# SOIL FERTILITY AND THE POTENTIAL FOR INCREASED CROP PRODUCTION IN THE SOUTH AFRICAN HOMELANDS

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## Introduction

The crop production potential of any area is a function of a series of factors. These factors can be grouped into two major categories, viz

(a) the physical-biological characteristics of the area and

(b) the prevailing socio-economic situation in the area.

The physical-biological factors *inter alia* include the following: the physical potential of the soil (soil depth, texture, structure, etc), various climatic parameters (quantity and distribution of rainfall, temperature, frost period, etc), topography, the availability of good seed of adapted cultivars with a high potential, availability of suitable fertilizers, availability of irrigation water, etc. It may, however, be argued that the latter three are dependent upon the prevailing socio-economic situation.

Socio-economic factors *inter alia* include the traditional attitudes of the people towards crop production, education level and management capabilities of the farmers, availability of capital and modern technology, systems of land tenure, the availability of adequate research and extension facilities and staff, etc.

Sustained high crop yields can only be achieved where *all* factors are optimal. The potential to increase crop production in any area depends upon the degree to which limiting factors can be corrected or eliminated. The most logical approach is identification of the limiting factors and a stepwise elimination of these, starting from the most limiting factor.

The vast increase in wheat yields under irrigation by the introduction of the new medium and short straw cultivars provides a simple but striking example of the importance of the simultaneous optimisation of various production factors. The potential yields of these cultivars cannot be realised without proper fertilization (especially with nitrogen) and irrigation. Field trials at Loskop, for instance, indicated that the traditional long straw cultivars can equal and even outyield the short straw cultivars at the traditional low levels of nitrogen application. At Vaalharts yields of as low as about thirteen bags per hectare were obtained with the high potential cultivar Zambesi, despite optimum fertilization, just because of poor irrigation practices (Eloff, 1971).

In this paper I shall attempt to present a brief outline of the present situation regarding crop production in the homelands and some factors responsible for this situation. Some special attention will be given to soil fertility as a production factor.

## Present crop production in the homelands and the physical-biological potential for crop production

A scrutiny of the available data reveals that the production levels of all agronomic crops under traditional systems of agriculture in the homelands are extremely low. (Anonymous, undated; Van de Wall, undated; Section Agricultural Advisory Services, 1972; and several unpublished reports). In 1972 the average dryland maize production for all the homelands was only 4,3 bags per hectare (90 kg bags). Averages for individual homelands ranged from 1,7 bags per hectare to 10,1 bags per hectare. The average yield for grain sorghums was only 3,1 bags per hectare, and for wheat only 4,4 bags per hectare. Under irrigation the average wheat yield was 12,3 bags per hectare and the average maize yield 9,6 bags per hectare.

Van de Wall (undated) indicated that due to these low average yields the three northern homelands Lebowa, Venda and Gazankulu in 1973 produced sufficient food for only about 250 000 people. Grobler (1969; according to Van de Wall) estimated that these three homelands have the physical-biological potential to produce grain for more than nine million people!

Grobler (1969) also estimated that the homelands Bophuthatswana, Lebowa, Venda, Gazankulu, Swazi and KwaZulu have the inherent potential to produce food for 25 million people as well as some products for secondary industries. This number is more than the total Bantu population in South Africa, including those in the white areas, Qwa-Qwa and the Transkei and Ciskei. (Anonymous, undated).

Fortunately the white areas of South Africa are at present able to produce sufficient food to balance out the deficiencies in the Bantu areas. The white areas have not an unlimited capacity for food production, however. This capacity may soon be exceeded by the increased demand which will be created by the expected population explosion. Since food surplusses in the rest of the world are also decreasing rapidly, it is essential that the potential of the homelands must soon be utilized fully.

## Reasons for the present low levels of crop production in the homelands

The low level of crop production is a complex problem which is caused by an enormous number of limiting factors. It is impossible to discuss all these factors in detail.

The socio-economic factor is the most important limiting factor in the agriculture of the homelands. If this factor cannot be improved drastically, then all attempts at increased crop production will be futile. The limiting socio-economic factors *inter alia* include the following aspects: the traditional farmer is satisfied with a purely subsistence economy; absence of young men from the agricultural sector; the system of land tenure; tribal customs; the low level of education; lack of the necessary capital; poor infrastructure and marketing facilities in most areas; the low level of technical knowledge of agricultural extension officers in the homelands.

Socio-economic factors are not the only causes responsible for these low yields, however. In many instances areas that are not arable are cultivated and areas that are not irrigable are irrigated. In some cases growing of specific crops are attempted in environments to which they are not adapted, especially with regard to climate. This aspect is so important that it warrants some elaboration at a meeting of soil scientists and agronomists, such as this one.

The following are a few examples of irrigation in areas where irrigation is not feasible, *especially under low levels of management.* In some cases problems are encountered because the soils are too sandy. On the Shiombo scheme in Venda, leaching losses (especially of nitrogen), due to irrigation and the high rainfall of the area, are extremely high on the very sandy soils. Under these circumstances it is difficult to control soil fertility and to prevent nutrient deficiencies. On the Taung scheme in Bophuthatswana, waterlogging occurs over vast areas due to the system of flood irrigation which is used. Salinity is also starting to cause concern. The clay contents of most topsoils of this area are less than 10 per cent. It has been indicated that a large agricultural development company considers all topsoils with less than 15 per cent clay as unsuitable for flood irrigation (Hensley, 1976).

At the other extreme, soils which are too clayey are also irrigated. Poor internal drainage leads to waterlogging and salinity problems. The low infiltration capacities of these soils also make irrigation management very difficult. Soils of this nature are found in parts of the Bulawane scheme in KwaZulu and the Ncora scheme in the Transkei. The best example is the Tonga scheme in the Swazi area where a recent soil survey indicated that out of 550 hectares that are irrigated only 185 hectares are actually irrigable.

In some instances irrigation is practised on soils which are too shallow. The major part of the Lepellani scheme is, for example, subject to salinity and waterlogging problems because of the shallow soils on impermeable hard rock. Parts of the Shiomba scheme in Venda are subject to the same problem.

With regard to rain fed (dryland) cropping a major problem is that crops are grown in many marginal areas which are not really suitable for rain fed production of that type of crop.

Maize production is, for example, often attempted in areas where the rainfall is too low and unreliable for this crop. For the major part of the Ciskei, water budgets, calculated on a monthly basis, revealed extreme moisture deficits during January, and to a lesser extent February (Marais, 1975). This places a serious limitation on rain fed maize production in these areas since this is the period at which maize is extremely vulnerable to droughts. Occasional scorching 'berg winds' further aggravate the situation.

The marginal rainfall areas of the Ciskei are furthermore dominated by relatively shallow soils of the Glenrosa form (Hensley & Laker, 1975). The water-storage capacities of such shallow soils are too low to supply adequate moisture to the plants during periodic droughts. Glenrosa soils are also the dominant soils of the Transkei. In almost all homelands, soils with limited water-storage capacities (either because they are shallow or because they are very sandy) are used for crop production under marginal rainfall conditions.

Clayey soils, with low water infiltration capacities and which are inherently droughty, are often utilized for crop production in marginal rainfall areas such as in parts of KwaZulu, the Lebombo flats in the Swazi area and the salt lake area in Owambo.

Under normal circumstances nothing can be done to eliminate the inherent physical limitations of areas such as those that have been discussed above. Such areas are best utilized under natural pastures. Apart from the aspects of continuous crop failures, such soils are usually also those which inherently are the most susceptible to erosion. During erosion these soils are not only denuded, but the whole landscape becomes unstable and associated high-potential soils are endangered.

In contrast there are significant areas with high or moderate potentials for rain fed or irrigated crop production, which are not utilized for this purpose at present. Examples are the Debe land type and other areas in the Ciskei, especially the Keiskama river basin and the Committee's Drift area (Hensley & Laker, 1975). The Lusikisiki district in the Transkei is another striking example. In Kavango a vast irrigation potential and in Bophuthatswana a potentially good maize area still awaits development.

Most of these areas are presently under natural veld and can still be cultivated in future. Unfortunately there has lately been an alarming tendency to develop vast townships and industrial areas on some of the potentially best arable and irrigable land in several homelands. Specific cases in Lebowa, Qwa-Qwa and the Ciskei could be mentioned. In the light of the fact that the average percentage of arable land in the homelands is less than fourteen per cent of their total areas, this tendency can be described as no less than a criminal offence. Areas under urban development are permanently and irreversably lost for crop production.

The people who took wrong decisions which led to cultivation and irrigation of unsuitable areas or urban development on potentially good arable areas cannot blindly be blamed for their decisions. The fact is that very little is known about the actual physical-biological potentials of individual areas in the homelands. Surveys and studies on which logical planning can be based are urgently needed. These studies cannot be done without adequate numbers of well-trained soil scientists and other agriculturists who can conduct the studies. In this respect, the Fertilizer Society recently made a valuable contribution when they provided four soil scientists to conduct studies in Owambo, Kavango and Caprivi.

Soil studies are usually the most limiting factor because they are so slow and tedious. Organisations such as the Fertilizer Society of South Africa, other private organisations and homeland Governments should seriously consider the possibility of making bursaries *specifically for soil science* available to black students at the University of Fort Hare.

If other socio-economic constraints can be diminished and if proper planning of farming units can be facilitated, then proper crop production will still be dependent upon the implementation of correct production techniques. Amongst the latter the introduction of realistic fertilization programmes should be one of the easiest to achieve.

## The role of chemical soil fertility and plant nutrition

At present the level of fertilizer usage (both artificial fertilizers and kraal manure) in the homelands is extremely low (Section Agricultural Advisory Services, 1972; Kempen, 1972). According to the Section Agricultural Advisory Services (1972) a total area of 972 757 hectares was cultivated in the homelands. Of this only 98 380 hectares received artificial fertilizers. (That is only 10,1 per cent of the total cultivated area.) For individual ethnical groups the fertilized fraction ranged from as low as 0,7 per cent for the Shangaan group to as high as 33,2 per cent for the Tswana group. There was no relationship between area fertilized and average yields, however. This can be attributed to the dominance of other limiting factors.

For the Herschel district Kempen (1972) found that only 8,6 per cent of the landowners used artificial fertilizers. The figures for individual locations varied from zero to more than 30 per cent. Kempen concluded that the latter was due to the efforts of a good agricultural officer in that location. He also concluded that increased fertilizer use had a positive effect on the average income per hectare.

According to Kempen (1972) the farmers who did not use artificial fertilizers gave the following explanations: 32,7 per cent attributed it to lack of finance; 29,6 per cent were ignorant about artificial fertilizers; 16,5 per cent stated that fertilizers were not available and the rest had other reasons or no answer.

In contrast, an increasing number of large agricultural projects are presently being developed by homeland corporations and private organisations. Sophisticated fertilization programmes are implemented on these projects. These projects can make important contributions to introduce the surrounding traditional farmers to the use and value of fertilizers.

More or less all the soil fertility problems which are known in South Africa can be expected in different areas of the homelands. Only a brief outline of some of the known and predicted problems can be given here.

As in all unfertilized soils it must be expected that phosphorus deficiencies will initially be the most limiting plant nutritional factor in most areas of the homelands. This will be most severe in those areas where extremely acid soils are found. These unfortunately cover the areas with the highest (most favourable) rainfall and some of the soils with the highest physical potential. These include areas such as the Stutterheim land type (which is the area with the highest dryland cropping potential in the Ciskei), the Lusikisiki district in the Transkei and the Nebo Highland in Lebowa – to name only a few.

At the other extreme, Eloff, (1971) indicated that the phosphorus-fixing capacity of the soils of the Taung irrigation scheme in Bophuthatswana is low and that favourable reactions can be obtained with relatively low phosphorus applications. The same tendency is expected for most of the dryland cropping areas of the homeland.

Due to the depletion of the organic matter content of most cultivated soils in the homelands, nitrogen deficiency has already become an important limiting factor, even under low levels of production. A single reconnaissance through the Ciskei during February or March will convince any sceptic of this. Under irrigation, nitrogen is of primary importance.

Zinc deficiency is a well-known problem in the sub-humid to semi-arid regions of different homelands. For the Vaalharts irrigation scheme, which is also representative of the Taung scheme in Bophuthatswana, Dietrichsen (1973) indicated that zinc deficiencies can be expected on all soils with less than 1,60 ppm zinc (extracted with 0,1NHCl). This is much higher than the critical value of 1 000 ppm which is usually given in literature. The dryland cropping areas of Bophuthatswana will also suffer from zinc deficiencies. Severe zinc deficiencies are encountered on the irrigated areas of the experimental farm of the University of Fort Hare. These are mainly on deep Oakleaf soils which are similar to many of the irrigated and irrigable river terrace soils in the Tyumie and Kat River Valleys, which are now

incorporated into the Ciskei. Zinc and other trace element deficiencies can also be predicted for other proposed or possible irrigation schemes in semi-arid regions of the Ciskei. These include areas of the Keiskama basin project in land types such as Middledrift and Zigodlo. Zinc, and even iron deficiencies are predicted on the calcareous soils which are being brought under irrigation in the St Marks (Qamata) area of the Transkei.

Molybdenum deficiencies can be expected in all the strongly acid areas, a few of which have been mentioned. Aluminium toxicities can also be expected on the strongly acid soils.

The problems of strongly acid soils can only be diminished or eliminated by judicious liming programmes. Unfortunately many of these soils have high clay contents and consequently high lime requirements. Many people doubt whether it is economically feasible to lime such soils. The fact remains that they can be limed and fertilized into a productive state. In contrast the depth of a shallow Mispah or Glenrosa cannot be changed — nor can the clay content of a swelling clayey soil in a marginal area be decreased.

In conclusion I would like to propose that homeland Governments should consider the possibility of undertaking initial liming and blanket phosphorus application programmes on a national basis. It could be implemented on a location basis. Farmers should be forced to repay the Government for these services in some way, otherwise they are not going to appreciate the service. The programmes must be based on proper soil analyses and sound scientific planning. Only areas with proven medium to high-cropping potentials should be included in such programmes. Implementation of such programmes should be according to a priority list. Factors such as the need for development of a specific area should be used to determine priorities. Furthermore it could, as far as possible, be done stepwise, starting with the soils with the lowest phosphorus-fixing capacities and/or lime requirements.

The basic arguments in the proposal of these national programmes are

(a) That a correct soil pH and sufficient phosphorus level are the cornerstones of soil fertility and

(b) that individual traditional farmers do not have the equipment or knowledge to implement this initial phase on an individual basis.

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## References

ANONYMOUS, Undated. Selfversorgendheid van Tuislande mbt voedselproduksie.

DIETRICHSEN, J.A.V., 1973. Studies oor die toeganklike sinkstatus van sekere Vaalhartsgronde. Unpublished M.Sc. Agric. dissertation. Univ. van Oranje Vrystaat.

ELOFF, J.F., 1971. Studies oor die toeganklike fosforstatus van sekere Vaalhartsgronde. Unpublished M.Sc. Agric. dissertation. Univ. van Oranje Vrystaat.

GROBLER, J.H., 1969. Die Landboupotensiaal van Bantoegebiede. Referaat — Kongres van Vereniging vir Aardrykskunde Onderwys, Potchefstroom.

HENSLEY, M., 1976. Personal communication. Univ. of Fort Hare.

HENSLEY, M. & LAKER, M.C., 1975. Land Resources of the Ciskei. Chapter 2 in : The Agricultural Potential of the Ciskei — A preliminary report. Alice: Faculty of Agriculture, Univ. of Fort Hare.

KEMPEN, P.D., 1972. Ontwikkelingsmoontlikhede vir die Herscheldistrik met besondere verwysing na die Landbou, Bloemfontein: I.S.E.N., Univ. van Oranje Vrystaat.

MARAIS, J.N., 1975. The climate of the Ciskei. Chapter 3 in: The Agricultural potential of the Ciskei — A preliminary report. Alice: Faculty of Agriculture, Univ. of Fort Hare.

SECTION Agricultural Advisory Services, 1972 Ann. Rep. Pretoria: Secretary for Bantu Administration and Development.

VAN DE WALL, G., Undated. Ekonomiese selfstandigheid van die Noordelike Tuislande: Die landbousektor as instrument in die proses van ontwikkeling tot ekonomiese selfstandigheid. Roneod paper.