DIVERSIFICATION OF SUGARCANE VARIETIES FOR CATTLE FEED AND SUSTAINABILITY

By

H. JORGE, O. SUÁREZ, H. GARCÍA, I. JORGE and L. BENITEZ

Instituto Nacional de Investigaciones de la Caña de Azúcar, Habana. Cuba
hector@inica.minaz.cu

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Abstract

THE PAPER reports results of a study of 44 sugarcane genotypes, evaluated as cattle feed, at 13 months of age, in the first ratoon crop, at Villa Clara–Cienfuegos Territorial Sugar Cane Research Station and the Sancti Spiritus National Breeding Center in Cuba. Fourteen traits were evaluated by means of multivariate analyses (Principal Components and Discriminant Function), and also a simulation was conducted of agro-ecological regionalisation for the allocation of the sugarcane varieties according to the main limiting factors (drought and poor drainage) on a cattle producing farm. Results showed that the variables, percentage of stalk fresh weight (% of stalks) and of tops (% of tops), had high influence in the first principal component, whereas the genetic disease (smut and rust) resistance had high influence in the second component. It should be pointed out that the percentage of digestibility of the dry matter showed very little variability, which indicates a high stability of this trait. The Discriminant Function Analysis allowed classification of cultivars into three groups: varieties of low forage value (below 40% digestibility of the dry matter), varieties of intermediate forage value (between 40–50%) and varieties of high forage value (above 50% digestibility). Results allowed the recommendation of 21 new genotypes, characterised by their resistance to main diseases and their high forage value, and nine were superior to the control My5514, four suitable for waterlogging stress and three for drought stress. The simulation of the agro-ecological regionalisation enabled spatial location and modelling for the appropriate establishment of individuals, in agreement to their digestibility, tolerance to the two environmental stresses (waterlogging and drought) and their disease resistance.

Introduction

Population growth is a problem in the world, today. It is probable that population will increase to 8 300 000 in 2025 (FAO, 1998).

This must be viewed in the context of a decrease in the area of arable land committed to food production because of competition for application of pasture and grain crops to energy production.

Mankind has knowledge and technologies to confront this crisis, but policies of unequal distribution of wealth have resulted in some negative environmental and social impacts (FAO, 1996).

Sugarcane constitutes an alternative to be used for animal nutrition. Countries like Colombia, Brazil and Costa Rica maintain that the technical and biological basis exists for sugarcane to replace cereals in intensive animal production systems, thus allowing the release of great quantities of foodstuff for mankind.

This paper was developed to characterise a group of varieties of sugarcane for use as animal food and for identifying suitable agro-ecological environments for them to be used as cattle producing units.

Materials and methods

The study was developed in two provinces of the country (Villa Clara and Sancti Spíritus) at the Sugar Companies Ifraín Alfonso and Melanio Hernández, in soil Eutric Cambisol (FAO – UNESCO, 1994).

Forty-four recently recommended new varieties of sugarcane from the Sugarcane Research National Institute for Sugar Production were studied.

The plots were of 64 m^2, with five replications in the first ratoon crop harvested at 13 months of age. Fourteen variables relating to crop morphology and the probable relationship with the digestibility of the biomass were evaluated.

Genetic resistance against two important diseases, brown rust and sugarcane smut, was also quantified.

The digestibility of the dry matter of each variety was determined by the *in vitro* technique of KOH (Kesting, 1977).

The statistical analysis was performed using the multivariate analyses of Principal Components and Discriminant Functions, in which the digestibility of the dry matter was used like a group variable, with three groups: <40 %, >50 % and the correspondent interval.

The varietal performance was assessed by comparing means of the percentage digestibility of dry matter with the control variety My5514.

The software MapInfo 8.0 was used for the agro-ecological zoning simulation on a cadastral base map of 1:10000 scale.

The utilisation of 90% of the area of the unit was assumed for cattle raising, and the distribution of the nutrition of the cattle mass was distributed in the following way: 57% improved pasture land, 26% King Grass (CT–115) and 17% sugarcane for animal nutrition.

We also took into account soil types in relation to the impact of physical properties such as soil depth, water holding capacity and drainage capacity on the suitability for production of the various sugarcane varieties.

Then we established the following premises: to obtain a fodder balance for fattening 1880 head of bulls to a finished live weight of 450 kg, equivalent to 1692 units of greater cattle (UGC), that represent one charge of two cattle per ha.

We considered that sugarcane fulfills 43.7% of the requests for foodstuff in the period of minor availability (212 days).

Results and discussion

Of the 14 variables used for the evaluation of the use of the varieties of cane as an alternative for the feeding of the cattle, Principal Components Analysis indicated that 9 of the variables across three factors contributed 64% of the total variation (Table 1) and they were considered sufficient in that objective.

The proportion of variance explained by top stems and the stems of the total biomass, as well as the genetic resistance to smut and rust allowed separation of the varieties and allowed recommendation of more disease resistant and productive varieties than the standard commercial clone.

In the second component, the digestibility of the dry matter was ranked as the next most important variable (Eigenvector 0.43) after the previous variables.

These results explained enough of the variation to allow easy selection of suitable varieties.

Table 1—Eigenvalues and Eigenvectors from Principal Components Analysis.

	Factor 1	Factor 2	Factor 3
Eigenvalues	2.688	1.865	1.231
% total variance	29.870	20.722	13.680
% total variance aggregate	29.870	50.592	**64.272**
Eigenvectors			
Stems percentage	**0.915**	0.087	0.160
Top stems percentage	**–0.949**	0.022	–0.008
Digestibility dry matter	0.286	0.427	–0.252
Brix	0.146	0.054	0.043
Pol %	0.183	–0.075	0.017
Thorns	0.131	0.340	**0.768**
Habit of growth	–0.083	0.015	**–0.874**
Smut	–0.006	**0.829**	0.207
Rust	0.045	**0.882**	0.041

The result of 76.7% of good classif ication from Discriminant Function Analysis (Figure 1) corroborated the im portance of the morphologic and physiological variables that were used in the evaluation of the varieties as possible indicators of the fodder value.

The results agree with those of Suárez (2002) who considered varieties to be accep table for the nutrition of cattle if digestibility of dry matter were greater than 50%.

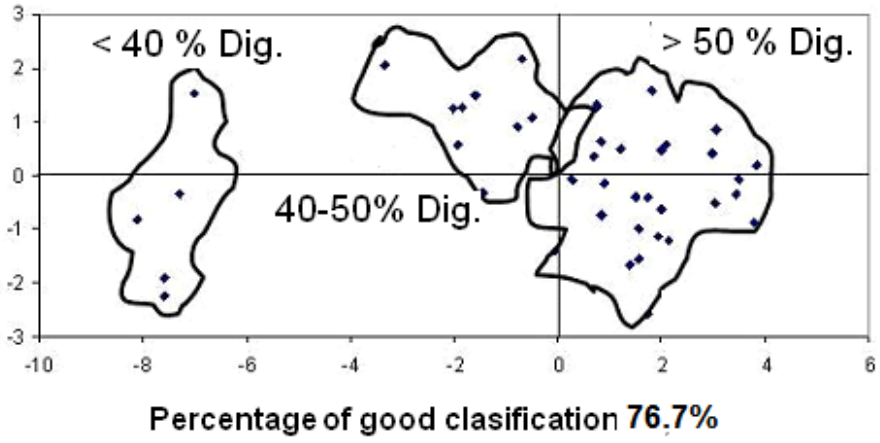

Fig. 1—Performance of the groups in Discriminate Function Analysis.

Twenty one of the 44 genotypes showed m ore than 50% digestibility of dry matter and tolerance to the principal sugarcane diseases (Table 2).

These can be used for animal nutrition (Jorge *et al.,* 2002). Thus a range of suitable varieties of sugarcane are available for commercial production.

The dendro gram repres entative of autom atic classif ication of the 21 cultiv ars p resenting higher digestibility of dry matter over 50% allowed the observation of two groups, which passed the threshold of 2.36. The first (group 2), that included the tester cultivar My5514, was characterised by a higher phenological relation of top and dry leaves than the other group, for which the digestibility was higher (Figure 2).

Table 2—Characteristics of the 21 varieties that were similar or better than the control variety for digestibility %.

Variety	DMS	IRT	Morphologic relation		Resistance to diseases	
			SP	STP	Rust brown	Smut
C89-176	56.63	109.75	12.43	6.26	I	I
B80250	56.28	109.07	11.70	9.50	R	I
C90-501	55.30	107.17	22.90	9.00	R	I
C86-12	55.30	107.17	10.60	9.50	R	R
Co997	54.80	106.20	29.00	10.10	R	R
C132-81	54.40	105.43	18.50	5.30	R	R
C90-530	54.30	105.23	20.50	4.10	I	R
C87-252	54.07	104.79	24.70	9.50	R	R
C92-203	53.30	103.29	10.70	7.60	R	R
C137-81	53.20	103.10	14.10	4.90	R	R
C89-161	53.00	102.71	13.30	12.70	R	R
C87-51	52.96	102.64	14.46	4.10	R	I
C86-536	52.40	101.55	20.60	12.70	I	I
C85-203	51.90	100.58	12.20	6.80	R	I
C86-503	51.80	100.39	14.10	6.70	R	R
My5514*	51.60	100.00	22.80	6.30	S	R
C90-317	51.33	99.48	11.60	6.16	R	R
C95-416	51.32	99.46	15.73	4.70	R	R
C128-83	50.60	98.06	13.20	5.50	R	R
C91-356	50.41	97.69	19.50	5.56	R	I
C86-165	50.32	97.52	19.76	7.90	I	R
C88-553	50.03	96.96	18.30	3.73	I	R

DMS = Digestibility dry matter, IRT= Increment in relation to the control varieties, SP = Stems percentage, STP=Top stems percentage, R= Resistant, I=Intermediate, S = Susceptible, *= Control variety.

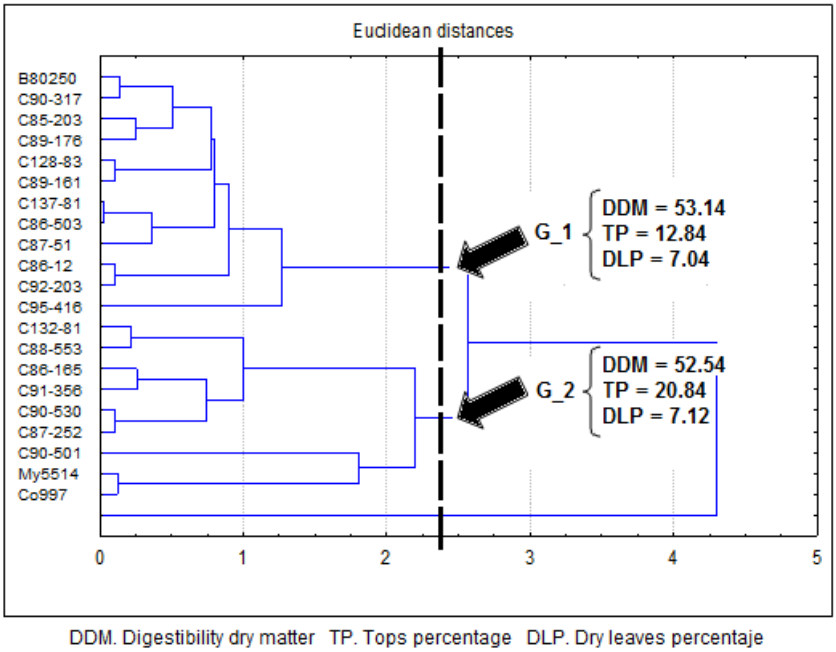

Fig. 2—Dendrogram of the classification of the cultivars.

According to Paretas (1990), 40% of the Cuban cattle area is susceptible to drought stress, because of low water holding capacity of the soils, and this contrasts with the 30% of the area that is poorly drained (Figure 3).

Nine of the varieties from this study can be used for anim al nutrition in areas of cane production subject to abiotic stress, C89- 176, C86-503, C86-12, C86-165, C90-530 to drought and C137-81, C86-503, C132-81, C86-12, Co997 for poor drainage, and they are likely to be important in those regions.

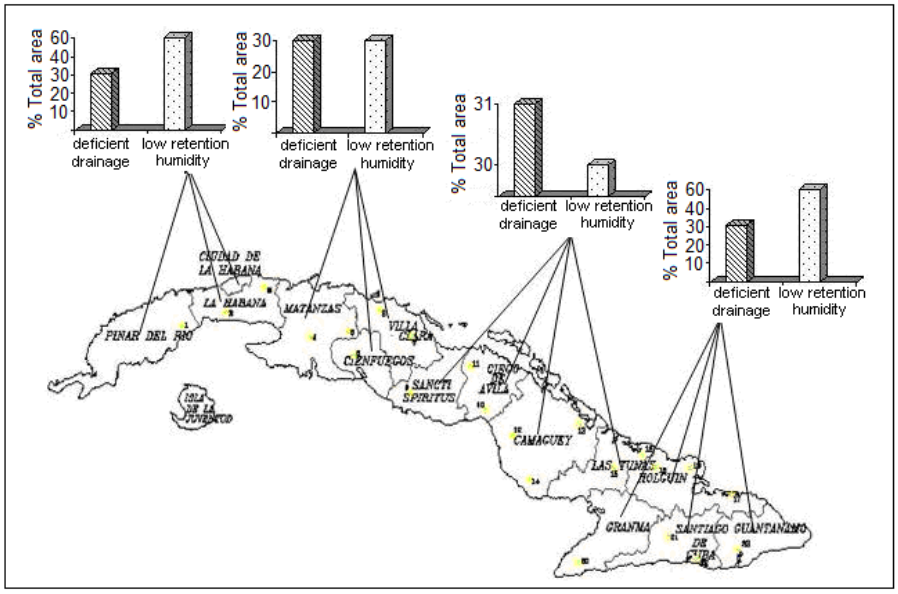

Fig. 3—Position of the cattle areas in relation to drought and poor drainage.

Simulation of zoning agro-ecological

The varieties, C86-12 and C132-81, were located in a 40.4 ha area of bad drainage and C90-530 in an adjoining 36.1 ha, also with poor draina ge (Figure 4). Areas of 30.3 and 34.2 ha of soils potentially affected by drought were planted to C90-317 and C89-176, respectively (Figure 4).

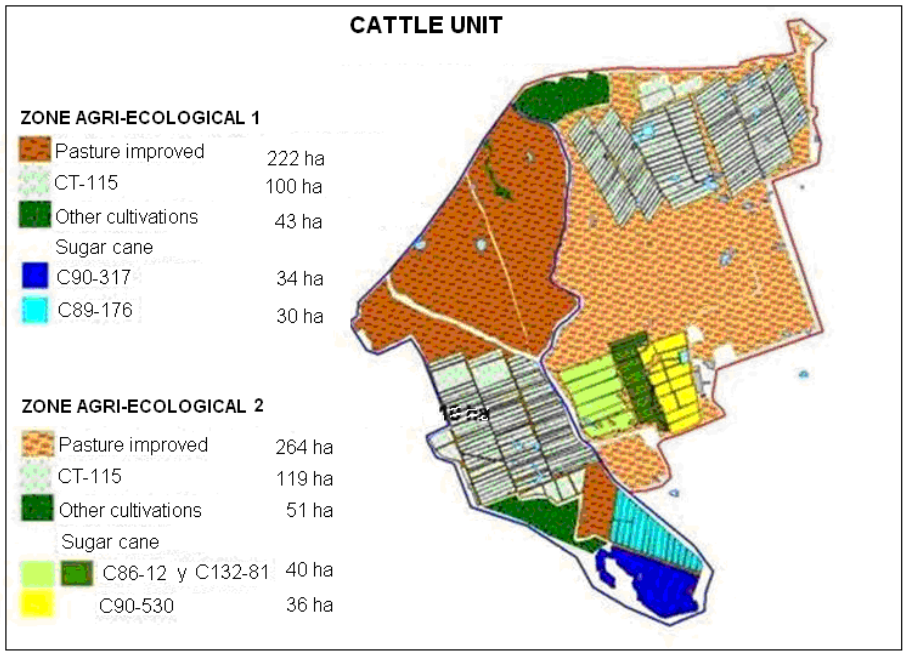

Fig 4—Areas planted to varieties based on their adaptation to different stresses.

Conclusions

- The percentage of fresh weight of the stem and percentage of the fresh weight of the top stem in sugarcane biom ass, along with resistance to rust and sm ut, were the variables w hich best characteriSed the studied population for variability in the percentage of dry m atter digestibility. This en abled the selection of varieties for use in the animal nutrition.
- The classification of the varieties for the percentage of the digestibility of dry matter showed 21 of the 44 varieties had m ore than 50% digestibility, making them suitable for use in the nutrition of cattle.
- The agro -ecological zon ing allowed the va rieties to be reco mmended for locations that matched tolerance of drought or waterlogging stresses.

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DIVERSIFICATION DES VARIETES DE CANNE A SUCRE POUR L'ALIMENTATION ANIMALE ET LA DURABILITE

Par

H. JORGE, O. SUÁREZ, H. GARCÍA, I. JORGE et L. BENITEZ

Instituto Nacional de Investigaciones de la Caña de Azúcar, Habana,Cuba

hector@inica.minaz.cu

MOTS-CLES: Alimentation des Bovins, Digestibilité, Matière Sèche, Sols, Le Stress Abiotic.

Resume

CE PAPIER rela te le s r ésultats d'u ne étude su r 44 génotypes de canne à sucre, évalués pour l'alimentation animale à l'age d e 13 mois en pre mière repousse, à la station territoriale Cienfuegos de recherche sur la canne à sucre de Villa Clara et au centre national de création variétale de Sancti Spiritus à Cuba. 14 traits f urent évalué s a u moyen d'analys es multivar iées (Analyses e n composantes principales et discri minante) et une sim ulation de ré gionalisation agro-écologique fut aussi réalis ée. Cette d ernière co ncernait l'allocation des variétés se lon le s f acteurs lim itants principaux (sécheresse et faible drainage) sur une ferme d'élevage. Les résultats m ontrèrent que les variables, teneurs en eau des tiges (%) et d es sommets (%) av aient une influence importante sur la première composante principale, tandis que la résistance aux maladies (rouille et charbon) avait une

influence importante sur la seconde composante. On a remarqué que le pourcentage de digestibilité de la matière sèche présentait peu de variabilité, montrant ainsi une grande stabilité de ce trait. L'analyse discriminante a permis de classer les variétés en trois groupes: .des variétés à valeur fourragère faible (en dessous de 40% de digestibilité de la matière sèche), les variétés à valeur fourragère intermédiaire (entre 40 % et 50 %) et les variétés à haute valeur (supérieures à 50% de digestibilité). Les résultats permirent d'établir des recommandations pour 21 nouveaux génotypes caractérisés par leur résistance aux principales maladies et leur faute valeur fourragère, pour 9 variétés qui étaient supérieures au témoin My5514, pour 4 variétés résistantes à l'excès d'eau et pour 3 variétés résistantes à la sécheresse. La simulation de la régionalisation agro-écologique a permis une distribution spatiale des individus appropriés à chaque localité, pour leur digestibilité, leur tolérance à deux stress environnementaux (excès d'eau et stress hydrique) et leur résistance aux maladies.

DIVERSIFICACIÓN DE LAS VARIEDADES DE CAÑA DE AZÚCAR PARA EL GANADO, ALIMENTACIÓN Y LA SOSTENIBILIDAD

Por

H. JORGE, O. SUÁREZ, H. GARCÍA, I. JORGE y L. BENITEZ

PALABRAS CLAVES: Ganado, Alimentación, Suelos, Estrés Abiótico.

Resumen

SE PRESENTAN los resultados del estudio de 44 genotipos de caña de azúcar evaluados con 12–14 meses de edad en la cepa de retoño en suelos Pardos con carbonato (Cambisol eútrico) de la Estación Territorial de la Caña de Azúcar (ETICA) Villa Clara -Cienfuegos y el Centro Nacional de Hibridación de Sancti Spíritus (CNH), con vista a su recomendación para la alimentación animal. Se evaluaron 14 caracteres mediante Análisis Multivariado (Componentes Principales y Factorial Discriminante), también se realizó una simulación de zonificación agroecológica para la ubicación de las variedades de caña de azúcar, de acuerdo a los principales factores limitantes (sequía y mal drenaje) de una unidad productora de ganado vacuno. Los resultados reflejan que las variables porcentaje del peso fresco del tallo (% de tallo) y el cogollo (% cogollo) tuvieron una alta influencia en la primera componente, mientras que la resistencia genética a las enfermedades (carbón y roya) lo fueron para la segunda. Es de destacar que el porcentaje de digestibilidad de la materia seca muestra muy poca variabilidad, lo que puede indicar una alta estabilidad de este carácter. El Análisis Discriminante permitió clasificar los cultivares en tres grupos: Variedades de bajo valor forrajero (menor del 40 % de la digestibilidad de la materia seca), Variedades de medio valor forrajero (entre 40–50%) y Variedades de alto valor forrajero (mayor del 50%). Los resultados permitieron recomendar 21 nuevos genotipos caracterizados por su resistencia a las principales enfermedades y su alto valor forrajero, donde 9 de ellas se adaptan a condiciones de estrés ambiental. La simulación de la zonificación agroecológica permitió la ubicación espacial y la modelación en cuanto al correcto establecimiento de los individuos en correspondencia a su tolerancia con los factores limitantes antes mencionados.