

ASPECTS CONSIDERED IN THE SEARCH FOR NEW FARMS FOR THE EXPERIMENT STATION

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Abstract

Urban encroachment of one SASA Experiment Station (SASEX) farm recently provided the opportunity to review the objectives and resources of the SASEX plant breeding programme. This indicated that the current rainfed farms were largely unsuitable for experimentation, mainly because the soils are too variable and not representative of the major soil types in the industry. Five new farms have recently been acquired. These are discussed.

The criteria considered when selecting new farms were soil type, soil uniformity, slope, altitude and agro-climatic region. For the coastal lowland region, one farm with a high potential soil and one with average potential soil were selected in Zululand. For the coastal hinterland, a farm on soil derived from Natal Group Sandstone (NGS, formerly Table Mountain Sandstone) was selected near Stanger. For the Midlands region two farms were selected, one on a high potential soil and the other on an average potential NGS (ordinary) derived soil. The move from the current to the new farms is now in progress.

Introduction

In 1925, the SASA Experiment Station was established at Mount Edgecombe for the selection and release of new cane varieties. With the advent of making crosses at Mount Edgecombe in 1945 the selection programme was expanded and new farms were acquired at Shakaskraal and at Mtunzini in the mid-1950s. In 1965, two additional farms were acquired, one at Pongola for irrigated conditions and the other, Central Field Station (CFS), on Recent Sands near Umhlanga Rocks. The expansion plans of Umhlanga Rocks Town Board in the early 1990s indicated that CFS would soon be completely surrounded by urban development and would therefore no longer be suitable for field trials.

Present farms

The size of the farm at Mount Edgecombe is 65 ha, of which 43 ha are planted to cane. The soils are mostly uniform and the production potential ranges from average to good. The area of Shakaskraal farm is 100 ha, with 62 ha planted to cane. The soils on this farm can be considered as low potential as most of the topsoils are shallow and variation within and across soil forms is high. Similarly, there are a number of soil forms on the Mtunzini farm (121 ha, of which 101 ha are

planted to cane) and the production potential varies from low to high. Even small fields on this farm vary widely in soil depth and texture, for example, in the Longlands soil form. Variation in fertility at CFS (66 ha) is also high even with the use of nematicides. CFS was purchased to test varieties for use on Recent Sands, but the proportion of cane grown on Recent Sands has since declined appreciably. The size of Pongola farm is 153 ha, of which 123 ha are planted to cane.

Outcomes of the Plant Breeding Workshop held in August 1993

One of the major outcomes of the workshop, summarised in Table 1, was that only a few varieties were released for rainfed areas compared with those for irrigated areas despite the number of seedlings for rainfed areas being double those planted at Pongola. A major reason for this appeared to be soil variability and associated variability in the results of trials on the rainfed farms. The depth of the topsoil varies from 15 to 40 cm within a few metres and thus the water available to the sugarcane plants also varies. This affects both sucrose content and cane yield. This variability cannot be contained by randomisation unless a large number of replications are used. This is not practical.

Another effect of soil variability is that the chance allocation of a selected seedling variety to a specific plot determines whether it is selected or not. If allocated to a plot with deep soil, it would have more moisture and nutrients available than varieties in less favourable plots. If, in the following selection stage, the same variety was planted in a shallow plot, the yield would be small and it would not be selected further.

The urban encroachment around CFS and the prospect of a large financial return on a sale of the property to developers created the opportunity to evaluate the outcomes of the plant breeding programme on the present farms. Should some of these farms not prove to be suitable, as was suspected, corrective measures could then be instituted by purchasing land that would be more suitable.

The variation in results from rainfed trials at three of the rainfed farms is far greater than that obtained from the irrigated trials at Pongola and the trials in the Midlands (Table 2). The variation at the Pongola and Midlands farms is acceptable but at the other sites it is high. This variability could only be reduced by acquiring farms on soils that are more uniform.

Table 1. Outcomes of the Plant Breeding Workshop held on 6 August 1993

Problem area	Requirements	Action
Breeding and selection.	Heritabilities not known. Heritabilities of major traits low.	Initiate special trials to determine heritabilities. Increase seedling numbers. Family selection at early stages. Determine selection efficiency.
Selection sites do not represent main production regions.	Determine main agro-climatic regions. Varieties best suited to areas where selected.	Correct siting of new farms.
Large variety x environment interaction.	Varieties required for different regions and soil types.	Acquire sites in major production areas.
Too many varieties are susceptible to diseases in late stages of testing.	Early screening for disease and pest resistance.	Screen varieties from early selection stages, even stage 2.
Data handling and trial design.	Use modern facilities to transfer data, maps to reduce manual transcribing.	Use electronic transmission.

Table 2. Mean coefficients of variation of trials in the primary trial stage on each of six farms.

Farm	No. of reps	No. of trials	Mean coefficients of variation		
			Tons cane	Ers % cane	Mass ers
Pongola (irrigated)	3	15	8,3	6,8	11,4
Midlands	3	7	10,1	5,6	11,9
Experiment Station	3	15	13,4	7,5	16,1
Shakaskraal	3	15	16,2	7,5	19,1
Mtunzini	3	15	16,6	8,6	19,4
Central Field Station	3	15	18,6	7,2	19,7

Criteria for selecting new farms

Regions

Four distinct production regions have been identified by SASEX, namely, the Northern irrigated areas, the Coastal lowland, the Coastal Hinterland and the Midlands. The sucrose production of each region is approximately 20% of the total for the industry, except for the Coastal Lowland which is 40%. One farm for each region and two for the Coastal Lowland were envisaged. The Northern Irrigated areas are already well served by the Pongola farm and this meant that four additional farms should be acquired.

Size of farms

The present farms had selection programmes starting with 25 000 seedlings each. For a number of years, the CFS and Mount Edgemombe farms (combined seedling number 42 000 seedlings) were managed by one Plant Breeding and Field Services team. Another team managed the Pongola farm starting with 45 000 seedlings. Based on past experience, the optimum number of seedlings per team is approximately 50 000. For the four new farms, the total could therefore be 200 000 seedlings, more than double the present number. With more efficient use of labour and contractors, the recurrent expenditure of the farming operations would not increase to the same extent as the seedling numbers.

The size of the farm is also affected by harvesting age and row spacing. On the Coastal Lowland farms, the age at

harvest will be 12 to 15 months for the high potential soil and up to 18 months on the average potential soil. The area required under cane is about 85 ha. For the Coastal Hinterland, the age at harvest will be 18 months and the area under cane will be 95 ha. In the Midlands, age at harvest is 24 months and the area required under cane is 140 ha. The site may exceed the cane area required as some parts of the new farms may not be suitable for experimentation.

Soil types

There are many soil forms and, to reduce the number of options, soils were classified into different levels of cane production, high, average and low potential. The major soil fertility groups and possible parent materials in the various regions are shown in Table 3. Because a large proportion of the industry's cane is grown on Natal Group Sandstone (NGS, formerly Table Mountain Sandstone) derived soils, it was imperative that some farms having a NGS (ordinary) soil form should be acquired. Similarly, the reaction of varieties to NGS (mistbelt) is different and therefore a farm with that soil form was also required.

Trial variability

The reliability of the results of field trials is determined by the level of variability to which the small plots are subject. After ensuring good standards of plot technique, this is largely dependent on how uniform the soil conditions are over the

trial sites. Soils on the Pongola and Midlands farms are relatively uniform, but other current farms suffer from severe disadvantages for conducting trials because of high soil variability.

To assess uniformity, numerous soil pits (1,5 to 2 m deep) were examined, a minimum of one every five hectares. This sometimes uncovered unusual, unrepresentative conditions, such as the presence of a water table, which are uncommon in the industry and should be avoided.

Slope

To ensure freedom from unwanted volunteers in the trials, about 30% of the area dedicated to plant breeding is fallow at any given time and another 25% is replanted after plant cane. Thus a large area is exposed to soil erosion. For this reason plant breeding trials are not planted on land with a slope of more than 10%.

Table 3. Major production regions and soil types required for new farms.

Region	Production potential	Typical soil parent material	Representative soil form(s)
Coastal Lowland	Farm 1. High potential Farm 2. Average potential	Dolerite, Tugela, Schist Vryheid sediments	Hutton, Shortlands Westleigh, Glenrosa
Coastal Hinterland	Average potential	NGS (ordinary)	Cartref
Midlands	Farm 1. High potential Farm 2. Average potential	NGS (mistbelt) NGS (ordinary)	Inanda Cartref

Industry approval

The proposals would involve changing the whole rainfed part of the Plant Breeding programme. The costs of purchasing and developing the new farms would be covered by the sale of CFS. To assist the planning of the exercise, a financial ring fence was proposed in which detailed plans of the proposed developments were made and the resulting expenditure and income were specified. The proposals were submitted to the Council of the South African Sugar Association and approved in November 1995.

Challenges with acquiring SASEX farms

The topography on the Coastal Lowlands from Margate to the Tugela River is undulating and few areas of approximately 100 ha in extent can be found that have a slope of less than 10%. North of the Tugela river, topography is less undulating and there were several suitable properties. In the Coastal Hinterland, most cane growing areas are steep, with slopes in excess of 10%. In the Midlands, care had to be exercised when choosing farms so that frequent frosts would not disrupt the supply of seedcane for the selection programme.

Farms with good soils were rarely for sale and, when these became available, they were often purchased by neighbours before this information became known to SASEX.

In the Midlands, a farm was required with two soil types, one a high potential NGS (mistbelt) and the other an average potential NGS (ordinary). However, no such farm could be found. Instead, two farms were acquired, one with a high potential soil and the other with an average potential soil.

One option when acquiring farms was to enter into a long term lease with the owners. It takes about 15 years from the time single stools are planted till the last results of the final variety trials are available. To ensure that the selection process on new farms would complete a number of cycles, the

term of the lease should be at least 25 years. A clause for an option to purchase the property was included.

On the present farms, almost all farm labour has accommodation on the farms. SASEX also provides facilities for single staff, including all the meals. Only the senior farm staff have houses in which families can stay. To ensure that most of the farm staff on the new farms would have the benefit of living at home and travel to work daily, daily transport will now be available for all staff living off the farm. The workers are to be recruited from neighbouring rural settlements.

Interruptions of the selection programme had to be avoided in any plans to acquire new farms because this would result in a delay in the release of new varieties for the rainfed areas. An exception was made with CFS as the developer was anxious to proceed with the development. No trials were planted at CFS after December 1995 and all material was transferred to the La Mercy farm as a temporary measure until a permanent site was secured.

The new SASEX farms

SASEX acquired all the four new farms by 1 April 1998. The first farm to be acquired was in the Midlands at Bruyns Hill near Wartburg and SASEX started operating it from 1 April 1997 (see Table 4 for details). The farm is being leased for a period of 25 years. The soil is a uniform Inanda soil form and meets all the requirements for a high production potential farm in the Midlands. The first series of 25 000 seedlings was planted at Bruyns Hill in November 1997 and the testing of these will be completed in the year 2012. In November 1997, the first seedlings were planted in the Coastal Hinterland at Kearsney on a portion of land which is to be purchased from Tongaat-Hulett Sugar.

SASEX has been operating all the new farms since 1 April 1998. With the co-operation and approval of the owners where necessary, it was possible to spray and kill areas required for planting as early as April 1997.

Table 4. Specifications of the new SASEX farms.

Criteria	Coastal Lowland (production potential)		Coastal Hinterland	Midlands (production potential)	
	High	Low		High	Low
Name	Empangeni	Gingindlovu	Kearsney	Bruyns Hill	Glenside
Nearest town	Empangeni	Gingindlovu	Stanger	Wartburg	Fawn Leas
Soil parent material	Tugela Schist	Vryheid Sediments	NGS (ord)	NGS (mistbelt)	NGS (ord)
Main soil form	Hutton	Westleigh	Cartref	Inanda	Cartref
Total area (ha)	109	137	110	108	165
Area under cane (ha)	95	120	97	100	150
Slope <10% (ha)	85	97	90	72	95
Date of acquisition	April 1998	February 1998	April 1998	April 1997	April 1998

This enabled SASEX staff to plant seedlings and variety trials at Kearsney in spring 1997, at Gingindlovu and Empangeni in March 1998 and at Glenside in October 1998. By planting all these trials at the time of acquisition, it will be possible to move all the Plant Breeding operations to the new farms within three years and without interrupting the selection of varieties into the successive selection stages.

The criteria set for the new farms have largely been met. There are now SASEX farms in all the major production areas, making up the previous shortfall in the Coastal Hinterland and in the Midlands. The soil types on the farms correspond to the major soil groupings in the industry (Table 5) and only the black soils are not represented. The detailed soil surveys and close observations of cane growing on these properties were measures taken to ensure that the soils were as uniform as possible. There is sufficient land on each farm to ensure that all criteria set out at the start will be met.

Table 5. Soil groups in the SA Sugar industry (as presented at the Plant Breeding Workshop in August 1993) and those on the new SASEX farms.

Soil Group	Extent of soil groups in industry	Extent of soil groups on new farms
Grey	60%	62,5%
Red	19%	25,0%
Black	13%	Nil
Brown humic	8%	12,5%

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