ECONOMICS OF FERTILIZER USE — MYTHS AND FACTS

M P W FARINA, Summer Grain Subcentre, Cedara

Introduction

For the purposes of this discussion I have defined a myth as "unfounded popular opinion". Based on such a definition, I suspect that many of you here today might acknowledge that fertilizer use has long been steeped in mythology. With so many unknowns being still involved in fertilizer recommendations, this is perhaps hardly surprising. More recently, the rationale of fertilizer use has become considerably more confused by major conceptual differences which have arisen regarding the economics of crop production under conditions of low crop prices, surpluses and farmer indebtedness. Many farmers, and perhaps even advisers, are more uncertain today about fertilizer use than they have ever been and years of accumulated research data are often totally ignored. Both in this country and elsewhere a call has gone out to farmers to extensify or go under. Not to diversify - that is something completely different - but to cut inputs in order to reduce losses in bad years and, by implication, to increase long-term viability. Since fertilizer is the only input cost farmers can significantly manipulate, this translates into a call for reduced fertilizer use and you are better aware than I am of the astonishingly low levels of fertilizer many farmers are currently being persuaded to use.

While I cannot speak with any authority as far as crops other than maize are concerned or with regard to the major maize producing areas of the country, such a doctrine makes very little economic sense in Natal. It may well reduce risk - so, too, would a complete cessation of farming activities - but I would regard **intensification** rather than **extensification** as being the surest way out of the difficulties many farmers currently find themselves in. It is my intention today to critically examine minimum input agriculture (extensification) as far as maize production in Natal is concerned. Quite obviously, the arguments put forward will be equally applicable to other areas of the country, which are climatically similar to the maize producing areas of Natal. There are, I suspect, more such areas than is generally acknowledged. Some of the points I will make are fundamental in nature and have universal relevance.

Reasons for extensification

Although the rationale behind minimum input agriculture has, to the best of my knowledge, never been clearly enunciated formerly, the following viewpoints appear to underlie such an approach:

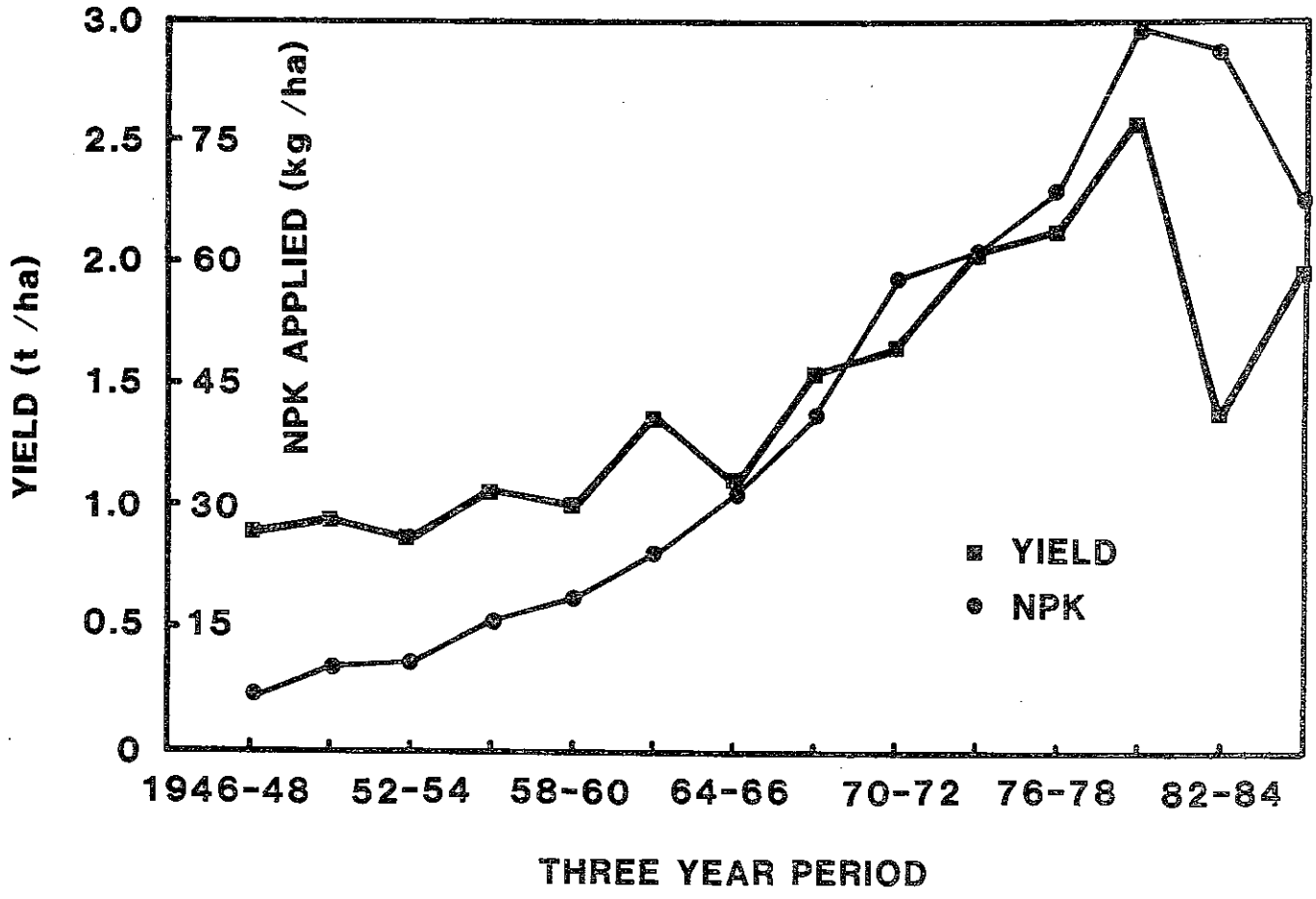

FIG. 1. Long-term maize production and NPK-use trends in South Africa.

1. National maize production increases have not matched the marked increases in fertilizer use, which have occurred over the past four decades or so. This is seen as clear evidence that maize farmers have been using needlessly high fertilizer inputs.
2. Farmers and their advisers have aimed for yield which are too high. Not from a managerial point of view, but as far as estimated climatic and soil potentials are concerned. Fertilizer use has, therefore, been too high.
3. In times of surplus and low crop prices lower yields are acceptable, particularly as bumper yields will depress prices still further.
4. Soil fertility build-up is unnecessary and results in excessive fertilizer use. The crop, rather than the soil, should be fertilized.

If these viewpoints are valid, there is some justification for the call to reduce inputs. But are they valid? Are they supportable by the facts at our disposal or are they tainted with mythology? Let us now take a critical look at these claims.

Production has not matched increased NPK use:

Long-term national maize production and fertilizer-use data are shown in Fig. 1. Contrary to the opinion expressed by proponents of extensification, there is a strong, highly significant positive relationship between yield and NPK-use (Fig. 2), 59% of the observed yield variation being ascribable to NPK-input. In view of the tremendous number of uncontrolled variables involved, the strength of this relationship is really rather surprising and I think that we can quite safely say that claims that no relationship exists are absurd.

Evidence that a strong relationship exists does, of course, not prove that it paid to use more fertilizer. Fingers have, for example, been pointed at the Natal 10 Ton Maize Club in this regard. The claim is made that the club is driving farmers to the wall economically and that high yields are only being obtained at considerable financial cost. On a national scale, the same finger has been pointed at your industry. We need, then, to attempt some crude economic analysis of the data presented in Fig. 1. This must necessarily be crude as a good many assumptions need to be made.

However, if we assume that all inputs other than fertilizer have remained the same since 1946 (that herbicide costs, for example, have matched reduced tillage costs), we value maize at a fixed price of R235 per ton, cost N, P and K at 1987/88 prices (N = R1,32/kg, P = R3,60/kg and K = R0,93/kg) and assume an average N:P:K utilization ratio of 5,2:1,6:1 (the 1987/88 average for Western Transvaal, North Western O.F.S., Eastern Transvaal and Northern Natal), we are able to measure the approximate return (positive or negative) from NPK-use. This is depicted graphically in Fig. 3. A net loss is shown in the dry 1982-1984 period, but an extremely

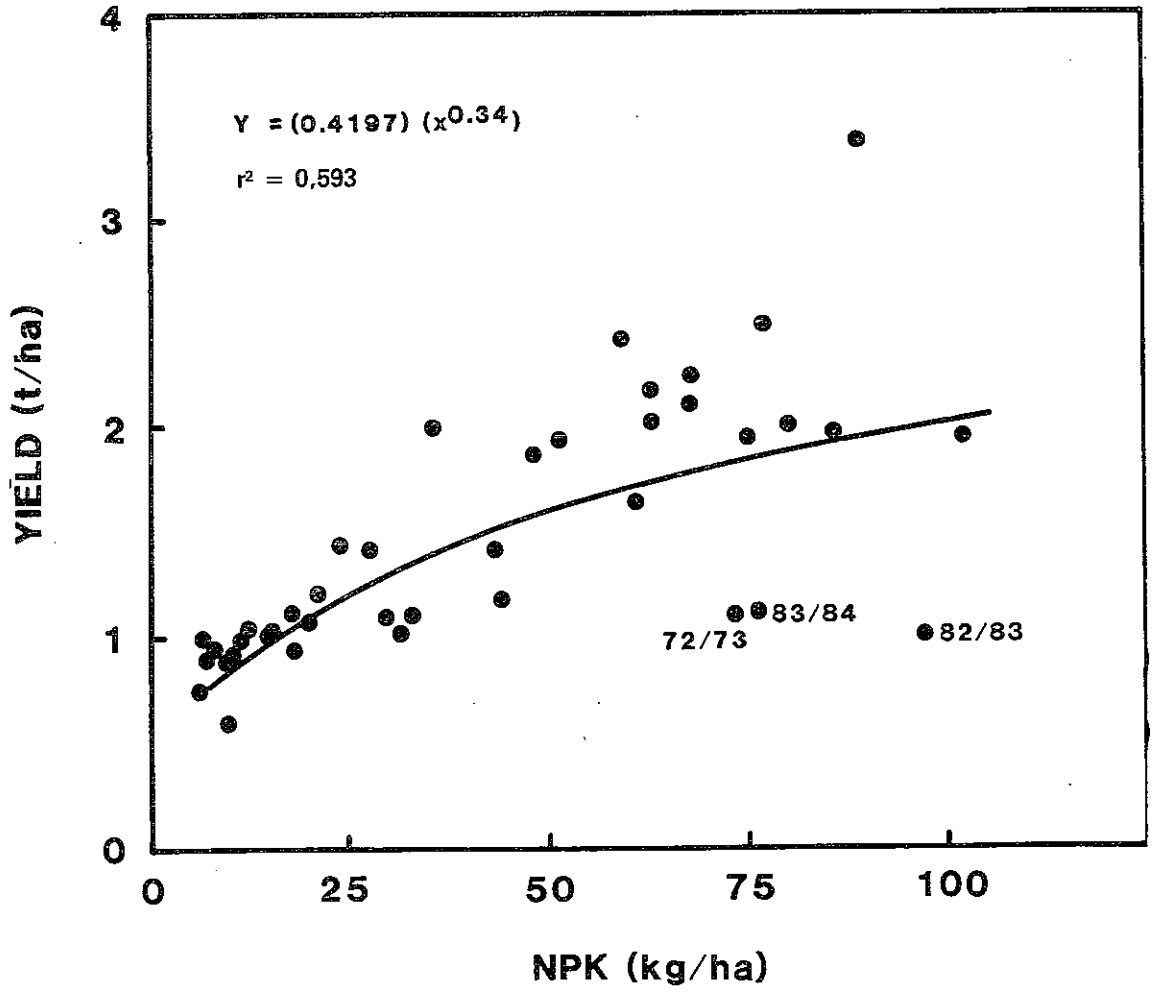

FIG. 2. The relationship between national maize yields and NPK-use for the period 1946-1987.

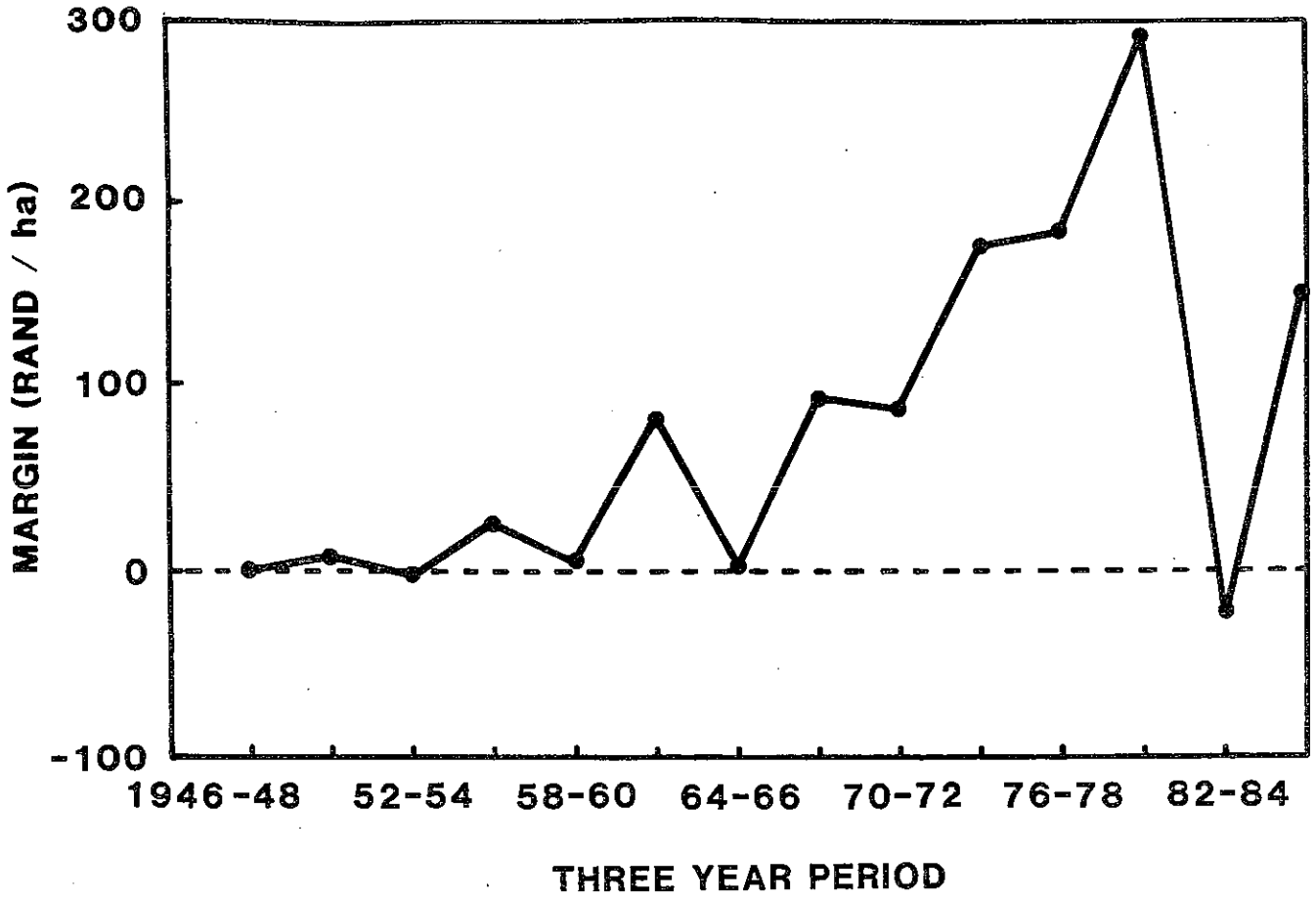

FIG. 3. Margin above fertilizer costs using 1987/88 costs and prices.

favourable effect of fertilizer is clearly evident overall. Since the droughts of 1982/83 and 1983/84 were among the worst ever recorded in the major production areas and the losses incurred during that period were very small compared to the economic benefits in other years, I doubt that any end-user of fertilizer would choose to return to the levels of NPK-use employed in the 1950's and 1960's. There is no evidence to suggest that fertilizer use has been excessive on a national scale and, in fact, a rather strong contrary argument could be made.

I would like now to move to Natal, an area with which I am far more familiar and for which I have a reasonable quantity of data with which to support my viewpoints.

Farmers and their advisers have aimed too high:

It is often claimed that the yield potentials estimated and targeted for by farmers and their advisers are unrealistically high and that too much fertilizer is consequently being used. Your industry is accused of having pushed fertilizer use regardless of the economic consequences. This may well be true in some localities and as far as individual farmer managerial ability is concerned, but all the experimental evidence at our disposal, the results achieved by top farmers, and seven seasons of Natal 10 Ton Maize Club data indicate that the average yields obtained in Natal (optimistically in the vicinity of 3 t/ha) are far lower than those actually obtainable. Yield data from long-term fertilizer trials at Bergville, Winterton, Dundee, Greytown, Normandien, Geluksburg and Cedara indicate that sustainable maize yields in most maize growing areas of Natal are in excess of 6 t/h. Natal 10 Ton Maize Club data collected over the past seven seasons (Fig. 4), two of which were the poorest recorded in over 25 years (Natal suffered severe drought during 1981/82 and 1982/83, but not during 1983/84), strongly suggest that these experimental yields are well within the reach of farmers. Out of a total of 231 participants, some 37 actually obtained dryland yields in excess of 8 t/ha on fields of 10 to 30 hectares in extent and one farmer near Vryheid has averaged more than 8 t/ha over the five seasons during which he has participated. Over 54% of the dryland participants have achieved yields in excess of 6 t/ha and some 41% have cracked the 7 t/ha barrier. We can, thus, quite safely say that as far as soil and climatic potentials are concerned, farmers in most parts of Natal are certainly not aiming too high if they target yields of 6-7 t/ha. I suspect that the same applies to some other areas of the country. Do we have enough long-term trials throughout the country to make valid conclusions about what is or is not obtainable if inputs are optimized?

Let us now examine the economics of high yields, not based on experiments, but on the real world of the Natal 10 Ton Maize Club. To do this I have compared the gross margins realised by the club participants with a group of Mail-in Record farmers (see yields in Fig. 4) from bioclimatic groups 6 and 8, two of Natal's best maize growing areas. Since the average area of maize produced by these farmers (100 ha) was larger than the 10-30 ha entered by 10 Ton Club participants, it could

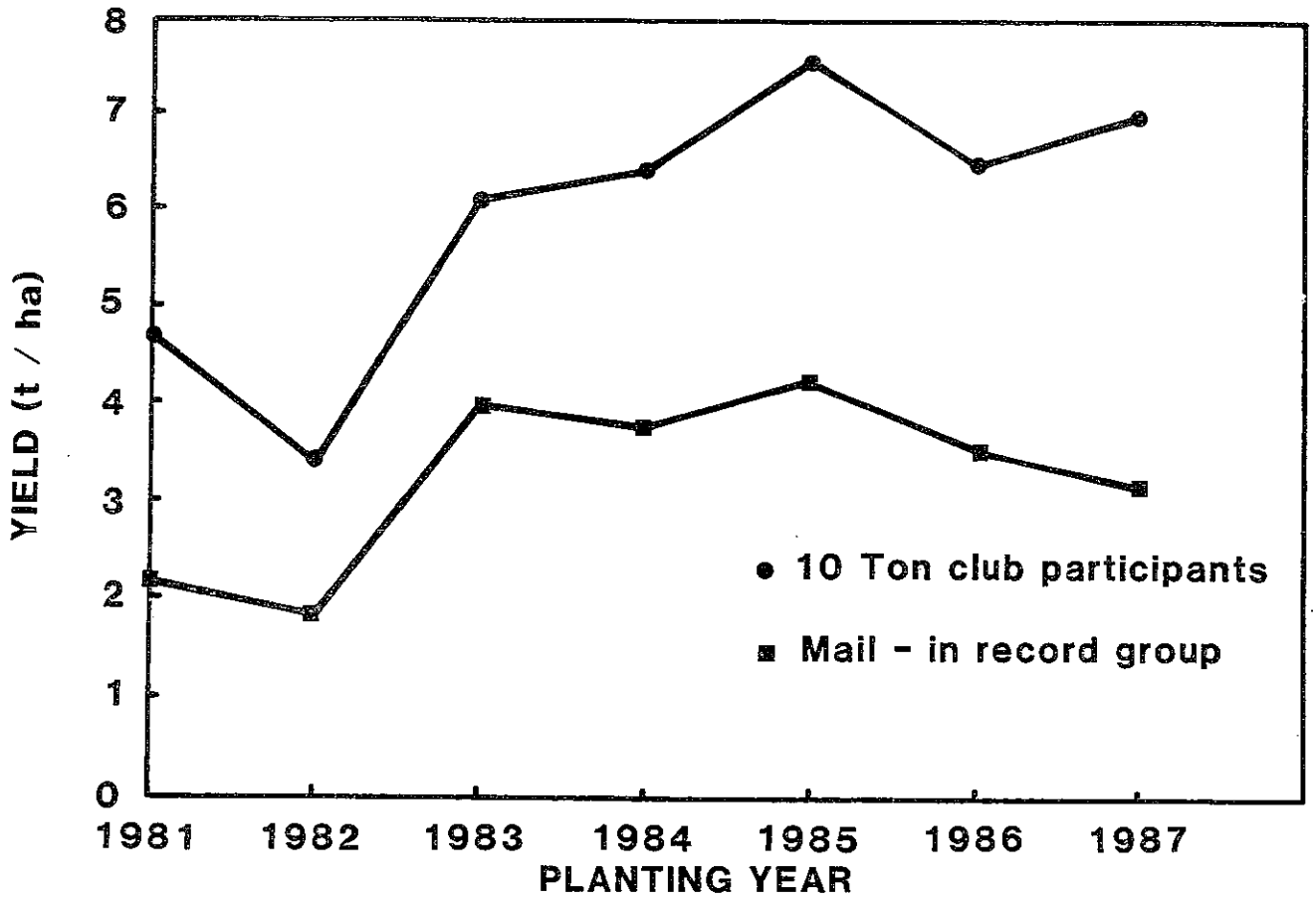

FIG. 4. Maize yields obtained by "intensive" and "extensive" groups of farmers over a seven year period.

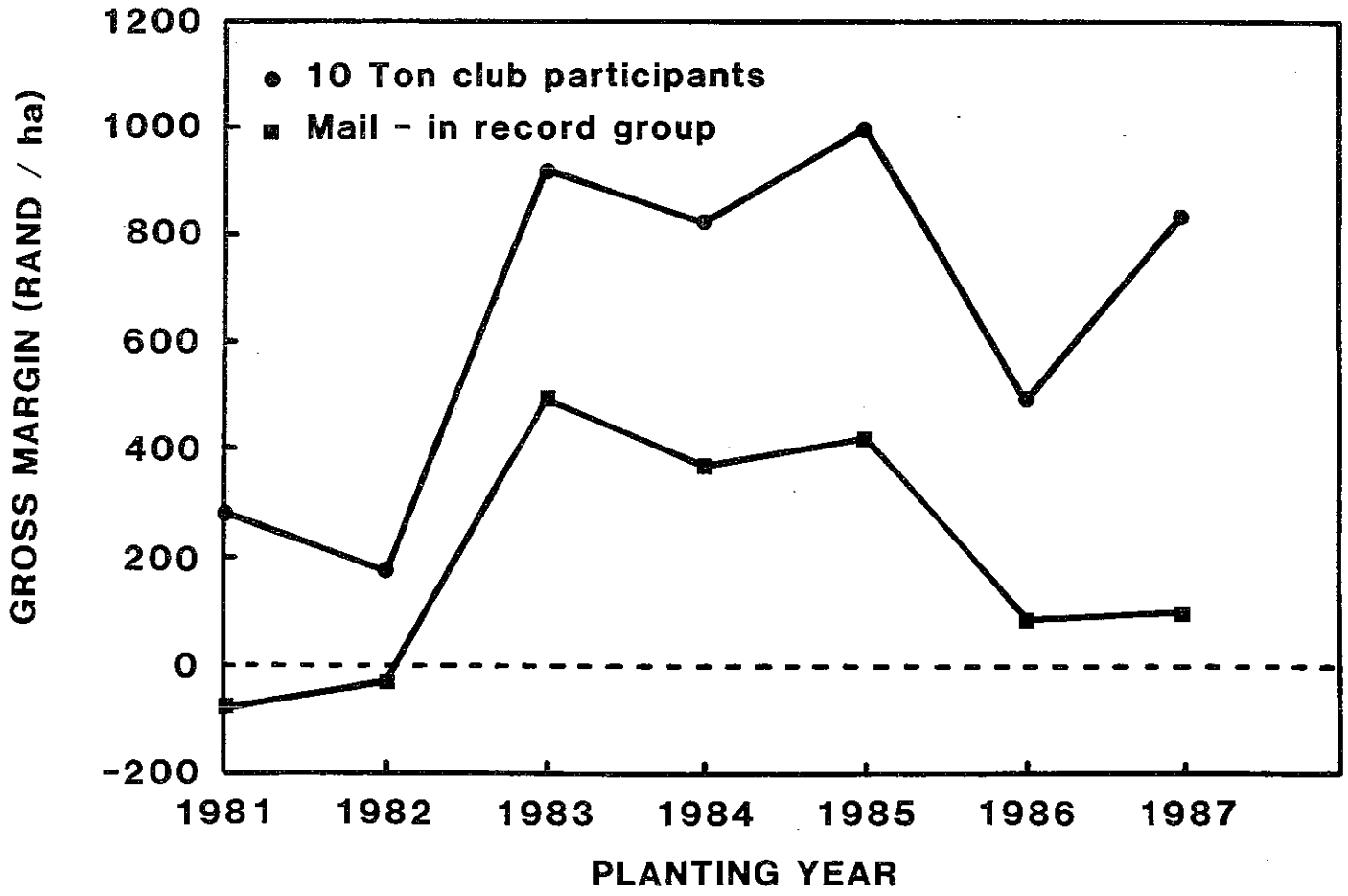

FIG. 5. Gross margins realised by "intensive" and "extensive" maize farmers over a seven year period

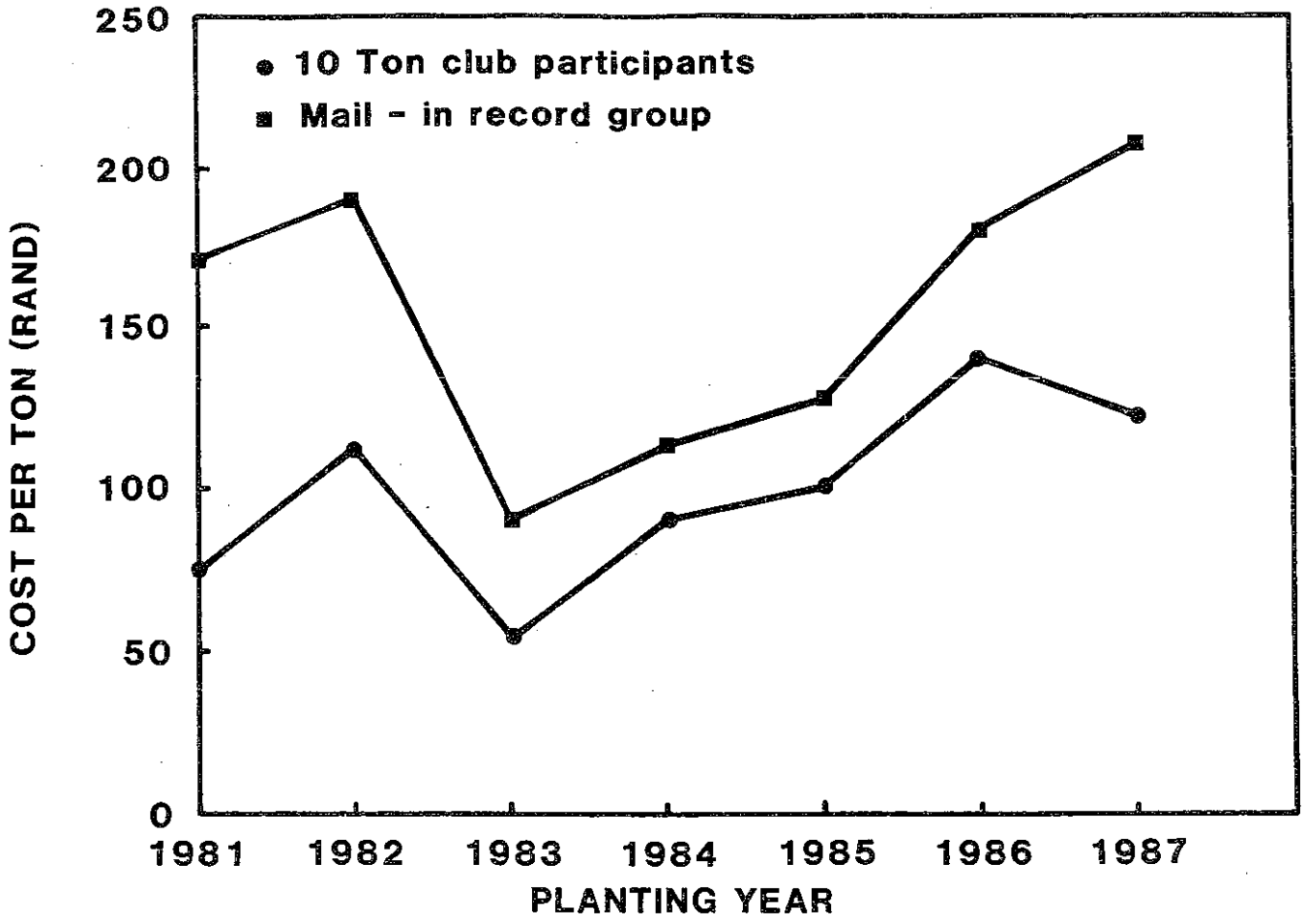

FIG. 6. Per ton production costs of "intensive" and "extensive" maize farmers over a seven year period.

be argued that the comparison is not entirely fair. However, strictly comparable data are not available and there is really little reason why yields obtainable on 10 ha should not also be obtained on 100 ha. A comparison of commercial plantings with experimental plots is certainly less valid.

Apart from NPK-use, production inputs for the two groups of farmers were virtually identical. The 10 Ton Club participants, however, used an average of 230 kg NPK per hectare versus 144 kg by the Mail-in Record group. Hence the use of the terms "intensive" and "extensive" in Figs. 4, 5 and 6. The higher quantity seems perhaps to be extraordinarily high to some of you, but is actually appreciably lower than the average figure of 265 kg used by American maize producers in 1983. A comparison of the average gross margins is presented in Fig. 5 and is actually quite startling. Over the 7-year period we are looking at an average gross margin difference due very largely to better fertilization of over R450 per hectare. Even after allowing for possible disparities introduced by the scale of operation, this is strong evidence to support the economic benefits of high yields. Certainly, many Natal farmers are not aiming too high and fertilizing too heavily if they target yields of 6-7 t/ha rather than the 3-4 t/ha generally considered to be more realistic. It is particularly interesting to note that the 10 Ton Club farmers maintained profitability in the two drought years, whereas the lower producing Mail-in Record group lost money.

In times of surplus and low crop prices low yields are acceptable:

This viewpoint is patently unfounded (a myth) and requires very little discussion on my part. Farmers who survive will be those producing at the lowest unit production cost. Those that are most competitive in the market place. In the example just discussed, for example, we have the Mail-in Record group producing at a cost per ton very much higher than the 10 Ton Club participants (Fig. 6).

It is particularly significant that in spite of yields almost certainly equal to or better than the Natal average during 1986/87 and 1987/88, per ton costs rose dangerously close to the break-even point. Should the cost/price squeeze continue, the Mail-in Record group is likely to experience real financial difficulties unless yields are improved. I would suspect that a great many farmers in the eastern, high potential areas of the country are currently in a similar, if not worse, situation as Natal is the only maize producing area of the country in which fertilizer use has not dropped drastically over the last decade. Total production costs are a lot lower in the drier, western parts of the country, but machinery costs - those input costs escalating most rapidly - are similar in all areas and it seems reasonable to assume that here, too, significant yield increases are urgently needed if profitability is to be maintained.

The crop and not the soil should be fertilized:

Proponents of extensification maintain that soil fertility build-up is not necessary. It is widely believed that the immobile nutrients (P and K) can, like N, be applied in accordance with anticipated crop needs. The term "build-up" is actually seen by many, both farmers and some advisers, to be a rather cunning invention of the fertilizer industry. Nothing could be further from the truth and if it were not for the build-up that occurred in the good, "free-spending" years, I have no doubt that agriculture would have found itself even worse off today than it is.

For reasons which I am unable to explain, little cognizance is generally given to the fact that optimum crop growth demands specific soil levels of P, K and acidity. These parameters are related to percent yield and not absolute yield and a specific soil level will subtend a similar percentage of the maximum obtainable yield over a wide yield range. Be the seasonal maximum 3 t/ha or 6 t/ha, the same soil level of P, K or acidity will be required. This is clearly illustrated in the examples shown for P, K and acidity in a selection of Natal trials (Figs. 7, 8 and 9).

This means that we cannot fertilize for a specific yield. All we can do is to fertilize for a certain percentage of the maximum to be determined by season. The implications of this are rather obvious. If we want to break into higher sustainable profits, we have to bring the soil to a state which will enable us to capitalize on the season and, by so doing, ensure optimum yields each and every year. Since P and K cannot be topdressed like N, adequate levels have to be established prior to or at planting. Soil testing and the concept of build-up are, thus, key components of profitable crop production. Claims to the contrary are not only unfounded, but are, in my opinion, dangerously misleading. It should also be remembered that responses of the nature shown (Figs. 7, 8 and 9) mean that under-fertilization is far more costly in terms of lost income than equivalent over-fertilization.

We have, thus, a survival strategy (extensification) based on a number of misconceptions (myths). I have no doubt that if such an approach were to be adopted in Natal, farmer indebtedness would increase rather than decrease. As it is, 20% of the soils planted to maize urgently need lime, some 40% are deficient in K (20% very seriously so) and the overwhelming majority are deficient in P.

Conclusions

From what has already been said, it should be clear that we need to intensify rather than extensify. We need to increase productivity (on smaller areas if necessary) under advanced and intensive management. To put together production packages based on all available technical information, which will ensure that unit production costs are minimized. We need to know what the true soil and climatic potentials in specific areas are and what inputs are required to realise maximum profits over the long-term. If minimum input agriculture is seen in this light - using the minimum inputs required to realise maximum profits - it makes good sense. It is quite non-sensical, however, to reduce inputs at the cost of potential profits.

Finally, at the risk of appearing flippant, I would like to leave you with two quotes, one from a paper presented

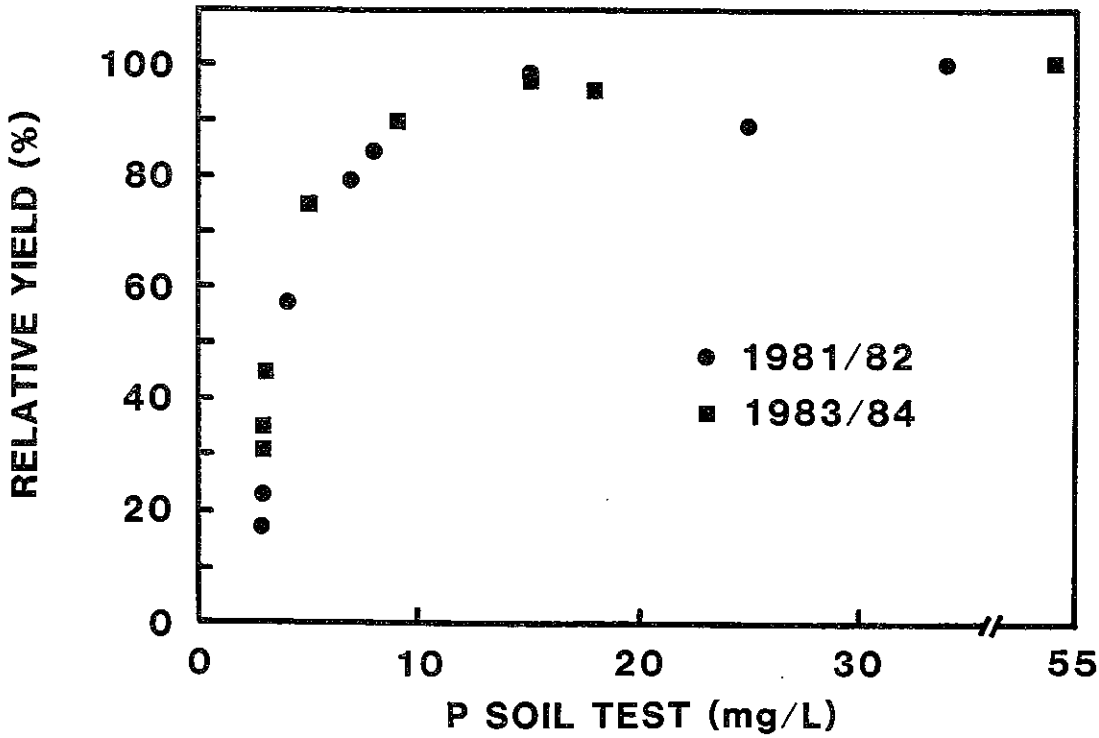

FIG. 7. Yield effects on optimum P soil test levels on a Normandien clay loam. (Maximum yields were 3,0 t/ha in 1981/82 and 6,7 t/ha in 1983/84.

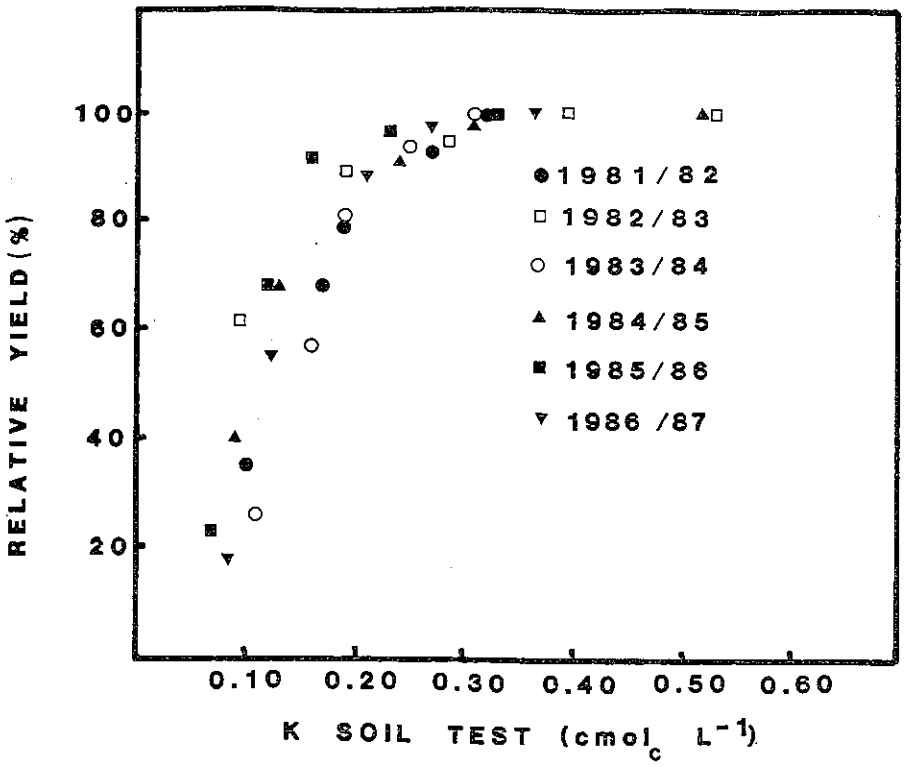

FIG. 8. Yield effects on optimum K soil test levels on a Metz silty clay. (Maximum grain yields varied from 5,8 t/ha in 1984/85 to 8,2 t/ha in 1983/84. In the 1982/83 drought only stover yields were measureable).

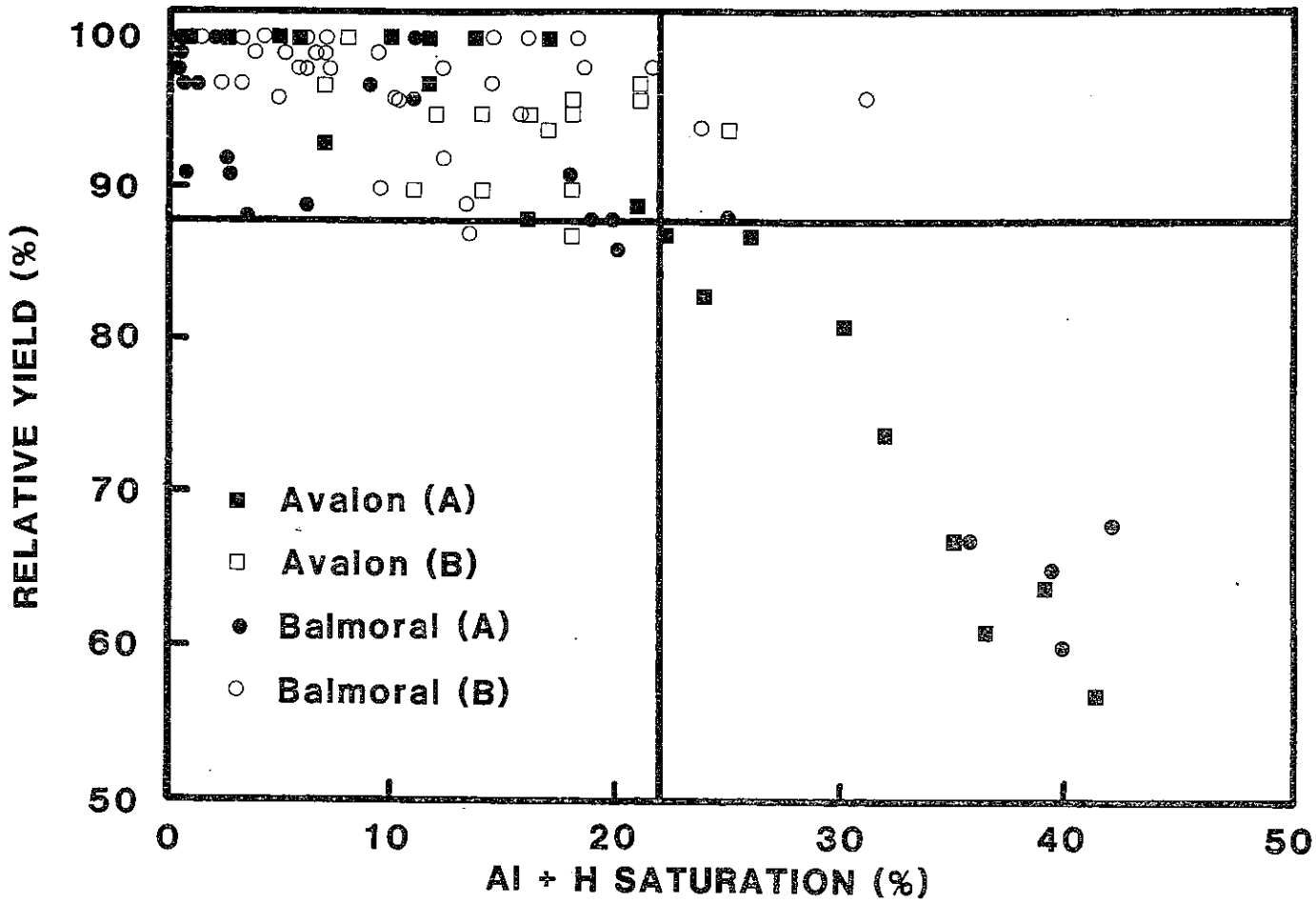

FIG. 9. Yield effects on optimum A1 + H saturation levels on Balmoral clay and Avalon sandy loam soilsover 22 site years. (Maximum yields varied from 4,1-8,1; 6,1-9,8; 4,2-7,2 and 4,6-8,2 t/ha on the Avalon (A), Avalon (B), Balmoral (A) and Balmoral (B) trials. respectively).

by Dr Robert Wagner at the American Society of Agronomy Annual Meeting in 1987 and the other from a book written almost 2 000 years earlier by the Roman Junius Columella.

Wagner, while addressing the problem of the cost/price squeeze, stated that "Low yields become less and less an economic alternative. Those who plant for high yields might not get them every year. But those who fertilize and otherwise manage for low yields are sure to get them".

Columella wrote that "Soils are not ageing if they are fertilized" and "Higher yields can be obtained by frequent, timely and adequate fertilization".

If "low" and "high" are seen as relative terms, both are extremely apt descriptions of the viewpoints I have expressed today. While Wagner's views could, I suppose, possibly be construed as a pitch for your industry, Columella must surely be considered to have been unbiased.

Acknowledgements

I would like to thank Hilmar Venter and John Ranwell for providing much of the yield and fertilizer use data, Neil Whitehead for Mail-in Record data and the Natal 10 Ton Maize Club for permission to use long-term data acquired by the club. Guy Thibaud is thanked for his help in producing many of the figures.