Economic Analysis of Research Results: Part 2

Example of a Maize Nitrogen x Phosphorus Trial in Zimbabwe

MATARUKA D.F., MAKOMBE G. AND LOW A.

1. Introduction

Maize accounts for seventy per cent of Zimbabwe's cereal growing area. Its productivity, particularly in the communal areas, is limited by both soil and rainfall characteristics. Most soils in communal areas are coarse-textured sands derived from granite and are inherently deficient in nitrogen and phosphorus (Grant 1981 and Mashiringwani 1983). These soils also have a poor water retention capacity. The majority of these areas do not have irrigation facilities and are situated in marginal rainfall areas, making the application of large quantities of fertilizer risky and uneconomical.

A maize fertilizer x population on-farm trial conducted by Agronomy institute in 19 sites showed that applying more than fifty per cent of the recommended fertilizer, which in most cases was 350kg Compound Z/ha and 400kg AN/ha based on soil analysis was uneconomical (Whingwiri et al 1987, Mataruka et al 1987). However, maize response to nitrogen and phosphorus separately would not be assessed by using compound fertilizers. If economically optimum levels of both nitrogen and phosphorus have to be established, straight fertilizers should be used. The second part of this paper discusses results from two seasons of a Maize Nitrogen x Phosphorus on-farm trial currently being conducted by the Agronomy Institute.

2. Trial Description

The trial was conducted at eight sites in natural regions II, III and IV during 1986/87, a poor rainfall season, and 1987/88 which had relatively good rains. Four of the sites during 1986/87 were written off due to drought. Total rainfall received from planting to harvest, one week before and two weeks after topdressing are shown in Figures 1 and 2. The average soil pH, nitrogen after incubation and P2O5 status of the sites are given in Table 1.

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FIGURE 1 Rainfall by Site (mm)

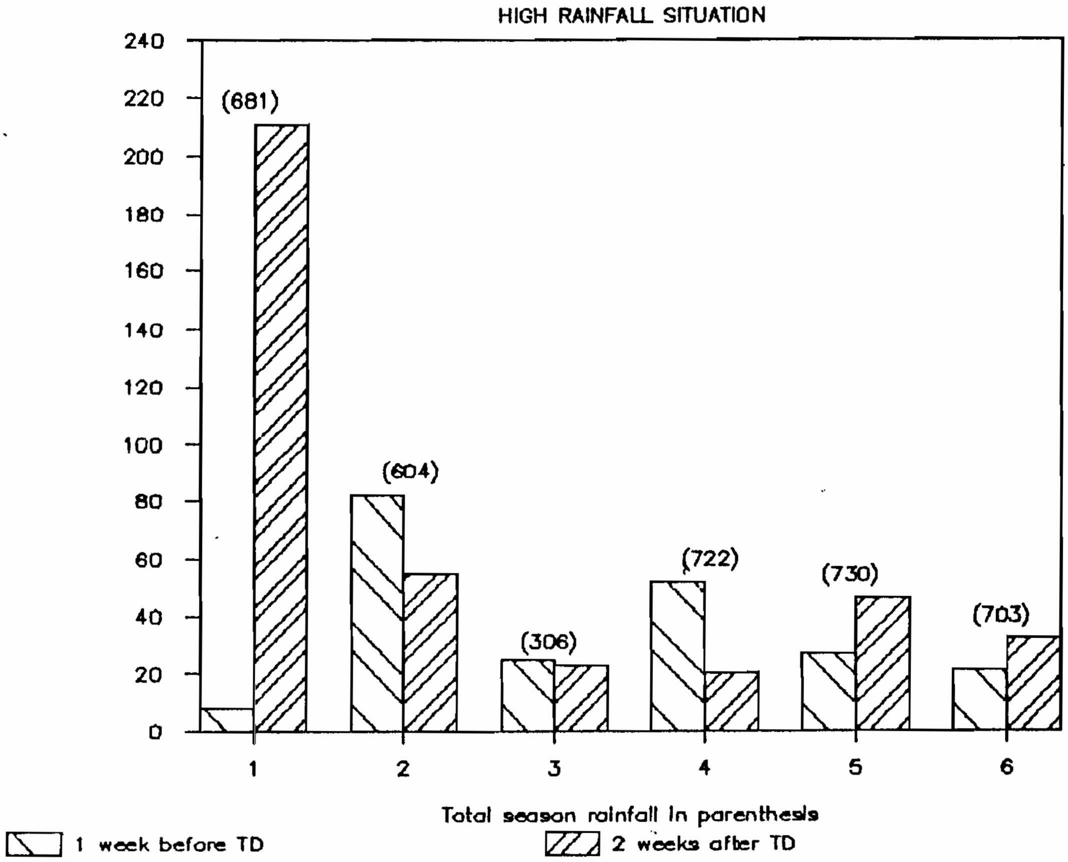

FIGURE 2 Rainfall by Site (mm)

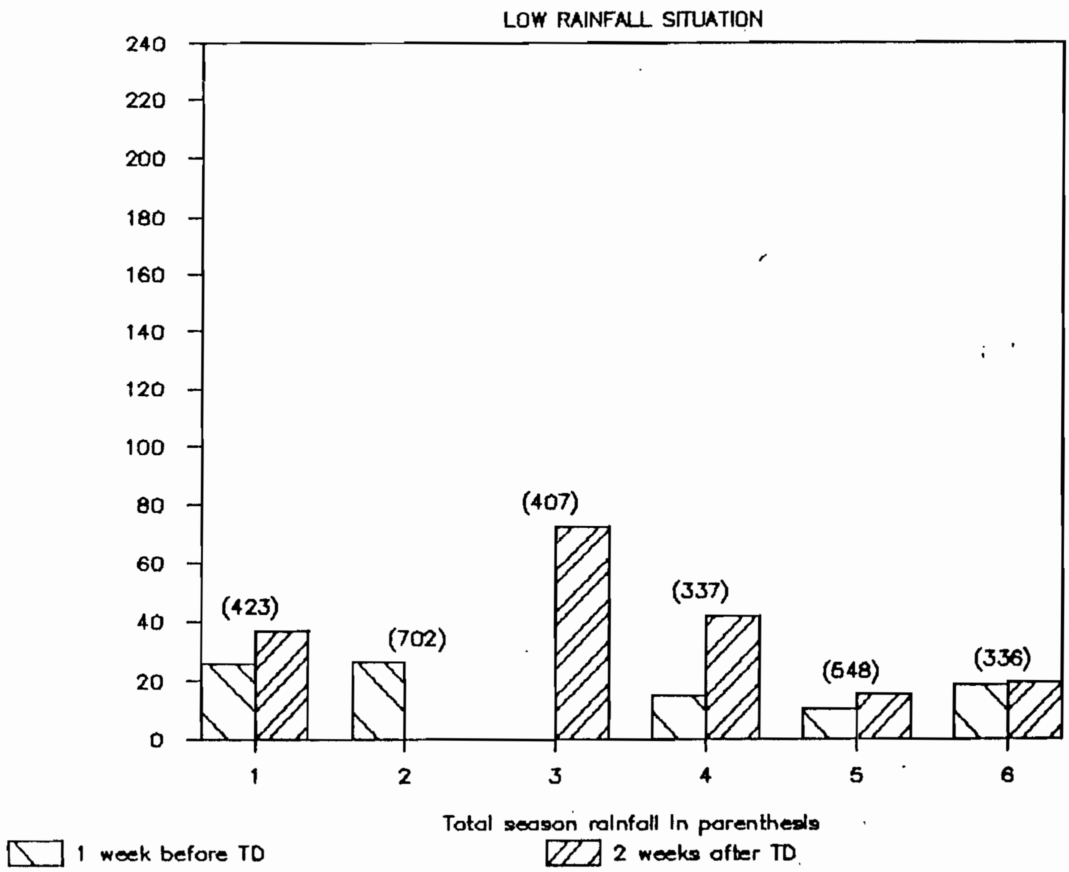

Table 1

Soil Nutrient Status

	1986/87			1987/88		
	Resin P_2O_5 (ppm)	N after incubtn (ppm)	pH $CaCl_2$	Resin P_2O_5 (ppm)	N after incubtn (ppm)	pH $CaCl_2$
SITE						
Ntabazinduna *	40	41	6.1	19	44	5.6
Esigodini *	05	06	4.8	33	53	5.1
Mutoko	15	06	5.5	27	12	6.0
Chiwundura	12	20	4.7	21	21	6.7
Zvimba *	21	11	6.5	05	20	4.5
Zaka	30	41	5.7	30	41	5.7
Marange North	36	40	5.0	33	02	4.5
Rushinga *				09	08	6.9

* Sites written off due to drought in 1986/87

A maize cultivar R201 was planted at a spacing of 30 by 90 cm. The treatment and design of the trial are given on Table 2. A blanket application of 60 kg K2O per hectare was applied as murate of potash to all the plots at planting.

Table 2

Trial Design & Treatments

DESIGN: Factorial - Randomised Block - 3 Replicates

TREATMENTS:

		Basal	Top	Total
A	Nitrogen (kg/ha)	0	0	0
		30	0	30
		30	30	60
		30	60	90
		30	90	120

B	Phosphorous P_2O_5 as SSP at planting	
		0
		20
		40
		60

3. Results and Discussion

In 1986/87 a dry season, only four sites could be analysed while all the eight sites were analysed in 1987/88. In the latter season, the distribution of rain was favourable except at two sites.

From the statistical analysis, differential responses were apparent for different sites. Where the rainfall was high and well distributed particulary during the period around topdressing there was response to topdressing. Where the distribution was poor (figures 1 and 2), there was little response. The sites were then grouped into two categories, high and low rainfall domains, depending on rainfall received around topdressing. Subsequent analysis is based on the resulting grouping of 6 sites into the high rainfall situation and 6 into the low rainfall situation. The high rainfall sites can be taken to be representative of the levels and distribution of rainfall that farmers in regions II and III might expect in the majority of seasons. The low rainfall sites will be more representative of what farmers in region IV might expect most years.

Figure 3

MAIZE NITROGEN RESPONSE

BY RAINFALL SITUATION

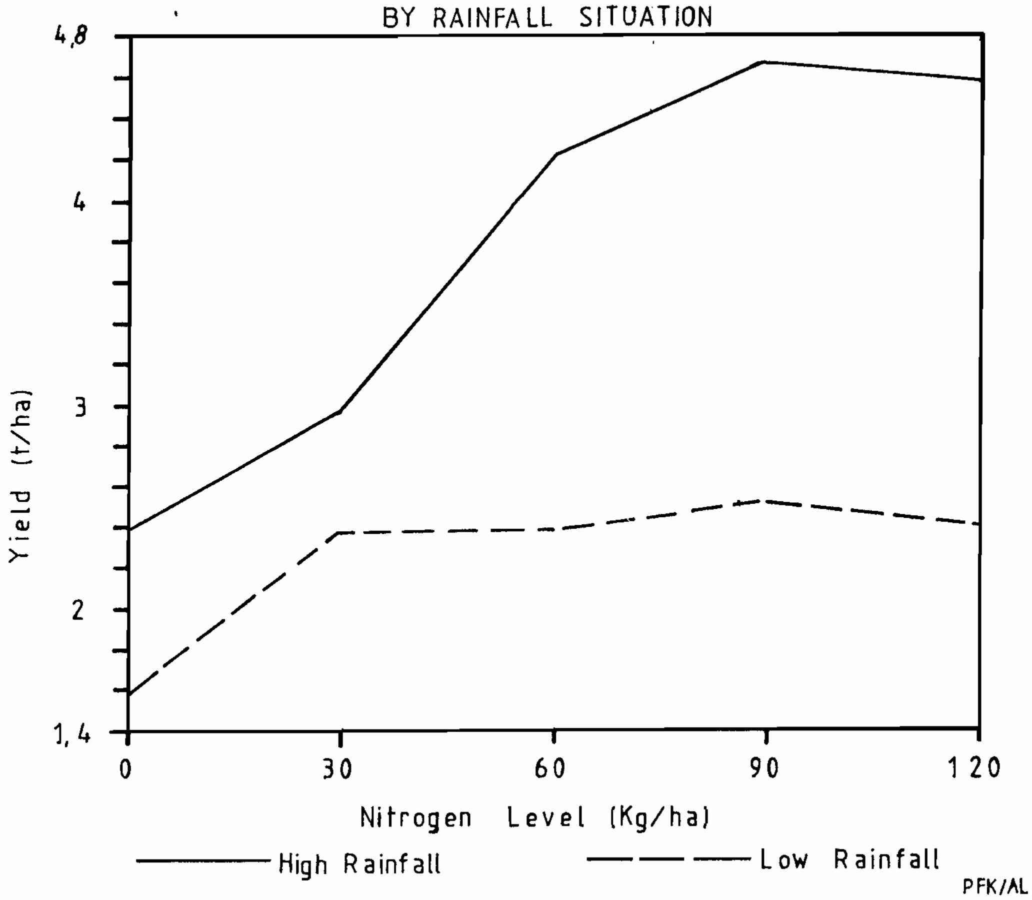

Figure 4

MAIZE PHOSPHORUS RESPONSE

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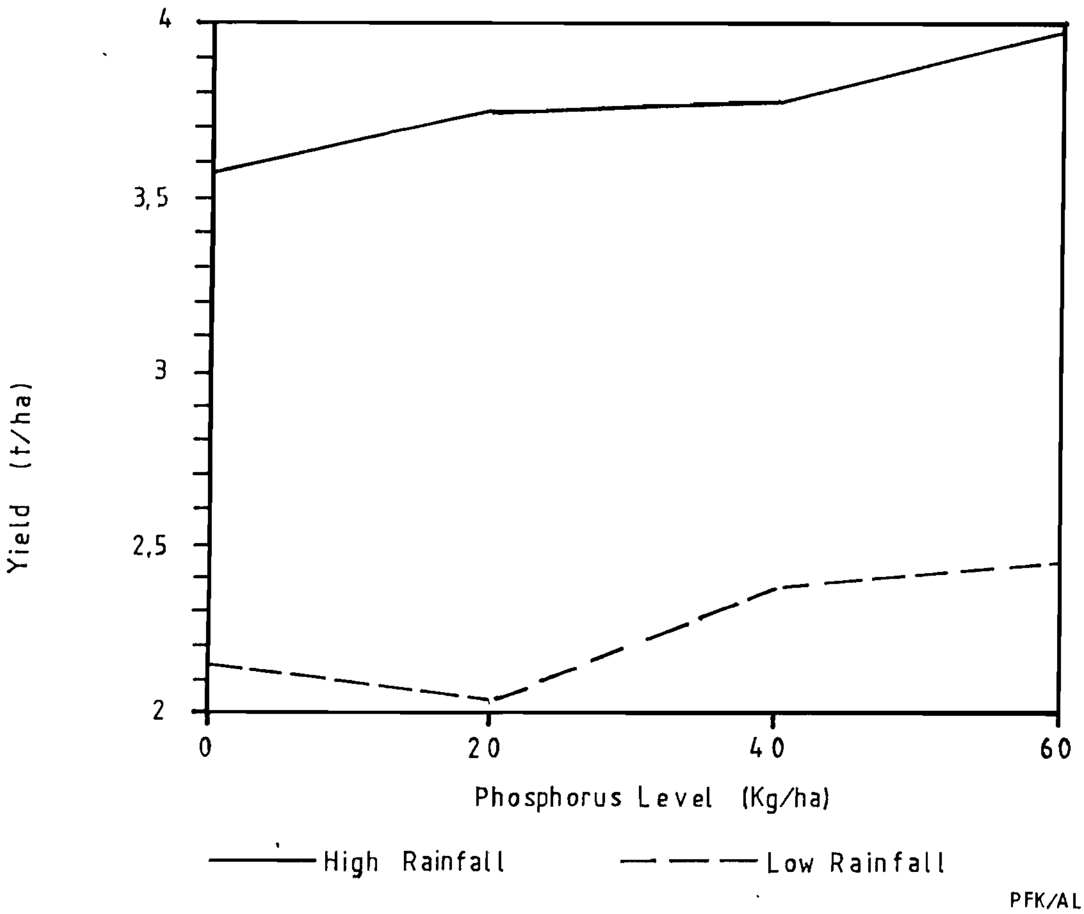


In both the low and high rainfall environments, there was a positive response to 30kg N/ha applied as basal-dressing. Further increase in applied nitrogen upto 90kg/ha (topdressing up to 60kg N/ha) significantly increased grain yield in the higher rainfall grouping. No advantage beyond the basal application was achieved in the drier areas (Fig 3). From figures 1 and 2, it would appear responses to topdressing were influenced by the total rainfall received from planting to harvest as well as the rainfall distribution just before and after topdressing.

The response to phosphorus was low in both environments (Fig 4). Under the present communal area production levels, a response to phosphorous where the P2O5 level is more than 18ppm is not expected. There was a significant increase in grain yield between 0 and 60kg P2O5 per hectare in the high rainfall area only, but this was not economic. The poor response to phosphorus was probably due to the generally high inherent phosphate levels in the soils were the sites were situated (Table 2).

No significant interactions between treatments were detected in the trial.

4. Economic Analysis

Figures 5 and 6 summarise the results of the economic analysis of the maize nitrogen by phosphorus trial data for the high and the low rainfall situations respectively. The analysis is presented for nitrogen only since P gave no technical and/or economic response in either situation site and there was no significant interation between N and P. In each figure two assumptions are made about the form in which the basal nitrogen is applied. The first assumption (basal N in the form of AN) reflects what happened in the trial. The second (basal N in the form of Compound D) reflects what farmers do and the current recommendations.

The data used to calculate these budgets is given below:

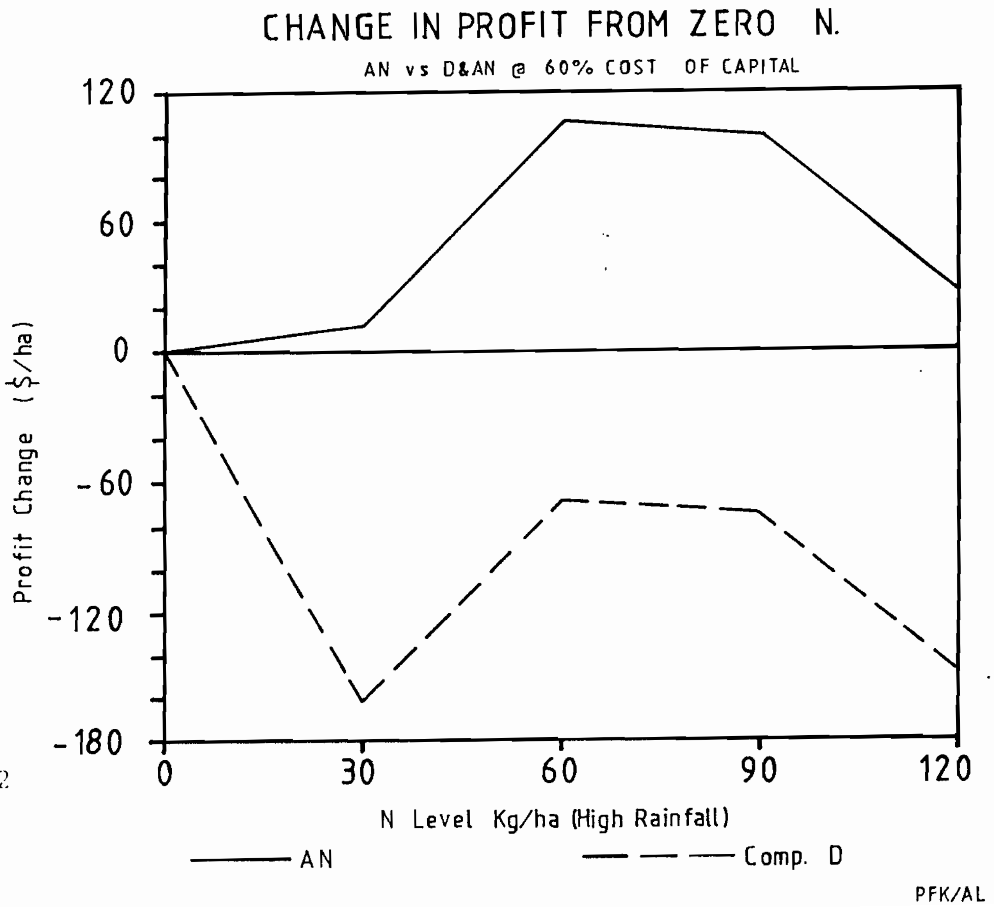
i)	Field price of maize	= Z$157.26
ii)	Field price of nitrogen from AN	= Z$1.26/kg
iii)	Field price of nitrogen from compound D	= Z$4.82/kg
iv)	Opportunity cost of labour	= Z$2.00/day
v)	Minimum acceptable rate of return	= 60%

A. High Rainfall situation (figure 5)

Figure 5 shows the profitability of using nitrogen on maize assuming that farmers require a rate of return of at least 60% on cash investment.

Figure 5

Economics of N in the High Rainfall Situation



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Under this situation, if 30kg of nitrogen are applied as a basal from AN and additional nitrogen levels are applied as a single application topdress, it is economic to apply nitrogen up to 60kg/ha or 174 kg/ha AN. Current recommendations are that farmers should apply 300kg/ha compound D and 200kg/ha AN, the equivalent of 93kg/ha nitrogen (Agritex) The economic level as indicated by this trial data is around 65% of current recommendations. But this holds only if AN is used as the nitrogen source for both initial and topdressing.

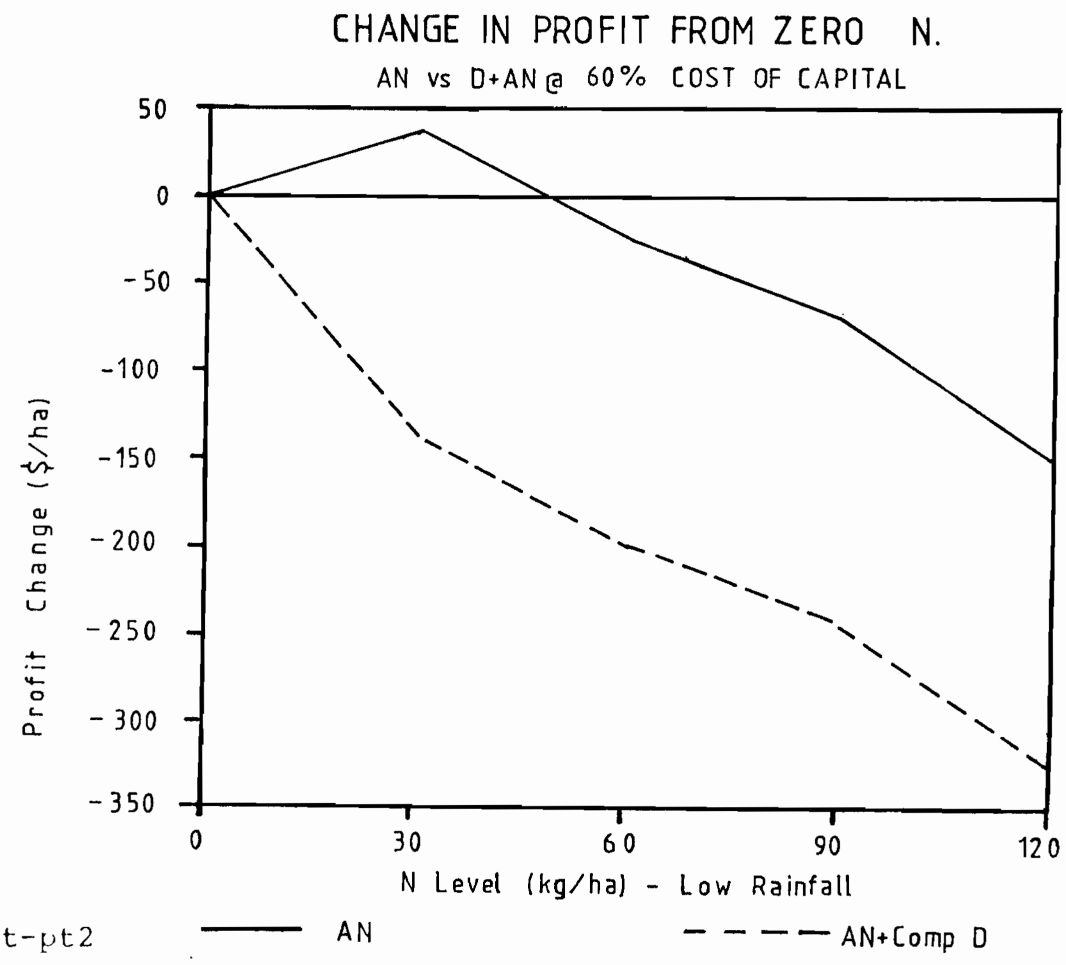
Figure 1 shows that applying nitrogen pre-emergence as compound D is not economic. The initial loss resulting from compound D even outweighs the benefits from the nitrogen subsequently applied as top dressing.

B. Low Rainfall situation (figure 6)

In the low rainfall situation, the same assumption is made about the minimum acceptable rate of return. However because of the risking nature of crop production in low rainfall areas, the required rate of return maybe higher than the 60% used in the budgets.

<u>Figure 6</u>

Economics of N in the Low Rainfall Situation



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In a low rainfall situation, if the source of nitrogen is AN, it is economic to apply 30kg nitrogen as a basal. Additional applications of nitrogen result in losses as shown in figure 6. The economic level of nitrogen (30kg/ha) is equivalent to 87kg/ha AN. Current recommendations are that farmers should apply 200kg/ha compound D and 100kg/ha AN, the equivalent of 51kg nitrogen (Agritex). The economic level as indicated in Fig. 6 is about 60% of the current recommendation. Figure 6 also shows that using compound D as as the basal N source, is considerably less attractive than using AN or not using fertiliser at all, assuming farmers requires a 60% return on thier cash outlay for fertiliser.

5. Discussion

In the high rainfall situations although there was agronomic response to 90kg N/ha, it was economic only up to 60kg kg N/ha, while in the low rainfall situation 30kg N/ha was both the agronomic and economic optimum. In soils with marginal to adequate phosphorus level it may also be uneconomical to apply phosphate fertilizer. Thus if profitability is the farmers only concern, it is not economic to apply compound D. This however may have serious consequences in the long term soil fertility status. A long term study designed specifically to look at phosphorus requirements for the crop may be worthwhile to ensure our soils are not mined.

Although this analysis cannot be used to give recommendations to farmers, it may be useful in modifying the experimental treatments. Since there were no interaction between nitrogen and phosphorus it seems justifiable to look at the efficeincy of the use of these two elements independently.

Low responses to P under researcher managed conditions will likely be reflected in even lower responses to P under farmer conditions. This is especially so because farmers generally apply their compound basal dressings POST emergence as opposed to PRE emergence as in most researcher managed trials. Recommendations to farmers to apply basal compounds pre or at planting have to do with the assumption of positive responses to P from these early applications. If these early applications do not give such responses and farmers do not apply basal dressings pre or at planting for valid reasons of risk, labour constraints or lack of response, the current recommendations should perhaps be reconsidered in relation to the most efficient methods of applying both P and initial N..

For sustainability reasons there may be a need to apply P, but this might be done more cheaply and conveniently at a time other than around planting, which is a labour pressure time for small farmers.

Given the increasing scarcity and expense of fertilisers, there is a need to investigate ways of improving the efficiency of their use. From these preliminary results there would seem to be some potential to substantially improve the economic efficiency of N application in maize on communal farms by:

a) reducing recommended application levels
b) changing the form of initial N application from compounds to AN

There is also a need to think in terms of different trial designs in respect of N depending on the rainfall characteristics of our different natural regions. In high rainfll areas work needs to be done on levels and timing of topdressing as well as the form of basal N applications. While in the low rainfall areas, the optimum timing, form and levels of initial nitrogen should be emphasised. In both areas the question of the best form, timing and levels of P application as a maintenance dressing needs investigation.

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