PRESIDENTAL ADDRESS

PROMISE AND PERFORMANCE

T.P. Palmer
Crop Research Division, DSIR, Lincoln

The worldly hope men set their hearts upon. Omar

ABSTRACT

Agronomists often fail to deliver as expected because of false hopes on the part of customers and because of regular over-estimation of treatment responses. I discuss some of the causes of these errors.

Nevertheless, I expect that agronomists will make increasingly greater contributions to agricultural production in New Zealand because crop science is closer than pasture science to the main international research stream.

International links between agronomists should be strengthened.

INTRODUCTION

When the latest miracle of agronomic science fails to live up to its advance publicity, it is easy for the farmer or produce processor to dismiss it as another aberration of the mind of some hair-brained, ivory-towered boffin. It is as easy for the agronomist to blame the peasant clod who lacked enough wit to partake of the miracle.

Neither view is particularly true and neither view is profitable. It is more reasonable to assume that both scientist and farmer are persons of good will, each working competently, and each wishing to improve his place in the world. It is more profitable to ask what went wrong rather that who went wrong.

What does the industry want from agronomists and what can they deliver? Satisfaction for both parties comes from demands which we can reasonably be expected to meet and from our meeting them. Dissatisfaction arises from unreasonable demands, or from our raising expectations to unrealistic levels.

GREAT EXPECTATIONS

Industry may expect the agronomist to change the laws of nature. In olden times the demand, and promise, was to turn lead into gold. Today it is to turn water into petrol, with a net gain in energy. Could better science education cure this problem?

DSIR has set up a number of research advisory committees, one of their functions being to try to reconcile industry expectations with research capacity. Even after fifty years, one of the oldest of these committees, the Wheat Research Committee, has failed to solve this central problem.

Agronomists, acting optimistically, may over-estimate their capacity to deliver. They may over-estimate responses obtainable from new crops, cultivars, or techniques. They may under-estimate costs and very commonly they under-estimate the time it will take to turn principle into practice. Biological processes may take longer than planned, or social attitudes or institutions may be quite resistant to change.

UNDER-ESTIMATING TIME

Mendel's laws were rediscovered at the turn of the century. In principle, problems of adapting plants more closely to their environment by genetic manipulation were then solved. But only now, eighty years later, is an adequate range of plant and animal breeding results becoming available. It was first necessary to develop many techniques for gene exchange and for selection and rapid multiplication of plants and animals. Perhaps equally importantly, it has been necessary to develop appropriate commercialisation systems. These are well developed for plants, and for chickens, and to some degree for pigs, but hardly at all for sheep and cattle.

On a less lofty level, about 1950 I showed that Garton's White Flesh swede was resistant to dry rot and about 1965 Lammerink (1970) showed that club-root could be transferred from turnip (*Brassica campestris*) to swedes (*B. napus*). Three research workers and nearly 20 years later, a swede cultivar combining high resistance to club-root and dry rot should be commercially available in 1983.

Agronomists are likely to under-estimate very considerably the time needed to adapt other people's attitudes to innovation. In 1964 I first seriously proposed that leafcutter bees should be introduced in New Zealand to pollinate lucern. It took until 1971 to convince entomologists that these insects could be beneficial in New Zealand. In the ten years since their introduction, they have not increased as rapidly as expected, which has at least shown it was safe to bring them in. Where they have become established lucerne seed yields have more than doubled.

Many research workers delay release of results unnecessarily by aiming at perfection before release. Should more competition in research be encouraged, and should more government research stations enter into agency agreements with private industry so that there will be more incentive for rapid release of results?

I am sure that both competition and cooperation have given crop farmers more and better cultivars more quickly than they would have received them from the old state monopoly.

OVERESTIMATING RESPONSE

Yields from research workers' trials are usually higher or reported as higher, than average yields on farms.

From 1970 to 1978, NIAB sugar beet trials in Britain averaged 7.5 tonnes of sugar per hectare, while farm crops averaged 5.5 tonnes per hectare (Kimber & McCullagh, 1979; Thomson, 1980).

Aotea wheat in 17 North Canterbury trials during 1976 and 1977 averaged 4.5 tonnes per hectare. Farm crops averaged 3.0 tonnes per hectare (Hall & Lancaster, 1979; Department of Statistics, 1979).

From 1975 to 1979, Kopara wheat averaged 4.8 tonnes per hectare from 63 autumn-sown trials in Canterbury and North Otago (Wright, 1980). In the same period it averaged 3.7 tonnes per hectare on farms in the region (Department of Statistics, 1979).

Riwaka Research Station yields of Green Bullet and Sticklebract hops averaged 2820 and 3080 kg per hectare in 1977. Commercial crops averaged 1770 and 1680 kg per hectare (Frost, 1977).

These results show that well conducted field trials on farms can over-estimate farm yields by as much as 50%. The reason for this inflation of yields in trials are not well known.

The effect is not important if it is recognised but often trial results from new treatments are compared with standard farm production yields. Dry matter yields from sugar beet trials should not be compared with average farm yields of corn when estimating the alcohol yields which could be expected from corn and beet in New Zealand (N.Z.E.R.D.C., 1980).

RELATIVE RESPONSES FROM NEW TECHNIQUES

Trials often overestimate responses from new treatments.

Responses to inputs are usually curvilinear, giving diminished response at higher inputs. Responses measured over a small part of the input range may be effectively linear and then it it tempting to extrapolate invalidly. Inflexions in response curves can be quite sharp. The relationship between stocking rates and pasture yield is a familiar example.

On the other side of the coin, normal farming practice is often well along the plateau of the response curve, so inputs can drop sharply without loss of performance. The relationship of seeding rate to crop yield is a familiar example.

Yield advantages to be gained from growing new cultivars have been over-estimated consistently in well conducted yield trials.

In 1957, Aotea wheat was released after yielding 23% more than Cross 7 in 98 trials over three years in all wheat growing districts (Copp, 1959). In 1963, it outyielded Cross 7 by 11% in the main Canterbury counties (Copp, 1964). In 1976 and 1977, Hall and Lancaster (1979) compared the two in 17 trials; Aotea outyielded Cross 7 by 7% in 1976, and 16% in 1977.

In 1971 Kopara was released after a large number of trials showing it yielded 15% more than Aotea in mid Canterbury (Copp and Cawley, 1974). Farm yields of Kopara were only 6%, 12% and 10% above Aotea in 1976, 1977 and 1978 (Department of Statistics, 1979).

Karamu was released in 1972 with a 30% higher yield than Gamenya in the North Island (McEwan *et al.*, 1972). In the years 1976-78, Karamu yielded 14% above Gamenya on farms (Department of Statistics, 1979).

The basic problem is to project past trial results into the future as there is often no reason to assume that any one cultivar is inherently better than another. There are exceptions such as when disease resistant cultivars are expected to have an advantage. Yield modelling is so primitive as to be of no help in predicting the sort of yield differences we are considering. The best evidence on which to base recommendations for cultivar replacements is the empirical evidence of higher yields in the past. However, cultivar x year interactions in relative yields of cultivars are often significant and past performance may not be a very reliable pointer to relative performance in the future.

Wright (1980) gave comparisons between Kopara and Rongotea wheats. Rongotea yield between 98% and 120% of Kopara over 6 years in mid Canterbury. He explained the results in relation to variations in rainfall and disease but the explanation comes plausibly after the fact and is useful in predicting relative yields only to the extent that one can predict the weather. His prediction that Kopara would outyield Rongotea in 1981 seems to have come true.

Manapou barley yielded between 122% and 98% of Zephyr in trials from 1974 to 1977 (Wright, 1977). Like Kopara, Manapou yields relatively better in dry seasons.

The importance of year x cultivar interactions has been studied more closely in Australia (Hill & Goodchild, 1981). The extensive data available from New Zealand trials should be studied in the hope of learning more about cultivar adaptation.

CULTIVARS AND DISEASES

Introduction of new diseases may upset completey the relative order of cultivar yields and predictions based on them. Bacterial wilt of lucerne is a fairly recent example, yellow rust of wheat will probably be another. This problem can be overcome in part by testing local breeding material in international disease nurseries. Quarantine procedures generally permit this and many New Zealand wheats had been tested against yellow rust, or reselected for resistance to yellow rust, before the disease reached New Zealand. Such international co-operative breeding programmes should be further extended.

In some cases, a cultivar resistant to a disease at the time of its release, selects out strains of the disease or even new pathogens which attack it and so it becomes susceptible and thus loses its advantage. Mildew resistant wheats and barleys have become susceptible after release while peas resistant to *Fusarium* wilt could be grown frequently enough to build up *Aphanomyces* to a damaging level.

Disease may also build up in propagating stocks of cultivars after their release and so lower their yield. Fortunately we can often reverse the process and potato stocks freed of diseases in New Zealand have yielded from 10% to 30% more than good Group 1 seed of the same cultivars (Ovenden, 1981).

However, it is unlikely that seed-borne diseases are of much importance in lowering the yields of seed crops. Major seed-borne diseases such as the smuts are controlled by chemicals or resistant cultivars and in annuals, seed-borne viruses tend to be self-limiting.

EXPERIMENTAL TECHNIQUES

Necessarily, research workers cannot conduct trials using farm production techniques when they are comparing a large number of treatments.

Yields from cereal cultivar trials are measured from small plots, harvested with experimental headers. Hall and Stevenson (1977) found considerable variation between cultivars was caused by sowing and harvesting methods. It is not known whether present cultivar trial results are distorted seriously by these effects.

Using experimental techniques permits many more treatments, trials and measurements. This justification is not valid if the results are irrelevant to farming practice.

There are cases where interaction between treatments and techniques can be expected. There is almost certain to be interaction between seeding rate treatments and comparisons of experimental and farm sowing techniques.

Last year the society debated whether yields might be more predictable if the environments in which trials were growing were specified more closely. The proposal might have merit for some uses but is most unlikely to contribute to useful predictions of relative future production of cultivars or indeed to specifying cultivars for particular areas.

THE FUTURE OF AGRONOMY

Despite the gloomy things I have been saying about the productivity of agronomists, there is no need to despair. Compared with our big brothers of the pastoral industry, we have been doing relatively well. Ojala (1980) gives some three-season volume production figures:

	Production Volumes		
	1964/7	1975/8	1975/8 / 1964/7
Milk	295	293	.99
Wool	307	309	1.01
Sheep meat	489	504	1.03
Beef	323	583	1.80
Wheat	297	357	1.20
Barley	118	272	2.31
Maize	30	190	6.33

The relative efficiency of pastoral production declined in world terms, while the efficiency of crop production increased. Note that wheat production was restrained during the later period by Government policy which paid less than world parity prices for New Zealand wheat.

The figures under-estimate the changes in relativity as they do not take account of the very large subsidy and price support inputs used to maintain production from the pastoral sector. In fact, the crop sector has contributed unduly to these subsidies by the imposition of price ceilings and prohibitions of grain exports to support the livestock sectors.

Why has cropping been doing relatively better? Is it because we are a better research team than the grassland and animal scientists? I think this is partly true, not necessarily because of our higher innate ability, but because there is more international competition in our field and therefore more incentive to co-operate and greater rigour in our science.

But I think it is much more important that we have research from all the world's crop agronomists to draw on and to apply in New Zealand with relatively slight modification. Because our pastoral industry is using largely native-grown techniques and animal breeds, it relies more completely on the narrow New Zealand research base and all advances here must be built from the ground up.

Some statistics from Plant Breeding Abstracts 1978 and reference to animal breeds in Animal Breeding Abstracts 1979 illustrate the point.

Number of Abstracts			
White clover	98	Lucerne	465
Lolium	251	Maize	1967
Sheep	384	Cattle	1035

White clover represents almost all the nitrogen and protein input into New Zealand agriculture; lucerne but a small part of the nitrogen protein input into northern hemisphere agriculture. Our carbohydrate base is almost all *Lolium*, maize is part of theirs. Sheep produce about half our meat, cattle about half theirs.

With this disparity in research inputs, our pastoral industry will fall further and further behind and agriculture's contribution to our economy will come increasingly from crops which can tap the world research output or from novelty production where we are best because we are first, as we are now with kiwifruit and deer farming. The situation will not be rectified by increasing spending on research in the plateau region of the research output curve. Marginal returns from such investments will be small. It is often argued that an annual increase of 1% in sheep production is worth a good deal in overseas earnings, whereas 100% increase in vegetable exports is still very little. But project the same growth rates to 1990 and the picture changes.

So far we have not evolved research institutions adapted to introducing complete novelty in agriculture, nor political or financial structures to support them. We should be bending our minds to this end. We should be working to draw more from the mainstream of world science by encouraging international co-operation in research. We have relatively little to offer and a large amount to gain from world research. Only we will lose from isolationist policies, be it with kiwifruit or white clover breeding, hop production or possum farming.

REFERENCES

Copp, L.G.L. 1959. Aotea wheat. *N.Z. Wheat Review*: 75-78.

Copp, L.G.L. 1964. Survey of wheat growing districts 1962 and 1963. *N.Z. Wheat Review 9*: 125-132.

Copp, L.G.L., Cawley, R.W. 1974. Kopara 73 — an improved line of Kopara. *N.Z. Wheat Review 12*: 35-37.

Department of Statistics, 1979. Dominion area and yield 1975-78. *N.Z. Wheat Review 14*: 53-57.

Frost, A.A. 1977. 1977 hop research report. DSIR Riwaka Research Station.

Hall, A.D., Lancaster, I.M. 1979. Yield decline in Aotea. *N.Z. Wheat Review 14*: 108-109.

Hall, A.D., Stevenson, E. 1977. Suitability of breeders plots and a small harvester for evaluation of spring barley. *N.Z. Journal of Agricultural Research 21*: 267-269.

N.Z.E.R.D.C. 1980. The potential of energy farming for transport fuels in New Zealand. N.Z. E.R.D.C. Report No 46.

Hill, T., Goodchild, N.A. 1981. Analysing environments for plant breeding purposes as examplified by multivariate analyses of long term wheat yields. *Theor. Appl. Genet. 59:* 317-325.

Kimber, D., McCullagh, S. 1979. Trials of commerical varieties of sugar beet. *British Sugar Beet Review 48. (1):* 44-46.

Lammerink, J. 1970. Interspecific transfer of clubroot resistance from *Brassica campestris* L. to *B. napus* L. *N.Z. Journal of Agricultural Research 13:* 105-110.

McEwan, J.M., Vizer, K.J., Douglas, J.A. 1972. Karamu a new spring wheat. *N.Z. Journal of Agriculture 125 (4):* 50-51.

Ojala, E.M. 1980. "New Zealand in the future world food economy" Commission for the Future, Wellington.

Ovenden, G.E. 1981. Evaluation of pathogen tested potato seed in New Zealand. *Proceedings Agronomy Society of N.Z. 11.*

Thomson, M. 1980. Sugar beet yield trends 1936-1980. *Arable Farming.* February: 22.

Wright, G.M. 1977. New Zealand-bred malting barleys for Canterbury. *N.Z. Farmer,* 11 August: 59.

Wright G.M. 1980. New cultivars and their contribution to maximum wheat production. *Proceedings Lincoln College Farmers Conference:* 196-202.