THE FUTURE OF AGRICULTURAL RESEARCH

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Summary

This paper is divided into two parts dealing with organization and future research requirements respectively. Because of the claim that the present organization of agricultural research in New Zealand functions reasonably well in comparison with overseas organizations, the paper stresses that it would be more profitable for agricultural research administrators to consider what is the best type of research to do, rather than the best form of organization in which to carry it out. Attention is drawn to the fact that all research organizations largely financed by public funds will necessarily have restrictions placed on the research administrators. When one considers the type of restrictions applied to overseas bodies, it is difficult to see how any form of organization would give more freedom in New Zealand than already possessed. It is also stressed that the biggest single danger in any of the proposed new organizations in New Zealand is the danger of monopoly.

The main theme of the second part is to stress that agriculture is an industry which starts with the cultivation of the soil, the production of the farm product, its processing, its distribution and marketing; and that the chain is not satisfactorily completed till a profitable sale has been made to a satisfied consumer. It is argued that the present pattern of research is unbalanced; that 92 per cent. of all Government funds for agricultural research is spent on research for production inside the farm gate. It is urged that more work at a higher level be done in the areas of farm management and economics, everyday processing, and attempts to find industrial uses of New Zealand's farm products. It is finally pointed out that the usual excuse that New Zealand is a small country is irrelevant. On world standards the agricultural industries are large industries, and, if they are to compete successfully in the future, they will have to spend proportionately the same amount of money on research as other large-scale industries.

THE PAPER is divided into two major parts, the first dealing with the organization of agricultural research and the second with the type of agricultural research which should be undertaken in the years to come.

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NOTE: The views expressed in this paper are those of the author only.

Organization

The organization of agricultural research seems to have bemused research administrators in New Zealand for nigh on thirty years. The problem has been discussed by almost everybody, but to save space and avoid tedious repetition only two representative sets of opinions will be given. Addressing the Eighth Lincoln College Farmers' Conference in 1958 such a well-informed and well-placed observer as Dr W. M. Hamilton recorded [1] that "in some respects the organization which has grown up over the last 30 years is illogical, *e.g.*, in the separation of soil and plant research in D.S.I.R. and animal research in the Department of Agriculture, but on the whole it functions reasonably efficiently by comparison with overseas. This is primarily due to the fact that New Zealand is a small country and that most research workers working in similar or related fields know one another personally."

Hamilton then listed what are believed to be the chief shortcomings of the present organization of research as:

(1) There is no body with the responsibility for allotting broad research priorities and seeing that funds are channelled to give effect to these.

(2) The solution of many problems demands team work, sometimes involving a number of scientific disciplines. This type of approach is less easy to achieve if workers are employed in different organizations.

(3) The public is confused as to what body is responsible for different phases of research. Such confusion hinders efforts to obtain adequate finance and facilities for research.

(4) The staffing of all existing departmental research comes under the Public Service Commission, whose control is not well suited to scientific staff.

(5) There is no body with responsibility for advising Government on questions of scientific and technological methods affecting the expansion of New Zealand industries or the utilization of natural resources.

The point of view of at least one influential farmer was well expressed by Sir Walter Mulholland [2] who asserts that

> . . . there is widespread dissatisfaction among farmers at lack of results in dealing with some of their problems, and every now and again the producer boards, among others, are being asked to promote, subsidize, finance or otherwise bring about the establishment of research agencies.

Some of the ideas put up are in themselves quite commendable, but what will be the result if they all go ahead, or only a part of them without some co-ordination?

In part, this pressure is occasioned by the failure to follow important problems through to a conclusion. An instance is ill-thrift in lambs in Canterbury, a problem for at least 50 years. In that time there have been many fairly severe epidemics. These have from time to time engendered a certain research activity which has never been followed to conclusions; when acute situation eased, the activity eased also. Farmers' impatient reaction to this situation is understandable.

It is the prospect of the establishment of a number of independent research organizations that is a matter for concern. The most important shortcoming in agricultural research is the failure so often to persist in an investigation. This may be due in part at least to the lack of a sufficiently close link between the scientific and practical sides of the industry.

As I see it, the scientific and advisory services required by agriculture at present could be directed into four groups or stages into which they naturally fall:

(1) The investigation of problems on a high scientific plane, including work that is referred to as "fundamental research" as well as work directly concerned with particular problems.

(2) Practical application of knowledge gained from (1) in regard to particular problems still more or less on a laboratory level, with excursions into the field as may be necessary.

(3) Field application of results of (2) with particular reference to discovering or devising feasible and practical ways of using them, including reference back to workers on (2) for adjustments to overcome difficulties.

(4) Adjustments of farm management, routine and operations necessary to enable results of (3) to be incorporated in normal farm operations and/or the adjustment of (3) to enable it to be so incorporated.

While for convenience I have regarded these as separate activities, and I have no doubt in practice they will generally be so, it is obvious they must not be regarded as independent of one another, and there must be a constant interchange of ideas and information throughout.

A point I wish particularly to make is that unless the exercise arrives at (4) the problem cannot be regarded as having been satisfactorily dealt with.

I, personally, would like to see controlled research all under one Minister. By "all", I would include all the services which I have indicated as required by agriculture.

In agricultural research we need an authority with sufficient power to allocate and co-ordinate research projects, with due regard to urgency and importance; and to see that any agency undertaking a project carries it through to finality. I am not particular about its form, so long as it has sufficient authority to do the job and does it. I think, however, it is important that it be so constituted that its personnel maintain a good balance between the academic and practical side.

I would suggest that about even numbers of representatives of both interests with—if it is to be under the Council of Scientific Research—a

member of that council as chairman. Farmer members should not be appointed as "representatives" but as persons with special knowledge which they can contribute, and should be selected to give a wide geographical and industrial coverage. Reference to the statement of scientific and advisory services by farmers given above will show how valuable the advice of practical men at the council table would be. On some matters that will arise it is not reasonable to expect academic people to make decisions unaided.

Another important use of such a body is that it will have within itself the knowledge to enable it to recognize developing problems before they have become acute. At present it is no one's business to look ahead. Then, when a crisis develops, the tendency is to drop other things for the latest hullabaloo—until another one develops.

I think that organization along these lines will head off a lot of the demand to set up independent agencies, by keeping the work up or ahead of the development of trouble; and by giving the farmers somebody whom they can ask to do something about a problem.

Where a problem is of major importance the use of local or special subcommittees working under the main committee could be of value. This set-up could be very useful in developing (3) and (4) of the groups of services set out earlier.

May I reiterate that unless the discoveries of science can be translated into farm practice they are not of much help to farmers. Nearly every recommendation to deal with a difficulty affects the established routine on the farm and the more it disturbs that the more difficult it is to make use of it.

I would emphasize that until research has found a solution which can be fitted into the work of the farm *at a profit,* it has not solved that problem. Here the advice of practical men on a controlling body would be of value.

The turning of research findings into farm practice is very generally neglected in scientific and technical farm service, but it should be an integral part of the service, and, until it is, much of the work in our laboratories is not fully effective.

It will have become evident why I think that the whole scientific service to the farmer should be under one control. This is urgently necessary, even though, because of the present existence of a number of research agencies and the possibility of others being established, we use them in a properly co-ordinated manner and they play their part in the scheme of things.

These are some of the things that we would hope an Agricultural Research Council would do:

Select projects and determine priorities.

Approve and generally control research agencies.

Allocate work to the most suitable agencies.

See that all projects are carried to a conclusion energetically.

Examine progress from time to time with criticism and suggestions.

Watch for problems coming up and provide to meet them.

Be a spur to endeavour on the part of research workers.

Maintain interest on the part of farmers in the work.

THE PUBLIC SERVICE COMMISSION AND DEPARTMENTAL CONTROL

The two major disadvantages arising from the control exercised by the Public Service Commission (P.S.C.) on the staffing of existing departmental research were listed by Hamilton as:

(1) The difficulty of appointing to a department senior officers from outside the Public Service, particularly the difficulties caused by appeal rights.

(2) The principle of relativity in salary scales between different sections of the Public Service has held scientific salary scales well below world parity.

Appointment of Staff and Appeal System

In the writer's opinion, the difficulties of the appeal system as regards appointments are greatly overrated and stem largely from either lack of administrative skill and foresight or lack of moral and intellectual courage. Two general points on Public Service practice and procedure should be noted. The first is that the P.S.C. is not wedded to a principle or practice of outright seniority. Figures taken out by the P.S.C. a few years ago [3] showed that in only one-sixth of the appointments made by the P.S.C. was the senior applicant appointed. Second, the Public Service is often accused of being a "closed" shop but it is no more a closed shop than many of the most successful business enterprises. Many private and flourishing enterprises regard it as a serious reflection on their managerial skill if they have to recruit people from outside their organizations over the age of forty. They require each and every one of their senior executives to train one or more of their subordinates to be able to take over when the senior officer retires, resigns, or is promoted. Some of them go further. The senior officer will not be eligible for further promotion unless and until he has satisfied his superiors that he has discharged this obligation.

Appointments of senior officers from outside the Public Service to a department are made, on the whole, for one of two reasons. Either the department is embarking on a new type of work for which there are no qualified officers either in the department or in the service; or it wishes to appoint an outsider to fill an established position when it must convince the P.S.C. and if necessary the Appeal Board that the outsider is in "great degree superior" to any applicant from within the service. In the first case there is no difficulty and the outside officer is appointed.

The difficulties in the second case are much more serious and usually occur when vacancies at director level require to be filled. In the writer's experience these always occur because

either of lack of foresight and skill or moral and intellectual courage by the head office of the department concerned in not enforcing a sufficiently high standard of recruitment and training by the branch in question. Hence, as time goes by, there are not people of reasonable seniority fit to take over as director. This has happened more than once. There is no excuse whatever for a head office to allow a laboratory to build up a staff of thirty to forty graduates of the University of New Zealand, of whom only four had a first-class honours degree, only two were senior scholars of the University and only two of whom had doctoral degrees. The director of the laboratory should never have been allowed by his head office to do such a thing.

All people in charge of research activities should be continually reminded that their first job is to recruit, train and retain a number of people better than themselves. Further, they should be given to understand that their success as research directors will be largely decided by their success in this respect and that failure in this vitally important matter will mean that their organization will not be allowed to grow and that they will either be superseded or some other research section will take over their more important functions.

It might be said that an appeal system makes it unnecessarily difficult to remedy such mistakes. Mistakes too easily remedied are too easily forgotten and repeated. The only change in the appeal system favoured by the writer would be that the Appeal Board should be required to give in writing the reasons for its decision.

The writer has often criticized the Public Service Commission both in private and in public and has no doubt that he will criticize them in future. But, in comparison with other large-scale public and semi-public employers, he believes that the P.S.C. is the most enlightened and liberal large-scale public employer in the country and very much doubts if any Council entrusted with the expenditure of somewhere between one and two million pounds of public money and employing between one and two thousand persons would do any better.

Relativity in Salary Scales

In all countries the principle of relativity in salary scales between different sections of the Public Service is maintained. In Great Britain, for example, Treasury controls the staff establishments of the Agricultural Research Council (A.R.C.) just as rigorously as it controls those of the Department of Scientific and Industrial Research, and there is frequent consultation be-

tween the Council and the Treasury to ensure that the Council's standards and conditions of employment are in line with those of the Government Service.

In Australia the position is similar. By law all the terms and conditions of employment in the Commonwealth Scientific and Industrial Research Organisation (C.S.I.R.O.) must be approved by the Commonwealth Public Service Board, and their financial arrangements are controlled by the Commonwealth Treasury just as tightly as those of any Commonwealth Government Department.

Taking departments out from P.S.C. control would, in itself, lead to very little change, if any, in salary scales as the Government would not approve salary scales for any body corporate financed almost entirely by public funds without taking advice from the P.S.C., Treasury and other Government agencies. Two examples should suffice to make the point. The University is a body corporate over which the P.S.C. has no legal control whatever; there is no right of appeal, but the University cannot fix its own salary scales to attract the type of person it wishes to recruit from overseas. The Dairy Research Institute, another body corporate, which derives slightly more than half its income from non-Government sources, has been repeatedly attempting without success to secure staff from overseas to replace senior people, now near the retiring age, who were appointed to the Institute when it was under P.S.C. control.

Control by a Department or by a Body Corporate

The picture is so varied in other countries that it provides no really clear guide. The position is summarized briefly in Table 1.

While it is true that most of the research organizations set up since about 1930 have been established as corporate bodies, it is hard to understand why this type of organization should be generally conceded to be more suited to research and to permit more flexibility than is possible in a Government department. Considering the types of restriction that C.S.I.R.O., the A.R.C., and other bodies corporate are subjected to, it is hard to see where they have any advantage over a Department. It is significant that in only one case—the A.R.C. in the United Kingdom—has any established Department of Agriculture had its research services transferred to a body corporate. In South Africa this question is being examined [4]. Further, it would be of the greatest interest to research administrators, and to students of administration generally, to know why the British Government,

TABLE 1: CONTROL OF AGRICULTURAL RESEARCH IN COUNTRIES OVERSEAS

Country	*Name of Organization*	*Form of Organization*	*Council*	*Notes*
United Kingdom	Agricultural Research Council (A.R.C.)	Royal Charter	Executive	
Canada	Department of Agriculture	Department	——	The National Research Council (N.R.C.) does a very small amount of agricultural research.
Australia	Commonwealth Scientific and Industrial Research Organisation (C.S.I.R.O.)	Body Corporate	Advisory	The Commonwealth Government has no Department of Agriculture but each State Government carries out agricultural research in State Departments. Prior to 1949 Council was Executive.
South Africa	Union Department of Agriculture	Department	——	The Council of Scientific and Industrial Research does no agricultural research.
India	Indian Council of Agricultural Research	Body Corporate	Executive	
Pakistan	Department of Agriculture	Department	——	The Council of Scientific and Industrial Research does very little agricultural research.
United States	U.S. Department of Agriculture	Department	——	
Netherlands	Ministry of Agriculture	Department		
	Organization for Applied Scientific Research (T.N.O.)	Body Corporate	Executive	

after twenty years' experience with A.R.C. as a body corporate and forty years with D.S.I.R. as a department with an Advisory Council, made such a puzzling reorganization as making the Council executive but leaving the Department a department of the Civil Service. This is extraordinary and it is a great pity, in some ways at least, that the reason for such an odd arrangement is not public knowledge.

Though there are several authoritative statements claiming, as *Nature* did [5], that "it seems generally admitted that the orthodox type of Government department is not suited where research is concerned", there are no specific examples described in sufficient detail to allow one to exercise one's own judgment instead of having to accept an opinion without adequate supporting information. This unfortunate situation is in great contrast with certain other fields of public enterprise such as education and defence, where the relative merits of various existing organizations are debated openly with considerable vigour and considerable supporting evidence.

Divided Control

Both Sir Walter Mulholland and Dr Hamilton refer to the problem of divided control at some length. Hamilton states, for example, that "there is no body with responsibility for advising Government on questions of scientific and technological methods affecting the expansion of New Zealand industries or the utilization of natural resources", and that "there is no body with the responsibility for allotting broad research priorities and seeing that funds are channelled to give effect to these".

As far as agricultural research is concerned, the Government has two major official advisers, the Department of Agriculture and the Department of Scientific and Industrial Research. This, surely, is the Government's business. If the Government wanted a single body to advise it, rather than several, it would certainly so arrange, unless it felt that the difficulty of making the necessary arrangements caused more trouble than it was worth. No responsible Minister has in the last 25 years ever publicly even hinted that he or the Government ever wanted a change. The only recorded instance found is in the Parliamentary debate in 1931 which amended the D.S.I.R. Act requiring the Council of Scientific and Industrial Research to set up an Agricultural Division of the Council "to investigate matters relating particularly to research in agriculture". In speaking to the amendment [6], the Prime Minister and Minister in Charge of Scientific and Industrial

Research, the Rt. Hon. Mr Forbes, told the House that "at the present time we have the Council working on problems which come under the Department of Scientific and Industrial Research, and then the Department of Agriculture is working on research, and there is a certain amount of overlapping. What we are intending to do with the whole system of research is to have a Board dealing with scientific research on the industrial side, and one dealing with it on the agricultural side, and the members of these two Boards will constitute the Scientific and Industrial Research Council." The Prime Minister continued by saying, "The main Council will determine what matters shall be referred to the Department of Scientific and Industrial Research to deal with, and what matters shall be referred to the Department of Agriculture, and there will be no overlapping".

Despite the fact that the Amendment was passed because the Government was "deeply concerned to get this measure through . . . and . . . that the Prime Minister had pledged his word to at least two deputations that legislation on these lines should go through this Session", the amendment was not implemented till 1938, seven years later, when the Agriculture Division was first appointed. It met three times only. For lack of information one can only guess at the real reasons why this first attempt never fulfilled the intentions of its promoters. Then, again, in 1938, Hammond advised the Government of the day that there should be an Animal Research Bureau, a body corporate with perpetual succession and common seal, to come directly under the Council of Scientific and Industrial Research. The Government saw fit not to accept this recommendation and was apparently quite happy to have both D.S.I.R. and the Department of Agriculture both engage directly in agricultural research.

In the face of these two examples, it would appear that Governments might prefer in their wisdom to have several sets of advisers on the best way to conduct agricultural research. After all, in other important fields—*e.g.*, power development—they do not rely exclusively on the advice of one department but of several bodies, including local bodies or their associations.

While recognizing that the present organization of agricultural research appears illogical because the bulk of it is split between two departments, the writer urges that no steps be taken to try to tidy it up unless the reasons were extremely strong and very obvious, for any such attempt could well lead to a second situation worse than the first and even more difficult to correct.

The main reasons for wishing to tidy up the present organization stem from the supposed need to co-ordinate research activities, allocate broad research priorities, and so on There are no specific cases mentioned in any detail in any public documents describing the difficulties administrators of agricultural research might be experiencing because of this divided control. But if they are experiencing difficulties because of the form of organization, the writer would humbly but earnestly recommend them to examine themselves and their attitudes, and not to consider how best to change the organization until they are quite satisfied that no further efforts of good-will, broad-mindedness and courage on their own parts can lead to improvement. It is a well-quoted maxim that it is people who count and not organizations; that a perfectly drawn up organization is doomed to failure if the people in it do not want to collaborate and that if people want to make things work then only the most extraordinarily inefficient and frustrating form of organization will prevent them. If the form of organization is leading to difficulties, then surely the heads of New Zealand agricultural research institutions, the Department of Agriculture, the Council and Department of Scientific and Industrial Research, the producer boards and the agricultural colleges can get together around a table once or twice a year to discuss broad priorities, pool their resources and get on with the job. If these difficulties are serious and if the top research leaders will not try this elementary procedure, then God help agricultural research, and one would be left to wonder if Sir Walter Mulholland [7] had not accurately diagnosed the ailment when he told the Electoral Committee of the New Zealand Meat Producers' Board that he believed that "there are strong inter-departmental jealousies involving also the agricultural colleges and other scientific institutions, each of them seeking a place in the sun. In this scramble there is no overall consideration of what is the most necessary work in the interests of the agricultural industries and what priorities need to be defined in certain cases."

Everybody is always anxious to assure everybody else that co-operation at the worker level is excellent; but why is not the same type of co-operation mentioned as existing at all necessary levels? If such co-operation can be found in non-agricultural research fields, then the question becomes more pertinent.

Consider, for example, the New Zealand effort in the International Geophysical Year. The International Geophysical Year (I.G.Y.) was a world-wide collaborative effort aimed at collecting

data which would help to solve global geophysical problems. In New Zealand, the following non-departmental bodies were direct participants: The Carter Observatory, the Universities of Auckland and Canterbury, the Victoria University of Wellington and the Royal Society of New Zealand; the Departments involved were: D.S.I.R., the Meterological Office, Lands and Survey, Ministry of Works, New Zealand Broadcasting Service, Post and Telegraph Department, and the Royal New Zealand Navy. In addition, other Governments and their agencies had to be consulted, particularly the American Government, and also international scientific societies and unions. The job was done by getting all the people concerned round the table, allotting broad priorities, seeing that funds were channelled to give effect to these, and, as so many of the problems demanded team-work involving a number of scientific disciplines, arranging for the best people to do the job irrespective of what organization they belonged to. On paper the organization looked much more untidy and illogical than the organization of agricultural research; but it is extremely doubtful if any efforts to tidy it up would have made it work any better for all concerned were determined to make the venture an outstanding success and they did.

The geothermal project at Wairakei is a second example. The writer has never been involved in an undertaking which requires a team involving such a number of scientific disciplines and other professional skills. On the scientific side, it is necessary to see the efforts of geologists, petrologists, geophysicists, metallurgists, chemical engineers, instrument designers, mathematicians, nuclear scientists, chemists and physicists are coordinated as far as possible to achieve the best available answers at the right time and place. This has all to be interlocked with the plans and efforts of the Ministry of Works and the New Zealand Electricity Department together with those of their contractors. Here, again, as in the case of the I.G.Y., the real driving force is the wish of all concerned to make the enterprise a success. In the geothermal case particularly, the strength of the collaborative effort between the Departments concerned is, to a considerable degree, due to the fact that they are separate, independent departments answerable in the final analysis only to their political masters. This means that the senior officers of one department have to listen attentively and sympathetically to the viewpoints of the others, for they know that, if it comes to a show-down, they cannot trample rough-shod over them with impunity. As far as D.S.I.R. and the Ministry of Works are concerned, the main driving force is the professional pride and

ability in trying to make a success of this fascinating undertaking in a truly collaborative effort rather than one department wanting to co-ordinate the others and telling them what they ought to do. Differences of opinion, and they are frequent, are not regarded as matters of departmental prestige but the tools normally required to solve outstandingly difficult, pioneering undertakings.

And, finally, it is worth pointing out that the only attempt in recent years to convene a meeting of all concerned to discuss some aspects of broad agricultural policy was made last year, not by the leaders of agriculture or agricultural research, not the Department of Agriculture, nor the Council or Department of Scientific and Industrial Research, not the agricultural colleges, the producer boards or Federated Farmers, but that body, "whose control is not well suited to scientific staff"—the Public Service Commission. When it is recalled that the Hon. C. F. Skinner, Deputy Prime Minister and Minister of Agriculture, stated that "in holding this Conference to review our primary production and marketing you people have addressed yourselves to a very important and crucial task," it is a sad and disturbing reflection that the conference had to be called, not by the leaders of the industry, but by the Commission, an agency which is not concerned with the advancement of agriculture at all, except in the matter of staffing of Government departments.

Danger of Monopoly

The biggest single danger in all the proposed schemes for the reorganization of agricultural research is the danger of monopolistic control. In this connection the remarks of the British University Grants Committee are very pertinent [8]:

> There are occasions when a scientific prophet is not honoured as he should be in his own university, and when the development of research under the stimulus of an exceptional man might appear to make disproportionate demands on a university budget. The research worker therefore needs a second string to his bow in his search for finance in order to minimize the risk that a promising line of research might be barred because its promise had not been recognized in the one quarter from which finance might be found for it, or that a newly emerging subject might fail to receive the timely support needed for its development. There is inevitably an element of speculation in backing new research, and this must be a handicap in obtaining finance if the new line is brought prematurely into competition for funds with the needs of established activities. It is therefore desirable that newly emerging lines of research should have sources of funds alternative to general university income, and thus be able to obtain outside protection against the hazards of interdepartmental competition for funds within the university.

If, in the detached air of the academic cloisters, it is necessary or, at any rate, desirable to have alternative sources of research funds, then surely in a country like New Zealand, where the economy is so dependent on efficient agricultural production, it is essential to avoid the possible dangers of monopoly. Further, at best it is a delicate conceit, and at worst, arrogance or stupidity, for any one person or one group of people to believe that they have sufficient knowledge or wisdom to be completely and solely responsible "for allotting broad research priorities and seeing that funds are channelled to give effect to these". In a number of these things, there are honest differences of opinion and judgment, many of them impossible to resolve in advance without actually trying them out.

Fears in this respect are shared by at least one prominent member of this Society, Dr C. P. McMeekan, who told the Society in 1954 [9] that:

> Separate departmental control of the two major branches of agricultural research in New Zealand has one real advantage. It has resulted in the development of a healthy competitive spirit between the two departments. This is apparent from the highest administrative levels to the lowest form of research life —the newly-appointed research officer. Looking up from below, I am not at all sure that scientists at the worker level would have received the very good treatment given them of recent years were it not for this rivalry at the top. Looking down from my precarious perch as a local controlling officer, I am quite sure that the level of work of my unit is higher because of the existence of our D.S.I.R. and college friends. In any case, it cannot be too strongly stressed that most of the workers in the two depaitments are friends and that, in consequence, the separation is much more apparent than real in matters affecting actual work. Once a firm critic of separate control, my experience has convinced me that, on balance, separation has been a good thing. Even further, I have become more than a little frightened that amalgamation of all research bodies in agriculture into one huge octopus organization would be the surest way of sending our research leaders permanently to sleep.

This is one of the main reasons why the writer believes that the present organization of agricultural research should be largely left alone.

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The Future Pattern of Agricultural Research

The Present Pattern

One of the most important tasks facing the administrators of agricultural research today is to address themselves to the difficult and arduous task of figuring out where they ought to go, of determining the best strategy to adopt in order to assist agriculture to make the greatest progress it can in the next, say, twenty years. This task is sadly neglected. Today New Zealand is following a pattern of agricultural research, the foundations of which were laid about twenty to thirty years ago. The results have been most impressive and, on the whole, have amply justified the faith and efforts of those who conceived them and of those who implemented them. But there appears to be a lack of effort to consider whether this pattern is necessarily the best for the promotion of agriculture over the next twenty to thirty years. It can only be said that the time and effort which have been spent in discussing the best form of organization of research would have been much more profitably spent on considering how research can best further the progress of agriculture in the years to come.

The present pattern of research is devoted predominantly to the problems of making two blades of grass grow where only one grew before. The very success of this pattern has had at least two consequences which it would be dangerous to ignore. The first is that there are far too few people who think agriculturally at all. Impressive and competent teams of specialists have been built up such as soil scientists, animal and plant geneticists, plant biochemists, and so on, all of whom, collectively or individually, tackle the problems in agriculture which might be soluble in terms of their skills and specialisms. But there are too few people who sit back and try to figure out, what is the best thing to do to promote the country's agricultural prosperity in the years to come. D. M. Smith pointed out [10] for example, in his presidential address to this Society last year, that, while an extension officer or a research officer is considered competent when he has mastered one aspect of the soil, plant, animal complex, the farmer depends on his livelihood on mastering the lot, in some degree at least. While all would agree with Mr Smith's next remark that "in common justice it must be said that the officers from all these divisions are competent to deal adequately with all aspects of farm production were they given the time and opportunity to do so," the writer's somewhat limited observations would suggest that few research officers are encouraged to ac-

quire this competency, and that practically none are told that their progress in this direction will be carefully watched and, if satisfactory, suitably rewarded.

The second consequence of the success in research aimed at increasing production inside the farm gate is that it has distracted attention from the fact that agriculture does not start and stop at production within the farm gate. It has not led to sufficient recognition and understanding of the idea that agriculture is an industry which starts with the cultivation of the soil, and is not really satisfactorily completed until a profitable sale to a satisfied consumer has been made. New Zealand has built up impressive and powerful organizations to cope with research problems arising from the cultivation of the soil and animal production and has given far too little research attention, relatively, to the problems of the other two sections of the industry—processing and marketing. At present, of all the funds spent by the State on agricultural research, at least 92 per cent. is spent on learning how to increase production inside the farm gate and less than 8 per cent. on how best to dispose of it after it has been so laboriously produced.

A larger share of the research facilities for agriculture will have to be devoted to problems in farm economics and management, the processing of the country's agricultural products and the marketing of them.

Agricultural Economics and Farm Management

It is most significant and disturbing that New Zealand, which depends more than any other country on an export agricultural economy, has no State research organization in agricultural economics and that the only co-ordinated group working in this field belongs to the Meat and Wool Boards. These two Boards are to be congratulated on their initiative in setting up their joint Economic Service. According to a previous Director-General of Agriculture, E. J. Fawcett, the work of this Service was worth £2,000,000 in 1952-53 season [11].

The Economic Service, however, exists to serve the interests of a pressure group (the term "pressure group" is used in a completely objective connotation). Despite some of the difficulties in the way of State Departments undertaking economic research there are several very important problems in economics which are almost completely neglected in New Zealand and which could reasonably be undertaken by the State.

Farm management practices and ideas have not been scientifically studied in New Zealand in the same fundamental way as industrial management and the art of war have been in other countries. By this is not just meant the analysis of farm budgets, time and motion studies in a milking shed, or more efficient operations such as a new type of sheep-dip, but rather an attempt to find a scientific basis whereby a farmer, an industrialist or military planner can more clearly and intelligently allocate his limited resources between the various things that have to be done so that he achieves optimum return. All members of the Society will have a much more vivid appreciation of the difficulties of actually running a successful farm than the writer, but consider a simplified version of some of the decisions a typical dairy farmer has to make. How much of what sort of fertilizer should he apply? to what extent should he cull? how much should he be prepared to pay for allegedly superior stock to increase his production per acre? and so on. All this has to be done within certain financial limitations. In other countries, particularly the United States, very serious efforts are being made, both by industry itself and in various research institutes, to find how best to solve this problem of the optimum allocation of resources.

The promise inherent in these methods developed for industry and military logistics for studies in farm management is well illustrated by a pilot study [12]. The farm studied grew oats and beans to feed to the dairy cows. The optimum programme preferred peas and wheat for sale and more purchased foodstuffs. It also included slightly more dairy cows and sugar beet. These changes, which might appear trivial, would have produced in fact an increase in profit of 25 per cent. solely from a rearrangement of cropping and live-stock and without any improvements in methods of production. If anybody thinks that commonsense is all that is required to arrive at such an answer, that person should try to solve the problem as posed in the paper quoted without recourse to the techniques and computations of linear programming.

Undoubtedly similar studies applied to farm management in New Zealand would prove valuable, even if they did nothing else than highlight large gaps in knowledge. Consider, for example, A. H. Ward's paper [13] delivered to this Society in 1953. When Ward delivered his paper New Zealand farmers were using 850,000 tons of phosphatic fertilizer per year, costing about £9½ millions, of which about £5½ millions were spent by the dairy industry alone, this being the greatest single item of cost in dairy farm working and maintenance charges. But no

one has been able yet to say when the application of an increasing amount of fertilizer ceases to be economic and how existing rates of topdressing might be related to previous rates. Must professional agriculturalists, to quote Ward again, "continue to let farmers topdress their pastures with a large measure of guesswork and accept the possibility that wastage in the use of superphosphate may continue at an unknown level to the national economic disadvantage and the expense of the primary producer".

Yet another method used extensively in industry which might be well worth considering in farm management is the process of evolutionary operations. In industry, just as in the case of superphosphate mentioned by Ward, one very often does not know just what are the conditions under which an industrial process will give maximum yield. Instead of going to expensive pilot-plant investigation, it is now quite common practice industrially to make small but systematic variations in the process iself, and from the resultant changes of yield determine in which direction one must go to achieve higher yields. This process is repeated until no further improvement is found but is then continued in order to see that the process remains at or very near to optimum performance.

Not only is much more research at a high level required in farm management, but also in agricultural economics in the widest sense of the subject. Here again, agricultural research in most countries, and particularly in New Zealand, lags far behind the research efforts of other industries, particularly in the fields of inter-firm productivity, distribution and marketing economics.

Inter-firm Productivity Comparisons

Briefly, the idea of inter-firm productivity comparisons is to draw up certain appropriate indices of productivity such as output per man-hour and to see what variations occur in these indices from firm to firm. In this way it is often possible to pinpoint weak spots, evaluate their importance, and take steps to rectify them.

In the French canning industry, for example, economies were seen to be possible without heavy capital outlay. One firm was able to raise its overall productivity by 50 per cent. in twelve months. One Belgian foundry has stated that, as a result of such methods, the average time per ton of sound castings had been reduced from 30 to 18 hours. This technique is being used extensively in Europe and the United States; it is being intro-

duced in Great Britain and when it is realized that in practically all industries in every country the most efficient firm, on a given productivity rating, is usually three to four times more efficient than the poorest one on the same rating, then it is readily seen that very worthwhile improvements in efficiency can be made, quite frequently, with only minor capital expenditure. In view of the results found in other countries, similar improvements could well be expected if these techniques were applied to the major agricultural processing industries of this country.

Distribution and Marketing Economics

Considering the value of primary exports, it is surprising how little rigorous scientific work is undertaken in order to gain a better understanding of the play of forces operating on the market. Admittedly this is a difficult field; some people point the finger of scorn at past failures both in this country and elsewhere at such attempts, but the advances made in econometric methods over the past twenty years give increased hope for better success in the years to come. The analogy between econometric research in world markets and meteorology is very instructive. In both cases, neither research worker nor the practical operator has much control over the forces he is studying or operating. In each case, both the research worker and the operators have had numerous failures either to forecast coming events correctly or to take corrective action sufficiently quickly. But it would be a very foolhardy operator indeed who chose to run an airline without regard to weather forecasts, even though the latter are occasionally inaccurate.

Preliminary work by W. B. Taylor of the Applied Mathematics Laboratory suggests that certain aspects of the market are amenable to attack by modern analytical methods. Amongst other things he has attempted to measure the influence of certain market factors on short-term fluctuations of prices of New Zealand lamb on the British market. Using the average monthly prices from January 1956 to August 1958, he found that two variables accounted for two-thirds of the variance of monthly prices. His results indicate that the two major factors which control the average monthly price are the amount of lamb which has arrived from New Zealand in that month and the amount of lamb held in publicly owned stores at the beginning of that month.

A number of people will say that this is only a very obvious restatement of the old, well-known principles of the laws of supply and demand. However, before his results can be dis-

missed so perfunctorily, three points should be taken into account. The first is that nobody in New Zealand appears to have tried to measure the extent to which the law of demand and supply did actually affect lamb prices. The second is that Taylor's results, using only the data up to August 1958, enabled him to calculate the prices to be expected in each of the succeeding twelve months and the calculations were, for this type of work, very accurate indeed. Thus in only two cases was he more than 5 per cent. out,—*i.e.*, a discrepancy of 1½d. per pound; in only another two cases was he more than a half-penny to a penny per pound out, a discrepancy of about 3½ per cent.; in the remaining cases he was less than a half-penny out. The third point is that, if the previous results are correct and are found to apply in future years as well as in the last, it provides one with additional information in the planning of market operations. If one knows reasonably accurately how supply affects prices, then it is possible to draw up optimum storage and disposal rules so that maximum return can be obtained from a season's kill.

PROCESSING OF AGRICULTURAL PRODUCTS

Of the 8 per cent. of State funds spent on research outside the farm gate, virtually all of it is spent on processing problems in the form of grants to the Research Associations. This has several major weaknesses. First, the Research Associations serve only established industries and there is no ready way of assisting newly emerging industries. Secondly, the amount of research done is determined entirely by the industry. The Government's contribution is in the form of a subsidy which is quite rigidly related to the amount of money the industry cares to find. It could well be that the amount, while quite adequate from the industry's point of view, is inadequate from the national point of view. Thirdly, the Research Associations are, on the whole, too small or too close to their industries, or both, to engage on long-term speculative research which may have considerable potential value, or to embark on long-term research which is of marginal value to any one of them but which, collectively, could be very significant. Of the latter type of research, three examples spring readily to mind—refrigeration and low temperature research; radiation sterilization and preservation of food-stuffs; and industrial microbiology.

The writer has never been able to appreciate the reasons for the marked difference in outlook towards the financing of research within the farm gate and that outside the farm gate. It would be exceedingly difficult to determine what contribution

the various farming industries should make towards the cost of soil research and that the only feasible solution is for the State to assume the whole cost. But it is equally difficult to understand why the State will undertake research on bloat on behalf of the dairy industry without the slightest suggestion that the dairy industry itself make any specific contribution, while the amount of research on the spreadability of butter, for example, is determined entirely by the amount of money the industry is prepared to pay.

New Zealand should set up as soon as possible a research organization similar to the Division of Food Preservation and Transport of the C.S.I.R.O. or perhaps, even better, one similar in purpose and outlook to the regional laboratories of the United States Department of Agriculture. The type of laboratory envisaged would have three major functions: (1) To assist newly developing industries which are struggling to establish themselves; (2) To carry out long-term research basic to groups of industries, and (3) To try to find new uses, particularly industrial, for agricultural products. Such an organization would have to be staffed by scientists of different kinds; chemists, physicists, microbiologists, chemical and mechanical engineers and processing technologists to name a few; its work would require coordination with other research efforts on the production, marketing and consumption of farm products. Above all, it would be necessary to see that it retained a high flexibility of outlook and did not become a more or less permanent full-time research centre for any particular industry.

In advocating the intensification of this type of research, one is really doing nothing but suggesting that the agricultural industries take a leaf out of the industrialist's book and be sufficiently alert and progressive to profit from his experience and, it is hoped, beat him at his own game. The United States Department of Agriculture [14] tell us:

> Producers of industrial goods and raw materials have been vigorously conducting their own utilization research for many years. It has paid handsome dividends, especially to the chemical process industries, which use mainly mineral raw materials—petroleum, coal and natural gas. Some of the new man-made products resulting from that research now compete in markets once held exclusively by farm products. Synthetic fibres have captured some of the markets for cotton and wool—plastics have invaded the leather market—and synthetic detergents command more than half the soap market once dominated by animal fats. The new synthetics are successful because they offer qualities not now found in farm products, or because they are priced at levels that discourage competition from farm products.

But we know that the qualities Nature puts into our crops and livestock can be changed and improved—through research. . . . On the discoveries of chemists, physicists, microbiologists, and engineers, we have built great industries that transform agricultural raw materials into billions of dollars a year worth of goods, fabrics, and other goods.

Yet we have so far only scratched the surface in farm-product utilization. The complex carbohydrates, proteins, fats, and other constituents of agricultural commodities have characteristics that differ from those of other raw materials. We should be able to take advantage of them in the manufacture of new products, different from any now on the market.

Research shows, in fact, that farm commodities can be used as raw materials for almost any of the products of our multibillion-pound chemical and plastic industries. Farm-grown materials are not more widely used by these industries today largely because industrial research has found non-farm sources of similar materials that are less costly and more stable in price, quality and supply.

It is the job of utilization research to endow farm products with the properties industry wants in its raw materials, and also to develop from agricultural sources new and needed products that cannot be manufactured as cheaply or as well from non-farm materials. Through such research, industries now using farm products can be broadened and strengthened. And completely new industries can be founded on the creative development of new, better and more economical foods.

. . . The main emphasis in utilization research is on finding *industrial* uses for farm products, especially those in surplus. Such uses offer the best prospects for large increases in farm product consumption. But an essential part of this work, also, is to develop new and improved *food* uses for what farmers grow. We know that if processed foods have a top quality and built-in convenience consumers will buy them in quantity . . . and this can change the whole aspect of an industry and greatly increase overall consumption of a commodity. Frozen orange-juice concentrate is one example of the kind of product that can bring about a striking change in the production, processing, and marketing of a crop.

Lest this quotation be considered just as an example of ill-founded American optimism or the special pleading of a Government department which has to justify the expenditure involved in running four utilization laboratories, consider the following statement made in Great Britain [15]:

At a time when the market for milk and milk products appears to be saturated, and when all efforts by publicity organizations to persuade people to drink more milk and eat more butter and cheese are failing, it is prudent to consider the possibility of producing new products from milk which might find new consumer outlets and create renewed public interest in dairy products as a whole.

When one studies the trends, one must admit that aggressive industrial research and marketing are hitting hard at the primary industries. Take just one example—the battle between margarine and butter. Table 2 gives the estimated consumption in pounds per head of population of butter and margarine in the following countries in 1938 and 1955.

TABLE 2: CONSUMPTION OF BUTTER AND MARGARINE IN SELECTED COUNTRIES [15]

Country	1938 Butter	1938 Margarine	1938 Total	1955 Butter	1955 Margarine	1955 Total
Australia	32.9	4.9	37.8	29.8	7.6	36.9
U.K.	24.1	10.0	34.1	14.7	17.8	32.5
Canada	31.9	—	31.9	20.6	8.0	28.6
Netherlands	12.3	15.7	28.0	6.5	42.9	49.4
Denmark	18.3	47.4	65.7	18.7	41.0	59.7
W. Germany	19.4	13.4	32.8	15.2	27.3	42.5
Belgium	17.9	14.8	32.7	24.5	21.8	46.3
U.S.A.	16.4	2.9	19.3	8.9	8.0	16.9

New Zealand is not as alert and progressive in the conduct of research aimed to increase the industrial uses of her agricultural products as she should be. No alert and far-seeing manufacturing firm would be at all happy at the thought of having so much capital expenditure in land, equipment and men devoted to the production of so few end-products. Such a firm would take very positive steps to free itself from this vulnerable position.

The United States Department of Agriculture (under the United States Civil Service Commission and not a body corporate with either an advisory or executive council) has given a lead which should be pondered seriously [14]. Prior to the last war, the traditional outlet for excess animal fats, both edible and inedible, was the manufacture of soap, which absorbed about 75 per cent. of the animal fats not used in foods. But when synthetic detergents (mainly products from petroleum chemicals, developed by aggressive industrial research) began to cut sharply into the soap market, the market was able to absorb only about 25 per cent. of the fats produced. Faced with this problem, the Department instructed its Eastern Regional Laboratory to tackle from many angles the problem of excess animal fats. Already some of its research findings have begun to pay dividends in the form of new domestic markets.

Fats in Livestock Feeds: The largest new outlet developed so far is in livestock feeds. Studies conducted for the Laboratory under contract by the American Meat Institute showed that fats improve the feeding efficiency of mixed feeds and increase their palatability. In the United States, many commercial broiler feeds contain 2 to 3 per cent. added fats and fats are also going into other mixed foods and into pet foods. These outlets now absorb 400 to 500 million pounds of inedible fats each year.

Epoxidized Fats: The same Laboratory has also shown industry how to use animal fats to advantage. Its scientists have developed superior plasticizers—stabilizers and softeners for plastics—by a chemical process that yields so-called epoxidized fats and oils. They are used to give longer-lasting pliability, and resistance to deterioration by heat and light, to such items of vinyl plastics as raincoats, umbrellas and clear garden hose. About 35 million pounds of epoxidized fats and oils are now produced annually for the plastics industry by a dozen companies licensed by U.S.D.A. public-service patents. The future of these fat-derived chemicals is very promising. Industry forecasts point to a possible increase of two- or three-fold by 1965 in the use of fats in plastics. It is expected also that further research will permit these materials to find use in the manufacture of surface coatings. This could well lead, during the next 5 or 6 years, to new outlets for an additional 200 million pounds per year of inedible animal fats.

Vinyl Stearate: Eastern Laboratory scientists also recently discovered how to use another chemical derived from fats—vinyl stearate—to produce new and improved plastics. This chemical gives industry, for the first time, a plasticizer that is chemically bound into the molecules of the plastic itself. Products made with vinyl stearate have superior resistance to grease and water and more durable flexibility. Vinyl stearate can be used as an ingredient of vinyl plastics of many kinds, including floor-wax preparations for use on vinyl tile, and in water-base paints. It promises to find use also in coatings for packaging materials, cotton finishes, electrical insulation, and other products. Although this chemical is still under commercial development, its attractive properties as an industrial raw material have boosted its current rate of production to about 2 million pounds a year.

Here is a lesson for New Zealand. Consider, for example, the casein market. In 1957 the export value of casein was £2,236,000. Slightly more than half the casein entering the international trade is used by paper manufacturers, and about 25 per cent. for adhesives. Hence it has at present only two major uses. But it is by no means inconceivable that as a result of aggressive industrial research by the chemical companies that casein could lose either or both of these market outlets. Yet, no one in New Zealand considers it worth while to pull the casein molecule apart, and try to put it together in a different sort of way to see what further uses can be found for it. No alert chemical industry would be content to assume that its produce had only two uses

and just devote a small amount of research to improve its manufacturing process. Not more than £5,000 a year is spent on casein research, a product worth, in 1957, £2,236,000. Yet in the same year, the State spent something like £50,000 on fruit research, the export value of which was less than £2 million. But the vulnerability of casein on the world market, makes this allocation of priorities and relative research effort hard to understand.

Where is the Money to Come From?

To do all these things will obviously require increased research expenditure in the future and the question of where the money is to come from would certainly be raised. It is not intended to enter into any discussion as to how much Government should find or how much should be provided by the agricultural industries. It will not avail to shelter behind the usual excuse, that this is a small country and hence it is impossible to carry out research on a scale comparable with that of other countries. The agricultural industries are big business, even on world standards, and unless they are prepared to fight other industries of comparable size in other countries they must inevitably slowly but surely fall behind. In comparison with some so-called giant industrial firms New Zealand agriculture is not such a small business after all. Consider I.C.I. In 1955 its total sales were £400 million pounds; the export value of New Zealand's agricultural industries, based predominantly upon sheep and cows, was £256 million, just about two-thirds that of I.C.I.'s output. But in the same year, I.C.I. employed 1,700 graduates, 2,800 technicians, spending £9 million on research development. In 1939 Du Pont's total sales were less than $300 million, at today's rate of exchange about £100 million. In the same year New Zealand's export earnings were about £53 million. In 1953 Du Pont's total sales were $1,560 million or £560 million at the official rate of exchange. New Zealand's major agricultural industries earned about £213 million, about two-fifths that of the total value of Du Pont's sales. But in 1953, Du Pont's sales of nylon exceeded the total value of all their products in 1939; to make nylon possible they spent £10 million in research, development and plant installation before the first commercial sales were made. In 1953 they were spending £19 million on research and development. This is formidable opposition.

The problems of organizing research for great companies like Du Pont's or I.C.I. are quite different from those of organizing research for this country's agricultural industries. But it is

to be hoped that the agricultural industries and the community generally will throw up leaders of sufficient vision and statesmanship so that the country's magnificent agricultural efforts will achieve even greater success in the future.

Literature Cited

(1) HAMILTON, W. M. (1958): *Proc. 8th Lincoln College Farmers' Conf.*: 10.
(2) MULHOLLAND, W. (1959): *N.Z. Meat Producer,* 3 : 13.
(3) PUBLIC SERVICE COMMISSION (1958): *Ann. Rep.*: 10.
(4) ADVISORY COUNCIL ON SCIENTIFIC POLICY (South Africa) (1959): *2nd Ann. Rep.*
(5) *Nature, 181* : 141 (1958).
(6) *N.Z. Parliamentary Debates, 230* : 892, 941 (1931).
(7) MULHOLLAND, W. (1957): *Evening Post,* 12 Sept.
(8) UNIVERSITY GRANTS CTTEE. (1958): *University Development, 1952-1957,* Cmnd. 534 (London), H.M.S.O.
(9) MCMEEKAN, C. P. (1954): *Proc. N.Z. Soc. Anim. Prod., 14* : 60.
(10) SMITH, D. M. (1959): *Proc. N.Z. Soc. Anim. Prod., 19* : 5.
(11) FAWCETT, E. J. (1955): *Proc. N.Z. Soc. Anim. Prod., 15* : 30.
(12) BARNARD, G. S., SMITH, V. E. (1959): *Resource Allocation of an East Anglian Dairy Farm; a study in the application of linear programming,* Farm Economics Branch, School of Agriculture, Cambridge. *Occasional Paper No. 6.*
(13) WARD, A. H. (1953): *Proc. N.Z. Soc. Anim. Prod., 13* : 97.
(14) U.S. DEPT. OF AGRIC. (1959): New Uses for Farm Products. *Information Bull., No. 209.*
(15) *Food Manufacture,* 33 : 153 (1958).

DISCUSSION

F. R. CALLAGHAN: Mr Callaghan expressed the opinion that the present system with its divided control worked reasonably well. Most of the criticism directed against it quite wrongly exaggerated its defects, and was generally ill-informed. It was easy in general terms to advocate an Agricultural Research Council and this had often been done by many earnest people and organizations, but when once the details of the necessary changes involved in bringing about such a Council were reached, disagreements of a very profound nature arose and the proposal was dropped. For example, "Should such a Council be advisory or executive?" was not easily decided.

Despite drawbacks of which he was well aware, Mr Callaghan favoured such a Council in preference to the present system of Public Service Commission control. There is too great a danger of stagnation if the present system does not change to make provision for the advance of science which seems inevitable if New Zealand's agriculture is to progress satisfactorily. During the past thirty years, most surprising changes have been evident in the institutions, the organization, and the staffs which have helped promote New Zealand agriculture, and he foresaw these changes increasing at an even greater progressive rate during the next thirty years. Of equal importance are the changes in attitudes which have occurred in scientists, extension officers and administrators. These changes are only too easily disregarded. Whatever administration is set up, if it is to be effective, it

will have to take into account all these changes in an expanding organization in which increasing remoteness of personal contacts will bring new problems which do not appear today, when so many scientific and extension officers know each other personally.

Though Public Service Commission control has much to commend it in a Government service predominantly clerical in character, and despite the fact that the Commission has done its best to administer scientific matters in accordance with the terms of its Act and again has become much more understanding of scientific aims, purposes and attitudes in recent years, he considered that it was not a satisfactory body to administer research and science. Mr Dick's references to the salary control exercised by Public Service Commissions overseas had to be looked at critically, for in the United Kingdom and Australia, for example, the control was by no means as close and detailed as it is in New Zealand, despite the New Zealand Public Service Commission's endeavours to adopt a liberal attitude. In the United Kingdom, for example, there was a special scale for the Scientific Services. In Australia, C.S.I.R.O. had established its own scale of salaries independently of the Public Service Board, and though now this had been changed somewhat, the supervision of the Board was now only exercised along very general lines. In New Zealand the Public Service Commission was obliged to keep scientific salaries in line with those of a Public Service which was predominantly clerical, but nevertheless in scientific salaries appeared to yield to the pressure exerted by strong professional associations; hence the anomalies evident in the salaries paid to medical, veterinary and engineering posts by comparison with those paid, for example, to botanists, geologists and chemists.

The Appeal Board suffers from the same restrictions as the Public Service Commission. It is comprised of men who have not had scientific experience, and it is naturally difficult for such men, even with the best wish in the world, to appreciate the significance of the weight of scientific argument placed before them.

The combined attitude of the Public Service Commission and the Appeal Board has rendered it difficult for scientific administrators to promote officers whose qualifications for advancement these administrators knew were ahead of those possessed by their seniors in service, and so progressively senior positions have been occupied by men lacking qualities of leadership.

Mr Dick commended the Public Service Commission's initiative in calling a meeting of departmental heads to consider important changes in agricultural matters brought about by a depression in the overseas market for farm produce. Rather the speaker thought the Commission should be congratulated for its action in adopting the suggestion made on the initiative of a senior officer in one of the departments concerned. If departmental jealousy in scientific matters exists to the extent as is alleged, then it could be assumed that a most important role of the Commission would be to initiate some positive action to bring the responsible officers of those departments together to discuss their responsibilities, as Mr Dick stated has been done in the case of the geothermal project. Mr Callaghan was not aware of such action ever having been taken in regard to agricultural research matters.

A preference for the Departments of Agriculture and Scientific and Industrial Research being under one Minister is expressed in Mr Dick's paper. Such a position did occur once, for about two months only, in

the 33 years of D.S.I.R.'s existence. Originally D.S.I.R. was considered a department appropriate to the Prime Minister's portfolio and this prevailed during the premierships of J. Gordon Coates, Sir Joseph Ward and George Forbes and, had such continued, there might have been much less prospect of that dual control arising, which is said to be lamented today.

A fundamental requirement for research is complete dissociation of its administration from statutory and regulatory responsibilities. Mr Callaghan considered that it had been this feature which had militated against progressive research in the Departments of Agriculture in many countries including New Zealand, the Australian States and the United Kingdom. In Australia almost all agricultural research now is done by C.S.I.R.O.; in the United Kingdom by the Agricultural Research Council.

Mr Dick had drawn attention to an anomaly which exists in New Zealand whose solution presents such baffling characters as to make a sound decision really difficult. Why should the State be prepared to undertake all the responsibility and costs for research relating to soils, plants and animals and only a portion of those relating to fertilizers, special crops such as wheat, tobacco and hops, and to animal products such as dairy produce, wool and meat? It is this division which has caused much concern for a long term and which has hindered the progress of organization in agricultural research.

There is not much evidence of the advanced thinking relating to surveys and to the preliminary research necessary to meet the changing needs of our rapidly progressing agriculture. There is a real need in this nuclear age for watching carefully the advances made in all the basic sciences, perchance they may have important repercussions on agriculture, as well as deliberating on those problems directly concerned with farming itself.

In most of the new fields mentioned by Mr Dick in the second portion of this paper, some small action is at present being taken in New Zealand, but it is altogether inadequate in view of their importance to our future farming prosperity.

Too much is required of our present official leaders in agriculture in the way of their administrative responsibilities, to enable them to undertake the surveying and planning and exploratory research necessary for the present and future demands of the farming industries.

It is this realization that makes him disagree with Mr Dick's opinion—that no change is necessary in our present organization and administration, and advocate, as an alternative, the setting up of an Agricultural Research Council. In a small country such as this, he felt that we might lose, if however such a Council were set up in isolation, for he considered agriculture here had much to gain from association with fundamental, industrial and medical research.

Consequently Mr Callaghan favoured an organization patterned somewhat on the lines adopted in the U.K. In this there would be a National Research Council which would deal directly at top level with the Government in overall policies, finances and programmes of research. The actual research programmes would be under the control of three separate bodies: (1) the Agricultural Research Council, (2) the Medical Research Council and (3) the Industrial Research Council. The Agricultural Research Council would be executive and composed of farmers and scientists. It would include permanent members whose task it would be to plan ahead the future of New Zealand agriculture in all its aspects, and to keep under constant review all trends in the research in progress. Advisory members would be

appointed from time to time to act in this advisory capacity on all matters coming before the Council. It would be essential that members chosen for the Council be prepared to do much thinking, much active work, and exercise sound judgement and courage in their duties, for much will be required of such a body, if it is to maintain its status and the confidence of both farmers and scientists.

Finally, he would consider it in the interests of New Zealand agricultural research, promotion, and education, if progressively all three were centred at the two University Colleges of Agriculture—Massey and Lincoln—each college to cater for the farming needs of the Island in which it is located.

SIR GEOFFREY PEREN: Sir Geoffrey agreed in the main with what Mr Dick said in his paper. He supposed that a National Research Council would in time be set up as this would be in today's pattern of things, but he was afraid of it—afraid of regimentation by people who had had little or no experience of research and did not really understand it. Under the existing organization we were not doing too badly in the matter of accomplishments in spite of the shortage of funds. Above all, we were allowed freedom of action. He would like to see more support for research given to the two Agricultural Colleges as, apart from the scientific value, the presence of such work in their midst encouraged students to become interested in research, and the recruitment and training of research workers was vitally important. Further, as the Colleges made very considerable contributions to the costs of research carried out by their staffs, the work was undertaken very cheaply from the point of view of the Research Council. Healthy competition between institutions doing research was an excellent thing and a little bit of overlapping provided a check on the soundness of work. Whatever might be done in the future in the directing of research, reasonable freedom of action must be allowed if the most was to be got out of the workers.

DR J. F. FILMER: Mr Dick is probably right in advocating more research into the economics of production and marketing. It is questionable, however, whether this should be undertaken by any of the existing research organizations. The object of research is truth; the object of business is profit. While these are not necessarily incompatible, they do occasionally clash.

The gospel of co-ordination of research is in need of a little debunking. Co-ordination, in essence, consists of directing that a specific problem should be investigated in one institution and not in another. The first may be ineffective and the second can be dangerous. The most valuable discoveries are often made in the most unlikely places—*e.g.*, the Plant Chemistry Division with no pathologists on its staff has made an outstanding contribution towards the solution of the bloat problem. The man who discovered the fungus which causes facial eczema, is not a mycologist and was not supposed to be looking for fungi.

The principles underlying the successful organization of research are essentially simple. A research director should get together a team of competent, well-trained enthusiasts; he should provide them with adequate facilities; he should get out of their way. If these principles are followed, New Zealand will continue to benefit from research. If they are not followed, the most elaborate organization, even if backed by lavish expenditure, may well prove utterly futile.