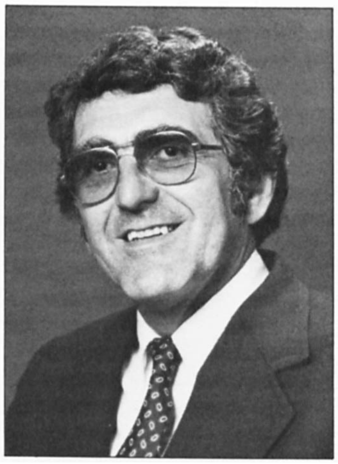

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Applied mathematics in agricultural research

During a recent review of California's Integrated Pest Management Project, I was struck by the mathematical basis of the program. Not only were mathematical models being used to describe the order of events in a cropping system, but these models were also being used to scrutinize each of these events.

Entomologists, plant pathologists, agronomists, and mathematicians were using a common language — the language of applied mathematics.

It has been almost impossible to integrate all the factors that must be considered in determining the appropriateness of a pesticide application to a growing crop or the optimum timing of an irrigation. Few growers have the time or the information to evaluate evapotranspiration, soil structure, wind velocity, relative humidity, water quality, soil moisture content, cost of water, value of the crop, and other factors in establishing an irrigation system. Few scientists have had the time, training, or resources to study the interaction of the life cycle of a thrip, the growth flush of a citrus tree, the cover crop of an orchard, the irrigation schedule, and the impact on other insects, diseases, and beneficial organisms while doing research on the control of one pest. It just wasn't feasible to study and attempt to isolate every variable.

Applied mathematics, and of course the availability of computers, has created a new breed of scientist and has brought us to a thrilling new frontier in science for agriculture. It is now both possible and practical for teams of scientists to bring together the many variables into one model and to predict not only the severity and timing of pest problems, but also the optimum control strategy. In most cases, this will make possible a substantial reduction in amounts of chemical agents needed to control pests.

We are only at the beginning. The problems of production, marketing, and policy issues related to agriculture will demand increasingly complex mathematical modeling. I wonder if the students who are preparing to be tomorrow's scientists will be ready for the challenge.

John Greenberg and Judith Goodstein, writing in Science magazine, recently discussed Theodore von Kármán, famed director of the Graduate School of Aeronautics at California Institute of Technology, and his role in fostering the more effective use of applied mathematics in America. They described the reluctance of American engineering students to learn and understand mathematics. Both von Kármán, and Timoshenko complained over fifty years ago that American engineers only wanted the final results: a formula that could be applied mechanically to solve practical problems. Engineering educators apparently viewed calculus courses as mere "cultural embellishments to the curriculum."

Much of what Greenberg and Goodstein said about applied mathematics and engineering seems to be just as appropriate in the application of science to agricultural problems today. It is not enough to simply take a formula and apply it to agriculture. There must be a basic understanding of the ingredients in the formula — how it was derived, how it works, why it works, why it may sometimes not work. The scientist and the mathematician, in some cases, must be the same person or at least be able to interact and communicate.

I don't know how many departments of biological sciences require a strong background in mathematics for the bachelor's degree today, or how many graduate students in plant pathology, entomology, agronomy, or plant physiology must have some level of applied mathematics, but I would wager that the number is small and that many of these students will be ill-prepared to deal with the mathematical application of their science.

Science for agriculture has just experienced several decades of individualism in research. Through it we have developed a tremendous library of tactical knowledge. Now we are in an era of integrating the results of these individual scientific efforts into a comprehensive program. I believe the language of that integration will be applied mathematics.