Agriculture and Behavioral Science: Emerging Orientations

Green Revolution experiences lead to changing views of technology, social organization, and agriculture.

William S. Saint and E. Walter Coward, Jr.

Increasing worldwide concern with the possibility of large-scale food shortages and concomitant recognition of the need to raise the standards of living of rural populations in developing countries have stimulated the investigation of ways to increase agricultural production and to improve systems of agricultural distribution. At the same time, it appears that future gains in world food production will occur primarily by raising productivity on currently tilled lands, rather than by bringing new land into production (*1*).

Efforts to increase productivity will depend for the most part on the success with which new agrotechnologies and appropriate organizational and institutional arrangements can be incorporated into systems of traditional agriculture, especially those in which small farmers predominate.

Recent experiences in agricultural development have highlighted human factor constraints in technology application and the importance of the income distribution effects of agricultural production. As a result, the influence that organizational and institutional factors exert on the agricultural development process has been increasingly recognized (*2–4*). With this awareness, there have been growing efforts to include behavioral scientists along with economists and agricultural scientists in multidisciplinary approaches to agricultural development in an attempt to understand these factors better (*5*). To date, the results of such endeavors have been mixed. However, the continued involvement of behavioral scientists is leading to the emergence of new orientations in the social science of agriculture. The purpose of this article is to trace briefly the involvement of behavioral scientists in agricultural development programs, and to sketch the emerging research orientations which may enhance the contributions that behavioral scientists make to agricultural development in the future.

The Existing Paradigm

The conceptual approach that a researcher chooses to guide research has direct implications for the assumptions made, the questions asked, the role played, and even the policies recommended at the conclusion of the research. For behavioral scientists working in agricultural development programs, the conceptual approach that has dominated their field and oriented much of their work in the past decade has been that of the adoption and diffusion of innovations. Much of the influence in this area has been provided by Rogers whose landmark text, *The Diffusion of Innovations*, first appeared in 1962 and summarized many of the earlier diffusion studies (*6*).

Diffusion of innovation research began essentially with the study of farmers' acceptance of hybrid corn seed in Iowa during the 1940's (*7*). Communication became the key variable in diffusion analysis, and the study of communication processes was deemed necessary for understanding agricultural modernization (*8*). From this perspective, development was most often viewed as the sum of many individually made decisions concerning the acceptance or rejection of innovations. Lack of information generally was assumed to be one of the major factors limiting modernization, and consequently, attempts were made to identify communication barriers which restricted the innovation diffusion process. Research questions accordingly tended to address the nature and characteristics of the innovation; the perceptions, values, and motivations that comprise the individual's decision-making framework; and the nature and characteristics of the adopter himself. Likewise, communication channels and local opinion leadership were identified in the effort to discover the most efficient means of reaching the target population. Recommendations ensuing from this approach generally concerned the most effective channels of communication, the types of persons most likely to be receptive, and construction of appropriate messages for compatibility with local culture, values, and aspirations. In most cases, these recommendations led to efforts to improve communication and were frequently made operational as increases in the quantity and quality of agricultural extension agents (*9*).

The assumptions made by researchers employing the diffusion perspective suffered inherent limitations. First, technology was assumed to be available and relevant. Practices that resulted in increased productivity under experimental conditions at a research station were frequently assumed to be applicable throughout the existing agricultural system. Likewise, the existence of the infrastructure necessary to support the innovation—that is, input markets, credit, transportation, and storage—was likely to be taken for granted. Second, the suitability of a particular technology for various types of farms or groups of farmers was normally not questioned, with the result that the possibility that, within certain social settings, technology may enhance rural welfare, while in others its impact may be detrimental was ignored (*10*). Third, the diffusionist focus on the role of individuals in the communication process usually placed considerations such as social structure and institutional influences in a secondary plane. The individual was seldom seen as belonging to a system, whether agricultural or social (*11*). Individual characteristics seldom came to be viewed as group patterns or structural features. Innovators may have possessed larger farms, but questions of land distribution were not pursued. Opinion leaders were included in the analysis only as communicators, and their possible sociopolitical roles in the community were not explored. The fact that innovators were consistently characterized as having more education, more resources, and more land failed to suggest that the innovator group may have been a rural elite attempting to

William Saint is a graduate student and Rockefeller Foundation Fellow, and E. Walter Coward, Jr., is associate professor and chairman, Department of Rural Sociology, Cornell University, Ithaca, New York 14853.

maintain its privileged position by means of various organizational and institutional arrangements. Finally, the diffusionist perspective was based on the assumption that information, and therefore technological change, would trickle down from more innovative to less innovative persons, and that the change agent could stimulate this process through contact with opinion leaders. This permitted the change agent to organize his work with a small group of progressive individuals, and to rely on an assumed multiplier effect to carry the innovation to poorer and more disadvantaged persons (*12*).

The role of the behavioral scientist within the diffusion approach to development has been largely that of a facilitator responsible for the rapid adoption of innovative practices. The behavioral scientist has organized communications networks, trained communicators or change agents, and monitored the innovation to determine its degree of social acceptability. He (or she) occasionally has been asked to evaluate the success of the program as determined by its extent of use in the local society, rather than by its distributional impact on social welfare or other success indications.

The Green Revolution called into question many of the tenets of the diffusion paradigm. The diffusion of high-yielding wheat and rice varieties was extremely rapid, even though for best results farmers were required to adopt not just one innovation, but a whole package, with their consequent required changes in farming practices. The adoption process seemed limited more by technological and institutional factors than by the traditional barriers to communication, including illiteracy, fatalism, rural values, and lack of media exposure. Whereas formal communication was important in this process, its role was not crucial to the spread of the new seed varieties (*13*).

At the same time, the Green Revolution's tendency in particular social settings to increase inequality along with agricultural productivity (*14*) stimulated a major new question that the diffusionist methodology had largely neglected: What are the consequences of the interaction of technology and social organization?

An Emerging Orientation

In recent years a major shift in goals in agricultural development has occurred within the programs sponsored by most international assistance institutions. Whereas increasing agricultural production was the primary objective up to and including the era of the Green Revolution, there is now a growing concern toward broadening the base of participation in the production process and creating equitable arrangements for distributing the benefits from these production increases. For a goal of increased agricultural production, the diffusion model has made significant contributions. However, when goals were modified to include considerations of participation and social equity, the effectiveness of diffusionism was sharply limited. Consequently, behavioral scientists have increasingly recognized the need to formulate other approaches to agricultural development.

We see a new orientation emerging, and, therefore, new research activities for the behavioral scientist. The thread of continuity between the diffusionist orientation and the emerging one is the importance of technology to the process of agricultural development. However, this element of continuity is also the element from which significant differences emanate.

The most fundamental new elements in the emerging orientation are the assumptions dealing with technology. Foremost among these assumptions is the simple proposition that technology itself is a social product: invention and discovery occur within specific group settings characterized by particular organizational patterns, group values, and resource endowments. From this basic proposition, three additional ideas important to agricultural development emerge.

1) Technological discovery and invention, as well as diffusion, are processes that occur in all agricultural systems and the technologies created thereby reflect the unique characteristics of the agricultural system that produces them.

2) Since many tasks are similar throughout agricultural systems, there exist alternative technologies for achieving any particular task. However, the transferability of these alternatives is problematic because of the location-specific factors that produced them and restrict their applicability.

3) Finally, the discovery and invention of improved technology for the various agricultural systems of the world will depend, in part, upon our ability to create technology development methodologies in which the existing situations of the agricultural systems to be assisted are simulated.

These ideas comprise an orientation that leads to several major changes in our view of the relation between technology and society, between technology and agricultural development. Whereas, previously, the agricultural technology of developed countries was assumed to be available, relevant, and beneficial to less developed countries, its suitability for any particular agricultural system is now viewed more tentatively. Only through the detailed analysis of the agricultural system being considered, as well as the socionatural environment in which it functions, can this indeterminate situation be resolved.

Similarly, this new orientation leads to a view of social organization as an independent, as well as a dependent, variable; focus is not only on the impact of technology on society, but on the influence of social organization on the development and utilization of new agricultural technologies. For example, organizational influences on technology are expressed through the institutional arrangements that provide agricultural inputs and credit, or that extract resources from the rural area through rents, taxes, subsidies, and investment incentives.

Tendencies to view technology as variable instead of given, and to see social organization as an independent variable as well as a dependent one, while not new, have increased markedly in the years that followed the Green Revolution. However, it is unlikely that the Green Revolution has been the sole cause of these changing perceptions. Two other phenomena that have significantly affected our thinking with regard to technology and society have been the environmental crisis and the energy crisis, both of which occurred shortly after the development of the high-yielding grain varieties. These two experiences further reinforced the ideas that technology can be modified to fit society's requirements, and that society may need to be modified to make the best use of alternative technologies. For example, the need for technologies minimally dependent on fossil fuels may require changes in social organization (for example, population distribution on the land, work schedules, and patterns of consumption and production) in order to employ these new technologies effectively (*15*).

When technology and social organization are viewed as variables that exist in an interactive relationship, a number of new perspectives that enhance understanding are opened.

1) The research process that produces technology becomes an object of inquiry, and the question of how technology is developed can then be asked.

2) The process used in the evaluation

and selection of alternative technologies can itself be evaluated. Is the focus of technological research client-oriented, problem-oriented, market-oriented, or social welfare–oriented? Who participates in technology development, and what are the criteria used in its evaluation (*16*)?

3) When technology is thought of as variable instead of given, its consequences are also seen as variable. Different technologies may have different social impacts. Likewise, a particular technology may have varying social consequences under different social conditions (*17*). This raises the question of how the choice of technology can be used to reinforce more equitable social arrangements.

4) Insights can be gained from viewing social organization as an independent variable which affects technology. How do organizational factors modify a particular technology, making it more amenable to a given socionatural context? For example, Japanese agriculture was organized on the basis of small farms; and consequent agrotechnological development, based on miniaturized mechanization, was compatible with this organizational context. Also, there is the question of which organizational and institutional arrangements are required in order to use a particular technology properly, whether it is an irrigation system of a new food grain variety.

5) The interaction effects between technology and social organization create new possibilities for planning and programming. Different technologies may be necessary in different organizational or institutional situations. There may not be a "one best solution." Under these circumstances, organizational situations can be identified and typed, and appropriate technologies that are compatible with the needs and limitations of each type developed. In Brazil, this approach is currently employed in preparing technical recommendations for crop production. Researchers, extension agents, and farmers meet to mutually define "systems of production" based on farm size, access to resources, and the current level of technology. Between two and four such systems are identified for each crop, and for each crop system a separate "package" of technological recommendations is developed on the basis of the system's resources and limitations. In this way, an effort is made to achieve compatibility between social organization and technology.

The contributions that behavioral scientists are now in a position to make in agricultural development are the result of combining the new insights discussed above with existing knowledge. The products of this integration may not necessarily be new, but they assuredly are better in the sense that our understanding of agricultural development processes is enhanced. Some of the forms that future behavioral science contributions in agricultural development will take already may be tentatively identified.

The Ecological Systems Approach to Agricultural Development

While systems theory is not new either to the physical or to social sciences, its application to the study of agriculture for development purposes is only just beginning (*18*). In this context, systems theory finds expression in an ecological systems approach in which both physical and organizational aspects of agricultural production are included as components of the same system; that is, the system perspectives extend beyond social organization to include agronomy, biology, and ecology, and vice versa. Relations are explored which link the environment, the crop, the crop producer, and the crop-producing community. Natural processes and social processes are seen as intertwined. Also, the relations between agriculture and the rest of society can be explored—for example, the impact of urbanization on agriculture.

An ecological approach similar to this is being used to guide some international agricultural research. At the International Institute of Tropical Agriculture in Nigeria, the study of farming systems proceeds first by defining general ecological systems based on environmental differences, then by defining agroecological systems that reflect the crops and technologies developed by man within these environmental constraints, and, finally, by defining cultural-economic subsystems of agricultural production in which cropping patterns are combined with resource limitations and other considerations to form farm types. Agrotechnologies are then developed, bearing in mind the constraints of these interrelated systems. The International Maize and Wheat Improvement Center (CIMMYT) in Mexico is following a similar approach in the effort to create technologies that are adapted to specific ecological conditions (*19*).

The academic groundwork for this approach is already being laid. At many universities social science students are taking courses in soil science, crop production, and tropical agriculture (*20*). Similarly, agricultural students study the social organization of agriculture and the sociology of irrigation systems. On both sides a body of literature is arising. See, for recent examples, the work of botanist Robert Loomis on agricultural systems (*3*) or that of anthropologists Robert Netting and John Bennett on ecological approaches to agrarian societies (*21*).

One special benefit of the ecological systems approach is that it integrates and focuses the work of various subdisciplines on a particular topic. Subdisciplines such as economic entomology, ecological anthropology, or cultural geography often understand interaction processes between physical and social phenomena quite well, but have yet to address directly the problem of agricultural development. An ecological systems approach permits such integration.

Study of Traditional Agriculture

Again, when technology and social organization are viewed as variable, the traditional system of agricultural production can be appreciated as an expression of the dynamic equilibrium that exists between man's needs and abilities and nature's resources and restraints. Given this perspective, the appreciation of traditional agricultural systems by both agricultural and behavioral scientists is a necessary first step before any planned intervention is attempted.

Whyte refers to the importance of indigenous knowledge in the efforts of agricultural scientists to increase maize production in the Puebla project area. Initial recommendations to the farmers dealt with the production of maize as a monoculture. Apparent limits on the number of farmers willing to adopt these recommendations led to a more careful examination of indigenous farming practices. It was found that the traditional practice was a "maize-bean association" and, as reported by CIMMYT, "The studies of the maize-bean association demonstrated that net income from the association was approximately double that obtained with either maize or beans alone" (*22*). In later phases of the Puebla project, scientists began making recommendations of improved practices for maize-bean production rather than for maize alone (*22, 23*). While the "learn from the farmers" approach may not always prove so beneficial, it certainly should not be overlooked as a means of understanding agricultural production systems.

Information on traditional agricultural systems can be "fed forward" to the research center and incorporated into the technology development process as suggested by Roling (*24*). This permits the experimental testing of new technologies under conditions simulating small farm reality as well as under ideal conditions. An extension of this idea involves the experimental testing of new technologies on the small farm itself, an approach adopted by the Guatemalan Institute of Agricultural Science and Technology and reported by Hildebrand (*25*). The importance of understanding traditional agricultural systems has also been demonstrated in Nigeria by Norman (*26*).

Limiting Factors Analysis

The term is borrowed from a principle used by plant biologists and, as recently applied to the behavioral sciences by Whyte, it means analyzing an agricultural production system for the factors which most limit its performance (*23*). The strategy is then to deal with the one or two factors most open to control rather than tackling all the factors at once. Just as this strategy is employed in dealing with soil or pest limitations, it can also be employed to identify and confront organizational or institutional limitations such as credit, water, or markets. At the same time, by understanding both the physical and institutional limits on crop production, the behavioral scientist may gain a better understanding of farmers' perceptions of risk, and of the risk-minimizing behavior and organizational safeguards which farmers create to insure themselves against it. Limiting factors analysis is one of the components of the research methodology being used to generate new technologies for small farmers in Guatemala by the Institute of Agricultural Science and Technology (*25*).

Analysis of Technology Development Systems

When technology is viewed as a variable, one begins to look for the source of variation. One possible factor is the organizational arrangements of the research process that develops technology. Interest in the sociology of science is not new (*27*), but the attempt to apply it to the analysis of agricultural research and technology development would be. The idea that different organizational arrangements for agricultural research lead to the development of different types of products and even to different levels of productivity has been recognized (*28*). For example, governments of many countries have a wide range of organizational systems for generating and disseminating agricultural knowledge. The analysis of technology development systems would deal with questions such as the relative effectiveness of differing organizational arrangements for achieving specific research objectives. Likewise, the process of technology development in indigenous agricultural systems remains relatively unexplored and little understood (*29*). We can expect these topics to receive increased attention in the future.

Use of Problem-Specific Typologies

Behavioral scientists have a long tradition of disaggregating information into subcategories in order to sharpen analysis. In fact, it was just this disaggregative analysis that first pointed up the social equity problems associated with the Green Revolution. By breaking down the agricultural population into farm types, it was possible to study the distributional impact of new technologies on different types of farm families. In the future, we may expect the increasing use of typologies to orient agricultural development planning and programming (*30*). If both technology and social organization are considered as variable, prevailing styles of agricultural production can be defined within a geographic area. Similarly, as in Brazil, alternative systems for the production of a given crop can be identified. In fact, by incorporation of the ecological approach and limiting factors analysis discussed above, problem-specific typologies could be developed to guide policy and research efforts in any area of agricultural production. For example, farmers may be typed according to the various combinations of technology, resources, and social organization which they employ in rice production, in the acquisition and use of fertilizers, or in irrigation arrangements. The use of such typologies reduces complex agricultural systems into more comprehensible subdivisions, permits identification of adaptive strategies which people use to deal with a particular problem, and allows assessment of the relative strengths and weaknesses contained in each subdivision. This approach implies that agricultural development strategies need to be tailored to differing socionatural situations in order to maximize their effectiveness, just as seed varieties must be adapted to different microenvironments. The use of typologies facilitates the definition of such alternative approaches.

A Methodology for Understanding the Organization of Agriculture

Perhaps the ultimate contribution that will emerge from the concerns defined above will be improved methodologies for understanding the social organization of agriculture. These methodologies will likely be grounded in the emerging orientations described above. They may begin by identifying the systemic patterns that people use to deal with standard concerns in agricultural production; for example, the provision of labor, maintenance of soil fertility, and sources of and responses to risk. These patterns could then be related to environmental resources and restraints, physical requirements of the agricultural production system, technology employed, and the broader institutional context such as land tenure, marketing systems, and the local political structure. From these patterns problem-specific typologies could be constructed and these would then be related to research objectives or to state agricultural policy goals. This would permit the evaluation of research recommendations and agricultural programs in terms of their distributional impact on the major subgroups of the agricultural population.

Summary

New research orientations are emerging in behavioral science approaches to agricultural development. These new orientations are the product of both experience gained during the era that followed the Green Revolution and a response to changing goals in agricultural development that now place a greater emphasis on considerations of participation and equity. They also reflect a more general concern with the relation of technology and society growing out of efforts to understand energy and environmental problems. These orientations are characterized by a shift away from a conceptual perspective emphasizing communication to one in which technology and social organization are deemed essential in understanding and promoting agricultural development.

This changing conceptual perspective is being manifested in the research process from which technology develops. Use of ecological systems approaches to the study of farming systems is increasing. The importance of understanding traditional agriculture is becoming evident and technology development methodologies are beginning to simulate farm conditions at the research center and to

conduct experimental research on the farm. The appreciation of technology as a variable is leading to the development of alternative technologies adapted to different socionatural situations. As these emerging orientations become elaborated, they enhance the contributions which behavioral scientists can make to agricultural development.

References and Notes

1. For example, see S. Wortman, *Sci. Am.* **235** (No. 3), 30 (1976); and W. D. Hopper, *ibid.*, p. 196.
2. Organizational and institutional factors refer to input and product markets; research, credit, and extension programs; land tenure; and irrigation arrangements (*3, 4*).
3. R. S. Loomis, *Sci. Am.* **235** (No. 3), 98 (1976).
4. P. R. Crosson, *Science* **188**, 519 (1975).
5. Behavioral science is used in the sense of research dealing with social, cultural, and psychological factors in agricultural development. Although from a disciplinary perspective the fields involved are sociology, anthropology, and social psychology, the point of view expressed here is essentially sociological.
6. E. M. Rogers, *Diffusion of Innovations* (Free Press, New York, 1962). More than 2600 publications on diffusion of innovation are currently reported by Rogers, in "Where we are in understanding innovation," East-West Communication Institute Conference on Communications and Change: Ten Years After (1975), unpublished. Anthropology and social psychology have also made important contributions although they have been somewhat less influential. For example, on anthropology see G. M. Foster [*Traditional Cultures: and the Impact of Technological Change* (Harper, New York, 1962)] and E. H. Spicer, Ed. [*Human Problems in Technological Change* (Russell Sage Foundation, New York, 1952)]. On social psychology, see E. E. Hagen [*On the Theory of Social Change* (Dorsey, Homewood, Ill., 1962)] and D. C. McClelland and D. G. Winter [*Motivating Economic Achievement* (Free Press, New York, 1969)].
7. For example, see B. Ryan and N. Gross, *Rural Sociol.* **8**, 15 (1943). An early summary of diffusion research is provided in G. M. Beal and J. M. Bohlen, *The Diffusion Process* (Special Report 18, Iowa State Cooperative Extension Services, Ames, 1962).
8. Elaborated by E. M. Rogers with L. Svenning, in *Modernization Among Peasants: The Impact of Communication* (Holt, Rinehart & Winston, New York, 1969).
9. In addition to Rogers (*8*), see F. C. Fliegel, P. Roy, L. K. Sen, J. K. Kivlin, *Agricultural Innovations in Indian Villages* (National Institute of Community Development, Hyderabad, 1968). On extension, see J. P. Leagans, "Extension education and modernization," in *Behavioral Change in Agriculture,* J. P. Leagans and C. P. Loomis, Eds. (Cornell Univ. Press, Ithaca, N.Y., 1971), p. 101.
10. This theme is fully explored by K. Griffin, in *The Political Economy of Agrarian Change* (Harvard Univ. Press, Cambridge, Mass., 1974).
11. In partial exception, Lionberger viewed the individual as a member of an informal social group defined by communication links [H. Lionberger, *Rural Sociol.* **19**, 233 (1954)].
12. As policies based on these assumptions are implemented, the outcome is likely to be increased inequality. For fuller critiques of diffusionism, see D. E. W. Holden [*Rural Sociol.* **37**, 463 (1972)] and N. Rolling, J. Asheroft, and F. Wa Chege [*Commun. Res.* **3**, 155 (1976)]. For an earlier expression of concern with the diffusionist approach, see C. P. Loomis and Z. K. Loomis [in *The Uses of Sociology*, P. F. Lazarfeld, Ed. (Basic Books, New York, 1967)].
13. A study conducted by the International Rice Research Institute (IRRI) has identified irrigation, pest control, soil fertility, credit, price policy, farm size, and land tenure as the principal limiting factors. IRRI, *Changes in Rice Farming in Selected Areas of Asia* (IRRI, Los Banos, Philippines, 1975).
14. This tendency has been documented D. K. Freebairn [*Land Econ.* **45** (No. 1), 31 (1969)] and A. Pearse ["Social and Economic Implications of the Large Scale Introduction of High Yielding Varieties of Foodgrains," Report 74– United Nations Institute for Social Development (UNRISD, Geneva, 1974), 55 pp.]
15. See L. R. Brown, *Futurist* **10** (No. 6), 307 (December, 1976).
16. A useful discussion of this issue appears in C. P. Timmer, J. W. Thomas, L. T. Wells, D. Morawetz, *The Choice of Technology in Developing Countries* (Harvard Studies in International Affairs No. 32, Center for International Affairs, Harvard University, Cambridge, 1975).
17. See C. H. Gotsch, *Am. J. Agric. Econ.* **54**, 326 (1972).
18. Systems theory was originally developed in response to the increasing complexity of modern technology [L. von Bertalanffy, *General Systems Theory* (Braziller, New York, 1968)].
19. I. W. Buddenhagen, personal communication; Dr. Winkelmann, "Comparative cases of farmer adoption of HYV technology," speech at Cornell University, March, 1977. CIMMYT's consideration of ecological variation is based on the research findings of R. Perrin and D. Winkelmann [*Am. J. Agric. Econ.* **58**, 888 (1976)].
20. Formal recognition of the importance of integrating agricultural development concerns within the behavioral sciences is also occurring at the professional level. Both the Rural Sociological Society and the American Anthropological Association have recently organized sections which deal specifically with the study of agriculture.
21. R. McC. Netting, *Hill Farmers of Nigeria: Cultural Ecology of the Kofyar of the Plateau* (Univ. of Washington Press, Seattle, 1968); and J. W. Bennett, *Northern Plainsmen* (Aldine Atherton, Chicago, 1969). Bennett and Netting are two contemporary researchers who build upon, and exemplify, a long tradition of systems approaches in economic and ecological anthropology.
22. International Center for the Improvement of Maize and Wheat, *CIMMYT Annual Report 1972* (CIMMYT, Mexico, D.F., 1973), p. 140.
23. W. F. Whyte, "Toward a new strategy for research and development in agriculture," paper presented at the Summer Institute on Science, Technology, and Development. Cornell University, 1976.
24. N. Roling, *Rural Afri.* **27**, 113 (1975).
25. P. E. Hildebrand, "A multi-disciplinary methodology for generating new technology for small, traditional farmers," paper presented at the conference on Developing Economies in Agrarian Regions: A Search for Methodology (Rockefeller Foundation Conference Center, Bellagio, Italy, 1976).
26. D. W. Norman, "Inter-disciplinary Research on Rural Development" (Overseas Liaison Committee Paper No. 6, American Council on Education, Washington, D.C., 1974).
27. See R. K. Merton, *Social Theory and Social Structure*, R. K. Merton, Ed. (Free Press, New York, 1949), p. 317.
28. See J. K. Boyce and R. E. Evenson, *Agricultural Research and Extension Programs* (Agricultural Development Council, New York, 1975).
29. An exception is the work of Boserup which illustrates the innovativeness of indigenous technology development [E. Boserup, *Woman's Role in Economic Development* (Allen and Unwin, London, 1970).
30. Two examples of recent work in which typologies are used are C. H. Gotsch (*17*) and J. M. Page [*Agrarian Revolution* (Free Press, New York, 1975)].

31. We thank A. Cavazzani, J. Cohen, J. Gilles, V. Gracen, B. Stavis, W. F. Whyte, and L. Zuidema for comments and suggestions.

NEWS AND COMMENT

Arthur Canfield Upton: New Director of the NCI

After an interregnum of nearly a year, the National Cancer Institute (NCI) has a director again—Arthur Canfield Upton, 54, a radiation biologist and former dean of the School of Basic Health Sciences at the State University of New York at Stony Brook. He knows a lot about cancer, can tolerate a certain amount of contradiction in life, and says he thinks he knows what he's getting into as he assumes command of the largest and most controversial of the National Institutes of Health (NIH).

Upton does not believe that vitamin C can prevent or cure cancer—or even the common cold for that matter—but he takes 500 to 1000 milligrams a day "on general principles."

He believes that Laetrile is a fraud but is nonetheless willing to authorize human trials if ethical questions about giving it to cancer patients can be answered.

Upton thinks it is foolish to make the "dogmatic statement that 90 percent of human cancer is caused by environmental factors," but he is certain there is a connection between cancer in people and carcinogens in the environment.

He maintains that anyone who believes there is such a thing as a "single human cancer virus" is "woefully naive," but he is "not a vociferous critic of viral oncology."

In a wide-ranging interview with *Science* on what was theoretically his first full day (28 July) on the job, Upton talked about the national cancer program, basic research, and the highly political arena he has entered. He introduced himself by cheerfully volunteering that he felt "a little strange" about being interviewed. "You see," he said, "I *think* I'm the director of NCI. Here I am anyway. But my appointment has not been made official yet and I really haven't any idea why." The NCI directorship is a Presidential appointment, and Upton had not heard a word from the President. It was not until the next day that Upton learned unceremoniously through a press aide that his papers finally had made it to Jimmy Carter's desk and that the White House officially announced his nomination.