

SELECTING VARIETIES FROM SEEDLING STAGE IN GPS SUGARCANE ESTATES

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Abstract

GROUPEMENT DES Professionnels du Sucre (GPS) is an association that groups three sugarcane estates in central Africa (SOSUCAM in Cameroon, CST in Chad, and SARIS in Republic of Congo) owned by the Group SOMDIAA. In order to improve the performance of selection and to face the challenge of renewing the variety situation, CERF and GPS has developed a strong partnership. Previously, the choice of cultivated varieties was based on a ten-year selection scheme supplied every year with 100 foreign varieties (elites and pre-selected varieties). This raises a major problem: the introduced varieties, selected abroad, are not well adapted to specific agro-climatic conditions of GPS estates. Moreover, previous results obtained by CERF showed that on-site selection increases the probability of identifying promising varieties. So it has been decided to establish a selection program for each estate with fuzz imported from CERF. Since 2005, CERF has made specific crosses for each estate and has dispatched the fuzz to the respective estates. About 4000 seedlings are raised in the respective estates and screened through a selection scheme designed by CERF. Training was provided to the estate personnel for raising and managing the seedlings for propagation. Results on family selection at the first stage (seedling nursery) and individual visual selection at 'stage 2' are presented for the first four years of this project.

Introduction

Growing high potential yield sugarcane varieties is a key point to increase field productivity. SOMDIAA owns three sugarcane estates in central Africa (SOSUCAM in Cameroon, CST in Chad, and SARIS in Congo). These estates must take up the challenge to develop an efficient method to identify high-yielding sugarcane varieties. In 2005, GPS (the association of the three sugarcane estates) decided, in partnership with CERF (the research centre responsible for sugarcane breeding in Réunion Island), to restructure its selection programs.

Three contrasting environments

SOSUCAM is situated along the Sanaga River, at 120 km north-east from Yaounde.

The subequatorial climate of SOSUCAM is characterised by two dry seasons, from November to March and from mid-June to mid-August (Figure 1). The annual average precipitation is 1450 mm generally well distributed throughout the year except for the dry months. Temperature varies from 23.5°C in July to 26.5°C in February. Humidity is very high and drops below 70% only during the long dry season. Daily evaporation is low: 3.8 mm/day. Sugarcane is cultivated under rainfed conditions.

The deep soil has good available water capacity and drainage is easy. Chemical properties are not so propitious: acid pH and low organic matter (Viremouneix, 2009).

CST is near Banda, near the Chari River, 600 km south east of N’Djamena. The tropical climate of CST is divided in two seasons: the dry season (from November to April) and the wet season (from May to October).

Monthly mean temperature varies from 24.2°C to 31.4°C. The annual average precipitation is 1023 mm; the average evaporation is 5.75 mm per day.

The humidity is relatively low (~45%). Fields are irrigated by pivot irrigation, by drip irrigation, or by gravity.

Depending on the ground water table depth and soil clay content, subsurface drain pipes are necessary. Although pH is 6, the soil has poor organic matter content and reveals a slight deficiency in phosphorus and potassium (Viremouneix, 2009).

SARIS is situated in Niari Valley, 250 km from Brazzaville.

The climatic year is composed of a wet season (from October to May) and a short dry season (from June to September). Monthly mean temperature varies between 23.8°C and 27.5°C. Evapotranspiration is low (~3.9 mm/day) (Viremouneix, 2009).

Soil is rich with a pH of 5.3, with high phosphorus and organic matter content.

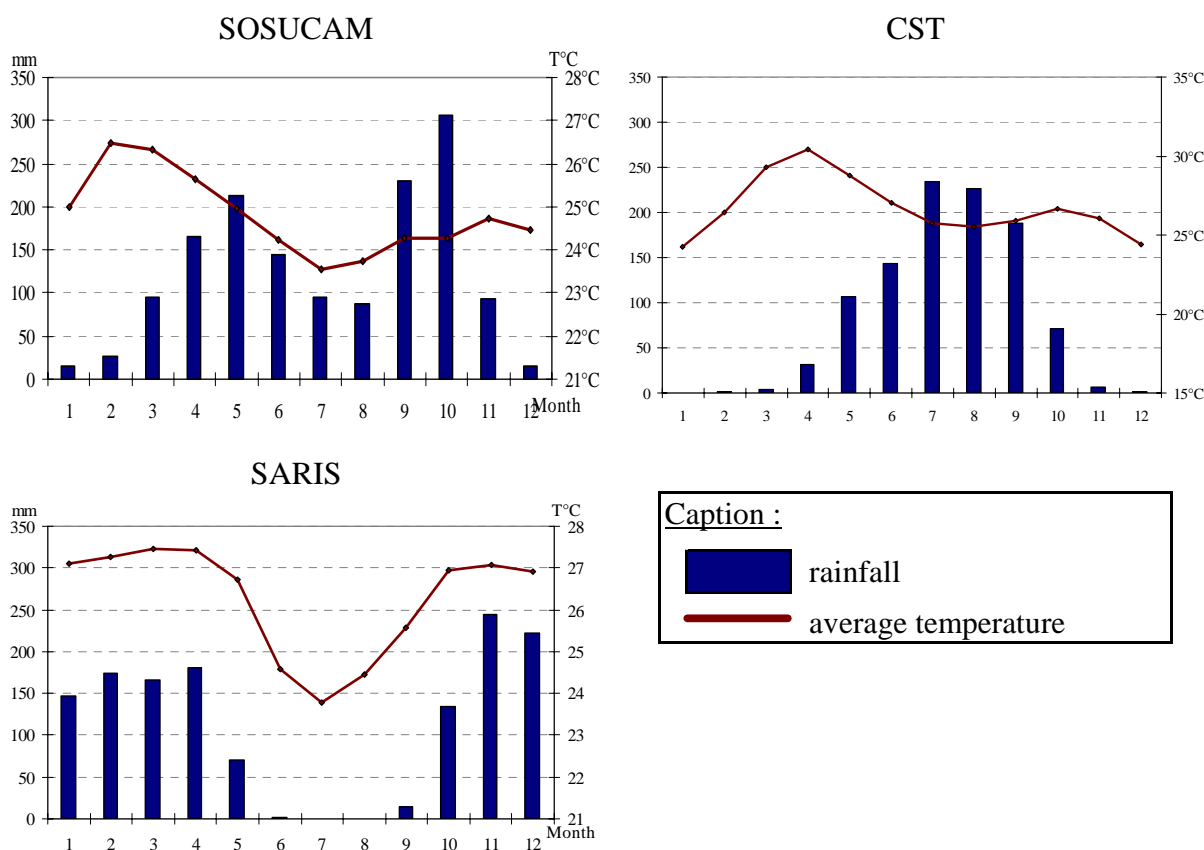


Fig. 1—Monthly rainfall distribution and mean monthly temperature for GPS estates.

Contrasting agronomic results

The contrasting agronomic data (Table 1) can be explained by the contrasting environments and cultural practices, but they could be improved on each sugar estate. Selecting adapted sugarcane varieties is a key point to achieve this objective.

Table 1—Agronomic performances of the three sugarcane estates.

	Area planted (ha)	Cane yield/ha (TC/ha)	Sugar content (%)	Sugar yield/ha (TS/ha)
SOSUCAM	20 000	70.5	13.2	7.0
CST	3872	86.7	13.4	9.2
SARIS	12 000	58.9	13.31	6.1

The previous selection program and its results

Since 1984, GPS estates were importing around 100 sugarcane varieties per year from different breeding stations such as, WICSCBS (Barbados), SBI (India), CIRAD (Guadeloupe), SASRI (South Africa), and CERF (Reunion).

The imported varieties could be:

1. Elite varieties i.e. they had better agronomic performance than standards in their original country and were adapted to the agro-ecological zones where they were selected.
2. Pre-selected varieties i.e. they had gone through the first selection trials in the respective countries.

To identify the best performing varieties, GPS has developed a ten-year selection scheme for each site (Figure 2). Figures 3, 4 and 5 show variety distribution at SOSUCAM, CST, and SARIS respectively.

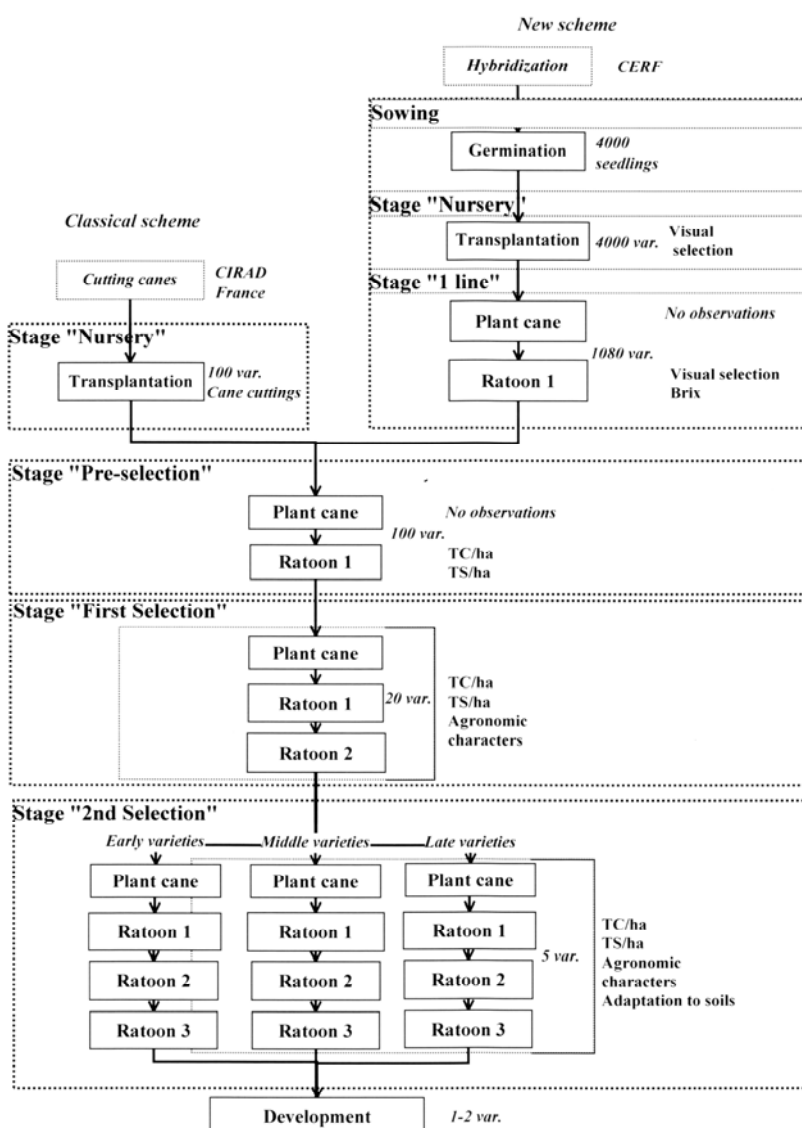


Fig. 2—Classical and new selection scheme.

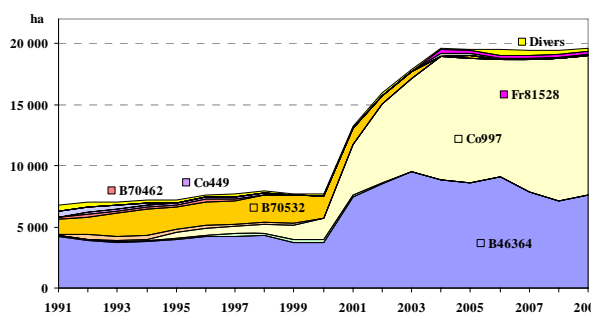


Fig. 3—Variety distribution at SOSUCAM.

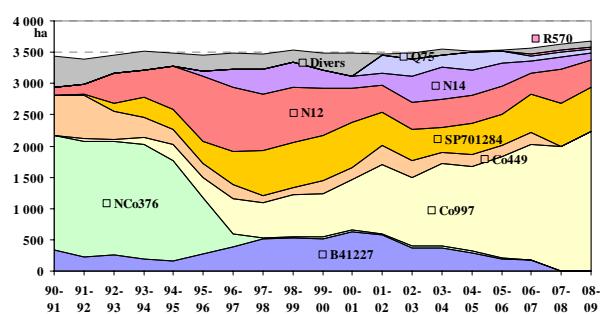


Fig. 4—Variety distribution at CST.

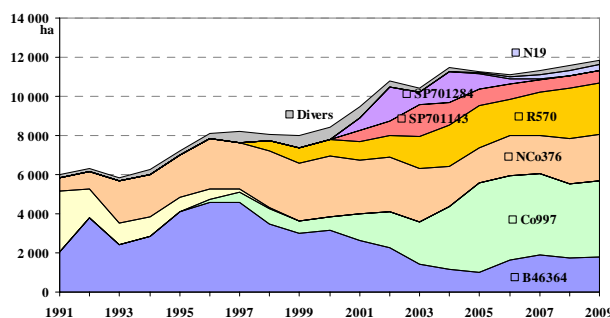


Fig. 5—Variety distribution at SARIS.

SOSUCAM cultivates mainly two varieties: Co 997 and B 46/364 on 97% of the cane area (Figure 3). B82333 and Fr 81/258 are being multiplied.

More than 57% of CST cane area is planted with Co 997, 21% with SP 701284, 12.5% with N12 (Figure 4). The varieties R570 and N18 are promising for commercial exploitation.

Four major varieties are cultivated at SARIS: B 46/364, NCo 376, Co 997 and R570; each cover around 20% of the cane area (Figure 5). N 19 and Mex73523 are under multiplication (Viremouneix, 2009).

Some old varieties are cultivated on most of the estates. Although a significant effort is being made to renew the cultivar situation, GPS selection programs are not reaping the expected results.

The new selection scheme

To improve the selection efficiency, GPS requested CERF expertise. The main weakness of the GPS selection program is its over reliance on imported varieties. Selecting in an environment and expecting similar performance in a different environment is a strategic error (Simmonds, 1991; Bouvet *et al.*, 1985).

Site-specific selection potentially generates local adaptation, and enables the identification of specific elites (Simmonds, 1991; Barau, 2007).

Since 2005, the estates have established a selection program from fuzzi imported from CERF and supported with CERF expertise.

The goal is to raise 4000 seedlings per year per estate. As it is not possible to accurately predict cross performance, the only way to identify the best families is testing a large number of crosses

However, the performance of the parent is a good indicator for targeting crosses (Hogarth *et al.*, 1997). So, parent varieties were identified as the ten best cultivars in each estate.

Table 2—Ten best varieties identified on GPS estates.

CST	SOSUCAM	SARIS
Co 997	B 46 364	NCo 310
N 12	Co 997	NCo 376
N 14	B 70 532	N 14
SP 701284	B 51 129	N 19
NCo 376	NCo 376	SP 70 1143
N 18	Co 62175	R 570
R 579	B81332	Co 997
M 3145	N18	B 46 364
Co 449	Co 449	Mex 73 523
Q 75	Co740	SP 71 6180

CERF breeders provided training to the estate personnel in Réunion Island and in Chad:

1. to design a new selection scheme
2. to manage seedling germination and propagation
3. to grow and select the seedling nursery
4. to select 'stage 2' where each variety is planted on one 3 m- line.

Fuzz is sown in trays under a plastic tunnel. A few weeks after germination, seedlings are potted. Three months later, seedlings are transplanted into the nursery. About four months after transplanting, the nursery is selected using a visual grade assigned to each family, which defines the selection rate per family.

About 30% of the seedlings are selected and planted into stage 2 (3 m plots) for clonal selection. In first ratoon, clones are evaluated for agro-morphological characters at 10 months, and Brix is measured on the clones with the best visual grades.

About 6% of cultivars (72 clones per site) are selected and screened through the ten-year classic selection scheme (Figure 2). Thus, the complete new selection program lasts around 14 years.

Table 3—Site-specific selection scheme.

Year	0	1	2–3	
		0–3 months	3–10 month	
Selection stage	Hybridisation	Seedlings	Transplantation in the field (nursery)	Stage 2 'one line'
Population size (crosses/varieties)	120 crosses	12 000	12 000	3600
Number of crosses/varieties per site	40 crosses	4000	4000	1200
Elementary plot	Crossing lanterns	Germination tray	1 seedling per variety	One 3m-row 4.5 m ² per variety
Selection Site	Réunion Island	Chad Cameroon Congo	Chad Cameroon Congo	Chad Cameroon Congo
Visual Selection criteria	Choice of parents Listed in Table 2 and CERF elites		Agronomic observation on family	Agronomic observation
Selection criteria				Brix of the best varieties at 1 st ratoon Selection on ratoon only

Table 4—Population of seedlings obtained and number of clones in selection trials at each site.

	2005		2006		2007			2008		
	CST	SOSUCAM	CST	SOSUCAM	CST	SOSUCAM	SARIS	CST	SOSUCAM	SARIS
No. of Crosses	23	36	19	18	32	43	25	42	28	28
No. of seedlings raised	2587	33	2099	2274	10 100	9449	6559	4100	5616	6616
No. of clones at stage 2 '1 row'	768	9	634	745	*	2828	1428	*	1671	*
No. of clones at stage 'Pre selection'	91	5	*	*	–	–	–	–	–	–

* Data available in December (2009)

Discussion

GPS emphasises the use of the best varieties in crosses. However, a number of varieties are not available in the CERF germplasm collection. So CERF plans to acquire them from the respective breeding centres. Moreover, the extent of flowering may limit their use in crosses since CERF relies on natural flowering for crossing.

CERF has suggested that GPS increase the number of seedlings raised in order to widen the genetic diversity for the new selection scheme.

In 2009, GPS will establish the first experimental trials as per the new scheme (stage 'Pre-selection').

In the process of developing the new selection scheme, GPS is faced with a number of difficulties, such as the reliability of the visual grades and the identification of diseases (with the classical scheme, the diseases were monitored by CIRAD).

Furthermore, the selection would progressively be improved from feedback received from GPS. Data on selection rates would rapidly provide useful information on the best crosses and parents.

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LA SÉLECTION VARIÉTALE DEPUIS LE STADE SEEDLING DANS LES COMPLEXES SUCRIERS DU GPS

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**MOTS-CLES: Sélection sur Site, Adaptation Variétale,
Environnements Contrastés**

Résumé

LE GPS (Groupement des Professionnels du Sucre) est l'association qui regroupe les trois complexes sucriers de la SOMDIAA en Afrique centrale (la SOSUCAM au Cameroun, la CST au Tchad et la SARIS en République du Congo). Pour améliorer l'efficacité de la sélection et pour renouveler la situation variétale, le CERF et le GPS ont développé un partenariat étroit. Jusque là, le choix des variétés cultivées se basait sur un schéma de sélection de dix ans. Ce schéma de sélection était alimenté par une centaine de variétés étrangères (des variétés élites ou des variétés pré-sélectionnées). Le problème principal de cette démarche réside dans le fait que les variétés introduites et sélectionnées ailleurs n'étaient pas adaptées aux conditions agroclimatiques spécifiques des complexes du GPS. De plus, des résultats obtenus au CERF montrent que la sélection sur site augmente la probabilité d'identifier des variétés prometteuses. Il a donc été décidé d'établir sur chaque complexe, un schéma de sélection à partir de fuzz importé depuis le CERF. Depuis 2005, le CERF réalise des croisements spécifiques pour chaque complexe, puis expédie le fuzz ainsi produit. Environ 4000 seedlings par an sont obtenus sur chaque site. Ces seedlings subissent alors un schéma de sélection élaboré en collaboration avec le CERF. Le personnel des complexes a pu suivre des formations sur la germination et l'entretien des seedlings. Cette étude présente, pour les quatre premières années de ce projet, les résultats de la sélection familiale au stade 1 (pépinière de seedlings) et les résultats de la sélection massale et visuelle du « stade 2 ».

SELECCIÓN DE VARIETADES DESDE ESTADO DE PLÁNTULAS EN LOS ESTADOS CAÑEROS DE GPS

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PALABRAS CLAVES: Selección en Sitio,
Adaptación Varietal, Ambientes Contratantes.

Resumen

GPS ES UNA asociación que agrupa a tres estados Azucareros en África Central (SOSUCAM en Cameroun, CST en Chad, y SARIS en la República del Congo) y son propiedad del grupo SOMDIAA. CERF y GPS han desarrollado un acuerdo importante entre ellos, con el fin de mejorar la respuesta de la selección y renovar variedades. Anteriormente, las variedades se escogían basándose en un esquema de selección de 10 años, que se aplicaba cada año usando 100 variedades introducidas (variedades élites y pre-seleccionadas). Esto causa un problema mayor que es la introducción de variedades seleccionadas afuera y no están bien adaptadas a las condiciones agroclimáticas específicas de los estados del grupo GPS. Más aún, resultados previos obtenidos por CERF mostraron que la selección por sitio incrementa la probabilidad de identificar variedades promisorias. Por ello, se ha decidido establecer un programa de selección para cada estado, usando semillas de CERF. Se han realizado cruces específicas para cada estado en la Isla de Reunion para luego sembrar en cada estado, desde el 2005. Estas siembras incluyen alrededor de 4000 plántulas en cada estado y seleccionadas dentro de un esquema de selección elaborado en colaboración del CERF. Se ha entrenado al personal de cada estado para el cuidado, propagación y manejo de las plántulas. En este trabajo se resume los resultados de los primeros cuatro años del proyecto, sobre la selección familiar en Estado I y selección clonal visual en Estado II.