SASRI'S FERTILISER ADVISORY SERVICE (FAS)

CELEBRATING 70 YEARS OF SERVICE!

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This year, SASRI's Fertiliser Advisory Service (FAS) celebrates 70 years of service to South Africa and other sugarcane producing countries. Fertiliser recommendations are based on soil and leaf analytical methods that have been calibrated from numerous research trials conducted since the early 1960s. Through its efficient and reliable service, FAS has gained international recognition as a leading agricultural laboratory.

In the beginning

Ever since the South African Sugarcane Experiment Station, now known as the South African Sugarcane Research Institute (SASRI), was established in 1925, there has been an awareness of soil fertility problems in the sugar industry and the economic importance of correctly fertilising sugarcane. The main concern was that fertiliser use by growers took no cognisance of the inherent soil fertility levels of the wide range of soil types that were under cane production.

While there was a growing realisation among growers that a central soil and leaf testing facility was long overdue, it was only in October 1954, that the vision of an independent soil/leaf-based fertiliser diagnostic service was fulfilled when the South African Sugar Association purchased a property in Briardene to house the first Fertiliser Advisory Service laboratory. The laboratory could cope with 300 samples per week, and additionally, fertiliser, compost and water samples could also be analysed for growers, with a turnaround time of four to five weeks. In its first year of operation, nearly 10 000 soil and leaf samples were analysed. Soil measurements included pH, plant available phosphorus (P) using dilute sulphuric acid and extractable potassium (K), calcium (Ca) and magnesium (Mg) based on a dilute ammonium acetate procedure.

(Figure 1: First FAS Fertiliser Advisory Service laboratory)

Sampling procedures and threshold values

Coupled with the new FAS laboratory, investigations were conducted by Experiment Station staff to develop a standardised procedure for taking soil samples in a field, after ploughing out of the old crop. This was successfully carried out in 1959 by Dr Bernard "Ted" Beater, the resident Soil Scientist who designed the Mount Edgecombe, bicycle-handled soil sample auger, fitted with a bag.

Fifteen cores taken to a depth of 20 cm along each diagonal of a cross in a 4 ha field could provide a representative sample of the soil in the field for testing by FAS (Figure 2). In practice, the collected cores in the bag would be thoroughly mixed before being sent to FAS.

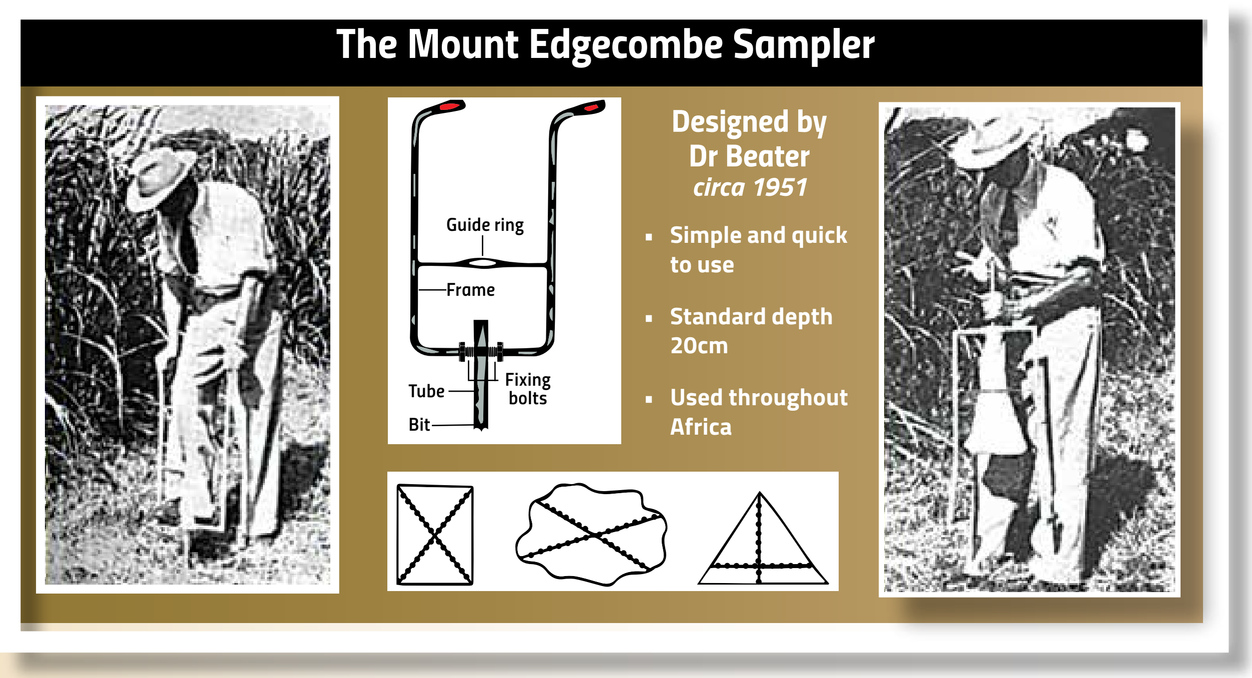


Figure 2: Recommended procedure for taking a soil sample in the field)

The next important milestone involved the development of soil and leaf threshold values for the N,P and K requirement of sugarcane and the optimum fertiliser rates to apply on a commercial basis. The initial results from exploratory trials revealed dramatic economic responses to applied K, of up to 4 t sucrose/ha on many soils. A further outcome of these investigations was that both soil and leaf analyses could predict the likely responses to K and P fertiliser, as well as the economic quantity of fertiliser to apply. Initially, several soil and leaf procedures were tested and the methods that showed the best correlation with yield responses to applied fertiliser were retained for advisory purposes.

FAS today

In 1962, the FAS laboratory moved to Mount Edgecombe and became part of SASRI, and it is from there that that the service still operates today. Over the years, analytical operations that were based on the slow manual operations of pipetting and dispensing of liquid samples on a macro scale by hand were transformed by computer controlled robotic dispensers. Small volumes of liquid samples could be transferred on a micro scale in batches of 25 samples, for analysis by atomic absorption spectroscopy (later replaced by ICP) for the analysis of K, Ca, Mg and sodium (Na), as well as trace elements such as zinc (Zn), copper (Cu), manganese (Mn), iron (Fe).

Another important milestone was the commissioning of NIR and X-ray fluorescence spectrometers in 1983, to analyse leaf samples directly without having to use time consuming acid digestion procedures. This world-first for sugarcane was followed by further applications of NIR to improve N use efficiency of sugarcane by matching crop N requirement to soil N mineralising potential and plant N status, both properties determined by NIR.

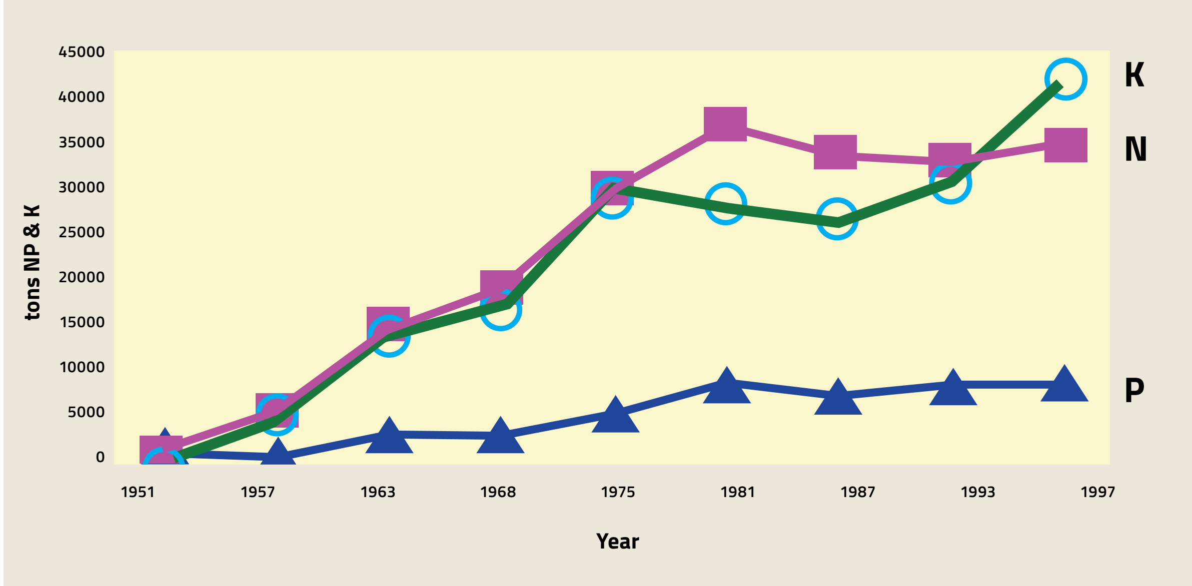
These rapid advances in analytical instrumentation now enables FAS to handle an average of 32 000 soil samples a year, 4000 of which are non-cane samples, with a greatly reduced turnaround time of eight days for soil samples and five days for leaf and fertiliser samples.

Impact of FAS on fertiliser use and yield performance

The early emphasis by FAS on recommending higher rates of N and K and lower applications of P fertiliser, led to some dramatic changes in fertiliser usage between 1952 and 1965 in the sugar industry (Figure 3). K use increased

by a factor of 15 from an average of 5 to 75 kg K/ha, and N use increased from 12 to 70 kg N/ha, while P increased only marginally from 14 to 18 kg P/ha. It is no coincidence that average industrial yields improved by over 75% from 24 to 42 tc/ha/an over the same period.

FIGURE 3: TREND IN AVERAGE ANNUAL N,P AND K USE (TONS) IN THE SOUTH AFRICAN SUGAR INDUSTRY BETWEEN 1951 AND 1997.



However, with N usage reaching a peak of 1,9kg N/t cane in 1980 (compared to the 1,6 kg N/t cane recommended by FAS), eldana borer began manifesting itself across the sugar industry, fuelled in part by excessive use of urea. The basis of N recommendations changed from expected cane yield to estimating the soil mineralisation potential of soils, based on research conducted at SASRI. For advisory purposes, analytical method based on Near Infra-red Reflectance Spectroscopy (NIRS) was pioneered to classify soils into four categories (low, moderate, high and very high), according to their potential to mineralise N from soil organic matter. The revised N recommendations led to a reduction in N use, particularly for cane growing on high to very high N mineralising category soils. Overall, between 1980 and 1999 throughout the industry, there has been about a 20% decline in N usage, with N use efficiency averaging about 1.5 kg N/tc compared to the initial level of 1,9 kg/tc.

Potassium usage between 1951 and 1975 closely followed N usage (Figure 3), likely due to the use of 1:0:1 fertiliser which was a popular mixture at the time for topdressing ratoon cane, which contained equal amounts of N and K. Between 1975 and 1987, K usage declined slightly, but increased again quite rapidly overtaking N usage after 1993, probably due to the increasing popularity of 4:1:6 NPK mixture, coupled with the reduced use of 1:0:1. It is interesting to note that, in terms of the total nutrient uptake by sugarcane, about 36 to 40% of the uptake is due to N, around 10% P and 55 to 60% for K which roughly conforms with the ratio of 4:1:6 N:P:K in the granular fertiliser mixture.

For many years, the K threshold value used by FAS was 112 ppm for all soils. However, in 1982, this was modified to account for differences in soil texture, based on results from glasshouse trials and a re-assessment of other fertiliser trials. Threshold values of 150 and 225 ppm were introduced for soils with clay contents of 30-40% and >40% respectively. Later, results from K trials in the northern irrigated areas indicated that even 225 ppm was inadequate for a winter cycle crop in heavy textured base saturated vertisols containing a high proportion of K-selective clay minerals.

Other tests that have impacted on grower cane productivity in the Midlands region characterised by acid soils during this period was the addition of two further rapid tests for determining soils that were at risk of containing toxic levels of aluminium (Al), based on acid saturation tests and exchangeable Al. These tests correlated well with response to lime in several trials that were conducted in the mid-1970s. P fixation, another factor that limited cane growth in the midlands, led to FAS adopting the PDI procedure to supplement the Truog procedure for determining the P requirement of sugarcane grown that was initially developed by researchers from the University of KwaZulu-Natal.

Whole cycle recommendations

During the first 20 years of FAS being in operation, considerable historical data from soil and leaf analyses, fertiliser recommendations and crop performance had accumulated. FAS maintained files for over 2000 individual commercial farms and about 500 small-scale growers. This represented a large portion of the 430 000 hectares under cane in South Africa at the time.

This database enabled FAS to provide growers with fertiliser recommendations for cane covering a plant crop and four succeeding ratoons, referred to as a whole crop cycle advice. Each recommendation was based on the chemical analysis of a representative pre-plant soil sample taken after the previous crop had been ploughed out.

Proven value of FAS

FAS has consolidated its involvement with Agrilasa, an organisation that strives to improve quality control of testing methods in laboratories by sending blind soil and leaf samples every three months to over 30 agricultural labs throughout Southern Africa. In terms of analytical performance, FAS has consistently ranked amongst the top four laboratories in South Africa.

In 2014, FAS also received ISO 9001 certification, marking a ten-year milestone this year. FAS has also recently been audited by SANAS and has provisionally been recommended for ISO 17025 accreditation for leaf and fertiliser analysis.

There can be little doubt that the advantages of soil and leaf testing are considerable, and that over the past 70 years, FAS has had a substantial impact on yield productivity and efficient fertiliser usage in the sugar industry. Since 1954, yield output in the industry has more than doubled, and whilst new varieties have undoubtedly had a large impact, the improvement could not have come about without eliminating nutrient deficiency in sugarcane and overcoming Al toxicity in areas with acidic soils in the midlands and sodicity in the irrigated areas of the lowveld.

FAS's remarkable achievements over the past 70 years would not have been possible without the invaluable support of SASRI's research and extension services, cultivating a legacy of optimising crop yields and promoting sustainable agriculture.

Jay Meyer was SASRI's Soil Chemist for several decades until his retirement, and is still active as a consultant.