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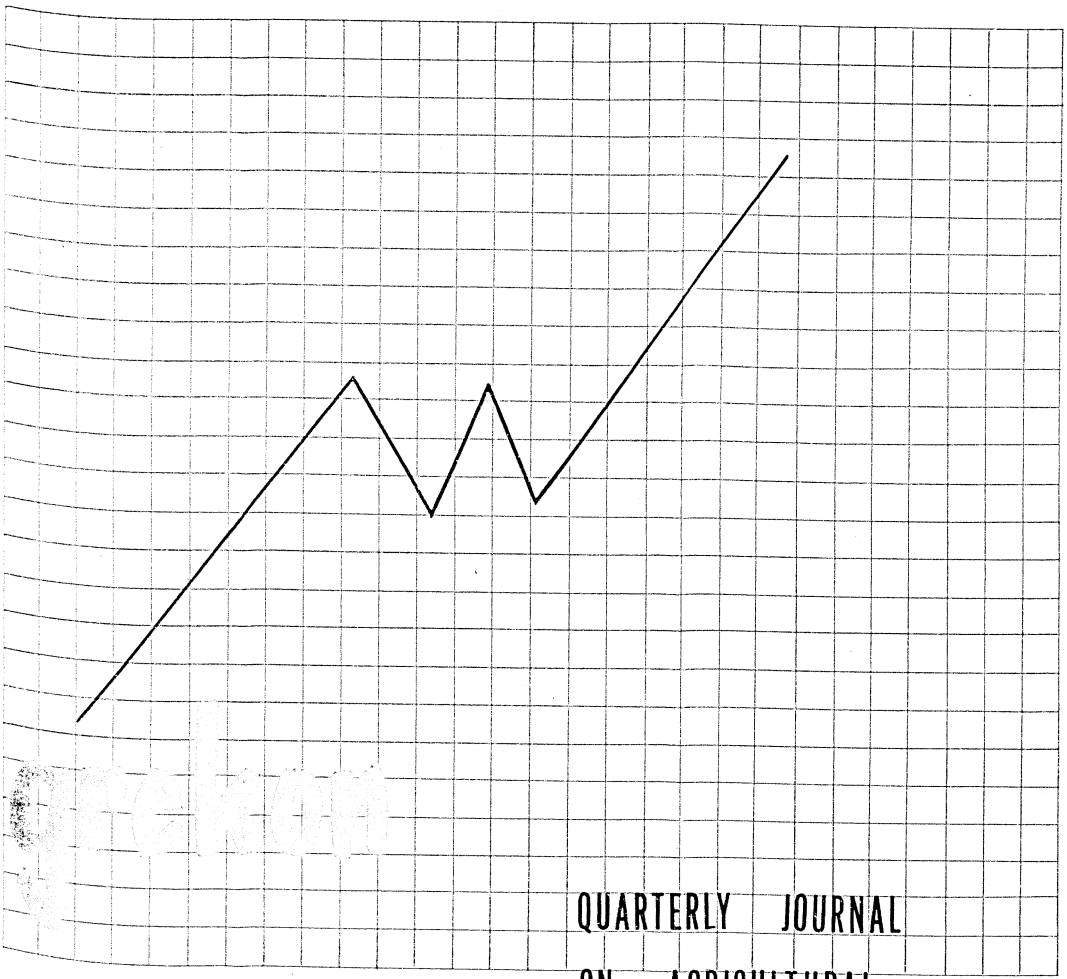

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Deserving articles in the field of agricultural economics, for publication in this journal, will be welcomed.

These articles should have a maximum length of 10 folio pages (including tables, graphs, etc.), typed in double spacing. All contributions should be submitted in triplicate (preferably in both languages) to the editors, c.o. Department of Agricultural Economics and Marketing, Pretoria, and should be received by the editors at least one month prior to publication date.

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Changes in Primary Resources in the South African Agriculture

by

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INTRODUCTION

The South African agricultural output has expanded considerably in the post-war years. Such an expansion can be the result of either one or both of two occurrences:-

(i) Increase in inputs of primary production resources; the latter being defined for this purpose as the area of land used for field crops, numbers of livestock used in livestock production and number of trees in fruit production.

(ii) Increase in physical yields per unit of primary production resource.

An effort has been made in this article to determine to what extent inputs of primary resources have increased in South African agriculture, and whether yields per primary production unit have been substantially different in the post-war period from those in the war years. In other words -

(i) whether inputs of primary resources have increased substantially over the period;

(ii) whether yields per unit of primary production resource have increased, decreased or remained the same over the entire time span; and

(iii) whether changes in the post-war years have been materially different from those in the war years.

A change in the yield per unit of primary production resource may come about through one or both of the following factors:-

(i) Increased use of other productive agents, such as labour, management, industrial inputs and other capital items per unit of primary production resource on a given production function.

(ii) Technological improvements - i.e. the production of a larger output with the same factor input, or the same output with fewer inputs. This usually accompanies qualitative improvements in some of the inputs, such as better seed, fertilisers and pesticides, improved machinery and better trained manpower.

COMPUTATION OF DATA

In this article two periods are considered: One is the 10-year period of 1936/37 to 1945/46, which can be regarded as representative of the war period. It includes the three years immediately before the war, the war years and some time immediately after the war - to allow for immediate post-war adjustments and scarcities. The other period is the 13 years stretching from 1946/47 to 1958/59.

For production data use has been made of the indices of physical production in agriculture as calculated by the Division of Economics and Markets.* These indices have been obtained from the Jubilee Issue of the Bureau of Statistics.[2)]

1) The author is indebted to Mr. S.P. van Wyk and Dr. R.W. Müller of the Division of Agricultural Economic Research for useful comments.

*Renamed in 1962 as the Division of Agricultural economic Research.

2) Bureau of Statistics: Union Statistics for Fifty Years. Jubilee Issue, 1910-1960 (Government Printer, Pretoria, 1960. Pp.1-27).

In order to calculate per unit yields, an index of input of primary production resources was required. This has been calculated on the basis of area under field crops, numbers of livestock units and numbers of fruit trees. The annual figures for livestock units have been obtained from the same source.[3] The areas under field crops have been obtained from a summary of agricultural census data in the years 1936/37, 1945/46, 1949/50 and 1954/55, as published by the Division of Economics and Markets.[4] The areas for the years between census dates have been obtained by means of graphical interpolation. The numbers of fruit trees for the same years as field crop areas have been obtained from the Jubilee Issue of the Bureau of Statistics.[5] For aggregation, these have been weighted according to the areas under various types of fruit trees in 1955. These data have been obtained from the same source. Interpolation for the years between census dates has been done graphically. Due to inavailability of census data for 1959/60 when the calculations were made, the trends between 1949/55 have been extrapolated until 1959.

The calculation of inputs of primary production resources has been done by coverting the input data (livestock units, areas under field crops and fruit trees) into indices (1936/37-1939/40 = 100) and then aggregating them, using the gross values of production over the entire period (1936/37 to 1958/59) as weights. These gross values have been obtained from the Bureau of Statistics' report.[6]

The input data thus obtained have consequently been converted into indices (1936/37 to 1939/40 = 100). A trend over time for the entire period (1936/37 - 1958/59) has been calculated by "least squares regression". The physical index of agricultural production for each year has been divided by the corresponding aggregate input index, and these results have been multiplied by 100 in order to obtain a yield index.

Table 1 shows the indices of inputs of primary resources and the computation of the yield index.

STATISTICAL INTERPRETATION OF INPUT TRENDS

Table 1 reveals that substantial increases occurred in the use of primary resources in respect of field crop and fruit production; with no corresponding increase in the use of primary resources in livestock farming. The trend equations in respect of the increases in inputs are shown in Table 2.[7]

Table 2 shows that the use of primary resources in the aggregate, as well as in the production of field crops and fruit, increased substantially over the entire period. The trend equations of these were highly significant when measured by the t-test. The correlation coefficients also indicate a high degree of linear relationship between time and these inputs.

In livestock production, however, this trend was absent. The trend equation in respect of inputs of primary resources in livestock production was significantly negative (at a 95% probability level) over the entire period. The non-significance of the correlation coefficient of livestock inputs does, however, cast some doubt on the reliability of this trend.

In all these cases, the regression equations for the first period (1936/37 to 1945/46) and the post-war years (1946/

3) Ibid., Pp. 1-3.

4) Division of Economics and Markets: An Abstract of Agricultural Statistics of the Union of South Africa (Pretoria, 1960) P.1.

5) Op. Cit., Pp. 1-17.

6) Ibid., Pp. 1-25.

7) The equations are of the type
$Y = b_0 + b_1 T$
with Y = inputs of primary resources.
T = year
b_0 b_1 = constants.
The intercept year is 1947/48 in each case.

TABLE 1. - Indices of inputs of primary resources and computation of yield index in South African agriculture, 1936/37 to 1958/59

Year	Indices of inputs of primary production resources				Index of physical production	Yield index
	Field crops	Fruit	Live-stock	Aggre-gate		
1936/37	98	99	101	99.6	100	100
1937/38	100	100	99	99.5	94	94
1938/39	102	101	100	100.9	106	105
1939/40	104	102	100	101.8	102	100
1940/41	106	104	99	102.3	106	104
1941/42	108	105	99	103.2	101	98
1942/43	110	106	99	104.1	112	108
1943/44	113	107	99	105.4	107	102
1944/45	115	109	98	105.9	104	98
1945/46	117	115	98	107.4	103	96
1946/47	120	118	95	107.3	114	106
1947/48	124	119	98	110.6	128	116
1948/49	127	120	95	110.4	121	110
1949/50	131	122	92	110.7	129	116
1950/51	134	128	96	114.5	140	122
1951/52	136	134	97	116.5	130	112
1952/53	139	141	96	118.0	147	124
1953/54	142	146	96	119.7	154	129
1954/55	145	144	97	121.1	160	132
1955/56	147	146	97	122.1	170	139
1956/57	150	152	98	124.5	179	144
1957/58	152	158	98	126.0	178	141
1958/59	154	163	97	126.9	181	143

TABLE 2. - Trend equations in respect of inputs of primary resources in South African agriculture, 1936/37 to 1958/59 [8)]

Section	b_0	b_1	r	t-value
Field crops	125.0	2.69	0.99**	4.57*
Fruit	123.4	2.94	0.97**	4.52**
Livestock	97.6	- 0.16	0.54 (N.S.)	2.50*
Aggregate	111.2	1.29	0.98**	4.51**

8) One and two asterisks denote significance at the 95% and 99% significant levels respectively. The letters "N.S." denote "no significance".

47 to 1958/59) were compared. The differences were all found to be insignificant.

The input trends of primary resources are also shown in Figure 1.

Several reasons may be hypothesised for the phenomenon of increased primary resource inputs in field crop and fruit production, and the absence thereof in livestock farming. One of these is the increasing agriculture mechanisation since the war, which has had a much greater impact on grain and horticultural production than on livestock farming. As an indication of this large-scale mechanisation, it may be pointed out that Möller[9] found that, taking 1947 as 100, the index of tractor numbers rose to 436 in 1956. By 1957 this index would already have risen to 448.

Improved plant breeding, better fertilisation and improved (or new) ways of producing field crops have also favoured expansion of these enterprises. In the field of horticulture, larger plantings have been made possible by improved fertilisation and pest control.

The initiation of new irrigation schemes in many parts of South Africa, as well as the eradication of Malaria in parts of Transvaal and Natal, also contributed to the settlement of certain areas and more intensive agriculture than had previously been the case. The introduction of new kinds of crops has also exerted an influence in this respect; livestock production has not benefited from technological developments to the same extent.

Larger numbers of livestock may undoubtedly be kept on the veld under soil conservation practices and with improved feeding (as well as more efficient production of stock feeds). Progress in this respect had, however, been slow in the past, affecting the expansion of livestock production.

An important stimulation for increased planting of fruit trees was provided by the high prices obtained for fruit on the export markets in the late 'forties and early 'fifties. Field-crop production possibly also shared in this boom. Although these high prices also applied to animal products, the South African livestock industry could not exploit the situation to the same extent; slower turnover prevented quick adaptation to exploit opportunities. Due to more remunerative crop farming, less attention had been paid to proper livestock management. In addition, the quality of South African livestock products (wool and mohair being exceptions to this rule) generally compared unfavourably with those of the major producing countries of the world. This had not been the case with the quality of South African fruits and grains.

Apparently, therefore, a variety of reasons can be hypothesised for the increased inputs of primary production resources in respect of field-crop and fruit farming, while these inputs in respect of livestock production have remained stagnant.

STATISTICAL INTERPRETATION OF YIELD TRENDS

The next step was to establish a trend equation of yields per unit of primary resource for the entire period (1936/37 to 1958/59) and for the two shorter periods (1936/37 to 1945/46 and 1946/47 to 1958/59) seperately. This has been done by the method of least squares regression.[10]

The correlation (r) between Y and T has also been determined. The t-test has been used to determine -

(i) whether the regression coefficients differ significantly from zero; and

9) Möller, C.A.: 'n Kritiese Ontleding van "Depresiasie" met Besondere Verwysing na die Landbou. (M.Sc. Agric. thesis, University of Pretoria, 1959.)

10) The equations are of the following type:

$$Y = b_0 + b_1 T,$$

with Y = yield per unit of primary resource

T = year

b_0, b_1 = constants.

Figure 1: Trends in Inputs of Primary Resources in South African Agriculture, 1936/37 to 1958/59

Figuur 1: Tendense in Aanwendings van Primêre Bronne in die Suid-Afrikaanse Landbou, 1936/37 tot 1958/59

(a) Field Crops - Akkerbougewasse
(b) Fruit - Vrugte
(c) Livestock - Lewendehawe
(d) Aggregate - Totaal

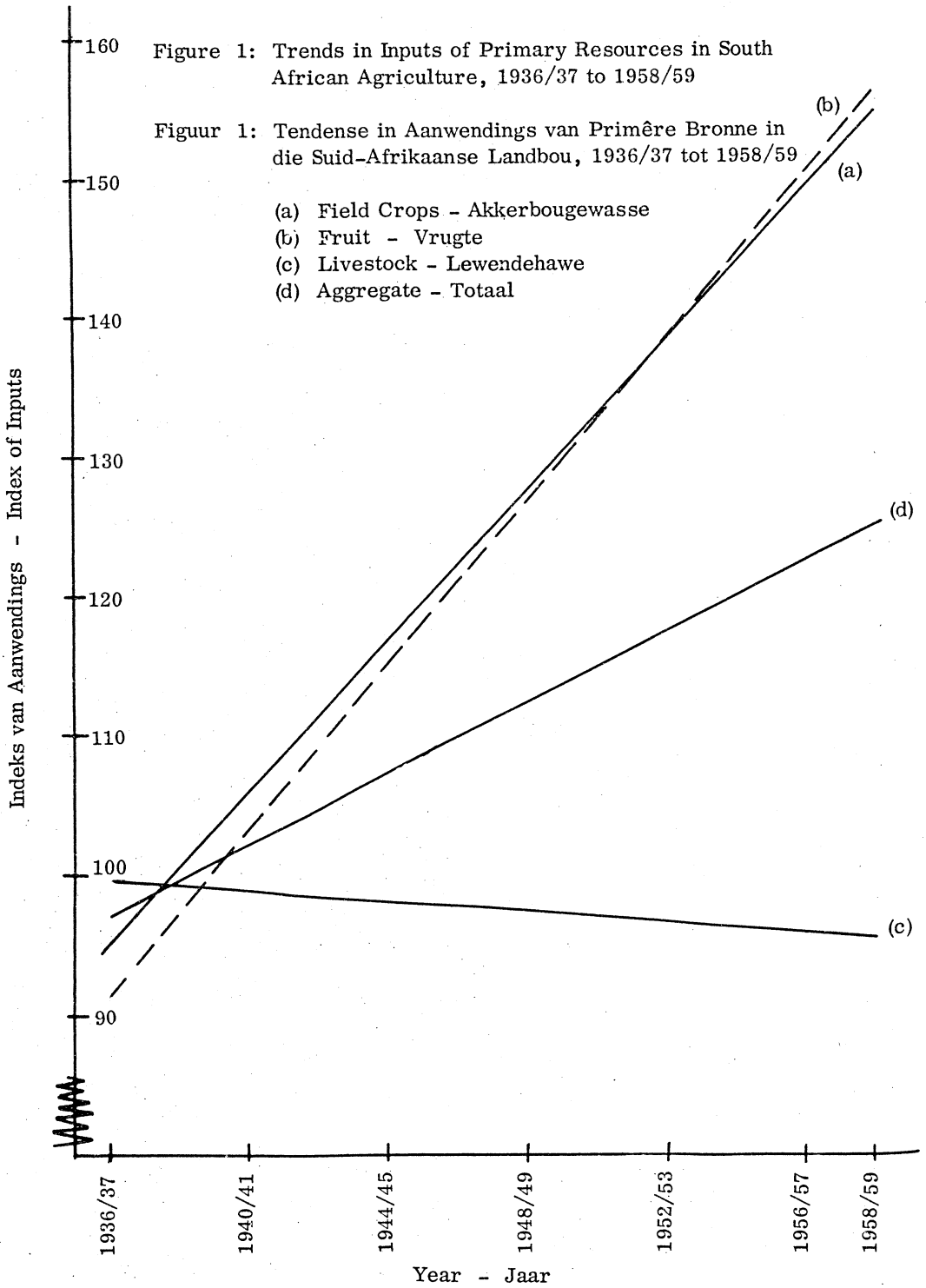


TABLE 3. - Statistical results of calculations of trends in productivity per unit of primary production resources in South African agriculture, according to the formula $Y = b_0 + b_1 T$. [11]

Period	b_0	b_1	Intercept year	r	t-value
(a) 1936/37 to 1958/59	114.70	2.20	1947/48	0.91**	5.36**
(b) 1936/37 to 1945/46	100.52	- 0.03	1940/41	0.02 (N.S.)	0.134 (N.S.)
(c) 1946/47 to 1958/59	125.70	3.24	1952/53	0.93**	3.34**

(ii) whether the regression coefficient for the period 1946/47 to 1958/59 differ significantly from the coefficient for the period 1936/37 to 1945/46. The statistical results are shown in Table 3.

In testing the difference between the regression coefficients of the 1936/37 to 1945/46 and 1946/47 to 1958/59 periods, a t-value of 2.25 has been calculated, which is significant at a 95% probability level.

The results are illustrated graphically in Figure 2.

The trend for the entire period (1936/37 to 1958/59) could also be fitted by means of a second-degree parabola of the nature $Y = b_0 + b_1 T = b_2 T^2$; however, in view of the high correlation coefficient obtained by linear regression, the degree of fit could not be improved upon substantially - neither would it alter the conclusions in any meaningful way.

The above analysis indicates a highly significant increase in yields per primary production unit in the South African agriculture between 1936/37 and 1958/59. However, if the full period is split into two shorter periods, the following becomes evident:-

(a) In the period 1936/37 to 1945/46, yield per primary production unit did not show a statistically significant trend;

(b) in the period 1946/47 to 1958/59, yields per primary production unit increased at a rate which is statistically highly significant; and

(c) the difference in the rate of increase between the two periods is statistically significant.

This may very well be interpreted as a substantial change in productivity of primary production resources in South African agriculture. Which part of this is due to more inputs of other productive factors, and which part to technological improvements, has not been determined.

SUMMARY AND CONCLUSIONS

(i) Indices in respect of inputs of primary production resources in South African agriculture have been calculated. It has been found that, while inputs of primary resources for field-crop and fruit production increased substantially over a period of 23 years, primary resource inputs in livestock production had lagged behind and, in fact, declined somewhat. This lag is distressing in a country with a growing economy, expanding population and prospering field-crop and fruit industries. It should also be remembered

11) Two asterisks denote statistical significance at the 99% probability level. The letters "N.S." denote no significance.

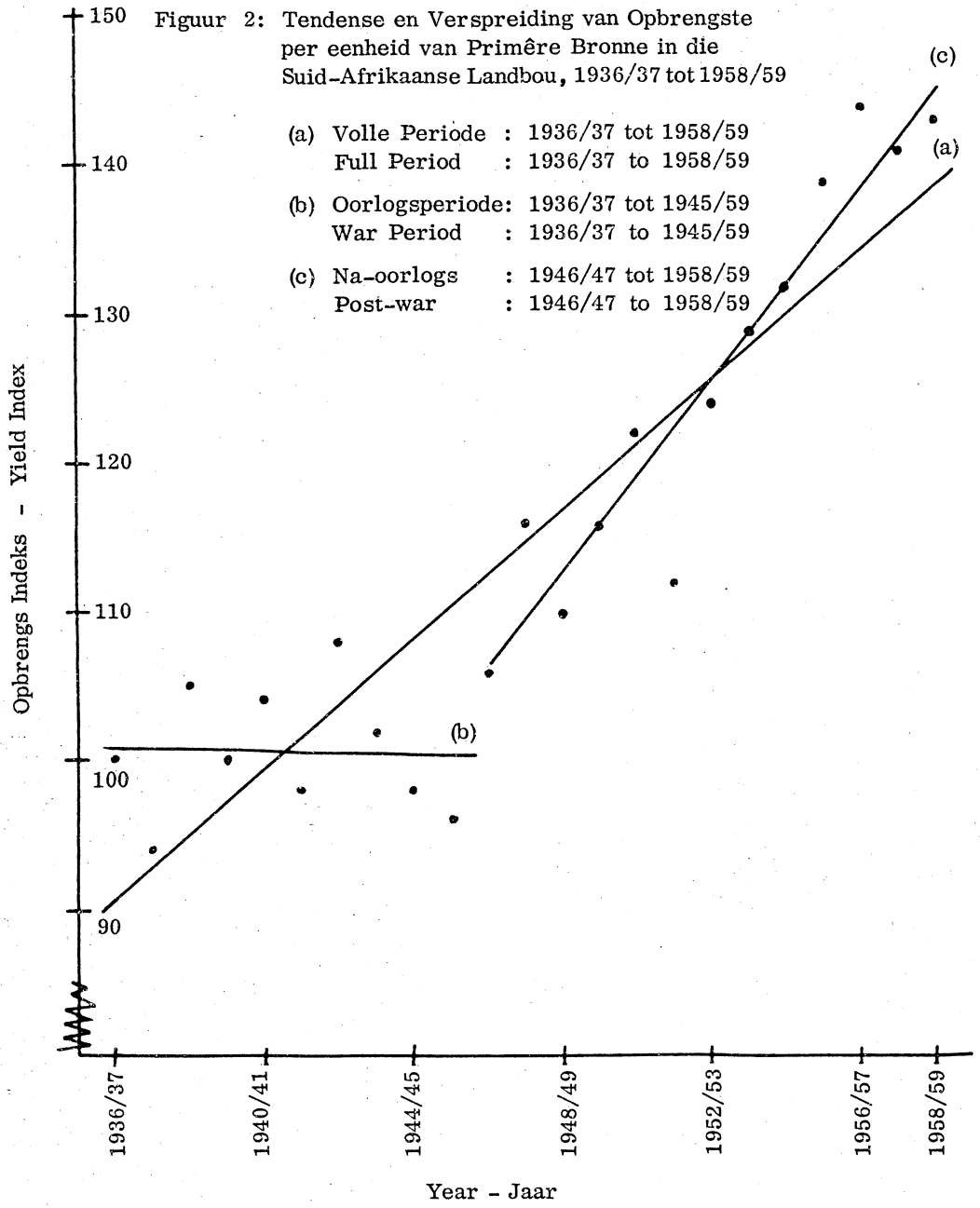
Figure 2: Trends and Scatter of Yields per Unit of Primary Resource in South African Agriculture: 1936/37 to 1958/59

Figuur 2: Tendense en Verspreiding van Opbrengste per eenheid van Primêre Bronne in die Suid-Afrikaanse Landbou, 1936/37 tot 1958/59

(a) Volle Periode : 1936/37 tot 1958/59
Full Period : 1936/37 to 1958/59

(b) Oorlogsperiode: 1936/37 tot 1945/59
War Period : 1936/37 to 1945/59

(c) Na-oorlogs : 1946/47 tot 1958/59
Post-war : 1946/47 to 1958/59



that, due to natural conditions, a very large part of South African Soil cannot be cultivated and will always have to be used as natural grazing. Several possible reasons for trends have been stated.

(ii) An aggregate index of inputs of primary resources has been constructed from these input indices. This aggregate input index rose steadily through the 23-year period. In none of the input index series significant differences in trends for the wartime and the post-war period existed.

(iii) The indices of physical production have been divided by the corresponding aggregate input indices. An aggregate yield index has thus been obtained. Analysis of these yields indices revealed that yields remained fairly constant during the war and increased appreciably in post-war years. These increased yields may be the result of increased inputs of other resources and/or of improved technology.

(iv) In general, these data point at an expansion of agricultural production in South Africa. This expansion has been accelerated after the war by improved yields. These trends are likely to continue for the next few years, particularly in response to the general buoyant conditions of the national economy. It can be expected that inputs in livestock and hence in livestock production, may increase in the future, due to technological improvements and/or increased domestic demand for animal products.

THE WORLD BY THE YEAR 2,000

(L.R. Brown, "Foreign Agriculture", 10.2.1964)

The world food problem itself is not new; it has always existed. It is the magnitude of the problem that has changed, and for two reasons. First, the number of people in the world is increasing so rapidly that the addition to world population between now and the end of this century - only 36 years hence - will equal or exceed the entire population of today. Second, this is occurring at a time when the amount of new land suitable for cultivation is rapidly diminishing. Thus man will no longer be able to augment his food supply largely by moving to unsettled areas and bringing new land into production. It has now become necessary to turn to the alternative method of producing more food - matching population growth with increased yields.

Total population growth in the regions currently classed as less developed is expected to amount to almost 4 billion people during this century, compared with only 800 million in the developed regions. As of 1960, only 1 billion of the expected 4 billion total had been added; thus the impact of this phenomenal growth in numbers will be reserved for the closing decades of the century. To feed these 3 billion new mouths, the less developed regions must add to their current food output an amount equivalent to the current output of the entire world.