Abstract

The thesis is concerned with the overall decision making process involved in the importing of Portugal's maize and sorghum requirements by a Government agency. Although based on this particular problem, the research provides a general framework for formulating and modelling problems associated with the planning and control of commodity import operations at a national level.

The emphasis is on the design of an integrated set of models in which

(i) the decision problem facing the Government agency is adequately set in the context of a wider Government planning process;

(ii) the solutions of the different aspects of the problem are combined to form a consistent overall decision policy;

The models described in the thesis cover all the most significant aspects of the planning and control problem facing the Government agency, namely:

(i) the specification of the amounts of maize and sorghum imports required, according to their prices on the international markets;

(ii) the definition of a delivery-inventory policy, stating the size of the feed grain shipments and the timing of their planned arrivals at the Portuguese ports; and

(iii) the derivation of a purchasing policy stating how and when those shipments should be bought.

Following the analysis of the demand for and supply of feed grains in the country, the animal feed industry is singled out as the major feed grain user. The process of substitution between maize, sorghum and the other raw materials used by that industry is initially analysed using "static" linear programming model in which all prices of the imported raw materials are assumed to be independent of the amounts imported. Economies of scale in the delivery-inventory operations of maize and sorghum are later incorporated in the static import mix model. This makes the model become non-linear. It is solved by a piecewise linear approximation. Two further extensions of the import mix model are considered:

(i) the model is made adaptive to the dynamics of the planning situation; and

(ii) a measure of the risks associated with the raw materials' unknown future price changes is incorporated in the model (a more general quadratic programming formulation is considered, but is found unnecessary in the context of the particular problem analysed).

The delivery-inventory operations of maize and sorghum are modelled jointly with those of other raw materials which share common unloading and storage facilities at the Portuguese port terminals. The modelling of these operations is preceded by an analysis of two important aspects of the sea transport operations: the uncertainty of vessels' arrivals and the shipping cost structure. The results of this analysis are incorporated into a simulation-optimization model which yields near-optimal delivery-inventory policies for all raw materials. By combining simulation (used as a means to evaluate policies)
with a direct search technique (used to select the best policy) the model succeeds in representing adequately a highly complex problem, whilst keeping the computational effort within acceptable limits.

The final aspect of the problem analysed in the thesis concerns the feed grains purchasing operations. Firstly a purchasing operating doctrine is selected, where the purchasing of maize 'futures' contracts is shown to be the central issue. Short and medium-term forecasting models are then reviewed and applied to the maize 'futures' prices. This is followed by an analysis of the buying decisions: new models are proposed to derive both short and medium-term buying policies.