

Fertilizer use by crop in South Africa



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**Land and Plant Nutrition Management Service
Land and Water Development Division**

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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The background photograph (maize) is from FAO Mediabase: FAO/17826/A. Conti. The sources of the other photographs are FAO Mediabase: FAO/20195/G. Diana (sunflower), FAO/22647/J. Spaul (grapes) and EcoPort (citrus).

Abstract

Only 14 percent of the total land area of South Africa receives sufficient rainfall for arable crop production and periodic droughts affect the rainfed areas. Less than ten percent of the arable area is irrigated but the irrigated area accounts for a substantial proportion of the value of the country's total agricultural output, the horticultural, fruit and wine sectors being particularly concerned. The commercial farming sector produces more than 95 percent of the total marketed agricultural output, the smallholder sector five percent.

In view of climatic and certain physical constraints (soils), the average yields of rainfed cereals are low compared with those of the temperate regions of the northern hemisphere. However, the implementation of best-known practices can result in high yields even under these conditions.

Maize accounts for 41 percent of total fertilizer application, the second largest fertilizer consumer being sugar cane at 18 percent. The horticultural and fruit crop sectors account for 20 percent of fertilizer consumption but their contribution to the total value of crop production is much greater.

Until the 1980s, the fertilizer and agricultural sectors received substantial governmental support. The removal of controls and subsidies accelerated a restructuring of the fertilizer industry. Some fertilizer plants have been closed, resulting in an increase in fertilizer imports. The reduction in agricultural support led to a substantial reduction in the area of cereals, marginal areas being taken out of cultivation and allowed to revert to natural grazing. Financial constraints and the reduced arable area resulted in a 37 percent fall in the use of phosphate fertilizers, compensated, but only in part, by a gradual but steady increase in nitrogen use.

A great deal of research has been carried out to determine fertilizer requirements for crops in South Africa. Fertilizer manufacturers and blenders provide a technical service to farmers through sales representatives and technical support staff.

Eighteen million people, or forty percent of the population, live in poverty, most of them in rural areas. An increase in the purchasing power

of these people would stimulate the demand for food and indirectly the demand for fertilizers. A proper use of fertilizers and other recommended practices could have a significant impact on raising the agricultural productivity and incomes of smallholders.

For the time being current trends are expected to continue, with a further reduction in the cropped area, more intensive production in the remaining areas and a stable or slowly growing fertilizer demand.

Preface

This study, commissioned by the Food and Agriculture Organization of the United Nations (FAO), is one of a series of publications on fertilizer use on crops in different countries.

The aim of the series is to examine the agro-ecological conditions, the structure of farming, cropping patterns, the availability and use of mineral and organic plant nutrients, the economics of fertilizers, research and advisory requirements and other factors that have led to present fertilizer usage. The reports examine, country by country, the factors that will or should determine the future development of plant nutrition.

During the past two decades, increasing attention has been paid to the adverse environmental impact of both the under use and the over use of plant nutrients. The efficient use of plant nutrients, whether from mineral fertilizers or from other sources, involves the shared responsibility of many segments of society, including international organizations, governments, the fertilizer industry, agricultural research and advisory bodies, traders and farmers. The publications in the series are addressed to all these parties.

Fertilizer use is not an end in itself. Rather it is a means of achieving increased food and fibre production. Increased agricultural production and food availability can, in turn, be seen as an objective for the agricultural sector in the context of contributing to the broader macroeconomic objectives of society. A review of the options available to policy-makers is given in the FAO/IFA 1999 publication entitled *Fertilizer Strategies*.

The contents of the series of studies differ considerably from country to country, in view of their different structures, histories and food situation. In each case, the aim was to arrive at a better understanding of the nutrition of crops in the country concerned.

Abbreviations

ARC	Agricultural Research Council
BASOS	Afrikaans Acronym for “Fertilizer Advisors Training and Accreditation Course”
CSIR	Council for Scientific and Industrial Research
EC	Eastern Cape Province
FAS	Fertilizer Advisory Service
FS	Free State Province
FSSA	Fertilizer Society of South Africa
Gau	Gauteng Province
GPS	Global Positioning System
GSA	Grain South Africa
ISCW	Institute for Soil, Climate and Water
KN	Kwazulu-Natal Province
Lim	Limpopo Province
Mpu	Mpumalanga Province
NC	Northern Cape Province
NW	North West Province
SASRI	South African Sugar Research Institute
SGI	Small Grain Institute
TUT	Tshwane University of Technology
UNCCD	United Nations Council on Combating Desertification
WC	Western Cape Province
WTO	World Trade Organization

Fertilizers

AS	Ammonium sulphate
CAN	Calcium ammonium nitrate
DAP	Diammonium phosphate
MAP	Mono-ammonium phosphate
MOP	Muriate of potash

SOP	Sulphate of potash
SSP	Single superphosphate
TSP	Triple superphosphate
N	Nitrogen
P_2O_5 or P	Phosphate*
K_2O or K	Potash*
NPK:	$N+P_2O_5+K_2O$ or compound fertilizers containing the three nutrients

* Phosphate and potash may be expressed as their elemental forms P and K or as their oxide forms P_2O_5 and K_2O . Nitrogen is expressed as N. In this study, phosphate and potash are expressed in their oxide forms.

Chapter 1

Introduction

South Africa has an average annual rainfall of less than 500 mm. According to the United Nations Council on Combating Desertification (UNCCD) system for defining dry lands, more than 80 percent of its land surface is classified as semi-arid to arid. Only 18 percent is classified as dry sub-humid and sub-humid. Rainfed crop production is concentrated in the latter two zones, as well as in the central and eastern reaches of the semi-arid zone, where favourable soil characteristics occur.

The total land area of South Africa is 127 million hectares of which 82 percent (100 million hectares) is agricultural land. Only 14 percent of the latter (14 million hectares) receives sufficient rainfall for arable crop production, while the remainder is used for extensive grazing, forestry and wildlife/nature conservation. Only 1.35 million hectares (less than 10 percent of total arable land) are under irrigation but they produce a significant proportion of the country's total agricultural output, notably in horticultural and vegetable production and viticulture.

South Africa's total gross value of agricultural output in 2003/04 is estimated at R72 000 million. The contribution of agriculture, fishing and forestry to Value Added in 2003 was R42 000 million, which represents 3.8 percent of the Total Value Added (R1 100 000 million) to the economy. However, when forward and backward linkages are taken into account, agriculture's contribution to GDP (Value Added) is estimated at 13 percent.

South Africa's total population (2000 census) is 44.7 million. The current annual population growth rate is estimated at 1 percent or below - down from 2.1 percent in 1991 and 1.4 percent in 2001.

Approximately 40 percent of the population, or 18 million people, can be classified as living in poverty. While the country is self-sufficient in food production, 43 percent of households are vulnerable to food insecurity (National Treasury, 2003). Poverty is more pervasive in rural areas, particularly in the former homelands. Alleviating food insecurity

will therefore require more effort being directed towards subsistence agriculture and developing smallholder agriculture. Fertilizer application in these sectors can have a significant impact on raising smallholder agricultural productivity, especially in view of declining soil fertility levels which have become synonymous of subsistence agriculture throughout Africa (Machete *et al.*, 2004).

South African agriculture is dualistic in nature, consisting of the less developed/subsistence sector referred to above and a well developed commercial sector. The number of commercial farmers is estimated at between 50 000 and 60 000. They produce more than 95 percent of total marketed agricultural output.

Since the democratic elections of 1994, major policy initiatives supported by legislation have been introduced to address the historical distortions in agriculture. These initiatives include the marketing of agricultural products, water policies, basic conditions of employment, skills development, land reform and trade policy reforms. Although these policy changes have resulted in significantly reduced formal support mechanisms for commercial farmers, agriculture as a whole and the fertilizer sector in particular, are still dominated by the commercial sector. Consequently, the focus in this study will be on fertilizer use in the commercial system.

Chapter 2

Climate and agro-ecological zones

Figure 1 shows the location of the nine provinces of South Africa, the main cities and towns, national roads and rivers and Table 1 shows the area.

RAINFALL

The average annual rainfall, illustrated in Figure 2, shows a rapid decline from east (> 800 mm) to west (< 200 mm). More than 60 percent of the country receives less than 600 mm per annum, and approximately one fifth of the country receives less than 200 mm per annum. The southern

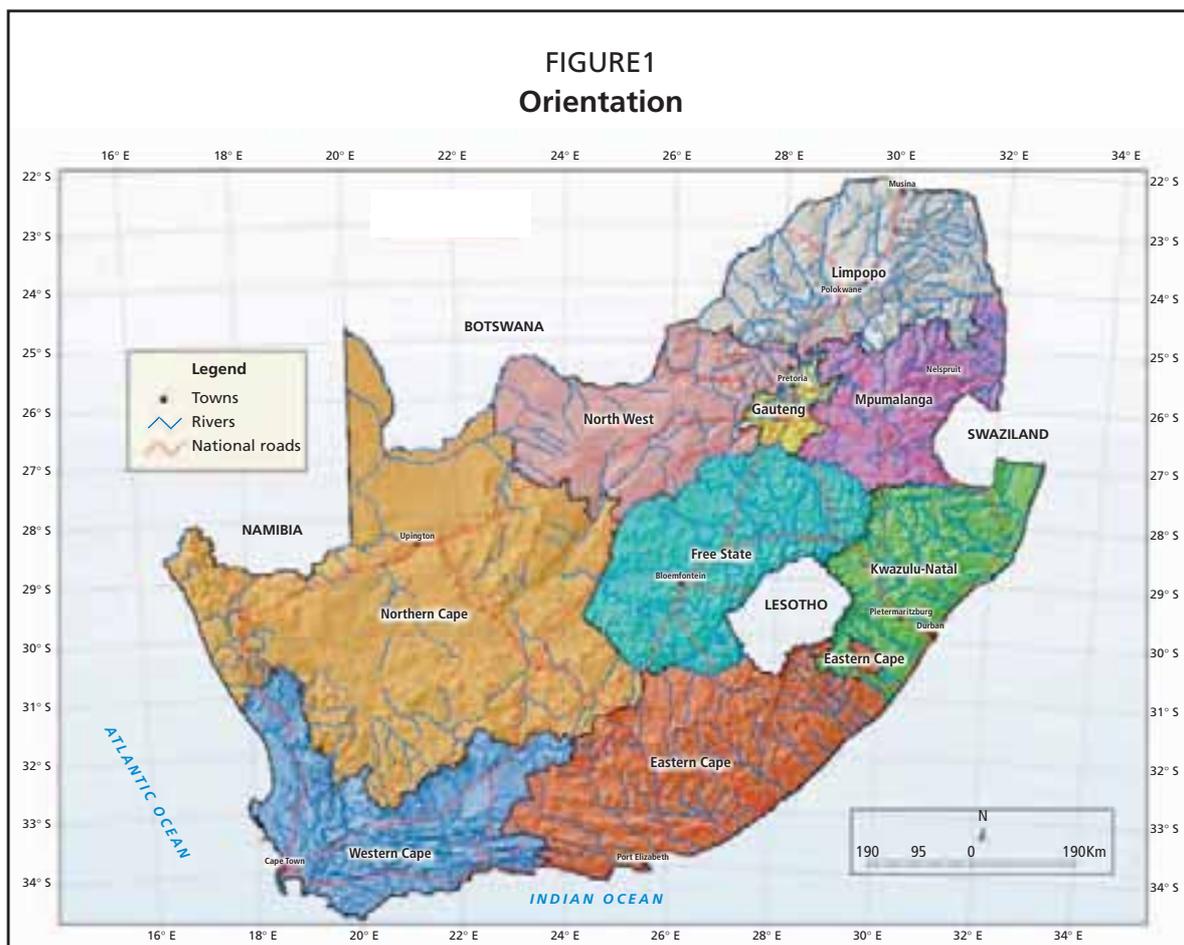
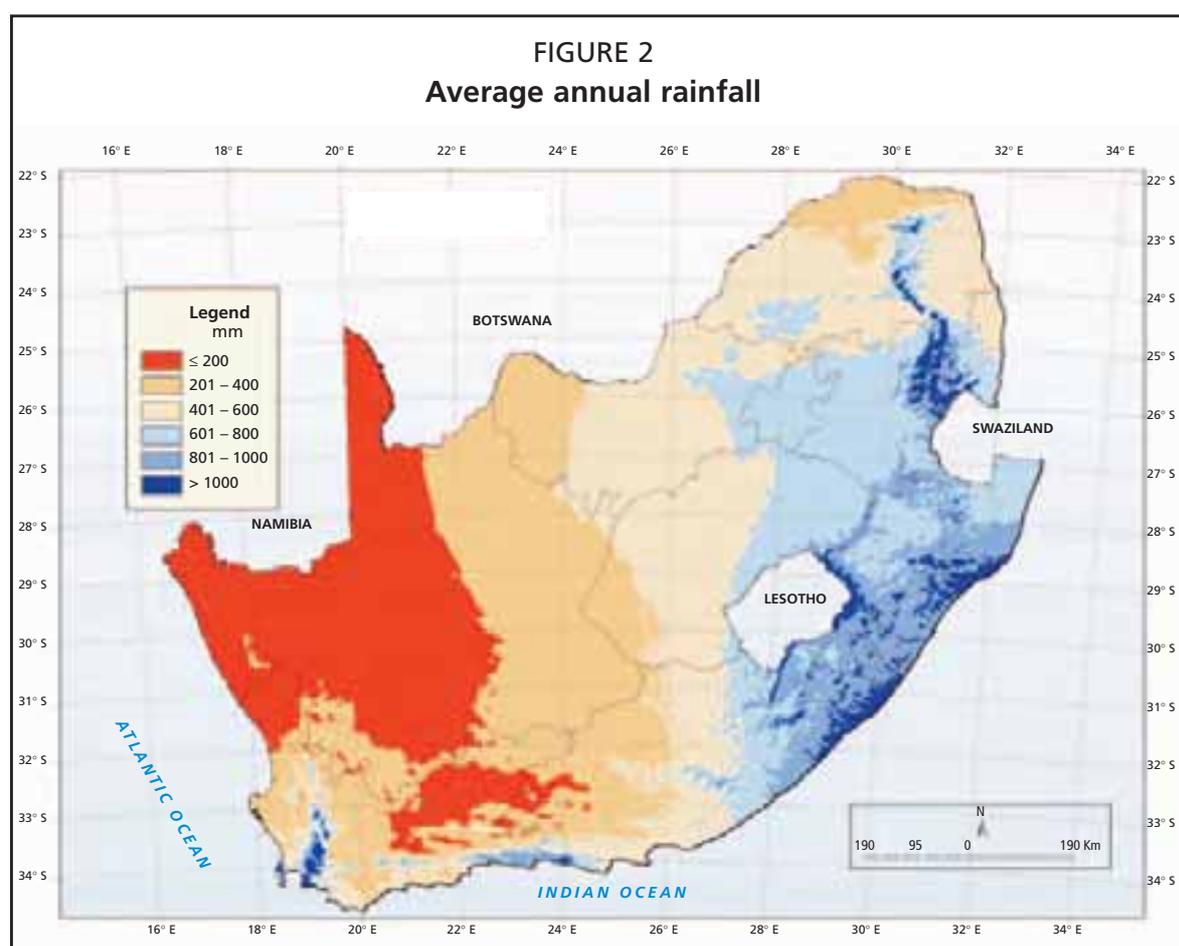


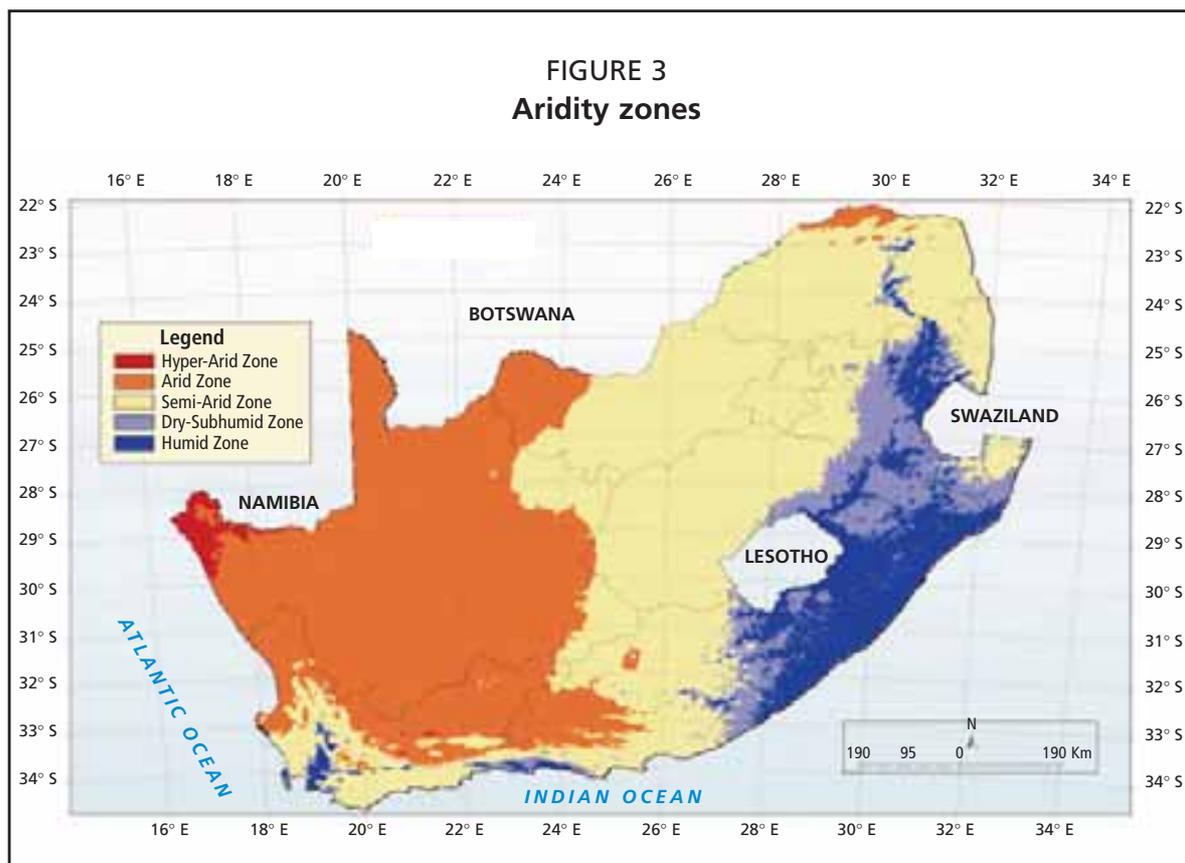
TABLE 1
Areas of the provinces of South Africa

Province	Area ('000 ha)	Percent
Eastern Cape	16 987	13.9
Free State	12 980	10.6
Gauteng	1 699	1.4
Kwazulu-Natal	9 231	7.6
Limpopo	12 282	10.1
Mpumalanga	7 937	6.5
North West	11 616	9.5
Northern Cape	36 274	29.7
Western Cape	12 951	10.6
Total	121 957	100

Source: ARC-ISCW, 2004.

coastal region of the Western Cape Province receives rainfall throughout the year, while the rest of the province gets its rainfall in winter. The remainder of the country is classified as summer rainfall area.





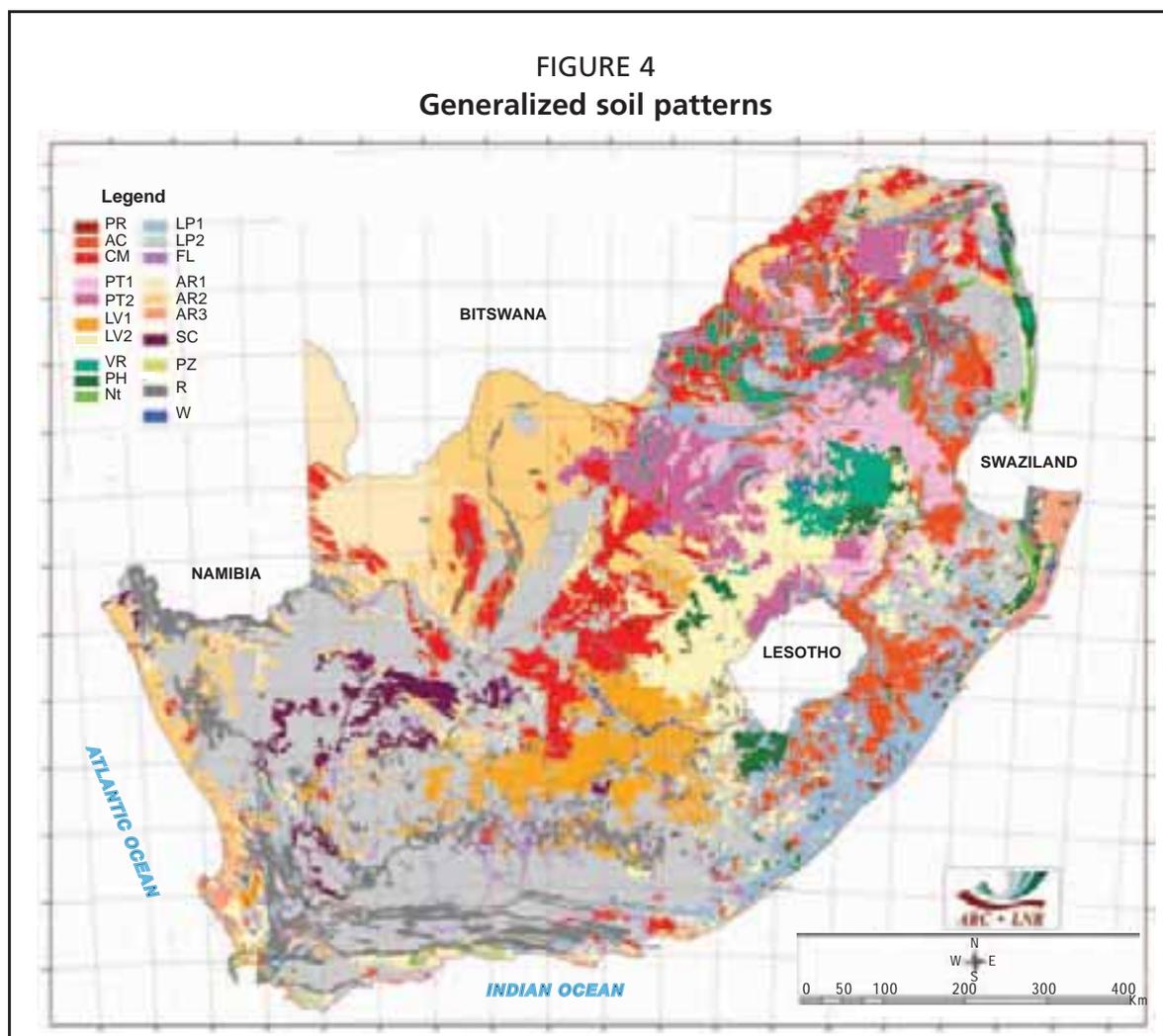
ARIDITY ZONES

According to the UNCCD index for defining dry lands, 80 percent of South Africa is semi-arid to arid, and only 18 percent is dry sub-humid to humid (Figure 3).

SOILS

Soil surveys have a long history in South Africa. Natural land type surveys, conducted by the land survey staff of the Agricultural Research Institute for Soil, Climate and Water (ARC-ISCW) since the early seventies, are the source of information of generalized soil maps of the country. Figure 4 represents a simplified baseline of soils of South Africa and the legend is explained in Table 2.

More than a third of the country's soils are shallow with minimal development. South African cultivated soils are generally very low in organic matter and are susceptible to wind erosion. They are also susceptible to acidification through cultivation and nitrogen fertilization



and a liming strategy is indicated under normal cultivation practices. This is particularly true for leached soils in higher rainfall areas.

Natural soils across the whole country are low in bio-available phosphorus (60 percent less than 10 mg/kg), zinc (< 3 mg/kg) and copper (< 2 mg/kg) (ARC-ISCW, 2004).

THE AGRICULTURAL REGIONS

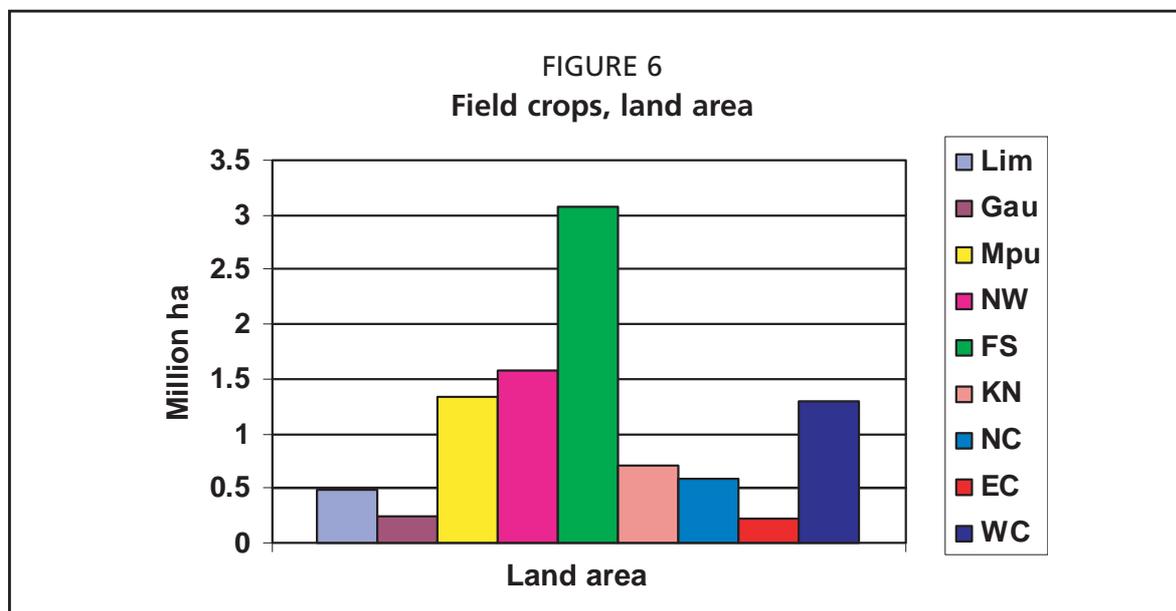
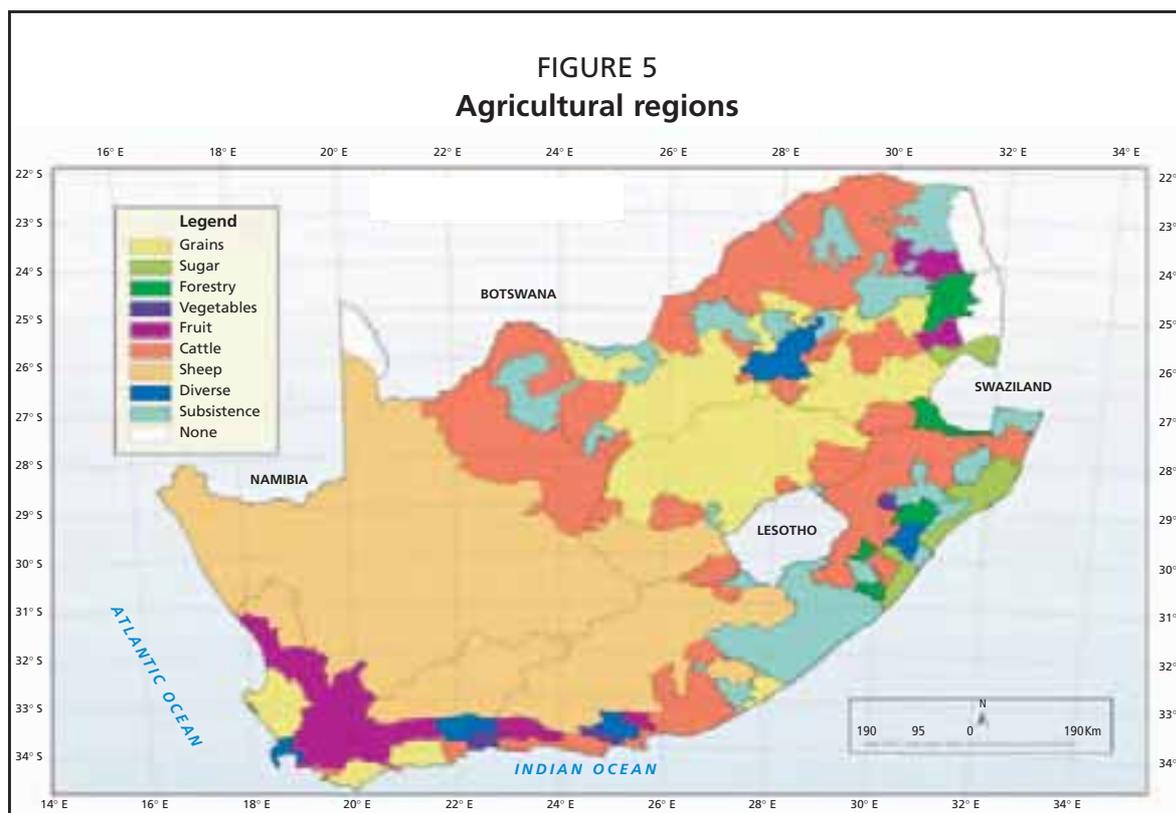
The main farming systems are shown in Figures 6 to 10 (Agricultural Survey 1993, as reported in Agricultural Statistics, 2004). They correspond closely to the aridity zones in Figure 3.

The Free State, North West and Mpumalanga highveld can be considered collectively as South Africa's "bread basket". Maize is the

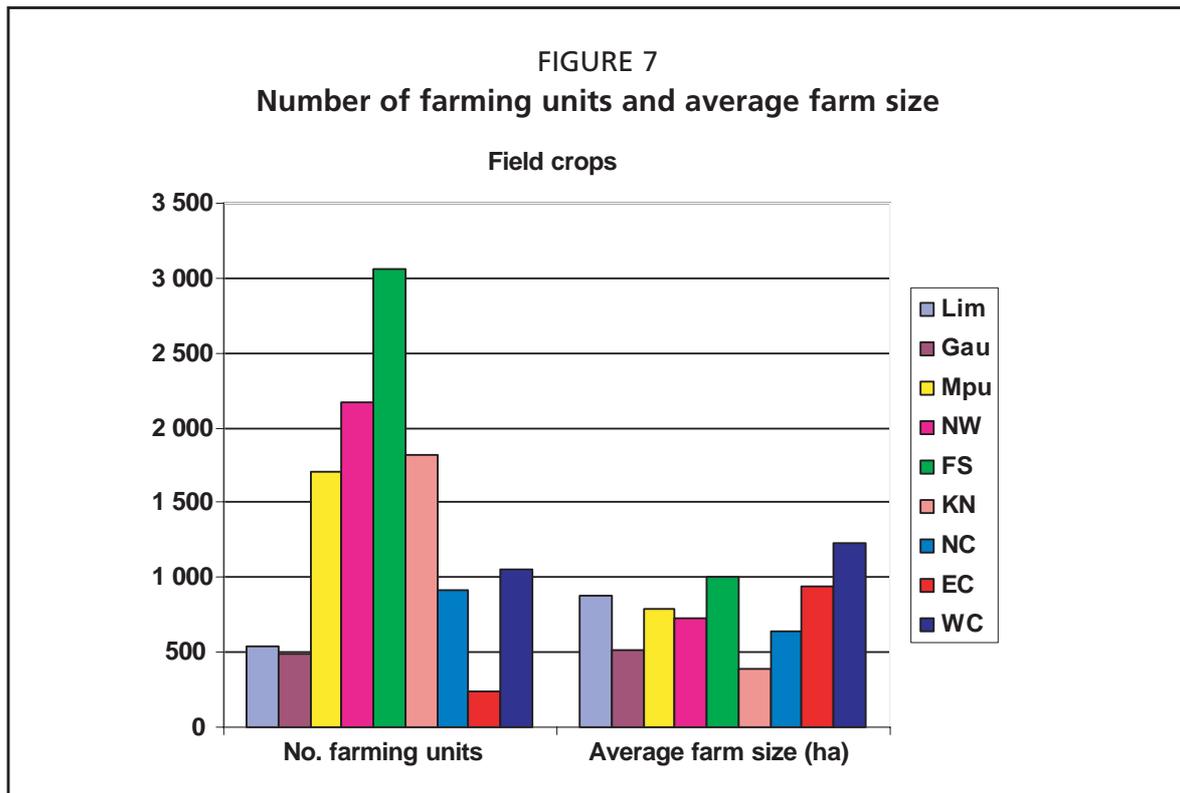
TABLE 2

Soil characteristics

Red-yellow well drained soils generally lacking a strong texture contrast	
Ferralsols (FR)	Red and yellow soils with a humic horizon
Acrisols (AC)	Red and yellow, massive or weakly structured soils with low to medium base status
Cambisols (CM)	Red, massive or weakly structured soils with high base status
Soils with a plinthic catena	
Plinthosols1 (PT1)	Red, yellow and greyish soils with low to medium base status
Plinthosols2 (PT2)	Red, yellow and greyish soils with high base status
Soils with a strong texture contrast	
Luisols1 (LV1)	Soils with a marked clay accumulation, strongly structured and a reddish colour
Luisols2 (LV2)	Soils with a marked clay accumulation, strongly structured and a non-reddish colour. In addition one or more of vertic, melanic and plinthic soils may be present
Well structured soils generally with a high clay content	
Vertisols (VR)	Dark coloured, strongly structured soils dominated by cracking and swelling clays (vertic soils). In addition, one or more of melanic and red structured soils may be present
Phaezems / Kastanozems (PH/KS)	Soils with dark coloured, well structured topsoil with high base status (melanic soils). In addition, one or more of vertic and red structured soils may be present
Nitisols (NT)	Deep, well drained, dark reddish soils having a pronounced shiny, strong blocky structure (nutty), usually fine (red structured soils). In addition, one or more of vertic and melanic soils may be present
Soils with limited pedological development	
Leptosols1 (LP1)	Soils with minimal development, usually shallow on hard or weathering rock, with or without intermittent diverse soils. Lime rare or absent in the landscape
Leptosols2 (LP2)	Soils with minimal development, usually shallow on hard or weathering rock, with or without intermittent diverse soils. Lime generally present in part or most of the landscape
Fluvisols (FL)	Soils with negligible to weak profile development, usually occurring on deep deposits
Sandy soils	
Arenosols1 (AR1)	Red, excessively drained sandy soils with high base status - dunes are present
Arenosols2 (AR2)	Red and yellow, sandy well drained soils with high base status
Arenosols3 (AR3)	Greyish, sandy excessively drained soils
Strongly saline soils	
Solonchaks (SC)	Strongly saline soils generally occurring in deep deposits on flat lands
Podzolic soils	
Podzols (PZ)	Soils with a sandy texture, leached and with sub-surface accumulation of organic matter and aluminium with or without iron oxides, either deep or on hard or weathering rock
Rocky areas	
Regosols (R)	Rock with limited soils



dominant field crop in all three provinces, followed by wheat (Free State), sunflowers, dry beans, grain sorghum and groundnuts (Free State and North West). In Mpumalanga province intensive crop farming under irrigation is practiced along lower river basins in the Lowveld, notably along the Komati and Crocodile rivers.

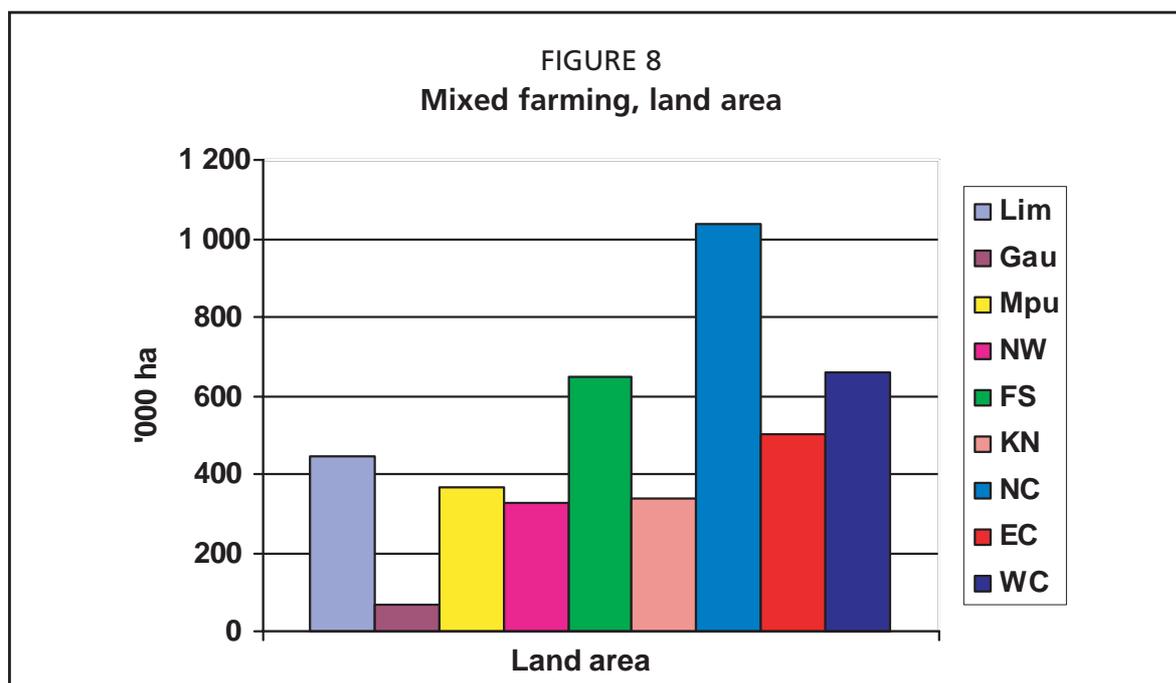


Irrigation farming is practiced in the Northern Cape, mostly along the lower Orange River basin. Low-yielding rainfed maize, sorghum and sunflowers are produced in the northeastern part of the province where average rainfall is slightly higher than in other parts.

In the Western Cape, cereals (mostly rainfed wheat in rotation with lupin, canola and/or sub-terranean clover) are grown mainly in the Rûens and Swartland sub regions.

Sugar cane (mostly rainfed) is the major crop in Kwazulu-Natal. It is cultivated along the Indian Ocean seaboard and the Midlands region. Soils vary from grey and red sands on the coastal dunes, to weakly weathered soils in the coastal hinterland (South African Sugar Experiment Station, 1999). Summer grain crops are grown at higher altitudes predominantly in the Winterton/Bergville area of northern Kwazulu-Natal. Soil acidity and aluminium toxicity are a problem. This requires specialized amelioration strategies to ensure optimum utilization of the soil potential.

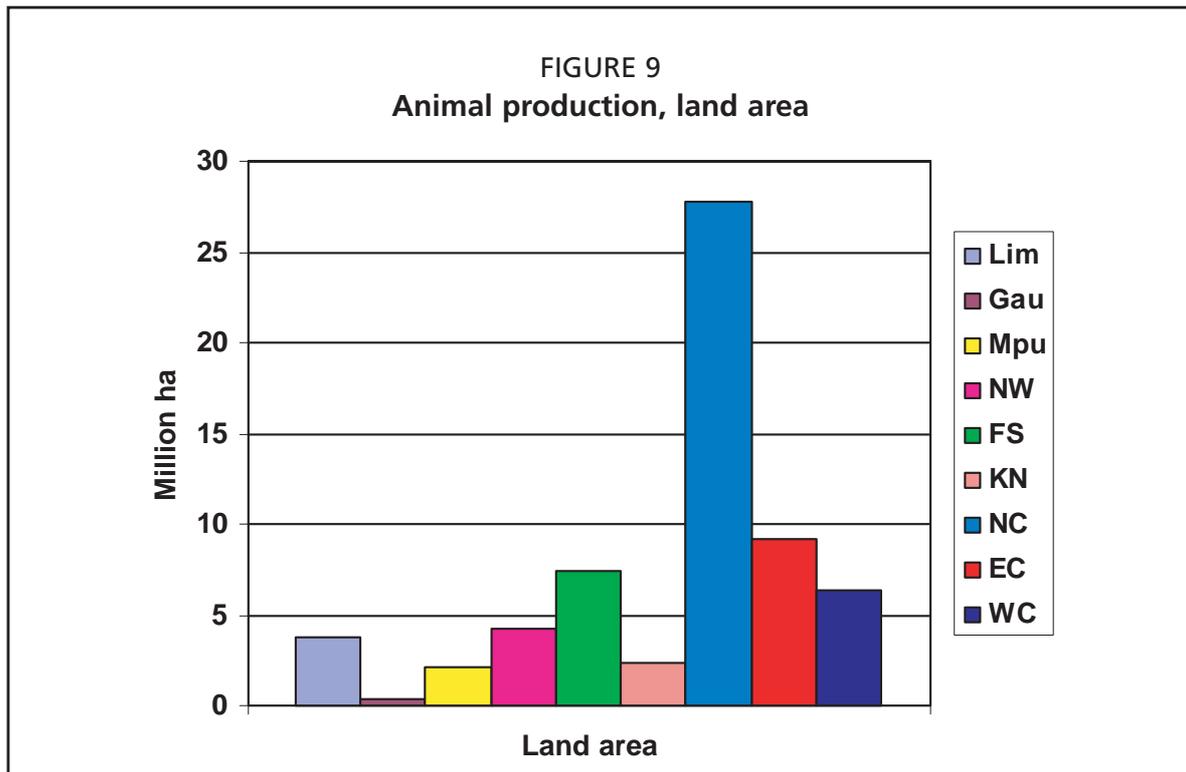
The Western Cape is well known for its vineyards, wines and deciduous fruits. Vines and deciduous fruits are cultivated in protected valleys where soil, terrain and irrigation possibilities permit. In the Northern Cape vines, table grapes (for export and domestic consumption), fresh



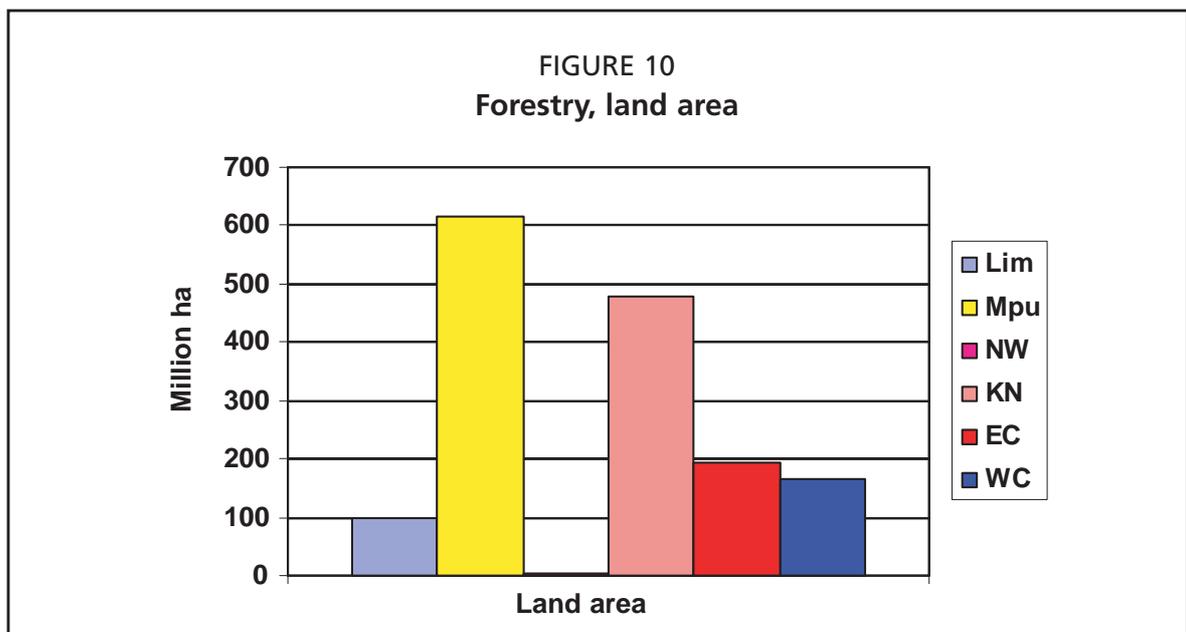
and dried fruits, wheat, maize and cotton to a lesser extent are cultivated under irrigation. In Limpopo, intensively irrigated subtropical fruit and vegetable production are practiced in the eastern Lowveld. In Mpumalanga province, citrus, subtropical fruits and nuts and sugar cane are the dominant crops under irrigation.

Mixed farming is particularly important in the Northern Cape Province (Figure 9). Gauteng province falls within the summer grain area but is classified as “diverse” because of its geographical location around the large metropolitan complexes of Pretoria, Johannesburg, the Vaal Triangle and East Rand. The emphasis in this province is on mixed and vegetable farming.

The Northern Cape is by far the largest province in South Africa and accounts for 36 percent of its total land area. Almost the entire province falls within the arid zone classification. Very extensive cattle and sheep farming predominate (Figure 10). Range farming predominates also in the Eastern Cape; the greater part of this subsistence region (previously Transkei/Ciskei Homelands) has a high agricultural potential but is underdeveloped. The typically dry savanna of Limpopo Province is devoted to cattle farming. Only about three percent of the animal production area is fertilized. Extensive range land receives little or no fertilizer.



Mpumalanga east of the Drakensberg escarpment favours forestry along the escarpment (Figure 11). There is an important area of forest also in Kwazulu-Natal. Forests receive little or no fertilizer.



Chapter 3

Crop production

The field crops occupy 92 percent of the total area, maize alone accounting for 51 percent.

REGIONAL CROP PRODUCTION

The assessments of the production of field crops in the different agricultural regions, described below, are approximate but more than 80 percent accurate. For example, both maize and wheat are grown in the dry sub-humid region of Kwazulu-Natal, but in the national context, the areas grown are small. The contributions of these “minor” regions, however, have been included in the total value of production and average national yields shown in Table 3.

Cereals and oilseeds

Crops in this category are grown under widely varying soil and rainfall conditions. In the summer rainfall regions of the Free State, North West, Mpumalanga and Kwazulu-Natal, rainfall varies from < 500 mm/year in the west to > 700 mm/year towards the east, in Mpumalanga and Kwazulu-Natal. With the exception of soybeans, which are grown mostly in the eastern, higher rainfall regions, the bulk of these crops are produced under arid to semi-arid conditions according to the UNCCD classification.

In the Western Cape region, which accounts for 33 percent of the total area under wheat production, wheat is produced under conditions of rainfall varying from less than 350 mm/year to more than 460 mm/year.

It is not surprising, therefore, that the average yields of rainfed cereals (2.4 to 2.7 tonnes/ha) and oilseeds (1.6 tonnes/ha) are much lower than in most parts of the world. However, with implementation of best cultivation practices and the use of the Global Positioning System (GPS) in conjunction with soil and foliar analysis, many progressive farmers are

TABLE 3
Sown/planted areas, yields and value of production

Crop/groups	Area (‘000 ha)	Average yield (tonnes/ha)	Production value (R billion)
<i>Field crops</i>			
Maize	3 354	2.73	8.45
Wheat	846	2.41	2.67
Sunflower	640	1.58	1.25
Soybeans	119	1.60	0.28
Sugar cane	432	51.1 ¹	3.32
Lucerne	180	-	0.61 ²
Other pastures	395	-	1.06 ²
Subtotal	5 966		17.64
<i>Industrial crops</i>			
Tobacco	17	-	0.71
Cotton	42	1.42 ³	0.14
Subtotal	59		0.85
<i>Horticulture/fruit</i>			
Citrus	64	-	2.64
Subtropical fruits/nuts	50	-	0.93
Vines	180		3.60 ⁴
Deciduous fruit	50		2.9
		Total production (‘000 tonnes)	
Vegetables	95	1 403	-
Potatoes	50	2 083	-
Subtotal	489		10.07 ⁵
Total	6 514		28.56⁵

Notes:

¹ Cane; ² Hay offered for sale; ³ Seed cotton; ⁴ Grapes, table and processed;

⁵ Excluding vegetables and potatoes.

The total value of production includes exports.

Source: Abstract of Agricultural Statistics, Department of Agriculture, 2004.

able to produce yields well in excess of the national average. It is common for these farmers to achieve yields of more than four tonnes/ha of maize in the Free State and North West provinces and five to six tonnes/ha in Mpumalanga where rainfall is higher. A group of maize farmers in northern Kwazulu-Natal have consistently produced yields in excess of eight tonnes/ha, with yields of eleven tonnes/ha on selected fields.

Sugar cane

Of the 432 000 ha under sugar cane, some 78 000 hectares (18 percent) are irrigated, mostly in Mpumalanga Lowveld but to a lesser extent also in northern Kwazulu-Natal (Pongola and Umfolozi Flats). Sugar cane accounts for 18 percent of fertilizer use, the second after maize and contributes some 10 percent to the total value of production.

Horticultural and fruit crops

Citrus and subtropical fruits, vines, deciduous fruits and most vegetables are grown under irrigation. A sizeable proportion of deciduous and citrus fruits is exported. Fertigation, either via drip or micro-jet, is common practice.

IRRIGATION

The official statistics produced by the Department of Agriculture do not differentiate between irrigated and rainfed areas. Estimates of the proportions of crops that are irrigated in some provinces are as follows:

Field crops

Mostly rainfed except:

- Maize: Free State 36 per cent, Mpumalanga 20 per cent, North West 28 per cent irrigated
- Wheat: Free State 35 per cent, Western Cape 33 per cent, Northern Cape 16 per cent
- Sunflower: Free State 51 per cent, North West 35 per cent
- Soybeans: Mpumalanga 55 per cent, Kwazulu-Natal 15 per cent, Free State 13 per cent
- Sugar cane: Kwazulu-Natal rainfed; Mpumalanga irrigated
- Lucerne: irrigated in most regions

Industrial crops

- Tobacco: Mostly irrigated in North West, Limpopo & Mpumalanga
- Cotton: Mostly irrigated in North West and Limpopo

Horticultural and fruit crops

- Citrus: Mostly irrigated in Mpumalanga, Western Cape, Eastern Cape and Limpopo
- Subtropical fruits & nuts: Mostly irrigated in Mpumalanga, Limpopo and Kwazulu-Natal
- Vines: Mostly irrigated in Western Cape and Northern Cape
- Deciduous fruits: Mostly irrigated in Western Cape
- Vegetables: Mostly irrigated in most regions
- Potatoes: Irrigated and rainfed in most regions

These estimates are reliable for some crops, for others they are part estimated. For example, citrus orchards are cultivated exclusively under irrigation. The same applies to sugar cane grown in the Lowveld region of Mpumalanga. Some areas of maize and wheat are irrigated but they are not significant in respect of the areas sown/planted, crop production or fertilizer use.

PRODUCER ORGANIZATIONS

Producer organizations in South Africa are well structured and in general they function efficiently.

Farmers organize study groups, usually not exceeding 25 members. They typically invite experts to address the group on topics related to technology and new developments. They conduct their own demonstrations to test new products or technology, as a first step towards their adoption or rejection.

Regional bodies provide the next tier, for which agri-political issues begin to play a more important role in day-to-day business. Their representatives lobby regional or provincial authorities on broader issues such as crime prevention and infrastructural issues.

The next tier comprises the national producer organizations. Grain South Africa (GSA) and the Cane Growers Association (through the South African Sugar Association) are two of the better-known bodies. Their senior executives lobby the national government at cabinet level on broad national issues affecting the industries they represent. Issues currently under discussion are education, the development of the skills

of farm workers, black empowerment in agriculture, health care, crime prevention and tariffs.

In addition, there are numerous similar but smaller producer organizations.

Chapter 4

Plant nutrient supply

FERTILIZER PRODUCTION

The development of the mining industry in the early 20th century necessitated the production of explosives. This led to the founding of a viable fertilizer industry, initially based on by-product sulphuric acid and imported rock phosphates.

Foskor (a government owned corporation) was established in 1951 to exploit the large igneous phosphate complex near Phalaborwa. This successful initiative stimulated further development and major facilities (nitrogen and phosphates) were commissioned through the 1960s, 1970s and 1980s.

During the post World War II years, until the early eighties, the industry flourished in a protected trade environment and government support measures for agriculture in general. One consequence of the latter was the encroachment of cultivation agriculture on marginal areas that are better suited for extensive and semi-extensive cattle farming. While these policies stimulated the horizontal expansion of fertilizer use in the 1970s and 1980s, the movement was not sustainable.

The liberalization of trade policies and the opening-up of the economy that started around 1984, and which gained momentum during the nineties, have led to large scale rationalization and restructuring in the industry throughout the 1980s and 1990s. The fertilizer industry of today is fully exposed to world market forces and operates in a totally deregulated environment with no import tariffs or government sponsored support measures.

Having been a net exporter of downstream fertilizers until the late nineties, South Africa became a net importer after further major plant closures in late 1999 and early 2000. In a fluid world fertilizer market, further rationalization is likely to continue in future.

The South African fertilizer market is very competitive, with four national and two regional operators. Competition is driven through price incentives, product differentiation and specialized services such as individual agronomic advice, custom blending and application.

FERTILIZER IMPORTS AND EXPORTS

South Africa's recent domestic fertilizer demand is around 760 000 tonnes plant nutrients (N + P₂O₅ + K₂O). This demand is met through local production and imports (Table 4).

With no local deposits of potassium salts, South Africa's total potassium requirement has to be imported. The situation as regards the use of locally produced phosphate rock concentrate as raw material for the production of most phosphate intermediates and downstream products may change in future in favour of a greater emphasis on importation.

South Africa is a significant exporter of phosphoric acid, with Foskor's Richard Bay's total capacity of 725 000 tonnes P₂O₅ being destined for the export market.

Apart from the intermediates and single element fertilizers listed in the table, a wide range of multi-element compounds is offered. Multi-element mixtures are available in the form of granular fertilizers, dry bulk blends, liquid or suspension fertilizers, with or without zinc and, if required, with copper or boron. Some 400 000 tonnes of granular NPK compounds are exported annually to markets in sub-Saharan Africa. These exports contain a component of imported intermediates.

TABLE 4
Fertilizer demand, domestic production and imports

Nutrient	Demand ('000 tonnes)	Domestic production ('000 tonnes)	Products	Imports ('000 tonnes)	Products
Nitrogen N	400	250	Mostly CAN, some AS	150	Mostly urea, some CAN and AS
Phosphate P ₂ O ₅	200	Over 90% of demand	SSP, TSP, MAP, NPKs, blends	Less than 10% of demand	Mostly DAP, some MAP and TSP
Potash K ₂ O	160	None		All imported	Mostly MAP and SOP, some KNO ₃ etc.

Source: Machete *et al.*, 2004 (modified).

The retail value of fertilizers sold on the South African market is more than R3 500 million.

THE USE AND VALUE OF MANURES

Manures remain an important source of plant nutrients, in addition to their undisputed advantages as a biological agent for improving soil health and productivity.

In a 1986 survey carried out by the Council for Scientific and Industrial Research (CSIR), as quoted in the Fertilizer Handbook of the Fertilizer Society of South Africa (FSSA, 2003), it is estimated that approximately 350 000 tonnes of chicken manure are generated in various forms, most of which was used as fertilizer at the time. Cattle feedlots also generate considerable quantities of manure. The same survey estimates that 75 000 tonnes of composted cattle manure was sold as fertilizer.

Assuming reasonable nutrient contents of these manures (FSSA Fertilizer Handbook, 2003), some 30 000 tonnes $N + P_2O_5 + K_2O$ were applied as fertilizer in 1986, or approximately 3 to 4 percent of the total nutrients consumed as inorganic fertilizer. In the absence of more recent data, it is reasonable to assume that today manures contribute about the same proportion.

The enrichment of manures (mostly chicken manure) with inorganic fertilizer has been general practice in South Africa for decades. In these products, the benefits of higher plant nutrient concentrations of inorganic fertilizers are combined with the benefits of manure. The NPK content of enriched manures typically varies between 18 and 20 percent.

Chapter 5

Fertilizer use, economics and distribution

TRENDS IN FERTILIZER CONSUMPTION

Between 1955 and 1981 fertilizer consumption grew at a steady rate, from 168 400 tonnes N + P₂O₅ + K₂O to more than 1.2 million tonnes – a seven-fold increase. This growth was made possible through vigorous support on the supply side by successive governments that supported agriculture during the apartheid era. The result was a steady expansion of cultivation agriculture – particularly maize – into marginal, semi-arid areas. This period saw also a rapid expansion of fertilizer manufacturing capacity in a protected environment. This involved quantitative import controls, high import tariffs and administered prices with guaranteed pre-negotiated returns on investment. The government supported market sharing arrangements between the major suppliers.

A protracted drought in 1982, followed by sharp increases in interest rates and a mini-recession stopped agricultural expansion. In less than three years, fertilizer consumption fell by thirty percent before finding a new equilibrium as demand driven agriculture began to take shape during the mid-eighties (Figure 11).

The steady growth in nitrogen consumption, albeit at a modest rate of 0.7 percent per annum, was accompanied by a decline in phosphate consumption, while K₂O consumption remained approximately constant (Table 5). During the expansion phase, farmers invested profits in increasing the phosphorus fertility levels of their soils. This became less attractive when interest rates became high and the cost per unit of P₂O₅ relative to N increased. The expansion in the area devoted to field crops, particularly maize, ceased and the area began to fall.

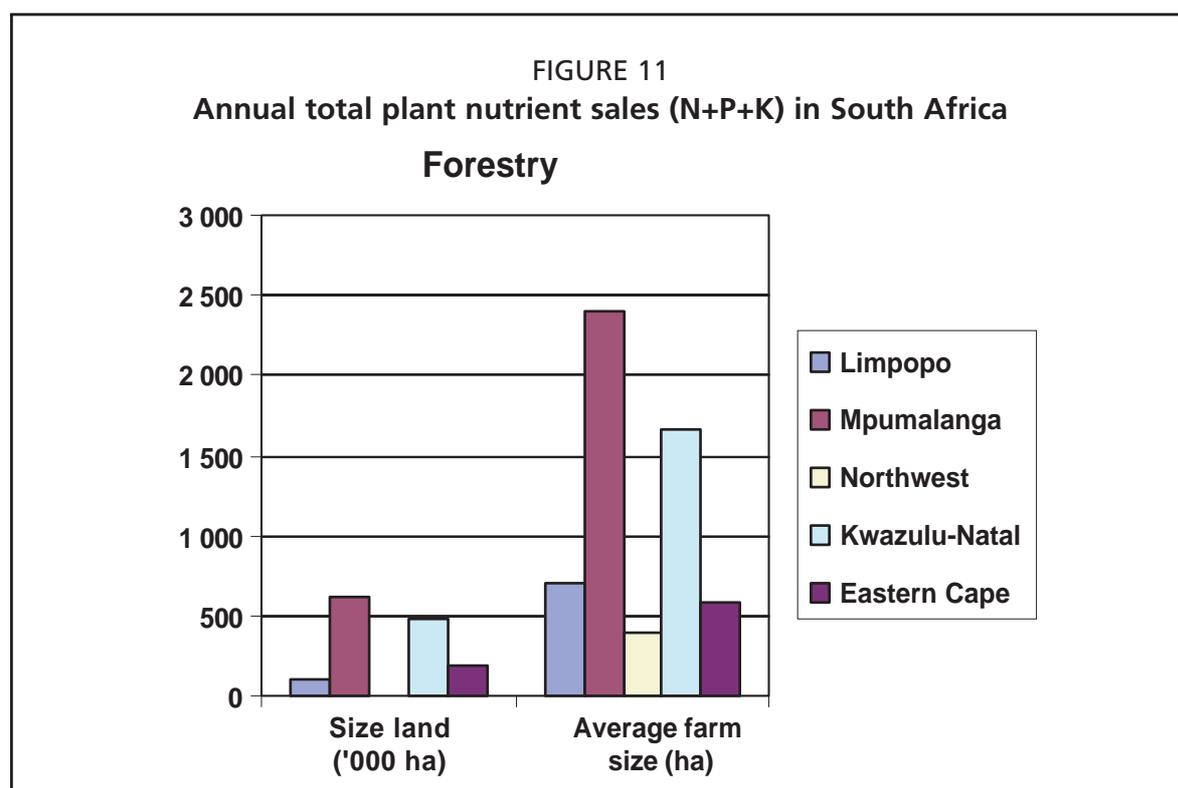


TABLE 5
Trends in fertilizer consumption

	Average of 5 year periods				Compounded growth rate (%)
	1984/88	1989/93	1994/98	1999/03	
	('000 tonnes)				
N	366.3	367.3	396.8	424.5	0.74
P ₂ O ₅	331.4	241.8	239.1	209.5	-2.26
K ₂ O	131.1	124.6	140.8	133	0.07
Total	828.8	733.7	776.7	767	-0.39

The area devoted to maize, wheat and grain sorghum has shrunk by 2.5 million hectares, while that of oilseeds has increased by 400 000 ha, resulting in a net loss of around 2 million hectares. Most of the areas taken out of cereals were allowed to revert to natural grazing.

FERTILIZER USE BY CROP

Although horticultural and fruit crops account for only 20 percent of total fertilizer use, their total value of production of R10 000 million is nearly 80 percent that of field crops, excluding sugar cane.

TABLE 6
Trends in planted areas of the major field crops

	5 year averages			
	1984/88	1989/93	1994/98	1999/03
	'000 ha			
Grain crops ⁽¹⁾	6 969	5 776	4 998	4 412
Compounded growth rate (%)	-	-1.9	-1.4	-1.2
Oil seeds ⁽²⁾	400	500	707	812
Compounded growth rate (%)	-	2.3	3.5	1.4

¹Totals of maize, wheat and sorghum

²Totals of sunflower and soybeans

Source: Abstract of Agricultural Statistics, Department of Agriculture, 2004.

TABLE 7
Proportions of crops fertilized and average rates of fertilizer use

Crop/groups	Percent fertilized	Rate, kg/ha of the fertilized area		
		N	P ₂ O ₅	K ₂ O
Field crops				
Maize	95	55	30	6
Wheat	100	30	40	4
Sunflower	85	15	21	2
Soybeans	40	7	25	8
Sugar cane	95	92	57	133
Lucerne	90	15	59	24
Other pastures	30	50	44	7
Industrial crops				
Tobacco	100	38	144	98
Cotton	50	36	22	3
Horticulture/fruit				
Citrus	100	80	35	60
Subtropical fruits/nuts	100	180	57	240
Vines	100	50	36	24
Deciduous fruit	100	110	159	83
Vegetables	100	170	159	120
Potatoes	100	170	160	120

Source: FSSA, 2004.

FERTILIZER USE RECOMMENDATIONS

The fertilizer requirements of crops have been researched extensively in South Africa. The first systematic field calibration work, with field trials

TABLE 8
Fertilizer consumption by crop

Crop/groups	N	P ₂ O ₅	K ₂ O	Total	Percent
	('000 tonnes)				
Field crops					
Maize	175	73	17	265	41
Wheat	25	18	3	46	7
Sunflower	8	11	1	20	3
Soybeans	<1	1	<1	2	<1
Sugar cane	38	24	54	116	18
Lucerne	2	10	4	16	2
Other pastures	21	16	3	40	6
Subtotal	269	153	82	505	78
Industrial crops					
Tobacco	0.6	3	2	6	<1
Cotton	0.5	0.5	0.1	1	<1
Subtotal	1	4	2	7	1
Horticultural & fruit crops					
Citrus	5	2	4	11	2
Subtropical fruit	9	3	12	24	4
Vines	8	5	4	17	3
Deciduous fruit	6	2	4	12	2
Vegetables	16	15	11	42	6
Potatoes	9	8	6	23	4
Subtotal	53	35	41	129	20
Total	323	192	125	641	100

Source: FSSA, 2004.

on the response of cereals to applied nutrients, was initiated in the early 1970s by the Department of Agriculture, Cedara (Farina *et al.*, 1992), with maize as the first test crop. This research was later extended to include also soybeans.

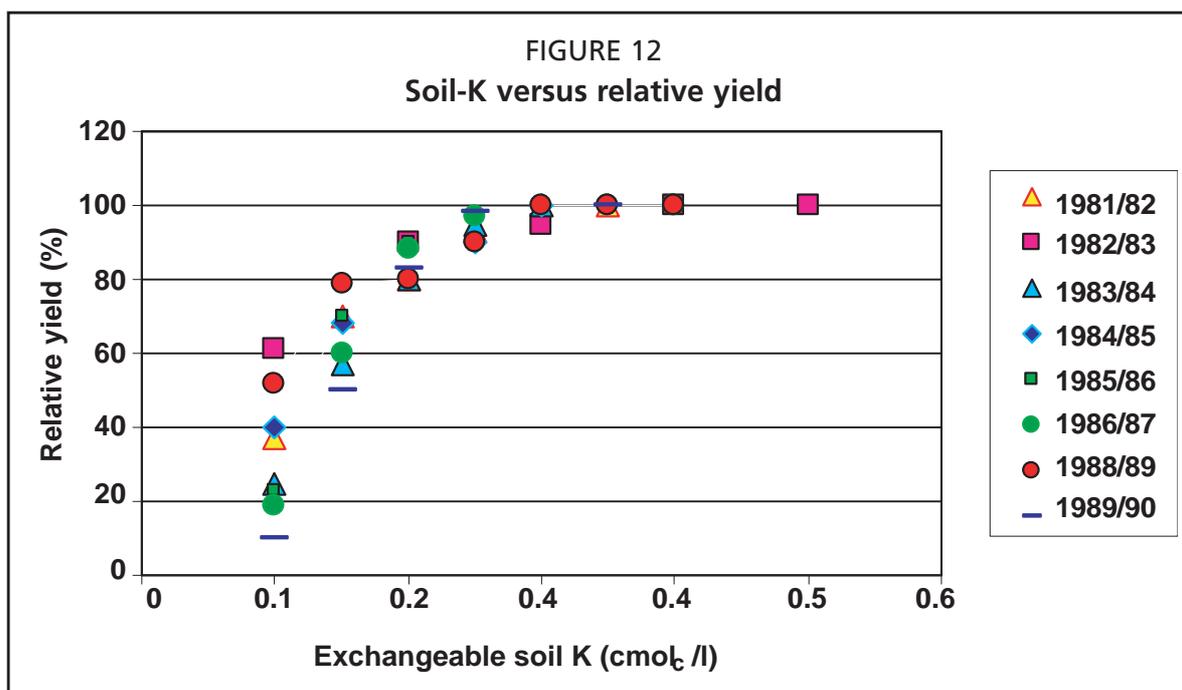
At about the same time, the FSSA established a research unit to conduct field calibration work on maize, sunflower, grain sorghum and groundnuts in the Free State, North West and Mpumalanga regions. The FSSA extended its research in the mid 1980s to include rainfed wheat in the Free State and Western Cape, while the ARC-Small Grain Institute (ARC-SGI) conducted its own soil fertility related research at research centres near Bethlehem in Free State and the Rûens region of the Western

Cape. This work culminated in fertilizer guidelines for rainfed wheat grown in the different regions, as well as for irrigated wheat (ARC-SGI, 2001; FSSA Fertilizer Handbook, 2003).

The profitability of the use of fertilizers, particularly on light and medium textured soils with low inherent nutrient fertility and low organic matter contents, was amply demonstrated by this research. An example from Farina's work, the relationship between soil-K and relative yield, is shown in Figure 12.

The South African Sugar Research Institute (SASRI, previously SASEX) is responsible for soil fertility research on sugar cane, including the economics of fertilizer use. In South Africa, efficient fertilizer practices have contributed greatly to the productivity of sugar cane (Meyer *et al.*, 2004). The history of this research dates back to the 1950s. It has led to detailed and widely accepted whole cycle fertilizer recommendation models for rainfed and irrigated sugar cane. The recommendations are given in Annex 1 of this publication.

The ARC-Specialty Research Institute's research responsibilities include the establishing of reliable fertilizer recommendations for the most important horticultural crops, citrus and other subtropical fruits and deciduous fruits.



Source: Farina *et al.*, 1992.

PRICE TRENDS

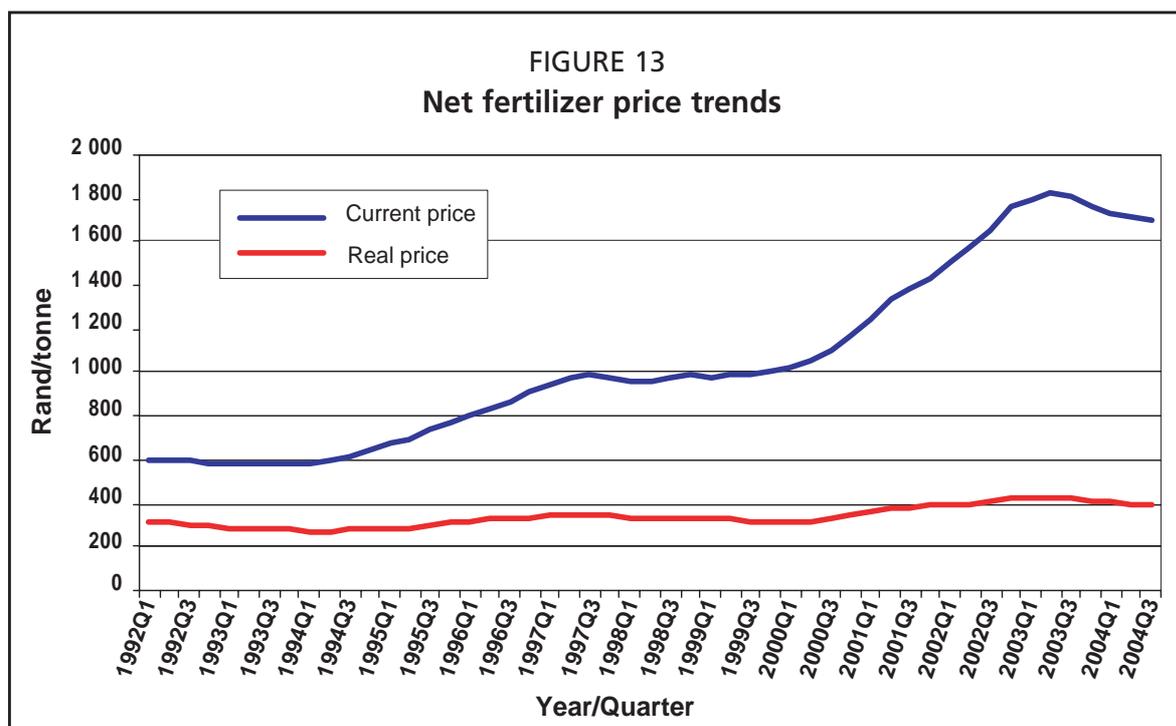
In a deregulated market environment, fertilizer prices are strongly influenced by international prices, currency exchange rates (R/US\$) and freight costs. Farm gate prices of fertilizer evidently include the cost of distribution, intermediate storage and packaging. Recent retail prices (industry averages, third quarter, 2004) are given below:

Urea	R2 464/tonne
MAP	R2 705/tonne
MOP	R2 110/tonne
CAN	R1 691/tonne

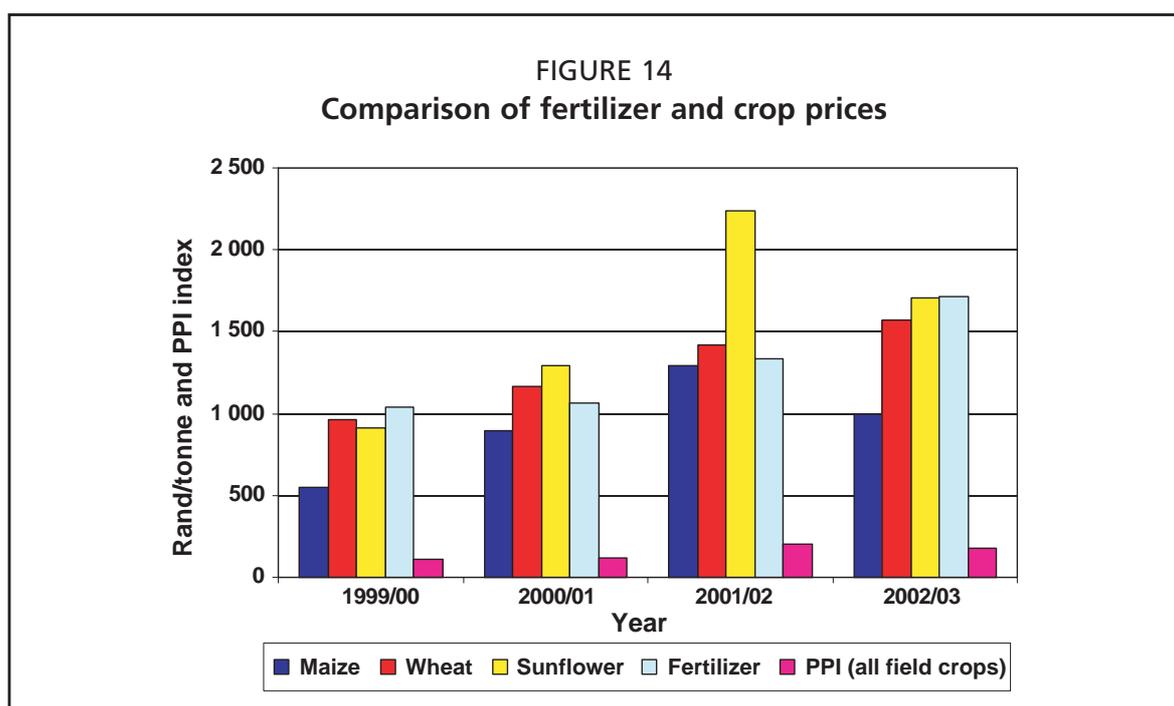
Fertilizer price trends are illustrated in Figure 13. The net fertilizer price in the figure reflects the weighted ex-factory / ex-importer fertilizer price per tonne of all fertilizer sold, calculated on a quarterly basis.

The sharp increases starting in 2001 and the easing of prices since the first quarter of 2003 reflected changes in the currency exchange rate and world prices.

In the strongly market-orientated agricultural economy, grain prices tend to fluctuate continuously between import and export parity, depending on the real and expected future surpluses or shortages.



Source: FSSA, 2004.



PPI: Producer price index

Source: FSSA, 2003; Abstract of Agricultural Statistics, Department of Agriculture, 2004.

The underlying price dynamics over a relative short period are illustrated by the comparison of fertilizer and grain prices given in Figure 14.

FERTILIZER DISTRIBUTION AND LOGISTICS

The two most common marketing channels in the commercial sector are:

- a. **Direct from the manufacturer/blender to the farmer.** The former employs his own sales representatives and technical support staff (e.g. agronomists). Direct contact is usually established by sales representatives. Soil sampling, fertilizer advice and evaluation of crop performance is a team effort, the quality of which often determines whether a customer is a first time buyer or becomes a long-time client. This model is preferred by most of the national and regional operators.
- b. **Manufacturer/blender to farmer via an agent or dealer.** The former enters into agreements with independent agents, who may also act on behalf of other agro-input suppliers, for example of seeds and agrochemicals. The manufacturer/blender would normally supply technical assistance as and when required.

A manufacturer/blender may employ a mix of the above models, depending on the circumstances.

In an effort to improve the standard of technical advice to farmers, the FSSA together with the Tshwane University of Technology (TUT) have established a Fertilizer Advisory Course (BASOS). Fertilizer advisors in the industry are obliged to complete this course successfully within a specified time limit.

Contractors normally deliver fertilizers to farms by road, either from factories or from intermediate storage depots. Today it is rare for fertilizers to be delivered by rail, to sidings near to the farmers. Deliveries take place throughout the year, with a main peak during the October to November season in the summer grain producing areas. Although most fertilizers are delivered in 50 kg polyethylene bags, bulk deliveries in liquid form are gaining in popularity.

Imported fertilizers are distributed from the main ports by rail and to a lesser extent by road, to inland blending operators or to intermediate storage depots before final delivery to the farm.

INFRASTRUCTURE

With the closure of some large-scale plants in 1999/2000 and a corresponding increase in imports, rail and harbour facilities came under pressure to handle the additional volumes. Sometimes product could not be moved in time due to capacity constraints of the national service providers. The government has announced a large expansion of capacity in the coming years which, if it comes to fruition, will alleviate the situation.

CREDIT

Fertilizers are mostly purchased on credit provided by commercial banks, large agri-businesses and cooperatives. Applications for credit for the following season are normally considered only when crop estimates can be made with a reasonable degree of certainty.

Chapter 6

Concluding remarks

Field crops which, for the purpose of this study, include sugar cane, dominate South African agriculture. This holds true for the area planted, fertilizer use and the total value of production. Maize and wheat alone account for more than half of the area planted, 48 percent of fertilizer use and 39 percent of the total value of production. National average yields of maize and wheat (less than 3 tonnes/ha) are low by international standards. Climatic and physical constraints (e.g. soils) in the arid to semi-arid production regions prevent South Africa from achieving yields attained in e.g. the temperate regions of the northern hemisphere.

Given the constraints mentioned above, South African farmers can be considered to be innovative and efficient, with an ability to survive financially.

With the exception of citrus and deciduous fruits destined for export, crop production in South Africa is destined for the domestic market. Surplus production is vigorously discouraged by GSA; especially since surpluses lead to reduced producer prices and lower farm incomes. Almost two million hectares of maize and wheat have already been taken out of production during the past 20 years in order to bring supply and demand into balance.

Fertilizer demand is a derived demand for food and future growth in fertilizer use depends on this demand. Nearly half of South African households are vulnerable to food insecurity. Growth in the demand for food, and therefore growth in fertilizer demand, has to come from the alleviation of poverty. While poverty alleviation and job creation are important priorities in the government's agenda, the situation cannot be expected to change rapidly. There are, however, some positive signs, such as recently published unemployment statistics.

Import tariffs for cereals are currently well below bound World Trade Organization (WTO) rates and, with a strong currency, cereal production in South Africa is under pressure from imports. This uncertainty is

compounded whenever regional droughts occur and when surpluses are produced. The bigger the surplus is, the bigger is the impact.

In this scenario, current trends in cereal production and fertilizer demand are expected to continue in the foreseeable future i.e. a further reduction in the cropped area, more intensive production in the remaining areas and a stable or slowly growing fertilizer demand.

It would seem logical to assume that by improving the productivity of the subsistence agriculture market, two purposes would be served: (1) alleviating food deficiency at household level of the rural population, and (2) increasing demand for fertilizer as well as other intermediate inputs.

Estimates of the number of subsistence farmers in South Africa range between 1,3 and 3 million, located mostly in the communal areas of former homelands. (Agricultural Abstract 2004, Machete *et al.*, 2004). They produce food mostly for subsistence. Machete *et al.* (2004) estimates a further 240 000 smallholder farmers who have “emerged” to a higher level of production than pure subsistence, and who provide a livelihood for more than a million of their family members.

Subsistence/smallholder farming in South Africa is saddled with constraints in limited purchasing power, inadequate infrastructure, limited access to support services including effective extension, high input prices and poorly functioning output markets. These have tended to counter balance efforts by many organizations – government, parastatal, commercial producer organizations and the private sector including the fertilizer industry – aimed at increasing the productivity of subsistence/smallholder agriculture. General acceptance of yield enhancing inputs such as fertilizer, hybrid seeds and plant protection products, and application thereof in practice, is still a long way off.

Although these initiatives have not as yet materialized in increasing fertilizer demand, most South Africans would agree that these efforts should continue for the sake of future social, economic and political stability.

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Annex 1

Fertilizer recommendations for sugar cane

NITROGEN

Recommendations are based on soil types and land systems (e.g. Coastal System), with four categories of N-mineralization capacity. These have been determined by yield responses from fertilizer field trials. The probability of a response to applied nitrogen increases as the organic matter content of soils declines from more than 4 percent to less than 2 percent. The organic matter content of soils, in turn, is related to soil types. Recommendations are further refined according to the rooting depth and differentiated between plant and ratoon cane. Rates for plant cane vary between 60 and 140 kg N/ha, those for irrigated cane being higher by about 20 kg N/ha. Rates for ratoon cane are higher than for plant crops and vary between 100 and 200 kg N/ha, again depending on the soil system, soil form and rooting depth.

PHOSPHOROUS

Recommendations are based on soil-P analysis, adjusted for the P-fixing capacity of soils occurring in the Natal Midlands. For plant cane, P-fertilizer is applied in the furrow to meet at least the P- requirements of the plant crop and the first ratoon. The recommendations aim to bring the soil P-level up to approximately 206 kg P₂O₅/ha, as in in the following example:

Soil P level	kg P ₂ O ₅ /ha	160	115	68	28
Rate	kg P ₂ O ₅ /ha	46	92	137	183

For ratoon cane, soil P-levels are maintained at 70 kg P₂O₅/ha, which converts to application rates of 46 to 92 kg P₂O₅/ha for decreasing soil P-levels.

For the high P-fixing soils in the Natal Midlands, supplementary broadcast P-applications are recommended for plant cane. These vary between 240 and 366 kg P₂O₅/ha for soils with less than 92 kg P₂O₅/ha and which have moderate to strong P-fixing capacities.

No differentiation is made in recommended P-rates between rainfed and irrigated sugar cane.

No P-fertilizer is recommended when soil P-tests are above threshold values.

POTASSIUM

Sugar cane requires large quantities of potassium for sustainable production. Soils are quickly depleted of available K if K- fertilizer is under applied.

Soil threshold values for soil-K have been established through extensive SASRI-FAS research:

Percent clay	kg K ₂ O/ha	ppm K
30% or less	300	112
30% or more	498	150
40% or more*	600	225

* For high base saturation soils in northern irrigation areas.

Potassium recommendations are influenced also by the winter or summer cycles on high base-saturated soils in the northern irrigation areas (Mpumalanga and Kwazulu-Natal).

The range of K-recommended rates can be summarized as follows:

Percent clay	Crop	kg K ₂ O/ha
Less than 30% ¹	Plant crop	90 to 210 ³
	Subsequent ratoons	150 to 210 ⁴
More than 30%, exc. high base saturation soils	Plant crop	120 to 240 ³
	Subsequent ratoons	180 to 240 ⁴
More than 40% clay and high base saturation ²	Plant crop	120 to 300 ³
	Subsequent ratoons	240 to 300 ⁴

¹ Mostly Coastal and Kwazulu-Natal Midlands areas

² Northern irrigation areas (winter cycle)

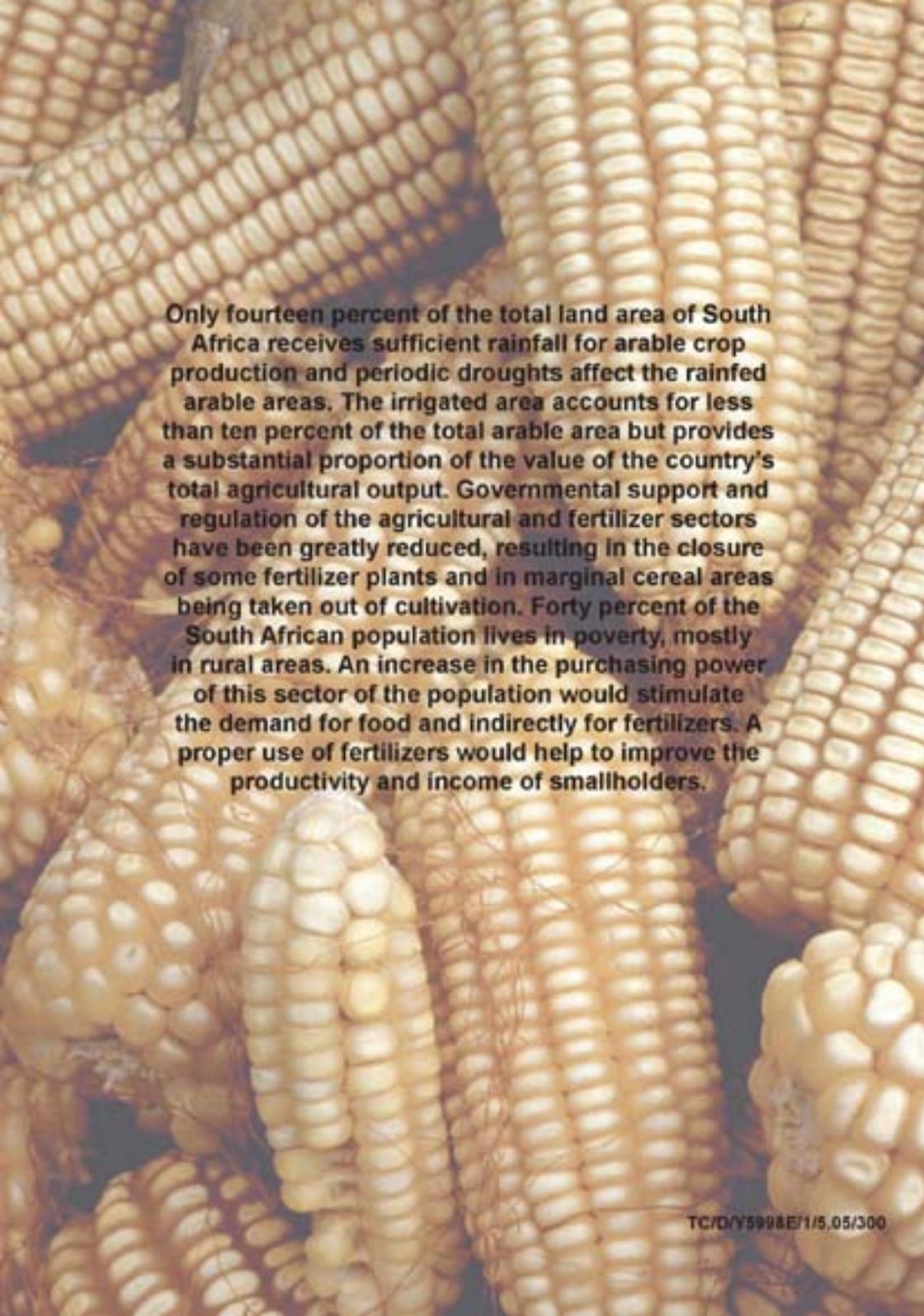
³ Depending on soil K- test below threshold

⁴ Whole cycle advice

Source: SASRI-FAS, 2002.

Rates for summer cycle cane are up to 25 per cent lower than for winter cycle, depending on the soil K-analysis

No K fertilizer is recommended if soil K-tests exceed threshold soil levels.



Only fourteen percent of the total land area of South Africa receives sufficient rainfall for arable crop production and periodic droughts affect the rainfed arable areas. The irrigated area accounts for less than ten percent of the total arable area but provides a substantial proportion of the value of the country's total agricultural output. Governmental support and regulation of the agricultural and fertilizer sectors have been greatly reduced, resulting in the closure of some fertilizer plants and in marginal cereal areas being taken out of cultivation. Forty percent of the South African population lives in poverty, mostly in rural areas. An increase in the purchasing power of this sector of the population would stimulate the demand for food and indirectly for fertilizers. A proper use of fertilizers would help to improve the productivity and income of smallholders.