© International Journal of Combinatorial Optimization Problems and Informatics, Vol. 8, No. 3, Sep-Dec 2017, pp. 39-44. ISSN: 2007-1558.

Project Management for Farm Production

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Abstract. This paper aims at being a guide to understand the Farm Production Management (FPM) implementing a new paradigm based on CPLEX method with Project Scheduling Problem (PSP) as an integration of Artificial Intelligence with Project Management. In this proposal we design a mathematical model to represent FPM and the objective function oriented to minimize the resources. In this paper we propose the simulation with random data where the parameters are classified as: crop, land, labor, and water. The declared variables are Amount Planted, Permanent Labor Hired, Temporary Labor Hired, Sales and Fraction Consumed. Restrictions: Land limitations, Labor requirements, Water Requirements and Family Consumptions.
Keywords. Farm Production Management, Project Scheduling Problem, CPLEX method, simulation.

1. Introduction

Fuentes Penna et al. (2015; 2016) describe the Project Scheduling Problem (PSP) as a directed acyclic graph where each node represents events and the arcs represent the activities between initial and ending node pairs. Project Scheduling Problem can be applied to different kinds of problems like the optimization of financial resources for technological innovation projects (Ruiz Vanoye et al., 2016). Diaz-Parra et al. (2014) describes the features of different types of transportation problems. As part of these problems, transport occurs in pipes and wiring, where the sources can be water, energy, electricity, natural gas, among others. The management of water in farm production can be presented as a water transportation required through pipes for irrigation.

2. Materials and methods

Ruiz-Vanoye et al. (2016) establishes the use of CPLEX tool as a method to design instances and propose solutions to the issues raised. CPLEX uses linear programming – integer programming, using different methods like: the simplex method, quadratic programming problems convex and quadratic programming problems non convex.

Received Jan 19, 2017 / Accepted Jun 10, 2017

3. Farm Production Management

The objective function is aimed to maximize the crop production, considering different variables and constraints. The method CPLEX is used to define the variables, restrictions, parameters, mathematical functions, and so on to calculate and generate the maximum resource performance at proposed solutions. In the case of the Farm Production Management we have defined a set of parameters:

- Crops,
- Months of production,
- Yield crop production,
- Land availability,
- Fraction of land occupied by crops
- Annual average salary,
- Annual average salary for permanent workers,
- Hourly average salary of temporary workers,
- Working hours,
- Annual water availability,
- Total water,
- Crop water requirement,
- Water prices.

For this problem, the variables are proposed as:

- The amount of crops planted,
- Recruitment of permanent staff
- Recruitment of temporary staff
- Sales
- Fractional approximate consumption.

Moreover, it is necessary to consider the problem constraints:

- Land limits,
- Work requirements,
- Water requirements (time and amount)
- Average family consumption.

On the issue of Farm Production Management, it is necessary to assign optimally the resources like the availability of land, the cost generated by the payment to workers and the cost of water requirement based on the crops. To optimize the use of water, it is necessary to implement irrigation systems commensurate with the type of crop depending on the crops. The computational solution proposed use the linear programming whose objective is to maximize resources and maximize the farm production.
The Project Scheduling Problem (PSP) is a directed acyclic graph where the main graph is presented as G = (Nodes, Arcs, $Node_0$, $Node_{n+1}$). Where Nodes = (1, 2, …, n) are the set of node events. The set of arcs represent the activities, where each arc(i,j) can be presented as one directed arc from node i to node j. $Node_0$ is the initial node or Event 0. $Node_{n+1}$ is the final node.

$$A(t) = \{ j \in J \mid F_j - p_j \} \quad (1)$$

$$MaxF_{n+1} \tag{2}$$

$$Max(r_{n+1}) \tag{3}$$

$$\begin{gathered} F_c \leq F_j - p_j \\ j = 1, 2, ..., n, n+1; c \in P_j \end{gathered} \tag{4}$$

$$\begin{gathered} r_c \leq r_j - p_j \\ j = 1, 2, ..., n, n+1; c \in P_j \end{gathered} \tag{5}$$

$$\sum_{j \in A(t)} r_j \leq F_j - p_j \tag{6}$$

$$\begin{gathered} F_j \geq 0 \\ j = 1, 2, ..., n, n+1 \end{gathered} \tag{7}$$

The equations 1 – 3 denote the objective function to maximize the project production and the makespan of the project using the minimum resources. Constraints are presented at the equation 4 – 6 where the time, resources and the enforce of the precedence constraints between activities and the related constraints, where the limit of each time instance t and resources demand of the activities are currently processed to not exceed the project capacity. The equation (8) define the decision variables.

4. Results

The Figure 1 present the input data, where the land data represents the hectares to us in each crop; the labor data represents the required labor needed if we combine the proposal crops; and the water data represents the required water for each crops combination.

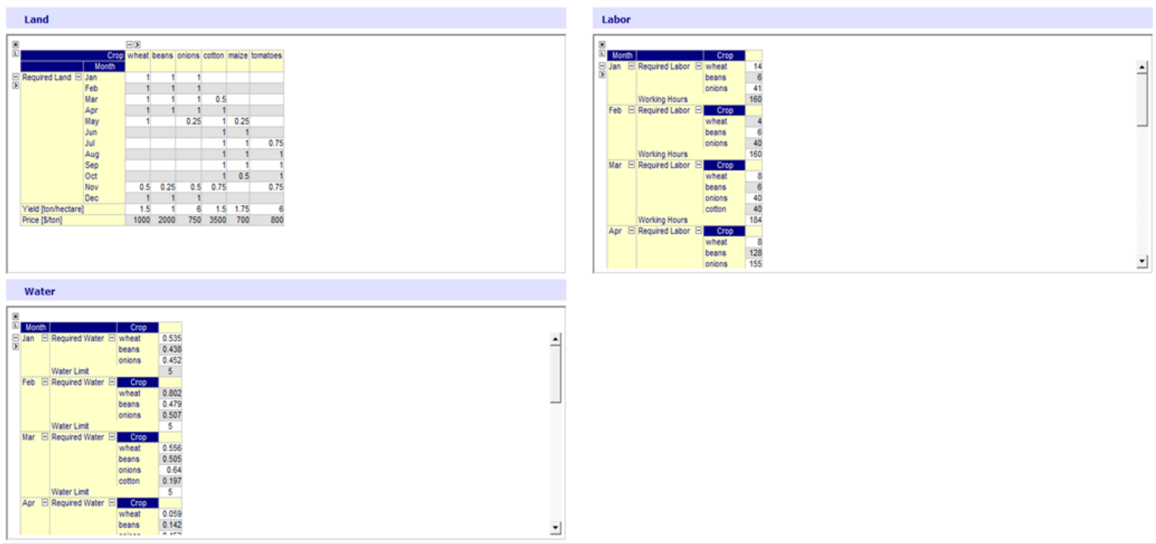

Figure 1: Farm Planning Problem Input Data

At figure 2 we present the results of combinatorial optimization based on the parameters, variables and objective function presented at figure 3. The results show the 54% of permanent staff to reduce human resource cost. The hectares occupied by each crop are based on the maximum production and the maximum yield. In this figure we present the estimated consumption of each crop and the estimated amount sold. In this case, the total revenue is $ 49,950.00 based on the presented model.

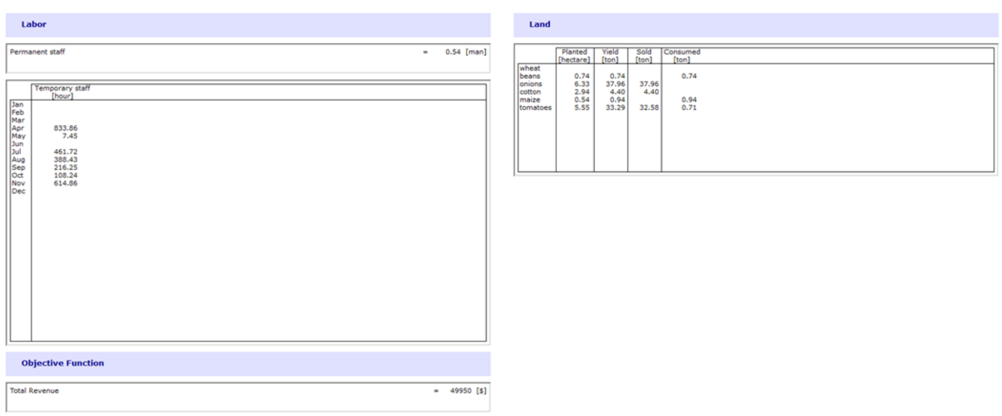

Figure 2.- Output data

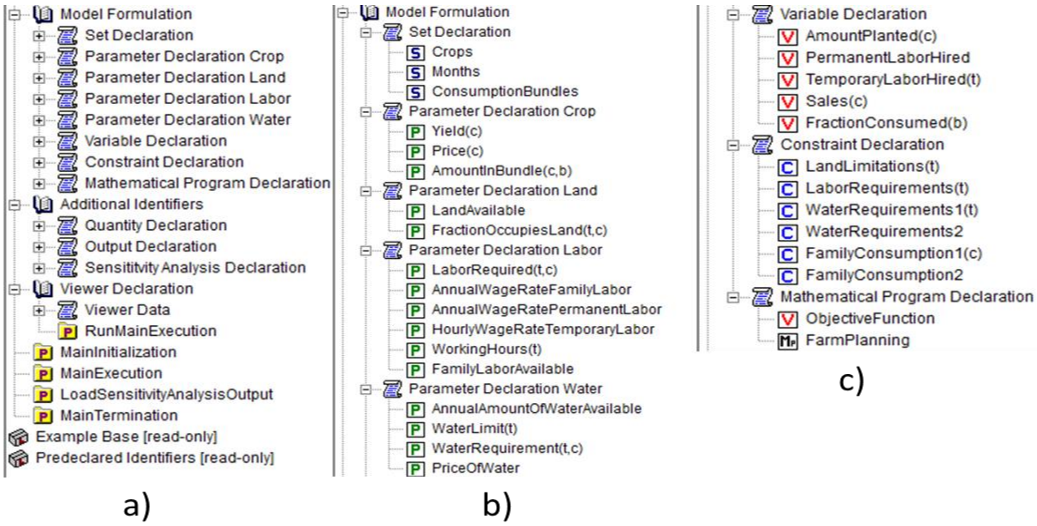

Figure 3.- Parameters, variables, constraints and mathematical model

The figure 4 presents the sensitivity analysis, where the farm earning show the cost of family labor, cost of permanent labor, cost of temporarily labor, and cost of water based on the consume of each issue. In this model, we estimate the shadow price or social price in the months: March, July and November.

Figure 4. Optimal crops as function of availability land

5 Conclusions

In this article we present the Farm Production Management (FPM) as a Project Management Problem, where we used a solution based on Project Scheduling Problem as Artificial Intelligent Technique and CPLEX method to maximize the crops production and to maximize the total avenue.

References

Alejandro Fuentes-Penna, Jorge A. Ruiz-Vanoye, Ocotlán Díaz-Parra, Joaquín Pérez-Ortega, Sócrates López-Pérez. 2016. Nursing Process Characterization for Patien Dagnosis. Año: Marzo 2016 Volumen 91 Revista Dyna Ingeniería e Industria. ISSN: 0012-7361. DOI: http://dx.doi.org/10.6036/7855

Alejandro Fuentes-Penna, Jorge A. Ruiz-Vanoye, Ocotlán Díaz-Parra, Joaquín Pérez-Ortega, Sócrates López-Pérez. 2015 Nursing Process Problem: una nueva propuesta NP-HARD Año: Enero 2015 Volumen 2 Número 1 Revista Dyna New Technologies ISSN Digital: 2386-8406 DOI: 10.6036/DYNANT

Jorge A. Ruiz-Vanoye, Ocotlán Díaz-Parra, Alejandro Fuentes-Penna, Mario Zurita-Barrón, María Beatriz Bernabe Lorca, Edith Olaco-García. 2016. Un Resumen de la Planificación de Proyectos de Innovación Tecnológica. Año: Marzo 2016 Volumen 91 Revista Dyna Ingeniería e Industria. ISSN: 0012-7361. DOI: http://dx.doi.org/10.6036/7855

Jorge A. Ruiz-Vanoye, Ocotlán Díaz-Parra, Alejandro Fuentes-Penna, Mario Zurita-Barrón, María Beatriz Bernabe Lorca, Edith Olaco-García. 2015. Problema de Programación de Proyectos de Innovación Tecnológica (PSP-TI). Año: Enero-Diciembre 2015 Volumen 3 Revista Dyna Management. ISSN: 2340-6585. DOI: http://dx.doi.org/10.6036/MN7663

Ocotlán Díaz-Parra, Jorge A. Ruiz-Vanoye, Beatriz Bernábe Loranca, Alejandro Fuentes-Penna, and Ricardo A. Barrera-Cámara. 2014. A Survey of Transportation Problems. Journal of Applied Mathematics. Hindawi Publishing Corporation. Volume 2014, Article ID 848129, 17 pages http://dx.doi.org/10.1155/2014/848129