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Articles in the field of agricultural economics, suitable for publication in the journal, will be welcomed.

Articles should have a maximum length of 10 folio pages (including tables, graphs, etc.) typed in double spacing. Contributions, in the language preferred by the writer, should be submitted in triplicate to the Editor, c/o Department of Agricultural Economics and Marketing, Pretoria, and should reach him at least one month prior to date of publication.

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PRODUCTION COSTS OF CROPS IN THE NORTH-WESTERN FREE STATE AND THE FACTORS WHICH INFLUENCE THESE COSTS

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INTRODUCTION

This study is based on information obtained from the full maize production cost study undertaken in 1969/70 in the area concerned.

The big variation in the production cost per unit of crops between different farmers in a fairly homogeneous area is an indication that most farmers could still do a good deal to increase their profits. For example, the cost per R100 of crop production varied from R42 to an unbelievable R308 in this particular area.

Individual farmers have very little or no influence on the prices they receive for their crops. For this reason, the increase in the profitability of the crop enterprises will be determined mainly by the acceptance of techniques and practices which will lower the production costs and/or increase the yield.

There has been rapid technological development in recent times. So much so, that science has failed to

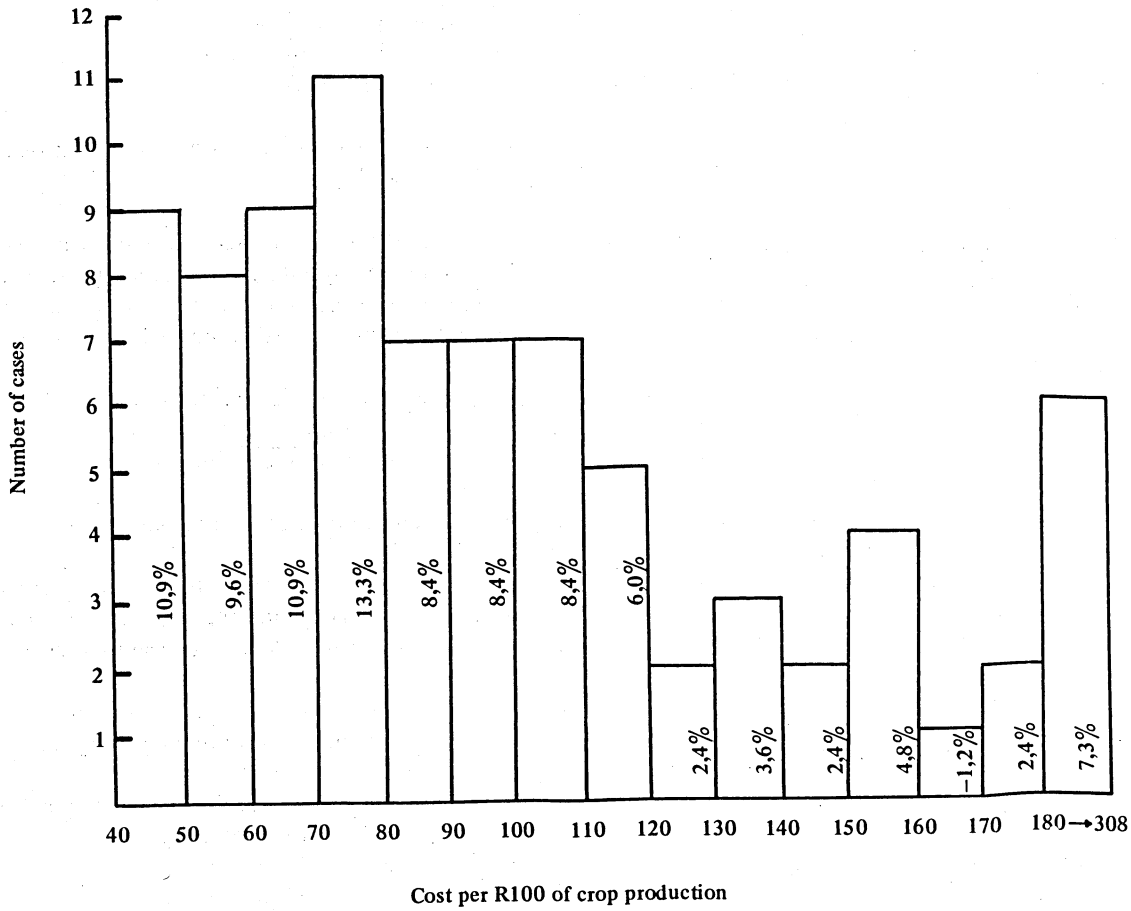

FIG. 1 – Variation in the cost per R100 of crop production : North-Western Free State : 1969/70

determine exactly the interaction between resource application, practices and production costs.

The purpose of this study is —

(1) to find explanations for the big variation in the production cost of crops; and

(2) to determine the relationship between production cost and (a) area under crops; (b) technical efficiency; (c) resource use; and (d) types of crops produced.

METHOD OF ANALYSIS

1. The determination of the gross production value

The yield is expressed as the value in rand of crops produced. Most of the farmers produce more than one crop, with the result that a problem of comparison arises. In order, therefore, to put the yields on a comparable basis, they were converted into monetary value. The farmer's estimates of the yields were accepted and were related to ruling market prices where possible, except in the cases of crops which are not marketable. These last were valued on the basis of their nutritional value.

2. The determination of the production cost

Land: Five per cent interest was calculated on the land value.

Labour: Labour costs include cash remuneration (wage and bonus) plus rations, housing and other benefits such as gleaning rights and grazing rights.

Fertiliser: The actual fertiliser costs were calculated by using the quantities given by each farmer. Where kraal manure was applied, it was included in the calcualtions.

Equipment: The total annual costs were taken, including depreciation, interest, fuel, repairs and insurance.

Other direct expenses: As the heading indicates, this item includes all other direct expenses obtained from the questionnaire. The abovementioned cost items cover the most important items. There are also sundry costs which are included in the total general farm costs, but which are not taken into account here.

3. Calculation of the technical efficiency index

The efficiency index is used as a yardstick to measure the farmer's ability to produce a certain yield with given resources.

A production function was estimated for the 1969/70 production year and the efficiency index was calculated by expressing the actual yield as a percentage of the estimated yield. The method of calculation of this index may be criticised for the following reasons: The resource determination may be incorrect; the regression fit may reflect bias in the index. Although it might be preferable to use a more independent yardstick, it does appear that this method is closely correlated with technical efficiency.

In the choice of the type of function consideration was given to both the quadratic and Cobb-Douglas type function because these two functions are apparently more suitable for estimating the production function. The choice fell to the latter because it is easier to calculate and handle and a function of $Y = aX_1^{b_1} X2^{b_2} \ldots\ldots\ldots X_n^{b_n}$ was used, where Y is the dependent variable — gross production value of crops — and the Xs the independent variables, or the factors which influence the productivity of crop production.

The model includes the following variables:

Y = gross production value of crops
X_1 = area under crops
X_2 = fertiliser costs
X_3 = investment in equipment
X_4 = other direct expenses
X_5 = land value per hectare
X_6 = labour costs.

These variables explain 93 per cent of the variation in Y.

The technical efficiency for each farm was then calculated by dividing the actual gross production value by the estimated gross production value and multiplying the answer obtained by 100.

$$\text{Technical efficiency index} = \frac{\text{Actual GPV} \times 100}{\text{Estimated GPV} \times 1}$$

4. Calculation of the cost function

For the calculation of the cost function the rectilinear type of regression function was used. The following variables were selected for the final cost function:

Y = cost per R100 of crop production
X_1 = investment in equipment per hectare
X_2 = labour costs per hectare
X_3 = seed, chemicals and other costs per hectare
X_4 = area planted to crops
X_5 = technical efficiency index
X_6 = percentage of row crops.

Although the "percentage of row crops" is not significant at the 0,05 level, it is nevertheless included in

order to determine the influence of this variable on the production cost.

RESULTS

The cost per R100 of crop production varies from R42 to R308 on farms included in the sample. The following factors explain 87 per cent of the variation in the average production cost of crops:

(1) Technical efficiency
(2) Investment in equipment per hectare
(3) Labour costs per hectare
(4) Seed, chemicals and other direct costs per hectare
(5) Area under crops
(6) Percentage of row crops.

The influence of these factors on production costs will be discussed below.

1. Technical efficiency

The quantity of resources (equipment, fertiliser, labour and land) used by the different entrepreneurs to produce a given quantity of crops varies considerably. This variation is closely correlated with production cost and may result from:

(a) **Differences in skill in the use of resources by the various entrepreneurs** — Timeliness of preparation of land and planting, planting depth, machine settings and many other practices cause differences in the yield which can be produced with given resources. Entrepreneurs who can produce a certain quantity with less resources as a result of above-average managerial skill will certainly have lower production costs.

(b) Errors made in determining the value of the resources — It is often difficult to indicate differences in

TABLE 1 — Statistical values of the technical efficiency index[1]

Variables	Regression coefficients		
	Estimated value	Standard error	t-value
Constant terms	3,111 1	-	-
X_1 = area under crops	0,338 4	0,100 2	3 337 3***
X_2 = fertiliser costs	0,167 1	0,078 8	2,118 7*
X_3 = investment in equipment	0,138 6	0,086 5	1,601 9
X_4 = other direct expenses	0,761 4	0,038 3	1,985 2*
X_5 = land value per hectare	0,234 7	0,131 4	1,785 8
X_6 = labour costs	0,398 1	0,070 1	5,676 0***
R = 0,929 8			

[1] Estimated by the equation $Y = a + b_1X_1 + ... + b_6X_6$
*** Significant at the 0,001 level
* Significant at the 0,05 level

TABLE 2 — Statistical values of the cost function[1]

Variables	Regression coefficients		
	Estimated value	Standard error	t-value
Constant terms	218 116 5	-	-
X_1 = investment in equipment per hectare	0,613 5	0,167 5	3,661 2***
X_2 = labour costs per hectare	-8,010 6	1,296 6	-6,177 6***
X_3 = seed, chemicals and other costs per hectare	1,998 7	0,295 0	6,774 3***
X_4 = area under crops	-0,019 2	0,007 5	-2,537 9**
X_5 = technical efficiency index	-0,952 2	0,097 5	-9,757 3***
X_6 = percentage row crops	-0,166 3	0,170 8	-0,973 5
R = 0, 872 26			

[1] Estimated by the equation $Y = a + b_1X_1 + b_2x_2 + ... + b_6X_6$
*** Significant at the 0,001 level
** Significant at the 0,02 level

quality between resources. It is, for example, not always possible to determine the production capacity of land accurately. Similarly, the performance of an implement is not directly related to its purchase price. It may also happen that the quantity of resources actually used differs from the quantity stated by the farmer. Variation in the rainfall from farm to farm was not determined during the survey. This would naturally also have an influence on the variation in yield with given resources.

A technical efficiency index was calculated to measure the yield per unit of input of different resources. This is an attempt to quantify that part of the producer's managerial ability which causes differences in the yield per unit of input. This managerial ability or skill is naturally reflected in the different production methods and practices.

Each farmer was given a technical efficiency index which is a reflection of the crop yield he achieved as compared with that of the average farmer with the same resources. This means that farmers with an average technical efficiency level receive a rating of 100, the above-average farmer receives a rating of more than 100 and the below-average ones less than 100.

The cost per R100 of crop production decreases from R152 to R57 as the technical efficiency level increases from 50 to 150 on an average farm, with other resources applied at the mathematical averages. It is clear from the analysis that even farmers with an average level of efficiency are not farming profitably and that it takes a farmer with an above-average level of efficiency to be able to farm profitably under the relevant conditions with the given resources. The level of efficiency varies within the sample from 43 to 177. One unit change in the technical efficiency level is accompanied by a R1 change in the average cost per R100 of crop production.

This exposition also illustrates the fact that pro-

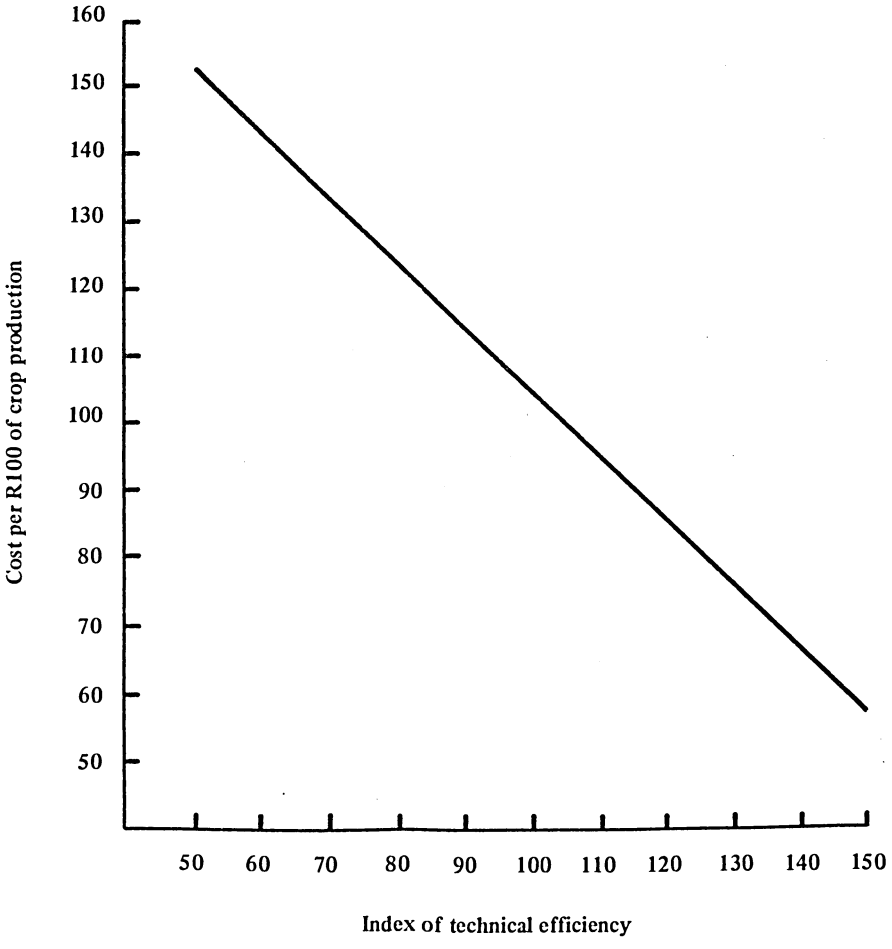

FIG. 2 – Cost per R100 of crop production at different levels of technical efficiency

Other variables at the following levels: Investment in equipment per hectare R33,44; labour cost per hectare R5,18; seed, chemicals and other costs per hectare R14,30; area under crops 516 hectares; percentage of row crops 80,4 per cent

duction costs can be cut back considerably by the application of improved practices and methods.

2. Investment in equipment

On a farm with 500 hectares under crops, the cost per R100 of crop production increases from R89 to R126 as the investment in equipment increases from R10 per hectare to R70 per hectare.

The investment in equipment varied from R12 to R211. It may be deduced from the results of the study that most farmers could reduce their average costs by keeping the investment in equipment as low as possible. By spreading the investment in equipment over a larger area and prolonging the life of the equipment by good care, the production cost could also be brought down.

Although it is not deducible from the results of this study, cases may occur in which too small an investment in equipment can increase production costs if the equipment is not adequate to complete certain ac-

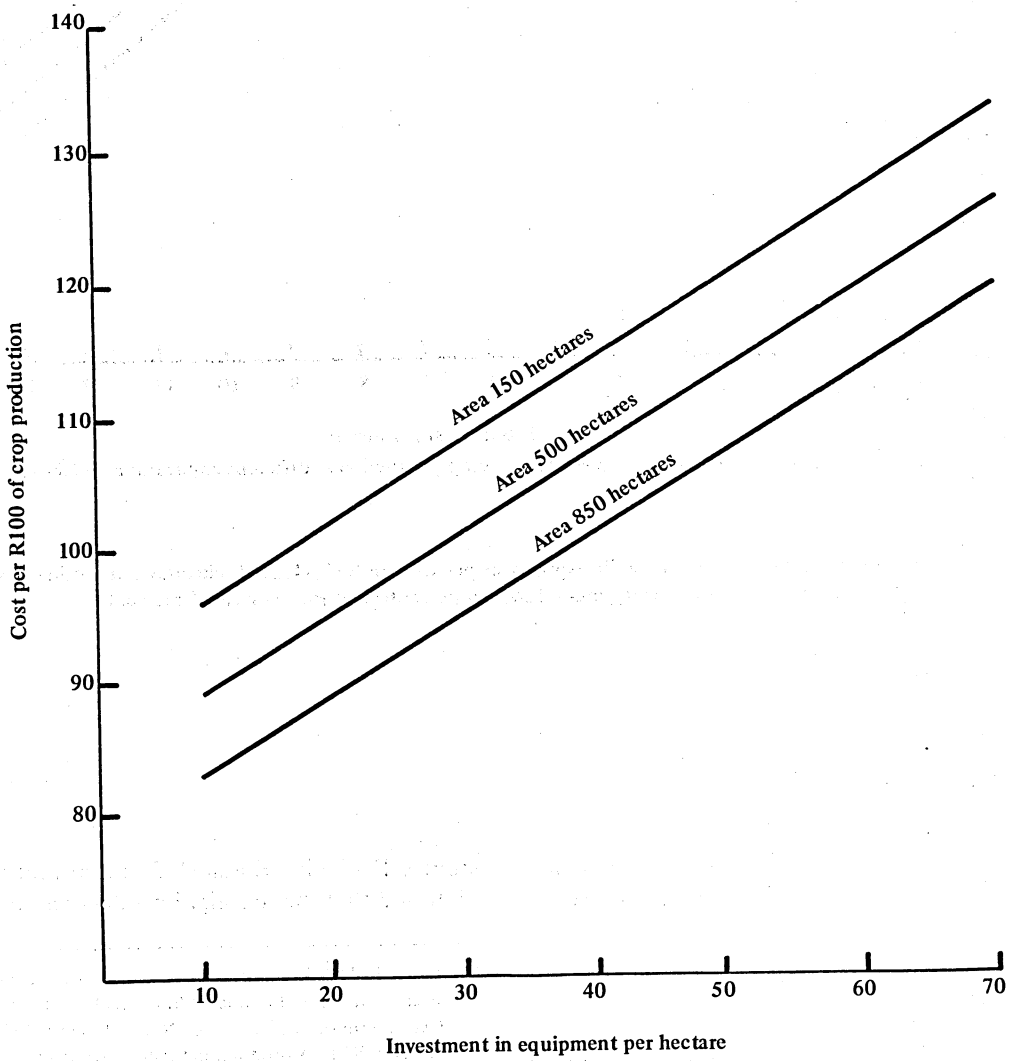

FIG. 3 – Average cost per R100 of crop production at different levels of investment in equipment

Other variables at the following levels: Labour cost per hectare R5,18; seed, chemicals and other costs per hectare R14,30; percentage row crops 80,4 per cent; and technical efficiency index 104

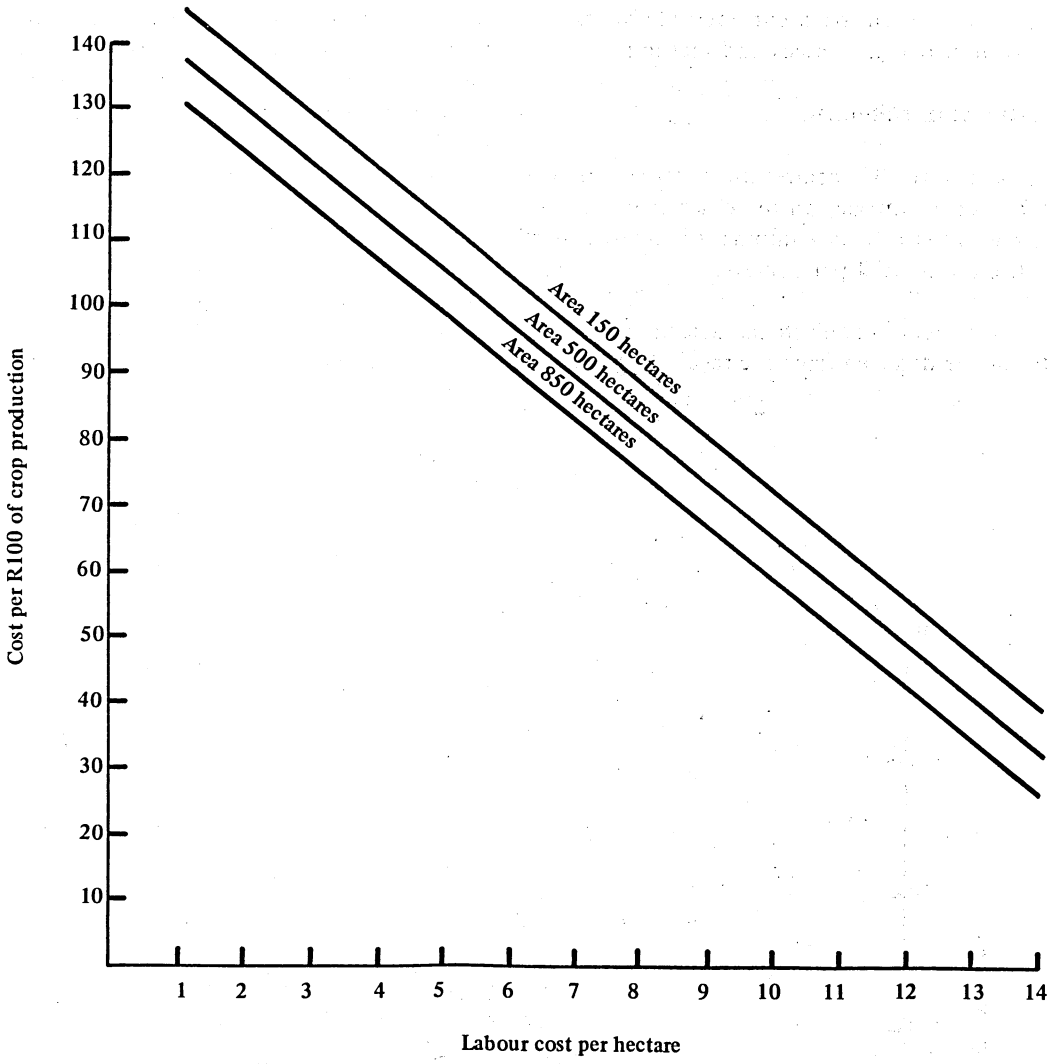

FIG. 4 – Average cost per R100 of crop production at different applications of labour

Other variables at the following levels: Investment in equipment per hectare R33,44; seed, chemicals and other costs per hectare R14,30; technical efficiency index 104; and percentage of row crops 80,4 per cent

tivities in time. Low investment in equipment must therefore not be achieved at the cost of timeliness.

3. Labour costs

An increase in the labour cost per hectare results in a drop in the cost per R100 of crop production. The labour cost per hectare fluctuates within the sample from R1 to R17.

This trend can most probably be explained by the high marginal product values of labour. In previous studies Du Toit[1], Kassier[2], Joubert[3] and Swanepoel[4] all found that the marginal product value of labour is

1. Du Toit, D.J. 'n Ekonomiese ontleding van die boerdery-organisasie in die Paulpietersburgstreek. Unpublished M.Sc. (Agric.) thesis, University of Natal, January 1972.
2. Kassier, W.E. A production function study of marginal returns and optimum intensity on East Griqualand farms. S.A. Journal of Economics, Vol. 34, No. 2, June 1966.
3. Joubert,J.S.G. 'n Ekonomiese basis vir boerderybeplanning in die Swartland. Unpublished M.Sc. (Agric.) thesis, University of Stellenbosch, August 1969.
4. Swanepoel, G.H. 'n Bedryfsekonomiese ondersoek na sekere boerderytipes in die Letabadistrik. Unpublished M.Sc. (Agric.) thesis, University of Pretoria, September 1969.

considerably higher than the factor price of labour. In his East Griqualand study Kassier attributed the high productivity of labour to the monopsonistic position of the entrepreneur coupled with the fact that labourers apparently prefer security to a high wage. Du Toit attributes it to the type of labourer and reports as follows: "As gevolg van die tipe arbeid, naamlik die semi-plakkerstelsel, is die arbeider baie meer plekgebonde as huurarbeid. Die sekuriteit van sy eie stukkie land met sy vee is vir die arbeider van groter belang as die loon wat hy verdien." This security and attachment to a locality may also play an important role in the North-Western Free State.

So labour is relatively cheap and, by implication, this would mean that farmers can make better use of their available labour. Therefore, where labour is not a particularly limiting factor and is reasonably plentiful, it would not pay in the present circumstances to replace labour with capital items.

Although "size" should not play any part under the latter conditions, management may still be a limiting factor.

4. Seed, chemicals and other direct expenses

Expenditure on seed and chemicals and other direct costs per hectare vary from R1 to R54 within the sample with R14,30 as the average for all the farmers in the sample. Additional investment in these items results in a cost increase per R100 of crop production.

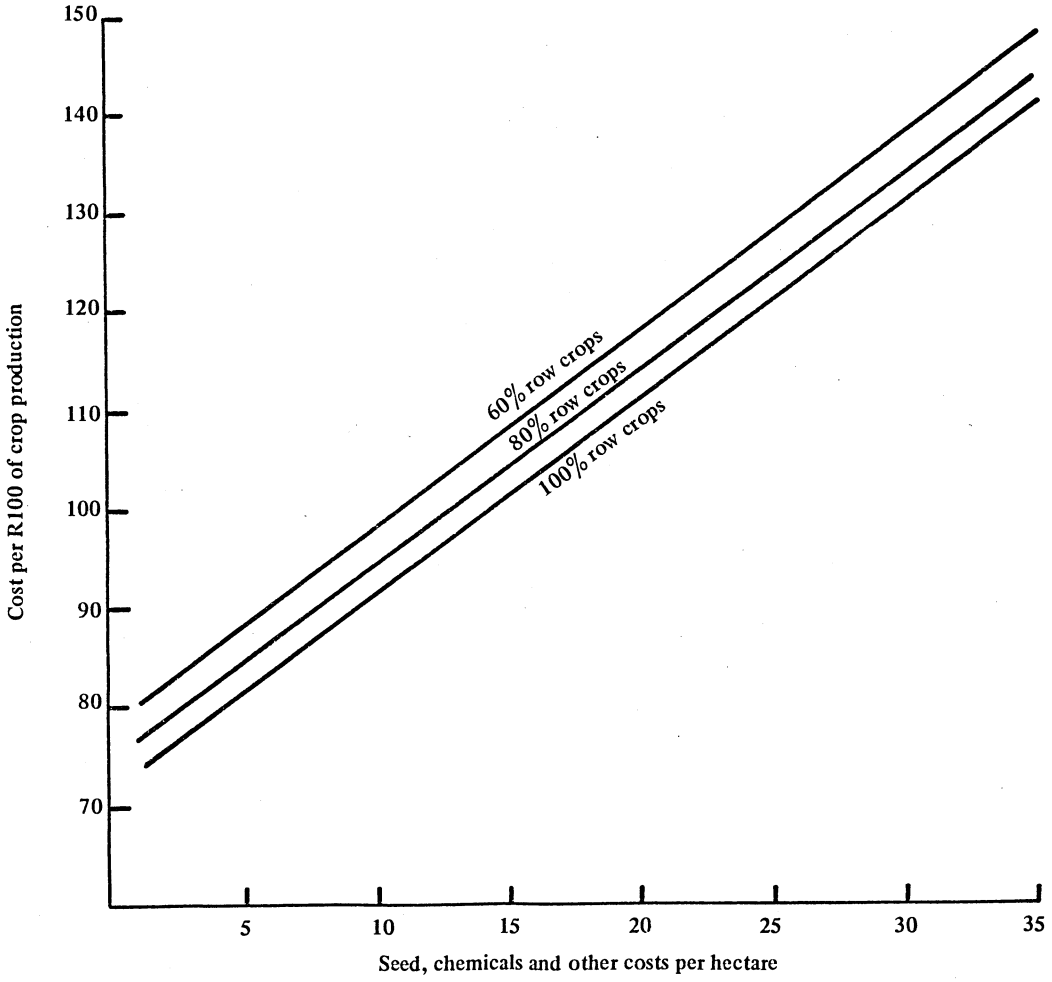

FIG. 5 – Average cost per R100 of crop production at different levels of application of seed, chemicals and other costs per hectare

Other variables at the following levels: Investment in equipment per hectare R33,44; labour cost per hectare R5,18; area under crops 516 hectares; and technical efficiency index 104

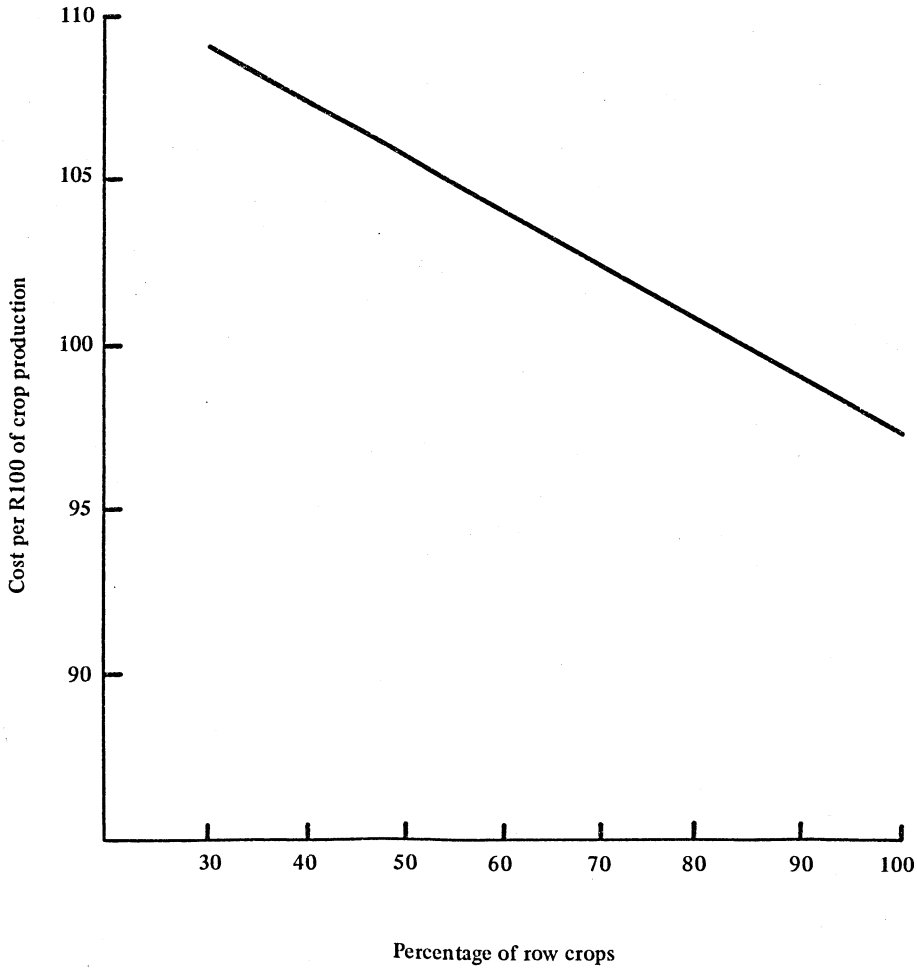

FIG. 6 – Average cost per R100 of crop production for different percentages of row crops

Other variables at the following levels: Investment in equipment per hectare R33,44; labour cost per hectare R5,18; seed, chemicals and other costs per hectare R14,30; area under crops 516 hectares; and technical efficiency index 104

It is clear from the figure that the application of these items is over-optimal. Uncertainty as a result of climatic conditions may be largely responsible for this. The possibility of a partial or a total replacement of certain of these items by labour must be investigated by the farmer.

5. Percentage of row crops

On the farms in the sample an average of 80,4 per cent of the area under crops was planted with row crops. This varied within the sample from 23 to 100 per cent. As the percentage of row crops increases from 30 to 100 per cent, the average cost per R100 of crop production drops from about R109 to R97. The percentage of row crops therefore does not have a great effect on the production cost. The relatively higher monetary yield that results from the production of row crops (mainly maize) is to some extent cut back again by the relatively higher production cost per physical unit of yield.

6. Extent of the area under crops

The average area under crops in the sample varies from 86 to 1 996 hectares, the average area being 516 hectares.

From the figure it is apparent that economies of scale do occur, but, taken over the large increase in area from 150 to 950 hectares, the advantages are not particularly striking. Technical efficiency is in this case once again the major factor (See Figure 2).

Hattingh[5] has the following to say about econo-

5. Hattingh, H.S. Enkele inleidende lesings. Division of Agricultural Production Economics, February 1971.

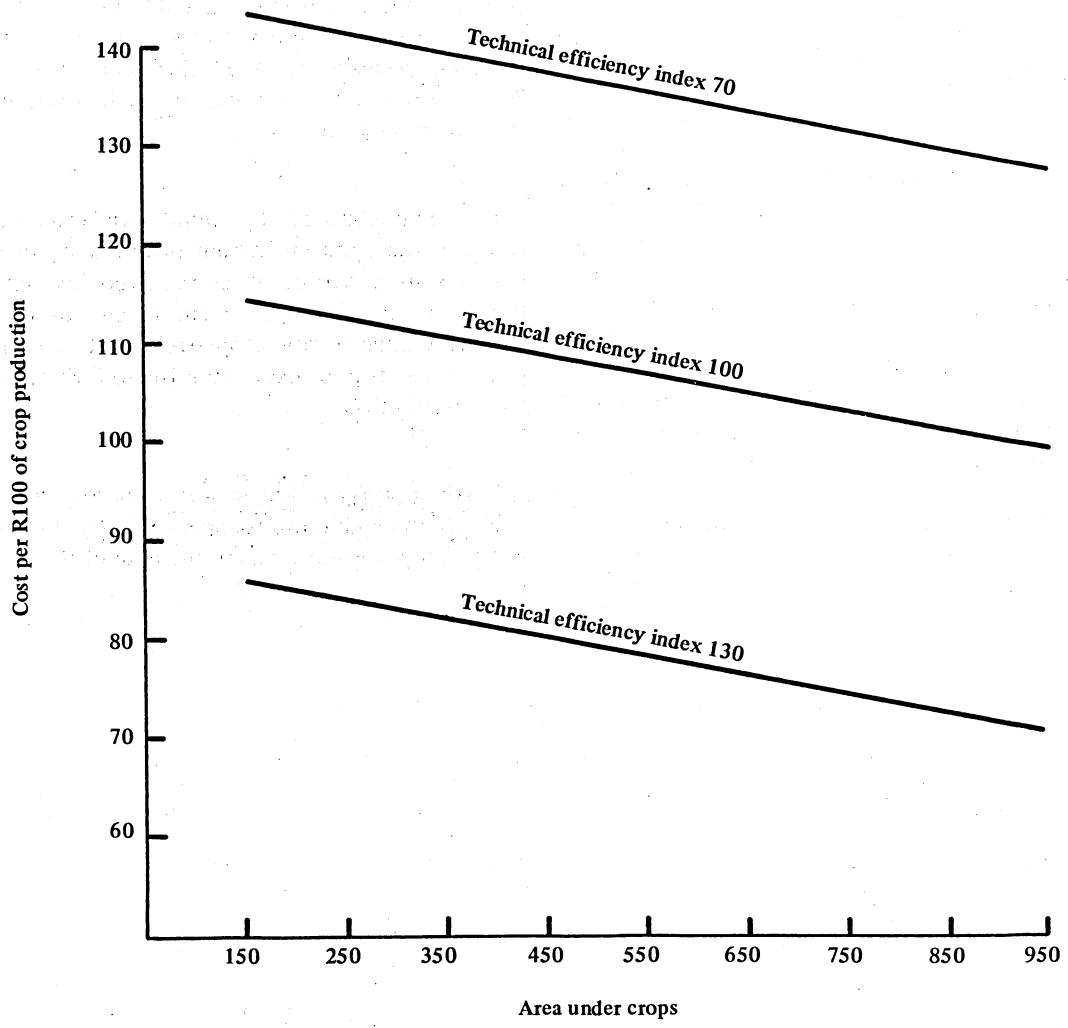

FIG. 7 – Average cost per R100 of crop production for different areas under crops measured at three different levels of technical efficiency

Other variables at the following levels: Investment in equipment per hectare R33,44; seed, chemicals and other costs per hectare R14,30; labour cost per hectare R5,18; and percentage of row crops 80,4 per cent

mies of scale: "Boerdery dwarsdeur die wêreld is een vername sektor van die ekonomie wat nog nie bewys kon lewer dat die toepassing van grootskaalse produksiemetodes veel ekonomiese voordele inhou nie." He bases this view on the following reasons:

(a) Cost reductions are possible in the case of crop production where expensive high capacity power machines and combinations of implements are used and are spread over a large number of units. However, their benefits are sometimes over-emphasised because their capacity and advantages are also limited.

(b) There are few possibilities for specialisation and division of labour.

(c) Larger units have no advantages over smaller units as far as the use of by-products in agriculture is concerned.

(d) Individual farmers, on however large a scale, can have very little influence on the demand for their own products.

(e) Because of the special credit facilities for agriculture, all farmers have access to credit provided they have a unit large enough to ensure a decent living.

(f) Management is synonymous with co-ordination.

SUMMARY

There is a wide variation in production costs per unit of crop yield between farmers in the North-Western Free State. The cost per R100 of crop production fluctuates from R42 to R308. From this it is deduced that there are many individual farmers whose farming organisation could be changed with a view to increasing profits. In order to reduce costs and in so doing increase profits, information on the factors that influence production costs is needed. Once this information was obtained, the influence of the following factors on costs was investigated: Technical efficiency, investment in equipment, labour costs, fertiliser costs, land value, seed, chemicals and other costs, size and crop composition.

Differences in technical efficiency, in other words, the ability to obtain a certain yield from given resources, has a considerable influence on production costs. For example, the average cost per R100 of crop production drops from R152 to R57 as the technical efficiency increases from 50 to 150. An increase in the investment in equipment, seed, chemicals and other costs per hectare results in a constant cost increase per R100 of crop production.

The opposite trend is found with labour costs because of the apparently high productivity of labour, which is an indication of the relatively low remuneration at which labourers are employed. An increase in the percentage of row crops from 30 to 100 per cent produces a drop in cost from R109 to R97 per R100 of crop production.

An increase in the area under crops results in a decrease in production cost per unit of yield, although not to the same extent as in the case of the other factors.