SIMULATION OF THE LENGTH OF SUGARCANE (*Saccharum* spp.) CROP ROWS IN THE OPERATIONAL MANAGEMENT OF SPRAYING

SIMULAÇÃO DO COMPRIMENTO DAS FILEIRAS DE CULTIVO DE CANA-DE-AÇÚCAR (*Saccharum* spp.) *NO GERENCIAMENTO OPERACIONAL DA PULVERIZAÇÃO*

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ABSTRACT: Brazil is the world's largest producer of sugarcane destined to mills and has an average productivity higher than that of other producing countries of this raw material. The application of agricultural control products in sugarcane fields of agroindustries is carried out in extensive cultivation areas with hydraulic self-propelled, trailed, and aerial sprayers. For this, the systematization of cultivation areas, making longer the length of crop rows in the cultivation plots, is necessary to reduce the bedside maneuvers of machinery. This study aimed to assess the impact caused by the length of crop rows on the operational cost of the hydraulic sprayer used for sugarcane management practices. Due to the difficulty in performing this study and meeting the aim under field conditions, a computational model called *TratoCana* was developed in a spreadsheet and programming language. The model was verified for possible routine errors, validated, and used in the factor analysis and generation of scenarios. The results showed that the length of crop rows positively affects the operational and economic performance of the equipment.

KEYWORDS: Agricultural mechanization. Hydraulic sprayers. Planning and management. Bedside maneuver. Computational model. Cost.

INTRODUCTION

In Brazil, sugarcane planted area for the 2017/2018 season is estimated at 8.74 million hectares, with a total production estimated at 635.60 million tons (CONAB, 2017).

The mechanized spraying system of sugarcane mills has its operational and economic performance influenced by the systematization of the planted area. According to Santos and Gadanha Júnior (2016), the plots should be adjusted in a rectangular geometric shape or winding strip in order to increase the length of crop rows and reduce bedside maneuvers of the machinery. Because of this, the length of crop rows is directly related to the operational and economic performance of the machinery.

For this, the management of agricultural machinery considers operational and economic performance. The operational performance consists of the variables operating speed, field efficiency, operational field capacity, worked hours, machine-hours, and number of equipment required. On the other hand, economic performance is formed by annual, hourly, and variable fixed costs (BALASTREIRE, 1990; HUNT, 1995; MIALHE, 1974).

According to Santos et al. (2015b) apud Williams (2008), in the management for selecting agricultural machines, computational modeling has been adopted because it is a tool that simplifies the development of the proposed idea in to represent the structures and generate scenarios. In addition, according to Santos et al. (2015b) apud Oksanen (2007), a computational model of planning and management of agricultural machinery is developed with the aim of providing acceptable solutions to solve problems. In this context, Hansen et al. (2007) created a model with the aim of determining a standard route for bedside maneuvers in order to obtain the shortest total waiting time to perform them. Santos et al. (2014a) used the computational model *"ColheCana"* in order to assess field efficiency and cost of the sugarcane mechanized harvesting system.

Mercante et al. (2010) elaborated the "*software* PRAPRAG" in a programming language to observe the cost of self-propelled sprayers. Buckmaster (2003) developed the model "TRACTOR COST" to determine the fuel costs by means of specific consumption of the agricultural tractor. Khoub Bakht et al. (2009), Rashidi and

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Ranjbar (2010), and Niari et al. (2012) developed models to analyze the participation of spare parts, salary of operator and mechanic, lubricants, oil filter, and fuel in the cost of repair and maintenance of agricultural tractors. Rohani et al. (2011) elaborated a model in order to solve problems in the cost with repair and maintenance of tractors.

Considering the importance of the length of crop rows in the operational and economic performance of mechanized spraying systems, the aim of this study was to assess the impact caused by it on the operational cost of the hydraulic sprayer for sugarcane management practices.

MATERIAL AND METHODS

In this study, a model scenario was considered for a mill called Fictitious Mill, with its own area of 22,000 ha. Hydraulic self-propelled, trailed, and aerial sprayers were considered in the control product application system that serves the sugarcane cultivation of this mill. The equipment and economic, technical, and operational characteristics are shown in Table 1.

Table 1. Economic, technical, and operational variables of the equipment.

Variable	Abbreviation	Unit	Self-propelled sprayer	Tractor	Sprayer	Airplane
Initial Value	IV	US$	170,350	38,005	37,736	233,154
Rated Power	Power	kW/CV	147/200	74/100	-	238/324
Number of Spray Tips	NST	Number	56	-	49	42
Spacing between Tips	ST	cm	50	-	50	35.71
Total Tank Volume	TTV	L	3,000	-	3,000	950
Operating Speed	OS	$km\ h^{-1}$	9.0		9.0	222.0
Bedside Maneuver Speed	BMS	$km\ h^{-1}$	5.0		5.0	-
Refueling Speed	RS	$km\ h^{-1}$	20.0		20.0	-
Transfer Speed from the Flight Track to the Field	TSFTF	$km\ h^{-1}$	-		-	280.0

To meet the objective, a computational model named *TratoCana Version 2.0*, which meets the basic characteristics of mechanized spraying for sugarcane cultivation, was developed. This model is based on a flowchart (Figure 1) constructed according to the symbology proposed by Oakland (2007).

TratoCana Version 2.0 was developed in an *Excel®* spreadsheet and in *Visual Basic®* programming language. The model begins its operation (1)[2] with the input of data from the crop (2), such as the area to be sprayed. Item (3) is the climate data input: total number of days to perform spraying, working day, relative air humidity, air temperature, and wind speed. Crop and climate data result in operational rhythm (4).

[2] Numbers in parentheses refer to the flowchart of Figure 1.

Data input (5) refers to technical/operational characteristics of terrestrial spraying: number of tips, spacing between tips, tip flow rate, refueling time, average distance between field and refueling pump, average length of cultivation stripes, operating speed, bedside maneuver speed, refueling speed, total volume of the sprayer tank, field efficiency, and others. Data input (6) refers to technical/operational characteristics of aerial spraying: number of tips, spacing between tips, tip flow rate, refueling time, average distance between field and refueling pump, average distance between flight track and field, average length of cultivation stripes, operating speed, transfer speed from the flight track to the field, effective strip width, time of each return curve, time in the ground between each flight, aerial application rate, total volume of the sprayer tank, field efficiency, and others.

The operational rhythm, associated with technical/operational characteristics of spraying, determines the operational performance of sprayer[3], tractor plus sprayer, and airplane (7): available time, operational field capacity, application volume, total application flow rate, total time of displacement and refueling, total traveled distance, machine-hours, and number of equipment required.

[3] When the text refers only to sprayer it is because it is self-propelled type equipment.

The results of operational performance, associated with the data of economic performance of machines (8): initial and final value, useful life in years and hours, interest per year, housing, insurance and fees, fuel consumption, repair and maintenance factor, and others make it possible to calculate the economic performance (9), which refers to the cost per hour, area, and liter.

The results of the model (10) allow the user to assess the operational and economic performance of the mechanized spraying and decide (11) on viability (12) or not. In case the spraying is not feasible for the user (13) or the user choose to assess another scenario, new data should be inserted.

The numbers in parentheses refer to the flowchart of Figure 1.

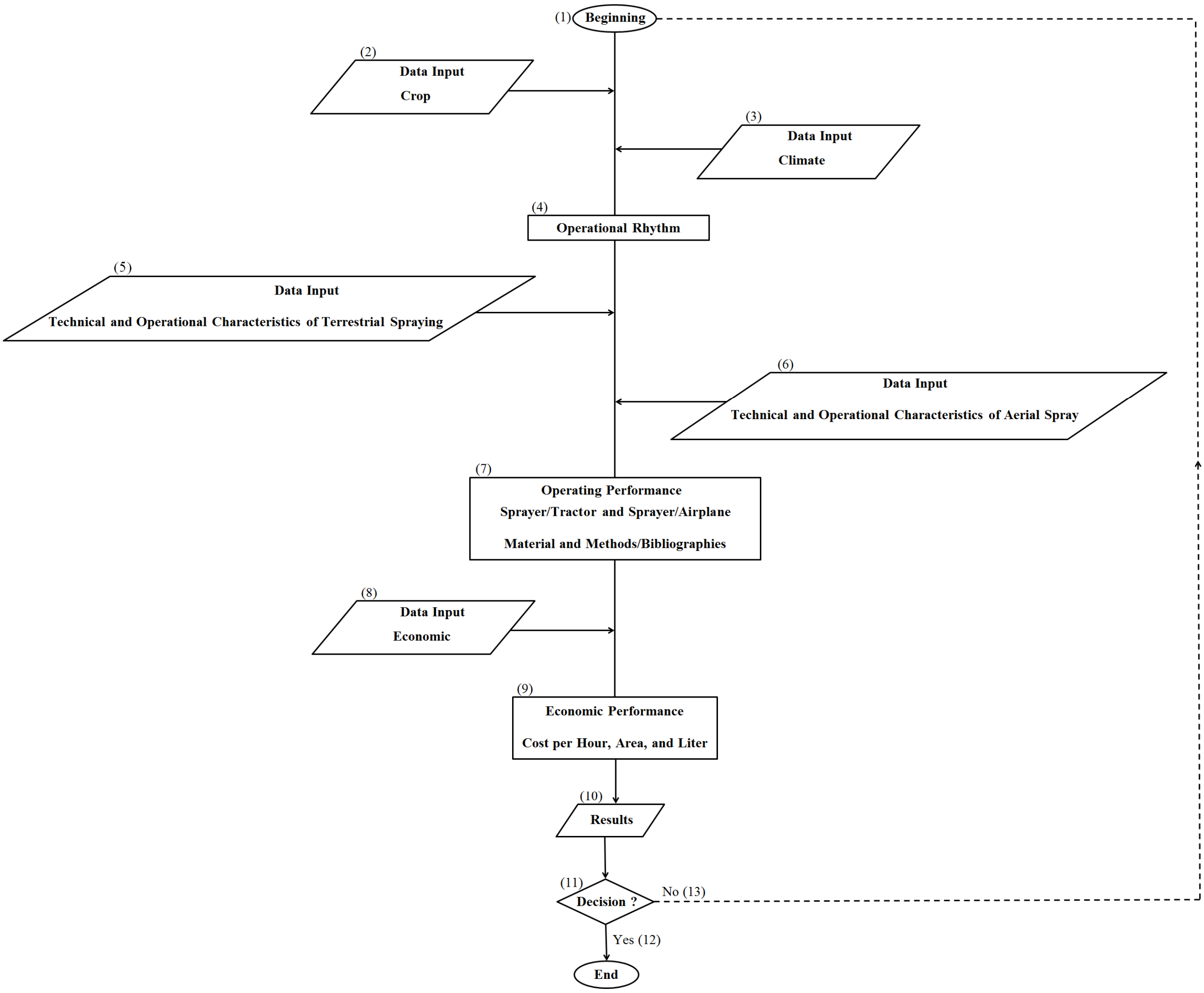

Figure 1. General flow chart of the computational model.

Agroclimatic factors

The factor climate of the mill was defined by the number of working days unsuitable for spraying (NWDUS) according to the methodological proposal of Santos (2017). The proposal considers agroclimatic parameters such as relative air humidity (RAH), wind speed (WS), and air temperature (AT).

Mean values of agroclimatic parameters of the mill were considered in order to meet this proposal (Table 2). These data refer to Rio Largo, AL, for the year of 2014, and were gathered from the Agrometeorological Station of the Center of Agrarian Sciences of the Federal University of Alagoas (CECA/UFAL).

The number of working days unsuitable for spraying (NWDUS) was considered in the available time (AT), according to the methodology of Mialhe (1974). The calculation of the available time (AT) was obtained by summing the number of Sundays and holidays (NSH) and number of working days unsuitable for spraying (NWDUS) then subtracting the total number of days (TN) and the values associated to the working hours (WH).

Table 2. Mean values of agroclimatic parameters.

Parameter	Abbreviation	Unit	Months of Control Product Application											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Air Temperature	AT	°C	26.15	26.05	26.75	27.70	25.70	24.50	23.95	23.35	24.65	24.65	26.25	25.60
Relative Air Humidity	RAH	%	65.65	67.60	67.40	68.91	71.75	69.20	67.35	69.95	70.60	69.05	63.95	66.10
Wind Speed	WS	Km h^{-1}	7.20	6.12	6.12	5.40	5.40	6.12	6.12	6.12	6.48	6.84	6.84	6.84

Source: CECA/UFAL

Operational performance

The operational performance of the set sprayer plus tractor and sprayer was based on the proposals of Mialhe (1974) and Santos et al. (2014b). These proposals define the number of equipment necessary to carry out control product application in the sugarcane cultivation of the mill.

The number of machines (NM) was calculated by the ratio between the operational rhythm (OR) and operational field capacity (OFC) of the equipment.

The operational rhythm (OR) was calculated by the ratio between the area to be sprayed (AS) and the available time to perform the agricultural operation (AT).

The operational field capacity (OFC) was calculated by the association between the total boom width (TBW), operating speed (OS), and field efficiency (FE).

The spray solution volume to be applied is in accordance with the proposals of Gadanha Júnior (2000) and Matuo et al. (2010). Application volume (AV) was calculated by the ratio between tip flow rate (TF), spacing between tips (ST) and operating speed (OS).

The total application rate (TAR) was defined by the association between the application volume (AV) and operational field capacity (OFC).

The travel time for refueling (TTR) is the round trip time to the field. The travel time was calculated by the ratio between the average distance between field and refueling pump (ADFRP) and refueling speed (RS).

The total travel and refueling time (TTRT) refers to the time spent to travel to the control product tank, refueling in the tank, and the return travel to the field. The total time was calculated by the sum of the travel time for refueling (TTR) and refueling time (RT).

The number of refueling (NR) was defined by the ratio of the application volume (AV), area to be sprayed (AS), and total tank volume (TTV) of the equipment.

The bedside maneuver distance (MD) was determined by the maneuver turning radius (MTR).

The bedside maneuver time (MT) was calculated by the ratio between the maneuver distance (MD) and maneuver speed (MS).

The number of bedside maneuvers (NBM) was defined by the ratio between the area to be sprayed (AS), total boom width (TBW), and average length of cultivation stripes (ALCS).

The operational performance of the airplane was also calculated according to the proposal of Mialhe (1974) and Santos et al. (2014b) to define the number of equipment required, as described for the sprayer and set tractor plus sprayer.

The operational field capacity (OFC) of the airplane is in accordance with the adjusted proposal of Araújo (2009). It is calculated by the association of total volume of the sprayer tank (TVST), application volume (AV), distance from the flight track to the field (DFTF), travel speed from the flight track to the field (TSFTF), effective strip width (ESW), time of each return curve (TRC), average length of crop rows (ALCR), and time in the ground between each flight (TGF).

Economic performance of the sprayer

The total cost of the sprayer (TCS) was determined by the association between the operational cost of the sprayer (OCS) and the area to be sprayed (AS).

The operational cost of the sprayer (OCS) was defined as the ratio between the hourly cost of the sprayer (HCS) and the operational field capacity (OFC).

The operational application cost of the sprayer (OACS) was determined by the ratio between the hourly cost of the sprayer (HCS) and the total application rate (TAR).

The hourly cost of the sprayer (HCS) was calculated by the sum of the hourly fixed cost of the sprayer (HFCS) and the variable cost of the sprayer (VCS).

The hourly fixed cost of the sprayer (HFCS) was calculated according to the methodology proposed by ASABE (2011), being defined by the ratio between annual fixed cost (AFC) and the number of hours worked per year (NHWY).

The variable cost of the sprayer (VCS) was defined by the sum of the cost with fuel (CF) and the cost with repair and maintenance (CRM).

The calculation of sprayer fuel consumption was adapted from Banchi et al. (2008). The adaptation occurred by the adoption of average consumption values per motor power range of agricultural tractors.

The calculation of the cost with repair and maintenance (CRM) and factor of repair and maintenance (FRM) of the sprayer are in accordance with ASABE (2011).

Economic performance of the set tractor plus sprayer

The total (TCS), operational (OCS), operational application (OACS), and hourly (HCS) cost of the set[4] were calculated in the same way as that of the sprayer.

The hourly fixed cost of the set (HFCS) was calculated according to the methodology proposed by ASABE (2011), as the calculation of the hourly fixed cost of the sprayer.

The variable cost of the set (VCS) was determined by the sum of the cost with the tractor fuel (CTF) and with repair and machine maintenance (CRM).

The calculation of the tractor fuel consumption considered the average values of consumption by motor power range of agricultural tractors proposed by Banchi et al. (2008).

The calculation of the cost with repair and maintenance (CRM) and factor of repair and maintenance (FRM) of the set are in accordance with ASABE (2011).

Economic performance of the airplane

The total (TCA), operational (OCA), operational application (OACA), and hourly (HCA) cost of the airplane were calculated in the same way as for the sprayer and set.

The hourly fixed cost of the airplane (HFCA) was calculated according to the methodology proposed by ASABE (2011), as the calculation of the hourly fixed cost of the sprayer and set.

The variable cost of the airplane (VCA) was determined by the sum of the cost with the airplane fuel (CAF) and with repair and maintenance (CRM).

For the airplane fuel consumption, an average value was considered according to the best power to be used and a higher working regime, according to EMBRAER/NEIVA (2012).

The calculation of the cost with repair and maintenance (CRM) of the airplane is in accordance with ASABE (2011). The factor of repair and maintenance (FRM) is in accordance with the data provided by PBA AVIATION (2012).

Validation

TratoCana Version 2.0 was validated by comparing simulation results with raw (primary) data obtained in the field and data from the bibliography (secondary). The sensitivity and consistency analysis of the computational model was performed by the cost.

RESULTS AND DISCUSSION

The average values of agroclimatic parameters of the mill, which is related to the agroclimatic conditions of Rio Largo, AL, in 2014, resulted in a number of working days unsuitable for spraying (NWDUS) of 257 days and available time (AT) of 2,583 hours.

Figure 2 shows the data and input variables of the computational model in the spreadsheet.

Figure 3 shows the data and output variables of the computational model in the spreadsheet.

Figure 4 shows the data and input variables of the computational model in programming language.

Figure 5 shows the data and output variables of the computational model in programming language.

[4] When only the word "set" is mentioned, it is a tractor and sprayer (trailed or mounted).

Planning-Climate	Parameter	Abbreviation	Unit	Jan.	Fev.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Output Σ	Output %
	Relative Air Humidity	RAH	%	65.65	67.60	67.40	68.91	71.75	69.20	67.35	69.95	70.60	69.05	63.95	66.10		
	Air Temperature	AT	C°	26.15	26.05	26.75	27.70	25.70	24.50	23.95	23.35	24.65	24.65	26.25	25.60		
	Wind Speed	WS	$Km\ h^{-1}$	7.20	6.12	6.12	5.40	5.40	6.12	6.12	6.12	6.48	6.84	6.84	6.84		
	Number of Days	ND	Number	31	28	31	30	31	30	31	31	30	31	30	31	**365**	-
	Number of Sundays and Holidays	NSH	Number	0	0	0	0	0	0	0	0	0	0	0	0	**0**	-
	Number of Working Days Unsuitable for Spraying	NWDUS	Number	24	20	22	21	20	20	21	21	21	22	23	23	**257**	**71**
	Working Hours	WH	h	24	24	24	24	24	24	24	24	24	24	24	24	**24**	-
	Available Time	AT	h	178.9	195.3	209.4	219.6	257.5	229.3	232.3	250.1	226.2	217.1	172.8	194.6	**2,583**	-
	Mark the Month of Application by Pressing the Corresponding Button			Jan.	Fev.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Uncheck Months	

PLANNING	Item	Variable	Abbreviation	Unit	Self-propelled Sprayer	Tractor	Sprayer	Airplane
	Climate	Available Time [Insert the Data of the Months of Pesticide Application]	AT	h	2,583			
	Crop	Sprayed Area	AS	ha	22,000			
		Average Sugarcane Productivity	ASP	$t\ ha^{-1}$	80.00			
		Price of the Ton of Sugarcane	PTS	US$ t^{-1}	19.01			
	Economic	Initial Value	IV	US$	170,350	38,005	37,736	233,154
		Final Value	FV	Decimal	0.20	0.20	0.15	0.40
		Useful Life in Years	ULY	Year	10	10	8	20
		Useful Life in Hours	ULH	h	10,000	12,000	6,000	10,000
		Interest per Year	i	Decimal	0.1350	0.1350	0.1350	0.0350
		Housing, Insurance, and Fees	HIF	Decimal	0.02	0.02	0.02	0.04
		Factor of Repair and Maintenance	FRM	Decimal	0.70	1.00	0.70	0.98
		Fuel Price (Diesel/Álcohol)	FP	US$ L^{-1}	0.78			0.81
		Consumption Factor [Average Consumption] [Estimated Consumption (L h)]	CF	$L\ h^{-1}$	0.50	0.50		-
	Technical Characteristics	Operating/Maneuver/Refueling/Airplane Operating Speed	SPEED	$km\ h^{-1}$	9.0	5.0	20.0	222.0
		Field Efficiency	FE	Decimal	0.8	0.8		-
		Motor Power of the Self-propelled Sprayer/Agricultural Tractor/Airplane	MP	CV	200	100		324
		Number of Tips	NT	Number	56	49		42
		Spacing between Tips	ST	cm	50	50		35.71
		Tip Flow Rate	TFR	$L\ min^{-1}$	0.32	0.32		2.00
		Refueling Time	RT	min	20			15
		Average Distance between Field and Refueling Pump/Average Distance between Flight Track and Field	ADFRP/ADFTF	m/km	500			10
		Average Length of Crop Rows	ALCR	m	1,500			
		Bedside Maneuver Turning Radius	BMTR	m	7.0	8.0		-
		Transfer Speed from Flight Track to the Field	TSFTF	$km\ h^{-1}$	-	-		280
		Effective Strip Width	ESW	m	-	-		15
		Time of each Return Curve	TRC	s	-	-		40
		Time in the Ground between each Flight	TGF	min	-	-		15
		Aerial Application Rate	AAR	$L\ ha^{-1}$	-	-		15
		Total Tank Volume	TTV	L	3,000	3,000		950

Figure 2. Data and input variables of the computational model in spreadsheet.

Item		Variable	Sigla	Abbreviation	Self-propelled Sprayer	Tractor	Sprayer	Airplane
RESULTS	Agronomy	Available Time	AT	Day	108			
		Operational Rhythm	OR	ha h^{-1}	8.52			
		Sugarcane Production	SP	t	1,760,000			
	Operational Performance	Total Boom Width	TBW	m	28.00	24.50		15.00
		Effective Field Capacity	EFC	ha h^{-1}	25.20	22.05		332.96
		Operational Field Capacity	OFC	ha h^{-1}	20.16	17.64		7.10
		Application Volume	AV	L ha^{-1}	42.67	42.67		15.14
		Total Application Rate	TAR	L h^{-1}	860	753		107
		Travel Time for Refueling	TTR	min	3.00			4.29
		Total Travel and Refueling Time	TTRT	min	23.00			19.29
		Number of Refueling	NR	Number	313	313		351
		Bedside Maneuver Distance	BMD	m	21.99	25.13		-
		Bedside Maneuver Time	BMT	s	16	18		-
		Number of Bedside Maneuvers	NBM	Number	5,238	5,986		9,779
		Worked Hours	WH	h	948	1,097	1,097	2,788
		Machine Hours	MH	h year^{-1}	948	1,097	1,097	1,394
		Number of Machines	NM	Number	1	1	1	2
		Total Distance Traveled in the Field	TDTF	km	7,857	8,980		14,668
	Economic Performance	Annual Fixed Cost	AFC	US$ year^{-1}	30,833	6,879	7,693	22,033
		Hourly Fixed Cost	HFC	US$ h^{-1}	32.51	6.27	7.01	15.81
		Depreciation	DPA	US$ year^{-1}	13,628	3,040	4,009	6,995
				US$ h^{-1}	14.37	2.77	3.65	5.02
		Annual Interest	AIT	US$ year^{-1}	13,798	3,078	2,929	5,712
				US$ h^{-1}	14.55	2.81	2.67	4.10
		Housing, Insurance, and Fees	HIF	US$ year^{-1}	3,407	760	755	9,326
				US$ h^{-1}	3.59	0.69	0.69	6.69
		Fuel Consumption	FC	L ha^{-1}	0.73	0.34		13.87
				L h^{-1}	14.78	5.98		98.40
		Cost with Fuel	CF	US$ h^{-1}	11.53	4.66		79.70
		Cost with Repair and Maintenance per Hour	CRMH	US$ h^{-1}	11.92	3.17	4.40	22.85
		Cost with Repair and Maintenance per Year	CRMY	US$ year^{-1}	11,308	3,475	4,830	31,850
		Hourly Cost	HC	US$ h^{-1}	55.97	14.10	11.41	118.36
		Operational Cost	OC	US$ ha^{-1}	2.78	1.45		16.68
		Application Operational Cost	AOC	US$ L^{-1}	0.07	0.03		1.10
		Total Cost	TC	US$	61,076	31,823		367,003
		Gross Income of the Mill	GIM	US$	33,457,600			
		Net Income of the Mill	NIM	US$	33,396,524	33,425,777		33,090,597

Figure 3. Data and output variables of the computational model in spreadsheet.

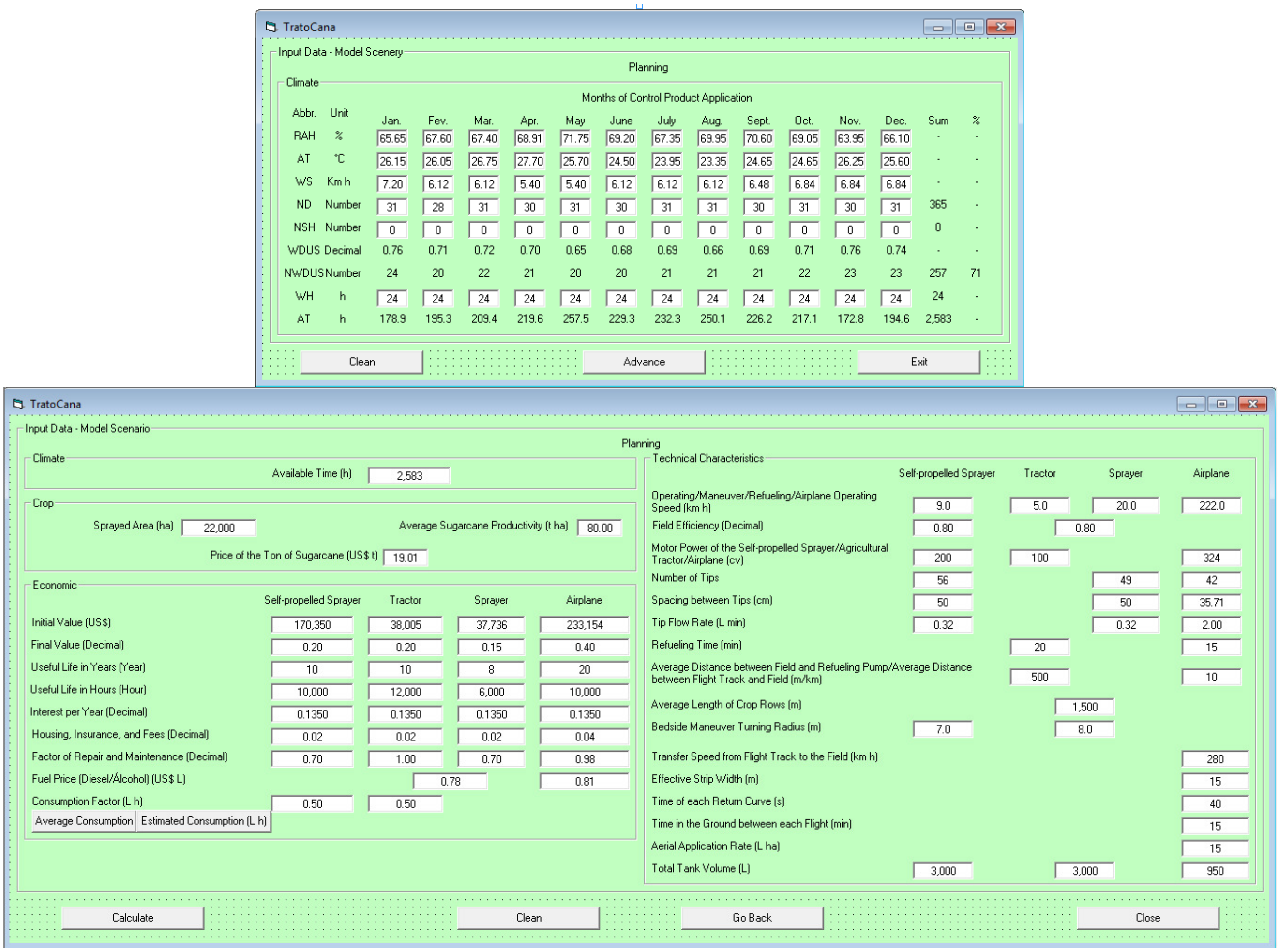

Figure 4. Data and input variables of the computational model in programming language.

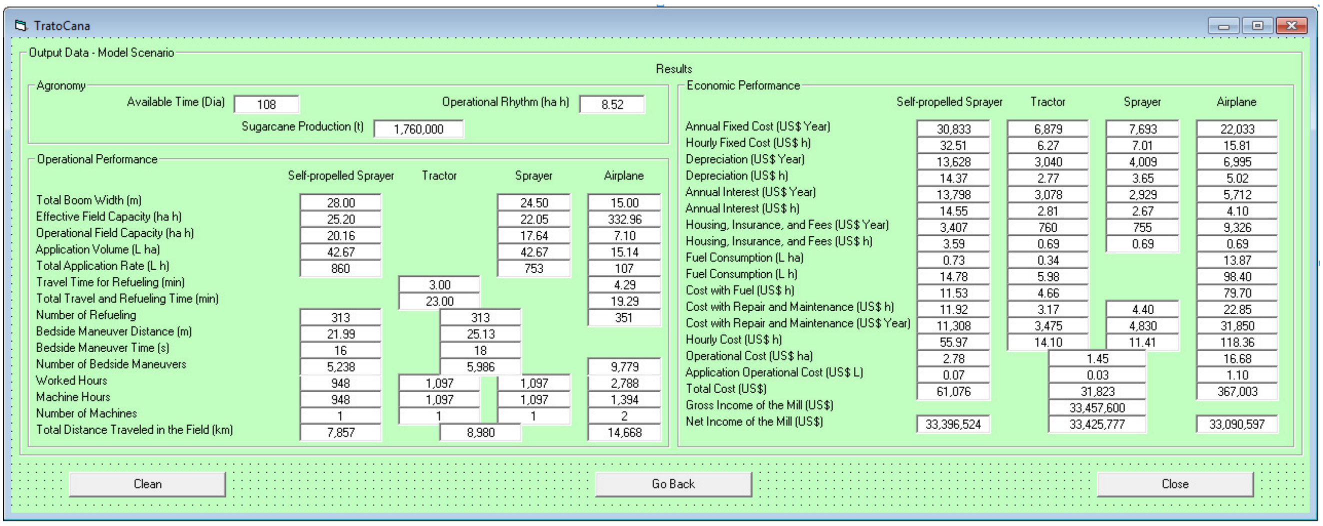

Figure 5. Data and output variables of the computational model in programming language.

According to the results of a model scenario, the average length of crop rows influenced the operational cost of the sprayer (Figure 6).

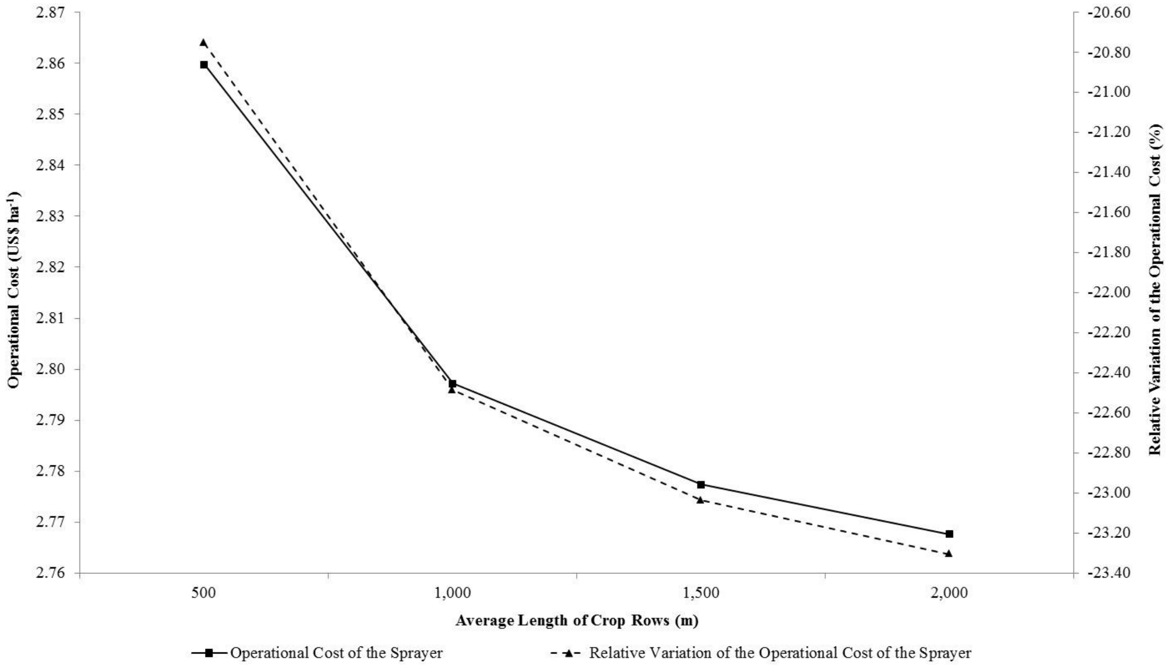

Figure 6. Operational cost of the sprayer and relative variation of the operational cost as a function of the average length of crop rows.

Having as reference a length of 100 m, the variation in the operational cost in 500 m had a reduction of -20.75% and 15,714 bedside maneuvers, while in 1,000 m, it was of -22.49% and 7,857 maneuvers. For a length of 1,500 m, the variation in cost was -23.04%, with 5,238 maneuvers, while in 2,000 m, it was reduced in -23.31%, being necessary to perform 3,929 maneuvers.

The average length of crop rows has a share in the operational cost of the set (Figure 7).

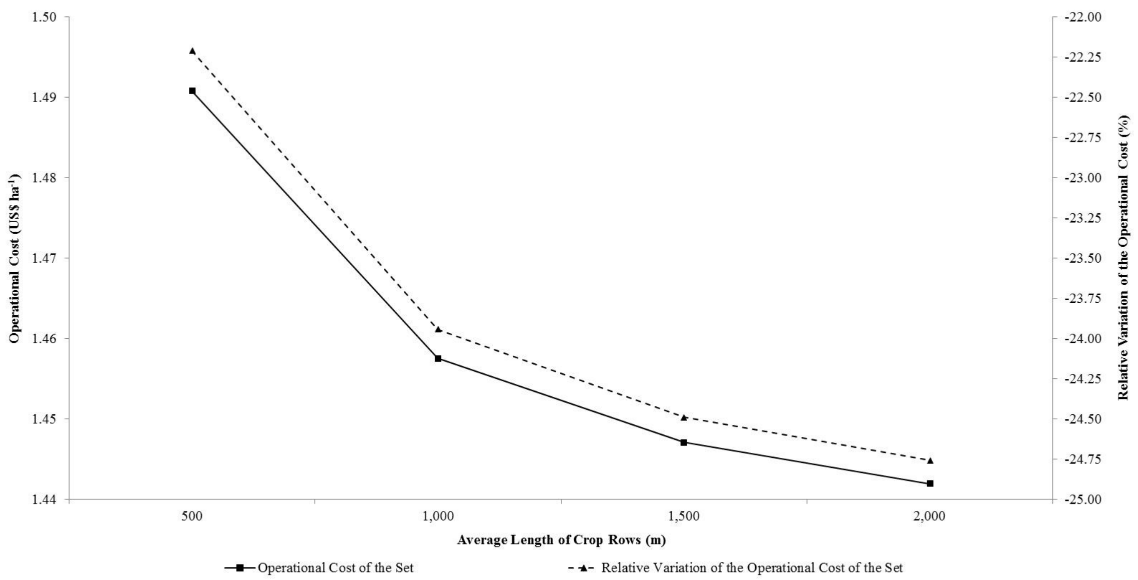

Figure 7. Operational cost of the set and relative variation of the operational cost as a function of the average length of crop rows.

Having as reference a length of 100 m, the variation in the operational cost in 500 m had a reduction of -22.21%, requiring 17,959 bedside maneuvers, while in 1,000 m, this variation was -23.94%, with 8,980 maneuvers. For a length of 1,500 m, the variation in cost resulted in a reduction of -24.49%, with 5,986 maneuvers, while for 2,000 m, the variation was reduced by -24.76%, being required 4,490 maneuvers.

The average length of crop rows interferes with the operational cost of the airplane (Figure 8).

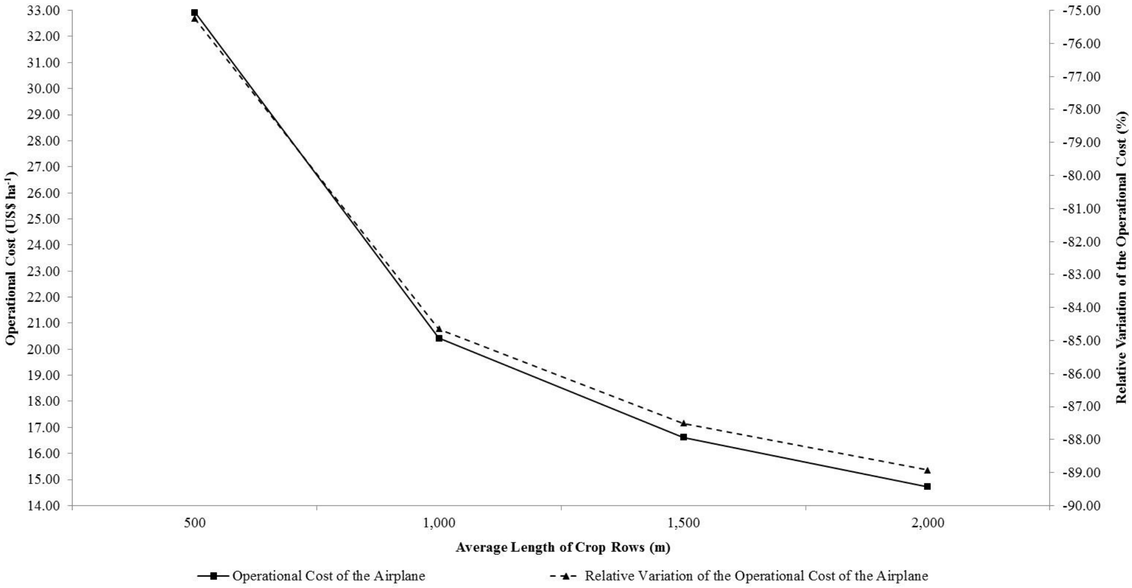

Figure 8. Operational cost of the airplane and relative variation of the operational cost as a function of the average length of crop rows.

Having as reference a length of 100 m, the change in the operational cost in 500 m was reduced by -75.25%, with 29,337 bedside maneuvers, while in 1,000 m, this variation was reduced by -84.65%, being required 14,668 maneuvers. For a length of 1,500 m, the variation in cost resulted in a reduction of -87.50%, with 9,779 maneuvers to be performed, while in 2,000 m, this variation was reduced by -88.93%, with 7,334 maneuvers.

According to the model scenario (Figures 6, 7, and 8), an average length of crop rows of 1,000, 1,500, and 2,000 m resulted in a reduction in the number of bedside maneuvers by 50.00, 66.67, and 75.00%, respectively. The increase in the average length of crop rows results in a polynomial reduction of the operational cost. However, this increase in length has a strong positive impact (variation) on the operational cost. According to Santos et al. (2015a), this is due to an increase in the productive time, worked time, and worked hours of machines. Therefore, according to Santos and Gadanha Júnior (2016), plots should be systematized with a rectangular geometric shape or a winding strip to obtain a long length of crop rows and reduce the number of maneuvers.

CONCLUSIONS

An increased length of crop rows is advantageous because it reduces bedside maneuvers and the operational cost of the machine.

The mills must carry out the systematization of their areas to enable mechanized operations.

RESUMO: O Brasil é o maior produtor mundial de cana-de-açúcar destinada às usinas e tem produtividade média, superior aos demais países produtores dessa matéria-prima. A aplicação de defensivos agrícolas em canaviais das agroindústrias é realizada em extensas áreas de cultivo, com pulverizadores hidráulicos autopropelidos, tratorizados e aéreo. Para tanto é necessário sistematizar as áreas de cultivo, tornando os talhões com longo comprimento de fileiras de cultivo, a fim de diminuir as manobras de cabeceira das máquinas. O objetivo do trabalho é avaliar o impacto causado pelo comprimento das fileiras de cultivo no custo operacional de pulverizadores hidráulicos para os tratos culturais de cana-de-açúcar. Pela dificuldade que existe em realizar o trabalho e atender o objetivo nas condições de campo, optou-se em desenvolver um modelo computacional denominado *TratoCana*, em planilha eletrônica e em linguagem de programação. O modelo foi verificado quanto a possíveis erros de rotina, validado, utilizado na análise dos fatores e na geração de cenários. Os resultados evidenciaram que o comprimento das fileiras de cultivo, impacta positivamente no desempenho operacional e econômico dos equipamentos.

PALAVRAS-CHAVE: Mecanização agrícola. Pulverizadores hidráulicos. Planejamento e gerenciamento. Manobra de cabeceira. Modelo computacional. Custo.

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