IMPACT: International Journal of Research in Engineering & Technology
ISSN (P): 2347-4599; ISSN (E): 2321-8843
Vol. 6, Issue 3, Mar 2018, 9-18

RATIONAL STRUCTURE OF THE SYSTEM OF MACHINES IN THE TRANSPORT PROCESS RICE HARVEST

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Received: 10 Feb 2018 **Accepted:** 15 Mar 2018 **Published:** 19 Mar 2018

ABSTRACT

Rice farming is one of the most widespread consumption of humanity foodstuffs, considering that is the staple food for about half of the world population. Harvesting and transport of cereal demand interaction machine system and may argue that, using linear programming can model the behavior of the technical and obtain optimal conformation variants thereof. At present, the development of science and technology and the possibility of having professional computer programs that solve complex problems in microcomputers, has helped increase the use of these mathematical techniques in economic trouble. In this paper a mathematical economic model that minimizes fuel consumption satisfying the harvest and transport of rice, which allows obtaining the rational variant of shaping the technical means available in the company to the different types of poses existing fields, the model results developed applied to a company dedicated to this process.

KEYWORDS*: Rice Harvest and Transport, Mathematical and Economic Model or Optimizations*

INTRODUCTION

The mechanization of rice is widely worked in the whole world because this cereal is undoubtedly one of the most consumed by the world population and therefore this issue is paying special attention by researchers in this area of knowledge.

In the implementation of the Mathematical Economic Modeling, must recognize the system, that is to say, what is the object of analysis in this case is the system of machines, the company structure, basic with lots and fields units, which are product volumes that are desired harvest and transport, are the limiting factors to achieve this result and that element will ensure the establishment of a solution under certain level of efficiency is At present, the development of science and technology and the possibilities of having professional computer programs, that solve complex problems in microcomputers, have allowed theincreased use of these mathematical techniques in economic problems. Countries like the US, Germany, Italy, China, Mexico, Spain, Brazil and others have great development in these methods. (Garcia E, 2010), (Guoging Q, 2012), (Roel A et al,2010), (Regalado M, 2009), (Public Works East Lansing. Michigan. U.S.A. 1980), (ZhanbaoZ, 2010).

It is also important to know that problems or tasks are solved with the application of mathematical modeling. In this work would then determine a real situation operating system machines optimum conditions for minimum fuel consumption and also using this model could also be used to schedule the next harvest so that:

- Comply with the proposed plans.
- More resources available are not spent.
- To ensure that the optimal solution, offering desired.

In the case analyzed the Mathematical Economic linear programming model can provide answers as all these elements of the system are likely to be represented by a system of linear inequalities, which are subject to a certain linear function, which is the objective to minimize: spent fuel (Zhanbao Z, 2010).

MATERIALS AND METHODS

Effect of Rational Structure of System the Machines

Following the general steps for formulating an optimization problem, it proceeded to approach the problem formulation and solution thereof.

Formulation the Problem

It is to organize the system of technical facilities for the rice harvest in the field and its transportation to the drying with minimal fuel consumption. From now on you will be called a harvest transport problem.

Mathematical Model of Process Harvest Transport

This problem is typical of linear programming; also by the nature of the variables involved in it and the values of the coefficients, it can be classified as a model of static and deterministic.

As an initial step, the set of decision variables present in the detailed problem and it is taken into account conceptual and dimensional definition. Also, the four components that make up the principle of a single variable (origin, destination, technological structure and economic coefficient) was taken into account.

As an initial step, the set of decision variables present in the detailed problem and it is taken into account conceptual and dimensional definition. Also, the four components that make up the principle of a single variable (origin, destination, technological structure and economic coefficient) taken into account.

The determination of the values of the coefficients involved in the model and experimentally obtained some other technical instructions by department mechanization of Rice Company and the National Technical Instructional Rice.

The values associated with the availability constraints, technical, capacity of technical means and capacity of the dryer were supplied by the management of the Department of Mechanization of Company "Rodolfo Ramirez Esquivel".

The Work Cycle of Technical Means: The time required for saturation of the capacity of the technical means at times called CTj.

Determining work cycles performed harvesters from statistical processing of the experimental data. In the case of transport, they were determined from the functional relationship of the speed depending on the shooting distances from the fields to the dryer obtained by regression analysis.

As decision variables involved in the problem, crop transportation has the following:

As decision variables involved in the problem, crop transportation has the following:

I denote harvested fields, i = 1, 4 and j the type of technical means, j = 1, 9.

Additionally, we denote by:

Cij - Amount of product in kg rice harvesting and transport by technical means in the field i j.

CCJ - Price in pesos per liter of fuel.

Tjl - Time in hours of the working day of technical means J.

Ex - Availability of technical means j.

CTj - saturation time in hours load capacity of technical means j.

$$\textbf{CTj} = \begin{cases} \textbf{Kj } j = 1,4 \\ \textbf{Fj(d) } j = 5.9 \end{cases} \quad \textbf{para cada } i = \overline{1,84}. \qquad \textbf{(1)}$$

Where:

Kj - estimated value experimentally for each j.

Fj (d) - value obtained by regression analysis of the speed depending on the shooting distance (d) from the field to the dryer, where:

$$F5\ (d) = \frac{d}{7.63 + 0.5436 * d} \text{ for tractor type Zetor Cristal} \qquad \textbf{(2)}$$

$$F6\ (d) = \frac{d}{9.1314 + 0.8559 * d} \text{ for tractor type Massey Fergunson} \qquad \textbf{(3)}$$

$$F7\ (d) = \frac{d}{10.3160 + 0.6823 * d} \text{ for tractor type Jumz 6} \qquad \textbf{(4)}$$

$$F8\ (d) = \frac{d}{10.4330 + 0.5729 * d} \text{ for tractor type MTZ} \qquad \textbf{(5)}$$

$$F9\ (d) = \frac{d}{9.1919 + 0.6902 * d} \text{ for tractor type T} - 150 \text{ K} \qquad \textbf{(6)}$$

We denote the expression gij = $\frac{Aj * CTj}{Ccj} pc$ is nothing more than spending incurred pesos per kg of rice harvested and transported therefore gij is the coefficient accompanying the decision variable.

Thereby the objective function will crop transport as follows:

$$\min z = \sum_{i=1}^{84} \sum_{j=1}^{9} gij \cdot Cij \qquad \textbf{(7)}$$

The values of the coefficients of the expression gij, is given in the following table.

Table 1

Equipment	Aj Saturation Time in Hours Load Capacity of Technical Means j.	CTj Saturation Time in Hours Load Capacity of Technical Means (hours)	Ccj Load Capacity (kg)
Harvesting Equipment			
Combinada Cubar 90	13	1.25	1380
Combinada Impar 411	13	1.25	1380
Combinada Ideal	17	1.11	2070
Combinada New Holland	17	0.75	2070
Means of Transport			
Tractor Zetor Cristal	15	d/ (7.6339 + 0.5436d)	1800
Tractor Massey Fergunsson	12	d/ (9.1314 + 0.8595 d)	1800
Tractor Jumz 6	6	d/ (10.316 + 0.6823 d)	1800
Tractor MTZ	3.6	d/ (10.433 + 0.5729 d)	1800
Tractor T 150 K		d/ (9.1919 + 0.6902 d)	1800

Them:

$$\min Z = pc[\ (17 * 0.75 / 2070)\ ] * Ci_{\text{New Holland}} + pc[\ (17 * 1.11 / 2070)\ ] * Ci_{\text{Ideal}} + pc(\ 13 * 1.25 / 1380)\ ] * Ci_{\text{Impag}} + pc[\ (13 * 1.25 / 1380)\ ] * Ci_{\text{Cubar}} + pc[\ (3.6*d / 0.5729d + 10.433 / 18000)\ ] * Ci\ MTz + pc[\ (15*d / 0.5436d + 7.6339 / 18000)\ ] * Ci_{\text{Zetor}} + pc[\ (12*d / 0.8595d + 9.1344 / 18000)\ ] * Ci_{\text{Massey}} + pc[\ (6*d / 0.6823d + 10.316 / 18000)\ ] * Ci_{\text{Yumz.}}] + pc[(21*d / 0.6962d + 9.1919)\ ]* Ci_{\text{T 150 K}} \quad \textbf{(8)}$$

Equipment Availability Restrictions

$$CT_1 / Cc_1\ TJL\ \Sigma\ C_{i\,1} \leq E_1 \quad \textbf{(9)}$$

$$CT_2 / Cc_2\ TJL\ \Sigma\ C_{i\,2} \leq E_2$$

$$CT_9 / Cc_9\ TJL\ \Sigma\ C_{i\,9} \leq E_9$$

Capacity Harvesters Restrictions

$$\sum_{J=1}^{4} Ci1 \leq CC_1 \quad \textbf{(10)}$$

$$\sum_{J=1}^{4} Ci\,2 \leq CC_2$$

$$\sum_{J=1}^{4} Cm\,4 \leq CC_4$$

Capacity Restrictions of Transport Equipment

$$\sum_{J=5}^{9} C_{i5} = \sum_{J=5}^{9} Cc_5 \qquad (11)$$

$$\sum_{J=5}^{9} C_{i6} = \sum_{J=5}^{9} Cc_6$$

$$\sum_{J=5}^{9} C_{i9} = \sum_{J=5}^{9} Cc_9$$

Reception Centre Restrictions

$$\sum_{i=1}^{84} \sum_{J=1}^{9} Cij \leq Cs \qquad (12)$$

Nonnegative Restrictions

$Cij > 0; gij > 0$ **(13)**

In the solution of the problem the following elements were considered:

They are defined as variables in this problem: cycle time team work i (Tcj) equipment capability i (Cj), time working hours (TJL), team capacity in the field i j (ij) Capacity i field (ICC), number of teams (Dj) type, number harvesters (A) Number of type tractors for shooting (B) Number of tractor mover field type (f) Number of tractors mover type kiln dry (g) Number of Fields (I), equipment type number (J), drying capacity (Cs).

It was assumed the following assumptions:

All production has insurance market to set prices.

Proposed production plans are met.

Another consideration also:

Performance standard fields, t / ha.

Media participating in the transportation harvest reception process by establishing organizational production variant: Mover Tractor in the field, harvesting rice, throwing tractor, tractor mover rice in the dryer and trailers.

Availability of technical means to participate in the process.

Availability of harvested fields.

Ability to drive tractors.

Working cycle time of technical means.

Distances from different fields to the drying batch, Km

Functional relationships, of the working speed and distance of transportation, from the fields to the dryer.

Daily production capacity or labor standard, in of Reception Centre, t / h.

Load capacities of rice trailers.

For use in the Company Rodolfo Ramirez Esquivel exposed procedure were considered interaction parameter values as follows:

Performance standard fields: 4,056 t / ha.

Media involved in the harvesting process, transport mover tractor in the field, harvesting rice, throwing tractor, tractor mover rice in the dryer and trailers.

Availability of technical means to participate in the process:

New Holland Combine: 4

Combine Ideal 9075: 1

Combine: Impag 411: 2

Combine Cuba 90: 1

Tractor Yumz 6: 1

Tractor Zetor Crystal: 10

Massey Fergunson: 1

Tractor T 150 K: 1

Rice trailers: 23

Tractor hopper: 5

Availability of harvested fields: 84

Traction tractor: 4

Trailer: 6 t.

Time of the working cycle of the technical means:

New Holland Combine: 0.75 h

Ideal harvester: 1.12 h

Combine Impag 411: 1.25 h

Combine Cuba 90: 1.27 h

Tractor Yumz 6: 0.54h

Tractor Zetor Crystal: 0.72 h.

Massey Fergunson: 0.53 h

Tractor T 150 k: 0.58 h

Distances from different fields to the dryers.

Functional relationships of the working speed and distance of transportation from the fields to the dryer.

Daily production capability of the reception center: 12000 kg / h.

Rice trailers capabilities: 6 t.

Analysis of results

Solution to the problem.

The problem was solved by linear programming, using the Solver software

As can be seen in a day's work the following results were obtained:

FO = $ 232.22

Ij = 176640.00 kg

He is indicating that harvested and transported the amount of 176640.00 kg of rice with a minimum fuel consumption of $ 232.22.

For total working hours determined by the model for the given area, the following result was obtained:

FO = $ 10,210.55

Ij = 1722301.75 kg

That is, it is harvested and transported 1722301.75 kg of rice with a minimum expenditure of $ 10,210.55 fuel. This result is obtained by the formation of technical means following:

The number and type of combined harvesters: New Holland Four Combined type

Number and type of propellant tractors in the field: Four movers tractolva type tractors.

Number and type of Tractors: A type tractor Zetor Crystal

Number and type of propellant tractors in the dryer: A tractor type Yumz 6

Number rice forming trailers tractotren: 4

Total number of trailers: 20

Number of days needed to meet the availabilities of rice obtained shaping technical means: 15.

Sensitivity Analysis of the Model

For sensitivity analysis of the obtained model was evaluated the behavior of the same at the onset of uncertainties that often occur randomly. To this end three levels of possible effects model, ie damages by 5%, 10% and 15% were established with respect to the variables: field performance, availability of the harvesters and number of trailers for a day working in a field.

The automated processing of these effects has: A 5% decrease performance field on a day in the lot a decrease in fuel consumption by 0.31% and a decrease in the volume of rice harvested 0.32%. If the allocation is 10% and even 15%, then this would represent damages of similar magnitude to those obtained with the previous 5%. A decrease of 5% ; of the availability of equipment in a field on a day represents a 0.82% decrease in fuel consumption and 0.83% relative to the volume of rice harvested. If the effect on the availability of harvesters is 10%, then decreased fuel consumption would fall by 1.33%, while the volume of rice and harvested decrease by 0.34%. If the level of involvement of the variable (available combined) was 15%, then the effect on fuel consumption would be decreased 1.83% and 1.85% of this magnitude for the volume of rice harvested. For its part the declining number of trailers in the three aforementioned levels (5%, 10% and 15%) in a field during a day would represent a 0.31% decrease in fuel consumption and 0.32% of the volume of rice harvested.

De forma general se puede plantear que las afectaciones del modelo en los referidos niveles de posibles incertidumbres presentan una dependencia lineal y que los valores de magnitudes obtenidos ratifican la viabilidad de utilización del modelo obtenido.

Economic Impact

In the research, it took into account as economic criteria for optimization of the system related to the fuel consumption of the technical means involved in the transportation process harvest rice.

For the calculation of the total net profit of the system, must also take into account the costs of fuels other expenses that occur in the process of operation of the system of means.The determination of operating expenses done by calculating the costs incurred in the process.Ce syst = C S + C + I + C A + C C C $_{MTTO}$where:Ce systemic --- Total operating expenses machines system forming, [pesos]C S --- wage costs [pesos].C Me --- other material costs of exploitation, [pesos].C A --- amortization expense, [pesos].C --- $_{MTTO}$ maintenance costs, [pesos].CC --- spending fuel consumed [pesos].

Them:

Ce sist = 157 639.15 pesos + 454.78 pesos + 115 4 1.13 pesos + 5 408.02 pesos

+ 102 10. 55 pesos = 185253.63 pesos.

Calculate system gain considering all expenses (GS).

The system gain is calculated considering the income produced by the sale of the wet rice harvested and transported by the machine system.

A Total volume of rice harvested and transported: 1722 301.75 kg.

A Sale price of wet rice harvested and transported: 505.76 pesos / t.

System gain from the sale of rice: 871071.33 pesos.

Gain considering all expenditures.

G s = 871 071.33 - 185 253.63 = 685 817.70 pesos.

The value obtained and considered the costs of other activities and / or material consumption, so perfectly it characterizes the financial status of the company to apply the model.

CONCLUSIONS

The optimal variant for existing facilities in the company "Rodolfo Ramirez" derived from the mathematical simulation is made of 4 New Holland, working full days, three movers tractor tractolva field type, a tractor Zetor Crystal kind shooting, one mover in the dryer of Yumz 6 type tractor, four trains composed of four trailers each and trailer operating reserve is included in the dryer and three trailers book in the field.

The proposed model fits the character of the harvesting process, transport receiving rice and model variables describing the system by making it valid for the same, used for harvest planning in the current real conditions and it is useful for the realization of the rational choice of the areas of land preparation and sowing of the crop within the schedule.

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