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Goal Programming Applications in Agricultural Management

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Abstract - ***Today, in agricultural sectors, as in all other sectors too, the farmers are more concerned about the economical issues also. It is necessary for all the farmers to do their best to make as much effort as possible to increase the production and protect their crop. Due to changing weather conditions, water problems, labor problems and the economic conditions, agricultural sector management faces many constrains in order to achieve the required goal for production. It is obvious that one of the ways is to apply mathematical programming model for the agriculture sector. Economic planning is of vital importance in agriculture planning and applying fundamental programming methods is inevitable. The goal programming model for multi-objective programming is an important tool for studying various aspects of agriculture systems.***

Key Words: *Multi-objective programming, Goal programming, agriculture systems, agriculture management*

1. Introduction

Goal programming technique is an important tool applicable in the situation of multiple objectives in order to minimize cost or maximize the profit. However, in practice, agricultural objectives may vary depending upon the weather conditions, availability of labor, water, electricity etc. For the agricultural system, when we have to maximize or minimize our goals we use a the technique of model formation through Goal Programming. Decision making is done through Goal programming, which is an extension of Linear programming.

Goal programming is of much importance in Operational Research and the technique of goal programming is extensively used to solve the problems of decision making. The use of goal programming model approach is widely employed in problems of multi-criteria decision-making. Charnes and Cooper first introduced goal programming technique in 1960. The method of solving the problems was further extended by Ijiri (1965). The refined method of Linear programming for decision making and to solve multi – objective problems is developed in goal programming.

The goal programming technique allows the decision maker to find feasible and optimal solutions to multiple and conflicting objectives. The linear programming methods are used to solve and find an optimal solution of a single dimensional or multi-dimensional objective function. with a given set of linear constraints. The objective function in the goal programming technique contains all the management goals, and the constraints are all those environmental conditions that are outside the management's control. Each goal set by the management is given a priority according to the higher and lower level. First the higher goals are considered and then the lower ones according to the priority order. For all linear goal constraints, we can find the solution by the technique of goal programming, depending upon the importance or contribution of goals. In goal programming method we minimize the sum of all deviations along with minimizing all possible priority deviations. The decision maker or the manager can deviate, giving concessions between goals to affect the multi- objective problem solutions. Goal programming problems deals with the extent and directions of these deviations. Goal Programming and decision making share great similarities although goal programming has its own characteristics.

Adaptation of multiple goal programming in decision making is very advantageous Ijiri (1965) gave the multiple goal programming as an extension of break-even analysis, which is widely used in business practice.. Pre- anticipated priorities of real life problems are given by Fishburn (1974) and Monarchi et al (l976). Goal programming finds its application in economics and business also Nijkamp and Spronk (1977).

Goal programming gives a solution to every problem even if some goals are in disagreement with other goals, least the feasible region contains at least one element. To achieve this deviational variables are included which show the possibility of goal being accomplished or not, also giving the distance between the achieved goal and the desired goal. Goal programming requires simple procedures to solve the problems. Available Linear Programming methods are used to solve linear goal programming problems, although it requires detailed a priori information on the decision-maker's preferences. A set of goals which are in disagreement with each other are managed by minimizing the deviations between goals and the outcomes Rifai (1994). The distance of the desired value is given in terms of under achievements and over achievements, which are also called deviations. These

deviations are termed as positive deviations d+ for over achievements and d- for under achievements. Some goals are of more importance than others, hence priorities are assigned to them . These goals are minimized according to the priorities in phases. In the first phase the feasible solution is obtained for the first goal, for second phase the second priority is minimized and a feasible solution is obtained and so on

2. Model Formation

A model is prepared for an easier representation of the true system and phenomenon. All the features relevant to the real system are incorporated in the study of the model. The model is used to take management decision for the proper planning of production planning problems. This model can be used to represent management's plans in algebraic and numeric forms. The use of the mathematical model is to understand the reasons of the management problems and to find the most appropriate solution with all the existing constraints.

Multiple goal models are constructed in recent past under the conditions of multi – objectives according to the circumstances and knowledge of manufacturing. In Linear Programming the objective function is minimized or maximized but in goal programming the approach is to minimize the deviations (both positive and negative) between the desired goals and the outcomes are acquired in agreement with the priorities.

A general Goal Programming model is given as

Min P_1^- ($w_{i1}d_{i1}$ + w_{i1} d_{i1}) : for i = 1,2,3,……n

Min P_2^- ($w_{i2}d_{i2}$ + w_{i2} d_{i2}) : for i = 1,2,3,……n

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. Min P_k^- ($w_{ik}d_{ik}$ + w_{ik} d_{ik}) : for i = 1,2,3,……n

Subject to $\sum_{j=1}^{n} a_{ij} x_j + d_i - d_i = bi$: i= 1,2,3,….n

X_j , d_i, $d_i \geq 0$

$P_1 >> P_2 >> P_3 \ldots\ldots >> P_k$

2.1 Area of Study

Goal programming research extents in many varied fields. Heady (1954) studied the models for proper allocation of cultivable land to cropping plan. Glen (1987) gave his research results in agriculture planning problems using linear programming. Goal programming finds its application in the field of cropping plan problems as they are multi objective. Ignizio (1976) used the tool of goal programming for multi – objective decision analysis to different farm planning problems. Natural Resource allocation management decision model was given by Kenneth et al. (1975). To take a decision, the decision maker has to satisfy several goals and the mathematical programming methods of goal programming can be used. Premchandra (1993) developed goal programming model under conditions of multiple items, multiple suppliers and resource limitation. He used goal programming models for decision making in production management and for the controlling and scheduling of the problem. . Anderle et al. (1994) applied multiple objective goal programming techniques in management of the Mark Twain National Forest in Missouri; they applied the Fuzzy numbers in the model for resource allocation in forest planning. The present day Goal programming review for multi criteria modeling using the lexicographic and weighted goal programming together with their distinct application areas were reported and presented by Springer (1995). How to give priorities and assign weights is an important factor of goal programming. Standard results and guidelines were established for the scope and correlation between them. A zero goal programming technique was presented by Ertugrul et al. (2002). This incorporates PTRs (Product Technical Requirements) which is obtained by using the ANP (Analytical Network Process), cost budget, stretchable level along with manufacture level goals , so that the PRTs can be taken into consideration for designing the product.

The application of the decision procedure was demonstrated via an illustrative example of the production planning problem. Taylor et al. (2003) applied a multiple objective approach for aggregate production planning. Adejobi et al. (2003) developed a linear goal programming model for optimal crop combinations under limited resource conditions with its application to small holder farmers in the driver Savannah zone of Nigeria, that would enable the small holder farmers meet their most important goals of providing food for the family throughout the year. A goal programming model was designed by Latinopoulos et al. (2005). They used the method of lexicographic goal programming in irrigation agriculture and designed a model that cared for the farmer's welfare along with the minimization of environmental factors for the allocation of land and water resources.

D. Barnett al. (2006) developed a methodology to estimate empirically the weights for a multiple goal objective function of Senegalese subsistence farmers. Nhantumbo et al. (2006) presented a Weighted Goal Programming (WGP) approach for planning management and use of woodlands as well as a framework for policy analysis. Moro and Ramos (1999) presented a goal programming methodology for solving maintenance scheduling of thermal generating units under economic and reliability criteria. Mathirajan and Ramanathan (2006) developed a goal programming model for

scheduling the tour of marketing executives. S. Partangel (1999) developed a goal programming data envelopment analysis technique in manufacturing plant performance for serial-manufacturing. . Hultz et al. (1981) studied the problem of multi- criteria facility location. Fortenberry and Mitry (1986), studied the application of integer goal programming for facility location with multiple competing objectives. Krukanont and S. Praertsan (2004) developed mathematical model for power plant where rubber woods were used as raw materials. Field et al. (1980) used the method of goal programming for public forest management planning models J Kornbluth (1973) applied goal programming model for the survey of industrial and economic planning. A goal programming model for sensitivity analysis was developed by Shim and Siegel (1980). Romero, (1986) studied natural resource planning in agro forestry management problems using goal programming techniques for multiple objectives.

Goal programming finds its wide application in the field of decision making policies with the limitation of resources. In agriculture sector GP technique can be used to plan a maximum yield by considering several goals Ghosh (1993, 1995). A goal programming model for nutrient management for rice production was given by Ghosh, Sharma and Mattison (2005). (Rehman and Romero, 1984, 1987), formulated a model for livestock ration. (Minguez, 1988) studied sugar beet fertilizer combination problems
Vivekandan et al. (2009) utilizes the goal programming approach to enhance agriculture pattern for distinct lands. They designed a model so that proper usage of surface and ground water is done to achieve good returns in irrigated cultivation. Alade et al (1998) formed a multi-objective model to be used in planning for developed countries by using the constraints of industrial network, availability and use of labor force, value added export, financial capability etc. They studied its effect on the Indian economy. A goal programming model for rice farms with multiple goals was designed by Jafari et. Al. (2008) to analyzing and enhance the compound agriculture product in a city of Iran.

For natural resources problems, goal programming technique finds sufficiently more solutions in comparison to linear programming model which contains only one criterion. It is of utmost importance . For decisions in realistic models in managing natural resources the social and environmental aspects of resource allocation cannot be ignored. Romero and Rehman (1987) reviewed the applications of GP and MOP in fisheries, agricultural land uses, forestry and water management. Diaze-Balteiro and Romero (2003) designed a goal programming technique for forest management, considering the effect of carbon capturing in the forest ecosystem. A GP model for mixed farming, discussing the planning for agricultural land management, was given by Wheeler and Russell (1977). Field (1973) studied the GP model with many conflicting goals of level of profits, budget limits, and timber harvesting targets. Krishna Rustagi (1973) developed a goal programming model in forest management for timber production. Khwanchai and Pasti (2005) gave a linear programming model for teak plantation in forest plantation of the forest industry organization. Suresh Chand Sharma et al. (2010) proposed a goal programming model to discuss the minimization of damages in milk production system

T. Gomez et al. (2006) designed a linear fractional goal programming a model for forest planning. The problem of Timber Harvesting Scheduling for forest plantation was studied and applied to the plantation in Cuba . Management of renewable resources in the areas of agricultural, fisheries and forestry was discussed by Andres Weintraub et al. (2001). Alireza Karbasi et al. (2012) study the goal programming for the optimal combinations of different kinds of fertilizers for rice cultivation. Shaik Md. et al. (2010) developed a multi – objective forest management process using the technique of mathematical programming .

3. CONCLUSIONS

Linear programming model maximize or minimize the objective function directly where as Goal programming model minimizes the deviations between the aspired goals and for the assigned priorities according to the decision makers choice. Goal programming allows the decision maker to evaluate and analyze the problems with multiple conflicting objectives under complex environmental constraint. The application of goal programming in agricultural management provides a way of striving toward several objectives simultaneously.

REFERENCES

[1] A. Charnes and W.W. Cooper. Goal Programming and Multiple Objectives Optimizations. European Journal of Operational Research (1977),1: pp. 39
[2] Ijiri.Y. (1965) Management Goals and Accounting for Controls . North - Holland, Amsterdam
[3] Fishburn, PC. (1974). Lexicographic Orders, Utilities and Decision Rules: A Survey. Management Science. 20: 1442-1471.
[4] Monarchi, D..; Weber, J..Duckstein, L. (1976). An Interactive Multiple Objective Decision Making Aid

Using Non-Linear Goal Programming. In M. Zeleny, editor, Multiple Criteria Decision Making, Kyoto. Monthly Rubber News: Rubber Board of India, January 2012 – November 2012

[5] Rifai, A.; Pecenka, J.. (1986). Goal Achievement Through Goal Programming: Short Versus Long Term. Engineering Costs and Production Economics. 102): 155-160

[6] Heady, E. O. (1954). Simplified Presentation and Logical Aspects of Linear Programming Technique. Journal of Farm Economics. 36:1035 (1954).

[7] Glen, J. (1987). Mathematical Models in Farm Planning: A Survey. Operations Research.35: 641-666

[8] Ignizio, J.. (1976). Goal Programming and Extensions, Lexington, MA: Lexington Books

[9] E. B. Kenneth and E. T. Bartlett.. Resource al1ocation through Goal programming, Journal of range management (1995), 28(6).

[10] B.C. Premchandra. Quantity discounts decision under conditions of multiple items, multiple suppliers and resource limitation. International Journal of Production Research (1993), 29(10): pp. 1953 - 1961

[11] C. Anderle, M. Fedrizzi and S. Giove, Fuzzy multiple objective programming techniques in modeling forest planning (1994) . Department of Computer Science, Eotvos Lorand University

[12] Ertugrul et al. (2002) Product planning in quality function deployment using a combined analytic network process and goal programming approach E.Ertugrul Karsak' , Sevin Sozer, S.Emre Alptekin , Computers & Industrial Engineering, Volume 44, Issue 1, January 2003, Pages 171–190

[13] Taylor et al. (2003) Aggregate production planning — a multiple objective approach Journal of Statistics and Management Systems Volume 12, Issue 2, (2009)

[14] Adeiobi, AO.; Kormawa, P.M.; Manyong, W.M.; Olayerni, J.. (2003). Optimal crop combinations under limited resource conditions: Application of linear Goal programming model to smallholder farmers in the driver Savannah zone of Nigeria. Department of Agricultural Economics, University of Ibadan, Nigeria.

[15] D. Latinopoulos, Y. Mylopoulos; Optimal Allocation of landand water resources in irrigated agriculture by means of Goal Programming, Application in Loudias River basin.Global NEST Journal, Vol 7, No 3, pp 264-273, 2005

[16] D. Barnett, B. Blake and B. A. Mc Carl. Goal programming via multidimensional scaling applied to Senegalese subsistence farms. Int. J. of Advanced Manufacturing Technology (2006), 20(4): pp. 1-10.

[17] Nhantumbo, I; Kowero, G., 2001). A Goal Programming Model for Planning Management of Miombo Woodlands. Modelling Methods for Policy Analysis in Miombo Woodlands: Occasional Paper No. 35: 3-15.

[18] L. Muñoz-Moro, A. Ramos ; IEEE Transactions on Power Systems. Volume: 14 Number: 3 Pages: 1021-1027. August (1999), Goal programming approach to maintenance scheduling of generating units in large scale power systems

[19] Partangel, N. (1999). The Relationship Between Process and Manufacturing Plant Performance: A Goal Programming Data Envelopement Analysis Approach. MSc. Thesis. Virginia Polytechnic Institute, Virginia

[20] Hultz, J.W., D.D. Klingman, G.T. Ross and R.M. Soland, (1981) "An Interactive Computer System for Multicriteria Facility Location", Computers and O.R. 8, 249—261

[21] Fortenberry, J..; Mitra, A. (1986). A multiple criteria approach to the locationallocation problem. Comp. Ind. Eng. 10: 77-87.

[22] Krukanont, P; Prasertsan, S. (2004). Geographical distribution of biomass and potential sites of rubber wood fired power plants in Southern Thailand. Biomass and Bioenergy. 261*: 4759.*

[23] Field et al. (1980) Field, R.C, Dress, P.E and Fortson, J.C (1980). Complementary Linear and Goal Programming procedures for Timber Harvest Scheduling, Forest Science. 26: 121 – 133

[24] Kornbluth, J. (1973). A Survey of Goal Programming. Omega, The Int. J. of Mgmt. Sci. 12): 193205

[25] Shim and Siegal (1980) , Sensitivity anylysis of goal programming with pre- emption . International Journal of Systems Science / abstract content. Volume 11, Issue 4.

[26] Romero, (1986) A survey of generalized goal programming 1970-1982. Europian Jouenal of Operational research 25. 183-191. (1986)

[27] Ghosh, D.; Pal, B..; Basu, M. (1993). Determination of optimal land allocation in agricultural planning through goal programming with penalty functions. OPSEARCH. 301: 15-34.

[28] Ghosh, D.; Pal, B..; Basu, M. (1995). Determination of optimal solution for a MCDM model in agriculture planning: A strategy. International journal of Management and System. *112): 267-283.*

[29] Ghosh, D., Sharma, Dinesh K. and Mattison, D. (2005), "Goal Programming Formulation in Nutrient Management for Rice Production," International Journal of Production Economics, Vol. 95, No. 1, pp. 1-7.

[30] Rehman and Romero, (1984, 1987) Goal Programming with penalty functions and livestock ration formula. Agricultural systems. 23 (1987) 117 - 132

[31] Minguez, et al (1988), Determining optimum fertilizer combinations through Goal Programming with penalty functions . An application to sugar beet in Spain. Journal of Opertional Society, 39, 61 -70, [A,H,IV]

[32] Vivekandan et al. (2009)Trophic level of fishes occurring along the Indian coast, J. Mar. Biol. Ass. India, 51 (1) : 44 - 51, January - June 2009.

[33] Alade, J..; Sharma, D..; Sharma, J.. (1998). A Multi-objective model for and Business Review. 12): 23-41.

[34] Jafari, H.; Koshteli, Q..; Khabiri, B. (2008). An Optimal Model Using Goal Programming For Rice Farm. Applied Mathematical Science. 223): 1131 - 1136.

[35] Diaze-Balteiro and Romero (2003) Diaz-Balteiro L., Romero C., 2003. Forest management optimisation models when carbon captured is considered: a goal programming approach. Forest Ecology and Management 174: 447-457.

[36] B. M. Wheeler and J. R. M. Russell Goal Programming and Agricultural Planning Operational Research Quarterly (1970-1977)Vol. 28, No. 1, Part 1 (1977), pp. 21-32

[37] D. B. Field. Goal Programming for Forest Management, Forest Science (1973), 19(2): pp. 125-135.

[38] K. Rustagi. Forest Management Planning for Timber Production: A Goal Programming Approach (1973), Yale University.

[39] [39] Gomez, T; Hernandez, M.; Leon, M.; Caballeroa, R. (2006). A forest planning problem solved via a linear fractional goal programming model. Forest Ecology and Management. 227: 7988.

[40] Andres Weintraub et al. (2001) Handbook of Operations Research in Natural Resources By Andres Weintraub, Jaime P. Miranda, Carlos Romero, Trond Bjørndal, Rafael Epstein .

[41] Alireza Karbasi et al. (2012) [18] E. F. Bell. Goal Programming for Land Use Planning. USDA Forest

[42] Lee,S.M. (1972). Goal Programming for Decision Analysis. Aurbach, Philadelpia.

[43]Nijkamp and Spronk 1977… Goal programming for decision-making: an overview and a discussion Erasmus universiteit

[44] Shaik Md. Yousuf Hossain [1] and E.W. (Ted) Robak A Forest Management Process to Incorporate Multiple Objectives: a Framework for Systematic Public Input Forests :(2010), 1, 99-113; doi:10.3390/f1030099 www.mdpi.com/journals/forests