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THE FINANCING OF AGRICULTURAL RESEARCH BY LEVIES ON FARM PRODUCE

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SUMMARY

The impact of scientific research in terms of subsequent technological advance is immense and far reaching. It influences the nature and the welfare of the whole of society, and the benefits are so spectacular that society tends to look to science to cure all problems, both social and physical.

In the field of agriculture, research similarly tends to be regarded as a panacea for problems confronting agricultural producers. Although this is unreal, there is no doubt that agricultural research and technological change have greatly increased the productivity of farm resources over the last half century. This has also influenced the welfare of the community at large.

Scientific research in Australian agriculture has been, and still is, mainly undertaken by specialized public institutions financed from government resources. The principle of community support for agricultural research seems well established. In latter days rural industries have individually supported research, particularly through the statutory levy schemes operating under Commonwealth legislation. Although the trust funds established in this way are providing large annual sums for the support of agricultural research, the effects of these disbursements on research, and the benefits farmers derive from this research are uncertain. There is therefore a need for some examination of the impact of these funds. The purpose of this study is to describe the structure of the statutory levy schemes and the part played by them in financing research, to consider their possible effects on research and on primary producers, and to examine the conditions under which farmers might benefit and how the funds might be allocated most profitably.

1. INTRODUCTION

The provision of research and associated services has been a major constituent of the farm policy of Australian governments for more than half a century. The establishment of departments of agriculture by the State Governments, beginning in 1890, and the rapidity with which these departments employed agricultural experts are evidence of this.¹ The assistance given in the establishment of agriculture and veterinary science faculties in the universities at the beginning of this century, and the subsequent establishment and growth of the Commonwealth Scientific and Industrial Research Organization from its forerunners the Institute of Science and Industry established in 1920, and the Council for Scientific and Industrial Research established in 1926 are further evidence.² As scientific research has increased in volume with the growth of these organizations, particularly the universities and the C.S.I.R.O., the call on official funds for the support of research has increased considerably.

¹ The New South Wales Department of Agriculture was the first established in 1890, and five scientific experts were appointed in the first year. See *Agricultural Gazette of New South Wales*, Vol. 1 No. 1 (July, 1890), pp. iii-iv.

² This development is fully outlined in V. Jansen, "The Development of the Commonwealth Scientific and Industrial Research Organization", *Public Administration*, Vol. 14, No. 3 (September, 1955), pp. 166-175.

The agricultural research organizations have, however, always received some support from the benefactions of groups and individuals including some primary producers. Often the latter have made contributions collectively through their organizations, such as grower co-operatives, marketing boards, and farm organizations. Similarly there have been regular contributions by commercial firms associated with agriculture.

More recently the Commonwealth Government has encouraged an increase in the financial support given by primary producers for research by announcing its intention to contribute to trust funds an amount proportional to that collected by various industries. The present schemes involve the tobacco, wool, wheat, dairy and beef industries. The accumulation of large research funds by these industries represents a significant recent development in the financing of agricultural research in Australia.

2. THE DEVELOPMENT OF STATUTORY LEVY SCHEMES

The five statutory levy schemes presently operating under Commonwealth legislation have all been established since 1955. However, legislation imposing levies on marketed farm produce is not new in Australia, although the proceeds of such levies have been used for diverse purposes. In some cases the levy has been primarily to finance the operations of marketing boards but authority to support scientific research has been included in the boards' powers. The first legislation placing a levy on produce to provide funds specifically for research work was the Dairy Cattle Improvement Act, passed by the South Australian legislature in 1921.³ Since 1921 twenty-three acts passed by the various state and federal parliaments have specifically provided for monies raised by levies to be used to finance research. The acts providing for the financing of agricultural research by levies are listed in Appendix A.

The initiative for the establishment of the levy schemes seems to have come from three sources; from the increasing number of scientific institutions looking for additional funds, from the Commonwealth Government insofar as it was attempting to lighten its financial burden for the support of agricultural research, and from farmers' organizations who regard research as an aid to the solution of problems in their industries.

The first of the present schemes to be established was the Tobacco Industry Trust Account. Its formation was foreshadowed at the Premiers' Conference held in 1949. The Commonwealth and State governments established a Standing Advisory Committee in 1950 to review progress and conditions in the industry. Under the auspices of this Committee subsequently renamed the Central Tobacco Advisory Committee, the Tobacco Industry Trust Account and the associated arrangements were established by legislation in 1955. The levy became operative on January 1, 1956. The Trust Account is managed by the Advisory Committee previously mentioned.

³ See *Australian Report of the South Australian Department of Agriculture* 1923-24, pp. 13-14. The money obtained under this scheme was used to finance some of the early research work of the South Australian Department of Agriculture, but was mainly used to subsidize the purchase of pedigreed stock by farmers, and to assist herd testing associations.

The Wool Research Trust Fund was the second of these funds established. The Wool Research Act was passed in 1957 repealing the Wool Industry Fund Act, 1946-53. Money standing to the credit of the Wool Industry Fund was credited to the Wool Research Trust Fund when it was initiated, so that this fund is continuous from 1946, and as such is the forerunner of subsequent schemes.

The Wheat Research Trust Account was also established in 1957, and the Dairy Produce Research Trust Account in the following year. The latter varies from the others in that it was established at the request of the Australian Dairy Produce Board. The Australian Cattle and Beef Research Trust Account, set up in 1960, was the last fund to be established, and is also closely associated with the marketing board of that industry.

Legislation relating to each scheme provides for a specific levy on all produce marketed by producers in each of the five industries, to be paid into industry trust accounts. The levy rate varies between schemes, as does the proportion of the Commonwealth contribution. Associated legislation has established research committees to make recommendations to the Minister for Primary Industry on the allocation of the funds.

Following the recommendation of the respective committees, the funds are allocated to separate research projects submitted by research units in state and Commonwealth departments, C.S.I.R.O., the universities and other organisations. Funds are also used to provide scholarships and to finance the dissemination of research findings, although these activities receive only a minor proportion of monies allocated. The type of research supported varies from industry to industry, but all industries support primarily biological research relating to farm production.

3. THE ORGANIZATION OF THE LEVY SCHEMES

Structure

Each scheme is characterized by a levy on farm produce, a trust fund into which the proceeds of the levy are paid, and a committee which makes recommendations on the allocation of the monies deposited in the trust fund. Apart from this basic similarity all schemes vary significantly in their organization. Membership of the various management committees is set out in Appendix B.

The Tobacco Industry Trust Account is managed by the Central Tobacco Advisory Committee, but in addition the State Governments have established State Tobacco Advisory Committees. The purpose of these committees, which are made up of representatives of growers, manufacturers, and the respective departments of agriculture, is to assist the planning of State research and development programmes and to indicate major problems in the industry. Income of the Tobacco Industry Trust Account comes from an initial contribution of £84,000 each by the Commonwealth Government and manufacturers. In addition to this there are annual payments of £36,000 from the Commonwealth and £15,000 by each of the four States in which tobacco is grown. All manufacturers are levied at the rate of one penny per pound weight on all leaf purchased, and growers are levied one half penny per pound weight on all leaf sold. The fund also receives some income from interest on money the committee has invested.

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The Wool Research Committee, which has been responsible for the management of the Wool Research Trust Fund, was originally supported by a secretariat within the Department of Primary Industry. However, with the introduction of the Australian Wool Board as an overall wool authority in 1963, responsibility for this committee has passed to the Australian Wool Board. Allocations by the committee of monies held in the fund are still subject to approval by the Minister for Primary Industry. The income of the Wool Research Trust Fund is made up of a levy of two shillings per bale from producers plus an equal contribution from the Commonwealth Government. Some additional income is obtained as interest on investments held by the trust fund. These investments, amounting to £8,340,000 in June, 1963, were accumulated following the winding-up of previous wool research funds and of the Joint Organization and associated bodies.

Administration of the Wheat Research Trust Account is shared between the Wheat Industry Research Council as a Commonwealth body and separate Wheat Research Committees in each State. The separate committees originated because grower organizations stipulated, as a condition for their approval of the proposed legislation, that the funds be distributed to the respective States in proportion to their production of wheat and that growers have a majority representation on the allocating committees. The membership of these committees is also summarized in Appendix B. The State committees are completely autonomous, and a separate account is kept in Canberra for each committee. By authority of the Wheat Tax Act, 1957, wheat growers are levied one farthing per bushel on all wheat delivered to the Australian Wheat Board. These collections are paid into the Wheat Industry Research Trust Account and become available on a pro rata basis for distribution by the respective State committees. These committees do not have to obtain ministerial approval for their expenditure. A contribution is also made by the Commonwealth, as is done in each of the other schemes. In this case the Commonwealth contribution is not specifically defined by law, and money is provided as required up to a maximum of pound for pound assistance against wheat tax collections. Such contributions have so far been at the maximum rate. The Commonwealth contributions are kept separate and are allocated by the Wheat Industry Research Council and approved by the Minister for Primary Industry. In addition a sum of £284,418 has been made available to the State committees, being undistributed amounts remaining in wartime wheat pools. The committees and the council have each set aside a reserve of about two-thirds of estimated annual average expenditure to allow for variations in levy collections which may occur from year to year due to fluctuations in the size of the wheat crop.

When the Dairy Produce Research Trust Account was established in 1958 the Dairy Produce Research Committee was also established to advise the Australian Dairy Produce Board on the expenditure of the money collected by the levy. Representation on the committee is mainly from the Australian Dairy Produce Board as is shown in Appendix B. The Dairy Produce Research Trust Account is thus under the control of the Australian Dairy Produce Board. Income for the trust account comes from the levy of one-sixteenth of a penny per pound of butter and one-thirty second of a penny per pound of cheese, paid by dairy farmers on all butter and cheese produced in Australia. The Commonwealth contribution is made on a pound for pound basis with expenditure approved by the Minister, providing the total does not exceed the amount raised by the levy in the

same year. The Board has established a reserve to meet fluctuations in collections which may result from bad seasonal conditions and other variations in the income of dairy producers.

Similarly the Australian Cattle and Beef Research Trust Account is administered by a committee, known as the Australian Cattle and Beef Research Committee. The trust account contains contributions by the beef cattle industry arising from a statutory levy of two shillings per beast, imposed on all cattle slaughtered for human consumption which weigh greater than two hundred pounds dressed weight, or two hundred and twenty pounds for carcasses with the skin on. The legislation provides for the Commonwealth to contribute pound for pound on the amount of expenditure recommended by the committee and approved by the Minister for Primary Industry. The activities of the committee were impeded because of a challenge by the meat trade to the validity of the legislation relating to collection of the levy. Following slight amendments to the legislation the committee became active in 1961 and made its first allocation in 1962.

Subsequently the Meat Industry Act, 1964, changed the organization and broadened the powers of the Australian Meat Board, and brought the Australian Cattle and Beef Research Committee under the Board's control, thus bringing this committee into line with the Wool and Dairy Research Committees.

As shown in Table 5, each committee has representatives from government departments, scientific institutions and producers' organizations, but all except the Central Tobacco Advisory Committee have a majority of primary producers among the committee members. Except for the committee secretaries, none of the committee members is fully occupied with the work of the committee. At various times officers of C.S.I.R.O. and the Bureau of Agricultural Economics have been used as advisers to the committees, but it was not until 1963 that scientists were appointed to assist in the evaluation of projects and programmes proposed for support from the Wool Research Committee. Since then the Cattle and Beef Research Committee has also appointed an adviser who acts as executive officer for the committee.⁴

Allocation Procedures

The allocation procedure adopted by each committee, although not laid down by the legislation, has become fairly standardized. The practice is for research organizations wishing to obtain funds to make a submission requesting those funds. The submission has to be forwarded by a stated time prior to the annual budget meeting of each committee. The research programme has to be fully outlined, and accompanied by estimates of costs, itemized into the categories of salaries, maintenance, and capital expenses. Each organization is requested to submit thirty roneoed copies of its application and a copy is circulated to each committee member prior to the meeting. The Wool Research Committee led the way by developing a standard form for use by organizations when making submissions, and the other funds have now adopted these forms.

⁴ The scientists appointed by the Australian Wool Board are Dr. G. R. Moule, on the production side, and Dr. A. J. Farnsworth on the textile side. The Australian Meat Board has appointed Dr. M. C. Franklin. All three were previously research officers with C.S.I.R.O.

Some of the committees have laid down general principles relating to the way in which they allocate finance. In particular, the Wool Research Committee has adopted a plan which supports biological, wool textile, and economics research. This committee has also decided that most work on biological and wool textile research will be done by C.S.I.R.O. and that most economics research will be carried out by the Bureau of Agricultural Economics. The Wool Research Trust Fund is used to support the Wool Section of the Bureau of Agricultural Economics as a statistical and research unit.

Because of the complexity of the universities' programmes in which there have been as many as five different departments from one university submitting projects for support, the Wool Research Committee has delegated to a sub-committee the responsibility for allocating a fixed sum, to universities. This maximum figure was £200,000 for 1961-62, and £250,000 for 1962-63. This does not represent any particular percentage of funds available, and no reason is given for allocating that particular amount for this purpose. However, in the Annual Report, 1961-62, the Secretary of the committee, noting that forty-one students were wholly supported by wool funds in the previous year, states: "This is in keeping with the committee's policy that research in universities should be, basically, a training for future scientists who will enter the sheep and wool industry. On the result of the above survey it is believed that the industry is assured of a steady flow of highly trained graduates for basic applied research and for special extension activities".⁵ This statement of the committee's policy toward universities indicates that they do not consider Australian universities to be important as research institutions but that they consider that, with the committee's assistance, the universities are doing their job of teaching satisfactorily.

Referring to state departments of agriculture, the Wool Research Committee "considered that little support should be given from the Wool Trust Fund to State departments of agriculture as it was considered that their work of extension was a State function".⁶ However, since 1959-60 the committee has allocated money to the departments to employ additional extension officers, and has also supported some research projects conducted by these departments. In addition the committee supports schools attended by sheep and wool officers from all States.

All committees have declared their intention to allocate funds only for the support of new work or for extending existing work, and have accordingly refused to assume responsibility for the support of projects which have, to their knowledge, been previously supported with money from other sources. The Wool Research Committee also attempts to discover whether projects submitted could be financed from other sources.

The Tobacco Industry Advisory Committee has specifically stated that funds are not to be used to relieve organizations of existing commitments for research or advisory work. In addition this committee has specifically laid down that monies from the Trust Account are not to be used for

⁵ *Annual Report, Wool Research Committee*, (Department of Primary Industry: Canberra), 1961-62, p. 7.

⁶ *Co-ordination of Agricultural Research—Exploratory Meeting—Background Papers*, (Department of Primary Industry: Canberra), January, 1961, p. 4.

economic investigations or research. This clause was inserted to ensure that these funds were not used to support work within the Bureau of Agricultural Economics which the committee believed was a government responsibility. This committee has followed a plan of keeping a close watch on projects supported by its funds.

The Wheat Research Council aims to support research of a more fundamental nature than that supported by the State committees, and it makes allocations only after reviewing those made previously by the Wheat Research Committees in the five States. The Wheat Research Committees have each selected their own particular allocation criteria. For example in New South Wales the committee sought to maintain wheat growers' equity and authority in the use of funds by establishing their own research institution. Because the Act specifically prevented any property being vested in the committee the members elected to form an independent New South Wales Wheat Research Foundation, and have proceeded to allocate a large proportion of their funds to this foundation each year. The governing body of the foundation is identical with that of the committee except that the representatives of the New South Wales Department of Agriculture on the committee do not appear on the board of the foundation. The foundation holds title to a research station at Narrabri, New South Wales, which is staffed and run by the University of Sydney. Similarly the Queensland committee chose to allocate most of its funds to the Toowoomba Wheat Research Centre proposed by the Queensland Department of Agriculture and Stock, and almost all funds have been held for use on this project.

On the other hand, a feature of the policy of the Dairy Research Committee has been a reluctance to provide funds for capital works, although this policy has been waived in cases where such expenditure has been particularly warranted.

All of the committees have authority to use funds for the dissemination of information relating to scientific and technical matters in connection with their particular industry. Each committee has used this power, some to support scientific publications and some to print research reports on projects being supported. The Tobacco Trust Account has financed many publications in this latter category.

However, in practice, the allocation procedure adopted by the committees has proved difficult to maintain. In particular the Wool Research Committee has delegated some allocating, mainly that to universities, to separate sub-committees. The consideration of a large number of submissions by the committees in the short period of their meeting is obviously a most difficult task. This large number of submissions, together with the fact that the members of all committees are involved in other full-time jobs, means that, despite the fact that submissions are circulated before the meetings, they can receive only cursory consideration in some instances.

Apart from broad guide lines set down by the legislation, and some broad principles adopted by the various committees as outlined above, the criteria used in selecting projects to support are indeterminate and monies are presumably allocated by reviewing the projects submitted and selecting from them on the basis of what is considered most important at the time.

4. THE SIGNIFICANCE OF THE SCHEMES TO AGRICULTURAL RESEARCH

Relative Volume of Funds

The development of the research levy schemes has meant a rapid increase in the volume of funds available for the support of Australian agricultural research in recent years. This growth has resulted in a change in the proportion of funds available from different sources, so that the industry funds now represent a large proportion of total funds available for this purpose. Allocations from the various funds are set out in Appendix C and a summary is presented in Table 1.

TABLE 1
Summary of Allocations from Industry Research Funds

Funds	1958-59	1959-60	1960-61	1961-62	1962-63
	£	£	£	£	£
Tobacco Industry Trust Account	127,627	161,000	217,915	289,081	237,158
Wool Research Trust Fund	1,603,889	1,870,166	2,211,516	2,731,923	2,989,459
Wheat Research Trust Account	398,887	338,294	884,471	435,960	565,398
Dairy Industry Trust Account	8,149	138,421	221,423	213,684	307,648
Cattle and Beef Research Trust Account .. ..	..	..	..	..	311,112
Total	2,138,552	2,507,881	2,985,325	3,670,648	4,410,775

The figures in Table 1 show the much greater volume of the Wool Research Trust Fund as compared with other industry levy funds. The largest part of the allocation from the Wool Research Trust Fund goes to the C.S.I.R.O. Allocations from the various funds, shown in Appendix C, indicate that the C.S.I.R.O. also receives important assistance from the other funds. The figures in Table 2 indicate that the C.S.I.R.O. has received greater benefit from the development of these funds than have other organizations. The proportion of industry funds received by the C.S.I.R.O. is greater than its proportional share of total expenditure on agricultural research, as shown in Table 3.

TABLE 2
Annual Allocations to C.S.I.R.O. from Industry Research Funds

Year	Total Funds Allocated	Total Allocation to C.S.I.R.O.	Percentage of Funds to C.S.I.R.O.
	£	£	per cent
1958-59	2,138,552	1,479,899	69
1959-60	2,507,881	1,717,242	68
1960-61	2,985,325	1,969,637	66
1961-62	3,670,648	2,500,040	68
1962-63	4,410,775	2,740,671	62

The total expenditure on agricultural research in Australia is estimated to have been about £11 million in 1960-61 (see Table 3). During that same year industry fund allocations totalled £3 million, being some twenty-seven per cent of the estimated total amount spent on agricultural research in that year. This level has been reached within four years of the initiation of the major schemes. With the further growth of these funds, and the probable development of additional similar funds, these sources seem likely to play an increasingly important role in the financing of agricultural research.

TABLE 3

Estimated Expenditure on Agricultural Research In Australia 1960-61

Organization	Estimated Expenditure	Percentage of Estimated Total
	£m.	per cent
C.S.I.R.O. (Divisions and Sections in rural research only) *	6.0	54
Departments of Agriculture and other Government Departments †	3.5	32
Universities ‡	1.5	14
Total	£11.0m.	100

* This estimate for C.S.I.R.O. includes expenditure on Animal Research Laboratories, Plant Industry, Tropical Pastures, Entomology, Soils, Irrigation Stations, Food Preservation, Forest Products, Research Services, Biochemistry and Nutrition, Fodder Conservation, Tobacco Research, Dairy Research, Wool Research, Land Research and Regional Survey, Wheat Research and grants to the Bread Research Institute, and Wine Research Institute. It omits expenditure on Soil Mechanics, Mining and Metallurgy, Radio Research, Chemical Research Laboratories, Fisheries and Oceanography, Mathematical Statistics, National Standards Laboratory, Tribophysics, Building Research, Radiophysics, Meteorological Physics, Fuel Research, Wildlife Survey, Miscellaneous Grants, and Overseas Studentships. All figures taken from the *Annual Report of C.S.I.R.O.*, 1960-61.

† This figure was reached by taking the number of persons said to be engaged in research as a proportion of total professional persons employed in each Department, and after deducting some special expenses, dividing the total department budget into the same ratio. For each department the amount so estimated to be spent on research falls between £6,000 and £8,500 per head of research personnel employed. When the number of research workers is divided into the total budget for the C.S.I.R.O. sections considered a figure of about £6,500 is obtained. The figure arrived at does not include Commonwealth Departments. University expenditure has been estimated to be nearer £4,000 per research worker; see "Science in Australia", *Current Affairs Bulletin*, Vol. 30, No. 7, August, 1962.

‡ This figure is based on the estimates of G. V. Cullen, "Research Departments in Firms", *Mining and Chemical Engineering Review*, Vol. 3, No. 1 (October, 1960), pp. 2-22, and J. K. Allan, *Applied Research on the Development of Australia: A Preliminary Survey*, Stanford Research Institute, January, 1961.

The proportion of these funds is such that the way in which they are allocated and the purpose to which they are put could influence the orientation and balance of Australian agricultural research. This situation is perhaps as much attributable to the small volume of funds available from other sources as to the size of the contributions from the various rural industries involved.⁷ The collections of the levy schemes are still a small proportion of the income of the industries concerned. For instance the average annual contribution to the Wool Research Trust Fund represents 0.6 per cent of the annual gross income of the wool industry over the years 1959 to 1962.

The effects of the industry funds may be extended by their influence on the use of research monies available from other sources. Although allocations from the industry funds are often used to employ and facilitate the work of additional staff, they are also frequently used to provide facilities and equipment for existing staff. In order to obtain funds for this purpose from a research committee the institution has to submit projects acceptable to the committee. Thus to obtain working finance institutions may have to orient their programmes towards particular industries, and to particular types of research. In this way the use of buildings, salaries, and other finance obtained without limitations on its use, may be indirectly determined by the research committees. So, in this way the levy schemes may be influencing research to a much greater extent than the ratio of industry to other funds would indicate.

Some Effects on Research

The process of scientific research has several special characteristics. Among them is a clearly recognized structure involving a graduation from the investigation of practical problems to research on academic problems. Research may be classified into categories of pure fundamental, oriented fundamental, applied and developmental research.⁸ The balance between

⁷ The shortage of finance for scientific research in Australia generally is discussed in "Science in Australia", *Current Affairs Bulletin*, Vol. 30, No. 7 (August, 1962).

⁸ It is usual to consider specific research projects as being in the categories of either applied or fundamental research according to the frame of the reference within which the research problem is formulated. However, there is within the structure of research a spectrum of scientific activity so that this definition inadequately defines the characteristics of the different types of research and does not clarify the relationship they might bear to one another. A more satisfactory division into four categories is possible. This has been fully outlined by Pierre Auger, *Current Trends in Scientific Research* (UNESCO, Paris: 1961), pp. 16-18. Fundamental research is divided into pure and oriented fundamental research, and applied research is separated into applied research and development work.

Pure fundamental research is characteristically the work of individuals working independently of research organizations or any overall programme. The work is not restricted to any clearly defined sector but is always associated with the fundamental sciences. Independence is considered to be an essential part of this type of work and it is generally fostered by financing individuals rather than a research unit. *Oriented fundamental* research is still associated with a fundamental science but workers no longer have complete freedom in objectives. Usually the work is limited to a clearly defined sector. Frequently this category can be defined into two types; first background research aimed at collecting a

these is considered critical since the solution of problems in the more applied fields is dependent, to a large extent, on findings in the more fundamental fields. Applied research largely builds on the findings of fundamental research, although fundamental research does not necessarily lead to applied discoveries. Fundamental research might be considered as lowering the cost of applied research and subsequent practical discoveries. For this reason it becomes important that more and increasingly expensive applied research should not be financed to the exclusion of fundamental work on which it may be dependent for its success.

But in addition each of the categories of research have characteristics which suit them to different types of research organizations, and different conditions. One of these characteristics is the place and importance of the scientist himself and the individual nature of much of his work. Incentives in the form of freedom of action, work opportunities and facilities available to the research worker greatly influence the success of research organizations even in applied research and development work.⁹

The Australian universities provide one example of how research work is being influenced by the allocation of levy funds. The schools of agriculture of the universities are particularly dependent on these funds as a source of finance for research. They have found themselves in this position because of a lack of public support for their research, and because they have increased in number and size so that previous sources of finance have become insufficient. For many newly developed university departments the industry funds represent a major source of financial support for research. To obtain these funds a programme acceptable to the respective allocating committees must be undertaken, and because of their tendency to favour applied projects the universities have tended to undertake more applied research.¹⁰

As a result of this trend the universities may be leaving the fields of research in which they have a comparative advantage. By tradition spanning centuries the universities have been centres of research, permitting maximum freedom and detachment to those working within their province, though

large body of fundamental data, and second, field centred research, concentrating on some special natural phenomena. *Applied* research may often be an offshoot of these last two categories but is deliberately aimed at some concrete result which will subsequently result in the production of new and increased amounts of goods or services. *Development work* is seen as the final stage in the effort to secure economic and social benefits from science. This is often the longest and most expensive process. Development work need not involve the use of any new scientific results but may call in much empirical, technical and scientific knowledge in a wide variety of fields. This process is employed particularly when transferring a technique from one area, and hence from one set of conditions, to another. The greatest problem is frequently the change of scale involved in going from laboratory to the field.

⁹ Some of the conditions beneficial to the successful performance of scientific research have been discussed recently by Leon Peres, "Research Organization and Incentives", *Public Administration*, Vol. 22, No. 4, (December, 1963), pp. 330-348.

¹⁰ The tendency for universities to have to follow applied fields in order to attract funds, and some of the disadvantages of farmers' funds, are outlined by J. R. A. McMillan, "The Role of the University in Agricultural Research", *Journal of the Australian Institute of Agricultural Science*, Vol. 20, No. 3, (September, 1954), pp. 138-142. See particularly p. 141.

the universities have changed in many ways they still provide an atmosphere where freedom of action is encouraged and where the efforts of the individual are of paramount importance. Such conditions reproduce as nearly as possible the conditions suggested as essential for the execution of pure fundamental research.¹¹ Also the universities have another feature in the form of graduate and advanced under-graduate students who all undertake projects as part of their training. These students under the leadership of permanent staff form a team which can frequently undertake the broad step by step attack on problems characteristic of oriented fundamental research. By selecting more applied problems in order to get finance the schools of agriculture may be leaving the fields in which they can make their greatest contribution. They may also be leaving fields which cannot be easily filled by any other type of establishment. Thus there may be a double disadvantage that, not only will there be a loss of efficiency because universities are forced out of the fields where they have an advantage but, the type of work they would normally undertake may not be undertaken.

Another very real effect of the allocation procedure is on personnel working in research through the increase of positions with uncertain tenure. Because committees allocate funds only for specific purposes and have stated a preference for programme allocations of two years, in the first instance, any additional personnel employed are usually employed for only two years; that is, for the duration of the allocation. Often the organization involved is able to guarantee the continued employment of such employees but in many cases this has not been possible, particularly in universities. This particular aspect of the allocation procedure favours some organizations at the expense of universities. While a university appointment for one or two years may suit a scientist undertaking work for a higher degree, such a term is likely to be quite unsatisfactory to a technician who would require an appointment of a more stable nature. Many research and laboratory technicians at universities and some other institutions have been employed on a year to year tenure. Such situations mean that these organizations have difficulty in obtaining the type of personnel they prefer.

These aspects detract from the advantages to research personnel arising from the increased availability of finance for research. But in general, the increased volume of funds has provided an additional number of employment opportunities and better facilities for scientists. This has meant that scientists from other countries have been attracted to Australia, and at the same time universities have been able to undertake more ambitious programmes and to provide more post-graduate opportunities for their students, so that the number of Australian scientists working in agricultural research has increased.

On the other hand the research committees tend to place some additional requirements on research workers. One example is the requirement by fund administrators of regular reports from those scientists receiving support. The report requirements vary from one fund to another but they are usually required on an annual basis. However, because projects are not always initiated immediately finance is allocated by committees, reports frequently have to be submitted within a short time of experimental work

¹¹ Pierre Auger, *Current Trends in Scientific Research* (Paris: UNESCO, 1961), p. 16.

being initiated. These reports are time consuming and are considered by research workers in many instances to be unnecessary, particularly when the work has not been given time to achieve results. The real effect of this on research would not seem to be very great, but it does mean that scientists can feel that they are being excessively controlled.

The system of allocation also influences individual workers, in that it tends to give recognition to particular research organizations regardless of the calibre of individual scientists. Also the State departments and universities are generally all represented by one individual from a particular university and State department. Because of this some research workers may be represented on committees by scientists who are rivals or belong to rival institutions in the competition for funds. Although the C.S.I.R.O. fares better in this regard, as it has representatives on most of the research committees, some organizations have no representation at all. Because of inadequate representation some scientists and organizations find that, although they have better qualifications and equipment ideally suited for particular work, they are unable to obtain support for particular projects they have planned. One effect of the appointment of full-time advisers to some of the committees may be a reduction in situations of this kind.

Similarly the way in which submissions are made, submitting several alternative programmes and allowing the committee to choose the ones they prefer, may mean that research directors lose the initiative in selecting programmes best suited to their resources, their workers' ability and the state of their scientific field at that time. It may be argued that, particularly in the fields of fundamental research, the research directors are better qualified to assess priorities than a committee with a majority of growers among its number. This problem will be largely overcome if the committees consider each project submitted on its merits without resort to restricted policies as to the type of projects they will support. The greatest problem then arises when research directors submit a large number of projects, many of which may be ill conceived or incompletely planned, in order to be sure of sufficient funds to enable the continued employment of existing staff or to permit desired expansion. A thorough evaluation procedure would, however, help to overcome this problem.

It is important that members of the various committees be aware of the several aspects outlined above when they are considering allocations. Otherwise the influence of the industry research funds may be contrary to the balanced development of agricultural research and to the successful work of research workers, without which there may be reduced gains from research whether these go to farmers or the community as a whole.

5. THE IMPORTANCE OF THE SCHEMES TO PRIMARY PRODUCERS

Some Effects of Innovation

In economic terms the successful result of scientific research is a discovery which, after subsequent development work, leads to the adoption of a new technique, a technological innovation.¹² The various innovations which arise from scientific research are diverse in their form and in their effects on farm organization, but they can be classified into three groups.

¹² The word "innovation" is used here to mean a new technique or factor which, when adopted, changes the established way of doing things.

First, there are biological developments which increase farm output without necessitating large capital expenditure. These include such things as new or improved plant varieties, new weedicides and pesticides, the development and introduction of myxomatosis which decimated rabbit numbers in Australia during 1951-52, and the application of trace elements to the soil in some areas such as the Coonalpyn Downs in South Australia, previously known as the Ninety Mile Desert. Although these innovations require little or no capital investment they often increase direct production costs.

The second class includes the labour-saving and capital-using mechanical innovations. These innovations, of themselves, do not usually increase output but have the effect of reducing total production costs. They often have the side effects of displacing labour from farms, and of reducing the work required of farmers. Examples of the impact of this type of innovation have been associated with the introduction of tractors and attached equipment, with the connection of electricity to farms, and, more recently, with the use of bulk handling methods for farm produce.

The third category into which innovations may be grouped includes new practices which are both output increasing and cost reducing. These innovations have some of the features of both the first two categories, and often require large amounts of capital and necessitate far reaching adjustments in management programmes for farms. While total production costs are often increased, the average costs are reduced by such innovations. The intensification of production associated with this type of innovation tends to offset the reduced labour requirement associated with mechanization, and always results in increased output from farms.

This classification, based on criteria associated with the impact of innovations on farms, suggests that some technological innovations will increase output while others will not, and involves the recognition of output increasing and cost reducing innovations. This division is appropriate at the farm level since a new development or invention will not usually be adopted by farmers unless it is known to either increase the output obtained from a given amount of inputs, or to produce the same output with less inputs. The only other condition for adoption, assuming farmers aim to optimize their economic position, is an effective reduction in the uncertainty of production and output.¹³ There are many reasons why a new development may not be adopted. In particular problems of capital formation and family sociological factors, such as an ageing manager, may prevent adoption. But the conditions necessary for a development or invention to be adopted are either increased output, decreased costs, or reduced uncertainty.

However, it can be argued that both cost decreasing and uncertainty reducing innovations will be also output increasing. A reduction in the cost of an input, or the discovery of a cheaper substitute will reduce the cost of production and make production more profitable. Consequently this

¹³ The inclusion of increased leisure as a further condition encouraging the adoption of new technology seems unnecessary since it is only a particular example of producing the same output with less inputs.

will encourage an increase in output.¹⁴ Also, some resources which are replaced in this way are immobile and tend to stay in agriculture. The continued output from these resources, such as some farm labour, helps to ensure that even labour saving innovations are output increasing in agriculture.¹⁵

Innovations may often reduce uncertainty. For example a new wheat variety may reduce production uncertainty by giving more even yields over good and bad seasons. This alone may give increased output, providing the variety performs better under unfavourable conditions without reducing previous performance under favourable conditions. But the more even yield obtained permits the more profitable use of other resources by reducing the likelihood of a loss by the failure of some crops in some years. This allows the fixed costs of mechanizations to be spread more evenly over a number of seasons, and permits variable inputs to be adjusted so that marginal costs are equated with a higher expected marginal return. From the farm manager's viewpoint the increased output or lower cost is the only economic gain to be had by reducing uncertainty. If this is the effect then, following the lines of the argument above, this type of innovation seems certain also to result in increased output.

This means that the eventual effect of agricultural research, providing it is successful in producing new technology, will be to increase farm output. Thus technological changes may be considered as the introduction of a new production function where a given input of resources gives an increased output. But the final condition for adoption is that, whatever its cost, the new technology should increase the profitability of production and thus initially increase the net income of adopting firms. For this reason it is necessary to consider the price effects of an innovation. In the aggregate this technological change can be visualized as an increase in supply, or diagrammatically as a movement to the right of the supply function. This change means that, without a proportionate increase in demand, the price of the product will fall. Accordingly this will affect the net income of farms. Accepting that the effect of adoption is to initially increase both farm output and net income (otherwise the change would not be adopted), it is possible to consider the income effects of subsequent changes in supply without resort to the total revenue and total cost curves used in some other studies.¹⁶

The Distribution of Gains

The magnitude of any fall in price following an increase in supply depends upon the elasticity of demand for the product concerned. If the elasticity is less than -1.0 then the gross revenue from the sale of the product will be less at the higher level of production output than at the

¹⁴ This point has been briefly outlined by F. H. Gruen, "Agriculture and Technical Change", *Journal of Farm Economics*, Vol. 43, No. 4, Part 1 (November, 1961), p. 838.

¹⁵ The various aspects of farm labour immobility have been discussed by T. W. Schultz, "A Policy to Redistribute Losses from Economic Progress", *Journal of Farm Economics*, Vol. 43, No. 3 (August, 1961), pp. 554-565.

¹⁶ See for instance E. O. Heady, "Basic Economic and Welfare Aspects of Farm Technological Advances", *Journal of Farm Economics*, Vol. 31, No. 2 (May, 1949), pp. 297-300.

lower level. Under these conditions society as a whole will benefit from lower prices for farm commodities. But apart from this society will also benefit from economic progress associated with the release of resources from agriculture to other sectors of the economy. Thus there is some doubt as to whether producers or consumers will derive most benefit from research, and whether the research levies on farmers are economically justifiable.

Most considerations of this problem have been based on an economic situation with a high domestic real income and no export markets for the products considered.¹⁷ The general conclusion drawn is usually that although some producers may benefit from research, the consumer, or society as a whole, receives most of the benefit in the form of lower priced rural commodities. In this situation the financing of research by farmers is, for the majority of these farmers, an unprofitable proposition. The exception arises because increases in output can be an individual process, achieved in some firms independent of the others, while the price effect is an aggregate effect which occurs only as a number of individual firms begin to increase output so that the total output is increased enough to influence the market. Thus any single unit which innovates and increases output, before the aggregate supply increase causes prices to fall, will profit from increased output selling at ruling prices. Of course, once prices have fallen it may still be profitable for other individual firms to adopt the change in order to increase their income to the same level as earlier adopters. In fact it may become essential for them to adopt to avoid making a loss. Thus, although farmers may collectively pay for research, it is by no means sure, given this type of market situation, that farmers will collectively benefit from the results of that research.

However, most Australian farmers are producing for a market which has many characteristics different from those of a closed economy where farmers sell all of their produce on the domestic market. In most cases the Australian producer sells a proportion of his produce on the export or world market.¹⁸ The features which a producer faces on a world market are different from those of a domestic market in that the net revenue depends not only on the world elasticity of demand for the product, but also on the elasticity of supply of the product in the rest of the world, and on the proportion of world supply of the product which is produced by the innovating country. Thus an inelastic world demand does not necessarily mean that producers of a single country face an inelastic demand. In the same way as an individual farmer might adopt an innovation and thereby increase his farm output without markedly increasing aggregate supply or the price of the product concerned, so a single country which increases output might benefit if its exports are a sufficiently small part of world trade in that product not to affect markedly its price on the world market. In such a situation there are three parameters which determine the elasticity of demand facing producers in the innovating country. If

¹⁷ For example *Ibid.* pp. 293-316; E. O. Heady, "Public Purpose in Agricultural Research and Education", *Journal of Farm Economics*, Vol. 43, No. 3 (August, 1961), pp. 566-581; M. A. MacGregor, *Journal of Farm Economics*, Vol. 40, No. 4 (December, 1958), pp. 1581-1595.

¹⁸ One of the few primary industries which does not export its produce is the tobacco industry. Most other non-exporting primary industries are very small in total production and are often "infant" industries.

both the elasticity of world demand and the elasticity of supply of the rest of the world are low, the proportion of output coming from the innovating country could be a very large proportion of total world production before net revenue would decline.¹⁹ If, for example, we consider a world elasticity of demand of say -0.4, and an elasticity of supply in the rest of the world of, say 0.3, net revenue will not fall until output in the innovating country exceeds 62.5 per cent of total trade in that product.²⁰

From this it might be argued that Australian primary producers seem likely to receive the benefit from any increased output in industries which produce, at least in part, for export markets. Thus farmers in these industries may profit by research undertaken to provide technological innovations and might profitably provide finance for this research, as they do through the industry levy schemes. But whether or not any specific group will benefit in this way depends on the particular conditions associated with that industry.

In this regard it is not only the pricing system which determines the returns to farmers in a particular industry. A variety of pricing arrangements and other institutional measures operate in the various industries to help maintain farm incomes and the profitability of farming. Because these arrangements interfere with the natural functioning of the price mechanism the foregoing discussion is incomplete for industries where these arrangements exist.

Briefly the various measures which are used can be classified into four groups. First there are *price supports* which are the most common means of making support payments to farmers. They include subsidies on produce sold, fixed prices for produce, and price guarantees. The second type are *demand supports* which include consumer subsidies to reduce retail prices, measures to ensure the use of domestic produce, such as the Australian tobacco quota, government contracts for various commodities such as the free school milk programme, and government assistance to advertising and promotion efforts. The third group includes several different types of *supply controls*. These include production quotas and acreage limits on the product concerned, and also restrictions on imports of the product and on the production of substitutes. Controls such as these are often associated with price supports. The fourth form of assistance to primary producers are *cost measures* aimed at preventing increases in the cost of farm inputs. This group includes cost subsidies, such as that on superphosphate fertilizer, concession rail freights for certain commodities, and such benefits as special taxation allowances and the provision of credit at low rates of interest.

¹⁹ The formula used here is: $E_{ai} = \frac{1}{f} (E_{aw} - G_{ao}) + G_{ao}$ where E_{ai} = price elasticity of demand for A in the innovating country, E_{aw} = price elasticity of demand for A in the world, G_{ao} = price elasticity of supply of A in the rest of the world, f = proportion of world market supplied by I, the innovating country, providing E_{ai} is greater than -1.0 the net revenue will not decline. For a derivation of this formula see A. A. Powell, "Export Receipts and Expansion in the Wool Industry", *Australian Journal of Agricultural Economics*, Vol. 3, No. 2 (December, 1959), pp. 73-74.

²⁰ This point has been demonstrated by several writers and recently emphasised by F. H. Gruen, *op. cit.*, p. 845; but, since the proportion of the world market supplied by Australian producers varies widely over time for some products, the price elasticity of demand facing farmers can also vary widely. The variations in demand elasticity facing wool producers have been set out by A. A. Powell, *op. cit.*, pp. 67-68.

The aim of all policies which employ these measures is to increase the profitability of farm production. Frequently these policies are introduced because of falling prices which are at least partly attributable to increases in output arising from improved technology. In other words these measures are designed to offset any fall in prices which may be associated with the introduction of new technology. Thus they aim to ensure that primary producers do receive some benefit from scientific research and subsequent changes in technology. But the extent to which farmers will benefit depends upon several factors. These include the success of the measures in maintaining farm prices and the amounts of money which society in general is prepared to vote for this purpose.

In particular there is the question of the length of time over which payments of this type can be maintained. To be justifiable these measures must increase the welfare of the recipient group by more than they decrease the welfare of the donor group. Although the objective measurement of welfare is impossible, society still supports policies which appear consistent with increased total welfare, and hence may be expected to support measures to maintain farm incomes where this is necessary. But since the trend toward increased output and declining prices is likely to be continuous, because research and innovation are continuous, the burden of these measures is liable to increase with time. Thus it is reasonable to expect that there will be a limit to the extent and duration of these payments. However, so long as this type of policy does exist, it seems safe to assume that farmers affected by them will receive much more benefit from research than they would otherwise, and thus that the research levies are economically justifiable under these conditions.

It seems, therefore, that Australian primary producers might benefit from research under both export trading and price support conditions and it is now necessary to look at the five industries providing research funds in the light of the foregoing discussion.

Considered individually the wool industry at first appears to be most susceptible to the downward pressure on farm prices arising from increased output, in that it is least protected by marketing arrangements. Most wool is sold by open auction, and since Australian exports represented about 52 per cent of annual world trade in raw wool, it is possible that Australian producers could face a low elasticity of demand on the world market. In an analysis of this aspect Powell has shown that only with demand elasticities on the world market of the order of -0.4 would there be a decrease in gross revenue associated with a 20 per cent increase in wool output.²⁰ But with elasticities of $+0.2$ for supply and -1.0 for demand, increases in gross revenue from 10 and 20 per cent rises in output were 6.5 and 6.0 per cent respectively. This supports the notion that the wool industry can gain by financing research which will lead to increased output.

But as well as this the wool industry receives some other forms of assistance to help maintain returns. The subsidy on phosphatic fertilizer, the provision of development finance at low interest rates and special taxation concessions on capital improvements all extend to producers in the wool industry as they do to those in other rural industries. There is also the

²⁰ A. A. Powell, *op. cit.*, pp. 69-71.

possibility of increasing demand by the successful promotion of wool.²¹ The promotion activities of the Australian Wool Board are supported by government contributions. These measures all help to ensure that wool producers will gain a profitable return from money which they spend on wool production research.

The next largest industry providing funds for research is the wheat industry. Wheat is used in the production of several basic food items, and as such it has a low price elasticity of demand. Thus if an increase in production should follow from research a fall in price might result.

However, Australia supplies only some 10 to 14 per cent of total world trade in wheat so that as a small exporter the Australian wheat industry will face much higher demand elasticities on the world market. Thus any fall in price due to increased supply will be less than that which is likely on a closed market.

On the other hand, the production of wheat has fluctuated in all producing countries with the result that prices on the world market have been uncertain. Partly as a result of this Australian wheatgrowers have become partly protected by institutional arrangements which guarantee wheat prices. In so far as government funds are used to maintain this guarantee this helps wheatgrowers to gain from increased output associated with technological change. But the protection provided by the stabilization scheme in this way is limited. The arrangements are renegotiated every five years, and the guaranteed price is reviewed annually in relation to a cost of production index. The scheme covers all wheat sold on the domestic market plus a definite volume of wheat exports. When renegotiated in 1963 the price was reduced by altering the basis of the cost of production index, but the volume of exports embraced by the scheme was increased from 100,000,000 bushels to 150,000,000 bushels. Production over and above this amount is sold at ruling market prices. So while wheatgrowers might expect to get some gain from research, particularly while increased amounts can be sold on the world market, there is no real guarantee that this return from research will be obtained.

The tobacco industry is different from the industries mentioned above in that it sells all its produce on the domestic market. Tobacco growers have an artificial market for their crop by virtue of legislation which allows import duty concessions to manufacturers using more than a certain percentage of Australian leaf. This fixed percentage has been increased from time to time to ensure a demand sufficient to take up increases in Australian output. Thus they have effectively had a price guarantee which has ensured that these growers receive a large part of the return from increased output due to technological development in their industry. However, the proportion of Australian leaf now used in domestic cigarette manufacture is so large that this measure may be approaching the limits of its effectiveness in maintaining the price of this product. Hence the future gains from research may be less for tobacco growers than they have been in the past.

²¹ Some of the possibilities and difficulties associated with advertising wool have been discussed elsewhere. See G. F. Donaldson, "Economics, Advertising and Wool", this *Review*, Vol. 30, No. 1 (March, 1962), pp. 5-12.

The elasticity of demand for dairy produce varies from one product to another. Because many of these products, including milk, butter and cheese, are basic items in the diet of western communities it is generally agreed that the demand for these products is relatively inelastic.

Australian exports of butter and cheese are in the ranges of 13 to 15 per cent and 4 to 5 per cent of total world exports, respectively, so that Australian producers probably face slightly higher elasticities than larger exporters of these products. However, dairy products, like wheat, are often in surplus supply on world markets so that prices are depressed. Again, this industry is protected in Australia by price supports in the form of fixed prices on the domestic market and a direct government subsidy. The limits of both controlled prices and the subsidy have been increased from time to time to cover increases in output, and so long as these adjustments can be continued the dairy farmer is assured of receiving a large part of the benefits from increased output in his industry. But if, as seems probable, there are no further increases in subsidy payments to this industry the gains received by present farmers from research will be uncertain.

Beef is a luxury item which can be replaced in the consumers diet by a variety of other meats or other forms of protein. Because their product is of this nature, beef producers face a more elastic demand than many other food producers. This, combined with the fact that Australia provides the relatively small proportion of between 15 to 20 per cent of world trade in beef, makes the prospects for producers gaining from increased output of beef fairly high. As the demand for beef on both overseas and domestic markets is expected to expand as standards of living increase, thus an increasing market seems likely. Also the price of beef is dependent on the prices of other meats and thus on the cross elasticities of demand from one type to another. Because of this, a fall in beef prices may tend to increase demand due to a change from one meat to another. In view of these effects beef producers also seem likely to receive much of the gain from increased output in this industry, and therefore they might profitably finance research to this end.

In summary, it seems feasible that, with the possible exception of the wheat and dairy industries, the producers supporting each of the five levy funds will obtain some gain from supporting research, providing that research is successful in yielding new technology which will increase output. However, without the existing institutional pricing arrangements this is less certain. If these arrangements are disregarded, then wool and beef producers seem more likely to receive benefit from growth in output than the other industries. Also producers with supported prices may be at a disadvantage if the growth in output is such that it threatens the existence of these institutional arrangements which protect their prices. Thus when considered in the long run the likely gains in industries with complex support policies are much less certain. It is likely that in time benefits from research and technology in these industries will be spread over the whole community.

Farmers in an industry may benefit financially according to the market conditions existing at any particular time, and will also benefit in other ways, particularly by reduced heavy and arduous work, and by the reduction of production uncertainty in farming. However, it is possible that, individually, some farmers will benefit more than others.

Early innovators seem the most likely to profit from the findings of research, even though later adopters may obtain some advantages or at least prevent larger losses which they might incur if they did not adopt new technology. But as well as this it is likely that farmers who are innovators will have special characteristics. In particular this category is likely to include those farmers with an abundance of available capital which will allow them to easily adopt new methods.

Also some farmers may benefit if either declining prices, or the development of some innovation favours an increase in the size of farms, forcing some producers to sell out. In these ways research, which is paid for by all farmers in an industry, may benefit only a select few. While this is not an argument against the financing of research by farmers it does provide an argument against such a contribution being compulsory for all farmers.

A further inequity may arise because of the time involved between the initiation of a research project and the application of a discovery. Depending on the nature of the research it may be several decades before a discovery is made and developed for application. Thus farmers paying for research from their present earnings may be providing some advantage not for themselves but for future farmers. This type of consideration causes some farmers to favour short term projects, and under these circumstances it is again questionable whether farmers should pay a compulsory levy to support scientific research.

Also research supported in various institutions is likely to aid producers in some regions more than others. This aspect will be influenced by the location of the research centre, the type of projects which are financed, and the way in which they are carried out. Therefore in this way some farmers may, again, be paying for research from which they will receive little or no benefit.

Consideration of this aspect of the distribution of gains again involves the basic principles of welfare economics as they apply to interpersonal comparisons. If the gains made by one group are greater than the loss to other groups then this is considered a net gain in welfare. However unless there is some means of compensation being made from the receiving group to the others there may still be some justification in farmers who do not gain from research refusing to pay for this research.

However, it is important to note again here that, under the existing levy schemes primary producers are in fact contributing only about half of the total funds being made available for the support of agricultural research. Thus additional research financed by government contributions may provide some compensation. As well as this government policies, in providing development finance, publications and extension services, ensure that new information and techniques arising from research are widely spread and available to all farm managers who can benefit by them. By doing this these policies help to overcome some of the inequities outlined above, but they also ensure that the increase in total output associated with the introduction of new technology is achieved rapidly. This then assists society in general in obtaining some advantage from research, by both economic growth and, in some cases, lower priced goods.

6. THE ALLOCATION OF FARMERS' AND GOVERNMENT CONTRIBUTIONS

Different Types of Research

Since both farmers and the rest of society stand to gain from scientific research in agriculture it seems appropriate that both farmer groups and the government should contribute to the support of this research as they do in the levy schemes. But it seems likely that some types of research will help farmers more than others. Thus the question arises as to whether funds contributed from farmers' levies and government sources should be kept separate and allocated according to different criteria.

In order to consider the merits of this question it is necessary to investigate the differential benefits which can be obtained from different types of research and ascertain whether different criteria can be established for the allocation of funds from the two groups. To do this it is convenient to consider first of all the two broad categories of fundamental and applied research.

Applied and developmental research, because it is aimed at a specific practical target, will provide more certain returns to farmers than will more fundamental work. Alternatively, fundamental research may or may not provide discoveries capable of practical application. While we can measure the benefits of applied research by measuring the returns to the innovations coming from that research there is no way of measuring the benefits of fundamental research. But since it is known that fundamental research is used as a foundation upon which much applied research builds then the benefits are likely to be very high. However, the specific benefits to farmers paying for such research are fairly uncertain, since by definition fundamental research is not necessarily aimed toward producing any discovery of practical value. Such research may on the other hand benefit society by some discovery which is in no way related to the agricultural industries. For these reasons it would seem more equitable for research of this type to be financed by government funds which have been collected from all parts of society.

The length of time taken for research to yield useable results also affects its profitability. Applied research which yields results in a much shorter time than fundamental work may give more gain to present farmers even though fundamental work might give greater advances over a longer period. By this it is not meant that applied research will always yield innovations faster than more fundamental work as this might not be the case. But the return to farmers who are levied to pay for research will be higher from research taking a shorter time to yield innovations because the financial return to the expenditure does not have to be discounted as much as returns which are obtained further into the future.

Also, research aimed at developing innovations for a particular area will yield more certain returns to farmers than research applicable over a wide area. That is assuming the area involved does not produce so large a proportion of total output as to influence the product price by the associated changes in its output. In this situation expenditure on applied research by farmers may give them an advantage over their competitors in other regions or countries.

But throughout this study the effects and implications of only farm production research have been discussed. However, farmers' funds might also be used to finance both market research and research into processing and alternative uses of farm products, as is the case with wool industry funds.

Market research may lead to innovations in marketing procedures, and also provide information on the function of markets. This information is useful to all persons associated with buying and selling on the market, and to those associated with advertising, promotion and product development. The gains from such research are difficult to assess but research which assists advertising and promotional activities for primary produce will, providing these activities are effective, benefit primary producers. Research which aids the efficiency of the market processes will aid both consumers and producers, depending upon the type of adjustment and the state of the market for the product concerned. This type of research may also provide information which is invaluable to advisers and administrators associated with policy making in the various industries.

Research into processing, and product development work seems also likely to benefit farmers. The demand for many farm products is a derived demand so that if research is successful in producing saleable new commodities, using farm produce as a raw material, or in improving the present product so that it has a competitive advantage over its substitutes, this research must be profitable for primary industries. Advances from textile research supported by the wool levy scheme have greatly enhanced wool as a fibre and so have helped wool maintain its competitive position with synthetic fibres. Research in the use of some other agricultural products such as cereal grains has not had such spectacular successes. However, this type of research, if successful, could be a much more fruitful investment for farmers' funds than much farm production research, particularly where farmers face an inelastic demand for their product.

Although it is clear that some types of research will benefit farmers more than others, it is necessary to consider each project individually in order to assess the possible gains for either farmers or the whole community. This is necessary because the cost of the project, the cost of the innovation, the length of time required for research work and possible benefits from resulting innovations vary widely from one project to another.

Criteria for Allocation

Considering farmers and the national community as the two groups financing research through the levy schemes it is possible to suggest broad criteria for research to benefit either group. Research to benefit the community will be aimed at increasing productivity and at lowering the value of the product. This effect, as suggested previously, is in keeping with economic progress since the lower prices cause resources to move out of agriculture to meet the needs of other developing and expanding industries in the economy. In this way, agricultural research extends economic progress.

The greatest benefit to producers will come from research which increases the price elasticity of demand for their product. Successful research to aid promotion and to develop new products, greater utility of products, and

alternate uses for farm produce will have this effect. Also, under those conditions where farmers can benefit from greater productivity there will be an advantage from shorter-term production research and with research to provide non-capital requiring innovations. These can be quickly applied in production and are available to all producers throughout the area to which the discovery is applicable. If the aim is to aid farm incomes there will also be benefit from research conducted on a regional basis rather than on an industry or product basis.

In order to assess the relative merits of a number of applied projects committees might begin by analysing the return to the innovation. The return would be equal to the change in volume of output times the price for the product adjusted according to its elasticity of demand. The total cost of the research and the innovation has to be deducted from this amount. Some allowance should be made for the estimated rate of application of the discovery, and if possible the net increase in return should be discounted over the number of years during which returns might be expected. Then, since the probable success of a particular research project depends on the amount expended, or on the total resources which can be applied to the problem, it will be necessary to assess the probability of success at various levels of expenditure and to calculate the return from the innovation for each level. Since some of these determinants can only be estimated subjectively this would give a subjective measure of the merit of a project as compared with other projects, according to the return likely to be received by farmers.

But producers and society have some mutual interest. Although prices alone will not determine the long run benefit to either group, it is possible for the price elasticity of demand to be such that consumers will benefit from reduced prices while producers will get increased net income, due to lower product prices but increased output. The benefits of economic growth will in many instances be distributed to both groups, although it is unlikely that the benefits will go to both groups equally. The relative benefits to different groups must be considered especially when allocating government funds.

In the allocation of all funds there is a need to consider not only the individual project but the overall research pattern. Once the place and importance of fundamental research is recognized, particularly as it influences applied research, the need to keep some balance between the two is obvious. Since increased scientific research tends to take personnel away from scientific teaching, there is a responsibility upon those allocating funds to be aware of this aspect as one of the determinants of future research effort.

But there are more fundamental aspects which warrant the attention of research fund administrators. The questions which are asked by research workers will determine the answers which are obtained, and it is essential that several questions be asked about a problem. In this regard it is vital for the allocating committees to be aware of the possibility of biases and prejudices in their allocation criteria which might restrict the questions which research scientists can ask. By virtue of limiting value judgments held by committees it may become impossible for some types of questions to be asked at all. There is no completely

objective means of evaluating any research project, but recognition of the many aspects involved will at least ensure that some of these are considered in the process of allocating research funds.

The policy of financing agricultural research jointly by farmers and government funds is becoming widely accepted. This is no doubt partly due to the fact that research is a popular symbol, so that a programme to finance research goes under the banner of science and efficiency. But the full impact of such a policy is often not fully recognized. Research is often supported as part of a policy because it is seen as a means of helping farmers to resist the economic pressures which confront them and to generally maintain the status quo in the farm business. Yet, disregarding the possible benefits which may come from research and on whom they fall, the one thing which seems certain is that research will upset the existing order. As technological innovation increases output and changes methods it causes resources to flow from one sector of the economy to the other. Competition by farmers to keep up with technology increases their uncertainty. The productivity of different resources may shift widely and management requirements change rapidly. The effects are such that the alterations and adjustments associated with technological change are themselves subjects for research.

The research levy schemes are not a new phenomenon among the institutional arrangements associated with Australian agriculture, but they have recently developed to a new level of significance by virtue of the large volume of funds which they are providing for the support of agricultural research. This contribution represents a valuable increase in the funds available for research. It has provided finance for an expansion in agricultural research of considerable proportions. This expansion has not been without some undesirable effects on research and research personnel. The returns to farmers from their expenditure on research through these funds are difficult to establish but under existing economic and market conditions it seems certain that they can expect to receive some benefit from this investment. The value of these funds to both research and to farmers can be greatly influenced by the allocation criteria and procedures adopted by the research committees. Although the evaluation of research priorities and of the projects submitted is not an easy matter, the establishment by the committees of some defined goals and the recognition of the various aspects mentioned briefly above seem necessary to ensure that the industry levy schemes make a greater contribution to farmers in the respective industries, and to the nation as a whole.

APPENDIX A

Legislation Providing for the Use of Levies Collected from Primary Producers to Finance Research

The first legislation of this type in Australia was the Dairy Cattle Improvement Act, 1921, which provided for a levy of ten shillings on bulls over six months of age and five shillings on bulls less than six months of age, and established the Dairy Cattle Fund into which the proceeds of this levy were to be paid.

The next significant legislation was the Canned Fruit Export Control Act, Amendment Act, 1930. This was the first legislation to specifically provide for marketing board funds, collected by a levy on produce handled by the board, to be used for experimental or research purposes. Subsequent Acts have been passed to amend the powers of other marketing boards so that they could support research, and most marketing boards established since 1930 have had provisions made for this function from their outset.

The legislation next in historical sequence is the Wool Publicity and Research Act, 1936. This is significant because the scheme established by this Act was the forerunner of the existing Wool Research Committee and the Australian Wool Bureau. Associated legislation imposed a tax on all wool grown in Australia after 1st July, 1936, and established the Australian Wool Board to administer the Wool Publicity and Research Fund. The Fund was to be used to aid the improvement of wool production in Australia and for the increase or extension, by publicity or research, of the use of wool throughout the world. This Act was amended by the Wool Tax Act and Wool Use Promotion Act, 1945, which reconstituted the Australian Wool Board and established the Commonwealth Wool Adviser. The Wool Research Trust Account was established, into which money collected under the Wool Tax Act, 1936-1945 was to be paid.

A further amendment passed by the Commonwealth Government in 1953, known as the Wool Use Promotion Act, repealed the Wool Use Promotion Act, 1945. This legislation was further amended in 1957 by the Wool Research Act, which established the Wool Research Trust Fund. Trust Fund moneys were made available for scientific and economic research into the production and manufacture of wool, and for publicity, information and training of staff. This legislation also established the Wool Research Committee to administer the Fund. Associated legislation placed a levy on wool growers and established the machinery for the collection of that levy. In 1963 the Committee responsible for administering this fund was altered by the Wool Industry Act, 1963. The Wool Research Trust Fund and the Wool Research Committee now operate under the auspices of the new Australian Wool Board.

Following this pattern, the Australian Meat Board was reconstituted by the Meat Industry Act, 1964, and the administration of the Australian Cattle and Beef Research Trust Fund and the associated Research Committee are now closely associated with the Australian Meat Board.

The legislation providing for levy funds to be used for financing agricultural research as set out in Table I, indicates that farmers have provided levy funds for the finance of research for many years. But although the previous sources of farmers' funds have been numerous, the volume of funds being provided has increased markedly under the five major schemes operating at present.

TABLE 4
Legislation for Levy Funds for Research

Year	Name of Act	Legislature
1921	Dairy Cattle Improvement Act	South Australia.
1923	Meat Industry Encouragement Act	Queensland.
1930	Canned Fruit Export Control Act Amendment Act	Commonwealth.
1936	The Wool Publicity and Research Act	Commonwealth.
1938	Apple and Pear Research Publicity Act	New South Wales.
1945	Wool Tax Act and Wool Use Promotion Act	Commonwealth.
1946	Wool Industry Trust Act	Commonwealth.
1947	Sugar Experiment Stations Act Amendment Act	Queensland.
1947	Wheat Marketing (Winding Up) Act Amendment Act	Victoria.
1947	Potato Growing Industry Trust Fund Act	Western Australia.
1947	Wine Experiment Bounty Act	Commonwealth.
1948	Poultry Industry Trust Fund Act	Western Australia.
1950	Poultry Industry Act Amendment Act	Queensland.
1953	Wool Use Promotion Act	Commonwealth.
1954	Wine Overseas Marketing Act	Commonwealth.
1954	Sugar Experiment Stations Act Amendment Act	Queensland.
1954	Soil Fertility Research Act	Western Australia.
1955	Tobacco Industry Act	Commonwealth.
1955	Wine Research Act	Commonwealth.
1957	Wheat Research Act	Commonwealth.
1957	Wool Research Act	Commonwealth.
1958	Dairy Produce Research and Sales Promotion Act	Commonwealth.
1960	Cattle and Beef Research Act	Commonwealth.
1963	Wool Industry Act	Commonwealth.
1964	Meat Industry Act	Commonwealth.

Source:—*Australian Legislative Digest*, (Premier's Department, Sydney) Vol. 1-39, 1921-60.

APPENDIX B

Representation on Research Committees of the Various Industries

TABLE 5

Representation on Research Committees

Representatives	Tobacco*	Wool†	Beef‡	Dairy§	Wheat Council	State Wheat Committees ¶
Department of Primary Industry	3	2	1	1	2	..
C.S.I.R.O.	1	1	1	1	1	..
Universities .. .. .	..	1	1	..	1	1
State Agriculture Departments	4	..	..	..	5	1 (NSW 2)
Primary Producers	4	4	7	3	2	3 (NSW 4)
Manufacturers	4	1	..	1	..	..
Australian Agricultural Council .. .. .	..	1	1	1	..	..
Others	1	1	1	2	..	..
Total on Committee ..	17	11	12	9	11	5 (NSW 6)

* The four State department and four producer members represent one each from New South Wales, Victoria, Queensland, and Western Australia. The one other member is a representative of the Department of Customs and Excise.

† The four primary producers represent growers' organizations, and the one other member is from the Australian Wool Board.

‡ All primary producer representatives are from producers' organizations represented on the Australian Meat Board. The Board provides a Secretary for the Committee, shown in the table as one other member.

§ Three primary producer representatives on the Australian Dairy Produce Board are appointed to this Committee. Both the Chairman and Secretary are also members of the Board.

¶ The New South Wales Committee has four grower representatives, one more than the other States. This enables the two growers' organizations in that State to be represented equally. When the Director of Wagga Agricultural Research Institute was included as an additional Department of Agriculture representative, because of the importance of the Institute as a wheat research centre, the extra grower representative was also necessary to ensure a grower majority. This was made a condition by the wheatgrowers' organizations involved before agreeing to support the proposed scheme.

APPENDIX C

Allocations from Research Trust Accounts

TABLE 6

Tobacco Industry Trust Account Allocation

Recipient Organization	1958-59	1959-60	1960-61	1961-62	1962-63
	£	£	£	£	£
State Departments—					
New South Wales ..	9,285	15,870	50,660	32,400	24,734
Victoria	21,165	33,540	29,386	62,118	46,418
Queensland	43,537	44,540	51,132	77,514	92,394
Western Australia ..	13,290	14,800	16,650	23,375	..
C.S.I.R.O.	37,750	49,250	64,737	88,074	69,282
Department of					
Primary Industry ..	2,600	3,000	5,350	5,600	4,330
Total ..	127,627	161,000	217,915	289,081	237,158

Source: Annual Reports of the Tobacco Industry Trust Account.

TABLE 7
Wool Research Trust Fund Allocations

Recipient Organizations and Activities	1958-59	1959-60	1960-61	1961-62	1962-63
	£	£	£	£	£
C.S.I.R.O. Biological ..	785,000	812,200	901,000	954,500	1,062,000
Textile	582,500	760,800	884,000	723,500	830,000
Capital .. ..	..	..	..	601,000	516,654
B.A.E.	46,300	45,100	67,730	67,100	63,750
Universities—					
Adelaide	14,263	16,660	25,333	26,273	30,896
Australian National ..	10,511	7,973	11,098	13,750	19,725
Melbourne	15,250	20,700	24,325	25,600	23,650
New England	10,000	16,150	23,400	26,413	32,487
New South Wales ..	21,540	37,250	48,385	51,142	82,687
Queensland	13,186	17,736	18,085	18,780	19,222
Sydney	18,300	21,253	28,700	31,270	36,008
Western Australia ..	9,725	17,155	16,670	16,525	21,282
Gordon Institute of Technology .. ..	..	..	6,010	7,630	4,962
State Departments—					
New South Wales ..	2,900	8,150	10,740	19,603	21,730
Victoria	23,098	18,657	44,418	39,811	40,125
Queensland	11,931	4,845	11,410	12,258	13,332
South Australia ..	15,085	14,790	19,942	24,037	29,708
Western Australia ..	4,700	1,700	5,200	7,720	9,200
Tasmania	1,450	1,253	3,277	3,800	5,880
Scholarships, Fellowships	9,552	14,500	18,275	23,911	25,100
Wool Industry Research Association	1,254	1,254	1,254	2,500	..
Administration ..	7,344	7,325	8,600	8,300	11,200
Special Conferences ..	..	10,000	2,000	1,500	..
Special Extension Grant ..	..	10,565	25,000	25,000	29,000
Miscellaneous .. ..	..	4,150	6,664	..	59,861
Total	1,603,889	1,870,166	2,211,516	2,731,923	2,989,459

Source: *Annual Reports*, Wool Research Committee, (Department of Primary Industry: Canberra), 1959-60 to 1963-64.

TABLE 8
Wheat Research Trust Account Allocations
 (a) ALLOCATIONS BY WHEAT RESEARCH COUNCIL.

Organizations and Activities	1958-59	1959-60	1960-61	1961-62	1962-63
	£	£	£	£	£
C.S.I.R.O.	69,500	43,592	46,600	55,866	66,748
Waite Institute	26,300	25,601	26,550	27,150	33,376
Bread Research Institute	6,000	5,093	3,500	4,700	3,890
State Departments—					
New South Wales	5,250	5,828	5,800	14,350	15,306
Victoria	11,110	11,440	17,550	24,265	20,838
Western Australia	16,200	13,570	12,400	10,760	14,600
South Australia .. ..	..	..	..	8,000	3,500
Queensland .. ..	..	..	1,250	..	13,085
Tasmania .. ..	..	..	..	..	1,450
Queensland Research Committee .. ..	..	15,000	..	9,300	..
Universities—					
Sydney	21,650	14,900	14,400	19,550	21,380
New South Wales	8,965	7,155	6,700	6,500	8,270
New England .. ..	..	..	1,000	1,150	4,450
Western Australia	11,500	20,550	14,300	14,300	17,400
Melbourne	22,337	21,150	17,650	22,955	13,300
Queensland .. ..	..	..	..	..	1,950
New South Wales Wheat Research Foundation .. ..	..	..	..	5,800	5,000
Standing Committee on Agriculture (Skeleton Weed Research) .. ..	..	..	..	15,000	10,000
Publications .. ..	..	..	..	5,000	2,400
Scholarships .. ..	..	..	..	..	5,650
Total	198,812	183,879	167,700	244,646	262,593

(b) ALLOCATIONS BY STATE WHEAT RESEARCH COMMITTEES.

(i) *New South Wales.*

Recipient Organization	1958-59	1959-60	1960-61	1961-62	1962-63
	£	£	£	£	£
University of Sydney	21,750	15,710	11,655	14,390	15,597
New South Wales Department of Agriculture	34,300	14,847	15,820	20,345	27,600
University of New England	450	..	..	..	..
Farrer Memorial Trust	1,000	..	1,000	1,000	..
New South Wales Wheat Research Foundation	50,000	33,776	25,000	25,000	40,100
Bread Research Institute .. ..	..	850	1,850	2,000	2,500
Total	107,500	65,183	55,325	62,735	85,797

TABLE 8—*continued*(ii) *Victoria.*

Recipient Organization	1958-59	1959-60	1960-61	1961-62	1962-63
	£	£	£	£	£
Victorian Department of Agriculture	39,266	32,985	33,019
University of Melbourne	6,100	8,435	10,625
C.S.I.R.O.	3,000	..
Department of Crown Lands and Survey	2,500	8,422
Total	45,366	46,920	52,066

(iii) *South Australia.*

Recipient Organization	1958-59	1959-60	1960-61	1961-62	1962-63
	£	£	£	£	£
South Australian Department of Agriculture ..	23,850	15,500	14,100	13,283	65,080
Roseworthy Agricultural College ..	6,300	2,500	2,000	2,175	3,090
Department of Chemistry University of Adelaide ..	3,250	2,000	2,250	2,356	3,180
Waite Institute	9,500	6,300	5,500	6,140	9,701
University of Adelaide ..	..	..	..	..	1,101
Total ..	42,900	26,300	23,850	23,954	82,162

(iv) *Western Australia.*

Recipient Organization	1958-59	1959-60	1960-61	1961-62	1962-63
	£	£	£	£	£
University of Western Australia	35,000	42,100	25,500	35,455	37,177
Western Australian Department of Agriculture	14,400	14,250	15,130	22,250	37,900
Co-Operative Bulk Handling Ltd. ..	..	..	..	..	7,703
Total ..	49,400	56,350	40,630	57,705	82,780

TABLE 8—*continued*(v) *Queensland.*

Recipient Organization	1958-59	1959-60	1960-61	1961-62	1962-63
	£	£	£	£	£
Department of Agriculture	275	2,500	..	..	..
University of Queensland .. ..	..	..	1,600	..	..
Wheat Research Centre .. ..	..	4,082	..	..	..
Total	275	6,582	1,600	..	..

(vi) *Total.*

Total Allocation	1958-59	1959-60	1960-61	1961-62	1962-63
	£	£	£	£	£
All Recipients	398,887	338,294	334,471	435,960	565,398

Source: Annual Reports of the Wheat Industry Trust Account.

TABLE 9

Dairy Industry Trust Account Allocations

Recipient Organization	1958-59	1959-60	1960-61	1961-62	1962-63
	£	£	£	£	£
C.S.I.R.O.	5,149	51,400	73,300	74,100	95,985
State Departments—					
South Australia .. ..	..	2,900	10,250	9,450	7,550
Tasmania .. ..	..	1,400	4,760	4,200	4,087
Victoria .. ..	..	23,771	32,472	28,229	27,601
New South Wales .. ..	..	11,900	31,135	24,097	33,698
Western Australia .. ..	..	3,000	7,700	7,100	7,850
Queensland .. ..	..	15,100	17,940	21,527	23,656
Universities—					
Melbourne .. ..	..	1,900	500	5,788	5,766
Queensland .. ..	..	6,050	12,563	7,450	10,850
New England .. ..	..	2,100	2,850	2,550	750
Sydney	3,000	12,800	19,183	19,393	25,322
Queensland Agricultural High School and College .. ..	..	2,500	3,920	3,950	3,125
Butter Marketing Board, Brisbane .. ..	..	3,600	4,850	5,850	5,480
A.D.P.B. Pasture Improvement Committees .. ..	..	..	..	..	6,350
Sub-total on Dairy Farm Research	5,333	70,621	125,344	115,909	133,968
Sub-total on Dairy Manufacturing Research	2,816	67,800	96,079	97,775	124,102
Total	8,149	138,421	221,423	213,684	258,070

Source: Figures supplied in writing by the Secretary, Australian Dairy Produce Board.

TABLE 10
Cattle and Beef Research Trust Account Allocations

Recipient Organization						1962-63
						£
C.S.I.R.O.	..	..	..	..	..	100,002
B.A.E.	..	..	..	..	..	13,500
Department of Agriculture—						
New South Wales	..	..	..	..	..	28,770
Queensland	..	..	..	..	..	66,921
South Australia	..	..	..	..	..	2,250
Tasmania	..	..	..	..	..	3,408
Victoria	..	..	..	..	..	30,043
Western Australia	..	..	..	..	..	10,500
Universities—						
Adelaide	..	..	..	..	..	4,500
Melbourne	..	..	..	..	..	6,500
New England	..	..	..	..	..	8,239
Queensland	..	..	..	..	..	23,479
Sydney	..	..	..	..	..	10,500
Western Australia	..	..	..	..	..	2,500
Total	..	..	..	..	..	311,112

Source: Figures supplied in writing by the Executive Officer, Cattle and Beef Research Committee.