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1-57

A NOTE ON THE APPLICATION OF LINEAR PROGRAMMING BY AGRICULTURAL ECONOMICS DEPARTMENTS OF LAND GRANT COLLEGES

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Linear programming has for a long time been, and to some extent still is, a technique which has been viewed by many with considerable suspicion and extensive doubts about its usefulness and "length of life." But a recent survey[1] has shown that linear programming has seemingly found a permanent place among the prominent methods used in solving research, management and extension problems in agricultural economics. In 1960, almost all agricultural economics departments at land grant colleges employed linear programming as a technique in some of their research projects. The majority of departments also made efforts to teach the technique to its students, either in especially designed courses or in courses the prime objective of which was other than teaching linear programming. About 30 per cent of the departments used, or plan to use, linear programming in extension. (Table 1)

Comments by those who use linear programming do not give the impression that linear programming is used for its own sake. Rather, the problems appear to be conceived and defined before the use of linear programming is decided upon. Also, limitations of the linear programming approach are recognized.

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[1] In May, 1960, questionnaires were sent to all agricultural economics departments at land grant colleges. Forty-seven completed questionnaires were returned.

Table 1. Application of Linear Programming in Agricultural Economics Departments of 47 Land Grant Colleges, 1960

How linear programming is utilized.	Per cent of reporting departments
Linear programming is used in research	87
Linear programming is used in extension	30[1/]
Linear programming is planned to be used in extension	15
Linear programming is taught	92
(a) in a course specifically designed for it	26
(b) as part of a course the prime objective of which is other than teaching linear programming	66

1/ This figure likely understates the usefulness of linear programming to extension work, since the results and insights about existing relationships as portrayed by the linear programming model undoubtedly are utilized in extension work, although the technique as such is neither studied nor applied explicitly to a particular extension problem.

This survey pointed out that there are basically two types of felt limitations. One is the lack of availability of sufficiently detailed and suitable input-output data, and the second is the difficulty of constructing a linear programming model which realistically represents relevant relationships and alternatives. [2] Interestingly enough, the first limitation, namely the lack of availability of suitable data, was most strongly, as a matter of fact almost exclusively, felt to be a serious limitation to the general applicability of linear programming by those departments who had most recently undertaken research with linear programming as a research tool. And, in turn, these departments tended to consider the highlighting of the deficiency in technical data a contribution by linear programming. Those departments (or more specifically individuals), usually at larger universities, who have worked with linear programming for a number of years, have presumably made up the deficiency in technical data and are now concerned with the second limitation mentioned above, namely that of constructing programming models which realistically represent relevant relationships and alternatives.

Attempts to adapt and expand models to empirical conditions of the problem are being made, but these attempts are relatively few and good results are even scarcer (Table 2). This should not be surprising, since these models tend to become large rapidly, the mathematics becomes involved, and although answers can be obtained, the reasons for a particular answer are difficult to explain. The latter difficulty represents a considerable loss of information relative to the standard linear programming model, where the relationships which brought about a particular solution could easily be followed and the information thus gained was frequently of more value than the solution itself.

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[2] Available computer facilities or computing costs were not considered a serious limitation.

Table 2. Modifications of the Standard Model Which are Employed in Agricultural Economics Departments of 47 Land Grant Colleges, 1960

Type of model	Number of departments employing the model
Transportation	17
Variable price programming	10
Dynamic programming	9
Variable resource programming	6
General equilibrium model	3
Other 1/	5

1/ Reactive programming, integer programming, non-linear programming, convex programming, stochastic programming.

In connection with model adaptation to empirical conditions it is interesting to note that the application of linear programming has primarily occurred in the field of farm management (Table 3), i.e., in a field where it would seem more difficult to adapt models than in much of agricultural marketing as generally defined. This may be due to the fact that marketing firms tend to do their own programming and/or because the pioneer applications of linear programming in agricultural economics were made by individuals whose primary interest was in farm management and agricultural production economics.

While 41 departments replied they used linear programming in research work in 1960, as many as 43 indicated that they taught the technique of linear programming to their students (Table 4). This is undoubtedly one of the reasons why much of the research where linear programming is employed is now carried out by M.S. candidates, while this was formerly (before about 1958) almost exclusively the domain of Ph.D. candidates or accomplished researchers.[3] However, the fact that the generally used standard model has been tested to the extent that it can be applied to many problems in an almost routine like fashion must not lead to the conclusion that the linear programming technique has now been mastered. This survey indicates that most researchers believe that the standard model should be altered in order to be usable for a variety of problems. But the researchers are at the same time concerned about the rapid increase in complexity of the model thus modified.

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[3] See Erwin M. Reisch and Ludwig M. Eisgruber, Bibliography of Linear Programming and its Application to Agricultural Economics Problems (September, 1960), Mimeo, Department of Agricultural Economics, Purdue University, 1960.

Table 3. Subject Matter Areas of Application of Linear Programming in Agricultural Economics Departments of 47 Land Grant Colleges, 1960

Subject matter area	Per cent of reporting departments
Farm Management	85
Agricultural Marketing	51
Agricultural production economics	13
Agricultural policy	9
Consumer economics	4
Other 1/	17

1/ Aggregate supply studies, agricultural business management, inter-regional competition, area adjustment, coal mining.

Table 4. Years of Incorporation of the Linear Programming Technique Into Various Programs of Agricultural Economics Departments of 47 Land Grant Colleges.

Year	Number of departments which in a specified year began to:			
	Teach Linear programming--		Use linear programming in research	Use linear programming in extension
	in a specially designed course	as part of another course		
1950	-	-	1	-
1951	-	-	-	-
1952	-	1	2	-
1953	-	1	3	-
1954	2	2	7	1
1955	1	4	3	2
1956	2	5	6	2
1957	4	4	4	1
1958	3	1	6	2
1959	-	4	7	4
1960	-	5	2	2
No date stated	-	4	-	-
Total	12	31	41	14