

THE PREPARATION OF HUMAN RESOURCES FOR SUGARCANE IN MEXICO

By

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Abstract

THE University of Veracruz (U.V.) is a public institution that has historically been recognised, both nationally and internationally, for its work in the fields of art and literature. However, U.V. is located in the Mexican State with the highest sugar production of the country and, therefore, in recent times has focused on social, cultural and technological aspects of the local community within which U.V. finds itself, particularly in this significant agro-industry of Mexico. The Institute for the Improvement of Sugar Production (IMPA), founded in 1949, was the institution that sponsored research in this area, but this entity closed in 1990. This was the main catalyst that led the University of Veracruz, jointly with other centres, to initiate a program to prepare students for a career in the sugarcane sector in Mexico. A total of 57 sugar mills operate in Mexico, which are distributed throughout 15 states and produce over 5.5 million tonnes of sugar. The State of Veracruz contributes 41% of the national production. Eleven of its factories are located in the region of Cordoba, where the MSc program 'Sugar Cane Cultivation and its Impact on the Environment and Social-Economic Factors' has been implemented. Based on the previous 40 MSc students of 'Management and Use of Sugar Cane Agricultural Systems', 8 students have qualified and the remaining are expected to qualify at the end of 2010. Currently, nine graduates are working in sugar mills within the Cordoba region. The paper shows all the characteristics of the MSc program and its relationships to the agro-industry of Mexico, through the research project and technological improvement, and offers several results of the finalised research. The preparation of highly trained human resources for the sugar cane industry is the essential goal of this program.

Introduction

In México, 57 sugar mills, distributed throughout 15 states of the Republic, are operating and grow over 650 thousand hectares of sugarcane, within 4 agro-climatic regions along west and east coasts of the Pacific Ocean and the Gulf of Mexico-Caribbean Sea at 19° latitude, (Marín, 1998; Flores, 2001). Production amounts to more than 49 million tonnes of cane and five million tonnes of sugar, with cane yields ranging in recent years between 64 and 72 tonnes/ha and factory recovery (commercial cane sugar) around 11% (Manual Azucarero Mexicano, 2008). That the industry supports, directly or indirectly, more than three million Mexicans. Veracruz comprises approximately 41% of the national production with 22 sugar mills, of which 11 are in the Cordoba Region, where the University of Veracruz (U.V.) is situated.

This University is a public institution with significant national and international stature. Being in the heart of the Mexican sugar industry, the U.V. has been associated with the sugar industry in social, cultural and technological fields. Consequently, when the former Institute for the Improvement of Sugar Production (IMPA) closed in 1990, the U.V., in collaboration with the

National Program of Research in Sugarcane Science and Technology and with the Latin America and Caribbean sugar exporting countries group, initiated a specialised sugarcane related program in 1993, which came to fruition in June 1995. This experience fostered a strategic alliance between the organisations and enabled the establishment of the Masters degree of 'Management and Use of Sugarcane Agro systems' in December of 1996.

The objective of this course was to provide the local sugar industry with highly qualified personnel, with 56% of the teaching staff having a Ph.D. degree. This high level teaching experience comprises staff having qualified at the University of Veracruz (U.V.) including its Library and Information Services Unit (USBI), the Autonomous University of Chapingo (ACH), the National Chamber of Sugar and Alcohol Industries (CNIAA), DGETA, the Veracruz, Oaxaca and Puebla sugar mills, and the Orizaba High Tech Lab (LATO-U.V.), all from Mexico, and internationally: the National Sugarcane Research Institute (INICA) of the Ministry of Sugar (MINAZ) of Cuba, the Havana Agricultural University (UNAH), CENGICAÑA, the University of San Carlos and Pantaleon Sugar Mill of Guatemala, the Luis de Queiros Higher Agriculture School of the University of Sao Paulo (ESALQ) of Brazil, and the Sugarcane Research and Extension Division (DIECA) of Costa Rica.

Program goals

The program goals are to prepare human resources, which may contribute to the development of a *competitive, diversified and sustainable sugarcane agro-industry*, able to design, lead and conduct programs of applied research, training and technological innovation in sugarcane, linked to the agro-industry and to the environment.

General characteristics of the program

The general characteristics of the program are as follows:

- Two years of postgraduate study (four semesters), including a dissertation or thesis work, except certain cases in which the research project requires a longer period, which must be certified by the tutor of the thesis and which cannot be more than one year.
- The student must submit a thesis title, at the beginning of the study program, which, once approved by the tutor, can be submitted to the Masters coordinator from which time the student has a two year period to finish his (her) thesis or to timely apply for an extension.
- The Study Plan is composed of 19 subjects, comprising three main groups; *viz* Methodological Training, General Agricultural Training and Specific Sugarcane Training. 14 of the subjects are compulsory and one elective subject needs to be selected from the remaining five. Furthermore, the program includes two activities as program requirements: the writing of a dissertation or thesis and an exam. This comprises a total of 1125 hours, of which 585 hours are of theoretical preparation and 540 of practical training. Tables 1 and 2 highlight the work hours and academic credits associated with the course as well as the broad curriculum structure.
- Students must also obtain Level II English and/or French Language as well as demonstrate computer use proficiency that may be acquired from institutions accredited by the Ministry of Public Education before the degree is awarded.

Applied research lines of the program

The dissertation or thesis projects of the students generally focus on the current research needs within the local sugar industry at that time but are confined to the broad areas of:

- Sugarcane breeding and selection.
- Sugarcane agricultural technology.
- Sugarcane byproducts, biotechnology and the environment.
- Sugarcane plant protection.

Table 1—Curricular structure by training areas.

Area of Training (4 Semesters)	Total No. of Hours	%	Total No. of Credits	%
Methodological	255	22.67	26	22.81
General Agricultural	300	26.67	30	26.31
Sugarcane Specific	570	50.66	58	50.88
Sub Total	1125	100.00	114	100.00
Dissertation work			5	
Degree Exam			20	
Total			139	

* 585 Hours Theoretical (78 credits) and 540 Hours Practical (36 credits).

Table 2—Curricular structure by subjects.

Methodological	Agricultural general	Sugarcane specific
1. Methodology of research	1. Edaphology	1. Physiology and biochemistry
2. Statistical methods and experimental design	2. Soil fertility*	2. Applied genetics
3. Company management	3. Agro ecology	3. Water resources and drainage*
4. Agricultural economics*	4. Biotechnology	4. Agricultural mechanisation *
5. Workshop I of dissertation	5. Seminar I	5. Cropping techniques
6. Workshop II of dissertation		6. Plant Protection
		7. Sugarcane byproducts*
		8. Seminar II

Note: 19 Subjects: 14 compulsory or obligatory, 5 Optional* (to select 1).

Requirements of the program include writing of the dissertation or thesis and the degree examination.

Academic results

Admissions and exits

During the period 1997 to 2008, ninety-seven (97) students registered, of whom 40 have graduated, amounting to 41% of the total number of registered students (Table 3). The masters graduated are, in large majority, working in various sugar mill plantations and other agro-industrial enterprises of the country, with excellent production and social achievements.

Table 3—Graduated students up to December 2008.

Generation	Dates		Registered	Graduated	Percentage
	Beginning	End			
1	Jan/1997	Dec/1998	21	18	85.71
2	Jan/2001	Dec/2002	19	6	31.58
3	Aug/2002	Jul/2004	26	10	38.46
4	Aug/2004	Jul/2006	20	4	20.00
5	Aug/2006	Jul/2008	11	2	18.18
	TOTAL		97	40	41.24

Training for growers and field technicians of the sugar mills

Since 2002, the Masters Degree program has also been conducting training courses for growers and field technicians in the following subjects: Sugarcane Pest, Disease and Weed Management, Varieties and Seed cane, Nutrition and Fertilisation, Field Management, Sugarcane Quality, Sugarcane By-products and Crop Harvesting. Until December 2008, twenty courses have been made available, with 614 students from 57 sugar mills attending, and 22 postgraduate professors have delivered classes. **Relationships with other national and international institutions and enterprises**

Practical tours arranged by the professors for the students have been arranged with the support and collaboration of the following institutions and countries:

- To the National Sugarcane Research Institute (INICA) Cuba, during years 2002,

2004, 2005 and 2007.

- To CENGICAÑA, Pantaleon Sugar Mill and the University of San Carlos, Guatemala, in years 2001, 2002, 2004 and 2006.
- To ESALQ and CENA of the University of Sao Paulo, Brazil, in years 2005, 2008 and to CINCAE of Ecuador in 2005.
- To DIECA, Costa Rica, in year 2007.
- To the CNIAA Breeding Station of Tapachula, Chiapas, México, in years 1997, 2001, 2002, 2004 and 2006.

Furthermore, support has been received to fulfil student's project tasks by the following sugar mills: Central Motzorongo, San Miguelito, Central Progreso, San José de Abajo, El Potrero, La Providencia, Constanca, La Margarita, Tres Valles, Adolfo López Mateo, El Modelo, Calipam and Huixtla.

Main research results attained

- Characterisation of the main commercial, promising and traditional sugarcane varieties of Mexico. Through various student dissertation (thesis) projects and the available information, the botanical and agro-industrial characterisation of the most important sugarcane varieties of the country, including photos and ripening curves, was carried out, including the following varieties: Mex. 69-290, CP 72-2086, Mex 79-431, Mex 57-473, Mex 68-P 23, Co 997, Q 96, SP 70-1284, RD 75-11, My 5514, ITV 92-1424, PR 66-2231, CMex 93-45, CMex 93-49, MotzMex 91-207, AteMex 96-40, C86-12, NCo 310, L 60-14, POJ 2878, B 4362 and Co. 421 (Hernández, 2004; Patiño, 2005).
- Characterisation and control of the main weeds of sugarcane in the region 'Central Veracruz', Mexico. Through various student dissertation (thesis) projects and the available information, the descriptive characterisation, distribution, propagation and integrated control of the 50 most important weeds, by their level of hazard to sugarcane, which include the following number of weeds by families: Poaceae, 17; Cyperaceae, 2; Amaranthaceae, 4; Compositae, 8; Commelinácea, 1; Portulacaceae, 2; Solanácea, 1; Papaveraceae, 1; Malvaceae, 2; Leguminosae, 3; Convolvulácea, 1; Acanthaceae, 1; Cucurbitaceae, 1; Euphorbiaceae, 3; Fabaceae, 1; Araceae, 1 and Boraginaceae, 1. (Ordóñez, 2002; Vilaboa, 2003; Illescas, 2004; García, 2008).
- Nitrogen fertilisation of sugarcane in San José de Abajo and San Miguelito Sugar Mills, Veracruz, showed no response in the plant cane cycle, nor to split application of this nutrient, under the prevailing rainfed conditions, in San José de Abajo Sugar Mill, both in cane yield or in sugar recovery. In the second ratoon cycle, under rainfed conditions, in San Miguelito Sugar Mill, nitrogen fertilisation positively influenced cane yield, and through this the pol or sucrose yield per hectare (Table 4), but not in a split application. An optimum rate of 140 kg/ha was found (Figure 1) (Escarola, 2003; Norato, 2004).
- Sugarcane potassium fertilisation on Cambisol soils, of San Miguelito Sugar Mill, Córdoba, Veracruz, México. At planting of trials, due to inadequate monoculture and crop agronomic management, losses of soil nitrogen (0.11%), organic matter (1.55%) and potassium (16.5 K₂O/100 g) had taken place, producing changes in the category of these components (Tables 5 and 6). Treatments of 150 and 225 kg of potassium per hectare and fixed levels of 167 and 0 kg/ha of nitrogen and phosphorus, respectively, resulted in significantly higher tonnes cane/ha/month, percentage of pol/cane and tonnes sugar/ha/month in plant cane while, in first ratoon, only the treatment of 225 kg potassium per hectare was higher (Tables 7 and 8). (Arreola, 2002; Niño, 2007; Colorado, 2008).

Table 4—Results of tonnes cane/ha, Pol % cane and tonnes pol/ha at harvest,

second ratoon cycle, in the locality of Tapia, San Miguelito Sugar Mill, Córdoba, Veracruz.

No.	Treatments	Mean values and formation of groups by LSD				
		tonnes cane/ha		Pol % cane		tonnes Pol/ha
1	00-00-00	87.7	- -	c	17.47	15.23 - - c
2	177-85-85	119.1	A -	-	18.01	21.34 a b-
3	00-60-120	93.6	- b	c	17.98	16.83 - b c
4	50-60-120	111.1	A b	-	17.82	19.88 a b c
5	100-60-120	114.3	A -	-	17.82	20.35 a b c
6	150-60-120	109.6	A b	-	18.02	19.83 a b c
7	200-60-120	113.1	A b	-	18.96	21.46 a b-
8	150 ₂ -60-120	114.3	a b	-	18.61	21.28 a b-
9	150 ₃ -60-120	121.5	a -	-	18.64	22.65 a --
10	150 ₄ -60-120	116.5	a -	-	18.57	21.68 a b-
	LSD 0.05	20.60		3.03		5.39

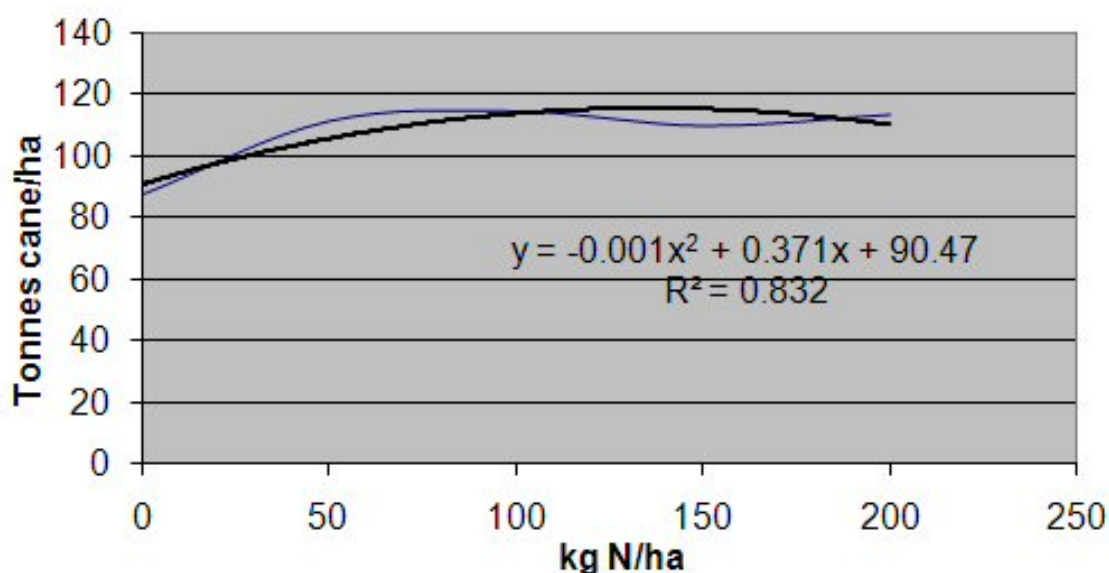


Fig. 1—Results of cane yield under various nitrogen dosages in a 12 months old, second ratoon cycle, at San Miguelito Sugar Mill (Inflexion point: 140 kg N/ha, expected yield 115 tonnes cane/ha).

Table 5—Category reached by the various cropping techniques for variables total nitrogen, organic matter and pH.

Samples from 0–20 cm depth	Moreno, (1978) quoted by López, (1998)		Moreno, (1978) quoted by López, (1998)		Letelier, (1967) quoted by López, (1998)	
	Total nitrogen		Organic matter		pH	
	%	Class	%	Class	%	Class
Soil without sugarcane during 15 previous years	0.28	Extremely rich	3.35	Rich	5.50	Moderately acid
Soil with sugarcane without harvest burning	0.16	Rich	2.17	Medium	5.70	Moderately acid
Soil with sugarcane with harvest burning	0.17	Rich	1.80	Moderately poor	5.10	Moderately acid

Table 6—Category reached by the various cropping techniques for variables

phosphorus, potassium and cation exchange capacity.

Samples from 0–20 cm depth	INICA (1997)				Cottenie, (1980) quoted by INICA, (1997)	
	P ₂ O ₅ /100g		K ₂ O/100g		CCC-meq/100g	
	Value	Class	Value	Class	Value	Class
Soil without sugarcane during 15 previous years	5.20	High	31.30	High	17.06	Medium
Soil with sugarcane without harvest burning	5.60	High	33.60	High	15.36	Medium
Soil with sugarcane with harvest burning	6.20	High	14.80	Low	16.75	Medium

Table 7—Results of harvest variables in a 17 months old, plant cane cycle, at San Miguelito Sugar Mill, Córdoba, Veracruz.

Treatments	tonnes cane/ha/month	Pol % cane	tonnes cane/ha/month	Pol % cane
1 (00-00-00)	8.38 – b	12.07 – b	1.01 – b	
2 (167-75-75)	9.35 A b	12.77 a b	1.19 a b	
3 (167-00-75)	8.76 A b	13.01 a –	1.14 a b	
4 (00-00-75)	8.58 A b	12.89 a b	1.11 a b	
5 (167-00-00)	8.47 A b	12.62 a b	1.07 a b	
6(167-00-150)	9.64 A –	13.35 a –	1.29 a –	
7(167-00-225)	9.52 A –	13.06 a –	1.24 a –	
Tukey 0.05	1.13	0.91	0.22	

Tabla 8—Results of harvest variables in a 14 months old first ratoon cycle, at San Miguelito Sugar Mill, Córdoba, Veracruz.

Treatments	tonnes cane/ha/month	Pol % cane	tonnes cane/ha/month	Pol % cane
1 (00-00-00)	7.05 – b	17.47	1.23 – b	
2 (167-75-75)	8.44 A b	18.00	1.52 a b	
3 (167-00-75)	7.86 A b	17.90	1.41 a b	
4 (00-00-75)	7.19 – b	17.82	1.28 – b	
5 (167-00-00)	7.76 A b	18.03	1.40 a b	
6 (167-00-150)	8.00 A b	18.34	1.47 a b	
7 (167-00-225)	8.75 A –	18.51	1.62 a –	
LSD 0.05	1.49	–	0.33	

- Influence of sugarcane harvest residue management on cane yield at El Potrero Sugar Mill, Veracruz. When evaluating the following harvest managements: 1) Cane pre-harvest and post-harvest residue burnings (PHRB), 2) Cane pre-harvest burning, without post-harvest residue burning (WPHRB), 3) Green cane harvesting, without pre-harvest and without post-harvest residue burning (GCWPHRB) and 4) Green cane harvesting, without pre-harvest but with post-harvest residue burning (GCPHRB), it was concluded that the best treatment was No. 3: Green cane harvesting, without pre-harvest and without post-harvest residue burning, which produced 24.25 tons of cane more than burnt cane, while the lowest yield was in the green cane harvest and subsequent residue burning (Table 9), as reported by Molina (2004).

Table 9—Results of tonnes cane/ha, tonnes tops/ha and tonnes trash/ha at

harvest, in second ratoon cycle, at El Brinco Farm, El Potrero Sugar Mill, Veracruz.

No.	Treatment	Mean values and formation of groups by Tukey				
		tonnes cane/ha			tonnes tops/ha	tonnes trash/ha
1	PHRB	90.38	–	B	29.150	5.4360
2	WPHRB	90.50	–	B	30.846	4.8840
3	GCWPHRB	114.75	A	–	31.730	5.3780
4	GCPHRB	70.25	–	C	28.312	4.1900
Tukey 0.05		20.08			–	–

Conclusions

Programs for training of human resources as presented in this paper can contribute to improve human capital for the sugarcane agro-industry. The programs require collective support of neighbouring countries for maximum effect. Many of the subjects included in the program are available as distance learning subjects, which assists in the admission of students in their own countries and the participation of professors from various countries of the world. Education and research is an important element for ensuring the sustainability of sugar industries around the world. This particular program has made an important impact in the Mexican sugar industry.

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LA FORMATION DES RESSOURCES HUMAINES DANS L’INDUSTRIE DE LA CANNE A SUCRE AU MEXIQUE

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**MOTS-CLES: Canne à Sucre,
Ressources Humaines.**

Résumé

L’UNIVERSITE de Veracruz (U.V.) est une institution publique qui a été historiquement reconnue, tant au niveau national qu’international, pour son travail dans les domaines de l’art et de la littérature. Toutefois, cette université se trouve dans l’état mexicain où la production de sucre est la plus élevée du pays et, par conséquent, elle s’est concentrée ces derniers temps sur les aspects sociaux, culturels et techniques de la communauté locale au sein de laquelle elle se trouve, en particulier dans cette importante région agro-industrielle du Mexique. L’Institut pour l’Amélioration de la Production de Sucre (IMPA), fondée en 1949, a entrepris la recherche dans ce domaine, mais cette entité a fermé ses portes en 1990. Cela a été la principale raison qui a conduit l’Université de Veracruz, conjointement avec d’autres centres, à lancer un programme afin de former les étudiants pour une carrière dans le secteur de la canne à sucre au Mexique. Un total de 57 usines sucrières fonctionnent au Mexique, réparties dans 15 Etats et produisant plus de 5.5 millions de tonnes de

sucre. L'état de Veracruz contribue à 41% de la production nationale. Onze de ses usines sont situées dans la région de Cordoba, où le programme pour l'obtention d'une maîtrise en Culture de la Canne à Sucre et son Impact sur l'Environnement et les Facteurs Sociaux-Economiques a été mis en œuvre. Parmi les précédents 40 étudiants de Maîtrise en Gestion et Utilisation des Pratiques Culturelles de Canne à Sucre, 8 étudiants se sont qualifiés et les autres le seront à la fin de 2010. Actuellement, 9 diplômés travaillent dans les usines sucrières au sein de la région de Cordoba. La présentation montre toutes les caractéristiques du programme de Maîtrise et ses relations avec l'agro-industrie du Mexique, à travers le projet de recherche et l'amélioration technologique et offre plusieurs résultats de la recherche finale. La formation des ressources humaines hautement qualifiées pour l'industrie sucrière est l'objectif essentiel de ce programme.

PREPARACIÓN DE RECURSOS HUMANOS PARA LA CAÑA DE AZÚCAR EN MÉXICO

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PALABRAS CLAVES: Caña de Azúcar,
Recursos Humanos.

Resumen

LA UNIVERSIDAD Veracruzana (U.V.) es una institución pública, de reconocido prestigio en las artes y la literatura a nivel nacional e internacional, que al estar en el Estado con mayor producción azucarera en México y con el compromiso social, cultural y de desarrollo tecnológico que la sociedad le confiere, no es ajena a la problemática de la principal agroindustria del país. El Instituto para el Mejoramiento de la Producción de Azúcar (IMPA), fue fundado en 1949 y desarrolló durante muchos años importantes investigaciones de gran valor para este cultivo, pero fue cerrada en 1990. Dada esta situación la Universidad Veracruzana, en coordinación con otras instituciones, inició el programa de formación de recursos humanos en el campo de la agricultura cañera en México. En el país operan un total de 57 ingenios azucareros, distribuidos en 15 estados y producen más de 5.5 millones de toneladas de azúcar anualmente. El estado de Veracruz contribuye con el 41% de la producción nacional. Once de estas fábricas están localizadas en la región de Córdoba, lugar donde funciona el Programa de la Maestría sobre el cultivo de la Caña de Azúcar y su impacto ambiental y socio-económico. Hasta el presente 40 alumnos de la Maestría en Manejo y Explotación de los Agro sistemas de la Caña de Azúcar han concluido sus tesis, 8 están por obtener el grado de Maestro en Ciencias de inmediato y el resto se espera que concluyan sus tesis el próximo año. En este momento están cursando el programa 9 alumnos, y todos ellos trabajan en ingenios azucareros de la región. En el presente trabajo se muestran las características generales del programa de la Maestría y su relación con la agro-industria azucarera mexicana, a través de proyectos de investigaciones aplicadas e introducción de tecnologías y se ofrecen varios resultados de las investigaciones finalizadas. La preparación de los recursos humanos para la agro-industria azucarera es el principal objetivo del presente programa.