

PROBLEMS AND APPROACHES TO ON-FARM RESEARCH

INTRODUCTION

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The ultimate aim of most agricultural research is to assist producers in adopting managerial strategies which will improve the efficiency and profitability of their enterprises. Yet currently, only a small proportion of animal production research is conducted on farms and the effectiveness of much of it could be improved.

The purpose of this symposium is to examine the major reasons for failure of on-farm research, which has come to be regarded by many people as more sociologically useful than technically necessary. Many problems of animal production however, can best be addressed by research on farms and the nature of these problems and the most appropriate forms of research are outlined. Two relatively new approaches to improving the effectiveness of on-farm research are also discussed. The first involves integration of basic research information on the animal and its environment so that the pattern of response to alternative management strategies can be predicted. The second is concerned with involving farmers in problem identification and research planning so that the rate of adoption of managerial strategies will be increased.

In this series of papers, the term on-farm research is taken to include any study conducted on a farm, which is aimed at either investigating a problem or obtaining information. These studies may be undertaken by farmers, extension or research personnel,

PROBLEMS OF ON-FARM RESEARCH

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On-farm research poses many problems which are not encountered on research stations. Most of these lead to a failure to interpret the results satisfactorily and to extrapolate them to other situations. On some farms, the facilities for research may be limited or the owners may impose management constraints which can lead to compromises in design. The goals of the farmer, extension and research personnel may differ when planning the research, which can lead to conflict as to the design, or to the types of measurements being taken. Research with different designs and measurements is often difficult to interpret and the results may not apply to a similar problem elsewhere.

This paper outlines specific problems arising from differences in goals, facilities and management, statistical design, administration and legal aspects of on-farm research.

Differences in goals

It is difficult to conduct on-farm experiments that satisfy the goals of farmers, extension and research personnel.. However, thorough preparation and good planning before experiments commence will enable compromises to be made where necessary.

Farmers' goals are to solve an immediate problem; in doing so, they are

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interested in seeing a result or solution to the problem rather than quantifying it experimentally or explaining the cause of the problem. The type of research they favour reflects some of these goals and usually leads to a **problem-**orientated experiment with management options immediately open to them. An example of a problem-orientated experiment was an on-farm study of poor growth in cattle in the Warrumbungle region of N.S.W. and the identification of copper deficiency (Smith and Thompson 1978).

The above goals differ from those of extension officers who wish to demonstrate new ideas in areas where they may not have been previously promoted, and to encourage as many farmers as possible to adopt the improved technology. The extension officers may wish to conduct on-farm research at a number of sites, to demonstrate a principle; this goal will depend on the extension priorities within a district or region at a particular time. Their experiments are aimed at groups of farmers and therefore may not be seen as the most important immediate problem by individual farmers.

The goal of research workers is to study and understand a problem and report their findings in a recognised scientific journal. They want quantitative results that can withstand critical appraisal by colleagues. Scientific journals have strict requirements regarding design, method, and statistical analysis of data and it may be difficult for them to meet these criteria from on-farm trials. In order to meet these, research officers look for familiar designs such as factorial designs, replication on individual farms and across farms. It is difficult for farmers and often extension officers, to understand these goals and requirements. They pose the greatest difficulty in overcoming the problems of on-farm research.

Facilities and management

On-farm research is often located a long way from the experimentalists' headquarters. This may seriously limit the measurements that can be taken, and farmer facilities may not be suitable for carrying out the research. The size of yards may not be convenient for handling small groups of experimental animals; extra fencing and watering may be required and large machinery may be unsuitable for small plot work. These problems often lead to less replication on a farm and the need to compromise design requirements to meet particular situations. Hence replication of trials over farms suffers. Substantial funds and the purchase of expensive mobile equipment may be required to overcome these problems.

Management practices and timing of the farmers' operation, such as lambing and shearing, may not suit research. The **manager's** goals and concern for the health of animals can limit the range of treatments imposed. This may occur when studying levels of feed additives that may be toxic in excess, or the minimal survival requirements for drought fed livestock. The expectations of a farmer can vary as an experiment progresses. In a copper supplementation experiment in N.S.W. (Smith and Thompson 1978) the farmer did not want unsupplemented controls included after the first year. Many of these problems can be overcome by compensating for losses in livestock and livestock production.

Statistical design

The most common design problem is lack of replication. It can result from either insufficient facilities for the researcher, or farmers' interests in comparisons which are only of direct relevance to them. With on-farm research the replications can be within a farm in the same year, within a farm between years or between farms. Many cropping experiments are replicated within a farm

in the same year, but this is often not possible with livestock experiments because of limitations in facilities. Using years as replicates both on, an individual farm or across farms can pose problems of maintaining the same design. This was demonstrated in the copper experiment where the farmer did not want controls in the second year because he had 'seen' a response in the first year. Without adequate replications it may not be possible to identify treatment effects and therefore interpretation and extrapolation is difficult.

The design of an experiment is influenced by the intrinsic variability of the characters under study. There is little information as to the nature of the error variance between animals within a treatment block from on-farm trials, but considerable information from research stations. We have no reason to believe that the error variance would be greater on-farm.

Administration

Research workers would be more inclined to conduct on-farm research if many of the problems associated with the lack of facilities and difficulties of publication could be overcome. This has serious implications for research administrators.

Some people believe that on-farm research is a cheaper way of conducting research, but this is often not the case. Special provision should be made by administration and funding bodies for the additional capital required to conduct suitable on-farm research. Fencing and travelling expenses are often significantly higher with on-farm research and mobile field research units are often necessary. Administrators need to ensure that adequate planning and consultation between all the co-operators is conducted at the local level so that experimental design and procedures are optimized. At the regional and state level, co-ordination and standardisation need to be implemented to ensure satisfactory interpretation and extrapolation of results.

Research workers in an on-farm situation need to be able to respond to changing situations quickly and therefore administrators must be flexible and able to make quick decisions. Administrators also need to make provision for the extra time it takes to obtain results from on-farm research and the difficulties encountered in publication and promotion by on-farm researchers.

An example in which some of these administrative problems have been faced is the co-ordinated approach to on-farm cropping by agronomists in the Western Region of N.S.W. and Trangie Research Station. In this project all on-farm crop trials are co-ordinated from Trangie Research Station where a mobile field research unit is located. District and research agronomists meet on a regular **basis** to determine which trials should be conducted and the design and measurements that should be adopted in the region. The administrative experience of the research station is used to seek outside funds for the project. The approach used in this project has allowed better facilities to be obtained and conflicting goals to be rationalised. On a regional basis interpretation and extrapolation of on-farm crop results have been improved.

Legal aspects

Legal obligation and liability are problems which can restrict on-farm research. Death of animals or loss of production may require **special** administrative provisions for compensation. Difficulties arise in valuing the extent of loss to the owner. An alternative is that the researcher owns the livestock and leases land from the farmer. With this system the farmer feels

less involved causing some of the benefits from on-farm research to be lost.

Experiments with unregistered drugs or chemicals can be done on-farm under licence but the legal liability of the experimenter needs to be established in the event of the property being subsequently quarantined. There is some reluctance to conduct these experiments because the Pesticides Act prevents the presentation of results of unregistered compounds.

BENEFITS OF ON-FARM RESEARCH

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On-farm trials frequently involve plot studies in which fertilisers and cereal varieties are evaluated so that estimates of variation can be taken into account when making recommendations for different localities or regions. On-farm research is often less convenient with animals but the benefits can be equally as useful. The nature of these benefits vary with the type of on-farm research being undertaken. Some of these benefits are described in this paper.

General field monitoring

Statistics for individual herds or flocks within a region can indicate the range in performance. The between-flock or between-herd variation is partly a reflection of differences in farmers' skill and judgement. It can also provide an indication of potential **increases** in production which can result if factors contributing to this variation can be identified. Within a region, one breed of cattle may perform better than another. Lambing rates may be influenced by the joining dates. Anthelmintic drenching or mineral supplementation are practices which regional surveys may indicate are being used effectively in some flocks or herds. This locally derived on-farm information is extremely useful to advisers.

An equally important outcome of analysing herd or flock records is that management practices which may have tended to be ignored are identified as important. For example in New Zealand dairy herds in which all the cows will calve in the late winter/early spring, it had been ~~thought that~~ a high conception rate to first inseminated was the essential requirement for maintaining this seasonally concentrated calving pattern. The analysis of field records showed that because most herd owners only used the insemination service for four to seven weeks before running bulls with the herd, submission rate (the proportion of the cows insemination during the first four weeks of **the breeding programme**) was a more important factor than conception rate (Macmillan and Watson 1974). The submission rate was an indicator of the level of anoestrus in the herd (Macmillan et al. 1975) and could be influenced by management, whereas conception rate was influenced by many factors over which the herd owner had no control (Macmillan 1979).

Detailed flock or herd monitoring

Although individual herd or flock statistics may indicate the range in performance, on-farm studies of a more basic nature may be required to explain the causes of the variation. Kelly et al. (1978) **developed a system** for identifying factors contributing to **the variation** observed in the reproductive performance of 64 sheep flocks in the South Island of New Zealand. This system involved subjecting 100 young ewes in a flock of up to 1000 animals **to** laparoscopy, and then carefully monitoring the lambing performance of the

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laparoscoped ewes. Ovulation rate (range = 1.12 to 2.31 ovul/ewe) was the major factor contributing to variation between flocks in lamb tailing percentages, with ewe liveweight at mating being identified as the most important contributor to variation in ovulation rate. Although lambs born/ewe lambing increased by 0.72% with each 1% increase in ovulation rate, lambs tailed increased by only 0.58% per 1% increase partly because the death rate among single-born lambs was 8.7% compared to 10.6% in twin lambs. The major factor producing the difference between ovulation rate and lambs born/ewe was the increase in eggs or embryos lost between ovulation and lambing in ewes with multiple ovulations (Kelly and Knight 1979).

Research station trials may be necessary to elucidate the nature of the live weight-ovulation rate relationship or to study factors contributing to lamb deaths. In contrast, the data from 64 commercial flocks allowed the relative importance of the different factors influencing lamb tailing percentages to be measured under the conditions that operated in that part of the country.

Conducting basic research under field conditions

Through using animals in selected herds or flocks a scientist may be able to measure small but potentially significant treatment effects which could not be detected in a smaller group of animals available on a research station. This is especially so in research related to semen diluents or semen processing. On-farm research is the sequel to laboratory studies on in vitro sperm survival.

In some cases, minor modifications in standard record keeping by a group of herd owners can be used for basic research which requires a large number of animals. Macmillan and Curnow (1977a) used insemination records from 557 herds whose owners simply identified cows first seen in oestrus at the evening milking (pm cows) or at the morning milking (am cows). All cows were inseminated after the morning milking. Whereas the pm cows largely comprised animals inseminated when at late/post oestrus, the morning cows were at early/mid oestrus. Sires of below average fertility had higher conception rates with the pm cows (61.9% vs 57.1%). In contrast, the sires of above average fertility had conception rates which were only slightly influenced by stage of oestrus at insemination (pm vs am = 67.9% vs 69.0%). The previously accepted recommendation that cows should not be inseminated until 8 to 12 h after first being detected in oestrus is of no advantage unless processed semen from sires of below average fertility is being used. On-farm research had provided a better understanding of a factor contributing to differences in sire fertility.

Testing basic research results under field conditions

Before the results of research station studies are advocated for use within industry it is essential that the newly developed technique is tested in a variety of field situations. As well as allowing the identification of management procedures which may contribute to the success or failure of the technique, field testing can indicate the best way to incorporate the new technology into husbandry practices. Successful results in a variety of situations can engender greater confidence in the practice when it is being advocated by advisers.

Few station trials are conducted using animals which have been poorly reared or managed, but the technique may still be recommended for use under field conditions without qualification. The potential value of oestrous synchronisation in cattle justified substantial research effort being expended to complete basic studies to better understand the oestrous cycle. These studies led to the identification of the role of prostaglandin $F_{2\alpha}$ in luteolysis. Theory suggested

that cows could be **synchronised** by the administration of two injections of this drug 11 days apart. Research station trials confirmed the theory. However, field trials showed that responses were variable because of differences in cow body condition, and age (Nancarrow 1976; Cummins et al. 1976). Although treated cows did have higher fertility than untreated herd mates if inseminated when in oestrus (Smith and Macmillan 1978), the degree of **synchrony** was not sufficiently precise to allow all animals to be inseminated simultaneously. One outcome of field trials was that tailpainting was developed as a simple and reliable form of oestrous detection in **synchronised** and **non-synchronised** cattle (Macmillan and Curnow 1977b). The field trials led to better application of the results of the original basic research.

Demonstrating the application of new technology

The value of on-farm trials in this regard is widely accepted. The adoption process as a sequel to on-farm trials is discussed in the next section of this paper. These trials may also indicate that a particular form of technology is only useful if other limiting factors present in the on-farm situation are overcome. For example, it was widely felt by scientists that the use of oestrous synchronisation would result in greater use of artificial breeding and consequently rapid improvement in genetic potential of flocks and herds. One reason for less than expected interest in synchronisation and insemination in sheep flocks and beef herds in Australia and New Zealand is that the economic advantages of extensively using genetically superior sires through artificial breeding have not been demonstrated under field conditions.

The economic benefits of some forms of new technology may become apparent only after several years. This problem might be overcome if the results of field trials can be used by a systems analyst in a manner similar to that described elsewhere in this paper. In some cases on-farm trials may demonstrate the value of a technique and hasten its acceptance, while in others the results will highlight the need for further research in specific areas of husbandry or management.

Management and research

Experiments on research stations often involve small groups of intensively managed animals. All the animals may be of one type and age. The on-farm situation will often be multi-enterprise (cropping-sheep-beef) with animals being less intensively managed. The effective integration of these enterprises under a range of management situations is rarely tested on research stations. This necessitates obtaining the assistance of several farmers, or using their records to provide information for computer modelling to identify the most profitable combinations. These should then be tested in several on-farm situations.

This same approach may also be necessary where a number of factors may be interacting to produce what finally appears as a single problem such as weaner or **hogget** ill-thrift. If several interested farmers **can** become involved in testing management strategies, as well as contributing ideas from their practical experience, the problem may be solved. Alternatively it will be more clearly defined so that other scientists with their specialised expertise can become involved.

Farmer-scientist involvement in research

Farmer-scientist **collaboration** in **on-farm** research means that resources not **available** to one party can be utilised to the advantage of both parties in the

short-term and to the industry in the long run. A small percentage of farmers are interested in devoting sufficient time to become involved in on-farm research. Including animals from their herds and flocks in on-farm trials is an inexpensive way of extending research beyond research station boundaries while at the same time utilising the experience of the participating farmers. The management objectives of the farmers may differ from the more basic objectives of a trial. For example, a simple means for accurately diagnosing pregnancy in the first trimester in sheep or cattle may be **useful** to the scientist in obtaining estimates of embryonic loss in a variety of field situations. To the **farmer, the** advantages may relate to the early identification of the non-pregnant animals which can then be drafted out of the herd or flock. Both points of view are important and can be considered together as part of on-farm research. Although there are problems associated with on-farm research, the benefits of such research justify it receiving greater emphasis. Then many of the problems of this type of research may be resolved.

APPLICATION OF BIOLOGICAL PRINCIPLES TO FIELD PROBLEMS

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Even when the logistic problems associated with on-farm research are overcome and the results can be properly analysed and interpreted, there often remains doubt about the relevance of the findings to other situations. In the grazing industry particularly, the results frequently apply only to the conditions prevailing at the time of the research and cannot be extrapolated satisfactorily to other seasons, years, farms, regions or enterprises.

For a producer to assess whether economic advances in production can be achieved, he must know for his particular situation the factors which are limiting animal performance, the pattern of response to inputs of these factors and the methods by which they could be provided. This information can seldom be obtained through conventional on-farm research because of the complexity of the measurements and treatments needed and because of the doubt surrounding extrapolation of results to other situations. Thus, in recent decades, many fundamental laboratory studies have been conducted with farm animals in the hope that a better understanding of their physiology may lead to the solution of field problems. Although the concepts derived from this **work have** been used by agricultural extension officers, the complexity of the interactions between an animal and its environment often makes confident diagnosis of the reasons for poor animal performance and the determination of a quantitative solution difficult.

However, with the aid of computers, it is now possible to effectively integrate basic research information and to use it in the solution of field problems. Computer simulation models which predict the effects of feed intake, diet composition, physiological state of the animal and environmental conditions on the growth and body composition of sheep have been developed (Graham *et al.* 1976; Black *et al.* 1980). The purpose of this paper is to describe **the types of farm problems that** can be investigated using this technique and the implications that it has for future on-farm research.

Future on-farm research

(i) Definition of animal and environment To effectively use computer programmes for assessing the consequences of alternative management strategies, it is **necessary** to obtain sufficient details about the animal and its environment **to**

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allow the quantitative prediction of performance and identification of the limiting factors. A major reason for on-farm research should, therefore, be to define the particular situation in the terms needed for operation of the programmes. The information should include basic climatic data such as rainfall, temperatures and windspeed, details of soils and pasture species, details of animal behaviour such as distance walked and times spent grazing and ruminating, pasture species and parts of plants selected and their chemical composition, details of animal genotype and other information on factors that may affect production such as parasite burdens and helminth infestation of pasture.

(ii) Management trials for verification of predictions and for demonstration
From the information collected for a particular farm situation, it will be possible eventually with computer models to select management procedures which should improve farm profitability. However, until full confidence in the predictions and acceptance of the approach are achieved, it will be necessary to demonstrate through farm trials the accuracy of predictions and the success of particular strategies.

Application of computer programmes

The simulation models already developed which predict the effects of protein and energy nutrition on the growth and body composition of sheep can be used to help in the solution of two types of farm problems.

(i) Decisions regarding long-term management strategies From information of changes in pasture availability and composition, and the nutrient requirements of different classes of stock under prevailing climatic conditions, it is possible to predict realistic stocking rates and to determine the effects of alterations in managerial procedures such as the time of shearing, lambing or weaning. By taking into account yearly variation in pasture and climatic conditions, it is possible to predict, for particular stocking rates and other management procedures, the likely need for conserved fodder or the need to remove sheep from the property and, hence, the risk of a proposed strategy.

An example of this type of application has been carried out for Tasmania where many producers have changed from spring to winter shearing dates without full knowledge of the consequences (Black and Bottomley 1980). Because winter shearing increases feed requirements during the period of the year when pasture growth is least, it could have a major effect on farm carrying capacity. Further, the effects of shearing are less in pregnant and lactating animals than in **non-breeding** animals because of their high feed intake and consequent production of heat. It would take many years and a great deal of expense to investigate by conventional farm experiments the effect on pasture requirement of alternative shearing and lambing dates in a variety of Tasmanian localities. However, with the computer models all available information can be used rapidly to assess the problem. Thus, the effects were predicted of five shearing dates and five lambing dates on the pasture requirement of sheep using data from two Tasmanian localities; **Swansea** on the east coast and Bothwell, inland and 650 m above sea level. The shearing of non-breeding sheep at **Swansea** in June was predicted to increase pasture requirement during the three winter months by 66% compared with October-shorn animals. With ewes lambing in July, a June shearing increased winter pasture requirement by only 18% compared with an October shearing, but the higher feed intake of breeding sheep meant that only 3.7 of the July-lambing ewes shorn in June and 4.4 shorn in October could be maintained on the same amount of winter pasture as six non-breeding sheep shorn in June or ten shorn in October. When the pattern of pasture growth is also taken into account, it is **clear** that shearing in winter or lambing before mid August severely reduces the efficiency of pasture utilization in Tasmania.

(ii) Decisions regarding current problems where animal performance is inadequate
By obtaining information on current pasture and climatic conditions and the particular class of stock, it is possible, using computer programmes, to determine the reasons for inadequate animal performance. This approach has been used in conjunction with the necessary data obtained from research stations to assess why lambs grazing summer-irrigated pasture at Leeton, N.S.W. fail to grow as fast as similar animals grazing annual pastures in spring (Black *et al.* 1979), and why lambs grazing white clover grow faster than those eating ryegrass (Black *et al.* 1976).

The approach is now being applied on a property at Holbrook, N.S.W., where weaner growth is very poor during summer and autumn. In collaboration with officers of the N.S.W. Department of Agriculture, measurements are being made of the growth rate and wool production of lambs under normal management, the availability, growth and composition of the pasture, the climatic conditions, the feed intake of the animals, the diet they selected and aspects of their grazing behaviour. From this information, we predicted that pasture availability was not limiting animal performance at any time but that during summer and autumn pasture digestibility and the absorption of amino acids from the intestine were insufficient to maintain required growth rates. The computer programmes were used to predict the amount of various feed supplements needed to maintain a range of different growth rates. Oat grain, which is often fed to weaners, was predicted to provide insufficient amino acids at all intakes investigated. However, by adding 20% lupin grain to the oats, the problem should be overcome. From predictions of animal performance resulting from the supply of various amounts of different supplements, it should be possible to assess whether an economic improvement in lamb growth will result. These predictions are currently being checked.

The future

More efficient use of research resources will occur in the future if many more farm problems are first analysed using computer programmes which integrate the mass of relevant fundamental knowledge now available. For this approach to be successful, sufficient research must be conducted on farms to adequately define the animal and its environment. In many areas, the accuracy of predictions is high (Graham *et al.* 1977) and some computer programmes such as the 'Decide' model for application of superphosphate (Anon. 1974) are already being used in farm management decisions. However, not all problems are immediately amenable to this approach because of insufficient quantitative information about specific aspects of animal production. In these situations, considerable fundamental research should be undertaken and careful consideration given before commencing conventional on-farm research which is often so difficult to interpret and extrapolate to other situations. There is likely to remain for some time a need for on-farm research for demonstration and extension purposes, but it is hoped that in the near future more of the fundamental knowledge now available in all areas of agriculture will be integrated in computer programmes and used in the rapid economic analysis of alternative farm management strategies. With the dramatic fall in price of mini-computers, many farmers and extension officers may soon be able to analyse problems on site.

INVOLVING FARMERS IN RESEARCH

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Adoption of new technology

Low rates of adoption of agricultural research have been widely observed even after long periods of research and extension on relevant farm practices (McEntyre 1976; Mitchell and Potter 1976). McEntyre (1976) found rates of adoption of recommended nitrogen, phosphate and sowing rates were 4%, 12% and 43% respectively.

Research has shown rate of adoption to be related variously to characteristics of the farming practice, type of farm, farmer attributes, source of information, type of community and other dimensions of the system within which farming practice is researched, extended and adopted (Rogers and Shoemaker 1971). Low adoption cannot be attributed simply to deficiencies in extension.

An approach used to improve the rate of adoption and the benefit-cost ratio of research, is to involve community groups of farmers in its planning and conduct. This research is likely to be conducted on-farm. The foundations for such an approach are presented and an example is discussed.

Community involvement in planning

There are two foundations for asserting that the involvement of community groups of farmers in the planning and conduct of research will increase the rate of adoption of research findings.

First, social science theory and research indicate the significance of perceptions and norms to behaviour change (Tully 1966). Many studies have shown that it is not lack of knowledge which prevents innovation taking place (Tully 1971). How people organise information and observations, how they view situations varies; perceptions differ. Each group of people who share a common bond sets its own standards of behaviour or norms with which all must comply.

Behaviour is determined by how situations are perceived. Situations are selectively perceived in accordance with the norms of reference groups. Norms are developed by social interaction within reference groups. Small communities are primary reference groups. Thus to change behaviour it is necessary to change perceptions and to change perceptions it is necessary to change norms. Such changes only result from group interaction and consensus for change. The direct association of researchers with community groups can help foster group interaction and consensus for appropriate change (Buggie unpublished data). A farmer's perception of research results will be influenced by his perception of researchers and research organisations. Mitchell and Potter (1976) sought farmers' comments on "bad things" about the Department of Agriculture. Thirty-three out of 56 replies alleged that the Department's advice or research was uneconomical or impractical. Closer contact between researcher and farmer can help overcome this aspect of the low adoption problem.

Second, the direct involvement of farmers in research planning ensures relevance of research findings. The relevance of many research findings and corresponding farm practices is linked to stage of farm development. Many farm

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practices are sequentially related to the process of farm development. For a farmer to successfully adopt a new practice, he must have already adopted those practices that normally precede it in the adoption sequence (Crouch 1975). For example, intensive grazing strategies are relevant only after pastures have been improved, higher stocking rates adopted and other more basic animal husbandry practices implemented.

Research developed in association with farmer groups will concentrate on problems experienced at the level of farm development of the majority of farmers. In contrast, research planned without farmer involvement will most likely aim at raising, the ceiling of maximum productivity and be relevant only to farmers at the upper levels of farm development.

Involving farmers in research planning will not overcome all low adoption rate problems. High adoption rates may not always be attainable. Barriers to adoption are likely to increase as farms develop because a more developed farm is a more complex unit to manage and a higher level of managerial ability is required for effective management. Further, the barrier imposed by managerial ability may be very persistent (Buggie 1977).

The heterogeneity of on-farm research

On-farm research can take a variety of forms and vary in content, methodology and commercial relevance. Research that is planned with community groups will lead most likely to a particular form of on-farm **research, developmental research**. This aims to incorporate existing knowledge and technology into commercial farming practice. Experimental design and analytical procedures must be developed round the dynamics of the commercial farm production system and its environment. The managerial as well as the bio-economic aspects of the farm system must be allowed to influence results.

Developmental research differs from basic and applied research 'conducted' on-farm. The previous paper by Black illustrates the need for field data to define situations and describe relationships in a basic research activity'. On-farm applied research often holds constant certain factors which do not remain constant in commercial practice. For this reason it has often fallen short of establishing procedures that are readily accepted by commercial farmers who then adapt rather than adopt research findings.

A case study

Kyogle Shire on the far north coast of N.S.W. was selected as the target area for a development **programme** to improve the production efficiency and profitability of beef enterprises. It is predominantly a specialist beef production area representative of the wet subtropics.

When the study began, **the** beef industry was severely depressed. Many producers had earned no more than a subsistence income for two years and this was to continue for a further two years. Many properties were in transition from dairying to beef, holdings were mostly **small, management** was conservative, and little credit was used for development purposes (Mitchell 1976).

The project team comprised a researcher, extension specialist, beef cattle adviser, district agronomist and economist. Additional expertise was available on a consultancy and service basis. This breadth of expertise in both subject matter and function was necessary to be able to respond most appropriately to the priority problems, identified by the farmer groups.

Target districts within Kyogle Shire were selected on criteria that are typically used by physical and biological scientists; that is, relative uniformity of environmental conditions, substantial number of commercial holdings and apparent prospect of response to improved technology. As the project progressed it became apparent that these criteria did not adequately account for how farmers group themselves into communities. Farmers do not define their community in the same way as the scientist **categorises** them.

In each of five target districts meetings were held to identify farming problems and to encourage action to solve them. Each meeting was convened by a contract farmer who sought the participation of 12 to 25 fellow beef producers; this procedure was aimed to secure a group of farmers who normally interact with each other and to give farmers responsibility for 'group enterprise from the outset. The choice of a contact farmer proved to be critical to the continuing activity of the group.

In order to promote farmer interaction, meetings followed a format in which the farmers were asked to nominate problems, allocate priorities, analyse the highest priority problems and reassess the remaining problems, until the dominant problem was clearly identified. Initial meetings with some groups led to extension **activities**. Priority problems raised by two groups led to on-farm research projects.

(i) Cattle-crop hill farming One group of farmers, recognised that worsening cost-price relationships in beef production combined with their inability to diversify was threatening their viability. Direct drilling technology and some favourable local experience with soybean cropping opened up new possibilities. On-farm trials have commenced to test the feasibility of diversification into grain legume cropping on hill country with direct drilling technology, and to assess the scope for the integration of cropping and cattle production into a stable and productive system.

(ii) Management strategies for winter-spring feed Another group recognised that paucity of winter-spring feed imposed a dominating restriction on the productivity of beef cattle. A sample of local herds is being monitored to assess the winter-spring feed problem and to identify the better management strategies that farmers have developed to cope with pasture dormancy in winter and adverse moisture conditions in spring.

Both research projects are in the phase of on-farm data collection. Our most important problem at this stage is to maintain contact with each group of farmers as a group and to ensure that a process of relevant interaction continues.

The approach discussed above in principle and by example is **modelled** on "community **development**" theory. **However**, the charter which the project team accepted was more restricted and the interaction with farmer groups was more structured than in a full community development activity.

There is nothing intrinsic about the technology being researched at Kyogle that lends confidence that findings will be more readily adopted. Our confidence stems from consequences associated with the way in which the research was planned and conducted - the farmers defined their major problem; they have a degree of possessiveness for the research and its results; they are developing a more favourable perception of research, researchers and the Department of Agriculture; they can monitor and redirect the research where appropriate; the research is being conducted on-farm and results obtained will be influenced by all the parameters of commercial farming. The farmers see the link between

their problem and the research and expect the results to alleviate the problem and improve their situations.

SUMMARY AND CONCLUSIONS

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On-farm research does have a major role to play in agriculture. It is appropriate where flock and herd performances are required under normal field conditions or to adequately define the animal and its environment. This type of research is needed to test new technology particularly in intensive livestock industries and for demonstrating the effectiveness of new technology in farming situations.

The complexity of interacting factors that influence the results of some on-farm research make interpretation and extrapolation difficult. New techniques using computers to integrate the available basic and field information can greatly improve the effectiveness of on-farm research and assist farmers in management decisions.

Adoption of results is often slow, but, if localised community groups of farmers can be involved in the planning and conduct of on-farm research then a much greater adoption is likely to occur.

The numerous problems that are associated with on-farm research mostly relate to design and influence the interpretation of results. Differences in design often stem from differences in goals of the farmer, extension and research worker, or the facilities that they have available. Conflicts in goals can be substantially overcome by including all people involved in the planning of on-farm research, while administrators need to make special provision for the additional facilities required.

The attitude and approach to on-farm research would be significantly improved if bodies involved in agricultural education recognised that this area requires special training in sociological, statistical, managerial and administrative aspects.

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