Linear Multi-Objective Modelling for Comprehensive Regional Agricultural Schemes in Crete Island, Greece

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Introduction

Agricultural development is undertaken to satisfy a number of socio-economic objectives, considering scarce agricultural resources. These objectives include maximizing business profitability, employment stability and increasing production, and others such as environmental stability [1]. The efficient use of these resources and the ability to evaluate the possible impacts of different agricultural policies are important to those responsible for policy in the agricultural sector [2]. A feasible development plan should consider all regional objectives, although these usually conflict, and the determination of policies to handle such problems is complex. Multiple objective mathematical programming models is one way of considering multiple objectives explicitly and simultaneously in a mathematical programming framework [3]. In this study, a multi-objective linear programming model was formulated whose general objective was to analyze the structure of the main agricultural regions in Crete Island.

Material and Methods

Study area description. The main occupation of the inhabitants of Crete Island is agriculture; 70% of the inhabitants are farmers; basic farming production in Crete Island - olives and vineyards [4].

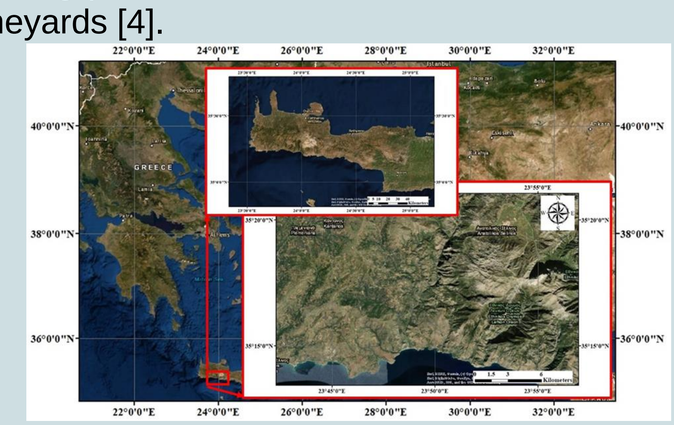

Figure 1. Location of the study farming area.

Designated Cooperative and Resources The PEZA Cooperative: started with 700 farm families; established in 1933 and today is an industrial group with modern equipment and technique that deals with 85% of the agricultural products of the 3,000 families in the cooperative, marketing them domestically and internationally.

Methodological Framework The model was designed for a typical agricultural year on Crete Island after de Almeida et al. [5]. To implement the model, four three-month periods are considered in the agricultural year, period 1: September - November; period 2: December February; period 3: March - May and period 4: June August.

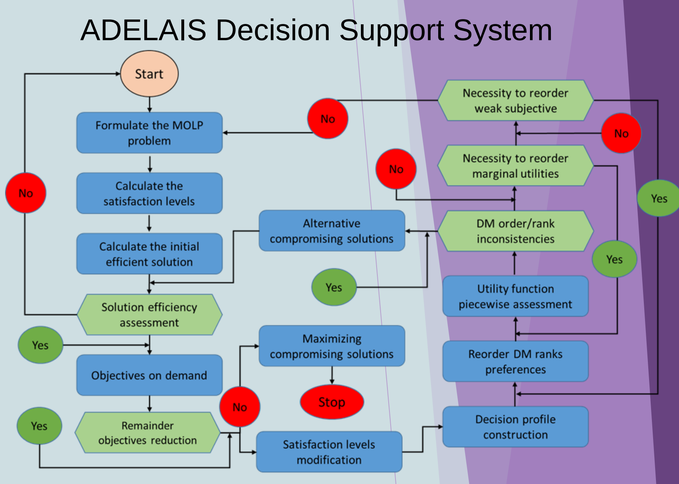

Figure 2. Schematic flowchart of the adopted methodology. The tool used for this was the ADELAIS multi-objective linear programming software, a system that fits the requirements since it guarantees a compromise between conflicting objectives.

Results and Discussion

Table 1. Upper and lower limits, compromise values and satisfaction levels for the five objectives determined in the final iteration.

	Seasonal labor	Employment	Gross margin	Machinery hours	Forage production
Upper bound	28852.190	77712.520	994.703	46376.000	12159.680
Compromise	52439.730	70026.945	898.745	54817.902	6894.226
Satisfaction level	64233.500	59372.000	861.671	59038.871	6656.995
Lower bound	134996.094	59372.000	715.096	59038.871	2625.000
Rate of closeness to the ideal value	77.8%	58.1%	65.7%	33.3%	44.8%

Compromises between the five objectives provided by the ADELAIS system guarantee a significant level of gross margin and employment with acceptable values for machinery hours and forage production, shown by the rates of closeness to the ideal values.

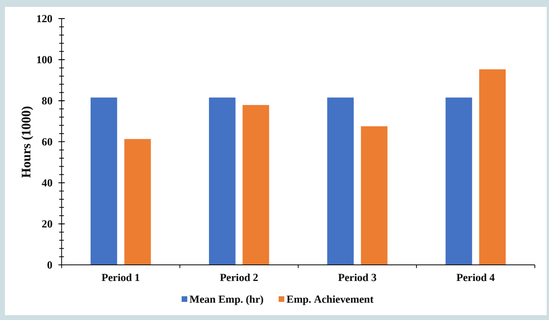

Figure 3. Employment achievement in each period determined in the final iteration. As the difference between total employment by period and the mean value is ideally null, only in the final period (Jun-Aug) is there over-achievement of employment, whereas in the other periods, the goals are achieved, because the harvest of both almonds and pistachios occurs in this period [6].

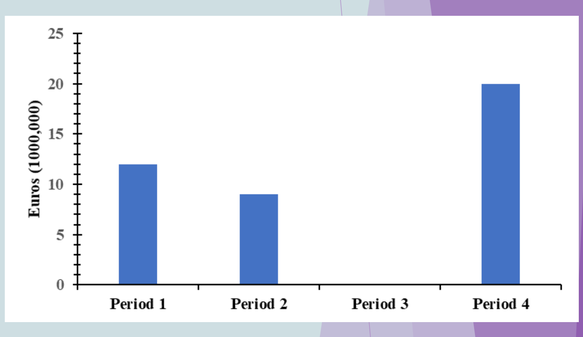

Figure 4. Possible cash surplus in each period generated by the model. Only in Period 3 (March-May), is there no surplus of capital since many activities occur.

Table 2. Tree crop areas proposed by the model compared with current use (ha).

Trees	Current	Suggested
Olive	3784	3784
Almond	1088	1088
Apricot *	52	0
Pistachio	35	185
Apple *	56	0
Almond + Olive	2384	2384
Pomegranate *	12	0
Table Olive *	100	133
Oil Olive *	153	250

* irrigated

Table 3. Area of forage selected by the model (ha).

Forage	Current	Suggested
Lucern	75	105
Vetch + Oats	191	127
Sorghum	100	0
Green Barley	39	6

The elimination of apple trees was an unexpected result which occurred because this trees has been introduced recently and is not yet in full production thus the model saw it as a high cost activity [7]. This is not the case for almond and unirrigated olive trees, whose acreages should be maintained because of the restricted amount of land made available by the DM [7]. The area of land allocated to lucern, vetch and oats should be increased and this increase must come by decreasing green barley, essentially because of the scarcity of land allocated for forage [8].

Conclusions

- ✓ The system furnishes the decision making with information for a better understanding of the decision making process; in this case, the application shows that:
  - ❖ Employment and business profitability are almost complementary; the high level of employment gives the maximum gross margin and vice versa;
  - ❖ Maximum employment is compatible only with increased seasonal labor and machinery-hours;
  - ❖ Minimum use of machinery hours can achieve only a low level of forage production and gross margin.
- ✓ The interactive multiple objective programming technique can help to decide feasible development policies within given socio-economic conditions.
- ✓ A policy of minimum seasonal employment is possible only at a high cost of added value and at a low level of table grape production.

References

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