

# THE ESTABLISHMENT OF A SUGARCANE VARIETY EVALUATION NETWORK FOR WESTERN AND CENTRAL AFRICAN COUNTRIES

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## Abstract

Sugarcane has been grown for some thirty years in Western and Central Africa. The annual sugar production is now around 500,000 tonnes, all of which is produced by recently privatised sugarcane companies. With a view to increasing productivity, producers aim at renewing the range of varieties grown. Unlike many sugarcane growing areas, this regional sugar industry does not have at its disposal a breeding programme to create its own varieties. It relies entirely on the introduction of varieties by individual producers and their evaluation locally. In 1999, CIRAD organised a workshop on variety improvement with the sugar producers of the region. These comprised some breeding centres (CERF, MSIRI) and the West Indies Sugarcane Breeding and Evaluation Network (WISBEN). The purpose was to set up a regional variety improvement network. It was noted that several existing selection programmes were relatively long, that the variety turnover was low and that some varieties were not being fully exploited. It was therefore decided to improve the existing selection programmes and the current methodologies, with the purpose of sharing information among growers on variety selection, to diversify the variety supply source and to increase the number of introductions. In 2001, during the second workshop, the sugar producers agreed to set up a regional variety evaluation network and to create an association. Once created, the association would establish collaborations with breeding centres to introduce genetic material. In the longer term, the producers of the region could initiate a hybridisation programme.

*Keywords:* sugarcane, varieties, network, Africa, Western, Central

## Introduction

During the 1970s, several Western and Central African French-speaking countries started to produce sugar to satisfy, their local consumption. Thus, sugarcane production began in Benin, Burkina Faso, Cameroon, Chad, Ivory Coast, Gabon, Guinea, Mali, Senegal, while in Congo and Zaire it developed once more. In these countries, sugar is produced by agro-industrial companies on areas varying from 1 000 to 12 000 hectares. Sugarcane is grown also by small growers on 2 500 hectares in Ivory Coast only, on land surrounding the large-scale production units.

With the exception of Senegal, all the large scale production units were public concerns until their privatisation in the 1990s. This has involved heavy investment with the result that proper control of production factors, including the use of adapted and high yielding varieties is important. However, in spite of the regular introduction of a limited number of foreign varieties and their selection locally expected results have not been obtained. Thus, in 1999, with the help of Cirad, the sugarcane producers of the region decided to initiate actions towards the setting-up of a regional variety improvement network similar to the one existing in the West Indies.

This publication aims at describing the various steps that have led to the setting-up of this network, its organisation and operation with a view to share information with sugarcane breeding centres that would be interested to bring their contribution to variety improvement for this region. The paper gives also the production sites data.

### Regional sugar production data

The sugarcane variety improvement network of Central and Western Africa comprises eight companies and eleven production units. Total sugar production amounts to nearly to 500 000 tonnes and the aim is to reach 700 000 T (Table 1).

**Table 1. Members of the network and sugar production (2000-2001).**

Region	Country	Company	Area cultivated (ha)	Tonnes sugar produced
Western Africa	Burkina Faso	SN.SO.SU.CO	3 626	35 388
	Ivory Coast	SUCAF-CI	11 404	91 563
		SUCRIVOIRE	9 630	80 000
	Senegal	Compagnie Sucrière Sénégalaise (*)	7 244	88 450
Central Africa	Cameroon	SOSUCAM	11 176	82 100
	Congo	SARIS	7 649	51 262
	Central Africa	SOGESCA (*)	1 248	9 957
	Chad	Compagnie Sucrière du Tchad	3 492	28 313
Total			55 469	467 033

(\*) = 1998-1999 data

These production units are located in:

- three countries of West Africa, namely Burkina Faso, Ivory Coast, Senegal, located between 7° and 16° North and benefiting from a Sahelian to a Sudano-Guinean climate.
- four Central African countries, namely Cameroon, Central African Republic, Congo and Chad located between 9° North and 4° South and benefiting from Sudano to Sudano-Guinean climate.

Cultural practices are very similar from one sugar production unit to the next, except the need to satisfy crop water requirements. Thus, sugarcane is grown without irrigation at SOSUCAM and SARIS while overhead or furrow irrigation is practised on the other production sites (Table 2).

### Variety profile and selection

None of the seven countries that have initiated the variety improvement network possess a variety breeding unit. Until now, each production unit imports varieties of their choice. They consist of (i) readily available and sometimes old cultivars from different sources: CP, F, L, M, N, Phil, Q, R, RB, SP, TUC, (ii) promising varieties or commercial clones (for example bilateral contracts e.g. Wisben varieties), (iii) pre-selected clones (Cirad's FR). Thus, over the last fifteen years, some fifty varieties have been imported annually in each country. Most of the varieties that are imported transit through the sugarcane quarantine facilities of Cirad at Montpellier. Senegal also possesses also quarantine facilities and regularly imports varieties from Barbados and Canal Point.

Although this variety introduction system has functioned over the last thirty years, variety renewal has been slow, sometimes absent. This has led to a restricted range of varieties being cultivated. The major ones are B 46364, Co 997 and NCo376 followed by Co 957 and R 570. The variety distribution is fairly well balanced on four out of the eleven production units. There, three to five varieties occupy each 15 to 30% of the total area whereas on the other sites, two varieties occupy 60 to 80%, sometimes 90% of the area under cane (Table 3).

**Table 2. Some characteristics of the production sites.**

Country	Company	Latitude, longitude	Maxi/mini temperature (°C)	Evap (pan) (mm/d)	Rainfall mm	Irrigation
Burkina Faso	SO.SU.CO	10°45' N 04°44' W	33.7 17.9	2480	1022	Overhead
Ivory Coast (SUCAF-CI)	Ferké 1 et 2	09°20' N 05°20' W	30.5 18.9	2215	1218	Overhead
Ivory Coast (SUCRIVOIRE)	Borotou	08°30' N 06°03' W	32.3 19.6	1789	1258	Overhead
	Zuénoula	07°25' N 05°20' W	33.9 21.1	1663	1152	Overhead
Senegal	CSS	16°27' N 15°43' W	36.0 20.0	3600	300	Furrow
Cameroon	SOSUCAM 2 units	04°26' N 11°52' E	29°6 19°9	1412	1423	None
Congo	SARIS	04°15' S 13°10' E	31°2 21°0	-	1177	None
Central African Republic	SOGESCA	-	-	-	1500	None
Chad	CST	09°11' N 18°28' E	33°9 19°5	2178	1030	Overhead

**Table 3. Variety distribution (ha grown) on various sugar production units (98-99 crop season).**

Varieties	Cst	Css	Sogesca *	Sосуco	Sosucam **	Saris	Sucaf **	Sucrivoire		Total (ha)	%
								Bor	Zué		
B 46364			1007		4035	3352				8394	16.0
Co 997	684		66	1164	1617	557	233	806	3216	8343	15.8
Nco 376			479		193	2647	3304	1360		7983	15.1
Co 957							3644	353	353	4350	8.3
R 570			17	533		669	497	1309	888	3913	7.5
N 14	288	2014		187		34				2523	4.7
B 70532					1733					1733	3.3
Co 449	216			609		32	801			1658	3.1
Co 62175		380		28			512	302		1222	2.3
Co 6806		950								950	1.8
PR 1007				833						833	1.6
SP 701284	720	20				53				793	1.5
N 12	756									756	1.4
SP 701143			83			669				752	1.4
CP 742005		647								647	1.2
Others	936	1806	0	534	123	502	2879	906	591	8277	15.0
Total	3600	5817	1652	3888	7701	8515	11870	5036	5048	53127	100

\* = 1997-1998 crop season

\*\* = two production units

This narrow range of cultivated varieties is due to factors linked to production constraints. The inherent water deficits have led to the choice of drought tolerant varieties even if they possess some major defects. Hence, NCo 376 and B 46364 have low sucrose contents and are susceptible to smut and mosaic diseases respectively. Owing to the Sudano-Guinean climate that does not favour proper maturation of the cane, a rich cane like Co 997 is often propagated at the expense of other varieties.

In spite of the variety selection programmes conducted by the producers over the last 30 years, variety turn-over has been poor on all of the sites. This indicates that local breeding programmes may be enhanced. The weaknesses of the current variety improvement programme are mainly due to the relatively limited number of varieties that have been introduced across the years, their poor adaptation to the local conditions and the adoption of inappropriate selection procedures. The selection programmes last between 12 to 15 years and are relatively long when one considers that the varieties introduced have already been selected, or partially so, in their countries of origin. This is also an indication of the difficulties that are being encountered to make appropriate choices during the course of selection.

In light of these factors and the concern expressed by the sugar companies to ensure the renewal and a diversification of available varieties, Cirad organised a workshop in Ivory Coast in 1999 with growers of the region to share information on variety improvement activities undertaken and to propose various steps that could be taken to satisfy local and regional needs in terms of varieties. Representatives of some research centres participated also in the workshop, namely CERF (Centre d'Essais, de Recherche et de Formation, Reunion), MSIRI (Mauritius Sugar Industry Research Institute), CNRA (Centre National de Recherche Agronomique, Ivory Coast) and WICSBS (West Indies Central Sugar Cane Breeding Station, Barbados).

### **Steps that have led to the creation of a variety improvement network**

#### *Yamoussoukro workshop, Ivory Coast October 1999*

During the workshop, each sugar producer of the Western and Central African region made a presentation of the characteristics at each production site and the variety improvement programmes that are conducted. The scientific isolation of the staff of the sugar companies was spelt out. The research institutes presented their sugarcane hybridisation and selection programmes. These presentations confirmed the relatively long time that regional producers take to select for improved varieties. The relative advantages derived from a regional network, namely the exchange of varieties, the sharing of information and shared experience through the holding of regular workshops were detailed by representatives of West Indies Network (WISBEN).

A first series of proposals for the improvement of the existing selection programmes and the possibilities to look for a diversified source of new varieties to be introduced were discussed (Table 4). Among the various scenarios that were presented, the current (option 1) was favoured for its simplicity and relatively lower cost as compared to the others. The possibility to diversify the source of varieties was not excluded. However, several producers expressed the wish to initiate selection as from fuzz fairly rapidly (option 3 or 4). One of the operators expressed the wish to undertake hybridisation locally eventually, this being a necessary condition to satisfy to be able to participate to network activities.

The main activities of a network organisation were discussed. At the end of the workshop week, Cirad was asked to co-ordinate these activities among the producers with the aim of setting up a variety improvement network for the region. It also proved necessary to attempt to assess the extent of variety x environment interaction from existing data, with a view to guide selection procedures that would have to be adopted eventually.

**Table 4. Proposed sugarcane selection programmes for Central and Western Africa region.**

Variety collection ↳		Hybridisation station ↙↘		Biotechnology ←
Option 1	Option 2	Option 3	Option 4	
Existing programme: Cuttings of readily available and pre-selected varieties ↓	One pre-selection station in Africa (Fuzz) ↓	Pre-selections stations in diverse environments ↓	A selection station on each sugar producing unit	
- Quarantine by Cirad - Quarantine in Africa ↙↘		Quarantine? Variety distribution according to environments concerned ↓	-	
Final selection on sugar producing units	Selection on sugar producing units: varieties FRx, Ry , Bx, Mz etc		-	
Drawbacks				
Insufficient variety distribution and pre-selection outside target environments	Needs good co-ordination and quarantine facilities	Needs good co-ordination	Heavy investment	
Advantages				
Simple programme	No quarantine for countries concerned and no pre-selection	No quarantine for countries concerned and pre-selection near target environment	Gain of time and increased probability to select for adapted varieties	

*Yaoundé workshop, Cameroon – June 2001*

During the second workshop, the various activities that had been conducted since the Yamoussoukro meeting were summarised. The sugar producers confirmed their wish to create the network and an agreement was signed whereby they agreed to finance the network on a pro-rata basis of their production. The wish to set-up a hybridisation station in one of the countries of the region was re-affirmed. First proposals of statutes and internal regulations of the network that had been prepared by the co-ordinator were discussed for eventual amendments and approval. Concurrently, an operational budget was prepared.

The Cirad was asked once more to pursue the co-ordinating activities of the emerging network and to undertake a mission to make an inventory of the activities and procedures that are conducted within the on-going selection programmes.

*Statutes and internal regulations of an association housing the network*

The statutes and internal regulations of the association aim at ensuring the setting up of a network that can operate efficiently at relatively low cost, that allows the circulation of information relating the introduction and evaluation of varieties, that favours the renewal of varieties through the adoption of adapted methodologies and selection programmes that permit the participation of new operators and partners. Within this structure, members will conduct their selection programmes depending upon the choice of vegetative material that suits them best, namely fuzz introduced from breeding stations, pre-selected varieties or commercial varieties that have proved of interest in other environments.

The association will be made up of ‘active members’ (sugar producers) and ‘associated members’. The latter consists of research organisations and associations or networks undertaking sugarcane breeding, and that can provide their expertise. The network proposed will be made up of an ‘operations committee’, a ‘scientific committee’ and a central unit. The operations committee will be the decision-making body of the network. It will be made up of representatives of the active members group. The scientific committee will be made up of scientific and technical decision-makers of the sugar producing units and breeders of the research organisations. It will be the scientific meeting place of the network. The central unit will undertake and co-ordinate the activities of the network. It will be managed by a technical co-ordinator. A scientific advisor will bring his expertise to scientific activities of the network for a three-year renewable period. This advisor will have to be a sugarcane breeder by profession.

#### *Genotype x Environment interaction*

It has been possible to undertake genotype x environment interaction analysis for data obtained from trials that included varieties planted in at least two environments on the basis of soil types and climatic conditions : (i) Banfora in sub-sahelian irrigated aerie and (ii) Zuenoula in a two rainy season tropical aerie and rainfed conditions. The results obtained have enabled to establish the different relative performance of varieties planted at final stages of selection at these two sites (Table 5). This series of analysis will be pursued on additional trials, as the data become available.

**Table 5. Classification of the same varieties at final stage of selection (tc/ha).**

Sn.so.su.co (Banfora)		Sucrivoire (Zuénoula)	
Varieties	Mean (tc/ha)	Varieties	Mean (tc/ha)
SP 701423	121.9	B 46364	86.7
N14	106.9	R 540	86.8
Co 957	97.9	SP 701423	86.7
Co 997	95.3	Co 957	77.8
B 46364	92.1	Co 997	75.1
Co 1007	81.7	N14	73.7
Co 449	78.3	Co 1007	70.0
R 540	75.7	Co 449	67.3
Sources of variation	F value	PR > F	
Site	Test F (1; 28) = 6.93	P = 0.0136	
Variety	Test F (116; 55) = 4.98	P = 0.0001	
Variety*site	Test F (7; 55) = 2.50	P = 0.0263	

#### *Circular mission to make an inventory of the activities and procedures*

A circular mission is being undertaken during the 2002 cropping season. As the selection charts at each selection site are known, the mission has provided useful information on the organisation of teams that undertake selection and their level of knowledge, the methodologies and analytical that are adopted, the equipment used and the various difficulties encountered by selection teams. These data will provide additional information to the various working groups and committees and will enable decisions to be taken to improve selection procedures that are currently adopted.

## Conclusion

Now that the privatisation process of the sugar producing units of the French-speaking countries of West and Central Africa is completed, producers are ready to invest in research activities, especially variety selection. The scarcity of recent varieties and the potential increase in production that can be expected by the exploitation of new varieties, reinforce this need and has led to the setting up of a variety improvement network. This activity will help to introduce more varieties, proceed with the selection of varieties in target environments from an early stage in the programme, facilitate the movement of varieties and information among members and eventually enable the creation of varieties specific to the region.

## REFERENCES

- Anon (2000). Handbook 2000 of the West Indies Sugarcane Breeding and Evaluation Network. West Indies Central Sugarcane Breeding Station, Barbados. 43 pp.
- Anon (2001). Protocole d'accord du 2<sup>ème</sup> atelier régional sur l'amélioration variétale de la canne à sucre en Afrique de l'Ouest et du Centre.
- Chapman, S, Cox, M and Jacsson, P (2000). Genotype x Environment interactions across regions in Australia – the Mega GxE Project. Communication presented at the 6th ISSCT Breeding Workshop, 13-17 November 2000, Barbados.
- Cirad (1999). Actes du premier atelier régional sur l'amélioration variétale de la canne à sucre en Afrique de l'ouest et du Centre. Yamoussoukro, 5-8 october 1999. 239 pp.
- Feldmann, P (1995). La création de variétés de canne à sucre au Cirad : Les clones FR. Projet Connaissance et Amélioration de la Canne à sucre. CIRAD Guadeloupe. 15 pp.
- Kennedy, AJ, Rao, PS and Chave, JW (1994). Breeding and Selection in the West Indies Sugarcane Breeding and Evaluation Network (WISBEN). West Indies Central Sugarcane Breeding Station, Barbados, Bulletin 44. 21 pp.
- Malafaye, N (2000). Interaction génotype x environnement sur des essais variétaux de canne à sucre en Afrique. DEA report. 40 pp.
- Marion, D (2001). Rapport des activités conduites de l'atelier de Yamoussoukro (Côte d'Ivoire), Yaoundé, Cameroun. 7 pp.