The Role of Hatch Funds in the Development and Running of the Cornell University Biometrics Unit

by

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I. Introduction

The Biometrics Unit at Cornell University was established in 1947 and was placed in the Department of Plant Breeding for its academic home. The first personnel hired for the Unit was in August 1948, when W. T. Federer was appointed along with a secretary and a biometrician. The second Faculty appointment was made in September 1952, when Robert G. D. Steel was appointed. Douglas S. Robson joined the Biometrics Unit in August 1949 as a Biometrician and was appointed to the third Faculty position in 1955. The first Hatch funds obtained were in 1955 when Gus Guterman, Director of the Experiment Station, College of Agriculture, provided funds for the third Faculty position. In 1956, the Research and Marketing 9B1 and 9B2 funds project 68, awarded in 1955, was replaced by Hatch Amended 125-1 funds (see Table 1). These funds were provided to support the research of the Faculty of the Biometrics Unit. Since 1956, Hatch funds have been allocated to the Biometrics Unit to support on-going and new research projects as described in Table 1.

Two of the first Hatch projects are discussed in some detail below. A fuller description of the work performed on these and the remainder of the projects may be found in the Annual Reports of the Biometrics Unit. Few comments are made about the latter group in Section IV. Some comments are given on the usefulness and effectiveness of Hatch funds in stimulating, facilitating, and supporting research efforts.

Since there are various definitions and concepts of what constitutes the subjects of Statistics and Biometry, the definitions utilized herein are given below for purposes of clarity.

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Biometry is the study, development, and application of procedures and techniques in computer science, mathematics, operations research, probability, statistics, and systems analysis for *biological* investigations and phenomena (see, e.g., Federer, 1984a).

Statistics is the study, development, and application of procedures and technique related to i) statistical design aspects of *planning* investigations. (Statistical design has many aspects and is discussed in Federer, 1984b.), ii) statistical aspects of summarizing data from investigations, and iii) statistical aspects of making inductive inferences from i) and ii) to the populations for which the investigation is a random and/or representative sample.

Table 1. A List of Hatch Projects in the Biometrics Unit.

Project No. (Leaders)	Topics	Year Start	Year End
125 - 1, 424, 425 (Federer,Robson)	Quantitative genetics for haploid and diploid systems, and for primitive organisms	1956	1967
315 (Federer)	Design and analysis of experiments	1963	1967
424 (Robson)	Sampling, estimation, and mark-recapture procedures for fish and wildlife populations	1964	1967
401 (Staff)	Statistics and Biometry	1967	1978
402 (Wood)	Statistical analyses of assumed biological models	1975	1977
455 (Searle, Quaas)	Variance component estimation and application to animal breeding	1976	1979
463 (Robson, Georgi, Skalski)	Methods for validation of the removal-sampling technique for estimating population density	1977	1979
401 (Federer)	Statistical designs and analyses of mixed cropping systems and mixtures of compounds	1978	present
403 (Staff)	Statistics and Biometry	1978	present
405 (Schwager)	Statistical method for multivariate outliers	1980	1984
406 (McCulloch	Statistical investigations of correspondence analysis	1982	present
407 (Schwager)	Construction methods for orthogonal experiment designs	1984	present
402 (Casella)	Empirical Bayes data analysis in in agricultural problems	1986	present

II. Hatch Project on Quantitative Genetics

The first Hatch research funds obtained by the Biometrics Unit were for research on quantitative aspects of genetics and were awarded in 1956. This funding continued up until 1967. These funds sparked considerable research activity in the area of quantitative genetics. Thirty technical reports and 20 publications were prepared by Biometric Unit personnel during the 1956-1967 period. Quantitative aspects of haploid and diploid genetics and statistical aspects of genetic experiments on primitive organisms were studied.

Owing to this research activity, National Institutes of Health (NIH), National Science Foundation (NSF), and Office of Naval Research (ONR) Grants and a 10-year Career Development Award for D. S. Robson were obtained. These funds allowed for considerable expansion of research activities by providing for resident and visiting staff and graduate students. Secretarial (vital for preparation of technical reports and publishing papers) and computing support were also obtained from these funds. Biometrics Unit Faculty were able to obtain travel expenses to travel to other institutions to carry out joint research projects.

Funding after 1967 was not specifically for quantitative genetic research but fell under a general statistics research umbrella funded by NIH, NSF, and other monies. As a result, the research activity in this area decreased. In the 1968-1986 period, 16 technical reports and 8 publications were prepared by personnel of the Biometrics Unit. Although research interests have shifted over the years, some interest in quantitative genetics still persists as indicated by technical reports and published papers, one of the latter appeared in 1984 and a technical report was written in 1985.

To assess some of the scientific impact of publications on quantitative genetics and breeding, which were partially supported by Hatch funds, a search of Scientific Citations for the years 1974-86 indicated that 15 of the 30 publications were still being cited (see Table 2) some 7 to 22 years after publication. Since most articles are cited most frequently shortly after publication, the relevance of articles being cited many years after publication is noteworthy.

Table 2. Scientific citations by paper and period for 15 papers on which Federer, Robson, or Searle was author or co-author.

First author, year, volume, and page	Period				
	'74-'78	'78-'80	'81-'83	'84-'86	Total
Powers, L., 1963, V12, p. 393	1	1	0	0	2
Federer, W. T., 1963,	5	2	4	0	11
Jensen, N. F., 1964, V4, p. 641	3	3	5	7	18
Jensen, N. F., 1965, V5, p. 449	6	2	6	4	18
Federer, W. T., 1967, V55, p. 783	1	1	1	0	3
Papa, K. E., 1966, V21, p. 595	3	0	1	1	5
Papa, K. E., 1967, V22, p. 285	0	0	1	0	1
Federer, W. T., 1967, V37, p. 174	2	3	0	1	6
Robson, D. S., 1967, V17, p. 205	0	0	1	2	3
Searle, S. R., 1961, V17, p. 607	3	1	1	0	5
Searle, S. R., 1963, V46, p. 447	0	0	1	0	1
Searle, S. R., 1963, V18, p. 351	0	1	0	0	1
Searle, S. R., 1964, V47, p. 402	2	1	0	0	3
Searle, S. R., 1964, V47, p. 414	1	2	4	2	9
Searle, S. R., 1965, V21, p. 682	8	7	1	2	18
TOTAL	35	24	26	19	104

III. Hatch Project on the Design and Analysis of Experiments for Marketing and Agricultural Experiments

Experiment design and treatment design (see Federer, 1984b), have been and continue to be one of the main areas of research and interest of the author. Limited Hatch support was obtained in 1963 while substantial NIH funds were obtained from 1958 until August 1974. Owing to this funding, it was possible to support a large number of short term visitors. The group associated with these projects were very productive. To illustrate from the 26th Annual Report of the Biometrics Unit, page 42, 25 papers on treatment design and 28 papers on experimental design were published in the five year period 1970-1974. Three books were also published in the same period. Eighteen of the published papers appeared in the Annals of Mathematical Statistics. The remainder but two, appeared in other statistics publications.

Many classes of experiment design were constructed including lattice designs, augmented designs, incomplete block designs, row-column designs and sets of orthogonal latin squares, F-squares, and F-rectangles. The motivation for constructing a design in a class, most frequently came from a design problem that arose as a result of statistical consulting on a research investigation. (As an aside, the topics of most papers published by Biometrics Unit personnel came from consulting with a researcher.) When the problem is researched sufficiently to be published in a statistical journal, most investigators would not recognize it as a solution to their problem.

Considerable new theory on factorial designs and fractional replication in particular, has been obtained as a result of the NIH and Hatch funds allocated for this purpose. Many papers and a book on the subject have been published over the years. The reader is referred to the Annual Reports for a detailed discussion of the nature and scope of this research.

IV. Other Areas of Research Partially Supported by Hatch Funds.

In 1967, Hatch funds for the Biometrics Unit were consolidated under one project to support research in Statistics and Biometry with no specific area being specified. Research topics at that time were fishery and wildlife statistics, nonadditivity, linear model theory, variance component

estimation, medical statistics, sampling and estimation, hypothesis testing, regression theory, statistical computing, and other areas. Again, despite the relatively small amount of Hatch funds available, it was possible to branch out into new areas and continue on-going research in areas of interest to Biometrics Unit personnel.

As a result of research activity in an area under Project 401 (see Table 1), 1967-1978, specific research areas have been funded over the years. In 1975, a Hatch project on yield prediction equations for data collected from several sites and several predictor variables was initiated. Also, application of the Kolmogorov-Smirnov statistic to experimental data was investigated. In 1976, a Hatch project was funded to study new methods of estimating variance components and the application of results to animal breeding data. In 1977, a Hatch project was started to investigate methods of validating the removal-sampling technique for estimating population density. Removal-sampling is sometimes used to estimate population density when a direct census of an animal or parasite population cannot be made. In 1978, a Hatch project was initiated to study statistical designs and analyses for mixed cropping systems and mixtures of compounds. This research had been conducted sporadically since 1967 but the initiation of this project accelerated the efforts in this area. In previous studies on mixture experiments in statistical literature, most concentrated on determining the ratio of factors or compounds achieving a specific goal. In crop mixture experiments, the ratio is fixed and responses are often available for *each* factor in the mixture.

In 1980, studies were initiated under Hatch support monies to study statistical procedures for detecting and studying outliers in a multivariate situation. In 1982, a Hatch project was started to investigate various aspects of a statistical procedure known under the name of correspondence analysis. This procedure is related to work on inference for discrete distributions. In 1984, another Hatch project on experiment design was initiated to investigate various combinatorial aspects related to the construction of sets of pairwise mutually orthogonal latin squares, F-squares, and F-rectangles. These results will be useful for constructing new classes of experiment designs. The most recent Hatch project, started in 1986, is using empirical Bayes techniques to improve predictions of crop yield, and improve estimation for nonlinear growth curves.

V. Some Comments

Although Hatch funding has been relatively limited and variable in amount, these funds have been extremely useful as a stimulant and support source for statistical and biometrical research in the Biometrics Unit. The College of Agriculture and Life Sciences of Cornell University has been able to utilize these funds in many ways to stimulate and support the research activities of the Biometrics Unit. Secretarial and graduate student support and computing and travel monies have been vital for the research activities.

One innovation in awarding funds by the College Administration has been to provide research monies in the range of $3,000 to $5,000 per year for new faculty members just beginning their research careers. The philosophy has been that it is usually difficult for these individuals to obtain NSF, NIH, or other research funds until they have attained some professional stature. Also, they are freed from searching for funds and can devote this energy to research efforts. Owing to this support, there should be no financial reason from not obtaining the necessary research publications required for promotion from assistant to associate professorship. For the Biometrics Unit this type of support has been very effective and useful. Three individuals (C. L. Wood, S. J. Schwager, and C. E. McCulloch, see Table 1) have been supported in this manner over the years.

Another manner in which Hatch funds have been very useful has been in supporting research efforts in a new area in which funding agencies are not currently interested. An example of this is Hatch Project 401 on mixed cropping systems. Past and, for the most part, present interest of funding agencies is in the area of single crop experimentation. Even for mixed cropping systems, the emphasis is on the response for each crop separately. Methods of combining individual crop responses is not currently high on the priorities of funding agencies and it has not been possible to obtain funding for such research. There is now some funding for these studies in specific directions. As the need for studying mixed cropping systems for disease and insect control, for fertilizer replacement, for increased yields, for stability of yields over seasons, and for improving soil conditions becomes more apparent to funding agencies, research funds for studying mixtures of crops, of insecticides, of herbicides, and of cultural practices should become more available. Until then, such funds as Hatch are vital to support the research efforts.

Although the emphasis in this paper has been on the impact and usefulness of Hatch funds for the Biometrics Unit, it should be pointed out that the Biometrics Unit has had considerable impact on the agricultural, biological, social, educational, engineering, medical, and economic research of the College of Agriculture and Life Sciences, Veterinary, Nutrition, and Human Ecology, and other Cornell research associated units. Much of this research has been partially supported by Hatch funds. In the course of statistical consultations on research investigations, suggestions are made which increase the amount of information to be obtained and sometimes the direction of the proposed research. Also, during consultations, suggestions have been made which make the experiment feasible whereas under the original proposal the experiment was beyond the scope of available resources. For example, in a nutritional cancer mortality study conducted by Cornell University and Beijing University, a suggestion was made for pooling samples which reduced the number of laboratory analyses to four percent of that originally considered. This made analyses possible which would have been impossible under the original proposal. These contributions have been recognized by the Directors of Research in their willingness to provide financial support for the Biometrics Unit over the years. Also, providing Statistics courses suitable for graduate students in all fields has had a considerable impact on the planning and statistical analyses reported in their dissertations. This is especially true for the two Snedecor-Cochran type courses taught in the Biometrics Unit, viz., Statistics and Biometry 601 and 602. In summary, the statistical consulting and teaching efforts of the Biometric Unit has had a considerable effect on research publications from a number of colleges and research units at Cornell University.

VI. Literature Cited

Federer, W. T. (1984a) Cutting edges in biometry. Biometrics, 40, 827-839.

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