources for his own scientific ends is, as for all of us, great indeed.

It would be timely and relevant also for the Australian Agricultural Council to organise a study reviewing needed developments in agricultural technology. Some years ago I suggested that the Western Australian branch of the Australian Institute of Agricultural Science organise studies of the gaps in agricultural research and in agricultural extension. These were never made. I submit that we tend to have a political rather than a scientific or organised approach to the application of science to agriculture. It would be appropriate for the Australian Agricultural Council to organise such a study which could best be done by a group of agricultural scientists, economists and farmers.

There is also a need to review the institutional organisation of research in Australia. One wonders whether scientific research is not concentrated too heavily within one institution, namely, C.S.I.R.O. Has this concentration contributed to the inability of the Universities to supply C.S.I.R.O.'s skilled manpower requirements, despite some selective immigration processes and an influx of scientific personnel from New Zealand? Has it contributed to the Universities' failure to educate at post-graduate levels at rates that ensure replacement and expansion of their own staffs? Should C.S.I.R.O. enter into direct competition with other organisations for non-governmental research funds? Its size and status and its past successes ensure it cannot lose in the scramble for these funds. I submit there is a shift needed in the balance of power to allocate research funds. This should be a function of a National Scientific Advisory Committee. Such a committee should each year advise the appropriate Minister on the sum required for research, how it should be allocated between C.S.I.R.O., the Universities and State Government departments, leaving the allocation within these research groups to the institutions themselves.

Farm Management Laboratories

Finally, farming in Australia is now being seen by officials and farmers as the management of one quarter of a million individual business units. Now that the economic rules and judgements required for the optimum use of their resources are becoming more widely appreciated; now that farm accounting is developing into farm management recording; and now that high speed data processing and computing facilities are available, there is a need in each State for a farm management service laboratory. Such a laboratory would bring analyses to farm management

advisers, and thus enable them to graduate from being mere improvers to becoming optimisers. Such laboratories could after a time be run on a commercial basis. Meanwhile they need to be established, and though they are needed in every State, the situation in Western Australia is ideal for the establishment of a first Australian farm management service laboratory. Conditions conducive to its establishment in Western Australia are the strong farm management advisory movement, the highly qualified extension service in the Department of Agriculture and the unique, for Australia, farm accounting organisation. Its effect on agricultural productivity could be as great as many other technical innovations in common use, such as trace elements and tractors.

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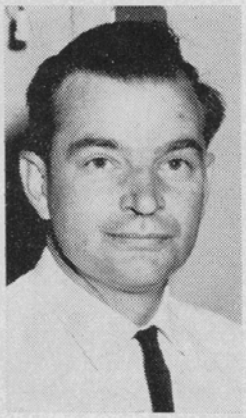
by B. R. MARTIN and B. R. DAVIDSON.

The Use of Experimental Results in Farm Planning



Field experiments are the scientist's chief means of assessing animal and plant productivity potential. Yet it has been generally recognised that the yields attained in experimental plots are greater than those achieved by the average farmer. This is no reflection on farmers' abilities, but is rather a result of the different circumstances in which experiments are devised and farms are operated. In this article the authors assess the importance of farm-experiment yield differences and discuss their implications for farm planning and experimental objectives and methods.

The goal of agricultural experimentation is to increase agricultural productivity. The normal method of introducing a new species or technique is to try it under experimental conditions using known species and techniques for comparison. If the new species or techniques are significantly better they are recommended to farmers. After a number of farmers have had some years of experience with them, or if similar introductions have been made in similar situations elsewhere, economists may calculate whether the additional returns obtained by farmers using the techniques are greater than the additional costs involved. If returns outweigh the costs the technique may finally receive the blessing of both scientist and economist and be recommended to farmers in a particular region.

This process is a long one and many resources may be wasted before a recommendation can be profitably made. The reason for this waste in time and resources comes from our lack of knowledge of the extent to which experi-

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mental yield increases will be reflected on the farm. A difference between farm and experimental yields has come to be expected, although there are many examples of planners (and particularly politicians) confidently predicting that farm yields will parallel experimental results. This is particularly the case where it is proposed to open up previously undeveloped areas. In this situation planners often have to predict from experimental results.

Little or no research has been done on the relationship between farm and experimental yields. This is strange when we realise that this is the essence of the usefulness of our experimental work. Without this knowledge planners, farm extension workers, and farmers themselves must base their judgements of expected returns on experimental results with no appreciation of the extent to which they will be achieved on the farm. This is not to say that these people do not apply some adjustment factor to the experimental yield before applying it to possible farm situations. Rather the facts concerning this all important step from experimental to farm situations are unknown, and will continue to remain so until some intensive investigations are made.

The difference between farm and experimental yields is readily understandable when the two situations are compared. Experiments are contrived with the view to investigating a particular effect whereas farms are operated with the emphasis on total inputs and total returns. Thus experiments are designed to look at one possible factor of production (more elaborate experiments may incorporate designs which look at interactions between factors but let us concern ourselves only with the simpler case) such as phosphate application and its affect on wheat yield. In such an experiment as many other factors as possible are controlled and the phosphate application altered. In order that differences in yield may be attributed to phosphate level alone, such factors as soil type, soil nutrients, seeding and harvesting time are strictly selected or controlled. This, of course, is a recognised experimental method and can give very useful results on phosphate application within the conditions of the experiment. Quite frequently the level of other nutrients such as copper, zinc, nitrogen, etc., is placed at a high level so that the experimentalist may be reasonably sure that none of these nutrients is limiting and that differences in yields are entirely the result of phosphate levels.

The results of such experiments are not applicable directly to farms because of the nature of the controlled conditions. But it is not for this reason alone that farm-experiment differentials exist. Recent research conducted by the authors has shown that these differences occur even when experiments are designed so that they are directly comparable with farming situations.

Different Objectives of Farmers and Experimenters

The basic cause of this difference comes from the different way in which experimenters and farmers examine their problems. Experimenters are essentialy concerned with production from **specific** resources, usually land or animals, so that experiments are designed which use production per acre or production per animal as the important

criteria. Farmers, on the other hand, although they tend to think of success in production in the same terms, must adopt a more economic approach. They are concerned with the way in which **all** resources are used in production. Whether they realise it or not, farmers must use a basic economic decision-making principle. They must evaluate the additional returns from adopting a new technique by comparing them with the additional costs involved.

The concern of the experimentalist with productivity per animal and per acre often leads to much greater use of labour and capital per acre in experiments than on farms. The number of man hours and the value of working capital or machinery concentrated on a very small acreage has been customarily much greater than the normal farmer would ever think of employing. The farmer on the other hand is in the main concerned with profit maximisation. To him labour and capital are usually more limiting than land, and he is more anxious to increase returns to these two expensive factors than he is to increase yield per acre or per animal. At these lower intensities of labour and capital use many of the critical farm operations cannot be performed at the most appropriate time, or they may not be performed at all. There is a consequent decline in yield.

There are, then, essential differences between the objectives of experimentalists and farmers which give rise to different intensities of resource (labour, machinery, fertiliser, etc.) use. From an appreciation of this difference it is not difficult to understand the observed differences in yield in the different situations of farm and experiment.

Some Comparisons

If this is so, it would be expected that yields on farms operating on a small scale, so that labour and capital were being used intensively, would enjoy yields close to those obtained on the experiment. This was found to be the case. In two studies made of tobacco grown in Victoria and beans at Carnarvon (where the average acreages of crop per farm are in the vicinity of 5 acres) farm yields averaged 95 per cent of experimental yields. Where farming is carried on at a more extensive level, on the other hand, the opposite was found to hold true. Wheat growers in various districts of Western Australia, where average acreages per farm are of the order of six to seven hundred acres, obtained only 57 per cent of the yields obtained in experiments using similar varieties and techniques in the same districts.

Comparisons were made between farm and experimental yields for a wide variety of crops and animal products. Care was taken to ensure that comparisons were made only within the same district, the same year, and on the same soil type. All comparisons led to the same general conclusion. When labour and capital are of major importance and not readily available, farmers achieve a low percentage of the yields

TABLE 1

THE RELATIONSHIP BETWEEN CROP AREA AND THE PERCENTAGE FARM YIELD FARM OF EXPERIMENTAL YIELDS

Crop	Average Crop Area on Farms (Acres)	Mean Farm Yield as a Percentage of Mean Experimental Yield (per cent)
Carnarvon Beans	5	95
Victorian Tobacco	5	93
Queensland Sugar Cane	60	76
Murrumbidgee Rice	80	65
Victorian Wheat	144	57
Beverley Wheat	150	64
Dundas Wheat	300	65
Narambeen Wheat	600	61
Merredin Wheat	700	57

obtained in experiments. When labour and capital are relatively unimportant or readily available, farmers achieve similar results to those obtained in experiments. The comparisons for crops are illustrated in Table 1, and those for animals in Table 2.

TABLE 2

AVERAGE YIELD ON FARMS AS A PERCENTAGE OF EXPERIMENTAL YIELDS

Product	Farm Yields as Percentage of Experimental Yields
Wool (lbs per acre)	97
Butterfat (lbs per cow)	66
Meat (lbs per acre)	53

It was also found that farmers obtained yields at least as good as the experiment in bad seasons. In favourable seasons the farm yield rose but not nearly as dramatically as did the experimental yields. These effects were most marked for those products with a high labour requirement. This piece of information can be used to support our original argument. Experimentalists, with their higher labour and capital usage per acre, are able to take advantage of favourable seasons to a far greater extent than can farmers. In poor seasons, however, it is not the labour and capital which are limiting but some overriding phenomenon, such as poor opening rains, so that experiment and farm are brought back to the same yield level.

Some Implications

There is a problem, then, which is important to those who are concerned with the application of experimental results to farming situations. This application involves not only the extension officer or farm adviser but also the farmer and the scientist. From our vantage point, what can be seen to be necessary to the solution of the problem?

One thing that can be done is to find out precisely what the relationship

between farm and experimental yields has been in the past. The authors have recently attempted to do this for a number of plant and animal products. This entails a considerable amount of research involving investigation into a whole spectrum of experiment-farm data; different relationships exist for different types of farm enterprises, depending on the causal factors involved.

If we know these relationships, farm planning for new innovations can be carried out with a greater degree of certainty than is now the case. Resources need not be used wastefully because of the prolonged periods of trial and error which usually take place before an innovation is finally accepted. But if this waste is to be avoided we must acquire a much greater appreciation of the way in which experimental conditions become modified on farms.

A further implication involves the planning of experiments. Experimental agriculture was developed in Europe at a time when land and livestock were expensive resources, labour was cheap, and little capital in the form of machinery was used. Under these circumstances the obvious units of measurement were production per unit of land and per animal. Experiments designed to conform more with the contemporary pattern of Australian farming would be of more value to farmers than many experiments as they are now conceived.

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by D. W. G. TRELOAR.

Investment in the Kimberley Cattle Industry

The Kimberleys is that part of Western Australia north of Broome. Its development has been based on extensive grazing of cattle and sheep, together with meat processing, transportation, and other services associated with this industry. Other industries include pearling at Broome and Kuri Bay, mining of iron ore at Cockatoo and Koolan Islands, and irrigated cotton at Kununurra. This article discusses some of the problems faced by station owners in planning investment.

Cattle-raising is the major pastoral concern throughout the Kimberleys, except for a handful of stations along the Fitzroy. Sixty cattle stations carry the bulk of the half million adult cattle in the region. These 60 stations carry about half the cattle in Western Australia. No wonder then that the names of the stations—Fossil Downs, Ord River, Gogo, Moola Bulla — are familiar to us all, and the names of some of the leaseholders equally familiar — Vesty, Emanuel, Rowell, McDonald, Blythe, Naughton, Quilty, McLarty, Hooker, and others. There are many others, but there you have the Kimberleys in a nutshell: a relatively small number of vast leases of a million acres, turning off well over a thousand head per annum, each from a herd of some ten to fifteen thousand.

Less than one quarter of the stations have achieved much semblance of control over their cattle through fencing. This small proportion is actively investing in all forms of improvement but most other stations have only a single "paddock" (up to 200 square miles) for segregating bullocks prior to sale and paddocks for spelling horses during the wet season. These latter paddocks vary from about 5 to 20 square miles each. Many stations are not fenced along their boundaries. The only other control of cattle is by yarding at branding times. When one considers that an unfenced station of a million acres might be managed by two or three whites helped by about 20 aboriginal stockboys, it is apparent that control over mating, nutrition and health of the cattle is almost non-existent.

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The original settlement of the Kimberleys was by the overlanders who shepherded their herds on the river frontages and gradually extended them over the open range. The present generation of pastoralists are apparently reluctant to change this pattern because of their experiences of natural conditions over the long period dating back to those early years, and because of their strong convictions that cattle husbandry in the region is unalterable. Let us look briefly at this "husbandry."

The husbandry of cattle in the Kimberleys is about as different from practices in temperate regions as it could be. It is so different, that it is difficult to know where to start a description and how to link it to the conventional guides to good cattle husbandry. Further difficulty arises from the fact that we know practically nothing about what is going on in the herds. The cattle are uncontrolled and unobserved, and the sole husbandry practice — mustering— is better defined as large scale hunting of wild cattle than as husbandry.

We do not even have sufficient information to compile a picture of the structure of the herds. The only reliable statistics are turnoffs and brandings. All the intermediate factors governing mortality, calving rates and mating we must assume. Reasonable assumptions lead to a pinpointing of the crucial stages in the lives of Kimberley cattle. They are the period between birth and weaning of all calves and the next two years of life of heifers.

To get to grips with these problem periods, we shall begin the discussion with a consideration of just what goes on in the Kimberley herds when the wet season ends.

As soon as the wet finishes and the country is negotiable, horses are prepared and mustering teams set out on horseback from each station. Each "plant" of 10 to 15 men and 70 or more horses works for a month or two scouring the run and bringing cattle into yards for branding, and for the segregation of bullocks. The musterers then take out a second or third lot of horses and continue mustering until either the whole run has been covered once and the best parts more frequently, until the onset of the wet prevents mustering, until the cattle are in too poor a condition, until there are no more horses fit to work, or until race-week. Not a large proportion of horses can be used more than once, and mortality is often high due to accidents, poison plants, and over-work.

When the wet began, many old-timers used to continue mustering the localities where rain had fallen. Cattle would "smell" the rain and congregate in such places, and these "storm-musters" were often highly successful in trapping unbranded "clean-skins" that would otherwise be missed. They also may have served a useful role in controlling cattle at a difficult time of the year, because it is widely thought that these early storms scatter the cattle into otherwise dry localities. The storm may be insufficient to produce lasting surface water and the cattle find themselves unable to manage the return journey to permanent water. So storms from September to November may be a blessing to most because they give green feed and fresh water, but a curse

and a cause of losses if they are too light to renew the watering points and then are not followed up either by further rain or by a storm-muster. Not only will cattle be stranded far from water, but the previously dry feed will be quickly rotted. The waning interest in storm-musters may be introducing yet another source of dependence upon uncertain seasonal conditions.

Before the days of the road-trains many musterers took time off to drove bullocks to market. The trip could take from five to 25 days. Due to the rigours of the droving trip, especially late in the dry season, the earliest age at sale was for a long time four years if the station was near the coast and five or six years if the stations were inland. Now they can be turned off at any age and in much poorer condition than before.

Grazing is almost entirely restricted to native grasses and shrubs. These grow lush in the wet season, even to the point of over-bulkiness, wilt as the dry season proceeds, and rapidly decline in nutritive value and palatability. As the plane of nutrition declines, so does the condition of the stock. Weaned steers are commonly thought to lose in the dry about half the weight they put on in the wet. In very prolonged dry seasons cattle no doubt die of starvation, although such losses are said to be confined to cows and calves. This is not to say that entire runs are eaten out. A more common restriction of available grazing than the total quantity of pasture is the number and distribution of water points. Cattle must drink —probably every day when the temperature stays around the century — and can only walk about eight miles between a drink and a feed. In each year, some water points go dry and parts of the runs go out of production as a result. Moreover, the drier the year the more natural "permanent" waterpoints go dry, thereby restricting still further the effective grazing and causing repeated concentration of cattle around the same water points and river frontages. At these places the most palatable and most drought-resisting plants are gradually eaten out. The bare and eroded landscape bears testimony.

With little done to disturb this elementary, fearsome conflict between cattle and plants — not to mention dingoes, kangaroos, donkeys, ticks, flies and disease — the size of the herds and the number of calves branded depend largely on the numbers in previous years and on a complex of seasonal conditions stretching back into the past.

The marketing decision is usually a simple one — try and sell all the steers that have reached what is thought to be the minimum age. If they are not sold they may be dead next year or the muster may miss them. So the number sent to market would be influenced by the factors affecting brandings and also by the suitability of conditions for mustering. Good rain in the preceding wet is usually advantageous, but on runs with inaccessible rocky areas, a very wet season may leave rock holes filled with water throughout the dry, with the result that the muster of steers may be reduced because of the large numbers that camp on these rock holes instead of watering in musterable country.

There have been very few field experiments in the Kimberleys that can possibly aid in the forming of hypotheses. Most hypotheses must arise from the influence of personal experience and the opinions of pastoralists upon a knowledge of animal physiology and behaviour. However, it is possible to test the predominating influence of environmental conditions. This has been done by analyses of 37 years of observation from five stations. Keeping statistical considerations to a minimum, the result was as follows: The turnoff in any one year was largely dependent upon the number of calves branded six years before. Intervening factors significantly reducing the turnoff were the rainfall in September and October both one year and three years previously, the length of the dry season when the beasts were two years old, and the rainfall in the wet season prior to sale. The annual rainfall two years prior to sale had a significant beneficial effect. Altogther, 82 per cent of the variation in turnoff was accounted for by these factors. In the procedure used for fitting this relationship, a large number of other facts providing alternative measures, as well as others originally thought to be significant, were tested. The latter included prices of cattle, and the amount invested in fences, water, etc., none of which had a significant influence. Brandings themselves were almost completely "explained" by brandings in past years, rain in September and October in the year itself and three years before, the number of successive droughts, and various seasonal factors two and five years before.

Statistics covering the whole region were not amenable to similar analysis. The range of climatic conditions is too great, and the official herd statistics are aggregates of very rough guesses on the part of pastoralists and accountants.

The overwhelming influences of the irrevocable past and the unpredictable seasonal conditions, exemplified by this statistical investigation, is indeed very much in keeping with impressions gained from interviews with pastoralists. And the suggested lack of influence of investment upon turnoff does not startle them. No wonder then that while most pastoralists have elaborate and idealistic plans for fencing and watering, followed by weaning, culling and segregating maiden heifers, there are few who push ahead with much confidence.

As mentioned already, summer is the wet season, and the rains begin any time from October to January. It would not do to bank on them coming by any particular date. The Kimberleys are characterised by great uncertainty about the date of opening rains. Sometimes there are none at all! When they come, or if they do, there is a rather spectacular flush growth of native grasses. This radically improves the animals' plane of nutrition. During the preceding long dry season of 200 days or more, there has been no growth worth speaking of and the pasture has been steadily getting less and less palatable, less and less nutritious and more and more scarce. Cows may be unable to conceive when they are on a very low plane of nutrition. So the flush of green feed means the beginning of the natural mating season for many cows. All very well for the cows for the first two or three months of their

gestation period, but by the time the full nine months are up and the calves are dropped, they are in the middle of the next dry season. This must practically be the worst time for calving. The lactating cow is then on her lowest plane of nutrition and has been throughout the critical prenatal period.

Ideally, for beef production, calving should be controlled to coincide with a period of good feed, because the calf's weight at marketable age and the cow's recovery in preparation for the next calf are profoundly affected by prenatal and postnatal nutrition of the cow.

Therefore, we might well ask why mating is not controlled so as to occur fairly early in the dry season, giving a calf drop in the wet and allowing marking of steers early in the following dry. In actual fact, some mating occurs at this time, but purely by chance. **Control of mating time in the Kimberleys is not possible at the moment, because there are hardly any fences.**

If you can imagine a million acres —or an area almost forty miles by forty miles — carrying ten thousand cattle unrestricted by any fencing except a large holding paddock for bullocks — then you can imagine the impossibility of controlling breeding.

This same lack of fencing thwarts most of the other suggestions we could make.

Take the question of the age at which maiden heifers are mated. Heifers can be mated as young as eight to ten months. Not that you would fancy doing this with the present state of knowledge. The heifer is far from reaching its mature size, and the rigours of carrying a calf would impose a severe setback on its own growth and development, let alone that of the calf it bore, unless its gestation period was spent on a very high plane of nutrition.

In the Kimberleys, everything is against the heifer. Firstly, there have been, until the Americans ate most of them in hamburgers, an excessive proportion of wild and inferior type bulls. They ensured that the heifers conceived when they were physiologically able to do so. Then, if the already unfortunate heifer calved in the dry season, what chance did she have? The deaths amongst calves that could not be adequately cared for and amongst the heifers themselves were staggering. Quite a proportion of those heifers that did survive were suspected of being sterile from then on. These lived for years in a completely unproductive manner until the muster caught up with them and they were sold.

So we have point two: without fences you cannot segregate your maiden heifers to control the age at first mating.

Point three: without fences you cannot wean calves. Without weaning, the cow is not given a chance to recover for the next calving. Especially if the next calving is on to dry stubble; especially if the cow was first mated at nine months, and is a poor stunted thing that cannot cover the distances (up to five miles) from water to grazing that become an essential for survival towards the end of the dry season.

Point four: without fences, it is impossible to have a complete muster. Scrub bulls repeatedly evade capture and their numbers are increased by the calves that are missed in the mustering process. Moreover, attempts to introduce new blood or to upgrade by selected culling, are somewhat set back by the indiscriminate nature of the mating process. Also, the most valuable introduction, the Zebu or Santa Gertrudis, is suspected of being rather wild when let loose on the open range. The need, whether imagined or real, for herding these animals, for which fencing is obviously essential, has deterred many pastoralists from introducing them.

Point five: without fences, it is impossible to give cattle grazing according to their needs. Calving cows, heifers and weaners are particularly susceptible to loss of condition, disease, and death if their plane of nutrition falls. Therefore, they require better grazing at the critical times of the year than bullocks being maintained in store condition. However, when all the cattle run on the open range (except the bullocks held for sale on a superior part of the run) it is the cows, heifers and weaners that are the very cattle **least likely** to succeed in the competition for food and water.

Sixthly, without fencing it is difficult, if not impossible, to practise any form of pasture management. The cattle unrestrictedly graze the most palatable species of grasses and shrubs, and when there is a prolonged drought they graze the hardiest drought-resisting species. With little control over numbers, there is a constant risk of overstocking, or overgrazing. Result: exit the most palatable species and exit the most drought resistant species; enter a gradual deterioration in carrying capacity, a reduction in plant cover, and a risk of erosion.

There is ample evidence that deterioration and erosion are common in many parts of the Kimberleys, particularly on the river frontages where cattle congregate on permanent pools every dry season. It is also clear that considerable investment in water and handling facilities over the years has merely managed to keep the total herd numbers constant in the face of deterioration.

Allied to this problem is the fact that rehabilitation of over-grazed country depends wholly upon all stock being excluded from it for a year or more and then periodically excluded when seed is being set. Rehabilitation is just as impossible without fencing as control.

We have seen that application of basic knowledge of animal husbandry discloses enormous scope for "improvements" in the Kimberleys and that fencing is a prerequisite for most such improvements.

The obvious questions are: "Why did the pastoralists not invest in more fencing in the past?" and "why are many of them **still** not investing in more fencing than a bullock paddock?"

Let us discuss what appear to be the major issues.

We begin by observing that climatic variation seems to so mask the whole

problem of the **profitability** of investment that all but the most obvious improvements, such as yards, boring for water in dry localities, and fences to keep some of the best ground reserved for horses, are viewed as great adventures and great risks by those who depend upon cattle for a livelihood.

To be more specific, some major issues are enumerated below.

(i) Funds Available for Investment

The net, or disposable, incomes of cattle stations have generally been ample, especially over the past five years, to finance far more investment than has taken place. However, the incomes were much less in earlier years, and as the Forster Committee pointed out for the nearby Top End of the territory.

> "Because of the poor markets in past years there has been no incentive and, indeed, very little money to justify any large fencing programme or similar improvements. There are many big pastoral companies with big interests in the Top End and they have often incurred some odium for sitting on large areas of country and not using it to the fullest extent . . . However . . . no-one in the Top End, big pastoral company or small struggling pastoralist, has been able in the past years to make enough money out of the place to put any large amount back into it."

Pastoralists are used to thinking in terms of long periods. They quite possibly regard the recent high incomes as some form of compensation for the many low incomes that came before, rather than an indication of an improving climate for investment.

(ii) Where Does the Money Go ?

In the case of twenty stations in the Kimberleys and adjacent Northern Territory, earnings which are not reinvested go as dividends to the various Australian and foreign shareholders in the four major "absentee owner" groups: Vesty's, Hooker's, Peel River, and Naughton's. There are three other stations managed for remote interests and six managed for companies which are centred in the region (including Rowell's and Clementson's former interests). In the case of the other stations, the money goes to owner-managers and their associates, some of whom live overseas.

Lest this preponderance of absentee ownership—29 compared to 26 owner-managed stations of significance, including the Emanuel interests—be taken as evidence of a general lack of genuine concern with the region except as a gold-mine, it should be pointed out that details to hand show that the investment behaviour of owner-managers, absentee owners, companies, and partnerships are substantially similar on the average and extreme cases occur in all classes.

Hired managers are almost unanimous in their pleas for more investment in fences and water. One can too easily gain the impression that absentee owners are a stingy lot. But if the owner-managers are any guide, the hired

managers would be less inclined to invest if the stations were their sole source of income. Absentee "landlords" have attracted criticism the world over, and they are not common on the Australian rural scene, but industry functions effectively with a similar structure and there seems no reason why it should be unsuitable for cattle stations.

In the case of the owner-managers who are not re-investing, the money is leaving the region just as surely as the dividends paid to absentee shareholders. That is, if there is any left over from a very considerable increase in the standard of living, including sending children to public schools, putting down floors instead of stamped earth, giving the wife a holiday, and the like.

(iii) Attitude to Debt

A large proportion of rural development in Australia is financed through banks and pastoral companies. It has been pointed out that few station owners should need to borrow in order to invest, so the general attitude to debt is of academic interest. However, it has been informally investigated, and some pattern has emerged amongst the old-timers. The depression, periods of drought, and the war kept their finances at a very low ebb for a long period. Those who survived saw the other properties sold and other owners walk off in despair. They have come through firmly resolved to keep something aside as a buffer against such hard times, and with a determination not to go into debt. Were they to seek loans, access to the usual sources would probably be difficult. Most banks are reluctant to lend on the leasehold tenure and stock firms are generally not interested because cattle stations do practically no business with them since cattle are sold directly to the meatworks. However, some larger, diversified interests have secured credit from both sources.

Requests for loans are more likely to come from people buying stations. Current prices would be anything from £100,000 to £250,000 for a million acres stocked with cattle, but this expenditure is, of course, not an investment at all but merely a transfer payment. Moreover, the vendor is likely to shift to Perth and the transfer will not even involve an inflow of capital to the region.

(iv) Tenure

All stations are held on leasehold under the Western Australian Land Act. Leases which were due to expire in 1984 have invariably been extended to 2034 by an amendment suggested by the Pastoral Leases Committee.

The insecurity of leasehold has been suggested as a rationale for low levels of reinvestment. Freehold would undoubtedly be preferred by the leaseholders for personal reasons, but the reasons seem to have little connection with the national welfare or with the likely rate of improvement. Fixed improvements and the leases themselves are perfectly negotiable and so are the cattle. No leases have been resumed except in the most flagrant cases of misuse, and all the improvements probably have working lives less than the duration of the lease. The inhibitory effects of leasehold have probably been exaggerated.

(v) The Size of the Holdings

Section 113 of the Land Act limits the lease held by any interest to one million acres. Most managerial units are in fact just less than this size, but a number of groups of companies each control several million acres and there is really no effective bar to planning operations on as large a scale as desired.

The sheer size of the holdings has two effects that might inhibit investment. Firstly, any effects of relatively small projects such as irrigating a little lucerne, using urea licks, introducing a few new bulls, are easily lost when, after the lapse of years, it comes to selling the thousand or so steers amongst which any benefits might be distributed. Secondly, where a single owner-manager, or even a few men in partnership, receive the entire net returns from a station, their pecuniary desires are easily satisfied because the returns are large in absolute terms even if they do not represent a high rate of return on capital. The incentive to increase returns may thus be slight.

However, a range of station sizes exists, and the same sort of passive role is found amongst large and small alike. A stricter interpretation of Section 113 might not stimulate investment at all. As for reducing the runs still more, a point is reached, probably in the vicinity of a turnoff of 500 head per annum, at which it is impossible to cover the fixed costs of a full-sized mustering plant, with existing mustering techniques. Were a reduction in size to induce a substitution of fencing for musterers, a better system of animal husbandry might result through closer and better control, but pastoralists evidently don't think it would pay well enough because their plans never extend to this amount of fencing.

Under farming conditions in a more uniform environment one might expect not to be able to find any economies of small-scale production demonstrated on small farms. In the Kimberleys, the demonstration effect is absent. There are any number of small holdings from 20,000 to 160,000 acres or more, but the smaller holdings are almost invariably on the poorer country and most have a long history of abandonment and failure to carry out the improvements required by the Land Act. The development of spray irrigation and cattle fattening at El Questro may prove to be an exception. The most successful small-holders have been butchers and cattle-rustlers. The smallest independent and successful cattle stations are well over 300,000 acres in total.

Probably 400 square miles (256,000 acres) of good musterable country carrying 20 beasts per square mile would be sufficient to support the basic mustering plant. The required area at the modal stocking rate of some five beasts to the square mile would be one million acres. Quite apart from any consideration of such figures, it is obvious that no sweeping proposal to reduce areas could satisfactorily deal with the diverse pastoral lands of the Kimberleys .

(vi) The Delay Between Costs and Returns, and the Size of the Outlay

A ten-mile square bullock paddock is not overlarge by Kimberley standards. The 40 miles of fencing, assuming no

natural boundaries, will cost from £7,000 to £10,000. Until it is completed, its effectiveness will be nil. Not only is this a large lump sum to spend before seeing the benefits begin but it takes a long time to put down 40 miles of fencing, especially if it is done with station labour.

(vii) The Profitability of Fencing

The possibility of demonstrating the profitability of fencing is small at the point in time. The costs are easily assessed, but the likelihood of clearing a profit is almost impossible to estimate. If a return of ten per cent on the investment of £10,000 is required, about 60 to 80 extra bullocks must be sold per annum just to cover the interest. One can at least present this figure to the pastoralist as an idea of the effect his fencing must have in order to pay. But in the absence of knowledge concerning the interplay between fencing, control, competition between bullocks and cows, possibility of introducing Zebu blood, effectiveness of mustering, pasture regeneration, and the like, neither the pastoralist nor the economist is likely to be able to predict the final profitability of the venture.

The Forster Committee remarks that "the native pasture is simply not good enough to grow good beef. There does not seem to be much that can be done about it (besides improved fencing) short of a quite expensive pasture improvement operation." They make a similar calculation to that above and conclude that "the carrying capacity of the country and the prices of cattle are so low that subdivision is just not profitable in a great many cases."

Prices have been well maintained since the Forster Committee reported in 1960 and the age at turnoff has been reduced by the road trains, but nowhere in the increase in incomes can evidence be found linking it to investment in fencing. The major increases in turnoff that have occurred since War II are clearly due to the creation of new outlets, the advent of road transport, and the development of a market for bulls, cows, and other animals that would never have been accepted before the trade with the United States began. Investment in fencing and water may not have been without effect, however. The concensus of opinion amongst pastoralists seems to be that overstocking has led to a decline in carrying capacity of the native pastures. That output has been maintained in the face of this decline indicates the possibility that investment has at least had a compensatory effect.

(viii) Disinvestment

The decline in carrying-capacity that has resulted from uncontrolled stocking may be thought of as a disinvestment in natural resources.

The Land Act Amendment of 1963 aims at controlling this disinvestment by stipulating that a lessee shall manage and work the land according to the most sound and approved methods of pastoral husbandry in relation to cattle and to the management, conservation, and regeneration of pasture for pastoral purposes. Any lease is liable to forfeiture if not stocked to capacity, having regard for seasonal conditions and length of tenure, or if the lessee permits deterioration to such an extent as to necessitate a lengthy period of

protection from grazing to effect regeneration of pasture. Whether these clauses will have the desired effect remains to be seen.

Prior to the amendment, the resumption of 1,000 square miles of badly eroded land on Vesty's stations had begun. Resumption is almost completed and one third of the cost of fencing out the cattle (at £230 per mile) is being borne by Vesty's. They are believed to be getting the land back again once regeneration is completed, so it is not a bad bargain. The regeneration is expected to cost £240,000. The productivity of the kapok bush and introduced grasses is expected to exceed that of the original vegetation, but the figure of £240,000 is a rough indication of the disinvestment on this area of 1,000 square miles alone. Moreover, the runoff from this eroded country enters the Ord River and could cause a major silt problem in the main dam, if not checked by the measures now being used. The Ord Fiver in flood can be 1.5 per cent silt by volume. The average silt content of 0.5 per cent indicates that some ten million tons of silt would enter the reservoir each year.

(ix) The Land Act and Investment

The Land Act was amended on the advice of the Pastoral Leases Committee, which reported in March 1963. Pastoral lessees now must submit plans showing existing improvements, improvements carried out each year, and proposed improvements. The annual expenditure on improvements must not be less than two and a half times the rent paid in each year until approved improvements have been completed. Excess expenditure in any year is carried forward.

Annual rents vary from six shillings to twenty-five shillings per thousand acres. In the words of the Committee "rents vary between one per cent and three per cent of the total costs of the operation of a station." With rents so small, the Act will not embarrass many stations. Only one pastoralist amongst those interviewed by the author seemed at all concerned. He had a very small station, and operated under severe capital rationing, just managing to clear costs. His livelihood could almost be described as subsistence agriculture and herding.

It is not yet clear just what will constitute "approved investments" but this new Act should serve to get the worst cases of inertia moving towards some sort of improvement without risking any great financial losses.

(x) Aboriginal Labour

A safe prediction is that the aboriginal stockmen will be receiving some form of basic wage in the near future. Most pastoralists expect this to follow proposed changes in the award in the Territory. At the moment an aboriginal stockboy may receive upwards of £3 per week, all found, plus assistance in keeping his many and varied dependants. A basic wage would increase the costs of maintaining fully-staffed mustering plants on many stations. The expectation of this important change might well be frightening potential investors. On the other hand, it may also be leading them to think about the possibilities of substituting

fencing for mustering, and of course of substituting white stockmen for aboriginals. A basic wage for aboriginals will surely force some of them into the ranks of the unemployed and they and their dependants will leave the stations for the towns of the Kimberleys.

(xi) Summary

The most serious problems concerning investment in the Kimberleys are the almost complete lack of research findings which might aid in budgeting and planning profitable improvements; and the disinvestment through the decline in palatable and nutritious pasture species and through erosion. The words of the Forster Committee are again relevant: "The gaps in knowledge, so characteristic of a frontier . . . (are) wide. These gaps will remain one of the north's problems for many years to come. Nor should it be forgotten that the history of development in the Territory is full of failures of one kind or another, which infuse a note of despair into any new plan to develop the north."

The State Government proposes to establish a research station near Fitzroy Crossing. This is an important step. Its aim is "to tackle the problems of low beef carrying capacities and lambing percentages . . . on pastoral stations in the West Kimberley." "One of the research station's priority objectives would . . . be to establish and demonstrate how to control both pastures and stock so that original carrying capacity can be restored and even increased. This would inevitably lead to the marketing of more and better cattle."

Another recent move is the inauguration of a campaign to eradicate tick and control pleuropneumonia. This disease is not frequently diagnosed in the Kimberleys nowadays, but the scare is enough for the entire area to be under quarantine. No cattle can come south for fattening. Eradication would have beneficial effects under the existing system, and the benefits of free movement south could be even greater.

Economists, the Government, and its Departments cannot help but be uncertain as the pastoralists about the chances of making a profit from investment in extensive fencing programmes. They cannot predict, recommend, nor enforce intensification under such circumstances.

The Editor of "The West Australian" once remarked that "the Kimberleys have an unhappy past to live down. The real challenge to the Federal and State governments is to create an atmosphere of confidence and enterprise that will lead to revolutionary changes in thinking beyond those inspired by better roads and ports."

This is indeed the real challenge, but an atmosphere of confidence and an atmosphere of uncertainty are mutually exclusive, and the latter is only dispelled by greater knowledge. In this region there is a profound shortcoming in technical knowledge which the State can reduce by organised research. In this aim it may be aided by observation of the successes and failures of those who are now investing in uncertain ventures, be they long-sighted, sagacious judges of the industry, professional gamblers, or optimists acting in blissful ignorance.

by J. S. NALSON and A. W. HOGSTROM.

Farm Population and Land Development in Western Australia

By 1974 there could be fewer farms available than are required by members of Western Australian farm families. This is likely to occur despite an estimated increase of 12 million acres in the cleared area over the next 10 years. In this extract from a detailed report to be published soon by the John Thomson Agricultural Economics Centre, the authors summarise the main research findings and discuss their implications.

Almost two-thirds of the farming population in the agricultural area of Western Australia live on farms of 1,000 acres or more. The total area of these farms amounts to over 90 per cent of the agricultural land of the State and contains over 90 per cent of its cleared area. The farms are essentially family farms, with three-quarters of the permanent labour force made up of farmers and members of their families.

By 1974, the existing family labour force will have expanded by 22 per cent, if farmers' sons continue to enter agriculture at the present rate, and allowing for deaths and retirements. In addition, people from outside agriculture and outside the State will also have taken up farms.

There are two sources of land for the extra farm population which could arise over the next ten years. These are the uncleared areas on existing farms and the land suitable for farming but not yet alienated. The estimates suggest that a further six million acres will have been cleared on existing farms in ten years time. A similar amount is expected to be cleared on new farms allocated during the next ten years, if the present rate of alienation continues and if the new farms are

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which may be necessary to maintain the economic viability of farms.

Physical Productivity of Available Land

Over 12 million acres, or about 60 per cent, of the uncleared land on and off farms is in areas with less than 14 inches of annual rainfall. Although considered suitable for agriculture, this land needs to be farmed in large areas to compensate for low and unreliable rainfall. Rates of stocking are low on unimproved pasture, and improved pasture is not feasible. Consequently, farm incomes are heavily dependent on the returns from cropping. Areas on the eastern margin of present development are less productive per acre than where farming was abandoned in the depression of the 1930's. Considerable advances in techniques have been made since then, including better crop varieties and, more especially, the use of large machinery enabling much increased areas of crop to be handled by the same labour force.

The available land in the higher rainfall regions is all of lower quality than that already alienated. Consequently, farms will need to be larger than the existing farms, if the same level of income is to be obtained. This applies to the coastal sands of the South West; to the Esperance-Ravensthorpe area; and in particular to the West Midlands, which has about half a million acres of deep sands not considered to be usable at present. Research is being undertaken into the problems of the deep sands, however, and, once suitable pasture species can be grown, it should be possible to allocate this land for farming.

cleared at the minimum rate set down for conditional purchase leases. Thus, by 1974, there could be an increase of 49 per cent in the area of cleared land on farms of 1,000 acres and over.

At first glance, it would appear that a 49 per cent increase in the area of cleared land should be adequate for the needs of the expected 22 per cent increase in farm family workers and still cater for some people from outside agriculture and outside the State. However, the adequacy of supply of the land which could be available in ten years time does not depend solely or even mainly, upon its absolute **quantity.** Rather it depends upon its **productivity** relative to the demands made upon it by existing and potential farmers. The magnitude of these demands will be governed by the number of people who enter Western Australian agriculture from within the present farming population and from outside it, together with the level of living these people will attempt to maintain, or improve upon.

To assess the adequacy of the supply of available land it is necessary to consider three factors:

(i) The physical productivity of the land which could be cleared over the next ten years and compare it with that of existing cleared land.

(ii) The effect of changes in the rate of entry into farming of farmers' sons and people from outside the State and outside farming, on the potential number of farmers and family workers.

(iii) The changes in labour productivity and in the size of farm businesses

The sizes of farms into which land is currently being allocated take some account of the variation in productivity per acre in the different regions. In the areas of heaviest rainfall, new farms may be no more than 1,000 acres, but on the eastern margin of cultivation blocks are between 4,000 and 5,000 acres.

There are about 12 million acres of unalienated land suitable for agriculture. Of this, over seven million acres are in areas with a rainfall of less than 14 inches. If the present rate of alienation continues, the available land will all have been allocated in about ten years. By then there will be an extra 3,000 farms, provided the sizes of the blocks are similar to those into which new land is currently being divided in the different regions.

The Eastern Wheatbelt contains 51 per cent of the unallocated land and the Light Land Development areas contain 31 per cent. But these two areas have only 27 per cent and 6 per cent respectively of the present total of family workers on farms of 1,000 acres and over, and only 22 per cent and 5 per cent respectively of farmers' sons not yet of working age. By contrast, the Sheep and Cereals Region has only 2 per cent of the unallocated land but has 48 per cent of all the family workers and 49 per cent of all the sons not yet of working age. Clearly, farmers and their sons from existing farms will need to transfer to other regions, if they wish to take advantage of the availability of new farms.

Entry Into Farming

The size of the future farm population depends upon:

(i) The size of the present population.

(ii) The number of deaths which will occur in that population over a given time period.

(iii) The rate of entry of existing farmers' sons into farming.

(iv) The rate of entry into West Australian farming by people from outside farming and outside the State.

(v) The rate of egress from farming of farmers and family workers part way through their careers.

Apart from any movement out of farming before the age of retirement, the further reduction in the numbers of people who are at present on farms, or obtaining a living from them, is a function of the age distribution of the farm population and its death rate. By 1974, the present number of male family workers on farms of 1,000 acres and over will have been reduced by death and retirement to 81 per cent. To arrive at the potential number of male family workers which could arise from the existing population we must add to this residual the number of farmers' sons and partners' sons who are at present under working age, but who may enter farming by 1974.

Currently, 90 per cent of farmers' sons of working age, from farms of 1,000 acres or over, are either working on their parents' farms or farming elsewhere on their own account. If the

same proportion is assumed to enter farming in the next ten years, the number of male family workers arising from the existing population would rise to 122 per cent of that in 1963-64. Thus, changes in the proportion of sons entering farming would have considerable effect on the size of the future population of male family workers. The population of sons from existing farms who will have attained working age by 1974 will amount to 56 per cent of the residual population of male family workers.

Twenty-six per cent of farmers on farms of 1,000 acres and over who started to farm during the last 15 years have originated either outside of farming or from outside the State. In the more closely settled Sheep and Cereals Region, the proportion is less than 10 per cent, but if this region is excluded, the figure is 40 per cent for the rest of the State.

If outsiders were to take up 40 per cent of the 3,000 new farms which could become available in the next ten years, the number of farm families entering these from outside agriculture or outside the State would be 1,200. In addition, there could be about 550 families from outside Western Australian agriculture entering **existing** farms. Thus, the additional farms available for members of Western Australian farm families would be 1,250. The number required to maintain the same intake of farmers' sons and the same average number of family workers per farm as at present would be 2,100. Consequently, for Western Australian farm people, there would be a deficit of over 800 farms. Expressed another way, the land available for new farms would be used up in seven years, if present rates of entry of people into farming were to continue and the average number of family workers per farm were to remain as at present. For farms to be taken up at this rate there would be required a 70 per cent increase in the annual amount of land alienated.

Lowering the rates of entry into farming of either farmers' sons or of outsiders would reduce the potential requirement for new farms, as would an increase in the average number of family workers per farm.

There is enough land to provide members of Western Australian farm families with new farms for about 12 years if all outsiders were excluded from taking up new land. Conversely, the rate of entry of farmers' sons into farming would have to drop from 90 per cent to 77 per cent if outsiders continued to enter farming in the next ten years at the same rate as in the past 15 years and if the number of family workers per farm were not to increase.

Another solution to meet the potential shortage of farms in ten years is for more family workers to work and share in the proceeds of existing farms. It is unlikely that this will occur merely by family workers replacing employed workers. Three quarters of farms over 1,000 acres do not employ permanent workers. Consequently, either the absolute level of employment (family plus non-family) would have to rise, or some farmers' sons would have to leave their parents' farms and work for other farmers. The

one alternative would involve a reversal in the trends of agricultural employment and the other a marked change in the pattern of employment of sons of farmers, few of whom work for other farmers at present.

Irrespective of who obtains the new farms, in about ten years all the land suitable for farming will have been alienated, if the present rates of allocation are maintained. Unless existing farms are subdivided, the supply of farms for the rising generation will then depend directly on the rate of death and retirement from farming of the current generation, and on the degree to which "outsiders" take over existing farms. In ten years time, the proportion of farmers' sons entering farming will have to fall to 56 per cent if the proportion of family workers per farm does not rise, and if "outsiders" take up 10 per cent only of the existing farms which become available through family changes. Sooner or later, farmers must face the situation in which collectively they have more sons available for agriculture than can be absorbed without increasing the average number of family workers per farm or without sub-dividing farms.

Costs and Prices, Sizes of Farm Business and Labour Productivity

The improvement of pastures and changes in stock management have made possible considerable increases in stocking rates in some areas. It can be argued that the increase in intensity of operation which is now possible could enable more people to earn an equivalent living from a given area of land and thus compensate for the falling supply of new farms which will develop over the next ten years. This is a vain hope.

Only given the most optimistic assumptions would there be no need for new farms for extra family workers in the next ten years. These assumptions are that price-cost ratios for agriculture do not deteriorate; that all the extra family workers entering farming displace an equal number of employed workers; that family workers surplus to the requirements of their parents' farms in one region will work for farmers in regions where agriculture can be intensified, and that the potential increase in sheep stocking rates is fully realised.

During the past ten years, one factor affecting the maintenance and improvement of farm incomes in Western Australia has been the increase of over 50 per cent in labour efficiency, as measured by sheep per man and crop acreages per man. Over 50 per cent more new farms than are likely to be available from unalienated land would be required for all surplus family workers from existing farms in ten years time if:—

(i) Another 50 per cent increase in labour efficiency occurred in regions where either sheep stocking rates or areas of crop could increase.
(ii) The size of the non-family labour force remained the same.
(iii) No new farms were allocated to outsiders.
(iv) Sheep numbers on farms of over 1,000 acres increased by 176 per cent.

On more modest assumptions, about 2,200 farms would be needed for surplus family members from existing farms, if efficiency standards of 1,500-2,000 sheep per man and 650-800 acres of crop per man were achieved, and if some non-family labour were replaced by some of the surplus family members. This would leave about 800, or 27 per cent, of the new farms for outsiders.

The number of new farms available has been calculated at 3,000 on the basis of present sizes of blocks being allocated in the different regions. If a marked fall in the price of wheat occurred without compensating falls in the cost of inputs, either the maximum size of block allocated on the eastern margin may need to be raised above the present limit of 5,000 acres, or it may be prudent not to allocate land as far east as the line used in this study for the calculation of available land. In either case this would result in less than 3,000 new farms.

Policy Recommendations

This study raises policy issues in relation to both people and land. The human issues are concerned with the future rate of entry into farming of farmers' sons and people from outside of agriculture and outside the State. The land issues are concerned with the release of new land and the research needs for optimum utilisation of cleared land on both existing and new farms.

Entry into Farming of Farmers' Sons

It appears unlikely that Western Australian agriculture can continue for more than a few years to absorb 90 per cent of farmers' sons, without a detrimental effect on the standard of living of farm families. Consequently, farmers and policy makers should consider, now, ways of reducing the number of farmers' sons who would otherwise enter farming in the future.

Already the number of sons is more than can be catered for by the potential supply of new farms. Thus, in the short run, more sons will need to take up occupations other than farming.

A farmer's son is under the influence of the farming environment from an early age. The need for his assistance at peak periods of work usually ensures that before he leaves school he knows much more about farming than any other occupation. Parents, too, are likely to encourage his interest in farming, both from a desire for an heir to the property and the need for reliable assistance with the work of the farm. Efforts to guide a proportion of farmers' sons away from participation in farming as future owner-operators will therefore need the approval of many farmers. They will have to be directed through informal channels of education as well as through the schools, and they will have to indicate alternative occupations acceptable to both sons and parents.

Paradoxically, a reduction in the number of farmers' sons entering farming may be brought about by policies designed to increase the supply of reliable employed labour. If reliable hired labour were available it would be less necessary for a farmer's son to participate in farm work before he left

school or to leave school at an early age. With a longer period of formal education, and more time to engage in interests other than farming, farmers' sons would be more likely to obtain the training for and interest in, other occupations. Farmers too would be more likely to sympathise with their sons' interests in other careers, if reliable hired help were available.

Informal educational media, such as the Junior Farmers movement and the Farm Management Advisory Services, could play a part in bringing the issues involved before farmers and their sons. In addition, through their contact with other occupations related to farming, workers in these advisory fields should indicate to farmers and their sons the opportunities available to serve agriculture as professional agriculturalists, such as agricultural scientists, farm advisers and rural educational and social workers.

Changes will be necessary also in formal educational policy for rural children. Teaching standards and breadth of curricula in country schools need to be similar to those available in the city, if farmers' sons are to have equal opportunities for training in occupations other than farming, and further provision may have to be made for farmers' sons in those private schools which specialise in training for the professions.

For the long run, the question arises of the need for farmers to have so many sons, once there are no longer new farms available and the opportunities diminish for increasing the total area of existing farms and their intensity of operation. Family limitation is entirely a personal matter, but farmers, collectively, should be made aware that, if they want their sons to follow them in the occupation of farming, the fewer sons they have, the greater the chance that farms of adequate size will be available for those sons.

Entry of Outsiders Into Farming

The analyses presented in this study indicate the importance which the proportion of "outsiders" entering farming has upon the number of new farms available for Western Australian farmers. Yet there is no published record of the proportion of new farms which have been allocated to "outsiders" in recent years. Such a record is needed as a guide for future policy. There is need also for a continuous assessment of changes in the proportion of "outside" applicants and in the proportion of farms allocated to them. Restrictions on the entry of "outsiders" into new farms might be of advantage to Western Australian farmers, but the net effect on the State could only be gauged if details were available on the uptake of existing farms by "outsiders" and the prices paid.

Recent allegations of speculation in conditional purchase leaseholds have assumed that "outsiders" are the speculators. Such charges cannot be refuted or confirmed unless it is possible to carry out research into the records of the Lands and Survey Department.

Because of the importance to Government of a full knowledge of the changes occurring, the Lands and Survey Department should be required to under-

take continuous investigation into land ownership, transfers and values. This information is basic for sound policy in land administration.

The Release of New Land

The maximum area of new agricultural land which can be allocated to one person is 5,000 acres, but many existing farms in the marginal areas are larger than this. The less reliable the rainfall, the larger the area of land needed to make a living comparable with that obtained by other farmers. Farmers on the eastern margin who had the larger areas of land would be able to withstand a fall in product prices better than those in the same area who had smaller farms. The survey indicates that in the Eastern Wheatbelt, farms of 8,000 acres and over have an average labour efficiency of 820 acres of crop per man compared with 650 acres of crop per man for farms between 3,000 and 8,000 acres.

In surveying land for farm settlement on the eastern margin, account should be taken of possible falls in the price of wheat. Farm sizes should be large enough for farmers to take advantage of the economies of large scale. This suggests farms larger than the present maximum allocated area of 5,000 acres. If this became policy, it might be possible to release more land for settlement than has been indicated in this study. The straight line from the mouth of the Murchison River to Israelite Bay is only an approximation of the likely boundary of development. Moving the line 2.2 miles east would add a million acres of land to the total available with about the same yield potential. At 10,000 acres per farm this would provide another 100 farms and increase the potential acreage of crop by at least 250,000 acres.

An ecological study of the area to the east and west of the present limit of development should be undertaken to relate size and type of natural vegetation on the unalienated land with that in uncleared areas where crop yields are known. Given a more flexible policy on farm size, it would then be appropriate to determine, for different areas along the line, the minimum sizes of farm necessary to withstand likely changes in the price of wheat.

Only one third of the land still available for eventual release is situated in areas with a rainfall of more than 14 inches. It is these areas which have the greatest potential for increases in stocking rates and therefore for intensive sheep farming. There is a continuing demand from within and without Western Australian agriculture for new farms and their supply is likely to run out in less than ten years. Yet the release of an extra one million acres in the Esperance region, equivalent to 500 farms or 20 per cent of the new land available in higher rainfall areas, is dependent on the policies of a private company. Agreements by Government cannot be repudiated, but at least a review of their terms should be considered, in order to ensure that development and release of the land to intending settlers is related to the needs of settlement, rather than to the maximisation of capital gain.

Research Needs

There is a need for increased and more concentrated agricultural research into the successful utilisation of land

in the lower rainfall areas. The concentration of agricultural research upon the utilisation of third class soils in high rainfall areas has been very successful and has contributed to the rapid allocation and development of those areas. Now the emphasis should be placed on research into utilisation of the soils in the lower rainfall districts. These areas do not have the potential for high yields per acre but there are millions of acres available. This suggests that research effort could be directed profitably towards methods of increasing productivity per man and per unit of capital in these areas.

A severe restriction on the area of crop which can be grown in the Eastern Wheatbelt is the amount which can be sown in the limited period when soil and climatic factors are favourable for the traditional methods of ploughing, cultivation for weed control and sowing. Greater research effort is warranted into means of minimising these operations. There should also be long term assessments of the yields which could be obtained from continuous cropping or from a shifting cultivation on a long fallow system, with and without livestock.

The experimental work carried out in the lower rainfall areas with the use of nitrogenous fertilisers has indicated that the most important factor limiting the response to nitrogen is the unreliability of the rainfall. Yet it is in these areas that there has been little success in the widespread establishment of leguminous plants as an alternative source of nitrogen. If a leguminous plant could be grown which is useless as a feed for livestock, but could give nitrogen to a following crop, it may be worth while developing a system of husbandry based on large areas of crop per farm at low yields alternating with a phase devoted to such a legume.

In view of the importance of nitrogen for crop production, further experimental work with nitrogenous fertilisers would seem to be justified in these areas. Such work should focus on the interaction of time and rate of application with placement methods and type of fertiliser for different soil types, total rainfalls, rainfall distributions, effective precipitations, and opening and closing rains. The object would be to assess the feasibility of obtaining sufficient marginal increases in yield beyond those necessary to meet the cost of the added fertiliser. At present prices a net gain of half a bushel per acre would represent an extra £900 per annum to a farmer operating a 10,000 acre property with 3,000 acres cropped each year.

In ten years time the cleared area on farms of 1,000 acres and over could be nearly 36 million acres. The increase in cleared land could require a further seven million sheep if existing stocking rates were maintained. If potential stocking rates were to be realised, the required number of sheep could be over 29 million. Natural increase in sheep numbers may keep pace with the increase in cleared area, at **existing** stocking rates. But it will be impossible to achieve the 176 per cent **potential** increase without considerable improvement in the supply of sheep. This supply could come from increased fertility, decreased lamb mortality, longer work-

ing life for ewes and wethers and importations to the State. Research is needed into all these sources which combine physiological, managerial and economic considerations.

Analyses of the future possibilities for the further development of Western Australian agriculture need knowledge of technical production possibilities, and the economic factors governing their realisation on individual farms. In all of the research suggested here there is a need for close liaison and co-operation between farmers, farm advisers, agricultural scientists and agricultural economists.

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by M. L. PARKER.

Understanding the Economy of Western Australia

Each £100 of rural output generates about £32 of manufacturing output, of which £22 involves sales directly to the rural industries and £10 involves sales to other industries which directly or indirectly service the rural industries. In this article, the writer presents some of the results of the first attempt to measure the amount of inter-dependence between the primary, manufacturing and servicing industries in Western Australia.

In a previous issue of **Farm Policy,** Schapper and Parker contended that the exploitation of primary products for export has been and is likely to remain a major economic base for the growth of the manufacturing and servicing industries in Western Australia. Such exploitation alone has not required elaborate processing, rare skills, or large amounts of labour; rather it has required both population and investment capital. As the export industries and the associated servicing industries have developed, so the population and investment opportunities have grown sufficiently to support manufacturing industries producing goods formerly imported.

In this article it is intended to measure some of the economic linkages which enable the rural and mining industries to substantially influence the rate and direction of the State's economic growth.

Sales Patterns

If all industries in Western Australia were grouped into five major classifications, the pattern of sales would appear as in Table 1. This shows the sales between industries in 1959. The figures across any one row are the proportion of the output of the particular industry sold to other industries for further processing, and the amount delivered to final consumers — that is, for local consumption, export or investment. The rural industry, for example, had a marketed output of £123.4 m. It depended upon the manufacturing industries (mainly grain milling, meat processing and milk processing) for 26 per cent of its sales and a further 66 per cent of its sales were to final con-

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sumers. In return, (column 1), the rural industry purchased 6 per cent of the output of the manufacturing industries, 3 per cent of the output of the building and construction industries, and 7 per cent of the output of the service industries.

The contents of Table 1 are of limited use. A better measure of inter-dependence between industries can be obtained from Table 2. Here the cost structure of each industry is described in terms of a common unit; input per 100 units of output. One hundred units of rural output are shown to require negligible inputs from the extractive industries (fishing, forestry and mining); 22 units of input from the manufacturing industries; less than 2 units of input from the construction industry; and 17 units from the service industries. The remaining inputs adding up to the total cost (= total output) of the rural industry are wages 9 per cent; non-wages (return to capital and to management) 24 per cent; depreciation 14 per cent; and indirect taxes less subsidies 2 per cent. The 2 per cent of cost attributed to imports is accounted for by the fact that the output of the industry has been inflated by the value of rural products imported.

TABLE 1

PATTERN OF SALES : WESTERN AUSTRALIA : 1959 (per cent)

Sector	Rural	Extractive	Manufacturing	Construction	Services and Govt.	Final Consumers	Total Output	
							%	£m.
Rural	8.5		25.6			65.9	100.0	123.4
Extractive		1.3	19.0	4.5	10.2	65.0	100.0	37.0
Manufacturing	6.3	1.3	12.2	7.2	11.3	61.7	100.0	435.2
Construction	3.4				13.7	82.9	100.0	56.0
Services & Govt.	6.8	3.9	33.0	0.9	17.5	37.9	100.0	305.2

TABLE 2

INDUSTRY COST STRUCTURE : WESTERN AUSTRALIA : 1959 (per cent)

Sector	Rural	Extractive	Manufacturing	Construction	Services and Govt.	*Final Consumers
						£m.
Rural	8.5		7.3			81.3
Extractive		1.3	1.6	3.0	1.2	24.0
Manufacturing	22.2	15.1	12.2	56.3	16.1	268.5
Construction	1.5				2.5	46.4
Services & Govt.	16.7	32.4	23.1	5.0	17.5	115.8
Wages	9.1	30.9	9.1	26.0	36.1	
Non-Wages	24.5	14.7	5.4	7.2	17.3	
Depreciation	13.9	3.8	1.1	1.5	4.9	
Indirect Taxes less Subsidies	1.6	—0.9	6.1	0.4	3.1	1.3
Imports	2.1	2.7	34.1	0.7	1.3	6.2
Total—per cent	100.1	100.0	100.0	100.1	100.0	
Total Cost £m	123.4	37.0	435.2	56.0	305.2	543.5

*Consumption, public and private investment, stock rise and exports.

The costs shown in Table 2 refer only to annually recurring items of expenditure. Costs involving investment items are identified only in the column showing final consumption. In deriving Table 2, the products of each industry were valued at the point at which they were consumed and not at the point of production. Thus the wheat component of the total rural output was valued at the flour mill or at the port of shipment. The transport and commercial charges set against each industry were the costs involved in the distribution of its output.

The information contained in Table 2 is confined to the **direct** relationships between industries. These are the inputs directly required per unit of output. Having classified sales in this form, however, it is possible to calculate Table 3 which shows the **direct** and **indirect** connections between industries. Table 3 can be interpreted as follows: When sales to final consumers, from an industry listed in one of the columns, increase by £100 the total output, of each of the industries listed at the left, will increase by the amounts shown in that column.

Each £100 of rural products delivered to the final consumer (local consumers, exports, etc.) is shown in Table 3 to require £112 of rural output and to generate £36 of manufacturing output and £33 of services. Each £100 increase in **output** of agriculture generates £32 (£100 times £36.3/£112.2 = £32.3) of manufacturing output. But **direct** requirements from manufacturing per £100 of rural output were shown in Table 2 to be £22. Hence £10 (£32 — £22) or 31 per cent (£10/£32) of the manufacturing output was generated from **indirect** flows. In other words, each £100 increase in rural output generated £32 of manufacturing output, of which £22 involved sales directly to the rural industries and £10 involved sales to non-rural industries which directly or indirectly service the rural industries.

TABLE 3

DIRECT AND INDIRECT RELATIONSHIPS BETWEEN INDUSTRIES
WESTERN AUSTRALIA : 1959

Sector	Rural	Extractive	Manufacturing	Construction	Services and Govt.
Rural	112.2	2.2	9.9	5.7	2.1
Extractive	1.1	102.4	2.5	4.6	2.2
Manufacturing	36.3	27.9	124.5	72.2	26.9
Construction	2.6	1.3	1.1	100.8	3.3
Services & Govt.	33.5	48.6	37.9	29.3	130.2

Each column shows the total purchases required, directly and indirectly, from each of the industries listed at the left, per £100 of sales to the final consumer from the industry listed for that column.

Again, the delivery of £100 of construction output to final demand generated an increase of £6 in rural output; £5 in extractive output; £72 in manufacturing output and £29 in services. Comparison of these results, representing **direct and indirect** effects with the corresponding coefficients in Table 2 indicates that here too a sizeable amount of output was generated indirectly. The generative effect upon the rural industry was entirely indirect; the indirect draw upon the manufacturing industry accounted for 21 per cent of the total draw upon this industry.

Some care is necessary in interpreting Table 3. Firstly, the transactions refer only to sales on current account. Secondly, the purchases by any industry refer to the total requirements of the industry regardless of source; that is, locally produced commodities are distributed together with imports. Finally, the classification used to define each industry can influence the degree of interdependence. For example, a number of rural commodities appear to qualify equally well as flows to processing industries or direct to the final consumer. Wholemilk, fruit, vegetables and eggs, undergo very little processing and were therefore consigned directly from the rural industries to final consumers. Livestock slaughtering on the other hand, was treated as a factory activity and meat was consigned to the final consumer through the meat processing industry.

As a further measure of the interdependence between the rural and non-rural industries, it can be shown that each £100 of wheat-sheep output, for example, embodied a wage content of £23; of this, approximately £8 comprised wages paid directly by farmers and the remaining £15 was paid in industries directly or indirectly servicing the wheat-sheep industry. A further £39 of the £100 was accounted for by non-wage, of which £35 represented the return to capital, management and labour of the average farmer, and £4 represented non-wage payments in other industries servicing the wheat-sheep industry.

Sources of Economic Growth

Table 3 appears to confirm the stimulus which an expanding primary output has had upon the Western Australian economy. It shows also the substantial stimulus which the construction industry affords the remainder of economy through inter-industry demand. The economic inter-dependence shown in Table 3 between the rural and extractive industries on the one hand, and the manufacturing and service industries on the other, appears to underlie Western Australia's ability to retain its industrial position relative to the nation as a whole (Table 4). Although there have been fluctuations between years there has been no trend evident in the State's contribution to Australia's total net value of factory production. The fact that the State's contribution has remained stable since the 1920's despite the industrial advantages enjoyed by the Eastern States, and in the absence (until the 1950's) of a policy of industrialisation, suggests that strong pressures for induced manufacturing growth have accompanied Western Australia's primary development. Likewise the absence of any marked upward movement accompanying the more recent policy of industrialisation suggests the existence of economic forces opposed to expansion in the manufacturing sector beyond that of the pro-

cessing and sheltered industries required to service the local population and the mining, pastoral, agricultural, forestry and fishing industries.

TABLE 4

WESTERN AUSTRALIA'S CONTRIBUTION TO AUSTRALIA'S TOTAL NET VALUE OF FACTORY PRODUCTION*

1929	1934	1939	1944	1949	1954	1959	1960	1961	1962	1963	1964
4.83	4.22	4.31	3.42	3.77	4.49	4.27	4.16	4.46	4.47	4.51	4.37

*Year ending June.

Market Outlets

It will be recalled that the figure at the intersection of row 2 and column 1, in Table 3, indicates the amount of output required (directly and indirectly) from the extractive industries if the rural industry is to sell £100 of rural output to the final consumer. By reference to the actual sales from the rural industry to the final consumer it is possible to calculate the amount of extractive output which (directly and indirectly) is required for these sales to occur. This was the method used to calculate Table 5, showing the Western Australian market for coal, petroleum products, electricity and engineering output.

Column 1 in Table 5 can be interpreted as follows:—Sales of coal directly to the final consumer are negligible—in fact the £88,000 shown in row 7 is largely an increase in stocks of coal during 1959. In other words, sales of coal are largely to other industries which in turn sell their output, directly or indirectly, to final consumers. It is this "final" market for coal which is shown in column 1. The cereals-sheep industry, for example, was responsible for £266,000, or 7 per cent of the market for coal and a further £636,000 was accounted for by sales to the remaining rural and food processing industries. Other industries responsible for a major part of the coal market were mining, engineering, gas and electricity, building and transport.

In the case of petroleum products, the direct consumer and export demand for petroleum itself accounted for almost £33 million (of which £26 million represented petroleum exports and bunker oil). Eliminating this direct sale to final consumers it can be calculated from Table 5 that the cereals-sheep industry was responsible for 21 per cent of the remaining market for petroleum products. This link between the rural and petroleum industries is further emphasised by the fact that the consumer demand for all rural products and processed foodstuffs jointly accounted for £9 million of petroleum sales; if the direct consumer demand for petroleum is removed this represents 49 per cent of the residual market for petroleum products.

The close economic ties between the engineering and agricultural industries is also apparent in column 4. In this case much of the linkage is not apparent from Table 5 because agricultural machinery (and all other sales of a capital nature) appear as a direct sale from the engineering industry to the investment component of final consumption.

TABLE 5

WESTERN AUSTRALIAN MARKETS FOR FUELS AND ENGINEERING OUTPUT : 1959

Industry	Coal	Petroleum Products	Electricity	Engineering
	£'000	£'000	£'000	£'000
Cereals-Sheep	266	3,871	311	5,073
Dairying	24	379	53	502
Pastoral	11	276	17	396
Horticulture	87	997	199	995
Sub-Total : Rural	388	5,523	580	6,966
Fishing & Forestry	20	502	48	624
Gold & O'r Mining	420	692	1,613	2,809
Coal Mining	88	2	3	14
Sub-Total : Extractive	528	1,196	1,664	3,447
Cereal Foods	100	714	242	845
Milk Processing	60	305	151	541
Meat Processing	132	1,444	380	1,978
Beer & Tobacco	114	706	245	706
O'r Processed Foods	108	450	140	947
Sub-Total : Food Processing	514	3,619	1,158	5,017
Woodworking	70	307	138	682
Paper & Printing	15	69	47	102
Mineral Oil	88	32,871	185	732
Chem. Fertiliser	0	0	0	0
O'r Chemicals	31	238	88	249
Cement, Bricks, etc.	57	91	43	116
Woollen Mills	48	577	101	782
Clothing & Textiles	68	779	218	588
O'r Manufactures	17	103	41	163
Iron & Steel	8	30	22	46
Vehicle Assembly	37	414	119	1,104
Engineering	160	731	387	42,869
Sub Total : O'r Manufacturing	599	36,210	1,389	47,433
Gas & Electricity	1,137	563	3,447	448
Building & Construction	363	2,467	762	7,140
Transport & Communication	120	761	67	1,345
Commerce	0	0	0	0
Other Services	258	1,302	678	7,349
Sub-Total : Building : Services : Govt.	1,878	5,093	4,954	16,282
Unallocated	3	7	10	85
Total Sales, £'000	3,910	51,648	9,755	79,210

Rounding errors are not included in the final row showing total sales.

Having measured the inter-dependence between the rural and other industries, an obvious next step is to measure the effect which further rural expansion could have upon the remainder of the State's economy. In order to do this, estimates have first been made of the likely increase in rural output by 1970.

Rural Output by 1970

A survey carried out by the John Thomson Agricultural Economics Centre has shown that there remain 12 million acres of unalienated land suitable for farming and a further 12 million acres of uncleared land (9.3 million suitable for clearing) on existing holdings in the agricultural districts. Here it is assumed that the overall rate of land clearing will be maintained at the conservative figure of 850,000 acres per year. From an examination of current rates of development and of the areas yet to be cleared, the additional area of cleared land by 1970 has been estimated for each of three regions defined as "wheat-sheep," "southern agricultural" and "dairying."

For the wheat-sheep region, it can be assumed that the extra 3.5 million acres likely to be cleared between 1964 and 1970 will be worked on a rotation of 3 years pasture and 1 year crop. For the southern agricultural region (the more intensive form of cereals-sheep production south of Williams) the pasture phase is likely to be about 5 years; and for the dairying region the additional land is likely to be devoted entirely to grazing. It has been assumed that the carrying capacity of the additional grazing land, by 1970, will be equal to the stocking rate in the same region in 1964—that is, without any allowance for the anticipated increase due to set stocking. It has further been assumed that the additional cropland will be planted to wheat, oats and barley in proportion to the area of each crop, in each region, in 1964. Crop yields for both the 1964 acreage and the additional cropland in 1970 have been equated to the State average yield for each crop during the 6 years 1959 to 1964.

The overall stocking rate in the wheat-sheep region in 1964 was 0.86 sheep per acre. A conservative estimate of future stocking rates is 1.5 sheep per acre in districts receiving 15 inches of rainfall and 2.5 sheep per acre where the rainfall exceeds 20 inches. On this basis, the additional sheep which could be grazed in each of 14 statistical districts on the wetter margin of the wheat-sheep region was calculated. The potential stocking rate for these districts averaged 2.1 sheep per acre. For the remaining districts in the wheat-sheep region whch receive 15 inches of rainfall, or less, it was assumed that stocking rates by 1970 would not be appreciably above the level of 1964. The average stocking rate for these drier districts in 1964 was 0.76 sheep per acre and their inclusion reduced the overall potential stocking rate to 1.1 sheep per acre. At this level the projected increase in livestock in the wheat-sheep region, as a result of heavier stocking, would be 28 per cent.

A similar procedure was followed for the southern agricultural region except

that the potential increase in sheep numbers was independently assessed for each of the 16 statistical districts involved. The weighted average carrying capacity of the region was assessed at 2.5 sheep per acre compared with the overall stocking rate in 1964 of 1.53. The average stocking rate in the dairying region in 1964 was 2.39 sheep per acre. Any assessment of the likely increase in livestock in ths region is made difficult by the changing proportions of sheep and dairy cattle and uncertainty that heavier rates of stocking can be maintained with cattle. As a first approximation the carrying capacity for the dairying region was set at 3.0 sheep per acre.

With the previous assumptions (Table 6), the **potential** increase in output from the agricultural districts by 1970 could be 18 per cent for cereal grains and 61 per cent for livestock.

TABLE 6

REGIONAL DISTRIBUTION OF PRODUCTION POTENTIAL WESTERN AUSTRALIA

Agricultural Region	1963-64		Stocking rate 1963-64	Potential Stocking Rate	Additional Crop 1970	Additional Grazing 1970
	Area Cropped	Area Grazed				
	'000 ac.	'000 ac.	Sheep per ac.	Sheep per ac.	'000 ac.	'000 ac.
Wheat-Sheep	5,221	12,936	0.86	1.1	875	2,625
Southern Agric.	839	4,407	1.53	2.5	217	1,083
Dairying	3	1,325	2.39	3.0	—	300
Total	6,063	18,668			1,092	4,008

It is unlikely that an increase of 61 per cent is possible for livestock due to an inability to import or breed the required number of animals by 1970. In apportioning the potential increase in livestock between classes of stock it has been assumed that the trend in cattle numbers between 1959 and 1964 will be maintained. This probably overstates the likely growth in cattle numbers. Even so, assuming that the remaining pasture is grazed by sheep, it is unlikely that the additional 11.2 million sheep required by 1970 will be available.

During 1962-63 and 1963-64, Western Australian farmers imported (mainly from South Australia) 125,000 and 155,000 sheep, respectively. If 300,000 sheep were imported in each of the remaining years to 1970, and if it is assumed that the net annual increase in flock numbers will be maintained at 5 per cent, then the State's sheep population in the agricultural dstricts could total about 29.1 million by 1970. This would be a 44 per cent increase over the number in 1964 but would account for only 79 per cent of the number required by 1970.

This restraint upon sheep numbers has been taken into account in Table 7 which shows, for each region, the projected increase in cereals producton and in the number of livestock (ex-

pressed in sheep units). The annual gross income foregone by the State if 2.3 million sheep (additional to the normal breeding and import programme) cannot be bred or imported, will exceed £6 million by 1970.

TABLE 7

PRODUCTION IN 1963-64 AND POSSIBLE PRODUCTION IN 1970

WESTERN AUSTRALIA

Agricultural Region	Production in 1963-64		Estimated Production 1970		Increase 1964 to 1970	
	Cereal Grain	Livestock	Cereal Grain	Livestock	Cereal Grain	Livestock
	'000 bus.	'000 sheep units	'000 bus.	'000 sheep units	%	%
Wheat-Sheep	78,929	11,109	92,148	15,509	16.7	39.6
Southern Agric.	12,641	6,749	16,012	11,503	26.7	70.4
Dairying	44	3,160	44	4,547	—	43.9
Total	91,614	21,018	108,204	31,559	18.1	50.2

The data in Table 7 should not be viewed as a forecast. Little account has been taken of possible changes in the composition of total farm output with changes in farming techniques and yields, nor has consideration been given to the effect of changes in relative prices and costs. The data should be regarded as a conservative indication of the magnitude of additional production possible from the agricultural districts, by 1970, with existing techniques, additional acres likely to be brought into production and likely increases in stocking rates. The estimated increase in output is substantial, being of the order of 18 per cent for cereal grains and 44 per cent for livestock.

In the case of Kimberley cattle, it has been assumed that improved road transport will make possible an annual turn-off of 12.5 per cent. Sheep numbers in the pastoral districts have been assumed to remain at their 1964 level. For the horticultural and poultry industries, the estimated increase in production by 1970 has been based mainly upon the continuation of the trend in output during the 6 years to 1964.

Economic Stimulus of Expanded Rural Output

Table 8 shows the output required from the industries listed at the left (located in Western Australia and elsewhere) to meet the 1970 requirements of an expanded rural (and rural processing) industry.

TABLE 8

ESTIMATES OF SALES FROM THE RURAL INDUSTRIES IN 1970 AND ASSOCIATED CHANGES IN OUTPUT OF OTHER INDUSTRIES

Industry	Total Output 1959	Total Output 1970	Incr. to 1970
	£'000	£'000	%
Agricultural, Dairying, Pastoral	98,357	147,761	49
Horticultural	12,010	15,652	30
Poultry	2,735	3,816	40
Fishing	5,216	7,046	35
Forestry	6,657	6,820	2
Gold (including Pyrites)	14,230	14,543	2
Coal Mining	3,910	4,232	8
Other Mining	6,949	7,174	3
Cereal Foods	18,251	18,247	0
Milk Processing	8,751	11,495	31
Meat Processing	25,375	39,872	57
Wine : Aerated Waters	5,022	7,122	42
Beer : Tobacco	28,274	28,377	0
Other Processed Foods	16,996	17,543	3
Animal Oils	2,332	2,529	8
Saw Mills	16,573	17,097	3
Furniture	7,773	7,800	0
Paper : Printing	14,704	15,751	7
Petroleum Products	51,648	55,903	8
Fertilisers	9,023	14,436	60
Other Chemicals	20,094	21,196	5
Cement Goods	4,332	4,438	2
Lime, Bricks, Glass, etc.	8,211	8,463	3
Leather Goods	6,449	6,455	0
Woollen Mills	11,962	13,000	9
Clothing & Textiles	25,704	26,670	4
Other Manufactures	12,606	13,557	8
Iron & Steel	3,975	4,039	2
Ferrous Wire and Pipe	5,764	5,935	3
Other Engineering	102,204	107,604	5
Gas & Electricity	11,215	11,828	5
Building & Construction	56,000	56,965	2
Rail Transport	14,679	17,606	20
Road Transport	15,278	17,024	11
Air & Shipping	8,675	9,472	9
Commerce	86,325	98,544	14
Other Services	150,655	156,149	4
Unallocated	17,163	18,136	6
Total	916,577	1,040,302	13

In calculating Table 8, it was assumed that apart from the rural and fishing industries, sales to the final consumer in 1970 were fixed at their 1959 level. The level of personal consumption of foodstuffs and other commodities produced by the rural and fishing industries by 1970, was projected from national estimates made by Coombs. The volume of rural and fishing exports was estimated from the previous projection of output after the increased

levels of personal consumption and demands by other industries had been taken into account.

From Table 8 it can be seen that the projected value of output of the agricultural, pastoral and dairying industries, by 1970, is 49 per cent greater than the actual output of these industries in 1959 (at constant 1959 prices). Increases of 30 per cent, 40 per cent and 35 per cent are projected for the horticultural, poultry and fishing industries. The output generating effect of this expansion upon the rural processing industries and other industries servicing the rural sector is likewise shown in Table 8. The generative effect of the growth in rural output is not confined to industries which directly service the rural industries, however. Thus the output of the coal mining industry is shown to expand by 8 per cent despite the fact that there are no direct sales of coal to the rural industries.

The 1970 projections are calculated from relationships which existed between industries in an earlier year. Due to changes in the cost structure of the rural industries, for example, the 60 per cent increase indicated for chemical fertilisers is likely to understate the growth in output of this industry. Nevertheless, Table 8 does indicate the stimulus which expanding rural production has upon the commercial, transport, manufacturing and other servicing industries. It does not indicate the additional impact of the investment programme needed if the rural industries are to achieve these higher levels of output.

Conclusion

Strong economic linkages between the primary and manufacturing industries have been shown to underlie Western Australia's past ability to retain its industrial position relative to Australia as a whole. Each £100 increase in rural output has been shown to generate about £32 of manufacturing output and £30 of services. These findings clearly have policy implications since scope exists for this derived industrial growth to continue and to be strengthened by a more rapid expansion in the mining and rural industries. The likely increase in output from the agricultural districts alone, between 1964 and 1970, has been shown to be of the order of 18 per cent for cereals and 50 per cent for livestock.

In the same way that it has been possible to identify the transactions which directly and indirectly link one industry with another, it is possible to identify each industry's direct and indirect dependence upon imports. For example it can be shown that the net overseas earnings from £1 m., of exports from the wheat-sheep industry in 1959 (after the direct and indirect imports embodied in these exports are deducted) amounted to £0.91 m. The import content of other primary exports is also quite low. From £1 m., of overseas exports of petroleum products, on the other hand, the net gain is of the order of £0.46 m., and from the engineering industries it is £0.86 m. Again, these findings have policy implications since the drive for exports is a drive for net-exports. Eighty-five per cent of Western Australia's overseas exports are currently of agricultural origin, and these clearly have a substantial net-export advantage for the economy.