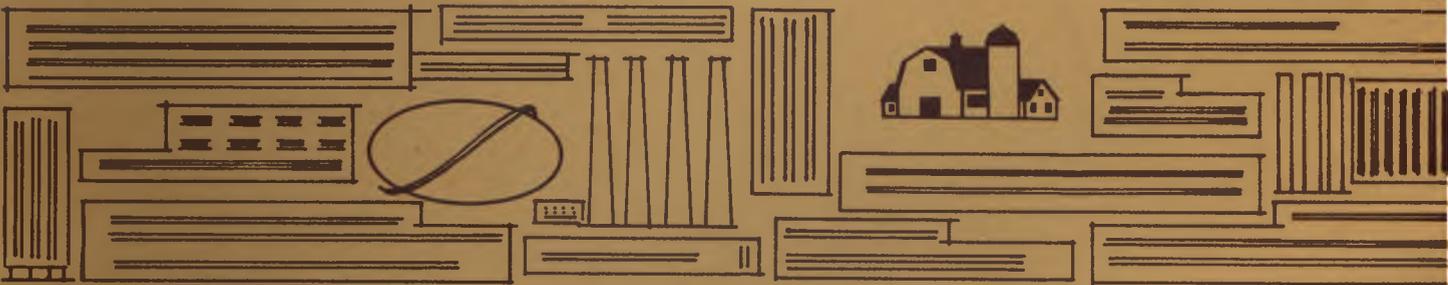


■ AGRICULTURAL ORGANIZATION IN



THE MODERN INDUSTRIAL ECONOMY

DEPARTMENT OF AGRICULTURAL ECONOMICS / THE OHIO STATE UNIVERSITY / COLUMBUS, OHIO

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**AGRICULTURAL ORGANIZATION IN THE
MODERN INDUSTRIAL ECONOMY**

**Department of Agricultural Economics
and Rural Sociology
The Ohio State University
Columbus, Ohio**

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FOREWORD

This volume contains papers and discussions presented at a seminar on changes in the economic organization of American agriculture. Organization alternatives were examined in terms of workability, acceptability, consequences, and implications for public policy. Seminar participants included members of two North Central Research committees, NCR-20 and NCR-56, and selected other individuals whose experiences and areas of interest qualified them to contribute in unique and valuable ways.

The contents herein should be of particular interest to agricultural leaders who are formulating policy proposals bearing on agricultural organization, to educators who are dealing with issues of changing industry structure in their research and teaching programs, and to students of agriculture who are seeking greater comprehension of the kinds of changes and problems likely to be faced by agricultural people in the years ahead.

The seminar was planned by a Subcommittee of NCR-20 consisting of Peter Helmberger, University of Wisconsin; R. J. Hildreth, Farm Foundation; James D. Shaffer, Michigan State University; and Paul L. Farris, Purdue University, Chairman. The subcommittee coordinated arrangements involving NCR-56 with Dale E. Hathaway, Michigan State University. Manuscript preparation and publication arrangements were handled by Thomas T. Stout, Ohio State University.

Paul L. Farris
Purdue University

THE SCIENTIFIC INDUSTRIALIZATION OF THE U.S. FOOD AND FIBER SECTOR
BACKGROUND FOR MARKET POLICY

James Duncan Shaffer
Michigan State University

"The major advances in civilization are processes that all but wreck the societies in which they occur." A. N. Whitehead

"There is absolutely no inevitability as long as there is a willingness to contemplate what is happening." Marshall McLuhan

The challenge of this seminar is to understand and evaluate some of the relevant potential modifications in the organization of the food and fiber sector of the U.S. economy. Our concern is centered on possible modifications in the rules of the market. We would like to be able to predict the performance of the food and fiber sector given various alternative sets of institutional constraints. This is, of course, a tall order.

My assignment is to attempt to set the stage up for the discussion of specific alternatives in organization. We are concerned with three interrelated classes of phenomena: (1) Changes in the behavior of economic organizations (the firm, cooperative, union, household, etc.), (2) changes in the political-social constraints on the behavior of economic organizations, and (3) changes in available technology. The organization of the economy is the outcome of the dynamic interaction of these phenomena within the natural environment. The organization is not determined by economic advantage or by technology nor is it prescribed by the laws of men. Each has its influence. The dynamic system is in a sense impossible to specify completely and thus perfect prediction and control is also improbable. We, therefore, must be content with a fairly high level of uncertainty. However, the absence of certainty should in no way restrict our efforts to understand the system or dampen our attempts to develop proposals for modifying it to better serve the purposes of the community.

2

I will focus attention on the trends and forces which seem to be associated with the process I will call scientific industrialization. By scientific industrialization I mean the process involved in successively more complex organizations of specialized activity, including the specialization in the production of scientific knowledge. Let me simply list some of the characteristics of this

recent, well known, but little understood process without attempting a description of the dynamics of the system created. The process includes:

- (1) The specialization of work roles and the integration of efforts of workers with different roles in a coordinated activity.
- (2) The specialization in the production and distribution of scientific knowledge.
- (3) The investment of labor and knowledge in capital goods.
- (4) The substitution of technical knowledge and capital equipment for traditional skills and labor in particular economic endeavors.
- (5) Related institutional changes.

3

Specialization and factory-like organization existed in some of the ancient civilizations. However, it is doubtful that any major civilization mastered their environment sufficiently to produce a level of living equivalent to \$200 per capita prior to the Industrial Revolution, which we can date from about 1730. The Industrial Revolution was above all else a significant change in the ordering of economic activity.

While great contributions to knowledge of man's environment were made earlier, modern science may be dated from Isaac Newton (born in 1737). Significant specialization in the systematic production of objective knowledge came some time after Newton's contributions to physics. The interaction of science and industrialization which characterizes our modern economy was little evidenced prior to the present century. Invention took place, technology developed and fed industrialization, contributing to economic growth, but for the most part technology was independent of the development of science until the end of the 19th Century.

The combining of science and technology within the process of industrialization is the seed for radical transformation. It is so significant that some observers are referring to the result as the post-industrial period. It is as unique as the original Industrial Revolution. We have effectively institutionalized the production of change. Before technology was science based, technological innovation depended largely on chance and genius of individual inventors. This had definite limits and produced a very uneven flow of innovation. The production of science-based technology by contrast is more systematic and certain. New technology, and thus change, is the product of a system of organized economic activity. Groups of ordinary men are organized by the scientific disciplines to produce a continuous flow of new knowledge.

The origin of scientific farming may perhaps be dated from Gregor Mendel (1822-84) and his contribution to the understanding of heredity. Significant events in the institutionalization of

the production and distribution of agricultural knowledge were the establishment of the Land-Grant Colleges and the Department of Agriculture in the 1860's. But it was not until the Hatch Act of 1887 and the second Morrill Act of 1890 that the agricultural colleges and experiment station system was extended to all states. ^{1/} The application of science to farming was a gradual but cumulative process.

We are in a late stage in the transformation from an agrarian to an industrialized food system. The transformation has, from the beginning, involved the substitution of specialized activities for farm work. The ratio of total population to farm workers gives a rough idea of the pace of the transformation. By the end of the first 100 years of the Industrial Revolution one person out of four in the U. S. was a farm worker. (This was more than 70% of all gainfully employed.) By 1920 (90 years later) the ratio was one to eight. From about this point in history the problems of technological displacement in farming were continually in evidence, excepting in the war periods. The depression of the 1930's may have held back the introduction of science-based farming technology. Between 1935 and 1940 the investment in science began to contribute to significant increases in yields. The work of Mendel and those who followed - the investment in the production and distribution of scientific knowledge in agriculture - began a major payoff. By 1950 only one person out of 16 in the population was a farm worker. The cumulative effect of industrialization brought about as much change in the organization of the food sector in the thirty years prior to 1950 as had occurred in the previous 200 years. And the pace has quickened. It took less than 15 years for the ratio of farm workers to population to reach one to thirty. And today the ratio is less than one out of forty.

The payoff from industrialization is increased productivity. Unfortunately this is exceedingly difficult to measure. Nevertheless output per man hour for the entire economy gives some indication of the aggregate changes in our opportunities. The change in the rate gives a notion of the cumulative nature of the industrialization process. Productivity in the U.S. economy has grown like compound interest and at the same time - at least for the past 100 years or so - the annual rate has increased by about .2% per decade. The average rate of growth in gross private output per man hour between 1850 and 1889 was about 1.3% while since 1960 the average rate has been about 3.6%.

^{1/} See J. T. Bonnen, "Some Observations on the Organizational Nature of a Great Technological Payoff," Journal of Farm Economics, Dec. 1962, p. 1279-1294 for an interesting account of the institutionalization of agricultural knowledge in the U.S. Conversations with Professor Bonnen contributed to my thinking about the early relationship of industrialization and science.

^{2/} C. E. Silverman, The Myths of Automation, Harper Row, New York, 1966, p. 9-10.

I wish to convey two perceptions with this brief bit of history. First, the changes now taking place are part of a long process and are, in a real sense, a continuation of that process. Second, the pace has altered to such an extent, the magnitude of the changes are so great, and the influence of the fusing of science, technology and industrialization is so pervading that we are witnessing a radical transformation in the character of our economic system.

5

During the 1940's and early 50's, the attitudes of scientific management for both private and public organizations came to full bloom. Technology became essentially science based. And we decided to institutionalize the production of change in a big way by investing large sums in the production and distribution of scientific knowledge. For example, based upon the best estimates we have, the investment in scientific research and development increased from less than \$3 billion in 1950 to over \$20 billion in 1965. The share provided by the federal government was about one-half in 1950 and about three-fourths in 1965.^{3/} Research and development became a major specialized input into the American economy, financed mainly by the community at large.

For the convenience of discussion I will identify the era of radical transition through scientific industrialization as from 1950 to 1984. This places us at the mid-point in the transition and suggests the possibility that the trends identified in the first half of the period will give us some understanding of what is to come in the second half. My argument is that such an understanding is essential to the development of appropriate market policy for the 16 years which follow.

The significance of this period for agriculture is shown by the fact that, based upon a straight line projection, the last hour of farm work would be performed in the U. S. in the year 1984. Only half as many hours of work were performed on U. S. farms in 1967 as in 1950.^{4/} And the total number of workers dropped from slightly less than 10 million to slightly more than 5 million during the same period.^{5/} (The projection of farm workers indicates we would have farm workers after running out of farm work.) I, of course, do not expect the straight line projection to be an accurate predictor. But neither should it be ignored.

^{3/} U. S. Bureau of Census, Statistical Abstracts of the United States 1960, p. 538, and 1967, p. 537.

^{4/} USDA Handbook of Agriculture Charts 1967 (No. 348), p. 13.

^{5/} USDA op. cit., p. 16.

I place no special significance on the fact that the projected replacement of farm work coincides with Orwell's dystopia of 1984. However, since we are discussing policy implications, it is well to take Orwell's message seriously. Increased capacity to control the environment can be used for evil as well as good.

While employment has been substantially reduced in farming, it has increased in other phases of so-called agri-business. From 1947 to 1966 it is estimated that the number of people employed in farm supply industries increased from 9.5 to 12 million. For agri-business as a whole (the food and fiber sector) employment was estimated to have declined from 24.5 to 23.3 million. As a percentage of the labor force it declined from 41% to 30.4%.^{6/} Thus, employment was not so much eliminated as it was transferred and restructured.

There is, of course, no basis for assuming the decline in farm work will continue at the present rate and completely eliminate farm work by 1984. However, all the evidence indicates the process of scientific industrialization will continue, and the consequences will include a continued modification of work roles in the food sector and the substitution of technology for work. Since the number of people on farms and the number and size of farms is an important variable when we come to examine alternative organizations of the food sector, it deserves further consideration.

6

Perhaps the most dramatic example of agricultural industrialization is that of cotton production. The 1950-54 average of man-hours worked in cotton for the U. S. was about 1,500 million and by 1966 it was reduced to about 300 million. In the same period the number of cotton farms declined from about 600,000 to about 100,000.^{7/} Share cropping was virtually eliminated.

A study of leading farmers in the Mississippi Delta shows that, between 1960 and 1967, man-hours per acre in cotton were reduced from 82 to 13.5, while their yield increased from 750 to

^{6/} H. Arthur, R. Goldberg and K. Bird, The United States Food and Fiber System in a Changing World Environment, Vol. 14, Tech. papers. National Advisory Commission on Food and Fiber, 1967, p. 22. It is not clear exactly how these data were calculated. Because of the difficulty of identifying that part of the economy engaged in farm supply and food processing and distribution, the data must be considered as estimates.

^{7/} U. S. Department of Labor, "Causes and Effects of Declining Cotton Employment", Farm Labor, Sept-Oct. 1967, pp. 20-34.

850 lbs. per acre. The substitution was an additional expenditure of \$4.00 per acre for power and machine services and about \$10 for pesticides and herbicides. Expenditures for fertilizer actually declined due to improved cultural knowledge.^{8/}

The transition in cotton seems to have involved the following:

1. The substitution of the cotton pickers and strippers for harvest labor.
2. The substitution of herbicides for labor in cultivation.
3. The substitution of chemicals and technical knowledge for labor through increased yields.
4. The substitution of synthetic fibers for cotton.
5. The shift of cotton to land more adapted to its production with industrial methods.
6. Some recent reduction in supported acreage which has significant current effect.
7. Anticipated application of minimum wage to farm work.

Although changes in employment of the magnitude already experienced is impossible, the transition involved in cotton will continue.

7

The scientific industrialization of the food and fiber sector involves three inseparable developments in the farm supply industries.

First is the transfer of work from the farm to specialized non-farm firms where the activity can be performed more efficiently. An example has been the development of specialized feed manufacturing. The value of purchased feed approximately doubled from 1950 to 1966. The index of the value added by non-farm firms to feed, seed and livestock purchases increased from 72 to 130 during the same period.^{9/} A great variety of specialized services are provided farmers from the application of fertilizers and chemicals to computerized accounting. In general this trend is likely to continue. However, the trend may be modified by the development of enterprises large enough to organize the services efficiently within the firm. The integration of feed mill operation in poultry and beef enterprises is an example. Specialization will continue. The only question is whether it will be coordinated through exchange relationships or integrated into the firm.

Second is the substitution of external sources of power and energy for that originating on the farm. I will mention several

^{8/} USDA Farm Index, Feb. 1968, p. 5.

^{9/} USDA Structure of Six Input Industries, E.R.S. 357, 1968, p. 2.

important examples. In 1920 about 26 million horses and mules supplied much of the power used on farms. The horses and feed were farm produced. The tractor and its fuel have virtually replaced the horse, releasing millions of acres of land for other purposes. This gain in productivity can, of course, only happen once. Mechanical power and machinery will continue to substitute for labor and will continue to contribute to increased productivity. However, the rate of increase will be undramatic. Another example is the substitution of urea for farm produced protein in animal feeds. It is estimated that urea had taken over about 12% of the oilseed meal market by 1964.^{10/} We have little notion of the potential for such substitutes. From 1950 to 1966 the index of mechanized power and machinery input increased from 86 to 103. This index is influenced also by the shift of activity to non-farm firms. Most dramatic has been the increase in the use of fertilizers and other chemicals. Purchases of fertilizers increased from \$868 to \$1,771 million from 1950 to 1966 and pesticides from \$179 to \$619 million during the same period.^{11/} The next several years should see continued increases in fertilizer use due to relatively low prices which will exist for fertilizer. In the next ten years substantial gains in production can be expected from increased use of fertilizer and pesticides. After that increases will be limited largely to those associated with development of new plants capable of utilizing increased nutrients.

Third, is the specialization in the production of knowledge and the substitution of knowledge for other inputs. The knowledge is often carried as part of other inputs -- as in the case of new varieties of seeds, chemicals, etc. Knowledge is also included in services provided with inputs. For example, application recommendations are supplied with pesticides, optimum feed rations calculated and supplied with feed, and some fertilizer companies supply substantial management services with fertilizer.

8

Food production in an industrialized system must be understood as a system of interrelated processing activities. Farming is simply several of many specialized processing activities. Inputs are purchased and transformed to inputs for the next processing operation. In 1967, expenditures for purchased farm inputs were about 1 1/2 times net farm income. Looked at another way the value added by farming, taking existing prices as accurate indicators of value, was only about two-thirds the value added by producers of farm supplies.

^{10/} See R. S. Corkern, "Synthetic Substitutes in Agricultural Markets," Marketing and Transportation Situation, USDA, August 1967.

^{11/} USDA, op. cit., p. 2.

In animal production -- that is, in the transformation of feed to animals -- the trend is toward specialization and large scale. Factory-like production is characteristic of the production of broilers, turkeys and eggs. Large beef finishing factories will soon dominate beef fattening. The technology for pig factories seems now at hand. The trend is likely to continue, resulting in the separation of a large portion of animal production from traditional farming. Only beef cows and dairy are likely to resist specialized large scale factory-like organization. And some method will have to be found to coordinate beef cow enterprises with the needs of the large beef finishing operations. Some exceptions will exist for dairy. However, the impact of scientific industrialization for dairy will come from the substitution of another processing technology for the cow.

9

Scientific industrialization supports a trend toward the development of new foods -- replacing traditional food and food production processes. The theoretical potential for the new foods or so-called food analogs is very great. Food technologists can now manipulate the chemical and physical characteristics of many low cost agricultural raw materials to make a wide variety of consumer food products and this capacity will greatly increase. The loss in the transformation of calories in animal production is something like 80%.^{12/} This suggests a major potential saving. The biochemists have managed to produce all of the 12 essential amino acids in the laboratory, suggesting the eventual possibility of manufacturing food independent of farming as we have known it. However this possibility has little relevance to the period of time under consideration here.

As of 1965, synthetics had 33% of the fiber market, 80% of the soap and detergent market, and 6% of the sweetener market.^{13/} So far, manufactured food analogs have been most successful as dairy substitutes. Butter has lost about two-thirds of its market to margarine. Coffee whiteners have about 35% of the "coffee cream market." Non-dairy whipped toppings are said to have about 60% of the "whipped cream market." Mellorine has about 5% of the frozen dessert markets.^{14/} And recently, filled milk is reported

^{12/} W. E. Hartman, "Meat-Like Products from Plant Sources," Speeches Presented at the Cornell Conference on New Foods, Flavors and Analogs, April 1967, p. 19.

^{13/} Corkern, op. cit.

^{14/} G. G. Quackenbush, "Dairy Products--Modifications or Substitutes," Cornell Conference, op. cit., pp. 7-8.

to have taken 4% of several western markets shortly after being introduced. Fruit juice analogs have been developed and as they are improved will have major implications for fruit production.

Perhaps as important as the developments in technology are the attitudes of food processors towards analogs. The American Meat Institute has adopted a policy of not fighting the introduction of meat substitutes nor supporting legislation restricting the introduction of mixtures of manufactured protein into processed meats. They have agreed they are in the food business not the meat business. A number of large traditional food processors have changed their idea of their role. Many are merging and expanding their lines in non-food areas and as a result have none of the negative attitudes towards producing food analogs of the traditional processor. Even a Minnesota farmer cooperative has produced a national brand non-dairy coffee whitener under contract. And a Michigan dairy farmer cooperative is processing and distributing a synthetic milk. A number of large firms, some with government support, are researching the development of low cost production of protein. This is now done with the intent of helping feed the hungry world, but could lead to some substantial breakthroughs.

These are only some of the examples of the development of synthetics and analogs reflecting one of the important trends of scientific industrialization of food and fiber production.

10

The era from 1950 - 1984, the era of scientific industrialization of the food sector, will very probably see a tripling of the real GNP in the U. S. (Real GNP increased by about one third from 1960-1966). While GNP is a very poor indicator of social improvement, it does give some indication of the increasing size of the economic pie which appears to be available to the community. No community has ever experienced such changes in economic opportunity. This change has altered and will continue to significantly alter personal incomes, labor costs, relative prices, and attitudes. In the brief discussion which follows I attempt to sketch some of the interrelations of these factors with the structure of the food system. I will emphasize some of the changes affecting the coordination of the system from the consumer to the farm supply manufacturer. Particularly emphasized is the reinforcing pattern of circumstances stimulating higher levels of specification in the characteristics of food products which will stimulate changes in the coordinating institutions. I want also to emphasize changes in attitudes which are a product of industrialization and are significantly altering the rationale for existing economic institutions..

11

In our economy, relative prices carry much of the information

coordinating the system. The following are among the important factors determining relative prices as industrialization progresses: (1) The labor intensity of production, (2) the susceptibility of the activity to technological innovation, (3) the structure of the producing industry, (4) the organization of labor, and (5) the income and price elasticities of demand.

Medical services and building construction are labor intensive, difficult to mechanize, involve restricted entry and have a high income elasticity. It would be expected that prices of these goods and services would increase relative to others. Farm production is not labor intensive, is very subject to innovation, is atomistically organized, uses mostly unorganized labor and products have a low income elasticity of demand. Prices of farm products would be expected to fall relative to most goods and services. Relative prices of most manufactured goods would be expected to range between construction and farm prices.

12

The following are among the factors stimulating increased specification of product characteristics, more specific coordination of the food system, and a related shift in location and control of food production and processing activities.

(1) As wages increase due to increased productivity, the price of an hour of household help increases relative to most goods. This is true of both hired help and work performed by the housewife, in terms of opportunity costs. Higher incomes also increase the demand for domestic services. The result is a steadily expanding demand for industrialized services such as higher levels of food preparation and quality reliability, making higher levels of product specification pay off. Larger discretionary income also provides greater potential for profitable advertising.

(2) Increasing labor costs also pressure restaurants to seek labor saving improvements. This increases the demand for products which reduce labor requirements within the restaurant. The institutional users are the first and often the largest users of food analogs because analogs may be manufactured to meet uniform specifications and purchase decisions are more often based on performance than habitual preferences. The development of the restaurant chain also creates units making very large purchases, further stimulating demand for large quantities of products of highly specified characteristics.

(3) Large scale industrialized enterprises are typical among farm supply manufactures, food manufactures and food retailing firms. The trend seems to be toward larger average size of enterprise in each area, although the share of business achieved by the top few firms is not necessarily increasing. Each of these firms has large

long term investments. Their costs per unit tend to decrease with increased volume. They have a high incentive to reduce or control risks. They are complex organizations requiring long term planning and financing.^{15/} They are large enough that demand for their products is not independent of the action of their competitors. The retailers and food manufacturers attempt to reduce risk and expand their markets through advertising and promotion of branded products. Successful advertising requires products of highly consistent specification available in large quantities. Food chains and processors also have an incentive for controlling product characteristics and timing as means of reducing costs.

Farm supply firms attempt to assure markets and efficient use of equipment by forward integration and contracting. Retailers attempt to reduce uncertainty and increase return on investment in plant and advertising by backward integration and contracting. Integration by retailers is most extensive for such staples as milk, bread and coffee processing. The food retail chains have also developed impressive specification buying organizations. Food manufacturers similarly attempt to assure uniform supplies and return on advertising investments by integration and contracting. "Currently more than half of fluid milk, broilers, turkeys, vegetable seeds, hybrid seed corn, sugar crops, citrus fruits and vegetables for processing are transferred under integrated and contractual arrangements."^{16/} There will be strong pressures from the process of industrialization for this trend to continue.

People -- at least their beliefs and attitudes -- are as much a product of the economic system as the system is a product of their design. Scientific industrialization is producing a changing pattern of beliefs and attitudes which is undermining the norms supporting the existing organizational structure. The old ground rules for determining the division of the increased productivity and the relationship of work roles are no longer accepted by large numbers of the community. Let me simply list some of the inter-related factors which seem to be associated with this change.

(1) Specialization and interdependence are opposite sides of the same coin. Up to the present time, at least, scientific industrialization has created a system where the individual is highly dependent upon the performance of large numbers of other people for his nurture and even survival. Each move from subsistence agriculture has made us as individuals more dependent. There is a quickening pace of technological change and the related threat of job displacement. These create tension, frustration, and perhaps alienation.

^{15/} See J. K. Galbraith, The New Industrial State.

^{16/} Food and Fiber for the Future, Report of the National Advisory Commission on Food and Fiber, 1967, p. 177.

(2) There has been very large increases in total production and expanding absolute discrepancies among incomes of people of similar backgrounds, and some groups in low status jobs, but in strategic positions, extract high rewards from the system. And because of the bureaucratic nature of the organization of much work it is impossible to identify many individuals' contribution to the productive process. The increasing rewards for less work raise a question of the relationship of contribution to payment.

(3) Advertising and television, both products of industrialization, combine to drastically alter beliefs and attitudes. Marshall McLuhan tells us "The medium, or process, of our time -- electric technology -- is reshaping and restructuring patterns of social interdependence and every aspect of our personal life. It is forcing us to reconsider and reevaluate practically every thought, every action, and every institution formerly taken for granted. Everything is changing -- you -- your family, your neighborhood, your education, your job, your government, your relation to 'the other.' And they're changing dramatically."^{17/} More specifically commercial television teaches that a man who cannot provide himself and family with all of the material things of our society is inferior. And at the same time, violence seems to be legitimized.

The result is that all kinds of groups -- farm workers, farmers, teachers, firemen, reporters, insurance agents, welfare recipients, ex-wives on alimony, and minority groups as well as factory workers are applying pressure to (1) get a larger share of the bigger pie and (2) to get a more important voice in determining their relationships to the economic systems.

The system is coming unstuck!

14

What are the implications of scientific industrialization for future food and fiber market policy? We still have to answer all of the questions about market performance we have discussed so often before. Recognizing scientific industrialization as a fact of life may modify some of our answers. I anticipate a considerable discussion of the implications of the changing situation, within the context of market performance, as alternative organizations of the sector are discussed. Let me simply list a few of the general implications as I see them, without getting to the tough problems of evaluating specific market rules.

1. The production of technological change has been institutionalized. Change will be continuous and will probably take place

^{17/} Marshall McLuhan, The Medium is the Message, Bantam Book 1967, p. 8.

at an increasing rate. The challenge for social scientists is to invent institutions which will manage change in the interest of the community.

2. Many of the coordinating institutions of the food and fiber sector have become obsolete or inadequate. The system demands more effective vertical coordination. If improved coordination is not accomplished through market exchange institutions it will be done by vertical integration. In addition to private vertical integration, proposals have been advanced for a public utility, marketing boards, marketing cooperatives and contracting. The ownership and control of the system are at issue.

3. The trend is toward large scale economic organizations. In addition to the benefits from monopolistic position, the incentives for large scale are often related to advantages in vertical coordination, planning, financing and promotion rather than economies in processing and manufacturing.

Among other small scale organizations, the family farm seems to be threatened from these "external" advantages. And some policy proposals would probably promote its demise. While the family farm must be justified on the basis of performance, it should not be placed at an institutional disadvantage.

Many of the policy proposals dealing with the coordination and income problems in agriculture would legalize collusion. We are in danger of creating institutions more appropriate for the past than for the future. The challenge is to structure market rules and fashion institutions which will reduce these "external" incentives for increased size without loss of performance.

4. Two products of the scientific industrial system -- the computer and the communications network -- may provide the technical means for developing viable exchange systems based upon performance contracts which would reduce the incentive for vertical integration.

5. Technological unemployment or displacement will be a continuous phenomena. Many thousands of farm families, owners of small businesses and workers in many areas will be displaced in the next several years. The present institutions inadequately spread the incidence of change. Increasing numbers who feel threatened will evolve methods for resisting innovation unless the individual effects are mediated. (The English workers have apparently effectively blocked much innovation, resulting in relatively low growth rates.) Some of the policies under consideration might provide the capacity for resisting innovation. The challenge is to develop institutions which encourage beneficial innovation and equitably spread the transitional costs.

6. The problems of externalities will increase in importance. That is, the discrepancies between social and private benefit-cost ratios will become more important. For example, the use of pesticides has very significant effects beyond the firms using them. And the social costs of the introduction of new technology in southern agriculture and the resultant migration of rural people unprepared for urban life are yet to be estimated. The challenge is to invent institutions to effectively incorporate the external effects of technological change into the calculus of economic decisions.

7. I judge the existing institutions for the resolution of conflict over the division of increased productivity to be inadequate for the future industrialized economy. The potential payoff from collective bargaining for many groups increases as the system becomes more interdependent. Ultimately the problem will be to protect the public from collective action and stalemates in bargaining conflicts. Without improved market rules structural inflation and unemployment will be stimulated. The challenge is to invent institutions for the resolution of economic conflict which reduce the costs of such conflict to the general public and also provide incentives and an equitable distribution of income. The system currently developing meets none of these criteria. Both guaranteed minimum incomes and arbitration need to be seriously evaluated in this context. Both may have special application for use in the food and fiber sector.

8. Any plan to improve farm income positions through monopoly pricing will stimulate the development of food analogs.

9. There is considerable evidence that, with all our abundance, the present system is producing frustration and alienation. The challenge is to develop institutions which provide for the psychological needs of the participants in terms of working relationships.

10. The food and fiber sector, including farming, is losing much of its uniqueness. Unique policy solutions for agriculture appear inconsistent with the industrial system which is developing. The challenge is to develop economy-wide income, manpower and industrial organization policies, which, with some adaptation to special conditions, will meet the needs of the food and fiber sector and the community at large.

It is clear this seminar is to wrestle with the most fundamental issues of social organization. As a society we have created an enormous capacity for good or evil. It is our responsibility to understand what is happening -- to define the issues -- and to predict the future consequences of adopting alternative sets of market rules.

I believe we should work with a sense of urgency. Nineteen eighty four is close at hand.

SOME IMPLICATIONS OF INDUSTRIALIZATION
OF THE FOOD SECTOR OF THE U. S. ECONOMY

Discussion

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Shaffer's paper is, in my opinion, an excellent one and a good keynote for this seminar. Using proper clinical procedure, Shaffer places diagnosis prior to prescription. The diagnosis that emerges, as I evaluate it, is that science and technology are producing changes in the food sector more rapidly than these changes can readily be digested. No pun intended. Shaffer cites striking figures on the pace of change. In a 14-year period, man-hours spent producing cotton in the United States fell 80 percent. The accumulation of these people in our urban ghettos is in some way related to our recent riots. Ray Goldberg, in his new book Agribusiness Coordination, states that from 1947 to 1966 the number of farm workers in the United States fell 44 percent. The Food and Fiber Commission says that in the last 10 years, one farm out of every four has ceased to exist. Shaffer cites the tension and frustration that have developed in the farm areas. He says the system is coming unstuck. This is in spite of substantial gains, during the last decade, in per capita real income for farm people. It may well be that the uneasiness in the agricultural areas arises in large part from psychological reasons. Agrarianism is being assaulted by technological change. Familiar ways of doing things are disappearing and new values have not emerged to take their place.

There is little question as to what has been instrumental in causing the profound technological changes that Shaffer describes. Chiefly responsible are tremendous inputs of research and education, about half of which have been supplied by public agencies. Those who are industrializing agriculture are simply applying the results of this research. The industrialization of agriculture, which gives rise to the problems we will discuss in this seminar, is not some autonomous managerial invention; it is the natural consequence of our scientific research. Our research inputs have been very great. According to a study of the 1915 to 1960 experience, done by Robert Latimer at Purdue, State Experiment Station expenditures for research from federal and state appropriations and from private sources increased by a compounded annual rate of 11 percent. Increases have continued into the 1960's, though recently the rate of increase has been less. Expenditures for extension work have shown similar behavior.

On the cover page of Shaffer's paper, offered without comment but with seeming approval, is a quotation from Alfred North Whitehead: "The major advances in civilization are processes that all but wreck the societies in which they occur." The idea here is one to which I personally subscribe: that the relationship between the rate of technological change in a society and the general good that accrues

to the society is in the form of a curve, with a low reading for a semi-stagnant economy, reaching a maximum at some intermediate rate of technological change, and taking on a negative slope when the rate of change exceeds some optimum point. This is contrary to the conventional view, held by almost all physical scientists, that the relationship of the rate of technical change in a society and the general good resulting therefrom is positive, linear and steep. The prevalent view equates change with progress and holds that technological change is good, that more change is better, and that the most rapid possible technological change will result in the most desirable situation.

Even if one accepts the idea that the relationship is curvilinear, he still will be unable to chart it accurately, or to indicate our present position thereon. I judge that Shaffer feels there is such a curve and that we may be approaching its apogee, or we may be at it, or we may be somewhat past it. My own view is that we are near enough to the maximum point on this curve to give us pause when we consider policy alternatives. We are all familiar with the Phillips Curve, which postulates incompatibility between the twin goals of stable prices and full employment. There must be some trade-off between them. There may well be a comparable trade-off between the twin goals of stability and progress in the agricultural sector, and we may be at a position in which the incremental value of a unit of stability exceeds the value of yet another increment of what we call progress.

If change is indeed coming more rapidly than it can readily be assimilated, then the logical thing would be to check the flow of public funds which fuel the change. The total input for agricultural research and development, public and private, is now approximately a billion dollars a year. We are spending approximately three billion dollars a year through acreage retirement programs, to induce farmers to forego full use of the new knowledge. It must be that we have collectively passed some form of adverse judgement on the utility of our new agricultural knowledge or we would not undertake such expensive programs to avert its full use.

Even to raise a question before a group of Land Grant college people about the appropriateness of the Experiment Station effort in research may be interpreted as an act of heresy. Behind our present effort is a century of precedent and momentum. We tried to change the direction of research while I was in the Department of Agriculture, away from strict production research and in the direction of facilitating adjustment. About all that happened was that we succeeded in renaming a few projects, getting the word "adjustment" inserted in the titles, with no real change in the nature of the studies.

Our farmers now supply America with the best diet in the world at the lowest relative cost in history, 18 percent of the

consumer's income. We might well ask whether farmers should be subjected to a yet faster pace of change, to be industrialized even more rapidly, in order to drive that figure a point or two lower. It is a fair question, not to be answered dogmatically or out of a conditioned reflex based on a hundred years of Land Grant philosophy.

Many years ago in England the industrial revolution resulted in dislocations and social problems that were largely ignored. It has become common to criticize the leaders of that day for their callousness. It may be appropriate to ask whether we who promote today's agricultural revolution may in time come under similar indictment.

There are two persuasive arguments for a continued high level of the public support which undergirds the drive toward an industrialized agriculture. First, it is important that there be cost-lowering technology to permit us to compete more effectively in international markets. Second, there will be need for agricultural technology with which to help meet world food problems. It may be that these two considerations outweigh in importance all of Shaffer's and my own misgivings about the rate of change, the industrialization of agriculture and the erosion of recognized social values. We may be on a treadmill of industrialization that we can't stop.

You will note that I speak more from a sense of concern than from conviction as to precisely what should be done. But I do have some general views. I think we should reorient our research, working more on agricultural adjustment, rural poverty, and world agricultural development. The invention of new institutional forms that would help more family farms to survive the technological revolution, and the development of new ways to help farmers preserve their decision-making role seem to me priority items for research and policy.

In any case, the problems that now confront us pose a real challenge. They are the problems of dynamism rather than stagnation, of abundance rather than scarcity. That fact that research has helped to bring these problems about should give us added incentive to work toward their solution.

I like Shaffer's second cover-page quotation, this one from Marshall McLuhan: "There is absolutely no inevitability as long as there is a willingness to contemplate what is happening." And it is vital to know what is happening. No prescription is likely to be helpful unless it is based on good diagnosis. I think Shaffer has told us what is happening with a good deal of accuracy.