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# LABOUR-RELATED STRUCTURAL TRENDS IN SOUTH AFRICAN COMMERCIAL GRAIN PRODUCTION: A COMPARISON BETWEEN THE SUMMER AND WINTER RAINFALL AREAS, 1945-1987

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**Abstract**

Data from the end of the second World War (1945) to the 1987 production year were used to quantify the pace of change in the structure of farming with regard to labour. Where possible explanations of certain parameters are put forward with the aim of identifying the economic problem with regard to farm labour. Two structural trends in South African commercial maize production are evident in the summer rainfall areas. The period 1945-1970 witnessed a large expansion in cultivated farm area, probably because tractors replaced draught oxen. Larger areas could be managed and more labour was required. Demands on labour for harvesting were heavy until the introduction of the combine harvester alleviated this problem. These trends were strengthened by policies aimed at lowering the costs of capital, giving rise to some of the socio-economic concerns expressed in this paper. In the winter rainfall region where wheat is cultivated the expansion in cultivated area took place before 1945. The period under consideration (1945-1987) therefore only saw the substitution of labour for machinery, especially in the period 1945-1970. It thus seems as if labour related developments in the summer rainfall area trailed that in the winter rainfall area.

**Uittreksel**

Data vanaf die einde van die tweede Wêreldoorlog (1945) tot met die 1987 produksiejaar is gebruik om die tempo van verandering in die struktuur van boerdery met betrekking tot arbeid te kwantifiseer. Waar moonlik is verklarings van sekere parameters gesuggereer met die oog op die identifikasie van die ekonomiese probleem met betrekking tot plaasarbeid. Twee strukturele tendense in Suid-Afrikaanse kommersiële mielieproduksie in die somerreënstreke is waarneembaar. Die periode 1945-1970 word gekenmerk deur 'n groot uitbreiding in bewerkte plaasoppervlakte, waarskynlik omdat trekkers trekosse vervang het. Groter oppervlaktes kon hanteer word en meer arbeid was nodig. Die vraag na arbeid in die oesproses was groot totdat die gebruik van outostropers hierdie probleem verlig het. Hierdie tendense is versterk deur beleide wat die koste van kapitaal verlaag het. In die winterreënstreek waar koring verbou word het die uitbreiding in bewerkte oppervlakte voor 1945 plaasgevind. In die periode onder beskouing (1945-1987) het dus slegs die substitusie van arbeid met masjinerie plaasgevind, veral in die periode 1945-1970. Dit blyk dus asof arbeidsverwante ontwikkelings in die somerreëngebied na die in die winterreëngebied gevolg het.

## 1. Introduction

Changes in the ratio of the quantity of land, capital and labour used in agricultural production have played a fundamental role in the transformation of agriculture throughout the world in the post-1945 era. The substitution of capital goods, including new technology, for land and labour has played an especially important role in, for example, the USA (Schertz, 1979:24) and has influenced the structure of farming there (Penn, 1979:11). The same is true for the commercial sector of South African agriculture (Biggs, 1982; De Klerk, 1983; Van Zyl *et al*, 1987).

This paper is particularly concerned with the analysis of trends concerning farm labour in five major commercial grain producing areas of South Africa. Three of these are mainly maize producing regions, namely the North-Western Free State, Western Transvaal and the Transvaal Highveld, while two are mainly wheat producing areas, namely the Rûens and Swartland. The data were obtained from production cost surveys done by the Department of Agricultural Development on a rotation basis. Physical and financial data have in each survey been collected for a random sample of approximately 80 farmers, each with more than 80 hectares maize or wheat.

The particular relevance of the analysis becomes evident when it is borne in mind that maize and wheat are by far South Africa's major crops (Abstract, 1990). Data from the end of the second World War (1945) to the 1987 production year were used to quantify the pace of change in the structure of farming with regard to labour. Where possible explanations of certain parameters are put forward with the aim of identifying the economic problem with regard to farm labour. In chronological order, discussions involve labour usage in quantitative terms, labour remuneration, capital-labour substitution and productivity of labour. Only trends and annual changes are considered. The exact level of the different parameters for any given year can be found in unpublished reports of the Department of Agricultural Development. Growth rates were obtained by fitting an exponential curve with simple regression analysis with time as independent variable. Because of the obvious differences in the annual growth rate of the total number of farm employees before and after 1970 as indicated by Table 1, trends are given for the periods 1945-1970 and 1970-1987, as well as for the whole period 1945-1987.

## 2. Amount of labour and machinery used

The annual growth rate of a number of key variables involving labour employment and related attributes are shown in Table 2 for the periods involved in the analysis.

It appears that the number of employees per farm increased from 1945 to 1970 in all the areas. This is also true for the period 1970-1987. The summer rainfall regions however show insignificant trends in the period 1970-1987, while the winter rainfall regions show marked increases in the number of employees per farm.

The above trends have to be seen in light of the general increase in the total farm area and area under cultivation in all the regions over all the periods under consideration. Cultivation as percentage of total farm area however differs between the winter and summer rainfall areas.

Table 1: Annual growth rate in the number of farm employees and real gross investment in machinery in commercial agriculture in the RSA for different periods, 1945-1987.

| Period | Annual growth rate % | |
|---|---|---|
| | Total number of farm employees | Real gross investment in machinery |
| 1945 - 1970 | 2.57 | 2.24 |
| 1970 - 1987 | -1.15 | 2.75 |
| 1945 - 1987 | 1.20 | 2.38 |

Note: All values are significant at the 10 % level
Source: Calculated from Abstract (1990)

The summer rainfall areas show a general increase in the percentage area cultivated over all the periods while the winter rainfall areas show a decrease.

This gives rise to two different phenomena in the summer and winter rainfall areas with regard to employees per 100 ha under cultivation. Employees per 1000 ha under cultivation increased significantly in the summer rainfall regions during the period 1945-1970 while it remained fairly constant in the winter rainfall areas over the same period. It however declined over the period 1970-1987 in all areas.

The decrease over the last period is partly explained by De Klerk (1983). From a sample of farmers who started farming maize before 1968 in the Western Transvaal, De Klerk (1983) obtained mechanization adoption rates as shown in Table 3. He also reports percentages of roughly the same order for farmers who started farming after 1968. These adoption rates show clearly that the majority of farmers in the Western Transvaal have already changed to mechanized harvesting, and this process must have contributed to a decline in the quantity of labour demanded, especially seasonal labour.

Table 3: Distribution (percentages of farmers) of harvesting methods of maize in the Western Transvaal, 1968 - 1981

| Year | Harvesting by hand | Mechanised harvesting | Hand and mechanised |
|---|---|---|---|
| 1968 | 81 | 16 | 3 |
| 1973 | 54 | 38 | 8 |
| 1977 | 11 | 81 | 6 |
| 1981 | 5 | 89 | 6 |

Source: De Klerk (1983)

The mean annual growth rates in real investment in machinery (total per hectare total farm area and per hectare under cultivation) are shown in Table 4.

According to Table 4, real investment in machinery per farm unit and per ha total farm area increased in the summer rainfall area over all the periods under consideration. It also increased in the winter rainfall region over the period 1945-1970, but decreased from 1970 to 1987.

The above identifies different trends in the summer and winter rainfall areas:

i) **Summer rainfall areas**

The increases in both the number of farm employees per 1000ha under cultivation (Table 2) and the real investment in machinery per hectare under cultivation (Table 4) in all areas indicate capital and labour to have been complements in crop production in the 1945-1970 period. However, the decline in the number of farm employees per 1000 ha under cultivation (Table 2) in the period 1970-1985, and increase in the real investment in machinery per hectare under cultivation (Table 4) in the same period, illustrate a substitution of capital for labour in crop production since 1970 in all three regions. Mechanization was originally almost completely geared towards substitution of machinery for animal draught power in the processes of soil cultivation. It brought in its wake increased crop yields per hectare. Since the harvesting process had not yet been mechanized, this necessitated increased labour employment, hence the complementarity between labour and capital. The rapid mechanization in maize harvesting since 1970 (see Table 3) introduced the era of capital substituting for labour. Joubert and Van Wyk (1984) also point at decreases in employees per hectare under cultivation with increases in farm sizes. This may be associated with more intensive machinery use on larger farms and economies of scale.

ii) **Winter rainfall areas**

In the winter rainfall areas trends are different for both the periods 1945-1970 and 1970-1987. During the period 1945-1970 the number of labourers per 1000ha under cultivation (Table 2) stayed fairly constant, while real investment in machinery per hectare under cultivation increased significantly. During the period 1970-1987 real investment in machinery stayed constant, while the number of labourers per 1000 ha under cultivation declined. This implies that contrary to trends in the summer rainfall areas, labour and machinery have been substitutes over both the periods 1945-1970 and 1970-1987. This is accentuated by the trends for the total period (1945-1987).

## 3. Remuneration of labour

Concern is frequently expressed regarding the work and living conditions of farm employees (Wilson *et al*, 1977; Bosch, 1983). Criticism usually centres on the low level of cash remuneration and the "neo-feudal" system of paying farm labourers in kind rather than in cash (Antrobus, 1976; Moorcroft, 1976). However, Wilson *et al* (1977) warn that comparisons between farm and other remuneration policies must be handled with caution because of possible differences in methods of calculation of remuneration, especially when considering payment in kind. In this latter case the difference between production and purchase cost for the farmer must be taken into account (Du Toit, 1980).

The mean annual growth rate in real total, cash and in kind remuneration per farm labourer are shown in Table 5.

TABLE 2
Mean annual growth rate (%) in employment and some related attributes in the grain producing areas for the periods 1945-1970, 1970-1987 and 1945-1987

| Item | | Summer Rainfall Region | | | | | | | | | Winter Rainfall Region | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North-western Free State | | | Western Transvaal | | | Transvaal Highveld | | | Rûens | | | Swartland | | |
| | | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 |
| Employees per farm unit | Growth rate | 3.82** | -0.29 | 2.51** | 3.69** | 0.01 | 2.59** | 2.60** | -0.64 | 3.04** | 0.50* | 3.23** | 1.76** | 1.35* | 1.94* | 0.79* |
| | $R^2$ | 95.9 | 8.2 | 90.2 | 92.7 | 1.2 | 86.2 | 65.7 | 18.4 | 87.3 | 21.1 | 55.5 | 63.2 | 37.2 | 10.4 | 21.4 |
| Total farm area | Growth rate | 1.85** | 1.08 | 1.85** | 1.68* | 1.47 | 2.16* | 2.24* | 0.35** | 3.01** | 1.62** | 2.50* | 2.04** | 1.09** | 1.28 | 1.13** |
| | $R^2$ | 79.4 | 18.5 | 93.5 | 51.6 | 10.8 | 72.1 | 37.4 | 49.1 | 81.5 | 98.2 | 73.2 | 96.0 | 95.4 | 34.6 | 87.1 |
| Area under cultivation | Growth rate | 3.47** | 1.18** | 3.17** | 3.50** | 1.53* | 4.05** | 3.96** | 3.65** | 3.93** | 1.02* | 3.18* | 2.00** | 1.06* | 0.72* | 0.95** |
| | $R^2$ | 81.4 | 60.7 | 95.4 | 95.8 | 14.6 | 87.8 | 58.0 | 50.0 | 86.7 | 78.5 | 74.7 | 91.2 | 72.01 | 33.1 | 85.1 |
| Cultivation as percentage of total farm area | Growth rate | 1.62** | 0.47 | 1.31** | 1.83* | 0.01 | 1.89* | 1.72** | 0.15 | 0.92* | -0.60 | 0.68 | -0.04 | -0.03 | -0.56 | -0.17 |
| | $R^2$ | 80.0 | 13.3 | 90.1 | 79.1 | 0.1 | 59.4 | 81.6 | 8.6 | 70.6 | 78.1 | 25.9 | 1.3 | 0.18 | 21.5 | 15.3 |
| Employees per 1000ha farm area | Growth rate | 1.98** | -0.93* | -0.59 | 2.00** | -1.13* | 0.38 | 0.40* | -0.73* | -0.14* | -0.48** | 0.02 | 0.07** | -0.27* | -1.60** | -0.25 |
| | $R^2$ | 81.6 | 26.9 | 29.3 | 81.8 | 37.3 | 36.8 | 25.7 | 36.4 | 61.8 | 99.8 | 0.2 | 75.8 | 19.1 | 91.9 | 27.7 |
| Employees per 1000ha under cultivation | Growth rate | 3.65** | -1.40* | -0.72 | 0.17* | -1.19* | -0.51* | 0.11** | -0.88* | -1.06* | 0.12 | -0.65* | -0.26 | 0.30 | -1.06* | -0.07 |
| | $R^2$ | 27.9 | 66.3 | 75.4 | 31.5 | 18.5 | 75.8 | 44.4 | 27.9 | 76.1 | 10.5 | 39.3 | 45.3 | 8.26 | 45.1 | 1.52 |

**, Highly significant ($P<0.05$); *, significant ($P<0.10$);
$R^2$=Coefficient of determination.

TABLE 4
Mean annual growth rate (%) in real investment in machinery per farm unit, per hectare under cultivation and per hectare total farm area for the periods 1945-1970, 1970-1987 and 1945-1987

| Item | | Summer Rainfall Region | | | | | | | | | Winter Rainfall Region | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North-western Free State | | | Western Transvaal | | | Transvaal Highveld | | | Rûens | | | Swartland | | |
| | | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 |
| Real investment in machinery per farm unit | Growth rate | 4.17** | 3.41* | 5.00** | 4.62** | 0.57* | 5.08** | 4.96** | 0.95* | 2.18* | 2.42** | -0.46 | 2.05** | 2.30** | -1.00 | 1.71** |
| | $R^2$ | 66.0 | 68.0 | 90.3 | 80.2 | 18.2 | 95.6 | 97.1 | 12.1 | 97.3 | 77.8 | 7.1 | 75.2 | 58.1 | 16.3 | 68.5 |
| Real investment in machinery per ha total farm area | Growth rate | 2.31* | 2.95* | 3.18** | 2.94* | 1.85 | 3.00** | 3.19** | 2.20 | 3.48** | 3.21** | -0.50 | 2.32** | 4.43** | -0.03* | 2.75** |
| | $R^2$ | 42.7 | 63.3 | 82.5 | 71.8 | 10.3 | 90.9 | 75.6 | 5.6 | 84.6 | 92.0 | 12.9 | 82.4 | 84.9 | 30.12 | 84.8 |
| Real investment in machinery per ha under cultivation | Growth rate | 0.70* | 2.56* | 1.85* | 1.11* | 2.54* | 1.79* | 1.66* | 2.19* | 2.32* | 1.26* | -0.23 | 1.08** | 1.03* | -1.58 | 1.10** |
| | $R^2$ | 38.9 | 44.1 | 64.9 | 21.5 | 14.4 | 68.9 | 15.9 | 6.4 | 72.4 | 21.1 | 0.4 | 42.9 | 18.2 | 13.1 | 35.7 |
| Investment in machinery as percentage of total investment | Growth rate | -1.78 | 1.3 | -0.10 | -2.64 | -1.50 | -0.98 | 0.08 | -0.63 | 0.02 | 1.95** | -0.26 | 0.73** | 3.39** | 1.61 | 1.65** |
| | $R^2$ | 30.3 | 16.1 | 15.7 | 53.5 | 10.0 | 14.1 | 21.1 | 12.2 | 14.6 | 38.8 | 0.5 | 15.2 | 81.3 | 7.9 | 54.1 |

**, Highly significant ($P<0.05$); *, significant ($P<0.10$);
$R^2$ = Coefficient of determination.

TABLE 5
Mean annual growth rate (%) in real total, in cash and in kind remuneration per farm worker for the periods 1945-1970, 1970-1987 and 1945-1987

| Item | | Summer Rainfall Region | | | | | | | | | Winter Rainfall Region | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North-western Free State | | | Western Transvaal | | | Transvaal Highveld | | | Rûens | | | Swartland | | |
| | | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 |
| Total remuneration per farm labourer | Growth rate | 0.88 | 3.47** | 1.95** | 10.29* | 2.8** | 1.60** | 0.67* | 3.10** | 2.24** | 2.42** | -0.46 | 2.05** | 2.30** | -1.00 | 1.71** |
| | $R^2$ | 8.4 | 61.1 | 50.9 | 1.15 | 68.1 | 54.7 | 24.2 | 71.0 | 61.7 | 77.8 | 7.1 | 75.2 | 58.1 | 16.3 | 68.5 |
| Cash remuneration per farm labourer | Growth rate | 0.14 | 6.34** | 2.86** | 11.20* | 5.00* | 1.19** | 1.88* | 3.87** | 3.4** | 3.21** | -0.50 | 2.32** | 4.43** | 0.03 | 2.75** |
| | $R^2$ | 0.25 | 57.9 | 60.1 | 9.13 | 61.0 | 46.0 | 17.6 | 80.1 | 74.3 | 92.0 | 12.9 | 82.4 | 84.9 | 0.02 | 84.8 |
| In kind remuneration per farm labourer | Growth rate | 1.09 | 1.93 | 1.44 | 4.34* | 1.04 | -0.20 | -0.046 | 0.64 | 1.35* | 1.26* | -0.23 | 1.58** | 1.03 | -1.58 | 1.10** |
| | $R^2$ | 4.7 | 25.8 | 26.6 | 64.4 | 42.4 | 0.5 | 0.02 | 18.4 | 29.7 | 21.1 | 0.4 | 42.9 | 18.2 | 13.1 | 35.7 |
| Cash remuneration as percentage of total remuneration | Growth rate | -0.74 | 2.88* | 0.95* | -0.91 | 2.45* | 0.31 | 1.20 | 3.14* | 1.19** | 1.95** | -0.26 | 0.73** | 3.39** | 1.61 | 1.65** |
| | $R^2$ | 6.6 | 33.5 | 22.9 | 36.8 | 32.1 | 15.9 | 27.1 | 51.2 | 52.0 | 38.8 | 0.5 | 15.2 | 81.29 | 7.9 | 54.1 |

**, Highly significant ($P<0.05$); *, significant ($P<0.10$);
$R^2$ = Coefficient of determination.

Real total remuneration per farm labourer increased in all the areas over the period 1945-1970. It also increased in the summer rainfall region over the period 1970-1987, but decreased insignificantly in the winter rainfall region over the same period. The same trends hold for real cash remuneration.

Cash remuneration as percentage of total remuneration increased significantly over the period 1970-1987 in the summer rainfall region, but was insignificant over the period 1945-1970. The trend is however reversed in the winter rainfall area where cash remuneration as percentage of total remuneration increased significantly over the period 1945- 1970, but was insignificant over the period 1970-1987.

The above results coincide with these obtained by Fenyes (1983) and Antrobus (1984). It also shows that in kind remuneration will play a progressively smaller role over time, both in the winter rainfall region (already since 1945) and summer rainfall region (since 1970).

## 4. Substitution of labour

In spite of an increasing trend in labour remuneration and total labour costs per farm unit over time, total labour costs constituted a declining proportion of total farm costs between 1945 and 1987. Table 6 shows the percentage real increase in labour costs per farm unit per annum against that of total farm costs, gross farm income, machinery costs and total direct and non-direct allocatable costs per farm unit. Real changes in gross farm income are also shown.

Table 6 shows that real total costs, real direct and non-direct allocatable costs and real machinery costs increased over time in all the regions. Real labour costs increased from 1945-1970 in the summer rainfall areas, but decreased from 1970-1987. In the winter rainfall region real labour costs increased over both periods. Real gross farm income increased in the winter rainfall region over both the periods 1945-1970 and 1970-1987, but declined in the summer rainfall region. This is partly due to the difference between total farm output and maize production, the drought that has been experienced in Southern Africa since 1980, and the inflation experienced since the 1970s with input prices rising faster than output prices (Louw, 1986; Van Zyl, 1988a).

Using the Taiwanese and Japanese experience as examples, Ishikawa (1981) suggested that the historical paths of change in per hectare labour input in rice production and the growth of yields may be represented by a curve with two distinct phases: in the early phase labour intensity increases and it only declines in the later phase. Ishikawa (1978) has therefore distinguished two types of technological factors, apart from the natural and institutional factors, affecting labour absorption: (1) labour-using technological factors e.g. higher yield varieties, application of fertilizer, and improved cultivation practices, all of which have yield-increasing properties at the same time; (2) labour-saving technological factors, mainly agricultural mechanization.

Utilizing the above-mentioned data it seems that the Ishikawa-curve also holds for commercial maize production in the summer rainfall areas of South Africa. Before 1970 the effect of labour-using technology outweighed the effect of labour-saving technological factors with the result that labour utilization increased. After 1970 the opposite happened, resulting in a decrease of labour intensity with higher yields in maize production. On the other hand wheat production in the winter rainfall area only used the second type of technology over the periods under consideration, namely labour-saving technology.

Labour cost as a percentage of gross farm income, total costs and machinery costs showed a negative annual growth rate over time in all cases. Table 7 depicts the situation.

The annual growth rates in real remuneration per farm employee (Table 5) were also lower than the real annual growth rate in total costs and machinery costs per farm unit.

The theoretical equilibrium for an economic optimum between the two factors of production, capital and labour, is found where:

$$\Delta X_1/\Delta X_2 = P_2/P_1$$

with $X_1$ = change in quantity of labour;
$X_2$ = change in quantity of capital;
$P_1$ = price of labour;
$P_2$ = price of capital.

It appears from Tables 2-6 that both the relative prices and quantities of capital and labour varied over time. However, in spite of the lower tempo of increase in labour costs relative to that of capital, the relative share of labour decreased in maize production. This trend is contrary to expectations as dictated by the theoretical equilibrium for an economic optimum. A possible cause is probably an overreaction to mechanization, partly due to the introduction of more productive technology, e.g. combines. There exists ample evidence that some farms in South Africa are over-mechanized (Van Rooyen, 1973; Brotherton and Groenewald, 1982). Tax provisions which enabled farmers to write off 100% of capital costs against taxes in the year of purchase, as well as subsidized interest rates, have contributed to this overreaction (Biggs, 1982).

In the light of the input-price inflation presently experienced in South African agriculture (Louw, 1986; Van Zyl, 1986a), it can be expected that farmers and agricultural producers will be forced to economize on expenditures even to survive (Janse van Rensburg, 1985; Louw, 1986). A continually increasing investment in farm machinery is therefore not expected. However, savings and economizing can initially include the fuller utilization of existing capacity. Other economizing measures can result in an initial stagnation in the demand for labour at current levels. These factors probably contribute to a delay in movement back towards equilibrium between capital and labour. The higher rate of increases in real remuneration per agricultural employee compared to that in certain other sectors, as well as the high unemployment rate in non-agricultural sectors will probably contribute to a move towards the equilibrium.

The elasticity of substitution, which is a pure number that indicates the extent to which one input substitutes for another (Henderson and Quandt, 1971), may be of some interest in this regard. If a high elasticity of substitution exists between a pair of factors, the manager can quickly adjust the input mix in response to changing relative prices. With a low elasticity of substitution, however, the input mix can hardly be altered even in the face of large relative shifts in prices. Positive coefficients denote complementarity, whereas negative coefficients denote substitution. The long-term elasticity of substitution between labour and capital for commercial maize farming in South Africa as a whole, for the periods 1945-1970 and 1970-1985, utilizing the Shadow measure (McFadden, 1963), were respectively -0.814 and +0.734 (Van Zyl, 1986b). The corresponding values for wheat production were +0.551 and +0.314, respectively. Labour and machinery were thus highly significantly inelastic complements in commercial maize production during the period 1945-1970, but became highly significantly inelastic substitutes during 1970-1985. Labour and machinery were highly significant inelastic substitutes over both periods in commercial wheat production. Movements in the direction of the economic optimum equilibrium between capital and labour may thus take even longer than initially expected. Institutional restrictions on the mobility of labour which have since been partly removed (eg. Influx Control) may have contributed towards the inelastic elasticities of substitution.

TABLE 6

Mean annual growth rate (%) in real labour costs, gross farm income, total costs and direct and non-direct apportionable costs (DAC and NDAC) per farm unit for the periods 1945-1970, 1970-1987 and 1945-1987

| Item | | Summer Rainfall Region | | | | | | | | | Winter Rainfall Region | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North-western Free State | | | Western Transvaal | | | Transvaal Highveld | | | Rûens | | | Swartland | | |
| | | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 |
| Real labour costs | Growth rate | 6.37** | -1.59** | 4.58** | 3.48** | -0.88 | 2.77** | 3.26** | -0.10 | 3.56** | 2.92** | 2.77** | 3.81** | 3.62** | 0.95** | 2.64** |
| | $R^2$ | 91.5 | 90.1 | 93.8 | 92.9 | 13.8 | 94.2 | 67.5 | 1.2 | 98.8 | 77.8 | 54.0 | 89.0 | 79.9 | 22.2 | 71.3 |
| Real gross farm income | Growth rate | -3.28 | -19.23* | -5.54* | -6.54** | -14.67** | -9.57** | -4.24* | -8.89** | -5.99** | 3.87** | 5.44** | 4.57** | 4.40** | 3.15** | 3.62** |
| | $R^2$ | 23.7 | 75.8 | 87.4 | 90.6 | 76.1 | 97.9 | 53.7 | 92.6 | 92.1 | 96.4 | 92.0 | 98.4 | 98.4 | 39.3 | 92.6 |
| Real total costs | Growth rate | 7.34** | 3.49** | 6.60** | 6.26** | 2.98 | 6.27** | 6.53** | 4.84* | 6.88** | 4.32** | 6.30** | 5.05** | 4.99** | 3.44** | 4.31** |
| | $R^2$ | 93.5 | 80.4 | 97.6 | 99.5 | 20.7 | 99.2 | 95.0 | 55.0 | 96.5 | 99.2 | 98.8 | 99.3 | 97.6 | 82.7 | 97.9 |
| Real DAC | Growth rate | 7.17** | 4.87* | 7.16** | 8.36** | 4.31* | 8.28** | 7.68** | 5.97* | 7.89** | 5.18** | 7.40 | 5.93** | 5.52** | 4.02* | 4.61** |
| | $R^2$ | 87.5 | 69.5 | 93.3 | 91.8 | 57.6 | 97.4 | 95.5 | 46.3 | 94.9 | 97.2 | 98.4 | 98.9 | 98.3 | 66.6 | 96.9 |
| Real N-DAC | Growth rate | 7.28** | 2.69 | 5.76** | 5.68** | 2.11* | 5.34** | 5.62** | 3.82* | 6.02** | 3.43** | 5.83** | 4.43** | 4.09** | 3.46* | 3.94** |
| | $R^2$ | 84.6 | 33.2 | 91.4 | 99.6 | 48.8 | 99.5 | 88.6 | 63.8 | 96.1 | 99.5 | 90.2 | 98.1 | 94.9 | 75.7 | 97.4 |
| Real machinery costs | Growth rate | 10.01** | 5.30** | 6.39** | 6.57** | 2.73* | 6.45** | 7.66** | 5.48* | 7.82** | 3.37** | 7.18** | 4.74** | 4.26** | 4.95** | 4.50** |
| | $R^2$ | 59.1 | 39.2 | 83.1 | 98.2 | 45.9 | 99.4 | 81.4 | 70.0 | 94.8 | 99.2 | 96.4 | 97.7 | 91.9 | 84.1 | 97.5 |
| Yield per hectare | Growth rate | 1.01 | 1.24 | 2.54** | 1.09* | -0.45 | 0.90 | 5.01** | 0.14 | 2.17** | 1.21* | 3.41** | 2.23** | 1.96** | 2.63* | 1.90** |
| | $R^2$ | 2.3 | 11.4 | 28.6 | 22.1 | 8.8 | 0.02 | 61.7 | 8.6 | 25.2 | 21.7 | 52.4 | 65.2 | 49.22 | 23.96 | 56.8 |

**, Highly significant ($P<0.05$); *, significant ($P<0.10$);
$R^2$=Coefficient of determination.

TABLE 7

Mean annual growth rate (%) in labour costs as percentage of real gross farm income, total costs and machinery costs per farm unit for the periods 1945-1970, 1970-1987 and 1945-1987

| Item | | Summer Rainfall Region | | | | | | | | | Winter Rainfall Region | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North-western Free State | | | Western Transvaal | | | Transvaal Highveld | | | Rûens | | | Swartland | | |
| | | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 |
| Labour costs as percentage of gross farm income | Growth rate | -0.21 | -1.40 | -0.97* | -1.65* | -0.57* | -1.97* | -1.89* | -4.34* | -2.42** | 0.14 | -3.21** | -0.81** | -0.61 | -4.43 | -0.72 |
| | $R^2$ | 6.6 | 9.8 | 58.6 | 58.6 | 2.1 | 75.4 | 32.5 | 73.0 | 82.5 | 4.3 | 83.9 | 52.3 | 23.3 | 37.3 | 14.9 |
| Labour costs as percentage of total costs | Growth rate | -0.97* | -5.0** | -2.02** | -2.78** | -2.87* | -3.49** | -3.26** | -4.94** | -3.32** | -0.30 | -4.07** | -1.29** | -1.21 | -4.72 | -1.42* |
| | $R^2$ | 35.4 | 84.6 | 84.2 | 94.4 | 53.5 | 98.3 | 85.5 | 87.3 | 93.3 | 5.6 | 96.3 | 65.9 | 39.8 | 63.5 | 52.1 |
| Labour costs as percentage of machinery costs | Growth rate | -4.83* | -6.40* | -4.81* | -3.64** | -3.42** | -3.76 | -4.80* | -5.01** | -4.26** | -0.65** | -4.95** | -0.98* | -0.48 | -6.22** | -1.6* |
| | $R^2$ | 33.8 | 55.1 | 78.4 | 82.9 | 81.7 | 94.9 | 56.8 | 85.3 | 80.2 | 14.7 | 96.9 | 38.3 | 5.95 | 92.1 | 57.0 |

**,Highly significant ($P<0.05$);*,significant ($P<0.10$);
$R^2$=Coefficient of determination.



TABLE 8

Mean annual growth rate (%) in productivity of labour, land and machinery for the periods 1945-1970, 1970-1987 and 1945-1987

| Item | | Summer Rainfall Region | | | | | | | | | Winter Rainfall Region | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | North-western Free State | | | Western Transvaal | | | Transvaal Highveld | | | Rûens | | | Swartland | | |
| | | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 | 1945 to 1970 | 1970 to 1987 | 1945 to 1987 |
| Productivity of labour | Growth rate | 2.63* | 2.24 | 3.14** | 1.25 | -0.03 | 1.59** | 2.53* | 2.56 | 3.28** | 0.14 | 3.21** | 0.81** | 0.61 | 4.43 | 0.72 |
| | $R^2$ | 33.7 | 27.0 | 72.1 | 52.8 | 0.01 | 51.3 | 47.0 | 25.9 | 77.4 | 4.3 | 83.9 | 52.3 | 23.3 | 37.3 | 14.9 |
| Productivity of land | Growth rate | 4.61** | 1.40 | 3.96** | 3.26* | -0.85 | 2.11** | 3.25** | 2.82* | 3.25** | 2.85** | 2.25 | 2.57** | 3.33** | 2.42 | 2.66** |
| | $R^2$ | 63.5 | 15.7 | 81.3 | 74.8 | 2.57 | 55.1 | 71.3 | 49.6 | 90.3 | 97.8 | 61.5 | 96.5 | 97.7 | 39.2 | 90.6 |
| Productivity of machinery | Growth rate | -3.82** | -25.24** | -9.55** | -5.27** | -23.1** | -11.2** | -6.05* | -1.91* | -5.57** | 0.50 | -1.73** | -0.17 | 0.13 | -1.79 | -0.84* |
| | $R^2$ | 67.8 | 98.5 | 86.0 | 94.9 | 98.5 | 90.7 | 62.1 | 73.7 | 91.7 | 24.1 | 91.4 | 8.3 | 2.3 | 14.2 | 39.5 |

**,Highly significant ($P<0.05$);*,significant ($P<0.10$);
$R^2$=Coefficient of determination.

## 5. Productivity

The increase in productivity of the production factors such as land, capital and labour in the different regions can be calculated by relating gross output to the value of inputs over time (Van Niekerk, 1978; Butterworth and Nix, 1983). These changes for the different periods are shown in Table 8. It can be seen that the mean annual increases in productivity of labour were higher than that of machinery, regardless of the region. This coincides with the results of Joubert and Van Wyk (1984) for total agricultural production.

## 6. Policy relevance

The identified trends and other characteristics of the agricultural labour market have definite policy implications. Capital is relatively scarce in South Africa, while there is an abundance of unskilled and semiskilled labour available. Capital should thus be used with a great deal of discretion to maximize income and work creation opportunities. Agriculture ultimately yields the largest number of job opportunities per unit of capital invested through the multiplier effect (Mullins and Scheepers, 1980; Van Zyl and Vink, 1988), but can lead to unemployment in the short term.

Development policy should therefore also be centered on creation of job opportunities and the relief of poverty in the intermediate period. However, work opportunities should be productive, and it must, given the scarcity of available resources, be created at the smallest possible cost. The use of capital to enable the growth of agricultural production is therefore not always wrong; it can be essential to use scarce capital to create more job opportunities. Capital should, however, be used for labour-using technology rather than for labour-saving technology (Ishikawa, 1978, 1981), taking into account that management of relatively large numbers of labourers has a cost attached.

Technological progress is generally not neutral to the use of production factors. It can contribute to savings in either labour, capital or land, or a combination of these. Much technology adopted in Southern Africa resulted from research and development in the U.S.A. and other advanced countries where labour is scarce and expensive relative to capital. Van Zyl *et al* (1985) have shown that these technologies, such as maize cultivars, are frequently not suitable for local conditions. It is therefore essential that production techniques and technology in agriculture are adapted to the economic realities of southern Africa.

The appropriate use of available technology in agricultural production is a function of a variety of influences: availability and prices of different factors of production, their relative marginal and average return, financial and managerial status of farmers, investment already incurred in fixed or semi-fixed assets, and also risk or variability attached to any particular technology. The adverse effects of labour displacement, in the light of a relative scarcity of capital, are especially acute in South Africa, given the dualistic nature of the agricultural sector (Van Zyl *et al*, 1985).

The South African authorities should therefore review certain policy aspects that impair job creation opportunities in agriculture which have resulted in distorted prices of the production factors relative to their scarcity. The major measures that kept the cost of capital relatively low were the control of interest rates in general, the subsidization of interest rates in agriculture, and tax concessions on capital investment. These, together with other measures that distort the relative cost of inputs, should be reviewed and modified.

Commercial agriculture still has a role to play in the development of southern Africa, (Van Zyl and Vink; 1988; Van Rooyen; 1990), and unless job creation abilities are enlarged, large-scale rural unemployment, poverty and social deterioration could be unavoidable.

## 7. Conclusion

As a factor of production, labour should not be seen in isolation. Since the Second World War, the following changes and trends were identified in the commercial grain producing areas of South Africa:

i) Two structural trends in South African commercial maize production are evident in the summer rainfall areas. The period 1945 - 1970 witnessed a large expansion in cultivated farm area, probably because tractors replaced draught oxen. Larger areas could be managed and more labour was required.

   Demands on labour for harvesting were heavy until the introduction of the combine harvester alleviated this problem. These trends were strengthened by policies aimed at lowering the cost of capital, giving rise to some of the socio-economic concerns expressed in this paper.

ii) In the winter rainfall region where wheat is cultivated the expansion in cultivated area took place before 1945. The period under consideration (1945-1987) therefore only saw the substitution of labour for machinery, especially in the period 1945-1970. It thus seems as if labour related developments in the summer rainfall area trailed that in the winter rainfall area.

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