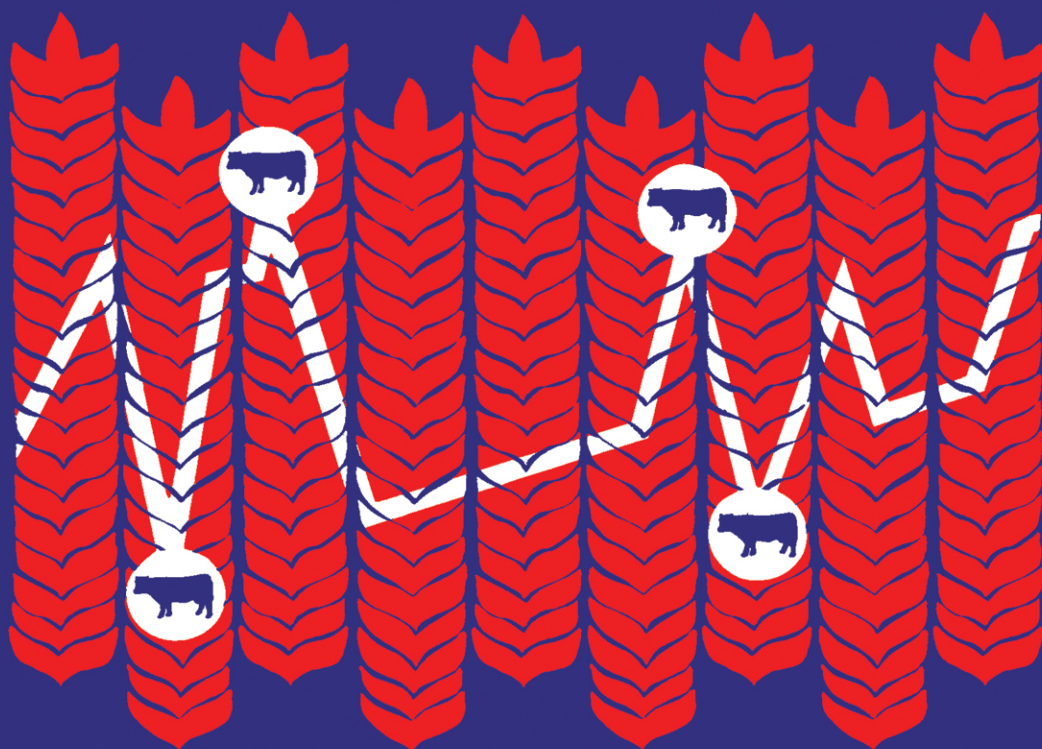


The Analysis of Response in Crop and Livestock Production

Third Edition

John L. Dillon and Jock R. Anderson



Pergamon Press

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The Analysis of Response in Crop and Livestock Production

THIRD EDITION

by

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and

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both at the
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TO

RITA, MIKE, CAS, MATT, SUE, ROSIE,
MARTIN, JOHN, TIM AND DOM

AS WELL AS
LIBBY, JULIE AND DIANNE

“No aphorism is more frequently repeated in connection with field trials, than that we must ask Nature few questions, or, ideally one question at a time. The writer is convinced that this view is wholly mistaken. Nature, he suggests, will best respond to a logical and carefully thought out questionnaire, indeed, if we ask her a single question, she will often refuse to answer until some other topic has been discussed.”

R. A. FISHER (1926)

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Preface to Third Edition

DESPITE a variety of revisions and the addition of much new material, the purpose of this little text remains unchanged. As with the first and second editions, its aim is to provide an introductory outline of the analytical principles involved in appraising the efficiency of crop-fertilizer and livestock-feed response.

As well as a variety of minor revisions, a number of major additions have been included in this third edition. These relate to the principles of modelling (Chapter 1), the concept of economic duality as pertinent to response processes (Chapter 4), the appraisal of aggregate response (Chapter 9) and the economics of response research (Chapter 10). As in previous editions, the temptation of attempting to cover all the refinements to response analysis discussed in the journal literature has been avoided so as to maintain the text's introductory nature. The relevant literature, however, has been extensively surveyed and referenced. Of these references, three monographs stand out as being of particular relevance—Frisch's *Theory of Production* for its thoroughgoing theoretical development of both the technical and economic aspects of production, Heady and Dillon's *Agricultural Production Functions* for its empirical orientation to crop and livestock response analysis and Chambers's *Applied Production Analysis: A Dual Approach* for its sympathetic treatment of duality theory.

As a primer on response analysis, it is hoped the present text will help fill the gap in providing students of both agricultural science and economics with a simple but formal exposition of the why, how and wherefore of the principles of crop and livestock response analysis, thereby helping to further co-operative effort among biological and economic researchers. This is not to say that the principles enunciated here are thought of as all-important in the real world. To some extent they are no more than ideals unlikely of achievement. This must be so, given the uncertainties that exist in the real world and the fact that crop and livestock response processes are generally embedded in larger response systems—both biological and economic—whose ramifications are not irrelevant. None the less, it is hoped this introduction will provide some of the know-how needed in establishing the massive programme of crop and livestock response analysis required if countries are to obtain full benefit from their agricultural resources.

Worldwide, the “easy” gains of the Green Revolution associated with modern cultivars, increased fertilizer use and enhanced irrigation have already been achieved. “Second-generation” gains will depend on better (i.e. more efficient) crop and livestock management. The more efficient a country’s agriculture is, the better fed its people can be; and the more resources there can be available to satisfy people’s needs and aspirations beyond the essentials of food and fibre. Therein lies the crucial importance of agricultural science. By manipulating crop and livestock response phenomena so that they better serve society’s needs, the scientist can ensure both the more efficient production of food and the release of resources needed for non-agricultural development.

For stimulus in preparing this third edition, as well as to our students and as evidenced by the references cited, we are grateful to our colleagues worldwide. Our thanks are also due to George Battese for some critical assistance and to Elizabeth Freyman and Diane Mitchell for manuscript preparation.

Armidale, Australia

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JOCK R. ANDERSON

CHAPTER 1

Modelling Response Processes

1.1 Philosophy

Any THEORY[†] is just a set of simplified assumptions about how reality behaves. The usefulness and test of a theory lies in its ability to predict. So long as it predicts adequately, a simple theory is to be preferred to a complex one. Since theories can be disproved but never proved, they should be continuously tested and replaced by better ones as they become available.

This thought pervades this book. To describe it as a philosophy may be a little pretentious, but certainly the essence of our approach to modelling response processes is simplification of representation, simplicity in manipulating the relationships invoked, and simple interpretation of response analysis. Such essence is, of course, in no way unique to response analysis, as it is properly involved in all modelling.

Different modellers naturally differ in what they regard as an appropriate degree of simplification or of its complement, refinement. Our own preferences, for example with regard to simple algebraic forms and use of the differential calculus, will soon become evident. Other authors, just as defensibly and sometimes more workably, will opt for linear algebra and mathematical programming methods as their primary tools in response work. Clearly, elements of subjectivity, not to mention considerable artistic judgement, can and indeed must be involved in response analysis.

1.2 Types of Models

There seem to be almost as many schemes for classifying models as there are modellers themselves. Some highlight primarily the purpose, such as normative versus descriptive, where the main emphasis is deductive and inductive, respectively (Headley and Carlson, 1963; Anderson, 1979)[‡].

[†] Throughout, when an important technical term is introduced for the first time, it is printed in SMALL CAPITALS with, where necessary, an immediate definition or explanation of the term.

[‡] References are listed alphabetically by author at the end of the volume.