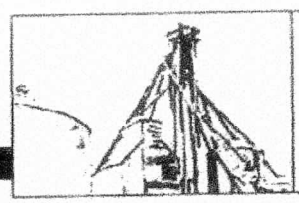
Mill Market



INFORMATION FOR FEED/GRAIN HANDLERS

'Least-cost' method grew as computers shrank

Economist, multi-room mainframe blazed the trail

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Special to Feedstuffs

High-speed personal computers with substantial capacity have caused feed manufacturers worldwide to adopt the automatic calculation of minimum-cost feed mixing. The basic mathematical technique remains the same as that introduced in 1955 by agricultural economist Earl R. Swanson of the University of Illinois.

In an article in *Feeds Illustrated*[1] published in 1955, Swanson illustrated the technique, called "linear programming," by calculating the minimum-cost set of ingredients for a swine supplement, using the university's mainframe vacuum-tube computer called Illiac.

At that time, Illiac was the only large-scale, high-speed digital computer built by a university. The computer occupied several rooms in a building on the engineering campus. Swanson predicted that the method of linear programming would eventually be used by feed manufacturers to solve the problem of selecting ingredients and combining them in a way that costs would be minimized and product quality maintained.

The widespread adoption of the method by feed manufacturers over the intervening 40-plus years was gradual. In June 1956, a year after publication of the article, at least two major feed manufacturers (General Mills and Quaker Oats) reported that they were investigating the use of electronic computers in their application of linear programming to feed formulation.

George H. Kyd, Ralston Purina, commented at the time that the Swanson article was reviewed with "considerable interest" by the company. "There isn't much question that formulation has become so complex that a speedier way of computation is desirable."

However, some skepticism remained. In 1960, Dale Batz, director of research for Illinois Farm Supply, expressed some doubt.

"I believe that it is safe to say that our experience with linear programming thus far leads us to question whether widespread use of the technique would be economically feasible for our company," Batz said. "Perhaps the advent and use of smaller computers will bring the cost down to where we can afford to do more."

He was correct. Illiac was a 3,000-vacuum-tube electronic mainframe with a "memory," or storage space, for only 1,024 numbers. However, in 1955, it seemed that Illiac performed mathematical operations at an amazing rate of speed. It took about 10 minutes to solve the problem of selecting minimum-cost ingredients for the 35% protein swine supplement that was used to illustrate the technique in Swanson's article. The formulation problem had 16 nutrient requirements and 20 potential ingredients, nearly reaching the limit of Illiac's memory.

Swanson, now retired, hadn't worked on feed formulation problems since the mid-1950s but recently addressed the swine-supplement problem again, this time with a modern personal computer, using the well-known MIXIT-WIN program. Of course, chips have now replaced vacuum tubes and memory has increased dramatically. Still, Swanson discovered that animal nutrition has become a lot more complex since 1955. The program automatically provides space to enter a very large number of rations and the nutrient content of an almost unlimited number of ingredients. The program has a list of ingredients with their ingredient contents, which can be altered. Swanson found that many "new" nutrient properties have been added. They include energy, amino acids, fatty acids and trace minerals — absent in the feed-mix requirements 40-plus years ago. Some refinements of the older nutrients appeared, too. In addition, there are other features, such as the daily nutrient quantities required. Some modern formulations include more than 50 required nutrients or additives that may be supplied by more than 50 ingredients in a single formula.

The trend toward formulating complete rations rather than protein supplements to be fed with grain has been apparent. Thus, the scope and importance of linear programming was increased by the shift to total rations in feed formulation. Modern feed formulation programs for computers include an extension of the linear programming technique called "sensitivity analysis" that shows the price ranges of ingredients necessary to keep in the solution, the opportunity prices of ingredients not in the solution and the "cost," or expense, associated with each minimum or maximum restriction that is placed on individual ingredients and nutrients.

Dr. Earl Swanson holds the computer tape in 1955 with the original Illiac computer in the background. Swanson is reading the tape, which preceeded computer cards, to George Maxwell, then another staff member at the University of Illinois.

The solution to the minimum-cost swine supplement appearing in Swanson's 1955 article was reproduced, together with the added sensitivity analysis, with MIXIT-WIN. That is roughly 200-300 times faster than solving the same problem with the old Illiac. The speed of the modern computer also invited experimentation.

For example, if the minimum protein requirement is changed from 35 to 35.5%, a solution is provided almost instantaneously.

Even though modern linear programming software has more bells and whistles than the early program used by Swanson on the Illiac, the basic logic is the same: In mathematical terms, it is the minimization of a linear-cost equation subject to a set of linear inequalities. The advent of relatively inexpensive, high-speed personal computers with large capacity has been the driving force behind the present use of linear programming by nutritionists and feed manufacturers.

REFERENCE

1. Swanson, Early R. "Fixing Feed Formulas to Produce Minimum Cost Mix — A Fast Operation as Done by Illiac, *Feeds Illustrated*, May 1955, pp. 15-18. ■

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