PUBLICACION MISCELANEA No. 223
DOCUMENTO PROTAAL No. 57

PROYECTO COOPERATIVO DE INVESTIGACION SOBRE TECNOLOGIA AGROPECUARIA EN AMERICA LATINA "PROTAAL"

MECHANIZATION IN CALIFORNIA AGRICULTURE: THE CASE OF CANNING TOMATOES

Alain de Janvry
Phillip LeVeen
David Runsten

IICA
INTER-AMERICAN INSTITUTE OF AGRICULTURAL SCIENCES
OFFICE OF THE ASSOCIATE DEPUTY DIRECTOR GENERAL FOR RURAL DEVELOPMENT

San Jose, Costa Rica November, 1980

BACKGROUND INFORMATION ON THE PROTAAL PROJECT

The Cooperative Research Project on Agricultural Technology in Latin America (PROTAAL) aims to develop a series of research efforts dealing with the nature of the agricultural technological change process in the region. This work is being carried out with the cooperation of the Inter-American Institute of Agricultural Sciences (IICA), which acts as the executor agency, the Ford Foundation, the United Nations Development Program (UNDP), and the International Development Research Centre (IDRC) of Canada.

The Project provides an integrated analysis of the process; that is, it views the process of generation and transfer of technology as a phenomenon endogenous to the society in which it develops. This analysis aims to provide information that will improve the understanding of the technological problem, and consequently, the definition of policies, organizational models and actions that will contribute to technological progress and the development of the agricultural sector.

Project activities began on January 1, 1977, and organizationally, they developed for the most part with the participation of official and private research teams in a number of countries on the continent.

Within the same general framework, the PROTAAL Project has also conducted a special research project entitled: National Agricultural Research Systems in Latin America. A comparative analysis of human resources in selected countries. It received funding from the Rockefeller Foundation and IICA.

Finally, in May 1980, a second phase of the Project (PROTAAL II B: "Technical Change in the Small Farm Sector") began with special funding from the Government of Holland. It aims to intensify the analysis of the technological process in the campesino farm sector. Case Studies for this new phase are expected to take place in Brazil, Peru, Ecuador, Colombia and Costa Rica, and provide information that will facilitate better management of the technological variable in rural development programs and projects.

In order to disseminate the research findings, and to generally improve the exchange of information, the Project publishes the following three types of papers and monographs:

a. Papers on methodologies and on empirical research findings resulting from central Project activities.

b. Papers dealing with activities related to the Project.

c. Papers written by Project staff, and eventually by other authors involved in Project activities, which prove useful to the development of the Project.

Inasmuch as the papers are not usually published in final form, critical commentaries are welcome.

PROYECTO COOPERATIVO DE INVESTIGACION SOBRE TECNOLOGIA AGROPECUARIA EN AMERICA LATINA (PROTAAL)

Lista de Publicaciones[1/]

TRIGO, E., ARDILA, J. y PIÑEIRO, M. Sistemas nacionales de investigación agropecuaria en América Latina; análisis comparativo de los recursos humanos en países seleccionados; antecedentes y propuestas metodológicas. Colombia. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 26. 1978. 28 p.

MUÑOZ, J., FIORENTINO, R. y PIÑEIRO, M. Inventario tecnológico del cultivo de la papa en Colombia y aspectos económicos de las nuevas técnicas propuestas. Colombia. Instituto Colombiano Agropecuario. División de Estudios Socio-Económicos. PROTAAL, Documento No. 27. 1978. 68 p.

TRIGO, E., PIÑEIRO, M. y ARDILA, J. Modelos de generación tecnológica en América Latina: notas para una evaluación crítica. Colombia, Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 28. 1978. 16 p. (circulación restringida).

publicado también como:

_____. Modelos de generación tecnológica en América Latina: notas para una evaluación crítica. Desarrollo Rural en las Américas. Costa Rica. 11(2): 85-100. Mayo - Agosto de 1979.

VERDUGA, C. y COSSE, G. Algunas consideraciones sobre las políticas estatales para el agro ecuatoriano. Colombia, Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 29. 1978. 36 p. (publicación miscelánea).

FIORENTINO, R. Notas sobre la evaluación de la naturaleza del cambio tecnológico. Costa Rica. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 30. 1979. 31 p.

1/ Un listado de los documentos PROTAAL 1 al 25, puede ser solicitado. Las publicaciones de la presente lista, pueden ser obtenidas, solicitándolas a la: Secretaría de PROTAAL, Subdirección Adjunta de Desarrollo Rural, Instituto Interamericano de Ciencias Agrícolas (IICA). Apartado 55, 2.200 Coronado, Costa Rica. Aquellas publicaciones que se encuentren agotadas, serán fotocopiadas al costo, si ésto es solicitado.

PIÑEIRO, M., TRIGO, E. y FIORENTINO, R. Technical change in Latin American agriculture - a conceptual framework for its interpretation. Food Policy. England. 4(3): 169-177. Agosto 1979. PROTAAL, Documento No. 31

VIGORITO, R. Generación y difusión de tecnología en la ganadería vacuna uruguaya. Uruguay. Centro de Investigaciones Económicas. PROTAAL, Documento No. 32. 1979. 32 p.

ASTORI, D. La disponibilidad de tecnología para la ganadería vacuna uruguaya. Uruguay. Centro de Investigaciones Económicas. PROTAAL, Documento No. 33. 1979. 91 p.

BARBATO, C. y PEREZ, C. La ganadería vacuna uruguaya; caracterización general. Uruguay. Centro de Investigaciones Económicas. PROTAAL, Documento No. 34. 1979. 69 p.

FLORES, O., GRILLO, E. y SAMANIEGO, C. Caso de la papa en el Perú. Costa Rica. Instituto Interamericano de Ciencias Agrícolas. PROTAAL , Documento No. 35. 1979. 58 p.

PIÑEIRO, M., TRIGO, E. y KAMINSKY, M. Políticas de tecnología y apropiación de excedentes bajo condiciones de integración vertical y cartelización de la oferta. El caso de la producción azucarera en Colombia. Colombia. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 36. 1979. 46 p.

PIÑEIRO, M. et.al. El proceso de generación, difusión y adopción de tecnología en la producción azucarera de Colombia. Costa Rica. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 37. 1979. p. irr.: (543).

SABATO, J.F. Las políticas frente al estancamiento y a la transformación del agro pampeano. Costa Rica. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 38. 1980. 41 p.

TRIGO, E. y PIÑEIRO, M. Modernization and institutional change in market economies. The dynamics of agricultural research organization in Latin America. Costa Rica. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, documento No. 39. 1980. 21 p. (aceptado para publicación en Food Policy en Febrero de 1981).

BARSKY, O. et.al. El proceso de transformación de la producción lachera serrana y el aparato de generación-transferencia en Ecuador. Ecuador. Facultad Latinoamericana de Ciencias Sociales. PROTAAL, Documento No. 40. 1980. p.irr. (604).

MARULANDA, O. et.al. Estudio del proceso de generación, difusión y adopción de tecnología en la producción de arroz en Colombia. Colombia. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 41. 1980. 8v. 346 p.

FLORES-SAENZ, O., SAMANIEGO, C. y GRILLO, E. Política de abastecimiento de alimentos y cambio técnológico: el caso de la papa. Perú. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 42. 1980. 299 p.

BARBATO, C. et.al. El proceso de generación, difusión y adopción de tecnología en la ganadería vacuna uruguaya (1950-1977). Uruguay. Centro de Investigaciones Económicas. PROTAAL, Documento No. 43. 1980. 2 v. p. irr. (780).

SABATO,J.F. et.al. El agro pampeano y la adopción de tecnología entre 1950 y 1978: un análisis a través del cultivo del maíz. Argentina. Centro de Investigaciones Sociales sobre el Estado y la Administración. PROTAAL, Documento No. 44. s.f. s.p. (versión preliminar).

ALVES, M. y FIORENTINO, R. A modernizaçao agropecuaria na sertão de Pernambuco. Brasil. Universidad Federal de Pernambuco. Departamento de Economía. PROTAAL, Documento No. 45 A. 1980. 93 p. (versión preliminar)

MUÑIZ, R. Modernizaçao tecnologica na pecuaria leiteira em Pernambuco. Brasil. Universidad Federal de Pernambuco. Departamento de Economía. PROTAAL, Documento No. 45 B. s.f. 77 p. (versión preliminar).

ARDILA, J., TRIGO, E. y PIÑEIRO, M. Sistemas nacionales de investigación agropecuaria en América Latina: análisis comparativo de los recursos humanos en países seleccionados: resumen metodológico y planteo operativo de la investigación. Colombia. Instituto Interamericano de Ciencias Agrícolas. (PROTAAL) Documento No. 46. 1980. 36 p.

ARDILA, J. et.al. Sistemas nacionales de investigación agropecuaria en América Latina: análisis comparativo de los recursos humanos en países seleccionados. El caso del Instituto Colombiano Agropecuario (ICA). Colombia. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 47. 1980. 148 p.

ARDILA, J., REICHART, N. y RINCON, A. Sistemas nacionales de investigación agropecuaria en América Latina: análisis comparativo de los recursos humanos en países seleccionados: el caso del Instituto Nacional de Tecnología Agropecuaria de Argentina (INTA). Colombia. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 48. 1980. 82 p.

ARDILA, J., TORRES, R. y TRIGO, E. Sistemas nacionales de investigación agropecuaria en América Latina: análisis comparativo de los recursos humanos en países seleccionados. El caso de la Universidad Agraria de La Molina del Perú. Colombia. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 49. 1980. 92 p.

ARDILA, J., TRIGO, E. y PIÑEIRO, M. Sistemas nacionales de investigación agropecuaria en América Latina: análisis comparativo de los recursos humanos en países seleccionados. Los casos de Colombia, Argentina y Perú. Colombia. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 50. 1980. 61 p.

PIÑEIRO, M. et. al. Relaciones sociales de producción, conflicto y cambio técnico: el caso de la producción azucarera de Colombia. Costa Rica. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 51. 1980. 47 p. (Also available in english)

LAZO, J. Situación mundial de la productividad en maíz, arroz, papa, caña de azúcar y leche. Costa Rica. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 52. 1980. 40 p.

TRIGO, J., PIÑEIRO, M. y ARDILA, J. Aspectos institucionales de la investigación agropecuaria en América Latina: problemas y perspectivas. Costa Rica. Instituto Interamericano de Ciencias Agrícola. PROTAAL, Documento No. 54. 1979. 37 p.

publicado también como:

_____. Aspectos institucionales de la investigación agropecuaria en América Latina: problemas y perspectivas. In Desarrollo Rural en las Américas. Costa Rica. 11(2): 3-25. Enero-Abril de 1980.

MURMIS, M. Tipología de pequeños productores campesinos en América Latina. Costa Rica. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 55. 1980. 41 p.

DE JANVRY, A. and CROUCH, L. Technological change and peasants in Latin America. Costa Rica. Instituto Interamericano de Ciencias Agrícolas. PROTAAL, Documento No. 56. 1980. 91 p.

DE JANVRY, A.; LEVEEN, P. and RUNSTEN, D. Mechanization in California agriculture: the case of canning tomatoes. Costa Rica, Instituto Interamericano de Ciencias Agrícolas, PROTAAL, Documento N°57, 1980. 212 p.

SABATO, J.F. El agro pampeano argentino y la adopción de tecnología entre 1950 y 1978: un análisis a través del cultivo del maíz. Resumen de un estudio de caso. Costa Rica, Instituto Interamericano de Ciencias Agrícolas, PROTAAL, Documento N°58. 94 p.

BARBATO, C. et.al. El proceso de generación, difusión y adopción de tecnología en la ganadería vacuna. Uruguay (1950-1977). Resumen de un estudio de caso. Costa Rica. Instituto Interamericano de Ciencias Agrícolas, PROTAAL Documento N°59, 1980.

MECHANIZATION IN CALIFORNIA AGRICULTURE: THE CASE OF CANNING TOMATOES

by

Alain de Janvry, Phillip LeVeen and David Runsten*

This study was funded through the PROTAAL PROJECT of the Instituto Interamericano de Ciencias Agrícolas — OEA and the Ford Foundation.

*The authors are, in respective order, Professor, Department of Agricultural and Resource Economics, University of California, Berkeley; Director, Public Interest Economics-West; Graduate Research Associate, Department of Agricultural and Resource Economics, University of California, Berkeley.

Berkeley, California
September 1980

TABLE OF CONTENTS

MECHANIZATION IN CALIFORNIA AGRICULTURE: THE CASE OF CANNING TOMATOES

by

Alain de Janvry, Phillip LeVeen, and David Runsten

PART I

THE PURPOSE OF THIS STUDY

The social tensions associated with rapid mechanization of vegetable and fruit production have recently been dramatized by two unprecedented events. A political association of small farm owners and farmworkers, the California Agrarian Action Project, filed a law suit against the University of California charging it with conducting research that principally benefits large growers and agribusiness corporations and displaces both small producers and farmworkers (Knickerbocker, 1979). Specifically, this action group denounced the existence of close economic ties between the university and agribusiness corporations as well as the university research funding policy whereby small agribusiness grants can divert large sums of public research money toward the interests of the large corporations. More recently, the United States Secretary of Agriculture abruptly cancelled all federal research funds supporting work on the development of labor saving technological innovations in California. This decision created the threat that state funds, which represent the bulk of research funding, could also be curtailed for the same reason.

These developments only illustrate the fact that mechanization in

California agriculture has become an active political issue. For many years, California agriculture has relied upon abundant supplies of cheap foreign labor, coming mainly from Mexico. As the rural labor market was maintained segmented from the rest of the economy, this allowed the mechanization of these specialty crops to be postponed. In 1964, when the entry of Mexican agricultural labor became severely limited by new immigration laws, a strong inducement was given to introduce mechanical harvesting techniques. Technological change thus became the focus of attention of growers, processors, and financial interests in defending the profitability of agriculture instead of lobbying for favorable labor and economic policies.

For example, in the interval of just a few years, the harvesting of canning tomatoes, one of the main specialty, labor-intensive crops in California, was fully mechanized, leading to the massive displacement of workers, to qualitative changes in the labor process, and to rapid concentration of production. The technology for mechanical harvesting had been developed by the University of California over a period of more than twenty years through a combination of mechanical engineering and horticultural research in order to develop jointly both the machine and the tomato plant necessary to its effective operation. A few years after the harvesting of tomatoes had been fully mechanized, and as the unionization of farmworkers was again exerting upward pressures on wages, new innovations were introduced to sort tomatoes electronically in the field, further reducing labor needs, changing the nature of the labor process, and fomenting greater economies of size.

The history of the innovation and diffusion of technological change in tomato production in California is strongly conditioned by three factors that

we will use as explanatory categories throughout this study:

(i) Technological change in agriculture is part of a broader process of UNEQUAL DEVELOPMENT among regions, activities, stages of production within activities, and farms;

(ii) The STRUCTURE of the labor market and SOCIAL CONFLICTS over the control of the labor process are key determinants of the pattern of mechanization;

(iii) Economic forces external to the farm deriving from the direct and commercial, financial, and bureaucratic-political interests determine, at least in part, the direction and timing of technological change in agriculture.

In the following report, we first outline the model of technological change used to analyze mechanization of tomato production in California. This model uses the categories of political economy in the particular elements of the theory of the state. We then provide the historical background of social relations and productive forces in California, emphasizing the constant dialectic between the labor process, labor markets, mechanization, and the role of the state. Finally, we give a detailed description of the process of inducement, innnovation, diffusion, and impact of mechanical tomato harvesting. We conclude with a number of propositions, which derive from empirical observations, that serve to enrich the theory of the political economy of technological change.

The Generation and Diffusion of Technological Change: Weakness of Conventional Theory

In the literature of neoclassical economics, there exist two dominant theories of technological change in agriculture. One is the theory of induced

innovation developed by Hicks, Fellner, and Ahmad which Hayami and Ruttan have applied to the case of agricultural technology (Hicks, 1964; Fellner, 1961; Ahmad, 1966; Hayami and Ruttan, 1971). It is fundamentally concerned with explaining the BIAS of technological change; that is, of predicting which factor of production will be the object of economizing technological change. This process is seen to be market determined: relative factor scarcities are reflected in relative factor prices. Relative factor prices set up profit incentives that guide technological research toward saving the expensive factor. In the Marshallian tradition, the active social agents are the individual producers motivated by the quest for profits, while scientists and agribusiness entrepreneurs are seen as responsive to these demands. As Hayami and Ruttan explain it, "farmers are induced, by shifts in relative prices, to search for technical alternatives which save the increasingly scarce factors of production. They press the public research institutions to develop the new technology and, also, demand that agricultural firms supply modern technical inputs which substitute for more scarce factors. Perceptive scientists and science administrators respond by making available new technical possibilities and new inputs that enable farmers to profitably substitute the increasingly abundant factors for the increasingly scarce factors, thereby guiding the demand of farmers for unit cost reduction in a socially optimum direction (Hayami and Ruttan, 1971, p. 57).

The second theory of technological change is that of the "technological treadmill," developed by Cochrane and Owen (Cochrane, 1958; Owen, 1966). It concentrates on explaining the RATE of technological change which is also determined by market mechanisms: profit seeking producers adopt new innovations and capture short-run Schumpeterian profits. But, as the

innovation diffuses more extensively, production increases and prices fall, eliminating differential rents until new innovations again set off another round of the treadmill process. If product prices are not affected by changes in supply, either because the country exports to the world market or because of price support programs, the technological treadmill operates through rising land prices instead of falling product prices. As in the theory of induced innovation, the active social agents are profit seeking entrepreneurs and responsive scientists with market mechaniams forcing both surplus creation via technological change and surplus extraction via falling product prices or rising land prices.

The main problems with these two theories is that, like all neoclassical economics, they reduce social processes to market and individual phenomena, they fail to identify the role of social classes in influencing the innovation and diffusion of technology and consequently, they cannot explain the bahavior of institutions and of the state even when these are essential determinants of technological change in agriculture. The visible phenomena — market prices and individual responses to their changes -- are taken as explanatory categories when the essence of these phenomena, namely the social proceses that underlie them, remain unexplained.

Since technology is a social product and since the growth and income effects of technolgy are determined not just by the nature of technology but by the social relations where it diffuses, it is essential to go beyond the market theories of technological change. To do this, we must relocate technology within the dialectic between productive forces and social relations, between objective and subjective forces, and between infra and super-structure. this requires developing a theory of technological change within the context of

political economy.

Towards an Alternative Conception of Induced Innovation

For purposes of presentation, we will distinguish among three stages in the process of technological (and institutional) change in agriculture. First, the INDUCEMENT of technological innovations determines a latent (potential) demand for innovations. For a given state of scientific knowledge at one point in time, there exists a latent supply of innovations. For a given social class and economic structure, this latent supply translates into a matrix of expected payoffs and losses that each class or fraction of class expects to derive from each alternative latent innovation. There are consequently three important levels of analysis in this first stage: (1) the social class structure; (2) the economic structure; and (3) the matrix of expected payoffs.

Second, the INNOVATION process itself translates a latent demand for innovations is translated into an active supply of innovations. This occurs via the response of both the private and public sectors to these demands. In the case of the public sector, it requires an analysis of the institutions and mechanisms of the state in dealing with its functions of accumulation and legitimation and of the degree of autonomy of the state relative to particular class demands. The allocation of public expenditures to specific research lines determines an effective demand for innovations to which the public innovation-producing institutions can respond. The outcome is an actual supply of innovations.

The third and final step consists of the DIFFUSION of technologies which leads to changes in both productive forces and social relations. It is those changes that determine the vector of actual payoffs for each social group. The

payoffs are conditioned by the nature of technlogy and by the social and economic structure through which it diffuses. The concretization of these payoffs in turn, creates new expected payoffs from the perceived supply of other technological innovations.

The key questions of interest to us here are the social processes whereby technological change occurs and, in particular:

(i) the specific and interrelated roles of the public and private sectors in generating new technology;

(ii) the degree of autonomy of the state in handling technological policy and in particular,

--the role of the research institutions (research administrators and scientists) in establishing priorities;

--the role of the legislative and executive branches of government (budget appropriations, vetoes and priorities);

--the role of corporatist organizations (marketing boards), private lobbies, and monopolies in influencing public research.

(iii) the role of specific economic and political crises in modifying the relative autonomy of the state and the purpose and means of public intervention in the realm of technology.

CITATIONS: PART I

Ahmad, S., "On the Theory of Induced Invention," Economic Journal, LXXVI (June 1966), pp. 344-57.

Cochrane, W.W., Farm Prices: Myth and Reality, (Minneapolis, University of Minnesota Press, 1958), see Section III.

Fellner, W., "Two Propositions on the Theory of Induced Innovation," Economic Journal, LXXI (June 1961), pp. 305-08.

Hayami, Y. and V. Ruttan, Agricultural Development: An International Perspective (Baltimore: Johns Hopkins Press, 1971).

Hicks, J.R., The Theory of Wages (London: The Macmillan Co., 1964).

Knickerbocker, B., "Trouble for Tomato-Picking Machines: U.S. to Farm Farmhand Instead," The Christian Science Monitor, Monday, Dec. 24, 1979, p. 1.

Owen, W.F., "The Double Developmental Squeeze on Agriculture," American Economic Review, LVI (March 1966), pp. 43-70.

PART II

THE POLITICAL ECONOMIC CONTEXT: CALIFORNIA AGRICULTURE'S UNIQUE DEVELOPMENT AND THE CHOICE OF TECHNOLOGY

This section of the study presents an historical analysis of the evolution of California's unique agricultural system. Our purpose is to uncover the social processes, the political relationships, and the interaction of these with the changing economic structure to provide some insight into the dynamic forces that have shaped the agricultural system and the choice of technology. This historical perspective helps to provide an understanding of the role of social class as it operates directly in the private sector and indirectly through the public sector on the material base of the agricultural system. What becomes abundantly clear is that control over the supply of labor and the labor process is the crucial determinant of the forces shaping agricultural development in California. The supply of labor is not exogenously determined by random market forces, but rather is carefully manipulated by a combination of private and public actions. Only when agricultural interests were no longer able to exercise the degree of control over labor that was needed to maintain profitable production did it turn to the alternative of mechanization. Thus, the choice of technology is seen to be the result of a complex interaction of social, political, as well as economic factors.

The Unique Structure of California's Agriculture

California agriculture is unique in three ways. First, its land tenure is dominated by large holdings, and therefore production units are generally

larger than the farms elsewhere in the nation. Second, output per acre, measured in the dollar value of the crops, is greater than elsewhere. This owes to the productivity of land, in combination with the favorable climate for high value fruit and vegetable crops and availability of water for irrigation. Thus, California farms are not only larger, on average, in terms of acreage, but also in terms of the value of output. Third, California farms rely upon hired labor, rather than upon family labor for most of the work in the fields. Family labor has been used chiefly in management. Taken together, these three characteristics describe an agricultural system that can be termed "industrial" in that the farms resemble factories. Under this type of organization, ownership, management, and labor are clearly separated and well-defined activities, each performed by a different group. Perhaps nowhere else in the capitalist world does such a system of agriculture exist. The question is, why does California have such a unique system? That is the subject of the rest of this section.

These characteristics that make California unique are not of recent origin. Although our statistics on farms and farm size are rather sketchy when we look back more than 30 years, as the following two tables indicate, the basic patterns described above were observable in the earliest of our data. For example, Table II.1 shows that as early as 1900, California land was concentrated in very large holdings. Over 50 percent of the cropland was located on holdings of 1000 acres or more in 1900. In sharp contrast, Iowa, a family farm state in the Midwest, had only one percent of its cropland in similarly sized holdings.

Likewise, the concentration of production on the largest farms was much more pronounced in California than in the rest of the nation. In 1939, for

COMPARATIVE AGRARIAN STRUCTURE CHARACTERISTICS:
IOWA, CALIFORNIA, UNITED STATES; 1900-1974

Structural Characteristics	1900	1920	1929	1939	1949	1959	1969	1974
Percent of farms over 1000 acres[a/]								
Iowa	0.0	0.0	0.1	0.1	0.1	0.2	0.8	1.5
California	6.5	4.0	3.5	3.9	4.6	5.5	8.3	6.8
United States	0.8	0.7	1.0	1.5	2.0	3.6	8.0	7.0
Percent of farmland on 1000 acre+ farms[a/]								
Iowa	1.0	0.1	0.1	0.4	0.9	1.0	4.0	7.4
California	50.8	30.0	29.0	35.0	40.4	45.8	51.9	55.4
United States	5.0	5.5	6.7	9.9	15.7	19.9	30.5	33.7
Percent of farms in largest sales class[b/]								
Iowa	7.1	n.a.	3.0	2.0	3.6	5.5	19.3	43.0
California	16.2	n.a.	10.0	6.8	14.0	21.0	27.3	38.5
United States	2.7	n.a.	1.7	1.0	2.8	4.2	12.8	20.7
Percent of total sales in largest class[b/]								
Iowa	n.a.	n.a.	n.a.	16.0	19.0	24.0	54.0	77.8
California	"	"	"	52.0	68.0	78.0	87.0	94.5
United States	"	"	"	17.0	22.0	33.0	57.0	78.0
Value of land and buildings on largest class of farms ($1,000)[b/]								
Iowa	2.8	35.6	19.7	12.6	69.0	114.2	187.4	321.0
California	9.8	26.1	25.2	16.3	170.9	395.8	675.1	789.5
United States	2.9	10.3	7.6	5.5	110.0	220.7	298.2	410.0
Value of machinery and equipment on largest class of farm ($100) [b/]								
Iowa	2.5	11.5	12.6	11.4	n.a.	n.a.	13.3	40.7
California	2.9	11.6	9.9	10.0	"	"	16.7	68.4
United States	1.2	5.6	5.3	5.0	"	"	13.1	27.4
Payment to hired labor (dollars/acre)								
Iowa	n.a.	2.60	1.79		3.04			5.39
California	"	19.12	20.00		47.93			150.00
United States	"	3.16	2.66		8.72			16.45

a/ data refer to harvested cropland only, except for 1920, which is based on "improved" land.
b/ largest class is: 1920, $2,500 in sales; 1929 and 1939, $10,000; 1949, $25,000; all others, $40,000.
Source: U.S. Bureau of the Census, Census of Agriculture, (various volumes, 1900 to 1974).

example, 52 percent of the total farm sales were produced on the 7 percent of California farms that ranked in the highest economic size class. In Iowa, only 16 percent of sales were located on similarly sized farms, and these farms amounted to only 2 percent of all farms.

The importance of hired labor is also evident in the earliest of our data. In 1920, California farmers paid roughly ten times as much, per acre, for hired labor as did Iowa farmers. Table II.2 shows this relationship from a slightly different perspective. In this table we have divided total cropland by the number of workers, both hired and family. As can be seen, California uses much more labor, relative to land, than is typical of the rest of the nation. It can also be seen that while the land/labor ratio is increasing in California at about the same rate as elsewhere, today California agriculture is still much more labor-intensive.

However, the overall trends mask important differences in the components of the labor force. For instance, in California, over the past 40 years, we find a much more rapid displacement of family workers than in Iowa or the rest of the nation. Thus, while California employed more family workers per acre than Iowa in 1935, today it employs far fewer family workers per acre.

this tendency toward fewer workers is reversed when we look at the hired sector of the labor force, for here we find a dramatic reversal in California. Over the past thirty years, Iowa has generally maintained a land/hired labor ratio roughly ten times as great as that of California. But what is even more remarkable, in the face of all of the mechanical, labor-saving technology that has come into use over the period, the land/hired labor ratio has actually been lowered in California. What this implies is that agriculture has become more hired-labor intensive in California over time, because of the increasing

TABLE II.2

Cropland Per Farm Worker by Acres:
Iowa, California, and United States, 1935 to 1978

Farm workers by category	1935	1950	1960	1970	1978
	acres per farm worker; (percent change)				
All Workers					
Iowa	61	67	72	97	95
percent change	(10)	(7)	(35)	(-2)	
California	23	23	26	32	37
percent change	(9)	(4)	(28)	(16)	
United States	29	50	56	74	92
percent change	(38)	(25)	(48)	(24)	
Family Workers					
Iowa	70	76	83	111	115
percent change	(9)	(9)	(34)	(4)	
California	39	51	67	121	152
percent change	(31)	(31)	(81)	(26)	
United States	33	49	69	100	135
Hired Workers					
Iowa	465	560	555	752	520
percent change	(20)	(-1)	(36)	(-36)	
California	54	49	42	44	50
percent change	(-10)	(-14)	(5)	(14)	
United States	225	215	186	286	287
percent change	(-4)	(-13)	(54)	(0)	

Source: U.S. Department of Agriculture, Agricultural Statistics, 1936, 1952, 1962, 1972, and 1979.

cultivation of crops requiring seasonal workers and also because of the substitution of hired for family workers. This latter tendency indicates a basic shift in the underlying structure of ownership and organization of California agriculture, as it moves towards increasing industrialization. Similar tendencies may be present elsewhere in the U.S. but they are not nearly as strong, especially in the family farm state of Iowa, where technology appears to have more or less equal impacts on both hired and family labor.

These unique characteristics of California agriculture require explanation, for if we are to understand the forces underlying the present mechanization of its production, we must first understand how it came to depend upon large-scale production and hired workers. The usual arguments of agricultural economists that farms have grown larger to meet the requirements of large-scale technology appears to be reversed in California where farms were large long before modern mechanical technology appeared. To find the answer to why this unique pattern developed, we first look at the land tenure patterns that emerged as California became a state.

Early Land Tenure:

The patterns of land tenure of the present derive directly from the earliest patterns of landownership, dating from the time California was partitioned from Mexico and became part of the United States. The United States honored claims on California land made during Mexican rule. Almost 14 million acres were originally contained in 813 different land grant claims; of this acreage, about 8.9 million acres (14 percent of the State's total land area) eventually were confirmed in land grants, many of which consisted of several thousand acres. Moreover, these "Spanish" land grants embraced the sites of all the major cities of today and most of the desirable arable land in

the coastal and inland valleys. Naturally, this land became the object of considerable interest by land speculators, and so even when they were initially owned by Mexican nationals, within a very few years, American entrepreneurs had purchased most of the promising grants; and thus the first of the major land empires were established (Gates, 1975, p. 159-160).

In addition to the Spanish Land Grants, there were other means by which individuals could obtain large holdings at low cost. California, on becoming a state, was entitled to receive a portion of the public domain in grants so as to finance its schools and other internal improvements. All told, the State received about 8.8 million acres from the Federal Government for these purposes (Gates, 1975, pp. 161-172). Limits were imposed on how this land could be distributed; no individual was supposed to buy more than a certain maximum acreage, generally this limit was 320 acres for most of the land, and 640 acres for some of the swamp land. However, these limits were not enforced, and with legislators frequently being the beneficiaries, very large acreages were assembled through fraud and corrupt practices. When such practices were challenged in the courts, they were condoned by judges who were strongly influenced by the legislature (see McWilliams, 1971; pp. 11-21).

The Federal Government also conferred large land grants directly to individuals. For example, the railroads were given almost 20 million acres of California land in grants, on the agreement that they would sell the land to settlers at $2.50 per acre and use this money to finance the expansion of the transportation system. Although much of this land was eventually sold (at much higher prices) the railroads retained large tracts of land. A 1919 survey showed that Southern Pacific Railroad owned 2.5 million acres in Southern California alone and was the largest landowner in the state (McWilliams, 1971,

p. 23).

The railroads were also successful in obtaining land given to the State that was supposed to go to settlers. By 1860, for instance, over 1.4 million acres of California's land grants were owned by railorads. In addition to the railroad land grants, the Federal Government also sold over 11 million acres of land to the public under the Homestead Act, which was intended to promote small-scale agriculture of 160-acre farms; however, very little of this 11 million acres found its way into such small holdings.

The results of these public as well as private land sales was a rapid monopolization of land. An 1871 survey showed that the 516 largest landowners owned 8.6 million acres (an average of 16,600 acres per holding) of the most fertile land in California. (McWilliams, 1971; pp. 20-22).

Some of the individual holdings were truly amazing. Miller and Lux jointly amassed almost 700,000 acres in California, and through their control over water rights, they virtually owned still larger tracts. This firm employed 700 hired hands and their livestock herds were estimated at 50,000 to 100,000 cattle, 80,000 sheep, 8,000 horses, and 5,000 hogs in the 1880's. The annual income of the firm was in excess of $1.5 million. (Gates; 1975, pp. 172-173). Miller boasted that he could travel the length of California and never need spend a night off of his property. This example is but one of many; most of the State's prominent and politically powerful families initially achieved power and wealth from the process of accumulating large landholdings. Many of these holdings remain intact to this day, though the ownership may have since passed on to different corporations or individuals.

Evolution of Large-Scale Farming

Such land speculation and concentration of landownership through the manipulation of publiic land distribution policies was not unique to California, although it was certainly much more extreme than elsewhere. Thus while the predominant pattern of land distribution in the Midwest was in family sized parcels of 40, 80, and 160 acres, there were instances of large scale landholdings in many other states. What was unique about California was that the land speculators did not subdivide their holdings and sell them to settlers at high profit, as did their Midwestern counterparts (see Gates, 1975, p. 177). Instead, the large tracts of land were retained and farmed in very large units, right from the very beginning. This pattern contrasted sharply with that of the rest of the nation, where experiments with large farms, using hired rather than family labor, quickly gave way to family farming. In California, the large farms were dependent on hired workers to a much greater extent than on family labor; this dependence on hired workers marked the single most important difference between California and the rest of the nation, excepting the South which retained its heritage of slavery and plantations in the form of a system of share-cropping.

The question is, why was the land retained in these large tracts and not distributed to family farmers, as in the Midwest? Certainly there was a demand for the land by settlers who migrated to California from the East. However, when they arrived in the State, they had great difficulty in finding affordable land to buy and settle. Indeed, struggles over the land by squatters and others who thought they owned the land were very common.

In one well publicized incident, Southern Pacific Railroad, after inviting settlers to begin farming and improving the land, evicted several thousand squatters who had expected to purchase the land. These evictions were

challenged and upheld in the courts, and the efforts to evict the settlers led to a violent confrontation known as the Mussel Slough Affair (see Norris, 1901). So the lack of small-scale settlement was not related to insufficient demand.

The answer to this important question of why the land was farmed in large units is that land in California could be more profitably farmed in large tracts (even before the advent of the labor-intensive, specialty fruit and vegetable crops) than it could in smaller, family-sized units. The reason a profit differential arose was hired labor could be employed at very low wages, and for only the periods of the year when needed. In general, these hired workers accepted lower wages and poorer working conditions than even family settlers were willing to accept (after all, the family could not unemploy itself after the season). As a result, owners of the large tracts were able to earn greater profits from farming the land or from selling it to others who would so farm it rather than from selling the land to settlers. That is, the land's value came to reflect the relatively higher income potential created by cheap labor, and hence family-oriented settlers, intending to duplicate the Midwestern pattern of farming, were unable to afford the land (see Fuller, 1940). So if family settlers wanted to gain a foothold in California, they had little choice but to purchase as much land as possible and use hired workers for the non-management labor tasks of the operation. Those that did not adopt this pattern earned very low incomes and faced considerable incentives to sell their land.

The next obvious question is, why did the pattern of hired, cheap labor develop in California and not elsewhere in the nation? The answer to this is that at the critical point in California's development, large numbers of

immigrant workers were coincidentally available for hire at very low wages and were willing to accept long periods of unemployment. Once this pattern was established, and landowners had a substantial stake in the continuation of the system, they were able to use their wealth to influence both the California and Federal governments to sustain this supply of workers. Because this is an important part of the analysis of the evolution of California's unique agrarian structure, we will discuss these state policies in more detail in the following pages.

A Brief History of Hired Labor in California:

The first large farms utilized the native Indian groups which inhabited California at the time of its entry into the United States. Later, in the immediate aftermath of the gold rush period of the 1850's, hobos and others who had come to California from the East in unsuccessful efforts to find gold were forced into the fields in order to earn their food, at least until they could find better jobs in the growing urban areas or could save enough to return to their homes.

Without doubt, though, it was the influx of Chinese workers in the late 1860's that established the pattern of large-scale agriculture on a permanent basis. The Chinese were imported to the State to do the very dangerous and difficult work of building the first transcontinental railroad through the Sierra mountain range; they were also used in the mining of gold and silver. With the completion of the railroad and the exhaustion of the mines, the Chinese found themselves without jobs and had to look elsewhere. Anti-Chinese sentiment was a growing force in the cities, as the Chinese were looked upon by white workers as a source of competiton for work. Therefore, they were forced

into the fields. Their ability to survive on a very low standard of living and their capacity for hard work made the Chinese extremely desirable workers for the owners of the large farms.

The availablity of large numbers of Chinese workers also allowed California to begin shifting its crop production away from the less labor-intensive grain crop to the much more profitable and labor-intensive fruit crops. The extension of the railroads, linking the State with the Eastern markets, together with the development of new means of preserving fruit further encouraged the change toward specialty crops.

The pattern that resulted from this coincidental convergence of large landholding and availablity of cheap labor was one that has remained to the present day. Crops such as wheat were quickly mechanized, and required little labor, although they still comprised most of the cropland. Indeed, California generally led the rest of the nation in adopting modern labor-saving devices in the grain crops. At this early time, "mechanized" agriculture implied the use of multi-share plows, horse-drawn reapers rather than hand reapers, and machine threshing of the grain, (rather than having horses trod on the grain). Later, California farmers pioneered the use of combines and tractors (Wik, 1975). The seasonal workers were reserved for the higher valued specialty crops, whose sharply peaked labor requirements could only be fulfilled by highly mobile Chinese workers who moved from farm to farm, as the harvest required.

This convenient arrangement between landowners and casual workers was threatened with the passage of the Chinese Exclusion Act of 1882 (Jones, 1970, p. 26). An alliance of urban labor groups and small farmers was successful in forcing legislation to prevent further immigration by people from China; the hostility toward the Chinese further encouraged many to leave the United States

and return to China. Thus, the pool of workers from which California farmers could draw began to shrink after the mid-1880's. Deep economic depression of the 1890's helped them to adapt to this situation, for during this period, white workers unable to find employment in the cities were forced into the fields. Child labor was also used during this period. Moreover, the decade of the 1890's was characterized by economic depression in California's orchard crops, which had over-expanded and were faced with large losses; thus the demand for labor was somewhat lessened at a time of shrinking supply.

The prosperity of the large farms was renewed and strengthened late in the 1890's by the introduction of sugar beets, a very labor-intensive and profitable crop, and by the arrival of thousands of Japanese workers were were recruited by California agricultual interests to take the place of the Chinese.

Like their predecessors, the Japanese proved to be hard working and willing to accept very low wages and seasonal employment. Therefore the Japanese were immediately accepted and put to work. The addition of sugar beets had another important impact on the structure of California agriculture: the crop brought about an integration of the farm and the industrialized processing economies. Sugar refineries were located in rural areas, near the fields. These large factories required extensive highway networks, which provided incentives for other agriculturally oriented industries to develop. Sugar beet production encouraged the development of new labor-intensive crops that could utilize the labor when it was not required to produce sugar beets; for example, strawberry harvest occurs at a different season, so production of strawberries increased rapidly after the beginning of the 20th century (McWilliams, 1971, p. 91). Thus, by the turn of the century, "the farm tended to become a factory and farming became an industry.....some sixty or more crop

industries had been established." (McWilliams, 1971, p. 91)

The Japanese proved much less easily controlled than the Chinese. They brought with them their own organization, and effectively used this to win wage concessions (Light, 1972, p. 169). But what changed large landowner attitudes even more was the ability of the Japanese to set themselves up as farmers. They brought with them the knowledge of farming under very marginal conditions, and used this knowledge to buy or lease undesirable and cheap agricultural land, which was then improved and profitably cultivated. In this way, the Japanese not only ceased to be accessible as hired workers, but also became competitors with fruit and vegetable producers. By 1918, for example, Japanese farmers cultivated more than 25,000 acres of rice, a crop they introduced to California (Poli, 1944, p. 9).

In response to the growing hostility of the general public to the Japanese, the U.S. negotiated a "gentleman's agreement" with the Japanese government to restrict further emmigration to the U.S. (see Appendix). This did not stop Japanese immigration, however, for it was possible to go to Hawaii, Canada, or Mexico and then gain entry to the U.S. Not until the passage of the Immigration Act of 1924, which prohibited entry of any person of Japanese origin, did this immigration come to a stop.

Immigration may have been slowed down by another set of disincentives that arose with the passage of the Alien Land Acts of 1913 and 1919. This California legislation was intended to inhibit Japanese access to land and to prevent their escape from the agricultural labor pool. These acts may have been marginally successful, but the Japanese found ways to purchase land through their American born children, and continued to lease and rent land that only they, with their knowledge of intensive agriculture, wanted. In any

event, after the first decade of the 20th Century, the supply of Japanese workers to California farmers was gradually diminished, leaving the farmers in a position of needing a new source of cheap labor.

It was the rapid expansion of the California agricultural economy during World War I together with the diminishing number of Chinese and Japanese workers that encouraged the last important groups of immigrant workers to the fields of California. Young, single, and male Filipino workers were imported in relatively large numbers and were used in asparagus and other stoop labor production. But by far the most significant new source of labor was from Mexico. The use of this source of labor increased rapidly during the very prosperous war years, and expanded even more during the decade of the 1920's, in response to the further intensification of agriculture, as cotton (a very labor intensive crop) was introduced and widely cultivated.

Until World War I, California farmers had been very reluctant to employ Mexicans, because they believed the Mexicans to be lazy and unreliable, especially in comparison to the Chinese and Japanese workers. However, farmers were willing to change their attitudes when they were faced with having to find their labor supplies in the traditional domestic labor markets, and so Mexican labor quickly became the dominant portion of the unskilled field labor during the 1920's and into the Depression years of the 1930's.

With the Depression, came the last important episode of the evolution of the unregulated agricultural labor market. A combination of drought, the introduction of the tractor, and New Deal agricultural policies served to destroy a substantial part of the South's sharecropper system of agriculture, and displaced thousands of farmers, many of whom were white. With the urban labor markets incapable of absorbing this labor, California became the direct

beneficiary as thousands migrated to its fields to pick cotton and fruit for wages of 15 cents per hour (wages of 35 cents per hour had been common in the late 1920's).

The influx of poor whites had the same impact as the influx of other immigrant groups, with some important differences. The whites brought their families and anticipations of becoming part of the mainstream economy. They were discriminated against by Californians, who regarded them as inferior; even though the immigrants were white they were treated as other racial minorities. However, the plight of these white farmworkers was given national attention by New Deal liberals, and special public policies were established; a variety of farm labor regulations and housing policies were implemented to reduce the worst effects of the agricultural labor system, over the active opposition of the agricultural interests.

The Second World War improved the employment opportunities for whites and all other groups, leaving a labor shortage in the fields. At this point, California began a new era in its agricultural development which lasted from the war years to the mid-1960's. What characterized this new period was the development of a cheap labor market explicitly regulated by government policy. In order to alleviate the supposed labor shortage of the war years, the United States government entered into a formal agreement with Mexico to supply sufficient unskilled workers to meet the "needs" of the specialty-crop farmers in California, Arizona, Texas, and elsewhere (Jones, 1970, p. 37). California employed most of these emergency workers; for example, 90 percent of the Mexicans brought to the United States in 1945 were employed in California.

The emergency program was ended in 1947, to be replaced by a series of annual agreements until the Korean War again provided an "emergency" situation

that permitted California farmers to urge the enactment of a more permanent relationship. These demands were met with the enactment of Public Law 78, popularly known as the Bracero Program, in 1951. Regulation of the field labor markets had some drawbacks from the farmers' point of view, for Mexico insisted on some safeguards for contract workers, including minimum standards for housing, pay, and perhaps most important, the guarantee of work. Under the Bracero Program, workers were recruited for specific crops and specific jobs; they could not be included in a general pool of labor intended for the use of any employer.

Nevertheless, in spite of these restrictions, California growers became dependent on this program and strongly supported it. Contract workers provided approximately 30 percent of all seasonal labor in California during the 1950's and 1960's; in some crops such as tomatoes, the entire seasonal labor force consisted of Bracero workers.

For reasons that we shall explore below, the Bracero Program became a political liability for the Federal Government, and over the strenuous efforts of California agricultural interests, the program was eliminated in 1964. The elimination of this program ended the era of the regulated labor market in California's agriculture, and presented farmers with an important crisis. If cheap labor could not be imported from Mexico, where would the seasonal labor force be found? If farmers had to compete with the urban labor markets, wages and working conditions would have to improve, thus threatening farmer and landowner incomes. Moreover, if the surplus supply of workers were to dry up, union organization, kept in check by the combination of the surplus and the vigorous efforts of the agricultural interests (and their allies in local government), would become increasingly feasible.

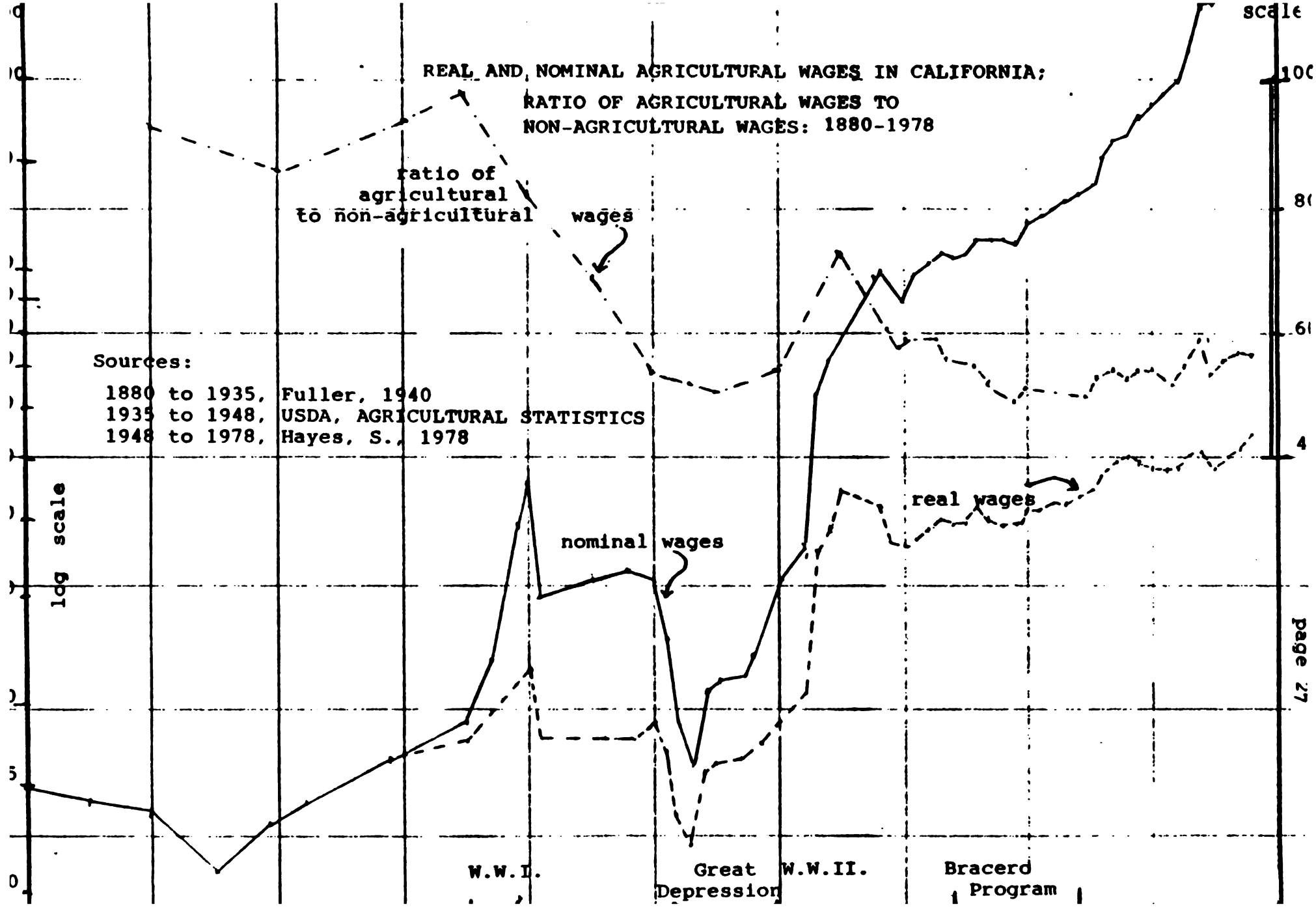
In short, with the termination of the Bracero Program in 1964, the prospects for California agriculture seemed bleak. However, several new strategies were developed that allowed the continued profitable expansion of specialty-crop agriculture in the face of rising farmworker wages and improved working conditions; we will examine these strategies in more detail after first summarizing the important implications of this brief history of California's agricultural labor history.

The Importance of Immigrant Labor to California Agriculture

The logic of the relationship between labor and California's agrarian structure has been developed in detail by such experts as Fuller (1940), McWilliams (1971 and 1976) and Burowoy (1976). In this section, we wish to highlight some of the implications of immigrant labor in California.

The essential characteristic of this supply of labor is its willingness to accept low wages, uncertain and temporary work, substantial periods of underemployment, and poor working conditions. Workers were not guaranteed employment, and when the work on one farm ended, it was up to the individual worker to find another job. Without a virtual army of individuals looking for such short-term employment, specialty crop production, which requires large numbers of workers for short, seasonal activities such as the harvest, would not have been able to expand. That is, the key to the successful development of highly profitable fruit, vegetable, sugar, and other labor-intensive crops was a labor supply of casual workers willing to work for very low wages.

The evidence of this manipulation of the labor suppy can be seen in Figure II.1, which documents nominal and real wages (discounted for inflation) of farmworkers in California and the position of agricultural workers, relative


REAL AND NOMINAL AGRICULTURAL WAGES IN CALIFORNIA;
RATIO OF AGRICULTURAL WAGES TO
NON-AGRICULTURAL WAGES: 1880-1978
ratio of agricultural to non-agricultural wages
Sources:
1880 to 1935, Fuller, 1940
1935 to 1948, USDA, AGRICULTURAL STATISTICS
1948 to 1978, Hayes, S., 1978
log scale
nominal wages
real wages
W.W.I.
Great Depression
W.W.II.
Bracerd Program
scale
100
80
60
4
page 27

to nonagricultural workers, expressed as the ratio of agricultural wages to those of similarly skilled workers in the rest of the economy. As can be seen, except for the very early years, farm wages have been very much below those of the nonfarm economy. It should be recalled that the typical farmworker does not work full-time, whereas his counterpart in the nonfarm economy is likely to have much more stable employment. Thus not only are wages low in the farm economy, but also employment is much less stable in comparision to the nonfarm economy. This combination implies much lower incomes for farmworkers (see Appendix).

Low wages were important in order to keep prices of the products sufficiently low to attract a large market. Growers as well as processors and distributors thus had a great stake in keeping labor costs as low as possible. Casual labor was necessary to keep the grower from having to pay the costs of workers when they were not needed. Had the grower been required to guarantee full-time employment, labor costs would have been much greater. Under such conditions, family farmers, using their own labor, could have successfully competed with large-scale producers. Thus the economic viability of large-scale farming, as well as the prosperity of the specialty crop agricultural production both required that the grower not be required to pay for workers when there was no work (McWilliams, 1976: 164-65).

The dependence on cheap labor became stronger with the passage of time, for as Fuller points out, the cheapness of labor resulted in higher income to landowners and, as land exchanged hands, the value of this additional profitablity was capitalized into the price of the land, hence:

> "...owners who have purchased their land at values already based upon the income received from the employment of cheap labor stand not to

> make large gains from the continued employment of cheap labor. On the other hand, if, after buying land capitalized on such a basis, real wages, ceteris paribus, commence to rise, the owner stands to suffer more than book losses" (Fuller, 1940, p. 19866).

In other words, landowners were committed to the maintenance of the system of cheap labor just to sustain their investment in the land. Any threat to the system was a threat to the wealth position of landowners. Given the magnitude of this wealth and its concentration, there were very strong incentives to see that the system was not disrupted.

The financial institutions understood this logic, for they loaned money to the large producers, and secured the loans against the value of the grower's land. Any disruption of the labor system would have had negative impacts on the banks as well as on the landowners, the processors and distributors of the fruit, sugar, and other specialty crops. In short, the entire agricultural economy developed an economic dependence on the continuation of the cheap labor system.

From the perspective of maintaining the supply of cheap labor, it was crucial to find first generation immigrants to do much of the agricultural work. Immigrants came to California with much different expectations, and from countries in which economic conditions were even more depressed than those of farmworkers in California. They were willing to accept the low incomes and hard work of farmworkers because of this difference in the nature of their socialization. In addition, because immigrant groups were usually dominated by young, adult males, California was able to reap the benefits of a reproduction process that took place outside of the state. Producers did not have to be concerned whether farmworkers were being treated well enough to reproduce themselves, to have families and raise children. These functions took place in

low-cost environments from which the adults were recruited. It was evidently easier for a single male to survive the uncertainties of migratory work patterns than it would have been for a family; thus wages could remain just high enough to allow workers to earn a sufficient amount to provide for their relatively low food and shelter requirements.

Of course, the costs of keeping this kind of labor supply were partially born by the non-agricultural sectors of the economy. Some charity and state-provided welfare helped to maintain the workers during the long periods of unemployment. In recent times, it has been convenient to have the labor force return to Mexico, where wages would buy much more food and shelter. The public sector need not bear the costs of helping to support unemployed farmworkers. Indeed, in their efforts to justify the continuation of the Bracero Program, California farmers sometimes pointed out that if they used domestic workers, the State would have to pay greater welfare costs.

It might be asked why farmworkers would not seek employment elsewhere, if working conditions and wages were more attractive in other sectors of the economy for similarly skilled labor. The answer is that eventually workers do look and find these jobs. However, because most of the workers are first-generation immigrants, they do not speak English and are ignorant of the alternatives. Perhaps even more important, almost all groups have been subject to racial discrimination in the cities (de la Torre, 1980). We have seen that it was urban labor organizations that led the fight to exclude Chinese from the United States. Strong hostilities were also expressed toward the Japanese, Filipinos, and Mexicans. Even the whites who came during the 1930's were the object of such hostilities; the natives in California considered the "Okies"

and "Arkies" to be of a different category of humanity. The result of racial discrimination, unfamiliarity with the political, legal, and economic institutions, as well as ignorance of the opportunities for other kinds of work, all served as important barriers to the higher-paying, higher-income jobs outside of agriculture. Some additional evidence of the existence of these barriers is presented in the Appendix.

In short, the agricultural labor supply has been successfully sealed off from the rest of the domestic labor market. As Fuller has noted, the agricultural labor market is easily entered by anyone, but once part of it, escape is difficult (Fuller, 1968; see also Fisher, 1953).

The segmented nature of the labor markets, which helped to hold captive the immigrants in agriculture, is the key to understanding the maintenance of "cheap" workers. (The concept of "segmented" or "dual" labor markets has been given considerable attention by some economists; see, for example: Doeringer and Piore, 1971; Piore, 1975). Had growers been forced to rely on domestic workers, it would have been very difficult, except during periods of deep economic recession in the cities, to keep workers in agriculture willing to accept the low wages and uncertain employment. Domestic workers would have been able to escape back into the higher income labor markets of the cities during periods of prosperity. It is probably also true that domestic workers would have attempted to organize agricultural workers into unions, as they did in the rest of the economy. In fact, during the periods when whites were in the fields, (e.g. during the First World War and then during the Depression of the 1930's) there were significant efforts to organize workers, and strikes were common. While no permanent successes were achieved until the late 1960's

in organizing farm workers, these earlier efforts presented agricultural interests with a considerable challenge. First-generation immigrants were much less likely to present these kinds of problems, although the Japanese were an exception to this rule.

In spite of the barriers that served to contain the agricultural labor market, there was a persistent tendency for the supply of agricultural workers to shrink, if not continually replenished by new immigrants. The reason for this need for renewal is that immigrants have been predominately single males and do not reproduce themselves. In the case of the Chinese, some immigrants were deported as a result of the Exclusion Act. Later, a series of policies tended to encourage the Japanese to return home. Thus there was little tendency of immigrants to replenish the pool. Morever, as the immigrants themselves become adjusted to the conditions of the United States, they eventually develop sufficient mobility to escape agriculture (see Appendix). We have seen that the Japanese were perhaps the most successful of all groups in escaping farmwork within a very short time. Certainly there is a strong tendency for first-genertion immigrants to adopt the standards and values of the mainstream society, and if they do have children, to see that the children do not remain in agriculture. As a consequence of these forces, there has been a continuing threat to the farmers that they would lose the surpluses needed to maintain low wages and poor working conditions. Hence the search for new sources of immigrant labor is a continuing theme that we find to the present time in the growing interest in the development of a new Bracero Program or in the provision of an open border with Mexico.

In summary, had California agricultural interests not been successful in

maintaining the labor supplies and conditions of control, they would have been forced to compete with the nonfarm economy for labor, which would have meant much higher wages and improved working conditions. In the early days, when there were no machines, such labor conditions would have implied the development of a different kind of agricultural system, based on family labor. Such a development would have further implied a new land tenure system and locus of control over the profits produced by the resources of the state. Today, however, there are alternative solutions to higher wages and better working conditions. The large farms are able to substitute machines for workers, and thus, even though wage levels have improved somewhat in recent years, they no longer threaten the basic core of the agricultural economy in the same way they might have fifty years ago. We will thus explore the implications of mechanization in this general context of the labor system in Part III.

CITATIONS ON PART II

Burawoy, M., "The Functions and Reproduction of Migration Labor: Comparative Material from Southern Africa and the United States," The American Journal of Sociology, Vol. 81, no. 5, March 1976.

de la Torre, A. , "Mechanization in the California Canning Tomato Industry,", unpublished working paper, Department of Agricultural and Resource Economics, University of California, Berkeley, 1980.

Doeringer, P. and M. Piore, Internal Labor Markets and Man-power Analysis, D.C. Heath, (Lexington, Mass., 1971).

Fisher, L., The Harvest Labor Market in California, Harvard University Press (Cambridge, Mass., 1953).

Fuller, V. , "Hired Farm Labor in the West," in: President's National Advisory Commission on Rural Poverty, Rural Poverty in the United States, Chapt. 24; Washington, D.C., U.S. Government Printing Office, 1968.

Gates, P., "Public Land Disposal in California," Agricultural History, Vol. xlix, no. 1 (January 1975).

Glass, J. "Conditions Which Facilitate Unionization of Agricultural Workers: A Case Study of the Salinas Valley Lettuce Industry" Unpublished Ph.D. Dissertation, University of California, Los Angeles, 1966.

Jones, L., "Labor and Management in California Agriculture, 1864-1964," Labor History, Winter, 1970.

Light, I., Ethnic Enterprise in America, University of California Press, (Berkeley, California 1972).

McWilliams, C., Factories in the Field, Peregrine Press, (Santa Barbara, Cal. 1971).

McWilliams, C., California: The Great Exception, Peregrine Press (Santa Barbara, 1976).

Norris, F., The Octopus, (San Francisco, Calif., 1901).

Piore, M. "Notes for a Theory of Labor Market Stratification," in Edwards, et. al. (eds.), Labor Market Segmentation, D.C. Heath, (Lexington, Mass., 1975).

Poli, A. Japanese Farm Holdings on the Pacific Coast, United States Department of Agriculture, Bureau of Agricultural Economics, 1944.

Wik, R., "Some Interpretations of the Mechanization of Agriculture in the Far West," Agricultural History, Vol. xlix, no. 1 (January 1975).

PART III

THE ROLE OF THE STATE IN CALIFORNIA'S AGRICULTURAL DEVELOPMENT

It is evident that the creation of the agrarian structure within California over 130 years ago was not a spontaneous event; it depended upon a series of deliberate public policies, first pertaining to land distribution, later to the perpetuation of the supply of cheap labor and finally to the development of labor-saving technologies. The brief history we have examined above shows that the policies influencing the evolution of California agriculture have been carefully designed to protect the interests of those who were the beneficiaries of the large landholdings, initially given away by the State, through corruption and fraud. Even in the few instances where the agricultural interests were unable to prevent unfavorable policy, such as evidenced in the loss of the Japanese and the Bracero labor, there were favorable state policies that helped to ameliorate any adverse consequences. Thus, Mexican labor was allowed to enter the country at a time when all other kinds of unskilled labor were excluded by immigration laws. The termination of the Bracero program came at a time when mechanization, designed by State institutions, was ready to compensate for this loss. The following summary gives a more detailed account of how some of the state policies influenced the direction and organization of California agriculture.

Policy Before World War II

We have already mentioned the corruption of the land grant policies that

permitted the accumulation of large holdings and the failure of the courts to enforce the laws as written. California enacted land tax policies that were favorable to holding land out of use, which encouraged speculation. The courts and the local law enforcement were willing to back up the interests of the large owners when they were challenged by squatters, as illustrated in the Mussel Slough Affair. Later, after 1902, and especially during the post 1932 period, the Federal Government further helped large landowners in California by providing heavily subsidized irrigation projects which helped to alleviate the overdraft of underground acquifers and to bring additional land into production, most of which was held by a few large corporations (see LeVeen, 1979).

But what was more important to the development and prosperity of large-scale agriculture was the many policies adopted to insure farmers adequate supplies of labor. Prior to the emergency programs of World War II, the government took a relatively passive approach to the regulation of labor supplies and the private sector was primarily responsible for insuring a steady flow of workers to the fields. However, the intervention of the state was still extremely important in a variety of ways. For example, the Alien Land Acts were policies intended to force the Japanese to remain in the agricultural labor markets by preventing the Japanese from becoming farmers. Immigration policy was frequently modified to serve the interests of farmers. In 1917 and 1918, during a war-induced labor shortage, the head tax and other provisions used to control the immigration of Mexican workers to the United States were removed, allowing an additional 20,000 to come to California (State of California, 1936, p. 41). The Immigration Act of 1924, which served to close the United States to unrestricted immigration, especially of the unskilled,

continued to allow unskilled Mexican workers access to the labor markets of the Southwest. It was during the Depression that measures were taken to close the United States to Mexico and to force the repatriation of Mexican nationals no longer needed in the United States (Hoffman, 1974). Again, when shortage arose in wartime, the Federal Government intervened to set up the emergency program that procured the needed workers from Mexico. Then finally, public policy established the Bracero Program that was to provide the needed labor during the immediate post-war period.

Another form of public policy that supported grower interests concerned the State's role in keeping the labor force disorganized and non-unionized. Organization efforts occurred sporadically; one of the first major efforts took place when, in 1913, the International Workers of the World (I.W.W.) organizers helped to begin a strike on a large ranch in Wheatland. Local law enforcement officials, in attempting to stop the strike by arresting two of its leaders, found themselves in a violent confrontation in which several strikers and officials were killed. The California National Guard was called out, and several hundred I.W.W. leaders were arrested all over the state. Laws were enacted to prevent the "wobblies" from holding meetings and disseminating materials. The strike was quickly ended (McWilliams, 1971, chapter IX).

During the Depression years, when large numbers of whites were in the fields, strikes became frequent and many were violent. Between 1933 and 1939 there were 150 separate strikes in California agriculture, and 30 others in the processing and refining sector; 65 of these involved incidents of violence (U.S. Congress, 1940). One important response to this increasing threat of union organization was taken by the State Chamber of Commerce. In 1933, it convened a "citizens' committee" on agricultural labor problems. The

membership of this committee included, in addition to the grower interests, representatives from Pacific Gas and Electric Co., the Southern Pacific Railroad, The California Packing Corporation, and the Bank of America. Out of this committee grew the Associated Farmers. Funds were raised in support of the group from all of the important agricultural interests and also from other large corporations, such as Standard Oil of California, the utilities, and American-Hawaiian Steamship Co. (Chambers, 1952).

The function of the Associated Farmers was created to engage in "direct action" against the strikers, which usually meant violent confrontations. These groups of vigilante farmers almost always operated with the support of local law enforcement agencies, and even provided the local sheriffs with lists of men who could be called upon during emergencies to serve as deputies. In this way, force could be applied against strikers, but in a strickly legal fashion (Jamieson, 1945).

The 1940 La Follette Committee Hearings (of the U.S. Congress, 1940) into the problems of farmworkers are full of stories describing the close working relationship of the Associated Farmers with local law enforcement agencies to prevent union organizing activities. These probably illegal associations between local government law enforcement and vigilante groups were effective in thwarting the efforts to organize in the fields.

However, even more significant public policy that helped agricultural interests was the exclusion of agricultural labor from the National Labor Relations Act of 1935 (known as the Wagner Act), which was enacted to protect the rights of workers to organize unions. Moreover, all subsequent efforts to include farmworkers under this legislation have been successfully defeated by large agricultural interests. This exclusion has been crucial in preventing

organizers from gaining access to the fields and gives management the upper-hand in the decision of whether, when, and how elections for union representation might be held. Finally, farmworkers are denied protection from employers who might take reprisals, should they become active union organizers.

Though the exclusion of agricultural labor from protective legislation has little justification, two arguments have been advanced in its defense (see Fuller, 1973). First, going back to the myth of an agricultural ladder, it is argued that a special relationship exists between farmer and hired hand; that the hired hand is really doing an apprenticeship, and will eventually become a farmer himself. This concept of upward mobility may have been based on real experience in the family farm states of the Midwest, but not in California (see Hatch, 1975). Second, it is argued that because of the great vulnerability of management to labor during harvest periods, traditional bargaining relationships, designed for other, less vulnerable industries, would be unfair to agricultural management and to the consumer, who would be deprived of essential commodities.

Neither of these justifications can be defended in terms of the principles that the 1935 labor legislation embodies, and both illustrate the double standard that exists with regard to the different labor markets. Thus, while it was important to rationalize labor-management relationships in the highly monopolized sectors of the industrial economy, it was not of overriding national importance that agricultural workers be included in the new social contract between capital and labor. Large agricultural interest groups, such as the American Farm Bureau Federation were willing to support the emerging labor legislation during the 1930's with the pragmatic agreement with organized labor that it would not insist on including agricultural labor (Berger, 1971).

In addition to the direct support from government policy given to the agricultural interests, there were other less obvious forms of government support that aided the various agricultural industries in controlling labor. Perhaps the most important of these policies was the Capper-Volstead Act of 1922 which allowed the establishment of agricultural cooperatives that would be free of corporate tax requirements and not subject to anti-trust laws. In California, the passage of this law encouraged the formation of several very large cooperatives of growers; for example, Sunkist quickly became the largest marketer of oranges, while other crops were similarly cartelized (see McWilliams, 1971). Cooperatives were intended to give small producers greater bargaining power in opposition to the processing and retailing sectors. To some extent, this goal was realized, perhaps to the detriment of the smaller growers, who were squeezed out by the larger growers dominating these cooperatives. From the perspective of the farmworker, this development had another result. Once the various crops were organized around central associations, it became much easier to coordinate the hiring of labor and most important, to establish uniform wage rates. Along with the greater organization came centralized hiring services controlled by the employers in a given region for each crop. Wage rate fixing was overt and never challenged; Fisher describes this practice as "organized noncompetition," (Fisher, 1953, p. 97-98).

In short, government policies had the effect of allowing the consolidation and organizaton of capitalists after 1922, and this further hindered the power of labor. Moreover, the organization of capital extended beyond the field. To illustrate, when a member of the Grower-Shipper Vegetable Association of Central California attempted to individually settle with a union

in 1936, the Association sent out letters to all of the lumber and ice companies asking them to refuse to supply the lettuce grower with needed supplies for the harvest; the grower was thus unable to harvest his crop, and was forced to accept the Association as its bargaining agent (Glass, 1966, p. 83).

Implications of the Bracero Program and its Termination for Understanding the Role of the State

As we noted above, the Bracero Program represented the entry of the state into the regulation and management of cheap labor for agriculture. The program began in the early 1950's and, over the strong objections of California agricultural interests, was terminated in 1964. Table III.1 indicates the annual peak employment of foreign workers brought into the U.S. under this program. As can be seen, most of these workers came from Mexico. Its termination was an important event for California agriculture, for it meant the loss of a source of cheap labor, upon which it had become very dependent. Why did an apparently powerful political interest lose in its efforts to maintain its control over the supply of foreign labor, and what does this event imply about the nature of political power and the role of the state? These are important questions to which we now turn.

California farmers and other concerned economic interests were united in their opposition to any change in the nation's agricultural labor immigration policy, for, as we have discussed above, the expansion of specialty-crop agriculture and the very structure of the agricultural system as well as the distribution of wealth it created appeared to depend on the continuing

TABLE III.1

Table 1. Annual Peak Employment of Foreign Workers Admitted for Temporary Jobs in U.S. Agriculture, by Nationality, Year, and Month, 1942-1967

Calendar Year	All Foreign Workers[a]		Mexicans		B W I's		Canadians		Japanese		Filipinos	
	Number	Month	Number	Month	Number	Month	Number	Month	Number	Month	Number	Month
1942	4,200	Sept.	4,200	Sept.								
1943	36,289	Sept.	36,289	Sept.	13,114	July						
1944	66,572	Sept.	65,097	Sept.	24,101	July	1,475	Sept.				
1945	94,210	July	65,421	July	28,789	July	3,635	Sept.				
1946	45,354	July	45,354	July	24,157	Oct.	4,926	Sept.				
1947	96,840	June	36,840	June	10,026	Aug.	6,254	Sept.				
1948[c,d]	40,000	Oct.	35,600	Oct.	8,000	July	5,400	Sept.				
1949[d]	85,600	Oct.	74,778	Oct.	6,480	Aug.	1,990	Oct.				
1950[d]	89,100[e]	Oct.	70,700	Oct.	8,300	July	2,500	Oct.				
1951	130,104[e]	Oct.	121,600	Oct.	13,900	June	2,300	Sept.				
1952	139,437	Oct.	125,473	Oct	12,257	July	5,200	Oct.				
1953	171,128	Oct.	159,174	Oct.	11,954	Oct.	5,700	Oct.				
1954	202,026	Oct.	194,534	Oct.	11,732	Feb.	6,276	Sept.				
1955	240,841	Oct.	232,297	Oct.	9,851	Dec.	6,686	Sept.				
1956	290,156	Oct	276,893	Oct.	11,257	Dec.	6,648	Sept.	390	Oct.		
1957	272,435	Oct	260,522	Oct.	12,199	May	7,200	Sept.	990	Sept.	33	Oct.
1958	284,835	Sept	274,525	Oct.	11,674	Jan.	6,876	Sept.	1,200	Sept.	25	Oct.
1959	308,168	Sept	291,515	Sept	10,978	Dec.	8,491	Sept	1,560	Dec.	30	June-Dec.
1960	246,675	Sept	234,171	Sept.	11,645	Dec.	8,026	Sept.	1,830	Dec.	30	Jan.-Apr.
1961	220,934	Oct.	208,511	Oct.	12,174	Dec.	8,561	Sept.	1,780	Jan.	0	---
1962	127,032	Sept.	111,414	Sept.	13,834	Dec.	8,722	Sept.	1,440	Apr.	120	Dec.
1963	105,454	Sept.	90,142	Sept	14,887	Jan.	8,442	Sept	1,260	Aug.	120	Jan.-Oct.
1964	92,784	Sept.	82,140	Sept.	15,062	Dec.	7,812	Sept.	1,240	July	120	Jan.-May
1965	23,698	Sept.	16,650	Sept.	14,929	Jan.	4,223	Sept.	870	Jan.	60	May -June
1966	12,169	Sept.	7,760	Sept.	8,835	Dec.	3,529	Sept.	194	Apr.	0	---
1967	12,531	Oct.	6,124	Oct.	9,015	Dec.	3,854	Sept.	0	---	0	---

Source: *Farm Labor Development*, February 1968, U.S. Department of Labor, Manpower Administration, Washington, D.C., p. 13.

[a] The monthly peak of total foreign workers does not necessarily coincide with the monthly peak for each nationality.

[b] Data from 1942 through 1947 were obtained from reports prepared by the U.S. Department of Agriculture.

[c] Data from 1948 through 1967 compiled by the Bureau of Employment Security, U.S. Department of Labor. (1948-52 figures based on special administrative reports; 1953-66 figures based on In-Season Farm Labor Reports; 1967 figures based on weekly reports of regional directors, Office of Farm Labor Service.)

[d] 1948, 1949, and 1950 data on monthly foreign-worker employment are estimated from incomplete reports.

[e] Although Puerto Ricans are not foreign workers they are included in these totals.

availablity of cheap labor. In this section, we will briefly examine the reasons why the Bracero Program was terminated, and then we shall discuss some of the ways in which agricultural interests responded, one of which was to press for the mechanization of some of those crops that were most dependent on this labor.Why di the Federal Government cease supporting California growers? Hawley (1966) suggests that as a result of the successful mechanization of the cotton harvest, states such as Texas no longer found the Bracero Program vital to their economic survival. Thus, by the early 1960's, many of the traditional allies of California growers no longer had much of a stake in the program. Therefore, California, which was unabe to mechanize its crops as fast as other regions, was caught by the impact of uneven development. The material basis for the continuation of a blatant class policy was gradually eroded.

The data appear to bear out Hawley's hypothesis. In the early 1950's, 8 percent of the cotton harvest was machine harvested; by 1964, 78 percent was so harvested (see Figure III.1). when the Bracero Program began in 1951, there was little organized opposition in Congress. Some labor groups were nominally opposed, but their concerns went unheeded during most of the decade of the 1950's. Agriculture had long been considered a sector apart from the rest of the economy, and the Bracero Program merely perpetuated old policies and old ideologies.

The Labor Department took an increasingly strong stand in favor of the protective provisions of the Program during the late 1950's. Perhaps cotton mechanization was stimulated by new restrictions imposed on the use of labor by U.S. growers. The Department also made public statistics showing that the Bracero Program was not widely used by farmers, even within those regions dependent upon it (e.g. only 2 percent of all U.S. farms employed such

FIGURE III.1

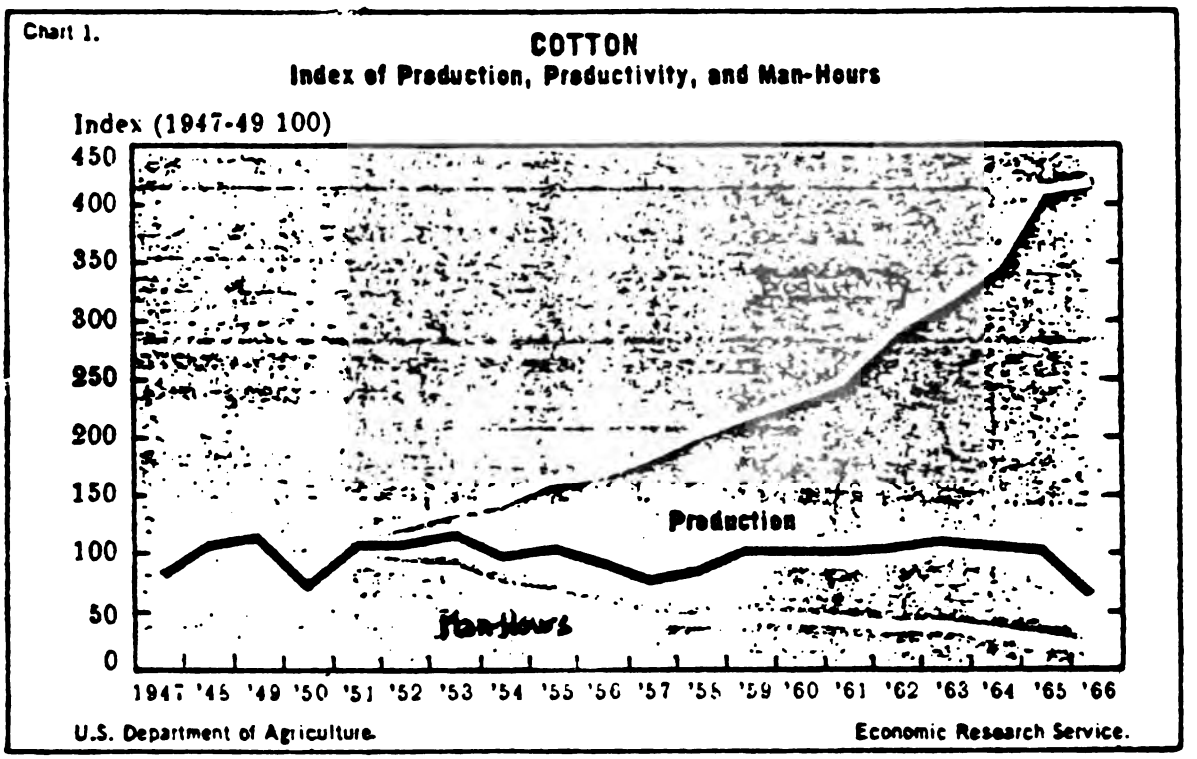


Chart 1.
COTTON
Index of Production, Productivity, and Man-Hours
Index (1947-49 100)
450
400
350
300
250
200
150
100
50
0
Production
Man-Hours
1947 '48 '49 '50 '51 '52 '53 '54 '55 '56 '57 '58 '59 '60 '61 '62 '63 '64 '65 '66
U.S. Department of Agriculture
Economic Research Service.

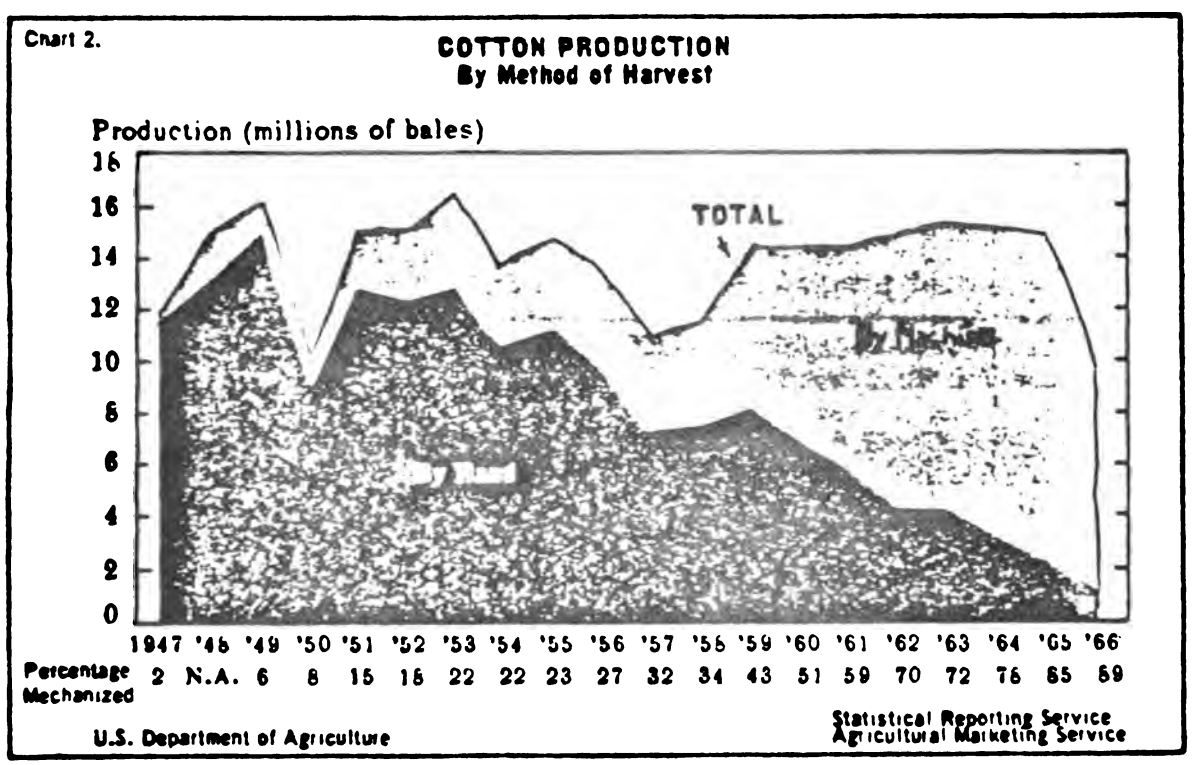


Chart 2.
COTTON PRODUCTION
By Method of Harvest
Production (millions of bales)
16
16
14
12
10
8
6
4
2
0
TOTAL
1947 '48 '49 '50 '51 '52 '53 '54 '55 '56 '57 '58 '59 '60 '61 '62 '63 '64 '65 '66
Percentage Mechanized 2 N.A. 6 8 15 18 22 22 23 27 32 34 43 51 59 70 72 76 85 89
U.S. Department of Agriculture
Statistical Reporting Service
Agricultural Marketing Service

labor). Such statistics further supported the opponents of the program.

But very important to this struggle was the material shift of the Bracero Program, from concentration in cotton, which was grown all across the South and especially in Texas, to concentration in specialty crops in California. Tables III.2 AND III.3 show the shift of Bracero labor out of cotton and away from Texas, and the continued heavy dependence of California and certain vegegatle crops, especially in lettuce and tomatoes.

Therefore, while the Texas legislators were strong supporters of the program at its inception, by 1961 they could afford to take a more principled and hard-line stand against the reformers in the Depertment of Labor who wanted to make the program more humane. Thus,"...representative George Mahone of Texas contended that his constitutents could not operate under the new restrictions of the law; they would rather have no program at all."(Craig, 1972, p. 70). The senators from Texas even voted against extending the program. The Californians, of course, were willing to compromise with the Department of Labor in order to extend the program. California interests did not have sufficient influence to win these compromises. In a sense, the California case had become too "unique".

As the restrictions on the Bracero Program encouraged the mechanisation of production of cotton, they had the eventual impact of changing the very determinants of the policy process. This dialectical process was probably not consciously anticipated by the participants in the policy process, but it still serves to underline the importance of understanding the dynamic interactions between the material development of the different parts of the agricultural system, on the one hand, and state policy on the other.

Bach (1978) suggests a different explanation for the enactment and then

TABLE III.2

PERCENT OF ALL MEXICAN CONTRACT WORKERS
IN SELECTED STATES, SELECTED YEARS, 1945-1962

Year	1945	1949	1952	1955	1959	1960	1961	1962
	(percent of all contract workers)							
State								
Texas	0	44	27	50	45	39	40	15
California	63	8	28	27	34	36	34	60
New Mexico	0	17	11	4	a/	a/	a/	a/
Arkansas	0	16	12	7				
Arizona	a/	a/	8	4				
Washington	6	0	b/	b/				
Idaho	5	0	b/	b/				
Oregon	4	0	b/	b/				
All Others	22	23	14	8	21	25	26	25
Total	100	100	100	100	100	100	100	100

a/ data not available
b/ insignificant number

Sources: 1945-1955: Anderson, H. A Harvest of Loneliness, (Berkeley, 1964), Table 9, p. 29.
1959-1962: Craig, R., 1972, pp. 130,181,182.

TABLE III.3

PEAK EMPLOYMENT OF FOREIGN WORKERS IN THE UNITED STATES;
NUMBER AND PERCENT OF TOTAL EMPLOYMENT, BY SELECTED CROP: 1959 TO 1964

Crop	1959		1960		1961		1962		1963		1964	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Lettuce	n.a.	n.a.	n.a.	n.a.	12,000	81.1	9,500	70.0	11,200	72.0	9,900	78.0
Strawberries	8,700	7.5	8,800	6.1	10,000	14.1	10,200	12.0	9,600	9.0	n.a.	n.a.
Melons	n.a.	n.a.	n.a.	n.a.	6,100	43.5	6,600	42.0	6,700	37.0	n.a.	n.a.
Asparagus	4,100	25.3	4,300	22.3	4,000	16.0	4,300	21.0	4,800	22.0	n.a.	n.a.
Cotton	187,100	27.9	133,500	21.4	121,900	21.1	25,900	6.0	16,200	4.0	14,300	5.0
Tomatoes	38,000	43.5	35,800	36.6	34,400	68.4	44,800	41.0	34,100	70.0	38,100	86.0
Sugar Beets	16,600	28.9	17,000	31.6	15,100	28.1	13,600	24.0	12,400	21.0	n.a.	n.a.
Citrus Fruit	n.a.	n.a.	n.a.	n.a.	13,600	37.0	13,100	33.0	10,100	28.0	n.a.	n.a.

"n.a." means no data available.

Source: U.S. Department of Labor, Bureau of Employment Security, Farm Labor Developments, various issues.

termination of the Bracero Program. According to this view, the Federal Government found itself facing a difficult situation in the late 1940's. As a consequence of Depression policies restricting Mexican worker access to the U.S. economy, illegal immigration to the U.S. from Mexico was growing very rapidly. Organized labor viewed this development with great alarm, for it perceived illegal workers as a source of competition that would reduce bargaining power. If the government chose to neglect this problem, it faced serious political challenges from an increasingly powerful labor movement. Capitalists, especially in agriculture, were not anxious to change these conditions; the influx of workers through annual agreements and illegal arrangements were excellent means of augmenting the unskilled pool of agricultural labor.

If the government gave in to labor, it would offend powerful agricultural interests. The political solution was to appease labor through a strong effort to prevent illegal entry, while at the same time, to develop a formal program intended to channel labor to those sectors of the economy where it did not threaten organized labor. This was accomplished through the Bracero Program, which directed unskilled foreign workers to agriculture, which was not an arena of labor organization. Nominal safeguards were built into the program to prevent the displacement of domestic agricultural workers, but these were ineffective and largely cosmetic. Agricultural wages generally declined with the imposition of the program, relative to wages elsewhere in the economy.

However, the Bracero Program was closely observed by its enemies, and within a few years was the subject of considerable criticism (Turner, 1965). As a result, the program became a symbol of government helping wealthy, powerful corporations at the expense of the powerless farmworker. The myth of

the hard-working farmer ceased to provide a protective cover for this difference in the treatment of labor, and as the ideological cover was eliminated, it became impossible for many of the friends of agriculture to continue supporting the policy. Therefore, the program was terminated. But there is, according to Bach, another important fact in shaping the policy toward immigrant workers. The termination of the Bracero Program did not eliminate the importation of workers from Mexico, it only drove the process underground. That is, illegal immigration replaced a regulated immigration scheme, and the situation of the late 1940's was reinstated. Bach supports this contention with the well-established fact that illegal immigration did increase dramatically after 1964.

The significance of this argument is that the termination of the program can be seen as an effort by the State to appease political interests without in fact damaging the position of important agricultural interests. Illegal workers were more desirable than Braceros because they had no rights and could be more easily controlled. At the same time, their use would be more difficult to document and track, so organized labor would not have any easy target to shoot down. Thus, even though California interests may have fought for the continuation of the program, they were benefitted by the elimination of the program.

Interestingly, the cycle would appear to have made a complete revolution, for now illegal workers are entering the rest of the labor markets, and their presence has again aroused the opposition of organized labor, just as in the late 1940's. As a result, there are substantial pressures in the Congress to institute a new Bracero-like program, for the same purpose of channelling the workers to those sectors of the labor market that are least organized

politically to protect themselves. However, this may be more difficult today because of the much greater awareness of the issue by all segments of the labor force, and especially on the part of the United Farm Workers.

Bach's analysis of the Bracero Program implies that policy-makers consciously opted for the replacement of a regulated labor importation policy by an illegal importation policy. Given the strenuous efforts by California agriculture to prevent the termination of the program, this kind of conscious decision process seems difficult to accept. Policy does not necessarily follow a well-charted course; the solution to a problem frequently becomes the problem for the future. There is little evidence that policy-makers or California interests anticipated the large increase in illegal workers, or if they did, that these workers would be capable of replacing Bracero workers.

However, Bach's analysis is very useful in illustrating a very important dynamic property of contemporary State policy, namely, the need to accomodate new and increasingly powerful non-capitalist interests in the form of organized labor. As a result of the development of a politically influencial labor movement, largely because of New Deal policies, it is no longer possible to neglect the impact of government policies on labor, especially when the direct interests of the organized sector of labor are threatened by the policies.

Bach's analysis further suggests that the way the State was able to accomodate organized labor was by redirecting the threat toward the sector of labor that was not organized and therefore not as important to union leaders. In doing this, it was important for both agricultural and labor interests alike that the new Bracero Program be justified by some accepted ideological cover. This ideology was that the program did not displace domestic workers and was structured with safeguards to protect foreign workers from exploitation.

However, once this ideology was destroyed by other analysis, some of which came from the government itself, the program could no longer be accepted.

In summary, the dynamics of present-day political economic processes toward agriculture depend on several important factors and their interaction. On the one hand, we have seen that the changing material base, itself influenced by past government policies as well as by market conditions, was an important determinant in shaping the choice of policy toward California agriculture. Second, we have seen that the creation of new political policies designed to cope with the political and economic crises of that era has introduced a new set of influences on the policy process which have implications far beyond the struggle for higher wages and working conditions in organized industries. And last, we have seen that there are important ideological aspects of policy. Agricultural policies are generally justified within a context that stresses the hard-working, small, independent farmer. Agricultural labor policies were justified on the grounds that agriculture was different from the manufacturing sector, and that policies should take into account the needs of the agriculture. This ideology serves to protect the unequal distribution of the benefits of policy; but when the ideology is shown to be what it is then policy must be changed. In a democratic system, the State cannot be widely perceived to be helping one class at the expense of others. This does not mean, however, that the new policies will be more equitable, only that they will be more easily rationalized.

In Conclusion

This brief history of agricultural policy shows that until the 1960's and the termination of the Bracero Program, the preferred method of State

intervention into the California agricultural economy was through manipulation of the supply of labor. However, when political conditions made this course difficult to follow in the 1960's, other alternatives, including involvment of the State in the mechanization of production, were adopted. This is not to say that mechanization was of no interest before the end of the Bracero Program, for some labor intensive crops had been mechanized by that time, including cotton and sugar beets. Interestingly, the private, not the public, sector was the ain impetus behind this mechanization. Moreover, mechanizatoin of cotton and sugar beets did not require complex packages of inputs, including new plant varieties, so mechanization of these crop was, in large measure, an extension of the principles of engineering already worked out for the grain crops by the private sector. With the specialty crops of California, however, the private sector was less capable of developing new labor-saving technologies — the potential markets for this kind of technology were small and regional (unlike cotton and sugar beets, which are grown by thousands of farmers all over the nation), and required a much more complex package of inputs to support the mechanical devices in such crops as tomatoes and lettuce. This kind of mechanization research demanded the coordination of public and private sectors. Therefore, with the termination of the Bracero Program, the pressure for publicly-subsidized mechanization research intensified and other developments were instituted to enable the rapid adoption of new kinds of labor-saving devices. The important point is, these devices were not preferred to cheap labor; they were demanded only when forces outside of the control of California agricultural interests successfully closed off the preferred policy options.

CITATIONS: PART III

Bach, R. "Mexican Immigration and U.S. Immigration Reforms in the 1960's", Kapitalistate, No. 7 (1978).

Berger, S., Dollar Harvest: The Story of the Farm Bureau, D.C. Heath, (Lexington, Mass., 1971).

Chambers, C., California Farm Organizations, University of California Press (Berkeley, Calif., 1952).

Craig, R., The Bracero Program, University of Texas Press, (Austin, 1972).

Fisher, L., The Harvest Labor Market in California, Harvard University Press, (Cambridge, Mass. 1953).

Fuller, V. "The Struggle for Public Policy on Farm-Labor Management Relations," Unpublished paper, University of California, Davis, Department of Agricultural Economics, 1973.

Glass, J., "Conditions Which Facilitate Unionization of Agricultural Workers: A Case Study of the Salinas Valley Lettuce Industry," Unpublished Ph.D. dissertation, University of California, Los Angeles, 1966.

Hatch, E. "Stratification in a Rural California Community," Agricultural History, Vol. xlix, no. 1 (January 1975).

Hawley, E., "The Politics of the Mexican Labor Issue, 1950-1965," Agricultural History, Vol. xl, no. 3, (July 1966).

Hoffman, A., Unwanted Mexican Americans in the Great Depression: Repatriation Pressures 1929-1939, University of Arizona Press (Tucson, 1974).

Jamieson, S., Labor Unionism in American Agriculture, U.S. Department of Labor, Bureau of Labor Statistics Bulletin, No. 836.

LeVeen, E., "Natural Resource Development and State Policy: Origins and Significance of the Crisis in Reclamation," Antipode, Spring, 1979.

McWilliams, C. Factories in the Field, Peregrine Press (Santa Barbara, Calif., 1971).

State of California, State Relief Administration, Migratory Labor in California, prepared by M. Lewis, San Francisco, California, 1936.

Turner, W., "No Dice For Braceros," Ramparts, September, 1965.

U.S. Congress, Senate, Committee on Education and Labor. Hearings before a subcommittee on the Violations of Free Speech and the Rights of Labor. 76th Cong., 2d Session, Washington, D.C.: Government Printing Office.

PART IV

AGRICULTURAL ADJUSTMENTS TO THE TERMINATION OF THE BRACERO PROGRAM

We have argued that mechanization was adopted as a strategy after it became evident that control of the labor supplies could not be maintained. However, to further develop this hypothesis, we now examine a variety of responses to the termination of the Bracero Program in other labor-intensive crops. Not all crops could be mechanized; indeed, even in crops that were susceptible to mechanization, alternative labor policies were preferable to adoption of mechanical picking devices. Therefore, the mechanization of the tomato harvest will be shown to be simply one of many methods of adapting to the new era of higher wages and less abundant labor supplies.

An Overview of the Utilization of Labor After the Bracero Program

With the termination of the Bracero Program came the first serious efforts to organize agricultural labor since the 1930's, and as a result, wages began to improve, both absolutely and relatively in comparison with the rest of the economy. The United Farmworkers Union staged a successful boycott of the table grape industry in 1967 and 1968, and signed union contracts in increasing numbers. Labor organizing efforts spread to all regions and sectors of the California agricultural economy. Yet, in spite of these obvious signs that growers were losing their control over the labor process, agriculture continued to prosper and the production of specialty crops continued to expand. Table IV.1 shows a comparison between the use of hired hand labor hours in 1963 and

TABLE IV.1

CALIFORNIA SPECIALTY-CROP AGRICULTURE
SEASONAL HAND-LABOR REQUIREMENTS: 1963-1976

Crop	Total Hand-Labor Hours Worked		Hand-Labor Supplied by Braceros 1963	Change in Hours 1963-1976	Change in Hours per Unit Output 1963-1976	Total Acres 1976	Change in Acres 1963-1976	Change in Yield 1963-1976	Change in Output 1963-1976
	1963	1976							
	1000 hours		percent total hours	percent	percent	1000 acres	percent	percent	percent
Almonds	2,249	2,609	a/	16.0	-62.8	260.9	166.3	16.7	210.7
Apricots	4,860	2,093	a/	-57.0	-50.0	27.9	- 22.5	11.5	- 13.6
Cherries	3,510	3,367	a/	- 4.1	-36.0	13.0	20.4	21.7	46.5
Grapes (raisin)	21,533	20,120	1.8	- 6.6	- 8.0	236.7	- 4.4	6.3	1.6
Grapes (wine)	5,990	11,382		90.0	-12.7	270.8	125.8	- 4.4	117.1
Grapes (table)	4,565	3,349		-26.7	- 2.2	63.2	- 24.0	- 1.6	- 24.9
Lemons	7,798	4,750	66.7	-39.1	-56.6	47.5	2.5	37.1	40.7
Oranges (navel)	9,559	11,040	22.8	15.5	0.0	114.9	- 10.2	13.6	2.1
Oranges (valencia)	6,129	9,826		60.3	0.0	82.8	22.0	33.3	81.6
Peaches (canning)	11,400	5,976	a/	-47.6	-46.4	49.8	- 16.7	16.0	- 3.3
Peaches (fresh)	6,630	4,926	a/	-25.8	0.0	21.7	- 40.5	16.0	- 24.7
Pears	3,455	3,375	a/	- 2.5	- 7.3	37.5	14.3	- 7.7	5.3
Plums	3,509	4,199	a/	19.7	0.0	24.7	2.1	17.5	19.9
Prunes	6,020	1,040	a/	-82.7	-83.0	74.3	- 13.6	10.0	- 5.0
Walnuts	3.611	2,380	a/	-34.0	-71.3	169.7	36.3	67.6	129.0
Asparagus	8,448	1,344	29.1	-84.1	-69.2	32.1	- 51.6	6.6	- 48.9
Carrots	4,826	330	9.0	-93.2	-94.2	23.1	27.3	18.2	50.0
Celery	2,622	3,686	34.6	40.6	- 6.0	19.4	40.6	3.6	45.7
Lettuce	16,200	11,395	25.9	-29.7	-55.9	156.1	30.0	22.5	59.3
Melons (cantaloupes)	10,824	7,067	8.3	-34.7	-18.5	37.0	- 30.0	33.3	- 6.4
Melons (watermelons)	880	441	5.7	-49.9	-20.3	9.8	- 39.0	2.6	- 37.2
Tomatoes (processing)	17,451	9,450	48.0	-45.8	-79.1	269.8	109.0	21.1	153.4
Tomatoes (fresh)	5,120	4,500		-12.1	0.0	29.8	- 6.2	20.0	11.8
Strawberries	17,150	30,780	4.1	79.5	0.0	10.8	10.2	66.6	83.7
Cotton	7,300	5,076	0.0	-30.5	-50.0	1,128.0	54.5	- 3.0	48.9
Sugar Beets	5,929	3,420	3.4	-42.4	-40.0	285.0	20.3	40.0	68.4
TOTAL	196,902	167,292	15.7	-15.1	-40.1 b/	3,496.3	33.8	11.5 b/	49.1 b/

a/ less than one percent; b/ weighted average

Sources: Cols. 1,3, 4 and 5: Thor, Eric et. al. California Agricultural Labor Requirements and Adjustments, University of California, Div. of Ag. Sciences, Sept. 1964. Cols. 2,4 and 5: Kumar, et. al. "Estimates of the Impact of Agricultural Mechanization Developments on In-Field Labor Requirements of California Crops," in Technological Change, Farm Mechanization and Agricultural Employment, Univ. of California, Div. of Ag. Sciences, July 1978. Cols. 6-9: California Statistical Abstract, State of California, 1964 and 1977.

1976. As can be seen, total use of labor declined, even though output increased by 50 percent in these labor-intensive crops. Indeed, labor per unit of output declined by 40 percent during this period. Evidently, growers were finding ways of accomodating the rising wages of workers, especially in crops such as tomatoes, lemons, and lettuce, which had been highly dependent on Bracero labor and which all exhibit major reductions in the use of labor per unit of output.

What lies behind these dramatic changes are a series of adaptive responses by the growers to the changed labor conditions. These responses vary from crop to crop, but they have in common the quality of allowing growers to maintain control over the labor process and retain the profitabilty of producing these crops.

The reponses to the challenge posed by the new labor situation were varied and innovative. Agricultural economists had been advocating the benefits of "labor rationalization" schemes since the Second World War (Fuller, 1944). Now these ideas were given serious consideration. The labor process in lettuce and in some citrus harvest was reorganized to improve productivity sufficiently to justify the higher wages implied. The new emphasis in these crops was to provide continuous employment for a relatively few highly productive workers, who, in return, would be provided with higher wages and benefits. The schemes have served to stablize the labor force, to reduce the number of workers needed substantially, and to improve output at least as fast as wages have risen.

The cost of these schemes has been the creation of an environment favorable to labor organizaton, and unionization has been given added impetus. Over the longer run, union demands for better working conditions as well as

higher wages may force labor costs up faster than productivity can be increased, and the only alternatives then will be to find new ways of improving productivity through the use of labor-saving technology or to break the power of the unions; both alternatives are currently being pursued. Much of the interest in a renewed Bracero Program is related to the desires of growers who want to undercut the United Farm Workers Union.

Strawberry growers have avoided some of these labor problems by devising new patterns of production in which farmworkers were converted into sharecroppers; in this way, some of the potential conflict between labor and managament was defused, though the ultimate control over the profits of the production process was still in the hands of the large landowners and packer/shippers.

Some crops made no adjustments, and were unable to cope with the increasing international competition; much of the asparagus production in California was moved out of the country shortly after the termination of the Bracero Program.

In some crops labor rationalization was either not feasible or more costly than mechanization. Where mechanization was less costly, such as in sugar beets and canning tomatoes, the adoption of labor-saving innovations was pursued with vigor as the Bracero Program came to an end. Mechanization not only freed growers of their dependence on a lost source of cheap labor, but also changed the patterns of labor utilization, allowing the use of an entirely different secondary domestic labor force, consisting of women and youth. Therefore, wages of those who continued to be employed in tomato production were kept low. Moreover, because mechanization tended to eliminate the higher skilled picking jobs, the displaced domestic pickers became part of the labor

pool for other crops, and therefore mechanization of tomatoes had indirect benefits for those crops that did not mechanize. Interestingly, California agriculture became more labor-intensive during the aftermath of the Bracero program, in part because of the complex impacts of mechanization on the utilization of labor. The introduction of the tomato harvester had widespread impacts which allowed growers to retain their control over the labor process in the face of a shrinking supply of workers.

In some crops, neither mechanization nor labor rationalization was feasible. Lemons, lettuce, and strawberries all have particular characteristics that make them susceptible to rationalisaton schemes, but those crops, such as asparagus, that cannot be easily adapted to a different pattern of labor use and cannot be harvested by machine faced very great obstacles with the loss of the Bracero Program. In the case of white asparagus, the crop ceased to be produced in California, as competition from other cheap labor countries eventually encouraged the canners to move their operations out of the state.

Because these adaptive responses to the new conditions of the 1960's are very useful to understanding the evolution the labor process and because they illustrate the nature of the choice between mechanization and other forms of control available to California, we now turn to a more detailed analysis of the changes that have occurred since 1964 in several of the most important specialty crops.

Adaptive Response #1: Sharecropping Strawberries

California has long been a leading producer of stawberries in the United

TABLE IV.2

Number of Braceros Employed at Peak and
Percent of Total Peak Employment
California, By Crop

Crop year	Cotton (chop)		Tomatoes		Lettuce	
	Number of braceros	Percent of total	Number of braceros	Percent of total	Number of braceros	Percent of total
1958	2,640	14	44,280	82	7,160	92
1959	2,900	14	37,140	83	6,880	94
1960	3,260	15	37,210	85	6,440	85
1961	2,580	14	34,960	80	6,260	82
1962	2,300	13	46,240	86	5,900	78
1963	1,700	10	38,100	85	6,140	69
1964	a/		37,870	89		
	Cantaloupes/melons		Oranges (Valencia)		Lemons	
1958	2,600	44	2,200	39	6,900	80
1959	2,370	43	3,400	43	7,240	80
1960	3,200	56	2,990	48	7,110	80
1961	3,990	44	1,770	33	4,210	67
1962	3,940	45	1,970	36	5,460	76
1963	3.720	43	2,880	62	3,530	72
1964						

(Continued on next page.)

TABLE —continued.

Crop year	Sugar beets (thinning)		Asparagus		Strawberries		Snap beans	
	Number of braceros	Percent of total	Number of braceros	Percent of total	Number of braceros	Percent of total	Number of braceros	Percent of total
1958	4,560	61	5,050	50	13,390	47	1,570	23
1959	4,120	50	5,780	57	8,750	49	2,040	29
1960	3,940	51	5,520	55	10,000	56	2,620	35
1961	3,010	44	4,600	50	10,320	61	3,600	40
1962	2,820	47	4,380	48	11,880	71	4,120	
1963	2,670	49	4,890	56	10,500	67	2,350	31
1964								

a/ Blanks indicate data not available.

Sources:

1958-1962: Division of Agricultural Sciences, Seasonal Labor in California Agriculture, University of California (1963).

1963: Idem, California Agricultural Labor Requirements and Adjustments, University of California (September, 1964).

1964: Eric Thor and John Mamer, "California Canning Tomatoes: 1965 Labor Situations," Agricultural Extension service, University of California, Berkeley, July, 1965 (mimeographed).

TABLE IV.3

California Strawberries, 1950-1978

Crop year	Harvested acres	Average yield pounds	Total production	Fresh product	Processing product
			1,000 pounds		
1950	5,700	14,260	81,282	47,724	33,558
1951	6,900	12,770	88,113	54,317	33,796
1952	8,400	13,680	114,912	68,162	46,750
1953	9,400	16,270	152,938	71,712	81,226
1954	10,900	14,630	159,467	71,577	87,890
1955	14,000	11,910	166,740	64,400	102,340
1956	19,000	12,800	243,200	88,500	154,700
1957	20,700	10,800	223,560	118,260	105,300
1958	17,000	12,400	210,800	97,800	113,000
1959	13,200	12,900	170,280	96,280	74,000
1960	11,700	13,400	156,780	85,780	71,000
1961	11,500	17,800	204,700	132,500	72,200
1962	10,500	20,900	219,450	143,450	76,000
1963	9,800	24,300	238,140	154,040	84,100
1964	9,000	25,400	228,600	141,100	87,500
1965	8,300	21,500	178,500[a/]	107,500	71,000
1966	7,800	22,800	177,800	117,300	60,500
1967	8,000	26,100	208,800	148,100	60,700
1968	8,600	33,700	289,800	213,200	76,600
1969	8,400	32,000	268,800	202,400	66,400
1970	8,500	34,000	289,000[b/]	215,400[b/]	73,600
1971	8,300	36,500	303,000	235,000	68,000
1972	7,800	36,500	284,700	226,400	58,300
1973	8,100	39,500	320,000	226,700	93,300
1974	8,900	43,000	382,700	277,600	105,100
1975	10,000	38,000	380,000	270,900	109,100
1976	10,800	39,000	421,200	281,100	140,100
1977	11,600	45,000	522,000	343,600	178,400
1978	12,900	40,000	516,000	386,100	129,900

(Continued on next page.)

TABLE --continued.

a/ Excludes 25.2 million pounds not harvested or marketed because of economic conditions.

b/ Excludes 10 million pounds not harvested or marketed because of economic conditions.

Sources:

1950-1953: California Crop and Livestock Reporting Service, Vegetable Crops in California: Acreage Production and Value, August, 1957.

1954-1959: Idem, California Vegetable Crops: Acreage Production and Value August, 1962.

1960-1963: Ibid., August, 1968.

1964-1968: Ibid., August, 1973.

1969-1976: Ibid., July, 1978.

1977-78: Ibid., August, 1979.

States. Set back by a loss of sharecropper labor during World War II (Japanese sharecroppers, the mainstay of the system, were interned in concentration camps), the industry revived with the advent of freezing technology and the use of Mexican Bracero labor in the 1950's. Production reached a peak of 243 million pounds in 1956 (see Table IV. 3). Prosperity was short-lived, however, as the freezing of strawberries was also begun in Mexico in 1957. This had the effect of reducing production for processing in California by more than half in the three years from 1956 to 1959 (see Table IV.3). The 1956 level was not regained in total production until 1968, and in processing volume until 1977.

The imminent demise of the Bracero Program in the early 1960's created a crisis atmosphere in the strawberry industry, which had become highly dependent on Mexican contract labor that provided 70 percent of peak harvest employment in 1962 (Table IV.2). One survey of 17 large growers found that Mexican contract workers accounted for 95 percent of total picking hours in 1963 and 91 percent in 1964 (Californa Stawberry Advisory Board, 1965).

At the same time, there was no immediate prospect of mechanizing the harvest, which represented well over 50 percent of total cost. The extreme fragility of strawberries, the practice of harvesting plants for more than one year, and the long season of continuous picking combined to make strawberries one of the most difficult crops to mechanize. Some work had been started at the University of Illinois on mechanical harvesting, but in California there was little in the way of impending labor-saving innovation on the drawing boards. Plant breeders were only starting to modify the plant to withstand mechanical harvesting in 1965; it took over 15 years to breed a tomato that could be mechanically harvested (Peterson, in State of California, Assembly

Interim Committee on Agriculture, 1964; University of Califoria, Berkeley, 1963, pp. B-161 ff.).

Finally, the competing growth of strawberry production in Mexico was based on the construction of freezing plants, affiliated with large U.S. firms (some of which had left California) in the Bajio area. These plants enjoyed tremendous cost advantages, paying, in 1965, $1.56 per day for labor, about one tenth of the U.S. wage. Moreover, sugar was subsidized in Mexico and cost only 5.6 cents per pound, less than half the U.S. cost (U.S.D.A., Foreign Agricultural Service, 1966, p. 8). Such advantages led to increasing exports of stawberries to the United States and Canada, both markets previously dominated by California. (Feder, 1977, pp. 104-105).

These three factors, the end of Bracero labor, a lack of labor-saving technology, and growing competition from Mexico convinced many observers that continued production of stawberries in California was highly problematic. For example, a University of California publication stated:

> "the general conclusion is that the large growers would probably cease to produce strawberries because of the lack of mechanical equipment available to replace the hand labor necessary. It would be greatly reduced if seasonal labor was not available. A much smaller industry built around small family and tenant-type operations would probably develop. Fruit would be produced primarily for the fresh market." (University of California, Berkeley, 1963).

As a result, several strategies were evolved to cope with the impending crisis. First, operating through their state marketing order (1)*, strawberry growers donated substantial sums of money to the University of California at Davis for research on yield-increasing technology. An average of $48,506 per year was given to the University from 1959 to 1973 (Fujimoto and Kopper, 1978,

* Numbers in parentheses refer to footnotes, found at the end of the section.

p. 1334). For this money, the industry achieved the highest yield increases of all crops in California since the early 1960's (see Table IV.1). California's recent average of 20 tons per acre (some growers achieve more than 50 tons per acre) compares with a U.S. average of about 3 tons per acre and Mexican yields of from 6 to 8 tons per acre (Wells, 1980, p.59; Feder, 1977).

Second, many growers in the early 1960's moved toward recuriting more "green card" Mexican workers (2). A survey of some southern California growers found this to be the consensus strategy in 1965 (California Stawberry Advisory Board, 1965). Farther North, in the Salinas and Pajaro Valleys, where the bulk of the stawberries are grown, recruiting Mexicans from border towns or from Los Angeles barrios is not as feasible an option as it is for those in the southern part of the State, so growers resorted to more permanent relationships. Miriam Wells describes this strategy:

> "As the Bracero Program came under increasing fire in the late 1950's, some of the smaller growers began to take additional measures to ensure reliable workers. Having established trusting and mutually profitable relationships with particular braceros because of their repeated employment and the personal contact possible on small farms, some growers agreed to sponsor Braceros for American citizenship. At that time, sponsorship was relatively easy and quick, involving primarily a written guarantee of future employment." (Wells, 1980, pp.19-20).

This strategy has continued up to the present time among smaller growers in the North. They hire the same core group of workers every year and they attempt to provide as long a season as possible for the workers, even growing other complementary crops to extend the length of employment. They hire many workers who want to return to Mexico from November through January and they recruit through kinship and village networks. This paternalistic relationship has earned the growers considerable loyalty from the workers (Wells, pp. 34-36).

Third, attempts were made by all growers to reduce the numbers of workers. Recruitment of a more stable labor force was partially aided by the introduction of piece rates. Growers had been paying hourly wages to ensure careful picking and high quality fruit, and because the braceros were rather easily coerced into whatever speed was desired. But they discovered that by hirng skilled workers, establishing more personal and interdependent relationships, and paying incentive piece wages they could achieve the same result with many fewer workers (3). Total man-years of employment in strawberries fell from an average of 4,563 in 1961-64 to 2,696 in 1965 (California Farm Labor Panel, 1965). (Part of this was also due to the decline in acreage and smaller harvest.)

Finally, larger growers have returned to sharecropping their land. Sharecropping was the norm in California strawberry production until World War II. But whereas in earlier periods a sharecropping family was generally able to perform all of the labor on their land, with the very high yields and more involved cultural practices of new strains of strawberries, sharecroppers have had to hire labor for irrigation, weeding, and especially for harvesting. Thus, sharecropping is even more of a labor strategy in its new reincarnation.

This strategy is doubly important because of union activities in agriculture. Organizing by the United Farm Workers (UFW) touched strawberries in the Salinas area in 1970, but only the largest grower in California has ever signed a contract with the union. However, the UFW successfully organized lettuce workers in the same area, and each new lettuce contract tends to set the wages and benefits for skilled strawberry workers (Wells, 1980, pp. 22-25).

To counter the rising wages associated with this "primary" agricultural

labor, a strategy of sharecropping provides indirect access for the largest growers (i.e. those most susceptible to union organizing) to "secondary" labor, i.e. the undocumented Mexican immigrants. The sharecroppers (mostly former Mexican-American farmworkers) have 3 to 5 acres and are responsible only for buying boxes and baskets and for paying field labor (Wells, 1980, p. 32; Mines, 1980, p. 92). Gross returns are split 50-50 with the landlord, who provides all other inputs, including spraying. The sharecroppers then hire low-wage labor through kinship or other networks. Richard Mines reported that in the two cases involved in his research, "...the labor force was principally inexperienced, Indian-speaking people from immature migrant communities in Oaxaca" and all were in the United States illegally (Mines, 1980, p. 92).

Thus, the potential for unionization has been greatly reduced, particularly as the UFW considers sharecroppers to be farmers and not farmworkers. Also, the large growers have reduced their exposure to the union, as they are no longer directly responsible for hiring the labor. Thus, through these various strategies, an extremely labor-intensive crop without a mechanical alternative has been able to restructure its labor force in such a way as to regain its pre-eminent position in strawberry production in the Americas.

Adaptive Reponse #2: Labor Rationalization in Lettuce

Iceberg lettuce is grown year-around only for the fresh market. The industry is dominated by a small number of grower-shipper firms which employ labor crews to move from the southern regions of Arizona and the Imperial Valley to the northern regions of the San Joaquin and Salinas Valleys. Harvesting goes on for almost the entire year. The industry appears very risky

in any one year, but extremely profitable over the long run to those who can withstand the yearly fluctuations of price and profit (Friedland, Barton, and Thomas, 1978). In the early 1950's, lettuce packing was moved from the packing sheds directly into the fields as a new technology was adopted known as vacuum cooling. This technology was more labor-intensive but reduced costs by substituting Mexican baracero field hands for the unionized Anglo shed workers.

But the labor force was not entirely made up of Braceros, and the first major agricultural labor strike in California since the 1930's broke out in the Imperial Valley lettuce harvest in 1960. Use of braceros to break such strikes came under great criticism. In 1961, the Bud Antle Corporation, one of the largest grower-shippers, signed a contract with the Teamsters Union to avoid having to deal with more radical labor groups (Friedland, Barton, and Thomas, pp. 54-55) (4). The increasing militance of workers led lettuce growers te find ways of reducing their dependence on labor, even before the end of the Bracero Program.

The University of California, following the lead of the University of Arizona, launched a lettuce mechanization program in 1962. Faced with the imminent loss of Bracero labor (lettuce used 70 to 80 percent foreign workers in the harvest in the early 1960's — see Table IV.2), the university decided that the only effective course of action would be the development of a harvesting machine that could selectively harvest individual plants. It was determined that it would not be possible to develop a strain of iceberg lettuce that would ripen uniformly, as had been accomplished with tomatoes. This meant that the nature of the harvester would be unique, since all previous harvesters have been based on the harvest of a uniformly ripened crop (Kelly, State of California Assembly Interim Committee on Agriculture, 1963, p.7).

Engineers developed a mechanical harvester within two years and a commerically licensed test model was in the field by late 1964 (Shaw in IBID. p. 97). But the machine was not adopted for several reasons. First, the extreme complexity of the sensor/selector device ensured a high cost and constant repair problem for the operators (5). Second, no tested machines had been produced by 1965, in contrast to the extensive commercial production of the tomato harvester at a similar stage in its development. Third, the high cost of the machine was not only a large capital investment, but led to higher labor costs than current labor-intensive methods (Thor, Goueli, and Hutchens, 1965). Fourth, this high relative cost was largely attributable to a failure to successfully mechanize the trimming of lettuce, which the hand harvesters accomplished simultaneously with cutting. This would lead to a serious problem of handling the lettuce once the machine had harvested it. Finally, an alternative strategy of recruiting and further rationalization of the labor force had proven feasible.This last and decisive point is explained more fully by Friedland, Barton, and Thomas:

> "As the Bracero Program came under increasing criticism, grower-shippers of lettuce... began to explore means to convert their former braceros into legal immigrants to the United States...This involved the conversion of the bracero lettuce harvesters into 'normal' U.S.-based workers through a process of obtaining green-cards for them...The probabilities are that lettuce growers became sponsors of braceros as immigrants, selecting those braceros who had demonstrated reliability in their work and encouraging them to apply for immigrant status. By 1966, the transition from braceros to green-carders was apparently complete and the present form of crew organization emerged." (6)

Such a strategy of labor raltionalization through the use of legal immigrants was feasible in lettuce but probably not in tomato harvesting because the number of lettuce harvesters was much lower than the number of

tomato harvesters (6,000 as opposed to 40,000), and because lettuce harvesting involved more skill and entailed year-round work (Friedland, 1980, p. 206). Tomato growers could not afford to undertake the costs of this kind of program for each worker represented much less potential profit and could not be made to be as productive through reorganization and the use of piece-rate wages.

Of particular note in this green-card strategy of the lettuce industry is that it called upon the state to provide the same workers as before, only under a different type of policy. As we have seen above, Robert Bach argues that the Bracero Program itself was a response of the state to permit unskilled workers to enter certain of the U.S. labor markets, while preventing illegal immigrants from threatening the labor markets of newly organized manufacturing workers (Bach, 1978). Thus, when the Bracero Program was no longer tenable, some agricultural interests were able to exploit a different set of labor policies. While the green-card policy was perhaps less desirable than the Bracero Program, because it required higher wages and carried with it an implicit threat from the increased dependence of capital on a permanent and more skilled and potentially united labor force, nevertheless the program has apparently worked. As can be seen from Table IV.1, the amount of labor per unit of output in lettuce declined 55.9 percent between 1963 and 1976 and the mechanical lettuce harvester remains unadopted.

Of course, this strategy contains its contradictions, as a stable and highly paid lettuce labor force was one of the first groups to be unionized (Friedland, 1980, p. 206). Subsequent strikes and boycotts have led growers to fund further work on mechanization, and now the machine has become an important factor that labor must take into account in its efforts to improve wages and working conditions.

Adaptive Response #3: Labor Rationalization in Lemons

The use of Bracero labor in citrus was extensive, as can be seen from Table IV.2; therefore the termination of this program presented lemon growers with a profound challenge. Lemon harvest crews have almost always been organized through grower associations and farm labor contractors. During the 1930's, workers were paid 28 cents per hour plus a certain additional amount per box picked (approximately 14 cents) (Smith, Seamount, and Mills, 1965). The advent of World War II and its drain on the agricultural labor supply (mainly indirectly through employment in war-related industries) brought on strikes over wages from 1941-43. The University of California was called upon to devise an incentive pay system, and it was introduced in late 1944 in Ventura County, which has accounted for about one-half of California lemon production (IBID. p. 16).

This "Tree Production Incentive Wage System" was a straight-forward application of Frederick W. Taylor's scientific management principles. Similar piece-rate systems have been widely employed in manufacturing and in cotton and sugar beet harvesting. The basic approach was to study the rate of picking and its relationship to height of trees, yield of orchards and other variables, and then to devise a piece-rate schedule which varied with the daily variation in such factors. Overall, however, the schedule was designed to yield, in any one year, a certain average hourly wage to an "efficient" worker (see Table IV.5). The introduction of this system in 1944-45 raised the rate of pick by about 40 percent and lowered the number of workers by about 29 percent. From 1947 to 1964 the rate of pick increased an additional 24 percent per worker, implying a 19 percent decrease in the number of workers required

(IBID. p. 54). Fewer workers lowered the overhead cost of growers while an increased rate of pick raised the earnings per hour of the remaining workers, but most important, there was no increase in the overall costs of labor to the grower.

The industry became heavily dependent on Bracero crews during the 1950's. These crews were organized by grower associations and directed by packing houses. In the late-1950's, some 70 to 80 percent of the peak harvest workers were contract Mexicans (see Table IV.2). But in the early 1960's, lower prices for lemons coupled with rising costs, including wages (which increased 30 percent between 1960 and 1964), brought negative returns to growers (as is evident in Table IV.6). As a consequence, acreage in lemons declined. Therefore, the end of the Bracero Program came amidst a larger crisis in the industry which was already forcing growers to find ways to increase the efficiency of workers.

Mechanization was not an alternative. The University of California tested some tree shakers for lemons, but the machines produced three to seven times as much unmarketable fruit as did hand picking (University of California, 1967, p. 3). As a result, attention focused on raising the rate of pick and limiting the total peak number of workers used. This strategy had several aspects:

First, attempts were made to develop more permanent employees. Many of the bracero workers returned every year, but contracts ran for only six weeks at a time and the workers moved from place to place (Smith, Seamount, and Mills, 1965, p. 46). In place of the braceros, the associations hired green-card workers through Public Law 414. The necessity of this was already clear by 1963 (University of California, 1963, p. b-66). These workers,

TABLE IV.4

California and Arizona Lemons, 1950-51 to 1977-78

Crop year	Bearing acreage	Non-bearing acreage	Total acreage	Total production	Cost of picking and hauling
	1,000 acres			million cartons	dollars per carton
1950-51	55.4	8.6	64.0	27.0	.37
1951-52	54.8	9.1	63.9	25.8	.39
1952-53	54.6	8.7	63.3	25.4	.40
1953-54	54.4	8.8	63.2	32.6	.37
1954-55	52.9	8.7	61.6	28.2	.40
1955-56	54.2	12.1	66.3	27.0	.39
1956-57	52.8	15.4	68.2	32.8	.38
1957-58	53.2	17.2	70.4	34.6	.38
1958-59	54.7	16.0	70.7	34.4	.38
1959-60	56.2	14.0	70.2	36.4	.37
1960-61	55.8	10.1	65.9	28.6	.41
1961-62	56.0	5.8	61.8	33.4	.39
1962-63	52.8	4.4	57.2	26.0	.42
1963-64	53.5	2.8	56.3	38.0	.46
1964-65	50.0	3.0	53.0	28.4	.55
1965-66	47.4	9.1	56.5	31.5	.55
1966-67	46.5	12.6	59.1	35.8	.54
1967-68	46.9	10.9	57.8	33.7	.55
1968-69	48.7	14.3	63.0	31.6	.59
1969-70	47.1	18.8	65.9	31.0	.60
1970-71	50.4	22.4	72.8	32.9	.66
1971-72	52.0	24.9	76.9	33.4	.62
1972-73	55.6	26.2	81.8	44.4	.70
1973-74	64.6	21.0	85.6	35.6	.74
1974-75	64.9	20.2	85.1	58.8	.83
1975-76	67.7	21.7	89.4	35.2	.92
1976-77	68.2	18.1	86.3	52.0	1.00
1977-78	67.9	15.0	82.9	52.2	1.16

Sources:

Sunkist Growers, Statistical Information on the Citrus Fruit Industry, 1967

Sunkist Growers, Inc., Citrus Fruit Industry Statistical Bulletin, 1975; also, ibid., 1979.

TABLE IV.5

AVERAGE HOURLY EARNINGS OF (BRACERO*) CREWS IN LEMON PICKING, VENTURA CO. CALIF.; 1943 TO 1966

Year	Hourly Rate
1943	$0.50
1944	0.75
1947	0.95
1954	0.94
1955	0.94
1956	0.95
1957	0.95
1958	0.99
1959	0.96
1960	1.01
1961	1.07
1962	1.12
1963	1.20
1964	1.30

*after 1954

Source: Smith, et. al. (1965), pp. 17,28,33,36,54.

TABLE IV.6

AVERAGE GROWER INCOME, CALIFORNIA LEMONS*

Crop Year	Income/acre
(5-year average)	(5-year average)
1934-1938	$113
1939-1943	117
1944-1948	72
1949-1953	235
(annual)	(annual)
1954	99
1955	132
1956	20
1957	27
1958	-63
1959	-31
1960	-22
1961	-41
1962	281
1963	87
1964	97
1965	161
1966	220
1967	281

* refers to income, per acre; on-tree crop value, less cultural costs.

Source: Sunkist Growers, Statistical Information on the Citrus Fruit Industries, (annual).

returning every year to work for the same association, became highly experienced and efficient.

Second, the incentive pay system was retained, but a minimum wage was instituted (Mamer and Rosedale, 1974, p. 10). New workers were given a two month "training" period. If they could not raise their productivity enough to earn more than this minimum wage, they were considered "unqualified" and not rehired (IBID. p. 13).

Third, many non-wage benefits were instituted such as paid vacations, health plans, education, and unemployment insurance. In 1978, almost 2,000 citrus harvest workers were covered by employer-sponsored health and life insurance programs (Hayes, 1978, p. 69). All of these programs contributed to stabilizing the work force.

Fourth, an attempt was made to provide year-round work. Lemons ripen over a considerable period of the year, and can be left on the trees even longer, even after they are ripe. The harvest can thus be spread out with proper planning, eliminating much of the need for a seasonal peak labor force. When not harvesting lemons, workers can be trained to prune the trees, a highly skilled activity that in the past was done by different workers. Training programs were developed to teach the harvest workers to do the pruning work, and hence extend their employment over a longer period.

Finally, research efforts were focused on increasing the rate of pick. Better picking bags were invented; time and motion and energy studies were done to eliminate the most exhausting parts of the job; mechanical picker position systems were invented to eliminate ladders (Mamer and Rosedale, 1974; University of California, 1966, pp. 8, 17).

A study of one growers' association of 300 growers found that the total number of pickers employed decreased by more than one-half between 1966 and 1972, while the number of boxes picked remained constant (see Table IV.7). Wages increased by more than 50 percent during the same period, keeping up with piece rates in other California crops. Costs per box picked and harvest costs per box both increased less than 20 percent over the same period, which represented a much slower rate of increase than overall farm wages (which increased 26%), or the rate of increase of prices paid by farmers for produced inputs (which increased 42 percent), or the Consumer Price Index (which increased 33 percent)(Mamer and Rosedale, 1974, pp. 30-31).

The success of the citrus growers' strategy is largely attributable to the centralization of labor management, much as in lettuce production. This centralization has a long history in citrus, but the recent intensification of labor rationalization has further reduced the citrus grower to a mere investor, dominated by his "cooperative" association (Friedland, Furnari, and Pugliese, 1980, p. 24).

We should pause here in our survey of various labor strategies to consider the plausibility of the recruitment of the "green card" workers who have figured so importantly in both the histories of lettuce and lemons. How was recruitment of this kind of labor possible? First, relatively small numbers of workers were involved (in contrast to the earlier large use of braceros in cotton, sugar beets, or tomatoes). Second, the immigration laws of the early 1960's provided employers with relatively easy access to such labor. Eric Thor and John Mamer offered the following description of the strategy in 1963:

TABLE IV.7

EVIDENCE OF LABOR RATIONALIZATION IN LEMONS: LABOR USE AND, LABOR PRODUCTIVITY IN THE COASTAL GROWERS ASSOCIATION

Year	Pickers Employed	Total Man-Hours	Average Days Worked/Worker	Total Boxes Picked
1965	8,517	1,286,000	17	4,358,000
1966	6,611	1,833,000	31	7,172,000
1967	5,188	1,849,000	40	8,615,000
1968	3,870	1,614,000	46	7,591,000
1969	3,585	1,342,000	42	6,386,000
1970	3,483	1,316,214	47	6,261,334
1971	3,757	1,594,531	50	7,100,144
1972	3,335	1,559,189	55	6,950,225

Source: Rosedale and Mamer (1974), p. 19.

"An apparent alternative source of labor is the Mexican who enters under immigrant visa -- the so-called 'green card' worker. His entry comes under the provisions of the Immigration and Nationality Act, usually referred to as Public Law 414. As Mexico does not come under immigration quotas, there is no maximum restriction on the number who may enter. The citizen of Mexico who seeks entry as a permanent worker-immigrant is required, as a condition of obtaining his visa, to have a letter from a U.S. employer offering employment, but neither party thereby enters into an actual contract relationship. Following entry into the U.S., the immigrant is free to seek employment as he moves about as he chooses. Many of those who enter under the immigrant provision have previously been Braceros. In contrast to the contracted Bracero, the immigrant may bring his family, and it appears that a substantial proportion do so.

"The provisions for immigrant entry under P.L. 414 have been in existence since 1951. However, it has only been in very recent years that the magnitudes of entry have reached significant levels. This recent build-up in the volume of immigrant movement is due in part to increasing interest of U.S. farm employers in this source of labor and to the development of systematic channels of approach for offering employment and recruiting of workers...

"It is estimated that by July 1, 1961, as many as 50,000 permanent immigrants from Mexico had been added to the U.S. farm labor force, with 22,000 being in California. In line with the recent upward trend, it appears that the number of green card immigrants in the California farm labor force at the 1962 peak was 30,000 to 35,000....

"Under the present administrative regulations relating to P.L. 414, the obtaining of immigration visas by Mexican citizens is relatively easy and depends primarily upon the holding of an offer of employment. The volume of entry is related directly to the level of interest and activity by U.S. employers or intermediaries (visa consultants) in obtaining labor from this source. If interest and activity continue to increase and if administrative regulations remain as they are at present, it appears highly probable that P.L. 414 entries will continue to mount." (University of California, 1963, pp.20-23).

That such a strategy was indeed subsequently pursued was suggested by California Senator George Murphy, who estimated that there were 35,000 more green card workers in 1965 than in 1964 (Murphy, in California Tomato Grower, 1966, p. 6). But green card workers could legally take any job once they were in the United States. Their use thus implied a relatively high wage for

agriculture and led to the sort of labor rationalization schemes pursued in lettuce and lemons. The importance of this relationship is its example of the complex interdependence of the labor process, technology, and State policies affecting the migration of labor.

The special nature of green card immigrants limited their use in California agriculture to those sectors that could employ high-wage labor rationalization. For those crops that could not undertake such schemes, other strategies were necessary, such as the use of illegal immigrants (whose existence was dependent on State policy) who were more appropriate to low-wage work, mechanization of labor activities, or the elimination of the crop altogether. Strawberries and many other crops now make use of large numbers of undocumented workers, sugar beets and tomatoes (which will be discussed below) are crops that employed the mechanization alternative, and (white) asparagus is an example of a crop that could not successfully adapt to the new labor conditions and therefore was eliminated. We examine this case next.

Adaptive Response #4: Asparagus Leaves California

Asparagus has been grown commercially in several regions of the United States since the last century, but California has been the leading producer, accounting for about fifty percent of U.S. production in the mid-1960's. There are two types of asparagus, white and green: green asparagus is eaten fresh, frozen, or canned; white asparagus is only canned, and U.S. production has been located entirely in the San Joaquin Delta region of northern California. Canned white asparagus constitutes the major portion of world trade in asparagus.

Asparagus is a perennial crop and requires a large investment in three years of cultivation before it is first harvested. Plants last from 8 to 20 years. Asparagus is also a very labor-intensive crop, both in the field and at

the cannery or packing shed (Del Monte, 1963). Harvesting must be done every day once the season begins. Workers walk through the fields examining the spears, cutting the marketable ones with a knife. Other workers then collect the asparagus and "sled" it to packing sheds. Green spears are cut only slightly below ground, while for white spears, the dirt is mounded and the spears cut 8 to 10 inches below the surface. White asparagus cutting is obviously a more difficult task than harvesting green asparagus. A similar disparity exists in the cannery, for the white spears must not only be trimmed and sorted like the green, but also peeled as well (International Trade Center, 1979). Approximately four times as much labor is required to process a can of asparagus as a can of peas or tomatoes (U.S. Tariff Commission, 1973, p. 25).

These high costs of production have made asparagus one of the dearest vegetables. For example, in 1962, U.S. processors paid on average $20 per ton for sweet corn, $28 for tomatoes, $85 for green peas, $104 for snap beans, and $251 for asparagus (Del Monte, 1963). Since the early 1960's, U.S. consumer prices for fresh asparagus have risen at least as fast as any other vegetable, and canned asparagus prices have risen more rapidly than all other processed fruits and vegetables (U.S. International Trade Commission, 1976, p. A-41).

The end of the Bracero Program in 1964 was a crisis period for the California asparagus industry. Some 10,000 workers had been employed in harvesting this crop, about half of which were Braceros (see Table IV.2). The Braceros were used most extensively in cutting white asparagus, grown only for canning and accounting for practically all of the U.S. exports of canned asparagus (U.S. Tariff Commission, 1973, p. 37).

The presence of Mexican contract workers acted to hold down wages. As we

TABLE IV.8

California Asparagus, 1950-1979

Crop year	Harvested	Total production	Total processed	Canned white	Canned green	Frozen	Recommended piece-rates (per 100 pounds) cutting and sledding: Green for canning	Recommended piece-rates (per 100 pounds) cutting and sledding: White for canning
	1	2	3	4	5	6	7	8
	acres			1,000 cwt.			dollars	
1950	71,700	1,792	1,160	631	434	20	a/	
1951	70,900	1,560	1,107	482	532	94		
1952	69,400	1,527	977	525	348	103		
1953	69,200	1,522	917	405	346	166		
1954	72,400	1,520	1,035	417	500	117		
1955	76,700	1,918	1,490	685	642	161		3.25
1956	76,200	1,829	1,212	528	390	287		3.25
1957	75,800	1,895	1,132	450	472	197		3.25
1958	76,300	1,831	1,188	641	408	140		3.25
1959	77,800	1,867	1,200	473	486	239		3.25
1960	73,500	1,911	1,280	466	548	266	3.75	3.25
1961	66,000	1,980	1,376	653	445	278	4.10	3.80
1962	66,600	1,998	1,420	694	450	273	4.10	3.80
1963	65,900	2,043	1,429	703	458	251	4.10	3.80
1964	65,400	1,831	1,246	632	340	296	4.10	4.10
1965	54,900	1,537 b/	900 b/	304	352	247	4.50	4.90
1966	51,900	1,609 c/	1,148 c/	444	343	361	4.95	6.15
1967	50,200	1,406	880	119	399	358		
1968	46,700	1,494	896	188	361	346		
1969	44,700	1,296	760	129	379	251		
1970	42,900	1,330	651		405 d/	246		
1971	43,000	1,376	781		348	343	6.75	8.00
1972	45,700	1,554	850		372	478	7.00	8.00
1973	45,000	1,260	600		378	222	7.00	8.00
1974	44,100	1,279	671		524	147	8.00	10.00
1975	38,200	1,070	413		157	256	8.00	— e/
1976	33,900	1,254	529		177	352		—
1977	30,300	1,121	560		204	356		—
1978	28,000	784	255		115	140		—
1979	26,400	924	444		235	333		—

a/ Blanks indicate data not available.

b/ Excludes 120,000 cwt. not harvested or marketed because of economic conditions.

c/ Excludes 91,000 cwt. not harvested or marketed because of economic conditions.

d/ No longer broken down by type. White asparagus production insignificant.

e/ Dashes indicate not applicable.

Sources:

Cols. 1-3: California Crop and Livestock Reporting Service, California Vegetable Crops, various issues.

Cols. 4-6: Idem, Vegetables Processing: Asparagus for Processing, annual issues.

Cols. 7 and 8: U. S. International Trade Commission, Asparagus: Report to the President, Investigation No. TA-201-4 Under Section 201 of the Trade Act of 1974, Publication No. 755, Washington, D. C., January, 1976.

TABLE IV.9

U. S. Canned Asparagus, 1945-1974

Crop year	U. S. production		Exports	Imports
	White	Green	Green and white	
	million pounds			
August				
1945-1949	a/		6.1	—b/
1950-1954			12.2	—
1955-1959	53.7	114.6	34.9	—
1960-1964	67.8	132.8	56.7	—
1965-1969	23.9	142.1	24.3	1.1
1970-1974		133.6	5.0	7.7
Annual				
1960	51.6	134.7	51.2	—
1961	67.6	127.7	44.3	—
1962	74.3	137.3	64.1	—
1963	80.3	136.2	62.2	—
1964	65.1	126.9	61.7	—
1965	30.6	137.8	46.4	—
1966	44.0	140.5	29.0	0.6
1967	12.0	143.1	18.9	2.5
1968	18.6	143.2	15.7	0.9
1969	14.4	144.9	11.5	1.5
1970	6.3	133.3	7.5	2.5
1971		129.7	4.5	5.4
1972		137.1	3.8	9.4
1973		135.6	4.1	12.5
1974		132.1	5.1	8.8

a/ Blanks indicate data not available.

b/ Dashes indicate data negligible.

Source: U. S. International Trade Commission, Asparagus: Report to the President on Investigation No. TA-201-4 Under Section 201 of the Trade Act of 1974, Publication No. 755, Washington, D. C., January, 1976, p. A-24.

see in Table IV.8, piece-rates remained constant through the 1950's, rose to a new plateau in the early 1960's, then took off in 1965. Of particular note is the disparity between white and green asparagus piece-rates. White asparagus harvesting was paid at a lower rate until after the Bracero Program, even though it was much more difficult to harvest white asparagus.

Attempts to mechanize the asparagus harvest had been underway for many years, originating during World War II, and located primarily in California. Efforts in the 1940's on white asparagus culminated in a harvester built in San Jose in 1951, under contract from the California Asparagus Advisory Board (Kepner, 1965; Kepner, et. al., 1966). The machine was not economic however, and the Bracero Program rendered it superfluous. It was resurrected in 1964 by the University of California at the instigation of asparagus canners and growers and it was tested for two years (IBID.). Results indicated that the machine had possible applications under the right field and economic conditions, but by 1967 white asparagus production had declined substantially, and the machine was never adopted commercially. Interestingly, the proto-type machine appears to have been about as successful as the early tomato harvesters, but unlike the asparagus harvester, the tomato harvester was widely adopted at about the same time.

A harvester for green asparagus was also developed, but non-uniformity of the stand made it uneconomic for harvesting spears; it reduced marketable yield by over 40 percent (University of California, 1963, p. B-96). A sled-type harvester had been used by the late 1960's in Michigan and New Jersey, but only for green asparagus pieces, intended for canning, not for the fresh market. The adoption of this machine in these states appears to have resulted from problems in recruiting labor (U.S. Tariff Commission, 1973, p. 24).

As a representative of the California Asparagus Growers Association summzrized in 1972: "Over 16 different mechanical harveting systems were developed and tested and hundreds of thousands of dollars expended in other research and devleopment. Based on the results to date, no break-through is now apparent or expected in the reasonbly foreseeable future." (IBID., P. 115). But in recent years, work has begun on breeding uniformity into the asparagus plant, a precondition for the successful mechanization of tomatoes, and perhaps a basis for the eventual use of the machines in asparagus (U.S. International Trade Commission, 1976, p. A-102).

Without mechanization and without the Braceros, wages for white asparagus harvesting jumped 20 percent in 1965 and another 25 percent in 1966, as growers struggled with the Filipino workers who had long been tha main harvest labor force in California for green asparagus. At the same time as this struggle was occurring, the Taiwanese began growing and canning white asparagus for export to Western Europe, the major souce of demand (IBID. p. A-50). In West Germany, for example, where the United States accounted for 76 percent of canned asparagus imports in 1964 and Taiwan only 1 percent, by 1971, the roles were reversed, with Taiwan supplying 95 percent of the imports and the U.S. supplying less than 1 percent (IBID. p. A-82).

White asparagus production, the most labor-intensive of the two varieties, was eliminated from the U.S. by 1975 (see Table IV.9). In recent years, the major producer and canner of white asparagus, Del Monte, has moved its production and canning operation to the Bajio region of Mexico, and now exports both white and green canned asparagus to the U.S. (IBID. P. 56,57). Fresh and frozen asparagus is also imported from Mexico. Del Monte is not the only major U.S. corporation to move to this region of Mexico.

This history is an excellent example of the potential for rapid structural change and dislocations under crisis within the evolving framework of a new international division of labor. If Taiwan had not imported U.S. technology in 1963 and begun an export-oriented industry, California might have successfully mechanized the crop over the few years after the Bracero Program and become even more entrenched in the production of this crop, as occurred in canning tomatoes. Of course, the low level of technology and labor-intensity of asparagus canning was, and is, a barrier to such an outcome, and it should also be contrasted to the capital-intensity of much of current tomato processing. Uneven development in many factors produces differential outcomes in any historical conjuncture.

Adaptive Reponse #5: Continued Mechanization of Sugar Beets

Sugar beets represent a different sort of example from the other crops we have considered, for the mechanization of harvesting was already completed in California during World War II and in the United States by 1958. But this partial mechanization is important to consider in comparison to other crops and to other phases in the production cycle of sugar beets.

Already at the turn of the century, mechanization of ground preparation, planting, and cultivation were well-advanced, but spring blocking and thinning and fall harvesting were very labor-intensive. To fill these large labor requirements, the sugar companies themselves recruited overseas labor (Taylor, 1967, p. 21). They would pit different races of workers against one another to break strikes and hold down wages. This domination by the refining companies pervaded the industry, for the refiners also provided the growers with seeds and extension personnel to supervise the production of the crop, and

it appears they eventually made the decision to mechanize the harvest (Arrington, 1967, p.12; Mamer, 1958).

Hand harvesting of sugar beets was one of the most arduous of all agricultural tasks. This led farmers to experiment with harvest machines even in the 1920's. But as with so much else in agriculture, the state came to play a key role:

> "The important step toward developing such machines...came in 1931, when the California Agricultural Experiment Station and the Bureau of Agriculural Economics of the U.S.D.A., cooperated in a study of the mechanization of sugar beet growing and harvesting...After 1938...grants from the U.S. Beet Sugar Association helped finance a more intensive research program." (Rasmussen, 1967, p. 32).

Blackwelder Manufacturing Company, later to produce the University of California's tomato harvester, worked with the Univeristy to develop one of the first successful sugar beet harvesters in 1940 (Blackwelder, in: State of California, 1964, p. 106). Still at the prototype stage, the machine was pressed into use because of war-induced labor scarcity. In 1942, sugar beet acreage in California dropped from 170,000 acres to 70,000 (Bainer, 1969, p.232). The next year, "growers accepted processed seed that approached single germ units and the crude commercial harvester available by 1943 and the processors accepted the poorly topped beets. The result was the harvest became fully mechanized by the end of the war" (IBID. p. 232). This was clearly a decision of the processors and can be partly attributed to government war price guarantees (Rasmussen, 1967, p. 33).

Adoption accross the country was not as rapid: in 1944 only 7 percent of the harvest was mechanized across the U.S., only 12 percent by 1945, and 100 percent by 1958. 1958 was also an important year for the cotton harvester

adoption, and the resultant decline in the use of Braceros in both cotton and sugar beets lessened the national significance of this program, as we have seen above.

This mechanization in sugar beets shifted that crop's peak demand for labor back to spring thinning. In California, considerable numbers of Braceros were still imported for this purpose, even after the mechanization of the harvest. Machines were developed to thin the beets, but they lowered yields beyond economic consideration. Much greater hope was placed on precision planters. Extensive mechanical seeding arose after the war with the development of the monogerm seed, finally perfected in 1956. This development, by itself, greatly reduced the need to thin but it also raised the possibility of precisely planting the seeds, thereby eliminating thinning altogether.

Thus, the end of the Bracero Program found growers of sugar beets well under way toward total mechanization. The number of Bracero workers needed to thin sugar beets in California had declined from 4,560 in 1958 to 2,670 in 1963 (see Table IV.2). At the same time, acreage had increased by more than 50 percent with the removal of planting restictions in 1962.

But it was not so much the adoption of mechanical thinning or precision planting that eased the transition, as it was the fact that sugar beet thinning required labor during the period of the year when there was little other demand for labor. Mechanization of the harvest removed sugar beets from the overburdened fall labor market, which was the peak for seasonal workers. Workers were more readily available during the spring, when beets are thinned. In fact, the large influx of illegal Mexican immigrants in the 1960's slowed the adoption of new machinery or herbicides, so that by 1976 fully 40 percent of the thinning and 90 percent of the hoeing were still done by hand (Kumar et.

al. 1978, p. 195).

One last point of importance should be noted. Sugar beets are grown all over the state by growers of varying size, but, in particular, they are grown in rotation with tomatoes and hence have the following desirable characteristic:

> "...beets were a uniquely desirable crop from an agronomic point of view. The sugar was sold to humans, the tops and pulp and molasses fed to animals, and the roots remained in the soil to enrich and condition it. Since the sugar was a mixture of water, sunshine, and air, the beet took nothing from the soil that was not returned in the form of manure from the animals which ate its by-products. The seven-foot taproot and the myriads of feeder roots broke up the soil, aerated it, and helped it drain and retain moisture. Beets were an "ideal" crop for rotation with grains, vegetables, or other crops which tended to exhaust the soil. Moreover, beet culture required deep plowing and careful preparation of the soil, leaving the soil in excellent condition for the crops which followed. Studies made both in Europe and the United States showed that the yields of other crops were increased when raised in proper rotation with beets. The beet was viewed as particularly adapted to the West because it was not competitive with wheat and corn, lent itself to diversification and stock feeding, improved the land, and provided the farmer on irrigation projects with the cash to meet his payments and to buy new equipment." (Arrington, 1967, pp.11-12)

The importance of this lies in recognizing that California tomato growers were also beet growers, and hence had experienced the mechanization of a formerly labor-intensive harvest in the 1940's. Similarly, the approaching mechanization of thinning (or precision planting) sugar beets, the recent mechanization of the cotton harvest, and the already completed mechanization of potatoes, canning peas and green beans, spinach, and all other small grains could only encourage the more progressive tomato growers to pursue a mechanical strategy. Their situation in this respect is in marked contrast to the fruit growers and the growers of perishable vegetables for the fresh market, where no significant mechanization had occurred. The rapid diffusion of the tomato

harvester in California and the support of certain large growers in its invention were particularly affected by these earlier experiences.

CITATIONS: PART IV

Arrington, L., "Science, Government and Enterprise in Economic Development: The Western Sugar Beet Industry," in Agricultural History, Vol. 41, no. 1, (January 1967).

Bach, R. "Mexican Immigration and U.S. Immigration Reforms in the 1960s," Kapitalistate, no. 7, 1978.

Bainer, R. "Mechanization in Agriculture," HortScience, Vol. 4, no. 3, (Fall 1969).

Blackwelder, E., testimony to California Legislature in Assembly Interim Committee on Agriculture, "Symposium on Farm Mechanization -- Transcript of Proceedings," Oct. 14, 1964.

California Farm Labor Panel, "Final Report of the California Farm Labor Panel to Secretary of labor W. Willard Wirtz," Los Angeles, December 1, 1965.

California Strawberry Advisory Board, "Agricultural Labor Requirements in the California Strawberry Industry," March 1965.

Del Monte Corp., Shield, Vol. 15, no. 9, (July, 1963).

Feder, E., Strawberry Imperialism, Research Report Series no. 1, Institute of Social Studies, (The Hague, 1977).

Friedland, W. H., A. Barton and R. Thomas, Manufacturing Green Gold. The Conditions and Social Consequences of Lettuce Harvest Mechanization, Department of Applied Behavioral Sciences, California Agricultual Policy Seminar, University of California, Davis, July 1978.

Friedland, W. H., M. Furnari and E. Pugliese, "The Labor Process and Agriculture," paper presented to the Working Conference on the Labor Process, Univeristy of California, Santa Cruz, March 14-16, 1980.

Friedland, W. H., "Technology in Agriculture: Labor and the Rate of Accumulation," in Buttel, F. H. and H. Newby, eds., The Rural Sociology of the Advanced Societies: Critical Perspectives, Allanheld, Osmun, (Montclair, New Jersey, 1980).

Fuller, V., "Comments on the Labor Situation," in Commonwealth Club of California, "California's Agricultural Objectives,"Transactions of the Commonwealth Club of California, 38:5 (July): 173ff.

Fujimoto, I. and W. Kopper, "Outside Influence on What Research Gets Done at a Land Grant School: Impact of Marketing Orders," in U.S. Congress, Senate, Subcommittee on Administrative Practice and Procedure of the Committee on the Judiciary, Priorities in Agricultural Research of the U.S. Department of Agriculture, Part 2, Appendix, 95th Congress, 1st Session 1978.

Hayes, S. "Farm and Nonfarm Wages and Farm Benefits, 1948-1977," in Technological Change, Farm Mechanization and Agricultural Employment, Division of Agricutlural Sciences, Publication no. 4085, University of California, 1978.

International Trade Centre, UNCTAD/GATT, Major Markets for Canned Asparagus, Geneva, 1979.

Kelly, C.F., testimony to the California Legislature, Assembly Interim Committee on Agriculture -- Transcript of Proceedings," October 14, 1964.

Kepner, R. A., "Mechanical Harvester Feasible for White Asparagus," California Agriculture, Vol. 19, no. 1, January 1965.

Kepner, R., M. O'Brien and A. Carlton, "Mechanical Harvesting of White Asparagus," California Agriculture, Vol. 20, no. 5, May 1966.

Kumar, R., W. Chancellor, and R. Garrett, "Estimates of the Impact of Agricultural Mechanization Developments on In-Field Labor Requirements for California Crops," in Technological Change, Farm Mechanization and Agricultural Employment, published by the Division of Agricultural Sciences, Publication #4085, University of California, Berkeley, 1978.

Mamer, J., The Generation and Proliferation of Agricultural Hand-Labor-saving Technology: A Case Study of Sugar Beets, unpublished Ph.D. Thesis, Dept. of Agricultural Economics, Univ. of California, Berkeley, 1958.

Mines, R., "Las Animas, California" -- A Case Study of International Village Network Migration", unpublished Ph.D. dissertation, Department of Agricultural and Resource Economics, University of California, Berkeley, 1980.

Murphy, Senator G., California Tomato Grower, Vol. 9, no. 2 (Feb. 1966).

Peterson, M.L., "The University of California Research Program on Agricultual Mechanization," speech given at the California State Chamber of Commerce meeting in San Francisco, October 6, 1964.

Rasmussen, W. D., "Technological Change in Western Sugar Beet Production," Agricultural History, Vol. 41, no.1, (January 1967).

Rosedale, D. and J. Mamer, "Labor Management for Seasonal Farm Workers: A Case Study," Information Series in Agricultural Economics, No. 74-1 (March 20, 1974).*

Smith, R., D. Seamount and B. Mills, Lemon Picking and the Ventura County Tree Production Incentive Wage System, California Agricultural Experiment Station Bulletin No. 809, University of California (January 1965).

Taylor, Paul, "Hand Laborers in the Western Sugar Beet Industry," Agricultural History, Vol. 41, no.1, (January 1967).

* University of California, Berkeley; Giannini Foundation

Thor, E., A.A.M. Goueli and A. Hutchens, "Costs of Alternative Methods of Harvesting and Packing Lettuce," Information Series on Agricultural Economics, No. 65-1, Agricultural Experiment Station, University of California, Berkeley, October 1965.

United States Department of Agriculture, Foreign Agricultural Service, Foreign Agriculture, May 23, 1966.

United States International Trade Commission, Asparagus: Report to the President on Investigation No. TA-201-4, USITC Publication 755, Washington, D.C., January 1976.

United States Tariff Commission, Conditions of Competition Between U.S.-Produced and Foreign-Produced Asparagus, TC Publication 550, Washington, D.C., April 1973.

University of California, Division of Agricultural Sciences, Seasonal Labor in California Agriculture, 1963.

University of California, Division of Agricultural Sciences, California Agricultural Labor Requirements and Adjustments, Berkeley, Calif. September, 1964.

University of California, Division of Agricultural Sciences, Research on Agricultural Mechanization, 1966.

University of California, Division of Agricultural Sciences, Research on Agricultural Mechanization, 1967.

Wells, M., "Regional Forces and Industrial Constraints: Changing Labor Market Structure in the California Strawberry Industry," unpublished paper, Department of Applied Behaviorial Sciences, University of California, Davis, 1980.

NOTES ON PART IV

1. The California Strawberry Advisory Board, established in 1955, is a state program, provided for by law when a specified percent of the voting farmers agree to establish a marketing order. The purpose of such an order is to allow producers of a particular crop to collectively undertake research, advertizing, data gathering and analysis, quality control standards and, occasionally, supply controls. Marketing orders have been permitted by both state and federal law since 1937; the enabling legislation was justified on the grounds that producers of speciality crops required some provisions to aid in the orderly marketing of their crops. Speciality crops, with the exception of milk, do not enjoy price-support provisions, such as those available to corn, wheat, cotton and other major field crops. Although marketing orders are not intended to restrict the flow of the commodity to the market, quality controls are permitted, and these serve the same purpose. Marketing orders generally support their activities through taxes on all producers of the related crop.

2. A "green card" is the document that allows a non-U.S. citizen to reside legally in the United States. While the strategy elaborated in what follows is no doubt true, it ignores the extent of undocumented workers employed in the U.S. This omission is largely related to our ignorance about the numbers of individuals involved. Hence the term "green card" could probably just as well read "illegal" throughout.

3. This sample of growers had paid Braceros $1.00 per hour in 1964. In 1965 they paid $1.25 per hour, then $1.40 with an option for a piece rate at $1.10 per hour plus 25 cents per crate. Piece rate workers were making over $2.00 per hour. In later years, the industry shifted entirely to a straight piece rate per crate.

4. Antle was widely denounced by California growers for his willingness to make agreements with any union, and he was thrown out of a number of agricultural organizations; see Friedland, et. al. 1978, pp. 54-55.

5. The first selector was a pressure sensor with an electronic memory, according to R.E. Griffen, et. al., in "Progress in Selective Harvesting Lettuce," California Agriculture, Vol. 18, no. 4 (April 1964), pp. 2-3. However, this device failed to win grower acceptance, so a gamma-ray, density sensor was developed — see University of California, Division of Agricultural Sciences, Research on Agricultural Mechanization, Berkeley, 1966. U.S.D.A. researchers have more recently developed an x-ray sensor.

6. This is the same strategy as was discussed in strawberries, and as will be discussed below in citrus. Again, this particular formulation, while evidently true to a certain extent, ignores the extent of undocumented workers.

PART V

THE MECHANIZATION OF CANNING TOMATOES -- INDUCEMENT AND ADOPTION PHASES

In the preceding section we discussed the labor strategies of agricultural capital in five labor-intensive crops as a response to the end of the Bracero Program: the lettuce and lemon growers turned to labor rationalization schemes; the strawberry industry saw the recreation of sharecropping; sugar beet growers extended the mechanization already underway; and white asparagus production disappeared from California.

The following discussion of the development, adoption, and consequences of the tomato harvester is presented both in greater detail and in contrast to these other crops. Its adoption must be understood as a response to crisis, but also as only one of several possible responses. Too often the tomato harvester has been analyzed in isolation from the context of its development. The purpose here, then, is to explore the unique nature of tomato harvest mechanization and, in particular, to draw out the critical role of the state as it shifted from a supplier of cheap labor to a purveyor of technology.

This section focuses on the forces causing the canning tomato industry to demand the development of a harvester and the obstacles that had to be overcome before the new harvester could be widely adopted. In this presentation, we concentrate on the roles of the various inducing agents, both public and private to highlight the complex interaction of state policies with private industry. We begin with a brief history of the mechanical harvester in California.

A Brief History of the Tomato Harvester

We must stress that the harvester under discussion here was developed to pick canning tomatoes, not those intended for the fresh market. This was feasible since only a short period elapsed between the harvest and the processing, and damaged tomatoes were cooked or mashed before being sold in cans. In recent years a machine has been developed for fresh market tomatoes, but this is a new phenomonon and is not considered in this study.

Table V.1 presents a chronological history of the California processing tomato industry since World War II, focussing on events important to the inovation or adoption of the harvester. One outstanding fact is the central role of the Land Grant Colleges in the innovation and diffusion process, whether in California, Florida, Michigan, or Indiana. This role is particularly marked in harvest and cultivation mechanization as the crops left to be mechanized are more difficult and more fragile and require a complex package of new inputs. As the former director of the California Agricultural Experiment Station remarked in 1965:

> "We must recognize that machines will never be completely developed to work under the cultural practices now followed, or with the varieties of fruits and vegetables as we now know them.
>
> This is the great advantage the University has: engineers have the opportunity to work in cooperation with biologists such as plant breeders, pathologists, biochemists, irrigationists, and soil scientists to create a harvesting machine and with it a harvestable crop." (Kelly, 1965, p. 11)

But the university researchers do not come to concentrate on the development of crops for machine harvest instead of for (say) higher yields just because of the physical juxtaposition of scientific disciplines. Rather, one can hardly think of a more clear exmple of the dialectic between science

TABLE V.1

CHRONOLOGY OF TOMATO HARVESTER DEVELOPMENT

World War II
—Labor shortages bring first impetus for tomato harvester development.

Nineteen Forty-One
—Conveyor machine in Pennsylvania.

Nineteen Forty-Two
—University of California's Department of Agricultural Engineering reviews mechanization work and lists tomatoes as a high priority.
—"A. M. Jongeneel, a California tomato grower, suggests to G.C. Hanna..... that the university develop a tomato that could be harvested by machine."(1)

Nineten Forty-Three
—Professor Hanna, a plant breeder at the University of California at Davis, begins a search for tomatoes with properties suitable for machine harvesting.
—"It was also reported in 1943 that a blacksmith in Holt, California, was building a tomato picker for a canning firm in Stockton."(2)

Late 1940's
—Pear-shaped tomato released to growers, adapted to machine harvest; i.e. more fruit ripens at the same time.

Nineteen Forty-Nine
—Professor Hanna approaches the agricultural engineering department at Davis with the results of his work and Professor Coby Lorenzen begins work on a tomato harvester at Davis.

Nineteen Fifty-One/Fifty-Two
—Growers in California experiment with conveyor sytstems.

Nineteen Fifty-Six
—California Tomato Growers Association makes a small grant to the University for work on a tomato harvester system.
—Tomato Day (an annual industry-wide meeting on research in progress) is first held at the University of California at Davis.

Nineteen Fifty-Eight
—Michigan State University team builds a tomato harvester.
—University of Florida team develops a conveyor belt machine.
—Food Machinery Corp. (FMC) and H. D. Hume Co. fund work on a tomato harvester at Purdue University in Indiana.
—The California Tomato Growers Association attempts to assume the role of bargaining cooperative, but canners are able to divide growers and two years later the Association returns to its role of providing service and information. This defeat appears to focus the energy of the Association on labor problems and on mechanization research, in an attempt to rebuild membership.

TABLE V.1 (CONT.)

Nineteen Fifty-Nine
—The Association grants $1,000 to the University and requests a crash program of research on the tomato harvester.
—The University builds and operates a prototype harvester in the field. "The University then patented the machine and licensed the Blackwelder Manufacturing Co. to undertake its commercial manufacture."(3). The machine was marketed as the U.C./Blackwelder tomato harvester, the only time the University's name has been attached to a commercial product.

Nineteen Sixty
—The Association grants $5,000 to the University to expedite the mechanization program.
—Blackwelder builds 15 harvesters.
—Five other harvesters are tested by other companies.
—1200 tons of pear-shaped tomatoes are harvested by machine.
—"On September 1, 1960, two thousand tomato growers, processors, bankers, etc. gathered at the Heringer Ranch, south of Courtland, Ca., to witness a demonstration of the University of California-Blackwelder machine..."(4).

Nineteen Sixty-One
—Mechanical tomato harvesters used commercially for the first time.
—25 U.C./Blackwelder machines sold to growers.
—0.5% of the California canning tomato crop is harvested mechanically.
—Six other firms test machines, including two large farm machinery corporations, Hume and FMC.
—Professor Hanna releases VF-145 tomates at the University of California. The strains selected from this variety were basic to mechanization in Califoria. It is reported that the basic stock for this strain was found growing wild in the Peruvian mountains.
—Canners and growers jointly finance a U.C. research team project on bulk handling problems arising from the use of the machine.

Nineteen Sixty-Four
—Public Law 78 (Bracero Program) terminated at the end of the season.

Nineteen Sixty-Five
—Tomato growers in California obtain special dispensation to import Mexican workers for the harvest (only 6,000 are used for this last time).
—Delano grape strike in California. This is the first major effort of the National Farm Workers Association (later to become the United Farm Workers).

Nineteen Sixty-Seven
—Federal minimum wage legislation extended to agricultural workers.

Nineteen Seventy
—Adoption of mechanical tomato harvester complete in California.
—Attempt by California Tomato Growers Association to pass a government marketing order to control the supply of processing tomatoes fails after canners raise the price of tomatoes.

TABLE V.1 (CONT.)

Nineteen Seventy-Four
—California Tomato Growers Association signs up more than two-thirds of growers and is recognized by processors, after some struggle, as the grower bargaining association for negotiating all contracts.

Nineteen Seventy-Five
—California law (Agricultural Labor Relations Act) gives agricultural employees the right to form unions and bargain collectively.
—United Farm Workers union organizes some counties where tomatoes are grown.
—Electronic tomato sorter (which reduces the necessary labor on the harvester from about 15 to 5 workers and doubles the price of the machine) used commercially in tomato harvest on 30 machines. This innovation developed by private firms, using a U.C. design for sorting lemons.

Nineteen Seventy-Six
—California law ensures unemployment benefits for agricultural workers.
—United Farm Workers push organizing among some tomato workers.
—Rapid adoption (20%) of the electronic sorter in response to labor organizing eliminates approximately 5,000 jobs from harvest.

Sources: General information: Rasmussen, W., "Advances in American Agriculture: The Mechanical Tomato Harvester as a Case Study," Technology and Culture, Vol. 9, No. 4 (October, 1968), pp. 531-543. Also used, various issues of the California Tomato Grower,, published by the California Tomato Growers Association.
(1) Rasmussen, Op. Cit., p. 534.
(2) Ibid., p. 533.
(3) Ibid., p. 536.
(4) California Tomato Grower, Vol. 8, No. 9, (October 1965), p. 5.

and society. This dialetical relationship is particularly evident in the evolution of the tomato harvester technology, the history of which we now summarize.

Labor shortages and strikes during World War II led to a re-evaluation by the Univeristy of California Department of Agricultural Engineering of the desired direction of new mechanization technology. Because of its heavy dependence on seasonal harvest labor, the canning tomato industry was placed high on the list of priorities for the provision of an alternative to hand-havest techniques (Bainer, 1969). At the same time, a farsighted plant breeder at the University, J. Hanna, began to work on a machine-harvestable tomato. In 1949 he approached the agricultural engineers with his progress and they drew up a design for a mechanical harvester. They determined that the tomato plant would have to be much more drastically redesigned, however, and so work continued, mainly on the plant breeding aspect, for the next ten years.

Early in the 1950's, Hanna interested the California Tomato Growers Association in his work, and they gave him some small grants (e.g. $1000 in 1956) according to the California Tomato Grower (1965), the major journal of the industry. However, the Bracero Program provided a ready supply of seasonal labor at a constant wage during the entire decade of the 1950s, and the machine appeared rather futuristic and irrelevant to most growers. In 1959, public discussion and action in the U.S. Congress first made it apparent that the Bracero Program might not survive, and the progressive tomato growers began examining the machine alternative more closely. The growers association granted the University's researchers more money for a "crash program," and the engineers put a prototype in the field during the same year.

From 1959 through 1964, a process of testing, redesign, and evaluation of

the mechanical harvester continued at an intense rate among a small group of the larger growers, the machinery companies, and the University. During the same period, the seed companies joined with Hanna to improve the tomatoes he had developed over almost 20 years of work.

The Bracero Progrm was not renewed after 1964, but some Mexican contract laborers were allowed into the California tomato harvest in 1965, as a transitional measure. The years 1965 to 1968 witnessed the rapid adoption of the machine, but what was adopted, it must be emphaized, was not entirely satisfactory, because the breeding of the tomato was not complete: the available machine harvestable tomatoes were still not sufficiently tough and did not ripen uniformly enough to prevent large losses of yields. It was not until after 1970 that these problems were overcome.

The Inducement of the New Technology

The development and rapid adoption of the tomato harvester must be seen in terms of the interrelated efforts of all segments of the California canning tomato industry. For example, some large and progressive growers were very important in testing the new machines and new cultural practices and in speaking in favor of them at grower meetings; the Tomato Growers Association, a group of canners, and Blackwelder Manufacturing Company all donated funds to the University in support of its work; canners would run "peelability" and "solids" tests for seed companies on new strains; some seed companies were among the first to adopt the harvester; the University plant breeders and the seed companies joined forces in Mexico to select new tomato strains; University engineers, Blackwelder Manufacturing Co., and some large growers all worked together on one machine; another large grower who was also a director of the

Tomato Growers Association worker with FMC, another agricultural machinery company, on testing its machine; University Extension personnel and county farm advisors organized all parties on the development and adoption of new cultural practices.

With more information, this list could be extended to include the banks, chemical companies, and other important sectors of the farm economy. But the three crucial parties were the growers organized around the Assocation, the canners, and the University.

The Association provided a forum through which information could be disseminated to growers, both at meetings held several times a year and through publications and fieldmen. The Association sponsored the "Tomato Day" annual meeting at the University of California at Davis. Begun in 1956, these "Days" brought together all elements of the industry to hear the latest research results from University professors and extension agents. The early adopters of the mechanical harvester were mostly directors or important members of the Association. Modest grants to University researchers aided continued progress on new breeds and the machine. According to testimony, these grants amounted to a total sum of only $25,000 between 1949 and 1964, a small amount in comparison to some other grower interests. For example, strawberry growers gave the University an average of $50,000 per year during this same period (Holt, in: State of California, 1964; Fujimoto and Kopper, 1978). In general, the Association represented and promoted the interests of large farmers.

Tomato processors played a very different role in these developments. Although some small independent processors were always interested in mechanical harvesting, little encouragement was given the program by the major firms until the early 1960's; it was not until the mid-1960's that Del Monte began

conducting research on new tomato varieties (Del Monte Shield, 1964). The division within the industry over this innnovation is exemplified by one group of canners who paid higher prices for machine-harvested tomatoes as the Bracero Program ended, thereby hoping to encourage the adoption of the machine, and another group who tried to lower prices (California Tomato Grower, 1966 and 1980).

An important step in the adoption of the tomato harvester was the decision by major canners to accept the machine-harvested tomatoes. This decision implied conversion of tomato receiving facilities to handle bulk containers, increased washing and sorting operations, greater problems with quality control, different hours of operation, and many other changes. Since almost all tomatoes were grown under contract, and since every contract specified the type of seed to be used and quality limitations, adoption could not have occurred without the consent of processing firms. It should be added that while some of the processing was done by grower-controlled cooperatives, they constituted a small minority of all processing capacity, so the support of the large proprietary canners was very important to the survival of the industry. In this sense, the end of the Bracero Program after 1964 was really more of an impetus to canners than to growers because it was no longer reasonable for the canners to withhold their support of the machine in favor of Bracero labor that no longer existed.

Once the processors decided to go over to machine-harvested tomatoes, adoption of the harvester was accomplished quickly. Some canners bought machines and leased them to their growers (California Tomato Grower, 1965); some searched out new (large) growers willing to buy the machines.

Finally, the University's role as an integral part of the industry was

crucial. The University provided practically all of the scientific research capability, including the new tomatoes that were the necessary prerequisites to the success of the overall strategy. The University was a focal point through which all segments of the industry could interact, hosting seminars, demonstrations, and Tomato Days, and thus proved to be an integrating force for the entire tomato industry. Finally, the University was involved in all phases of the development and diffusion of the harvester system and the necessary cultural practices.

Some have argued that we should expect mechanical and chemical technology to be supplied by private firms, since they can supposedly capture their research and development costs. Under this argument, the public sector must be relied upon to provide biological innovations that have high research costs and are difficult to monopolize (Bieri, et. al. 1972; Peterson and Hayami, 1977). In the case of the processing tomato industry, all of the crucial biological work was indeed accomplished by University personnel. Seed companies only marginally improved basic strains released to them by the University.

The mechanical harvester was also developed at the University, but this ws mainly due to its importance in testing the new tomato varieties. Blackwelder Manufacturing Company participated in the latter stages of this work and was licensed to produce the resulting machine. Other machinery companies and farmers developed their own machines, which indicates the University's role in this regard was not essential. The whole concept of a tomato harvester was in reality only an adaptation of previously existing technology.

Chemicals important to the new tomato "system" appear to have been developed by private firms, although the University tested them to determine

which ones worked best, and extension agents advised farmers on which ones to use. Very little is known about this aspect of the process.

All cultural practices (e.g. the number of plants per acre, ground preparation, irrigation schedules, etc.) were developed by University and extension personnel in cooperation with growers and canners. These new practices were crucial for the success of the system, and implied gains for all sectors of the industry, but they were the least saleable innovations and hence only tangentially approached by the private sector.

Thus we can conclude that the hypothesized division of labor between public and private agricultural research and development appears to be substantiated by the experience of the development of the tomato harvester. However, as we will discuss below, recent changes in laws and further concentration of capital appear to be shifting some biological research out of the public agencies and into private firms, making this public/private relationship a dubious generalization for the future.

Mechanization as a Labor Control Strategy

Tomatoes were a very labor intensive crop to harvest by hand, and California canning tomato growers had come to be almost entirely dependent on Bracero labor in the 1950's. In the last years of the program, they constituted from 80 to 90 percent of the peak laborers in the harvest. From World War II until 1965, never less than 65 percent of the California canning tomato harvest labor force was foreign immigrant workers, whether legal or illegal (California Tomato Grower, 1960). This disproportionately heavy dependence on migrant harvest labor exemplifies the problems which arise from

the uneven development of technology within and among crops.

The uneven development of technology within crops is usually manifested by the partial mechanization of planting and cultivating well before the mechanization of the harvest. This unequal mechanization among stages of production and an accompanying increased specialization of production together tend to increase the seasonality of labor needs. Increased seasonality (i.e. a sharper peak in the demand for temporary workers) implies a division of labor requirements between, on the one hand, family and permanent labor for continuous activities(maintenance, supervision, mechanized work and management tasks) and, on the other hand, a migratory labor force for harvesting. Uneven development of technology thus may accentuate the dependence on very temporary and low-wage workers.

Canning tomatoes provide a particularly good example of this process of uneven development, since they required such a large number of workers for the harvest, but required far fewer workers for the planting and cultivation of the crop. The age-old pattern of agricultural development in California, in which immigrant labor was used for the non-mechanized aspects of production was thus accentuated by the continuing development of technology. A migratory pattern of seasonal labor utilization had, over the years, become reduced to the brief importation of Mexicans for a short harvest period.

Similar structures are evolving in many parts of the world. Much of the history of California agriculture is characterized by this duality and by the contradictions inherent in attempting to reproduce the migratory labor force. These contradictions have been reinforced by the uneven development of technology among crops.

This uneven development is not only a consequence of social, economic,

and political factors, but also of scientific forces. Some crops are inherently more difficult to mechanize than others, since they require biological and cultural change as well as engineering innovations. Which of these crops are mechanized results from a social process of inducement, and this, in turn, depends on the social importance of the crop and the inducement efforts of groups associated with the crop.

The mechanization of selected crops may destroy migration patterns by eliminating jobs in one crop that had been an employment link between jobs in other crops in the same region (California Agrarian Action Project, 1977; Hightower, 1978, p. 32) For example, in the early 1960's, in Santa Clara County, California, an attempt to mechanize the prune harvest was resisted by local growers because they believed it would become more difficult to obtain workers to harvest other fruits in the area (e. g. apricots (Curley and Thor, 1964)). A second example of the same phenomenon is given by Bainer, who points out that the rapid adoption of the cotton picker in California brought about a serious labor problem for Central Valley raisin and wine grape producers. Grapes and cotton are grown in the same general area and the labor normally picking the cotton comes two or three weeks early to pick the grapes. With cotton mechanized, the workers did not show up in as large numbers to pick the grapes, causing growers considerable problems. As a result, efforts to develop a mechanical grape harvester were begun immediately. This is a good example of how the process of uneven technological development works. Mechanization in one crop leads to mechanization in other crops, through the indirect impacts on the labor force (see Bainer, 1969, p. 232).

The sheer numbers of workers involved in tomato harvesting — 30,000 to 50,000 -- made the Bracero Program more critical to this industry than to all

other California crops combined. However, the large numbers also tended to preclude a labor rationalization or green card strategy, as was used in some of the other crops. Tomato growers had hired Braceros mainly though labor contractors or temporary associations set up only for that purpose. Many growers did not plant tomatoes every year. Thus they did not have the small, tight-knit groups necessary to undertake systematic labor recruitment and management.

The alternative possibility of the canning tomato industry following the example of white asparagus and leaving the United States for cheap labor regions of other countries was raised as a very real threat at the time the Bracero Program was being considered for termination. Del Monte and some other firms had recently set up operations in Mexico, and it was widely believed that if wages rose high enough to attract domestic laborers, the crop would move to Mexico. Interestingly, California interests appear not to have anticipated the large increase in illegal immigrants in the fields which occurred after the end of the the Bracero Program.

The fear of rising wages was based on recent labor organizing in California agriculture. The Bracero Program had held wages virtually constant throughout the 1950's (Hayes, 1978, pp. 64-65), and had frustrated efforts to organize workers. Imported workers were overtly used to break strikes in the late 1940's, and this strategy was attempted again, with some success in the early 1960's. But wages began to rise after 1958 as organizing among farmworkers finally began to be successful. A series of strikes in 1960-61 reached the tomato fields, convincing growers that the end of the Bracero Program was sure to be accompanied by serious labor struggles and rising wages (Mines, 1974). This view was confirmed by the successes of organizers after

1964 and by the 26 percent jump in wages in 1964-65 (Brandt, et. al. 1978, p. 35).

Hence the availability of the machine and a reasonably tough tomato, early successes by a few large growers to adopt the mechanized harvest, the difficulties of the alternative labor strategies, the rising evidence of labor organization and higher wages, and the possible demise of the industry all contributed to make mechanization appear as the only alternative when the Bracero Program ended in 1964. We now examine the adoption and diffusion of the new technology.

Adoption and Diffusion of the Tomato Harvester

Because there was such a vast difference between the machine-harvest and hand-harvest systems of production, with seeds, cultivation, machinery, chemical inputs, handling, processing, product mix, and marketing all affected by the shift, the transition to the mechanical harvester required that the innovating grower not be penalized for making the change. Had the processors not been willing to accept the new tomatoes and develop the facilities for handling them, growers would not have had sufficient incentives to make the investments necessary. As it was, the processors provided the needed support, paid sufficiently high prices for the tomatoes, and adjusted their facilities to accept the new product. Adoption of the technology, spurred on by the forces described above, went very quickly after 1965, as Table V.2 indicates.

The cost savings to growers who adopted the technology were significant. "According to the California studies, mechanical harvesting reduced costs by $5.41 to $7.47 per ton, including amortization and interest charges on the new machine at 6 percent." (Schmitz and Seckler, 1970). These savings arose

TABLE V.2

PERCENT OF CALIFORNIA TOMATO CROP HARVESTED BY MACHINE, NUMBER AND SALES OF HARVESTERS IN CALIFORNIA, 1960-1970

Year	Percent of Crop Harvested by Machine	Number of Harvesters	Sale of Harvesters
1960	0.0	N.A.	1
1961	0.5	25	25
1962	1.3	25	5
1963	1.3	30	6
1964	3.5	75	44
1965	20.0	250	158
1966	70.0	800	512
1967	80.0	1,000	329
1968	92.0	1,300	406
1969	98.0	N.A.	49
1970	100.0	N.A.	5

Sources:
Col. 1 -- Brandt, French, and Jesse, 1978.
Col. 2 -- California Bureau of Fruit and Vegetable Standardization, Canning Tomatoes, Sacramento, 1962-1972.
Col. 3 -- Carman and Brandt, 1975.

...gely because the harvester was a once-through-the-field operation, whereas hand harvesting required 3 to 6 passes through the field, and because the machine sorters, who replaced the field pickers, were paid 15 to 25 cents per hour less (see Lorenzen, in State of California, 1964, p. 18; California Agrarian Action, 1977).The example of the tomato harvester conforms superficially to the induced-innovation model outlined in the introduction of this study: labor "scarcity" during World War II induced work to begin on the labor-saving technology package; further labor "scarcity" at the end of the Bracero Program brought about an increase in wages, inducing the adoption of the machine.

But this formulation masks the social relations which lie beneath these changes in prices and wages. Thus, the Bracero Program, its termination, higher wages, and the adoption of the harvester can only be understood as the outcomes of a social conflict between capital and labor. The notion of labor "scarcity" in California agriculture is really not one of absolute scarcity, but rather refers to a scarcity of labor that is willing to work for very low wages and under poor working conditions. It is a better representation of history to place the tomato harvester into this context of cheap labor. The harvester thus becomes a strategy for the replacement of cheap labor, after the industry lost its ability to control directly the supply of this cheap labor. This is a much different perspective than the usual one that sees such invention as induced by changing factor price ratios.

CITATIONS: PART V

Bainer, R., "Mechanization in Agriculture," Hortscience, Vol. 4, no.3 (Fall, 1969).

Bieri, J., et. al. , "Agricultural Technology and the Distribution of Welfare Gains," American Journal of Agricultural Economics, Vol. 54, no. 5 (December 1972).

Brandt, J., et. al., Economic Performance of the Procesing Tomato Industry, Giannini Foundation of Agricultural Economics, Bulletin 1888, University of California, Berkeley, 1978.

California Agrarian Action Project, No Hands Touch the Land, Davis, California, July, 1977 reprinted in U.S. Senate, Subcommittee on Administrative Practice and Procedure of the Committee on the Judiciary, Appendix to Hearings titled Priorities in Agricultural Research of the U.S. Department of Agriculture — Appendix, Part 2, 95the congress, First Session, 1978.

Carman, H. and J. Brandt, "Production Life Cycles and the Adoption of Durable Inputs; An Example of the Tomato Harvester," unpublished paper presented at the annual meetings of the American Agricultural Economics Association, Columbus, Ohio, August, 1975.

California Tomato Growers Association, California Tomato Grower, 1960, Vol. 3, no. 9 (October); 1965, Vol. 8, no.10, (November); 1966, Vol. 9, no. 4 (April 1966); 1980, Vol. 23, no. 5 (May).

Curley, R. and E. Thor, "Migrant Labor and Mechanization," Paper presented at the annual meetings of the American Society of Agricultural Engineers, Ft. Collins, Colorado, June, 1964.

Del Monte Corp., Del Monte Shield, Vol. 16, no. 12, (October 1964).

Fugimoto, I. and W. Kopper, "Outside Influence on What Gets Done at a Land Grant School: Impact of Marketing Orders," in U.S. Congress, Senate, Subcommittee on Administrative Practice and Procedure of the Committee of the Judiciary, Priorities in Agricultural Research of the U.S. Department of Agriculture, Part 2, Appendix, 95th Congress, 1st Session, 1978.

Hayes, S. "Farm and Nonfarm Wages and Farm Benefits, 1948-1977," in University of California, Division of Agricultural Sciences, Technological change, Farm Mechanization and Agricultural Employment, Publication No. 4085, Berkeley, California, 1978.

Hightower, J. Hard Tomatoes, Hard Times; The Failures of the Land-Grant College Complex, Schenkman, Cambridge, Mass, 1978.

Kelly, C. in California Tomato Grower, Vol. 8, no. 10 (October, 1965).

Lorenzen, C., testimony to the California Legislature, in Assembly Interim Committee on Agriculture, "Symposium on Farm Mechanization -- Transcript of Proceedings" Oct. 14, 1964.

Mines, R., "The AFL-CIO Drive in Agriculture, 1958-1961," unpublished M.A. thesis, Dept. of Latin American History, Columbia University, 1974.

Peterson, W. and Y. Hayami, "Technical Change in Agriculture," in Martin, L. ed. A Survey of Agricultural Economics Literature, Vol. 1, (Minnesota, University of Minnesota Press), 1977.

Schmitz, A. and D. Seckler, "Mechanized Agriculture and Social Welfare: The Case of the Tomato Harvester," American Journal of Agricultural Economics, Vol. 52, no. 4, (November 1970).

Thompson, O. and A. Scheuring, "From Lug Boxes to Electronics: A Study of California Tomato Growers and Sorting Crews," published by the California Agricultural Policy Seminar, Monograph No. 3, Department of Applied Behavioral Sciences, University of California, Davis, December, 1978.

PART VI

MECHANIZATION AND STRUCTURAL CHANGE WITHIN THE CANNING TOMATO INDUSTRY

The adoption of the mechanical tomato harvester has caused profound changes in the processing tomato industry. Here we examine these changes and their distributive implications, focusing on the unevenness of technological change and capitalist development and the competition among fractions of capital over the distribution of the surplus produced by the new harvest technologies.

Uneven Technological Change and Inter-regional Impacts

California's adoption of the mechanical harvester and its non-adoption in other states, solidified California's increasing dominance of the canning tomato industry. Production in California has increased from 35 percent of the U.S. total in 1950 to 55 percent in 1960, 65 percent in 1970 and over 80 percent in the mid-1970's (see Tables VI.1, VI.2). Californa has enjoyed a yield advantage throughout this period, and it was really the mechanical harvester that led to a more rapid decline in both processors and tomato growers in other regions (see Tables VI.3; IV.4).

Why was it not adopted in other areas? First, California tomato growers had much larger farms than growers in other states (see Table VI.3). The harvester required a minimum acreage of nearly 100 acres to be fully utilized when it was first introduced in the early 1960's (Friedland and Barton, 1974). Second, weather conditions were more variable in other regions, and uniform

TABLE VI.1

CALIFORNIA AND U.S. CANNING TOMATO PRODUCTION:

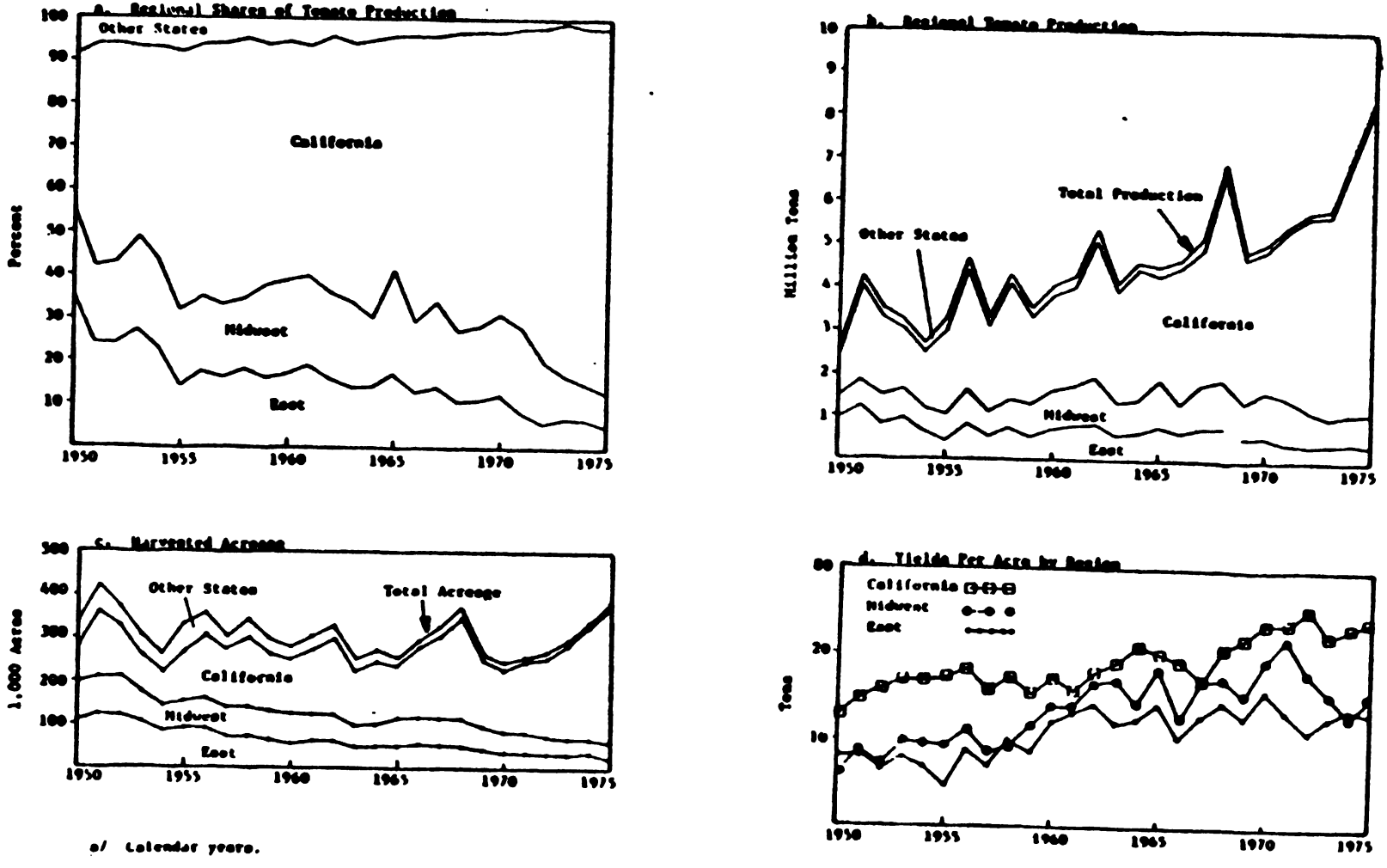
1946 to 1974

YEAR	UNITED STATES			CALIFORNIA TONNAGE AS PERCENTAGE OF U.S.	CALIFORNIA ACREAGE AS PERCENTAGE OF U.S.	CALIFORNIA YIELDS AS PERCENTAGE OF TOTAL U.S. YIELD
	PRODUCTION-TONS	ACRES HARVESTED	YIELD (TONS/ACRE)			
1946	3,393,700	570,770	5.94	39.2%	23.9%	166.6%
1947	3,242,800	511,370	6.34	44.1	27.9	157.7
1948	2,913,500	400,850	7.27	32.8	21.9	149.9
1949	2,518,700	345,140	7.30	39.8	21.9	182.2
1950	2,733,860	359,620	7.60	35.1	21.0	167.1
1951	4,267,070	423,830	10.06	51.8	35.0	148.1
1952	3,523,450	376,100	9.37	51.6	30.0	170.8
1953	3,234,910	297,300	10.88	43.6	27.9	156.3
1954	2,697,690	268,550	10.05	49.8	29.6	168.2
1955	3,277,990	330,800	9.91	60.9	35.2	172.6
1956	4,638,300	354,080	13.10	59.8	42.7	139.7
1957	3,314,500	305,020	10.90	61.0	42.2	151.4
1958	4,287,400	345,750	12.40	61.3	44.2	138.7
1959	3,508,800	292,130	12.00	56.9	44.4	128.3
1960	4,043,170	279,350	14.50	55.6	46.5	119.3
1961	4,247,700	303,950	14.00	54.6	48.3	112.9
1962	5,377,000	326,700	16.50	59.8	54.2	110.3
1963	4,070,640	248,060	16.40	60.5	52.0	116.5
1964	4,561,010	270,080	16.90	65.8	52.9	124.3
1965	4,482,240	255,160	17.60	55.1	48.1	114.2
1966	4,660,570	300,130	15.50	67.3	54.1	124.5
1967	5,187,540	327,560	15.80	61.5	57.0	108.2
1968	6,965,860	370,150	18.80	70.4	62.5	112.8
1969	4,897,700	266,940	18.35	68.9	57.7	119.7
1970	5,058,950	245,540	20.60	66.5	57.5	115.5
1971	5,552,100	258,130	21.51	69.9	63.4	110.2
1972	5,804,600	265,020	21.90	78.0	67.5	115.5

Source: Friedland and Barton, 1975, p. 2.

TABLE VI.2

Processing Tomato Production: 1950-1975 Trends in Regional Production, Acreage, and Yields[a/]



a/ Calendar years.

Source: Brandt, French and Jesse (1978), p. 4.

TABLE VI.3

Number of Farms Growing Fresh Market and Processing Tomatoes for Commercial Sale, Total, and Average Acreage, Selected Years[a/]

Census Years	California			East[b/]			Midwest[c/]		
	Farms	Total Acreage	Acres Per Farm	Farms	Total Acreage	Acres Per Farm	Farms	Total Acreage	Acres Per Farm
1954	2,896	92,896	32.0	20,635	107,965	5.2	13,757	65,495	4.8
1959	2,724	156,978	57.6	14,668	81,403	5.6	12,181	73,565	5.8
1964[d/]	1,883	159,183	84.5	6,024	64,055	10.6	4,318	53,850	12.5
1969[d/]	1,582	176,088	111.3	5,069	53,882	10.6	3,791	58,713	15.5
1974[d/]	1,493	259,308	173.7	4,271	42,825	10.0	3,035	51,682	17.0

a/ Collins, Mueller, and Birch (p. 31) report an average acreage for processing tomato growers in California of 91.1 acres in 1956 based on a survey of Northern California growers. In 1975, 845 California grower-operators produced 305,600 acres of tomatoes for processing for an average of 361.7 acres per operator, based on figures from the California Tomato Growers Association.

b/ East includes Delaware, Maryland, New Jersey, New York, Pennsylvania, and Virginia.

c/ Midwest includes Illinois, Indiana, Michigan, and Ohio.

d/ Includes only farms with gross sales of $2,500 or more (Classes 1-5), while for earlier years all farms are included.

Source: Brandt, French and Jesse (1978), p. 8.

TABLE IV.4

Number of Firms Processing Tomatoes, Total and Average Volume of Raw Product Per Firm, Selected States, 1956, 1962, 1972, 1975

Area	Number of Firms in:				Percentage Change	Raw Product Production								Percentage Change 1956-1975 Average Per Firm
						1956		1962		1972		1975		
	1956	1962	1972	1975	1956-1975	Total	Average Per Firm[a]	Total	Average Per Firm	Total	Average Per Firm	Total	Average Per Firm	
						1,000 tons								
California	56	44	28	28	-50	2,772.45	49.5	3,225.04	73.3	4,526.15	161.2	7,270.55	259.6	524
Midwest														
Illinois	15	10	5	5	-66	141.00	9.4	162.00	16.2	b/	--	b/	--	--
Indiana	69	40	21	17	-75	348.80	5.1	341.40	8.5	234.65	11.2	209.30	12.3	241
Ohio	49	38	24	20	-59	225.70	4.6	449.00	11.8	480.65	20.0	423.00	21.2	461
Total	133	88	50	42	-68	715.50	5.4	952.40	10.8	715.30	15.9	632.30	17.1	317
East														
Maryland	99	53	23	20	-80	104.00	1.1	110.90	2.1	40.20	1.7	53.30	2.7	245
New Jersey	34	23	15	10	-71	306.20	9.0	375.20	16.3	173.00	11.5	154.00	15.4	171
New York	50	29	10	9	-82	102.70	2.1	115.10	4.0	28.30	2.8	40.30	4.5	214
Virginia	52	26	13	9	-83	58.80	1.1	67.50	2.6	36.00	2.8	33.85	3.8	345
Total	235	131	61	48	-80	571.70	2.4	668.70	5.1	277.50	4.5	281.45	5.9	245
U.S.[c]	424	263	139	118	-72	4,059.65	9.6	4,846.14	18.4	5,518.95	39.7	8,184.30	69.4	723

a/ Average volume is state production divided by number of firms in state; it does not take into account interstate movement of the raw product.

b/ Not reported separately.

c/ Includes only states listed

Source: Brandt, French and Jesse (1978), p. 25.

ripening and dry fields were important for success with the machine (Brandt, et. al. 1978).

But some other structural factors were very important too. Changes in per capita consumption of tomato products show a trend towad more concentrated forms such as paste and sauce (Table VI.5). This can be attributed to a shift of market demand, from retail to food service and remanufacturing. Fast food restaurants, food service preparation, and ethnic foods are all part of this growth. These concentrated products were dominated by California even in the 1950's (Table VI.6), and this differential has grown in recent years (Table VI.7). Some of this recent growth is a direct result of the harder, greener, and more damaged machine-harvested tomatoes in California. These tomatoes have a higher solids content than Eastern strains. But the longer historical dominance is probably due to the large capital investment required for paste and sauce processing and the very large relative size of California processing firms (Table IV.4).

Thus, the historical process of inter-regional uneven development and concentration of capital in processing is dialectically related and reinforcing to the tendencies of uneven development of harvest technology between these same regions. This has led to the decline of tomato processing in the Eastern and Midwestern regions of the United States, no doubt with deleterious social consequences. Of course, California's dominance is not without contradiction, the most obvious being the heavy dependence on fossil fuel energy for both production of the product and for shipping it throughout the nation. The process of concentration of production and processing in one region took place in a "cheap" energy environment, and with the advent of much higher transportation and production costs because of rising real energy costs, this

TABLE VI.5

Per Capita Consumption of Tomato Products: United States, 1948-1974

Calendar years	Tomato products					Total tomato products
	Canned, whole	Catsup and chili sauce	Paste and sauce	Pulp and puree	Juice[a]	
	processed weight, pounds					fresh equivalent, pounds
1948	4.4	2.2	2.3	.5	3.9	32.6
1949	4.7	2.5	2.2	.6	4.2	34.0
1950	5.1	2.7	2.4	.7	4.7	37.6
1951	4.9	2.5	3.3	.8	4.4	41.0
1952	4.1	2.8	2.7	.9	4.8	38.6
1953	4.5	2.7	2.9	.8	5.2	40.2
1954	4.6	2.8	2.7	.5	4.8	38.2
1955	4.5	3.0	3.3	.7	4.5	41.0
1956	4.6	3.1	3.3	.9	4.3	41.6
1957	4.6	3.3	3.2	.7	5.0	41.7
1958	4.6	3.5	3.4	.7	4.4	42.3
1959	4.6	3.6	3.5	.7	4.8	42.8
1960	4.6	3.8	3.8	.7	4.7	43.7
1961	4.8	3.9	3.7	.8	4.6	44.2
1962	4.6	4.1	3.9	.8	4.7	45.0
1963	4.6	4.3	4.0	.8	5.4	46.5
1964	4.5	4.6	3.9	.8	4.5	45.0
1965	4.5	5.0	3.9	.8	4.7	45.9
1966	4.6	4.8	4.2	1.0	4.4	47.6
1967	4.6	4.7	5.0	1.0	4.2	51.0
1968	4.9	9.8		1.1	4.0	50.4
1969	4.9	10.1		1.0	4.1	51.3
1970	4.8	10.1		1.0	4.1	51.3
1971	4.9	9.9		1.0	3.9	50.4
1972	5.1	10.2		1.1	3.7	52.0
1973	5.8	11.3		1.1	3.3	56.2
1974[b]	5.0	11.3		1.2	3.6	55.4

[a] Tomato juice and other vegetable juices: 94 percent of reported per capita consumption.
[b] Preliminary.

Source: Chern and Just (1978), p. 22.

TABLE VI.6

Output of Processed Tomatoes and Tomato Products, United States and California, Annual Average of 1954–1956

Product	Production		California production as percentage of United States
	United States	California	
	Thousands of actual cases		per cent
Total	98,473	89,627	91.4
Whole tomatoes	24,440	9,213	38.1
Tomato juice	28,294	12,188	42.8
Tomato paste	6,928	6,825	98.5
Tomato sauce	8,692	7,918	89.9
Tomato chili sauce	2,586	1,196	46.8
Tomato catsup	23,938	11,289	46.8
Tomato puree	6,825	2,168	89.8

Per Cent of California Production of Processing Tomatoes Consumed in Production of Specified Tomato Products, 1955

Tomato product	Per cent*
Whole tomatoes	10
Juice	12
Paste	34
Sauce	14
Catsup	16
Puree	4

* Columns adds to 90 per cent. Other minor products account for the remaining 10 per cent of production

Number of Firms Which Process Specified Tomato Products, Ten States, 1955

State	Tomato products						
	Total	Whole	Juice	Puree	Paste	Sauce	Catsup
	Number of firms						
California	87	46	26	34	26	27	16
Illinois	20	20	10	8	1	2	6
Indiana	91	84	63	33	2	2	20
Maryland	124	122	12	8	2	2	3
New Jersey	33	29	4	13	1	3	6
New York	61	44	43	17	4	3	9
Ohio	89	84	22	19	2	2	10
Pennsylvania	84	44	12	7	0	3	5
Texas	46	44	16	21	2	6	4
Virginia	73	73	3	1	0	1	1

SOURCE: Collins, et al., pp. 10, 11, 14.

TABLE VI.7

Pack of Tomato Products: California and Other States
Annual Average, 1951-52 to 1955-56 and 1967-68 to 1971-72

Period	Tomato products									
	Canned		Juice		Puree		Paste		Catsup	
	California	Other states	California	Other states	California	Other states	California	Other states	California	Other states
	millions of 24 No. 303 equivalent cases									
1951-52 to 1955-56	12.7 (40)[b]	18.7 (60)	14.4 (36)	25.5 (64)	3.2 (56)	2.5 (46)	5.8 (100)	[a]	8.5 (45)	10.6 (55)
1967-68 to 1971-72	27.7 (70)	11.7 (30)	17.5 (46)	20.5 (54)	7.4 (85)	1.3 (15)	12.6 (100)		21.1 (46)	31.8 (54)

[a] Blanks indicate insignificance.

[b] Figures in parentheses denote percentages.

Source: Chern and Just (1978), p. 22.

past tendency toward regional specialization appears to be less and less economically rational.

Harvester Impacts on California Growers

The introduction of the tomato harvester brought on two shifts in the production of processing tomatoes within California: a shift of acreage from north to south, and a shift from smaller to larger growers.

The southern portion of the San Joaquin Valley in California is an extremely hot and dry region where the land has long been held in very large farms. Federal irrigation was brought to this area in the 1960's, and laws against holding more than 160 acres and receiving this water were not enforced. These large farms then turned to such cash crops as cotton. The advent of the tomato harvester and the new tomato varieties made possible the growing of tomatoes in the area. The University of California, FMC Corporation, the seed companies and other firms pursued a joint research project to determine just which tomatoes and other vegetoduction and processing in one region took place in a "cheap" energy environment, and with the advent of much higher transportation and production costs because of rising real energy costs, this past tendency toward regional specialization appears to be less and less economically rational.

sfully, and basis for growing tomatoes in the region was the new machine variety tomato, which was adapted to salinity and to the requirements of the harvester. This new variety of tomato therefore allowed the expansion of production in that the real without towns or population, but with large, flat landholdings that were ideal for the harvester (California Tomato Grower, 1968).

The effect of this shift in production technique has been a boom in

tomato production in Fresno County. Production went from zero in 1960 to 22 percent of state production in 1975, moving the county into first place in California tomato production (see Table VI.8). This expansion has made possible the extension of the tomato canning season, which has allowed processors to better utilize fixed investment (Table VI.9).

An accompanying effect has been the leveling off of acreage expansion in the northern counties, although the very substantial general growth of California tomato production has increased the absolute output of all regions (see Table VI.8).

As we have mentioned above, the growers who adopted mechanized tomato production in the south were generally very large. This tendency for producers of tomatoes to become larger was part of a more general bias of the new technology toward large farms. Thus, like many other kinds of mechanization, tomato harvest technology implied a very uneven development among farmers.

The adoption of the tomato harvester was not possible for all tomato growers because many did not possess sufficient land to make full and effective use of the machine. The first machines required about 100 acres, but by the early 1970's the newer machines required over 200 acres. Moreover, tomatoes cannot be grown on the same acreage year after year; tomatoes must be rotated with other crops to preserve yields, thus the farmer must have access to more than 100 or 200 acres, or not plant the crop every other year.

Machine sharing and custom harvesting arrangements did arise (California Tomato Grower, 1966), and these should have protected farmers with less than enough land for full utilization of the technology. However, the problem was not simply one of speading the high fixed costs of the machine, but also the field requirements for effective operation. The machine required long rows;

TABLE VI.8

California Production of Processing Tomatoes by Major Producing Counties[a/]

Area	1960		1965		1970		1975	
	1,000 Tons	Percent of State Total	1,000 Tons	Percent of State Total	1,000 Tons	Percent of State Total	1,000 Tons	Percent of State Total
Yolo	572.9	25.5	468.6	19.0	871.1	25.9	1,354.2	18.6
San Joaquin	578.7	25.7	707.6	28.7	597.0	17.8	860.1	11.8
Sacramento	182.5	8.1	152.3	6.2	155.3	4.6	205.4	2.8
Fresno	b/	--	47.0	1.9	246.3	7.3	1,612.9	22.2
Solano	164.5	7.3	181.2	7.3	243.6	7.2	472.7	6.5
Sutter	136.6	6.1	112.6	4.6	212.9	6.3	617.3	8.5
Kern	b/	--	b/	--	b/	--	311.1	4.3
7-County Total	1,635.2	72.7	1,669.3	67.7	2,326.2	69.1	5,433.7	74.7
State Total	2,249.0	100.0	2,468.3	100.0	3,363.0	100.0	7,270.6	100.0

a/ On the basis of "Paid for Tonnage" purchased from growers as reported by processors.

b/ Not reported separately.

Source: Brandt, French and Jesse, (1978), p. 7.

frequent turns reduced its efficiency. Farmers with relatively small plots, on which they successfully grew hand-harvested tomatoes, could therefore not use the machine, even if they could evolve sharing or renting arrangements with other farmers. This explains why less than 10 percent of the acreage is harvested in this way (Thompson and Scheuring, 1978).

Not only was the land requirement a difficult obstacle for smaller growers adopting the harvester, but so too were the capital requirements. The machine was expensive, and adoption implied not only the harvester itself, but also investment in a package, which eventually included direct-seeders to insure uniformity in planting, power tillers, chemicals for weed control, bulk bin carriers, a machine to open up the fields for the carriers, and perhaps thinning machines (Sims, et. al. 1979). The new package was thus expensive, and for a farmer without a strong credit rating, adoption may not have been possible. Moreover, there is some evidence that bankers and processors, who were sources of credit, tended to favor the large growers who had never grown tomatoes over the smaller farmers with experience in the crop.

An additional and more subtle implication of this new technology is that it required a shift from what economists call "variable" costs to fixed costs. The hand-harvest technique implied relatively low fixed costs; if a farmer decided not to grow tomatoes, he incurred no costs; he simply did not incur the seed, fertilizer, water, fuel, and labor costs associated with producing the crop. With the new harvest technology, if the farmer decided not to produce tomatoes, he still had to pay the high fixed costs associated with all of the implements. High fixed costs thus reduced the farmer's flexibility to choose his crop mix, virtually forcing him to produce tomatoes, year after year. Reduced flexibility meant greater vulnerability to changes in the market or

weather conditions, and increased the risk of farming. Only larger farmers, with enough land for other crops could afford to grow tomatoes and still have a sufficiently diversified crop pattern to minimize these kinds of risks.

It is therefore not surprising to find a shift from small to large growers. The data on tomato production do not provide the degree of detail that we might desire to see all of the distributional consequences of this technology. However, the data we have all indicate the nature of the change. For example, a survey of tomato growers in 1964 indicates that a majority of farmers growing tomates harvested less than 100 acres (see Table IV.10). Since the first harvester required more than 100 acres for efficient utilization, it is likely that many of these small growers either had to expand production or sell out. We have estimates of the number of canning tomato growers and the amount of acreage harvested for several different years. For example, in 1964 there were about 1072 farmers with tomatoes (see Table VI.10) on about 143,000 acres; average size was 132 acres. By 1975 there were about 845 tomato growers with almost 300,000 acres; average size of 354 acres, almost three times the size of the 1964 farms. While average size did increase for most crops in California during the same period, the rate of growth in the size of tomato farms far exceeds the rate of other crops (see LeVeen, 1978).

These average data mask the distribution of production, for there are very likely many small farms with a relatively small amount of total acreage that help to bring the average down; most of the production is most likely on a few very large units. For example, in the 1974 Census of Agriculture, the average size of a vegetable farm was about 150 acres, but 58 percent of all production was on the 11 percent of farms with more than 1000 acres of harvested cropland. The Thompson and Scheuring survey of tomato growers in two

TABLE IV.9

Production of California Tomatoes for Processing by Months, and Utilization of Processing Plant Capacity, 1958-1960 and 1973-1975

Year	Total Tonnage Delivered	July	August	September	October	November	Highest Tonnage Delivered in Single Week	Number of Weeks Receiving Deliveries Greater Than __% of Capacity		
	tons	percent					1,000 tons	90%	80%	50%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1975	7,561,239	3.6	32.5	40.9	22.7	0.2	810.7	4	6	10
1974	6,040,441	6.4	43.1	42.6	7.7	0.1	710.5	2	6	10
1973	4,937,868	1.9	28.6	55.6	13.8	0.2	571.1	4	6	9
1960	2,315,499	0.2	4.3	43.4	49.4	2.7	329.0	4	4	7
1959	2,108,724	0.4	23.1	49.8	25.0	1.8	275.5	3	4	8
1958	2,674,073	0.0	16.5	53.1	28.4	2.0	391.5	3	3	7

Source: Brandt, French and Jesse (1978), p. 60.

TABLE VI. 10

DISTRIBUTION OF CALIFORNIA TOMATO GROWERS, BY ACRES; 1964

Acres	Number of Growers	Percent of Growers
1-99	697	65.1%
100-199	249	23.2
200-299	66	6.2
300-399	31	2.9
400-499	15	1.4
500 plus	14	1.4

Source: Thor, E. and J. Mamer, "California Canning Tomatoes, 1965 Labor Situation," Department of Agricultural Economics, University of California, Berkeley.

important California agricultural counties found an average size of about 500 acres, but also found one grower who produced 13,000 acres (Thompson and Scheuring, 1978, pp. 14-16). In summary, the data bear out the contention that the new technology stimulated a substantial consolidation of tomato production on large farms.

The consolidation of farming into fewer and larger units is a general tendency arising out of the competitive processes of capitalist agriculture, but this development is speeded by publicly-funded innovations such as the mechanical tomato harvester. The uneven adoption of the machine among farms of different size heightens the struggle for survival within agriculture by foreclosing to small producers the option to produce one of the highest value crops of all the vegetables.

Mechanization and Structural Change within the Processing Industry

The tomato harvester is also associated with changes in the tomato canning industry. Technological change has also occurred within the canneries, so it is difficult to sort out the direction of causality, but more rapid developments in California than elsewhere suggest the importance of the machine-harvest system, and the benefits to certain sectors of capital of uneven development.

Canners were reluctant to accept the machanical harvester because of quality control problems associated with the new tomatoes. Jack Hanna admitted in 1968 that one-fourth of the crop of his new tomatoes were damaged with impact cracks contaminated with soil,yeast, and bacteria (California Agrarian Action Project, 1977). As one canner summarized it in 1968, "on balance, the effects of machine harvesting thus far have tended to add to processing costs

and to increase the processing and marketing problems traceable to product quality at time of delivery to our cannery." (Allewelt, 1969).

Bulk bins required canners to install bin unloading devices; the later transition to truckload tubs necessitated new water flume equipment. Washing and sorting costs increased. One study estimated dirt and trash removal costs at $75 million in 1975 (California Agrarian Action Project, 1977), and some processors included dirt tolerance limits in their contracts with producers.

But at the same time, the new tomatoes and their problems provided the basis for new products, new processing techniques, and therefore renewed profitability in tomato canning.

The new technology of aseptic processing has led to the development of bulk-storage processing (1). Tomatoes are partially processed and bulk-stored aseptically until the height of the season is past, when they are reprocessed into various products. Also, different colors (ripeness) of tomatoes, which result from machine harvesting can be partially processed separately, then later mixed to meet grade standards. This development has enabled growers to pick tomatoes when they are greener and harder without any reduction in the utilization of the crop (see Luh and Woodroof, 1975).

Bulk-storage processing has extended the processing plant's useful season, thus improving the return on fixed capital. It has also allowed processors to wait to determine the optimal mix of marketable products. Finally, the high capital-intensity of the technology has made possible the location of aseptic processing plants in very rural areas where normally there would be insufficient labor.

These developments resulted in tomato processing becoming the only dynamic and growing sector of California's canning industry (Rea, in Moulton,

1972, p. 54). Practically all new plant capacity after 1965 has been devoted to tomatoes. For example, in 1966, Heinz, a major producer, doubled its tomato capacity, while at the same time, a totally new firm began processing tomatoes; Tri-Valley Growers constructed an entire plant in 1975 in a very rural area that only makes aseptically processed tomato paste in 55-gallon drums; Del Monte opened a new tomato processing plant in 1970; and a tomato plant opened in Kings Co.in 1976 (see Figure VI.1).

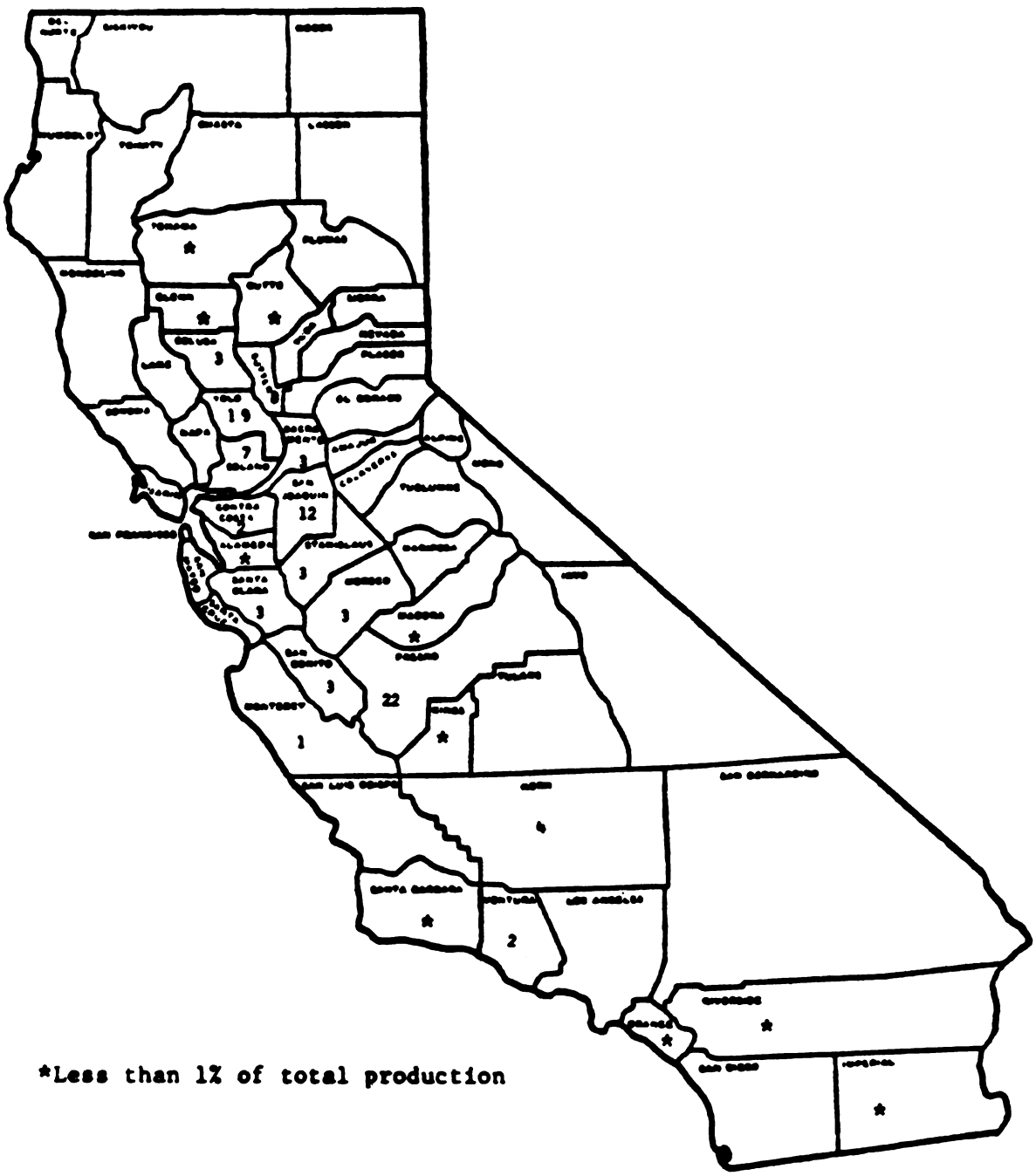
More examples could be cited, but in every case these new plants were located in the valleys near the tomato production, and away from the San Francisco Bay Area where they were historically built. The social effects of this shift in jobs are unstudied, though in moving from urban to rural areas, it is very likely that the firms were able to tap a less well organized labor market and perhaps increased their power over the unions.

Of course, concentration in the industry has continued. The number of firms declined from 42 to 22 in the past twenty years (California Tomato Grower, 1980). But this decline has been slower than in other states, and it has been slower than the decline in firms processing other California crops. For example, according to the California Cling Peach Advisory Board Almanac, the number of cling peach processors declined from 38 to 14 over the past 20 years.

It would thus appear from the rapid expansion of the industry, the introducton of new technology, and the continued involvement of several multinational firms, that in spite of problems caused by machine-harvested tomatoes, processors in California have benefitted from the introduction of the harvester. If this is so, then (ignoring their own labor conflicts) they must have accomplished this partly though the uneven development of technology

FIGURE VI.1

Spatial Distribution of Processing Tomato Production in California, 1975 (Percent of Total Volume)



*Less than 1% of total production

Source: Brandt, French and Jesse (1978), p. 10.

relative to other areas in the nation and through a struggle with the growers over the distribution of the gains from this new technology. It is to the latter subject that we now turn.

Conflicts Between Growers and Processors

As capitalism develops in agriculture, a process of increasing integration with industrial and merchant capital is accelerated by technological change. The traditional concept of "agriculture" thus becomes just one stage in an articulated industrial process, ever more dependent on external inputs and contracted services, ever more tightly bound through contracts to processors and first handlers (Friedland, et. al. 1980). This process of capitalist development has led to the reconceptualization of agriculture as "agribusiness" (see Davis and Goldberg, 1957) or "complexes" of interrelated production and marketing (Arroyo, 1977).

Students of these developments have tended to portray this process as leading either to a more efficient coordination of a complex production and distribution system (see Davis and Goldberg, 1957) or to the domination of agriculture by industry (Friedland, et. al. 1980; Davis, 1980). In this section we assert by example that the first view abstracts from social reality and fails to note the conflict and competition inherent in capitalism, and that the second is too functional and ignores the contradictions inherent in any capitalist structural form.

In other words, there is a process of concentration and organization under way in agriculture that tends to raise barriers to the domination of agriculture by industry. While a theory of contract farming that sees the farmer as merely a piece worker for capital (Davis, 1980) is perhaps

appropriate in early stages of integration, the internally contradictory nature of this relationship (bound up with the process of capital accumulation) tends to negate its functionality for non-farm capital (2). Specifically, the process of capital accumulation tends to eliminate some of the farmers and leads those larger producers remaining in agriculture to organize and oppose those who would attempt to dominate and extract all of the surplus from farming. Of course, there is no necessary relationship between increasing concentration of agricultural production and economic or political organization, but concentration does remove the barrier to effective organization set up by large numbers (see Babb et. al. , 1969).

In other words, there would appear to be a process of development within agriculture whereby capitalists within the primary production enterprise become sufficiently powerful to confront the economic power of the rest of the agribusiness system, and a struggle over the distribution of the surplus from innovations such as the tomato harvester ensues. Such a representation of the relationship between fractions of capital seems appropriate to the analysis of the relatonship between growers and processors in California. There is even some evidence that in the cases where nonfarm capital appears to dominate agriculture, such as in the broiler industry of the South, that growers have begun to organize against the processors and exploitative contract relationships (Shockley, 1980)

Increasing vertical integration between agricultural producers and processors develops simultaneously with the increasing specialization of farmers. This specialization on the one hand tends to reinforce dependent contractual relationships and limit the farmers' options, but on the other, it leads to organization to defend the farmers' interests. In our example of

tomatoes, this process of organization and intra-capitalist conflict was markedly accelerated by the concentration and specialization which arose from the adoption of the mechanical harvester.

First, specialization is generally associated with new technology and new skills/knowledge which together imply a high capital investment on the part of the farmer. Tomato harvesters costing $150,000 and usually purchased or leased on a three to five year basis are only one example. As the director of the California Tomato Growers Association noted in his retirement message, before the mechanical harvester "any farmer who had a cultivating tractor was a potential tomato grower," (California Tomato Grower, 1980) but the competition for credit and market became crucial to successful entry into tomato production after the introduction of the technology.

Second, the very product itself becomes more specialized through breeding programs generally conducted by land grant universities and associated with the processing or shipping industries (3). Thus, the development of tomatoes for machine harvesting at the same time limited the marketing options of tomato growers. Tomato breeding programs had increasingly differentiated the growers of fresh and processing tomatoes, and the invention of the machine and the conversion by procesors to handling the new types of tomatoes just reinforced an already-existing division of labor. In the Midwest and East, it has been common for tomato canneries to be used as overflow markets from fresh production, but the eventual mechanization of their harvest will eliminate this as well.

An earlier example can be found in California cling peaches, developed especially for canning in the late 19th century. Processing was the only market for the new peaches, and this led to early confrontations between the

growers and processors, formation of a grower bargaining association, constant overproduction, and government supply controls (Jamison, 1966). Many of these same events have occurred or are about to occur in the processing tomato industry.

Finally, the limited markets and high investment which result from specialization tended to increase the risk associated with tomato growing and reinforced tight contractual relationships with processors. No grower wanted to be without a "home" for his crop. While expensive new technology tended to reduce the number of potential tomato growers and thus theoretically increase the bargaining position of the remaining farmers, the same investment made it even more imperative that the farmer retain access to markets, implying perhaps a weaker bargaining position against processors.

Processors took advantage of this lowered supply elasticity of tomato growers, and tomato prices fell in the late 1960's (see Table VI.11). The industry had long been characterized by oligopsony power, with price leadership being exercised by a dominant firm, and so canners had a structural mechanism through which to capture the surplus arising from the lowered costs of producing tomatoes (Collins, et. al. 1959). Chern and Just, in examining various elasticities, provide empirical support for this model: higher fixed costs made growers more vulnerable to the market power of the processors (Chern and Just, 1978).

While we have not pursued actual quantification of this assertion, a cursory review of the facts lends it credence. First, nominal prices to growers fell from $38.70/ton in 1967 to $25.20/ton by 1970 (real prices fell to $21.67) while one measure of real grower costs rose from $449.68/acre in 1967 to $533.74/acre in 1970 (see Table VI.11). Second, overproduction in 1967-68

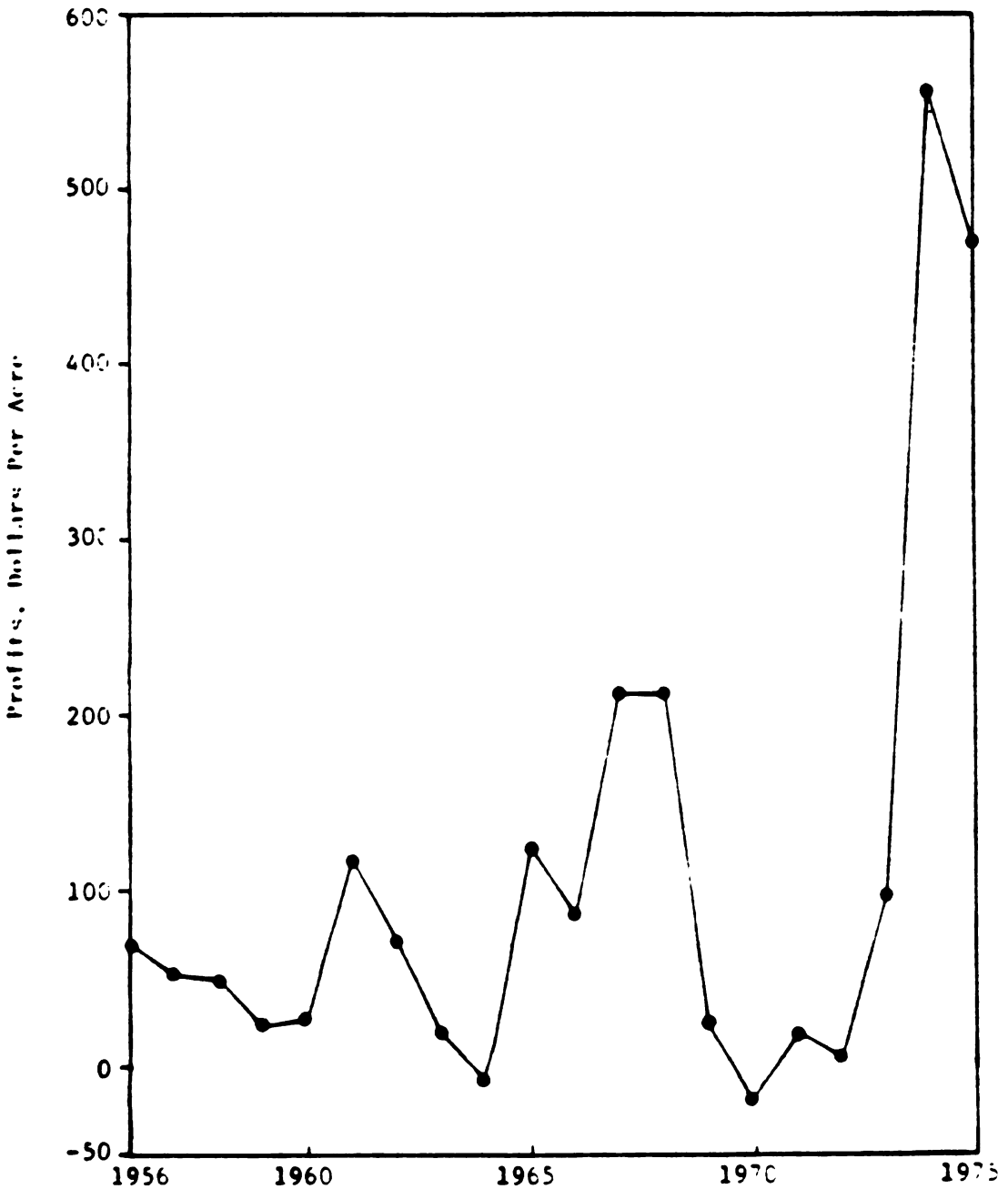
led to a glut of tomato products which idled some 300 harvesters at growers' expense in 1969-1970 (Brandt and Carman, 1975). (This oversupply cannot explain the low grower prices, though, because they continued low through 1973, even though surpluses were moderated). Third, estimates of tomato growers's profits show very low (even negative) returns in 1969 through 1972 (see Figure VI.2). But the two trends which best demonstrate the probable monopsony power of processors are the formation of a bargaining association among growers and the growth of the cooperative processing firms, controlled by growers.

The California Tomato Growers Association had attempted to bargain for growers in the late 1950's, but the farmers were so divided that the effort ended in disaster, almost destroying the organization. The glut of tomatoes in 1969 and 1970 led to an attempt to pass a state-supervised supply control marketing order in 1970. This also failed as processors raised prices slightly. Finally, as low prices and returns continued into the early 1970's, and as the number of growers was reduced, over 65 percent of the growers signed up in support of a bargaining association in 1974, which has since brought growers much higher returns (see Figure VI.2 and Table VI.11).

This type of price bargaining represents the institutionalization of conflict between fractions of capital over the distribution of the surplus afforded by the change in technology and the rapid growth of demand for tomato products. Tomato growers' success can only squeeze the processors' margins, and this has contributed to continued conflict. Seeveral lawsuits against processors have been filed by growers, charging that processors have colluded to set prices and to destroy the bargaining association through a strategy of divide and conquer. A similar stategy had apparently worked in 1959 and 1970. One suit by two growers also charges that canners induced them to spend more

FIGURE VI.2

Representative Tomato Grower Profitability



Source: Brandt, French and Jesse (1978), p. 87.

TABLE VI.11

CANNING TOMATO PRODUCTION STATISTICS FOR CALIFORNIA, 1950-1976

Year	Harvested Acreage	Yield	Total Production	Farm Gate Price	CPI Deflated Price	Real Grower Costs
	1000-acres	tons/ac.	1,000 tons	--dollars per ton--		$/acre
1950	75.50	12.70	958.5	23.50	32.59	n.a.
1951	148.30	14.90	2,209.7	30.20	38.82	245.62
1952	112.90	16.10	1,817.6	25.50	32.08	292.29
1953	83.00	17.00	1,411.0	22.90	28.59	332.56
1954	79.50	16.90	1,343.6	20.40	25.34	343.83
1955	116.30	17.10	1,988.4	22.80	28.43	374.65
1956	151.50	18.30	2,772.5	22.70	27.89	421.92
1957	128.70	15.70	2,020.6	21.90	25.98	345.21
1958	152.90	17.20	2,629.9	22.70	26.21	392.92
1959	129.70	15.40	1,997.4	21.80	24.97	357.88
1960	130.00	17.30	2,249.0	23.40	26.38	425.31
1961	146.80	15.80	2,319.4	30.10	33.59	400.97
1962	177.20	18.20	3,225.0	27.60	30.46	475.97
1963	129.00	19.10	2,463.9	25.40	27.70	508.84
1964	143.00	21.00	3,003.5	25.40	27.23	576.38
1965	122.80	20.10	2,460.3	35.40	37.46	582.17
1966	162.50	19.30	3,136.3	30.00	30.86	505.71
1967	186.70	17.10	3,192.6	38.70	38.70	449.68
1968	231.30	21.20	4,903.6	35.20	33.78	512.32
1969	154.00	21.90	3,372.6	27.20	24.73	520.46
1970	141.30	23.80	3,362.9	25.20	21.67	533.74
1971	163.70	23.70	3,879.7	28.00	23.08	529.19
1972	178.90	25.30	4,526.2	28.00	22.35	559.92
1973	218.90	22.30	4,861.4	35.00	26.30	512.67
1974	249.90	23.40	5,847.8	56.80	38.46	522.53
1975	299.20	24.30	7,270.5	55.60	34.49	546.27
1976	233.80	21.70	5,066.5	47.40	27.88	n.a.

Source: Brandt, et. al. 1976; Table A12, p. 111

than $1 million on harvesting machines and then reneged on promises to buy enough tomatoes to pay off the loans (New West, 1979; S.F. Chronicle, 1979).

The basic problem which arises from the tomato growers' new-found bargaining power is common to all such associations -- an inability to control supply. With only one market for the crop, high prices inevitably bring overproduction. For example, in 1976 some 1.8 million tons of tomatoes were left in the fields (California Agrarian Action Project, 1977, p. 1361-62). Thus a cyclical boom and bust pattern sets in, and success becomes a long-term empirical question (Helmberger and Hoos, 1965).

Cooperative processing, on the other hand, is not a response to price, but a result of uncertainty, a desire of growers to be assured a market every year. Such firms have grown rapidly in California fruits and vegetables, particularly in the past 15 years. They enjoy the decided advantage of not having to pay their farmer-owners the full going price for their crops in any year. The competition which results from this cost advantage, added to the increased bargaining by tomato growers, has severely limited the profitability of proprietary canning:

> "We have seen some of the proprietary operators sell off their processing plants to grower cooperatives. In effect, they have moved away from the least profitable parts of their business and used their recovered investment to exploit better opportunities. The growers, on the other hand, have had to make investment in processing facilities by necessity. I can forsee a time when all the bricks and mortar of the fruit and vegetable processing industry will be owned by the farmers. In many cases the farmers are forced into it just to find a home for their products." (Moulton, 1972).

But this ownership of processing faciltities, this forward integration, merely reposits in a new form the same problems which have historically faced

favor canning everything they produce, no matter the market situation. Then, too, cooperative processors find themselves again faced with oligopsonistic buyers in the form of large retail chains, wholesalers, or the very brand-name firms who sold them the canneries, now limited to the role of merchant capital, but with privileged access to markets. This reminds one of nothing so much as the agreements Third World countries must strike with multinational corporations to gain access to markets for their exports.

The struggles are resposited at a new level, the battle enjoined in a different form, but the contradictions remain to ensure that these new forms of capitalist agriculture will themselves be destroyed in some new process of accumulation.

Mechanization and Class Struggle

A dialectical approach to society seeks to locate the contradictions inherent in social reality that give rise to conflict and thus to qualitative changes in that reality. For understanding much of capitalist development, the fundamental motor force is that of the conflict between capital and labor. In the present example, this conflict plays a central role.

As we discussed above, the invention and adoption of the tomato harvester was a response to the problems associated with reproducing a cheap and docile labor force, the attempts to organize agricultural labor, and the resulting strikes and related higher wages. In the following section, we analyse the effects of the mechanical tomato harvester on labor by examining the struggles between growers and workers both over the control of the labor process and over the returns to labor. While the adoption of the harvester was an attempt to resolve some contradictions, and while it has provided a basis for a new

process of accumulation, the basic contradictions of capitalist agriculture have merely been reposited in a new form.

The mechanical harvester offered tomato growers a new form of control over the labor process. Braceros had been tremendously efficient workers: young men, coming from a very low-wage environment, paid on a piece-rate basis, and subject to being sent home if they did not perform up to a standard, had considerable incentives to work long and hard. These workers were effectively controlled by the ethnic separation from the rest of the labor force and by their non-citizen status, which served as a powerful threat. As we noted in Part II, this ethnic separation had characterized the history of labor control in California. But with the end of the Bracero Program, growers faced a new situation in which they were, for virtually the first time, without access to a source of foreign workers to replenish the domestic labor market when conditions became tight. As a result, wages rose and labor organization became a real possibility for the first time since the 1930's. As we noted, there were several responses to this situation, but for tomat growers the solution was mechanization of the harvest.

The harvester both reduced the number of workers needed and altered the method of control. The ethnic segmentation was retained (over 90 percent of the post-Bracero labor force consisted of workers of Mexican descent (Thompson and Scheuring, p. 37)), but growers were able to substitute women on the sorting belts for the formerly all-male hand-picking crews (Friedland and Barton, 1975). About 80 percent of the new labor force was female (Thompson and Scheuring, 1978). Interestingly, this strategy of substituting women for men was recOmmended by a 1965 University of California study (Becket, 1966). This substitution increased grower control over labor by opening up a new

low-wage and unstructured labor market for exploitation.

Grower control over labor was also increased by the discipline of the machine. Under the previous hand-picking regime, pressure for worker productivity was maintained through the institution of the piece-rate wage. A worker had to perform at a standard acceptable to the grower, or his wages were very low. Under the machine technology, productivity of labor was set by the assembly line process of the sorter belt. Thus the speed of the belt, coupled with hourly wages, helped to increase control over worker productivity (Edwards, 1979).

This new machine process brought about a structural change in the nature of the labor force: it reduced the seasonality and magnitude of labor needs, but redefined the composition. There was a "deskilling" of the majority of the workers, as the women sorters replaced men pickers, and a "skilling" of a minority who worked in new jobs as drivers and mechanics (see Table VI. 12).

Thus, in general, there resulted an unequal payoff to labor due to several effects of the harvester. On the one hand, an unemployment effect displaced those (few) domestic workers and all of the Braceros who had picked tomatoes, and eliminated the domestic picking job slots which might have resulted from the end of the Bracero Program. An accompanying employment effect provided jobs for women and certain (skilled) men. It should be noted that a likely additional effect of the harvester was to reduce the demand for labor in rural Mexico, for had this technology not arisen, at least some of the tomato production would have followed the Bracero workers back to Mexico.

Because the tomato industry did expand in California, the net impact on employment must be seen as the difference between the new jobs created by this expansion, based on the substitution of unskilled for more skilled workers, and

TABLE VI.12

COMPARISON OF WORK ORGANIZATION:
HAND V. MACHINE HARVEST

	HAND HARVEST	MACHINE HARVEST
Number of Workers	50,000 (1964)	18,000 (1972)
Machinery Used	Trucks (hauling)	Harvester Tractors or Semi-trucks Forklifts
Job or Skill Gradations	Supervisors Pickers Lug Counters Swampers Drivers	Supervisors Harvester Operator Truck/Tractor Drivers Lift Conveyor Operators Head Sorter Forklift Operator Sorters Repair and Service Workers
Rate of Pay	Pickers/Piece Rate All Others/Hourly	Hourly
Length of Working Day	8-12 Hours (Conditions Permitting)	8-12 Hours (Conditions Permitting) Night Shift Optional
Working Conditions; Posture	Stoop	Standing Restricted Movement
Pace Control	Individual	Machine-controlled
Special Clothing Used	None	Rubber Gloves Bandana Sunglasses

Source: Friedland and Barton (1975), p. 41.

the jobs lost as a consequence of the substitution of machines for human labor. It must be remembered that expansion of the industry created jobs in the related canning, manufacturing, and transportation sectors of the economy, many of which were held by more skilled, and higher-paid workers. One study estimates that the total number of jobs created approximately equalled the number of jobs lost (Brant, et. al., 1978). Of course, there is no reason to believe that those workers displaced in the fields found new employment in these other sectors. Indeed, given the segmented nature of the labor market, it is very unlikely that agricultural workers found work in these nonagricultual occupations (see Appendix). Thus, while the harvester may not have caused an overall reduction in aggregate employment, it still may have had highly unequal impacts on labor in that it increased the demand for skilled, organized workers at the expense of the less organized and less-skilled workers. The effect of this inequality is to increase the welfare of those who already enjoy some measure of economic well-being and to reduce the employment and incomes of those who live at the margin of society.

In addition to its differential impact on employment of different groups of workers, the harvester technology, through its impact on the race/sex/skill levels of agricultural workers, also effectively increased income inequality among agricultural workers. For skilled, year-around male workers are paid considerably more than female workers who do seasonal work on harvesting machines. The sorters are chosen from a more marginal labor market; women who are supplementing family incomes, who are not family heads, and who work for only a short period of the year are less demanding of higher wages and less likely to organize to get them. During the period when mechanical picking and hand-picking were both taking place, sorters were paid 20 percent less than

pickers, and 10 to 20 percent less than the average California farm wage (California Agrarian Action Project, 1978, p. 1365). Though the women perform exactly the same job as cannery workers, they are paid only half as much due to the lack of unionization and the absence of white or male workers.

This restructuring of the labor force occurred in the context of a growing labor movement. A strike in Delano in 1965 set the stage for Cesar Chavez and the United Farmorkers Union to build an increasingly powerful organization of agricultural workers. The new-found success of these efforts helped to provide impetus to all of the strategies we have discussed.

Labor also won a number of victories in the arena of state policy: in 1965, a federal law regulated labor contractors; in 1974, the California minimum wage was extended to male agricultural workers; in 1975, the California legislature passed the Agricultural Labor Relations Act, giving farm workers the right to organize unions, and also passed a law including agriculture in the unemployment insurance program. All of these laws and regulations have tended to raise the cost of labor to growers, both in terms of wages and fringe benefits (Mamer and Fuller, 1978).

The United Farm Workers pursued an organizing drive in some tomato fields in 1974. Strikes at the height of the season led to a 50 cent per hour incrase in wages (California Agrarian Action Project, 1978, p. 1365). The next year brought the California Agricultural Relations Act which provided labor with a stronger based from which to demand union recognition. The growers responded to this increasing threat of higher wages by adopting the second major harvester innovation, the electronic sorter, which uses an electric eye to do the work of the hand-sorters, thereby eliminating about half of the labor previously required by the harvester. In 1976, 19 percent of the canning

tomatoes in California were electronically sorted; in 1977 about 35 percent were so sorted, and by 1978 virtually all are electronically sorted (Kumar, et. al. 1978, p. 189). The electronic sorter does not have offsetting job creation, as did the original harvester, and it is estimated that its adoption eliminated roughly 12,000 to 14,000 jobs (Thompson and Scheuring, 1978).

Movements to organize workers in other regions of the nation have met with similar responses (Downs, et. al. 1979). Ohio farmers had never adopted the mechanical harvester because of the scale of farms, weather problems, different tomato varieties, and a different processing orientation (tomato juice and soup rather than catsup and paste, etc.), and hence the process of concentration of farming was not as advanced as in California. When workers struck the farms supplying one large processor, they were not successful in their efforts, primarily because the farmers were themselves so dominated by the processor that they had no margin which which to bargin. When workers attempted to involve the processor, it responded by making technical changes necessary to process machine-harvested tomatoes, and proceeded to force the adoption of the tomato picking machines through its contract arrangements with its farmers. Efforts by the workers to form an alliance with small farmers, whose existence was threatened by these developments, failed, as did their efforts to raise wages.

In these examples, capitalist agricultue provides the basis for the organization of workers into coherent and powerful groups. In response to the rising power of labor, farmers substitute machines for workers, in an effort to reduce dependence on labor and to increase the productivity of the remaining workers sufficiently so as to permit higher wages without a loss of profit. In the course of these events, farms become larger and fewer in number, and

TABLE VI.13

Selected Performance Measures Associated with the Mechanical Tomato Harvester and with Raw Product Handling in California, 1960-1976

Year	Raw Tomato Production	Adoption Rate of Mechanical Harvester	Harvest Season Work Units		Farm Wage Rate	
			Total[a/]	Per Ton Harvested	California Tomato Worker[b/]	U.S. Farm Worker[c/]
	1,000 tons (1)	percent (2)	1,000 weeks (3)	weeks (4)	Index. 1960 = 100 (5)	(6)
1960	2,2[illegible]9	0.0	341.4	.152	100	100
1961	2,319	0.5	367.4	.158	105	103
1962	3,225	1.3	403.2	.125	96	105
1963	2,464	1.3	308.7	.125	101	108
1964	3,003	3.5	378.5	.126	104	113
1965	2,468	20.0	267.4	.108	131	118
1966	3,136	70.0	288.6	.092	138	126
1967	3,193	80.0	247.8	.078	135	139
1968	4,90[illegible]	92.0	292.5	.060	155	150
1969	3,3[illegible]3	98.0	182.1	.054	168	166
1970	3,363	100.0	155.2	.046	169	179
1971	3,88[illegible]	100.0	182.2	.047	178	187
1972	4,524	100.0	206.8	.046	178	197
1973	4,86[illegible]	100.0	208.4	.043	233	215
1974	5,848	100.0	248.1	.042	235	247
1975	7,271	100.0	252.6	.035	270	267
1976	5,066	100.0	195.6	.039	293	292

a/ Harvest season extends from July 1 through November 15. The figures represent seasonal harvest labor. See Appendix B for details of these calculations.

b/ Index is based on weighted wage rate for harvest season tomato workers (see Buccola, p. 323).

c/ Index is adjusted for seasonal variation.

Source: Brandt, French and Jesse (1978), p. 35.

workers are displaced from agriculture. The tomato harvester is far from unique in its impact; indeed it is only the latest in a long history of such machines. The cotton harvester, adopted under similar conditins, led to the transformation of many rural areas and the migraton of millions of poor blacks to the cities (Bertrand, 1948).

To summarize, the tomato harvester was the result of labor's opposition to the low wages/high exploitation that has characterized California agriculture from its inception. Labor's efforts to terminate the Bracero Program caused the adoption of more machines and the rationalization schemes outlined earlier. These, in turn, provided a new basis for accumulation, with the California tomato industry, in particular, coming to dominate processing tomato production in the United States.

But the basic contradiction of capitalist production has not disappeared, and the basis for organizing workers remains and hence, so does the continued possibility of conflict. To this must be added new contradictions associated with the rapid rise in real energy costs and the growing evidence that many labor-saving innovations imply ecological destruction that will reduce the long-run productivity of the land. These new contradictions may make the tomato harvester just one aspect of a unique, and passing, historical development.

CITATIONS: PART VI

Allewelt, W., "The Influence of Mechanization of Processing of Fruits and Vegetables," HortScience, Vol. 4, no. 3 (Autumn 1969).

Arroyo, Gonzalo, "Institutional Constraints to Policies for Achieving Increased Food Production in Selected Countries," in Proceedings of the World Food Conference of 1976, Iowa State University Press, (Ames, 1977).

Babb, E., et. al. "An Analysis of Cooperative Bargaining in the Processing Tomato Industry," American Journal of Agricultural Economics, Vol. 51, no. 1 (February 1969).

Becket, J., "The Domestic Farm Laborer: A Study of Yolo County Tomato Pickers," Department of Agricultural Education, Research Monograph No. 2, University of California, Davis, 1966.

Bertrand, A., "The Social Processes and Mechanization of Southern Agricultural Systems," Rural Sociology, Vol. 13, no. 1 (March 1948).

California Agrarian Action Project, No Hands Touch the Land, Davis, California, 1977. Reprinted in U.S. Senate, Subcommittee on Administrative Practice and Procedure of the Committee on the Judiciary, appendix to hearings titled Priorities in Agricultural Research of the u.S. Department of Agriculture, Appendix, Part 2; 95th Congress, First Session, 1978.

California Tomato Growers Association, California Tomato Grower, Vol. 9, no.6 (June 1966); Vol. 10, no. 7 (July-Aug. 1967); Vol. 11, no. 6 (June 1968); Vol. 23, no. 5 (May 1980)

Carman, H. and J. Brandt, "The Production Life-Cycles of the Adoption of Durable Inputs; An Example of the Tomato Harvester," unpublished paper presented at the annual meetings of the American Agricultural Economics Association, Columbus, Ohio, August, 1975.

Collins, N., et. al., "Grower-Processor Integration: A Study of Vertical Integration between Growers and Processors of Tomatoes in California," California Agricultural Experiment Station Bulletin No. 768, University of California, Berkeley, October 1959.

Chern, W. and R. Just, "Econometric Analysis of Supply Response and Demand for Processing Tomatoes in California," Giannini Foundation Monograph No. 37, University of California, Berkeley, Sept. 1978.

Davis, J. E., "Capitalist Agricultural Development and the Exploitation of the Propertied Laborer," in Buttel, F. and H. Newby (eds.), The Rural Sociology of the Advanced Societies -- Critical Perspectives, Allanheld, Osmun, (Montclair, N.J. 1980).

Davis, J. H. and R. Goldberg, A Concept of Agribusiness, Graduate School of Business Administration, Harvard University, Boston, 1957.

Downs, P., et. al., "Migrant Workers, Farmers, and the Mechanization of Agriculture: The Tomato Industry in Ohio," Science for the People, Vol. 11 no. 3 (May/June 1979).

Draper, A. and H. Draper, The Dirt on California: Agribusiness andthe University, Independent Socialist Clubs of America, Berkeley, 1968.

Edwards, R., Contested Terrain, Basic Books, New York, 1979.

Friedland, W. and A. Barton, Destalking the Wily Tomato: A Case Study in Social Consequences in California Agricultural Research, Department of Applied Behavioral Sciences, Research Monograph No. 15, University of California, Davis, June 1975.

Friedland, W. et. al. , "The Labor Process and Agriculture," paper presented to the Working Conference on Labor Process, University of California, Santa Cruz, March 14-16, 1980.

Helmberger, P. and S. Hoos, Cooperative Bargaining in Agriculture: Grower-Processor Markets for Fruits and Vegetables, Berkeley, Calif: University of California, Div. of Ag. Sciences, 1965.

Jamison, J., "Marketing Orders, Cartels, and Cling Peaches: A Long-Run View," in Food Research Institute Studies, Vol. 6, No. 2, (Stanford, 1966).

Kumar, R. et. al. , "Estimates of the Impact of Agricultural Mechanization Developments on In-Field Labor Requirements for California Crops," in Technological Change, Farm Mechanization, and Agricultural Employment, Division of Agricultural Sciences, University of California, Berkeley, 1978.

LeVeen, E. "Economic Advantages of Large Crop Farms in California," working paper, Department of Agricultural and Resource Eonomics, University of California, Berkeley, 1978.

Luh, B. and J. Woodroof, Commercial Vegetable Processing, The Avi Pub. CO., Westport, Conn. 1975.

Mamer, J. and V. Fuller, "Employment on California Farms," in Technological Change, Farm Mechanization, and Agricultural Employment, Division of Agricultural Sciences, Publication No. 4085, University of California, Berkeley, 1978.

Moulton, K. (ed.), "Adjustments for the Future: A Workshop for Fruit and Vegetable Processors, Oct. 10, 1972," Giannini Foundation of Agricultural Economics, University Of California, Berkeley, 1972.

New West, Sept. 25, 1978.

Rea, P., speech published in Moulton, Op. Cit..

San Francisco Sunday Examiner and Chronicle, Aug. 5, 1979.

Sims, W. et. al., "Mechanized Growing and Harvesting of Processing Tomatoes," University of California, Division of Agricultural Sciences, Cooperative Extension, Leaflet 2686, Berkeley, March 1979.

Shockley, W. "Discussion,", in United States Department of Agriculture, Economics, Statistics, and Cooperatives Service, Proceedings of the 24th National Conference of Bargaining and Marketing Cooperatives, Jan. 10-11, 1980, New Orleans, Louisiana, ESCS-83, Washington, D.C., July, 1980.

Thompson, O. and A. Scheuring, "From Lug Boxes to Electronics: A Study of California TomatoGrowers and Sorting Crews," California Agricultural Policy Seminar, Monograph No. 3, Department of Applied Behavioral Sciences, University of California, Davis, December, 1978.

NOTES ON PART VI

1. Under this process, the container and product are sterilised separately, and then the container filled and sealed with cooled product. This is necessary for the use of large containers, else the product would be ruined by the high heat necessary to sterilize the container in the usual manner.

2. This is not a linear process. Certainly small farms can be recreated and appended to capital, or can survive in some altered form. The point is that such functional relationships are inherently contradictory and capitalism tends to destroy non-capitalist forms of production.

3. For example, growers who contract with some large processors, such as Heinz and Campbells, must use the seeds developed by these firms, and not by the large seed manufacturers.

PART VII

THE PAYOFF MATRIX: WHO BENEFITS FROM THE HARVESTER TECHNOLGY?

A full accounting of the costs and benefits of the introduction of the mechanical harvester would require that we could know what would have happened had the harvester not been introduced. Such a "counter-factual" hypothesis is very difficult to specify, though any claim about the advantges or disadvantages of mechanization certainly must be based on such a conception, even if left implicit. Given the limitations on data availability and on our resources, we have not been able to quantify the magnitude of the payoffs and costs to the various affected groups. Nevertheless, we can indicate what we think the nature of the benefits and costs have been in qualitative terms, using the material presented above and our understanding of how the tomato harvester affected the course of the tomato industry in California. This analysis of the pay-off matrix can then help to identify the probable sources of support for the new technology.

Consumers

Looking first at the consumer, it is virtually an axiom of the American agricultural economics profession that all cost-savings benefits of technology must flow to the consumer in terms of lower prices. The literature on the social returns to public and private investment in agricultural research always begins with this basic assumption (e.g. Griliches, 1958; Just, et. al.

1978). Not only is it assumed that the benefits of technology are passed along to consumers, but also it is asserted, on the basis of "empirical analysis" that the benefits are very large. For example, Schmitz and Seckler found that the social returns to the tomato harvester were in excess of 1000 percent of the public investment costs. Leaving aside the fact that this analysis neglects a major portion of the costs associated with the tomato harvester (namely those of breeding the new tomato plants and those of educating farmers as to the best ways of employing the new machines), and hence overstates the social benefits, there is an even more important conceptual flaw upon which this analysis is built.

This flaw is the assumption that the food system can be characterized as being competitive, so that all cost-savings are passed along to consumers in lower food costs, and none are captured by producers, processors, wholesalers, or retailers in the form of excess, or monopoly profits. Indeed, this same assumption is found in virtually all of the studies of the social benefits of agricultural technology, even though the presence of monopoly power in the food industry is well documented (e.g. National Commission on Food Marketing, 1966; Federal Trade Commission, 1969; Connor, 1979).

In the particular case of canning tomatoes, we have already seen that processors possessed sufficient market power to manipulate prices, first to encourage adoption of the harvester, and later to extract the surplus created by the new technology. We have also seen a struggle between growers and processors over the surplus and the formation of the producer bargaining association, which improved the prices received by producers. Finally, we have noted that under the new technology, it became increasingly difficult to become a tomato grower because of the capital requirements and because of the

importance of access to tomato contracts. Thus the supply of tomatoes is manipulated through contracts and the price through bargaining. Certainly these arrangements are inconsistent with the usual assumptions of competition and they raise the question of who really does benefit from such technology. We are aware of no empirical investigations in the agricultural economics literature tracing the actual distribution of benefits; previous analysis assumes away this important question by failing to take seriously the possible presence of monopoly power.

There is an even more important reason for questioning the conventional studies of the tomato harvester that purport to find large social benefits, for they implicitly assume that the alternative to the adoption of the new technology is the status quo ante, adjusted for rising labor costs. Thus it is pointed out that the rapid expansion of the tomato industry in California could not have taken place without the harvester. That is, a connection between the availability of the new technology and the increasing supply of tomato products is drawn, with the implication that without the harvester, the supplies would have been reduced and prices would have been higher. However, as we have already pointed out, at the end of the Bracero Program, there was a clear choice available to processors; namely, they could promote the adoption of the harvester and make the necessary internal adjustments, or they could move to cheap labor areas in Mexico and meet the rising demand using hand-labor rather than machines.

In other words, if the machine had not been available, it appears likely that the cost of tomatoes would not have risen with domestic wage rates, for the industry would likely have expanded in Mexico and the supply would have kept pace with demand, using human labor.

Thus, in assessing the impact of the machine, it is extremely important how one specifies the alternative production possibilities. It may be correct to assume that Mexico would not have supplied the world with wheat, had the combine not been developed, or cotton, had the cotton picker not been adopted, but for a relatively small crop such as tomatoes, the possibility of alternative supplies from other nations at the supply price similar to that of the machine harvest is sufficiently strong to require it be taken into account in assessing the benefits of the machine to consumers. Consumers are not particularly concerned whether the tomatoes are produced in California or Mexico as long as the price is the same, though perhaps the higher quality of hand-picked tomatoes might have some tangible benefit to the consumer.

For these reasons, then, while we do not have any quantitative results to support our contention, we believe that the harvester had, at best, a relatively small beneficial impact on consumer welfare. We further think that the burden of proof should lie with those who argue in favor of substantial consumer benefits, since previous analyses have not adequately dealt with the problems posed by monopoly power in the food system and by the alternative supplies from other nations in their efforts to document the benefits of mechanization to consumers.

These preceeding comments imply that the major impact of the harvester was to preserve and indeed concentrate the locus of canning tomato production in California. If this is accepted, then it follows that primary beneficiaries are those who have an economic interest in the tomato industry remaining in California. These interests would include the growers (and landowners), local processors who could not easily move to Mexico and those with large fixed investments in processing capacity that would have no economic value if the

crop should move, and those who sell inputs to the producers, such as the machinery, chemical, and seed companies.

Finally, the harvester had important impacts on the welfare of workers. Some jobs were eliminated, others were created; some categories of workers were thus benefitted while others were injured. We now examine the welfare implications of the new technology for each of these affected groups.

Agricultural Machinery Companies

Jim Hightower (1978) argues that the agricultural research of the Land Grant College complex greatly benefits machinery and chemical corporations by providing them with free research and development, low-cost licenses to produce profitable products, and generally by helping to encourage farmers to utilize their products. The facts that we can uncover relating to the tomato harvester technology tend to bear out Hightower's assertion.

As discussed earlier, the University played a critical role in developing the mechanical tomato harvester package of inputs. The development of the machine and the new varieties of hard tomatoes went hand-in-hand, making it virtually impossible to develop one without the other. Blackwelder Manufacturing Company worked closely with the University of California's agricultural engineering department, while other machinery companies developed their products in close associtions with other universities in Michigan, Florida, Maryland, and Illinois. Schmitz and Seckler (1970) estimated that the University of Califoria spent about $600,000 in developing the harvester while Blackwelder spent $500,000. These figures neglect all of the University's research costs incurred in the development of the tomato varieties necessary to the successful adoption of the machine and also do not include many of the

salaries and overhead (fixed) costs that were necessary to maintain the research capability of the University. Unfortunately, the accounting system of the University does not permit us to disaggregate expenditures for these other activities, and therefore we are not able to estimate the full public costs of developing the new technology. In any event, these costs were substantially higher than estimated in the Schmitz and Seckler analysis.

It should also be pointed out that because of the complex interaction between engineering and biological research, private firms would most likely not have undertaken the developmet of such a technology, for the development period for the biological innovations was very long and risky. Therefore, even though a machine could have been developed outside of the University, it is not likely that the tomato harvest could have been mechanized without the support of the University. This is another way of stating the obvious fact that the University's research efforts substantially benefitted those firms that eventually constructed tomato harvesters, even those firms that did not obtain the patent to the machine developed by the University.

University licensing of firms to produce the patentable products which result from its research provides industry access to vital information at much less than production costs. In many instances, this information would not otherwise have been produced by the private sector because of difficulty in caputuring its benefits. Moreover, royalties have been very low, allowing the private firms to receive a substantial subsidy (Draper and Draper, 1968). The licensed firm is also placed in a favorable marketing position through its relationship to the University's extension program.

In the case of the tomato harvester, Blackwelder was able to add the University of California's name to its product, the only time the University

has allowed the use of its name for such a purpose. As a result, Blackwelder dominated the market for many years and had held its own against much larger firms. Many small companies were driven out of business in the late 1960's, after the first round of adoption, and only three or four remain. Some smaller firms have argued that even if they were to produce a superior product, the University's access to the farmers through the extension program represents an enormous obstacle to their being able to compete (Ruegg, in: State of Californa, 1964).

Just what the payoffs have been to the machinery companies are unknown, but the creation of a new and profitable market for some firms is evident. Almost 2,000 tomato harvesters were sold between 1964 and 1974, and another 1000 have likely been sold over the past five years (Carman and Brandt, 1975). These sales represent a signficant market. The original harvester sold for between $18,000 and $25,000, which implies a total value of sales of at least $50 million by 1974, and this is a conservative estimate, especially if the service and spare parts components are included. The new electronic sorter and harvester, which is much faster and larger, sells for up to $150,000 per machine, implying a likely sales figure of over $100 million over the past five years. Some of the benefits of the machine sales go to the financial institutions which provide the credit, so the total value of these machinery sales must be increased by the interest charges on the loans. Conservatively estimating a typical loan of three years on all but ten percent of the purchase price, this implies that the harvester is worth at a minimum, $5 million per year to the banks.

The introduction of the machine had spinoff effects on cultural practices, requiring much more precise cultivation, planting, and weed control

(Friedland and Barton, 1975). This led to increased use of machinery, specialized seeds, and more chemical herbicides. For example, a University of California publication suggests the following machinery as a prerequisite to growing canning tomatoes: a direct seeder, a power tiller/cultivator, possibly a mechanical or electronic thinner, a weed cultivator, mechanical harvesters, bulk carriers, and a machine to open up the fields for the bulk carriers (Sims, et. al. 1979). Many of these implements are specialized to tomato production, and were not required prior to the introduction of the new technology. Likewise, chemical herbicides, relatively unknown under the old technology, have become a mainstay of the new production process. All of these complementary inputs imply new markets for machinery and chemical firms, and their economic importance may be substantial.

Seed Companies

The seed companies have also benefitted both from the introduction of the tomato harvester and from the more general pattern of public research in developing biological innovations. In the particular case in point, California seed companies were often able to market new varieties released by Hanna at the University after only one or two years of further development. Thus, these firms were able to benefit from the innovation by being spared the long lead time that such development usually requires. In this case, the University did the work, but most of the economic rewards were captured by the private sector.

In the transition to machine harvest tomato varieties, new strains were constantly introduced and because of demand, they were usually in short supply. This constant condition of tight supplies was conducive to an environment favorable to "co-respective" behavior among the few large seed companies; such

behavior is also known as oligopoly pricing, whereby competition between firms in pricing is replaced by price leadership of one large firm whose example is followed by the rest of the industry. Whether or not seed companies practiced this pricing behavior is not clear, however, since some of the large canners (Del Monte, Heinz, Campbell's) often bred and sold their own seed, thus providing a counter to the power of the large seed companies.

In recent years, a dramatic change has occurred in the seed industry which could have serious consequences in the future. The Plant Variety Protection Act was passed in 1970. This law allows patenting of new seed varieties. In the past ten years, the law has led to a shift of plant breeding research from the public to the private sector. Research by private seed companies hs tripled during this period (Crittenden, 1980) and the USDA financing of plant breeding has declined.

One important result of this shift has been the consolidation of seed production in a few large firms. Thus, according to Crittenden, during the past decade dozens of seed companies have been bought, often by large petrochemical and pharmaceutical firms which include, among others, ITT, Ciba-Geigy, and Sandoz, Inc. With consolidation comes the increased threat of monopoly control over seed production and the development of new varieties. Control over the production and sale of seeds can be an important lever for these corporations in extracting the benefits of new technologies such as the tomato harvester.

In our case study, four of the five major suppliers of tomato seeds were sold in the 1960's, just prior to the passage of the law: Seed Research Specialistis acquired by Food Machinery Corp. in 1965; Asgrow Seed Co. by Upjohn Co. in 1968; Ferry-Morse Seed Co. by Purex Corp. Ltd. in 1968; and

Peto Seed Co. by G.J. Ball, Inc. in the late 1960's (California Tomato Grower, various issues). Under its new owner, Peto Seed Co. hired Professor Jack Hanna away from the University of California in 1971, by establishing a new breeding center not far from his home in Davis (Ibid.).

A new law has been introduced in Congress that would add patent protection to the six vegetables (including tomatoes) that were excluded in the 1970 legislation "because the Campbell Soup Co. and the H.J. Heinz Co. felt prices of these might rise rapidly" (Crittenden, 1980). The fact that these firms no longer oppose the inclusion of vegetable seeds under the patent act is difficult to understand, for in the long term, it seems clear that the price of seeds must rise if firms are allowed to recoup through patents the research and development costs formerly internalized by the public sector. Perhaps these firms now have their own production of seeds sufficiently under control that they do not fear the seed companies and may, instead, be in a position to capture some of the possible benefits themselves.

These developments are not confined to the United States, but rather are occurring on a world scale through the instigation of transnational corporations (Mooney, 1979; Byres, 1980; Black, 1980). Whether or not one detects a conspiracy to monopolize world germ plasm, the ultimate effect of these patents will be to consolidate the grip of large agribusiness firms, especially in the Third World. The privatization and centralization of research and development by these large firms in Europe and the United States raises serious issues and emphasizes the importance of analysing the development of capitalism in agriculture at a world scale (Wionczek, 1978).

Growers and Landowners

In addition to the suppliers of the new inputs for the mechanized tomato harvest, it is clear that the growers themselves benefitted from the introducton of the technology. As discussed above, the machine probably saved the canning tomato industry for California and was responsible for the concentration of production in California, at the expense of the rest of the nation. Had tomato production been allowed to move to Mexico or remain in the Midwest of the United States, California growers and agricultural landowners would have been deprived of the additional profit allowed by tomato production, especially after the early 1970's, when growers were able to achieve a measure of collective action with respect to the processors through their bargaining association. Prior to that time, the harvester had created large surpluses, and grower profits were, in several years, negative (at least, on average). But with the rapid growth in demand for tomato products and the formation of the bargaining association, prices to farmers rose after 1972 and have remained relatively high since that time.

Higher prices mean either higher income to the farm entrepreneurs or higher rents to landowners. Tomatoes have been more profitable to produce than the alternative crops. For example, in 1978 net income from tomatoes, after paying all costs except land, was about $350 to $400 per acre; for cotton net income was about $125; for sugar beets about $90; for alfalfa, about $100, for barley about $80, for cantaloupes, about $225 (based on University of California Farm Budget Estimates for 1978). If tomatoes were not grown, some combination of these other crops would most likely have taken up this acreage. The difference in net income per acre between tomatoes and the other crops is on the order of $150 to $200. If one assumes that all of the canning tomato

acreage in the state would have been lost to Mexico without the harvester technology, this implies a net loss of income to growers and landowners of up to $45 to $60 million per year!

It might be asked why competition does not eliminate this profit by increasing acreage of tomatoes to reduce the profit differential. Here the role of the financial institutions and the contracting arrangements of the processors are important. Given the considerable costs of becoming a tomato grower, it is no longer possible for anyone to start growing tomatoes without a large initial investment. Hence entry into tomato production is limited to those growers with access to capital and to those with access to contracts to sell tomatoes. In short, competition in tomato production is limited by the decisions of financial institutions and by those of the canners as to how much acreage to contract to growers. When we recognize that the price-setting mechanism is subject to colllective bargaining between large growers and the processing industry, we see that the industry has less incentive to over-contract, since this implies having to accept the large surpluses. This is not to say that the planning process necessarily produces the right supply for market conditions or that one year's surplus will not be used in the following year's price negotiations. The point is, a profit differential can persist because of these kinds of institutional arrangements that prevent the normal workings of competition, and further, they allow for growers to capture some amount of the benefits created by the new technology.

The division of the benefits between landowners and farm entrepreneurs is a matter for additional research. Large vegetable farms typically do not own most of the land on which they farm; instead, land is leased (LeVeen, 1978). Tomatoes must be rotated with other crops, so many farm managers will attempt

to lease land that is in the right phase of its production cycle for tomatoes. Thus, the question arises, who receives the benefit from the technology, the landowner or the entrepreneur? The preliminary evidence suggests that the profit is divided between landowner and entrepreneur. Land rents are generally established as a percentage of the gross value of the crop; tomato land leases for approximately 20 percent of gross value, which amounts to between $150 and $300 per acre (Reed and Horel, 1979).. Cotton also rents for approximately the same percentage, but since the gross value of cotton is roughly half of the value produced by tomatoes, the rents amount to about half of the tomato rents. This relationship is typical of other crops as well. Only crops such as lettuce, which uses very little land, pay higher rents than tomatoes. Thus, it would appear that landowners earn up to $100 per acre more for land in tomatoes than in other substitute crops; this suggests that about half of the benefits of the technology captured by the farm sector flows to landowners; the rest goes to entrepreneurs who obtain contracts and who own the specialized machinery.

Agricultural and other Labor:

As was discussed above, the harvester both displaced tomato pickers and substituted a different type of occupation: sorting tomatoes on the machine. In addition, new, higher-skilled jobs were created by the requirements of the machinery. With the advent of the electronic sorter, many of the remaining hand-sorting jobs were eliminated. Therefore, in agriculture, the net impact of the harvester technology has been to eliminate jobs for seasonal workers. However, it must be recalled that these jobs may have been lost if canning tomato production moved to Mexico, so the true impact of the harvester is less

obvious. Fewer jobs in California would have been offset by a much larger employment in Mexico, and since many of those picking in California were from Mexico, they could have found work in Mexico had the production increased there. Thus, only if one views the employment from the perspective of both economies does it appear that the harvester reduced the number of jobs for seasonal labor.

The analysis of Part V also indicated that in addition to the creation of a few new higher paying jobs in agriculture, the harvester also contributed to employment in the machinery and processing sectors. However, given the nature of the segmented labor markets, the increased employment in these activities probably did not include those displaced in agriculture. Thus, from the perspective of economic welfare, the harvester may have increased the incomes and employment of the industrial labor force, at the expense of the unskilled and unorganized labor force in agriculture. This point is the central thesis of Schmitz and Seckler (1970).

Whether agricultural workers found employment to replace tomato jobs is unknown, although during the same period that the harvester was being adopted, there was a general increase in the production of labor-intensive crops in California, as more fruit, nut, and vegetable crops were planted. Given the fact that the Bracero Program had ended and the overall demand for labor was growing in other crops, it would appear likely that displaced workers were able to find other employment. As we have seen, the organization of agricultural labor continued during this period as well, and real incomes rose. The real losers thus would appear to be those Mexicans who would have had more agricultural employment had the harvester not been introduced.

The Canners

The other major category of possible beneficiaries of the new technlogy are the processors, wholesalers, and retailers of tomato products. For most of these firms the benefits are likely to be relatively small, for as discussed above, in all likelihood tomato supplies would have been maintained at about the same price levels had production moved to Mexico. Thus, only those who had fixed capital investments in the United States, who would have lost some of the value of these past investments, and who could not have moved to take advantage of the new market would have been economically injured by the shift of production. This is another way of stating that they were not substantially benefitted by the introduction of the technology. Evidently, some of the firms with processing facilities in California were anxious for the introduction of the new harvesters, once the Bracero Program terminated, as illustrated by their willingness to grant farmers higher prices at the outset. However, in light of the subsequent formation of bargaining associations and the necessity of having to share the benefits of the growth in tomato profits with growers and landowners, one must speculate whether these firms would not have preferred the shift of production to Mexico, where the likelihood of such collective action from the producers would have been much more remote. At this time, we can not indicate the quantitative nature of the gains to the profits of the processors; data are not readily available and the research effort necessary to make such a quantification is beyond the resources of this project.

In summary, we have shown that the introduction of the tomato harvester and related technology had important favorable economic impacts on a wide variety of firms, if not on consumers and agricultural labor. It is therefore not very surprising to find that with the termination of the Bracero Program,

there were strong pressures on the public sector to do what it could to facilitate this new technology. To develop the nature of these political-economic relationships in greater detail, we now turn to the analysis of the public sector.

CITATIONS: PART VII

Black, E. , "Seeds of Destruction?", Monthly Review, Vol. 31, no. 11 (April 1980).

Byres, T., "The Green Revolution's Second Phase," Journal of Peasant Studies Vol. 7, no. 2, (January 1980).

Connor, J. , "Manufacturing and Food Retailing," in United States Department of Agriculture, Structure Issues of American Agriculture, Agricultural Economics Report #438, Washington, D. C., November, 1979.

Crittenden, A., "A Rhubarb Over Patenting Vegetables," San Francisco Chronicle, June 13, 1980 (reprinted from the New York Times).

Friedland, W. and A. Barton, Destalking the Wily Tomato: A Case Study in Social Consequences in California Agricultural Research, Department of Applied Behavioral Sciences, Research Monograph No. 15, University of California, Davis, June 1975.

Griliches, Z., "Research Costs and Social Returns: Hybrid Corn and Related Innovations," Journal of Political Economy, Vol. 66 (1958).

Just, R., et. al., "The Social Impact of Technological Change in Agriculture," in University of California, Technological Change, Farm Mechanization ad Agricultural Employment, Division of Agricultural Sciences, Publication #4085, July 1978.

LeVeen, E. "Economic Advantages of Large Crop Farms in California," working paper, Department of Agricultural and Resource Eonomics, University of California, Berkeley, 1978.

Mooney, P., Seeds of the Earth: A Private or Public Resource? Inter Pares, Ottawa, 1979.

National Commission on Food Marketing, Technical Studies Nos. 1-10. U.S. Government Printing Office, 1966.

Reed, D. and L. Horel, "Leasing Practices for California Agricultural Properties," Division of Agricultural Sciences, University of California, Leaflet 2359, Jan. 1980.

Ruegg, C.,"Testimony of Carl Ruegg," in California Legislature, Assembly Interim Committee on Agriculture, "Symposium on Farm Mechanization -- Transcript of Proceedings," Oct. 14, 1964.

Sims, W. et. al., "Mechanized Growing and Harvesting of Processing Tomatoes," University of California, Division of Agricultural Sciences, Cooperative Extension, Leaflet 2686, Berkeley, March 1979.

Wionczek, M. "Measures of Strengthening the Negotiation Capacity of Governments in their Relations with Transnational Corporations: Technology Transfer through Transnational Corperations -- A Technical Paper," U.N. Centre on Transnational Corporations, ST/CTC/11, New York, 1979.

PART VIII

THE PUBLIC SECTOR AND THE BIAS OF TECHNOLOGICAL CHANGE

Our analysis has shown that in the case of the tomato harvester, the public sector played a vital role in its development and diffusion. It is clear that, for many reasons, the private sector cannot or will not undertake the necessary investments for the development of new agricultural technology and that historically, the public sector has filled this gap. From the perspective of the theory of induced innovation, then, the role and direction of public sector research is critical. The question is, why does the public sector choose to develop some kinds of technologies and neglect others? Is there a logic to this process that is akin to the logic of economic rationality? If we can uncover the forces that shape public sector research priorities, we will have made considerable progress in understanding the process of induced innovation.

Introduction

The Hayami/Ruttan model posits a model of the public sector as consisting of a set of institutions that respond to the demands by the private sector. Thus, when farmers recognize a kind of technological development, they go to their local research institution, express their demands, perhaps attempt to influence the direction of change by having funds appropriated from the government to support the research, and eventually the desired innovation is produced. The line of causation is from the interaction of relative resource

endowments with prices and profits, which alert the private sector to potential improvements of particular kinds of research; the private sector then either tries to develop the new technology itself, or if it cannot, then it attempts to influence the direction of public sector research and development. Situations in which the private sector may fail to develop a potentially beneficial innovation are related, under this theory, to "market failures" where the benefits of research may not be capable of being converted into a sufficiently large profit to warrant investment, or because the riskiness of the potenital innovation discourages private investors. Biological innovations, which require a long period of experimentation and perhaps some prerequiste "basic" (as opposed to "applied") research may yield high profits, but may not produce enough benefits that any single firm can capture to warrent its undertaking the risk.

This model of the demand for political innovation assumes that there are no conflicts within the society over the direction of change. If there is a conjuncture of conditions that imply a profitable new development, then it is assumed that a "public interest" exists and is manifest in a set of political demands; the public sector simply responds to these demands. The result is the improvement of the overall welfare of the entire society. That is, the public sector's sole rationality is to redress the problem of inadequate private investment; it is not to interfere on behalf of one group or class in its contests with other groups or classes. Thus, this general model that underlies the Hayami/Ruttan hypothesis is consistent with much of American social science that presumes underlying social harmony and consensus rather than conflict.

Obviously, these implicit assumptions are untenable in the example of California. As we have already argued, there are profound differences in

interests of different groups and classes that have played a major role in structuring the policy that has directed the evolution of California agriculture. In addition to the fundamental struggle between capital and labor, we have also seen that there have been important conflicts between fractions of agricultural capital, as between large versus small growers or between processors, distributors and farmers. Moreover, machinery manufacturers have an important concern over the direction of technological change, as do the producers of chemicals, fertilizers, and seed. Finally, as we saw in the instance of the termination of the Bracero Program, there are regional interests within agriculture in potential conflict as well as differences between urban (especially organized labor) and rural agricultural interests. When all of these various conflicts are taken into account, the model proposed by Hayami and Ruttan is seen to be inadequate in providing insight into the course of policy formation and public agricultural research.

What is of even greater significance in this analysis is not only that underlying social conflicts have played a major role in the determination of agricultural development, but more that this history reveals a strong bias in the relative abilities of certain of these groups to control the policy process. Agricultural labor has had, until very recent times, no ability to influence the direction of policy. Likewise, small farm interests have been systematically excluded from influencing this process. In other words, if we are to understand the bias in technological change, we must not only understand the underlying economic forces (e.g the need of capital to grow and its need to control labor to do so), but also the nature of influence within the political process whereby these economic incentives are translated into research priorities and policies. Such an understanding cannot be very profound unless

there is a far more sophisticated approach to the analysis of the political process, based on a theory linking the State to the functions of economic growth and reproduction, for certainly the apparatus of the State does not exist in isolation from the rest of the social and economic system.

The purpose of this section is not to develop a novel theory of the State, but to build on the hypothesis that the State has two fundamental roles: it must facilitate the process of capital accumulation and it must be able to legitimate its policies of accumulation so as to provide the basis for social stability. That is, it is assumed that in the course of promoting economic growth, conflicts between capital and labor, and between fractions of capital, will arise that threaten the stability of the overall system and its ability to reproduce itself. It is the State's role to mediate these conflicts in such a way that they can be resolved, without unduly altering the accumulation process. In this sense, the State must be more than the simple representative of the various factions of capital, for at times its policies must be injurious to some of these interests and favorable to labor or at least appear to be so. (This general interpretation of the role of the State is based on a rapidly growing literature; see for example, Gold, et. al., 1975; O'Connor, 1973; Castells, 1980). Using this hypothesis as a starting point, we want to examine very briefly a few key aspects of the particular role of the Land Grant College System with respect to the generation of research and agricultural policy. In this analysis, we will first try to establish the mechanisms which have shaped the overall orientation of this public instutition toward certain interests within the agricultural community. Then we will suggest some of the specific mechanisms which are at work within the research establishment that insure the generation of research supportive of these favored interests.

A Brief Political Economic History of the Land Grant College Complex

The Land Grant system was established under the Morrill Act of 1862; the purpose was to establish colleges for the "tillers of the soil". Most of the population was rural in 1862, and the cost of this act was relatively small to the Federal Government, which gave each state a grant of the public domain to underwrite the initial development costs of the Universities. In 1887, federal funds were authorized for direct payment to each state that would establish an agricultural experiment station in connection with its land grant college. The Hatch Act directed that these research stations be oriented toward solving the problems of agriculture and of rural society. However, Hatch Act funds were of a relatively small amount, and it is recognized that the Land Grant Colleges did not have much of a direct impact on the farming practices of the U.S. until the passage of the Smith-Lever Act of 1914, which added the extension service to the system. The colleges were not anxious to do extension activities, but they were forced into this role by the threat of a private extension service or by the possiblity of a publicly-funded service under the authority of some other agency. The Land Grant Colleges thus perceived a challenge to their territory, and agreed to add extension to their research activities (see McConnell, 1949).

What is particularly noteworthy about the creation of the extension service is that the impetus for it came from outside of the agricultural community. According to McConnell, bankers and agricultural implements manufacturers were the strongest supporters of the concept of extension, and provided the funds to finance the political campaign that resulted in the legislation. The motives of these nonagricultural interests in advancing this

legislation were clear. American agriculture went through a political upheaval in the late 19th century, as the Populist Movement swept the rural communities. Populism was seen as a threat by those who provided farmers with their tools and their capital, for Populism was aimed at destroying the power of the large corporations that were emerging at the time. If there was to be stability in agriculture, it would be necessary to bring some portion of farmers into the mainstream economy, so as to have a solid core of interests who would, in the future, resist political efforts to control Eastern capital.

Moreover, it was becoming increasingly clear to the farm implement manufacturers that their business would depend upon increasing the markets for their products. Thus, extension agents were not only supposed to provide information that would lead to scientific management of America's agriculture (and incidently increase the demand for inputs produced outside of agriculture), but it was also intended to create an environment conducive to political stability. It is interesting that the leaders of the Land Grant Colleges at first were reluctant to undertake these tasks; for them extension appeared to be an unpleasant burden.

The importance of the newly formed extension service became clear almost immediately. Agents set up small committees of progressive farmers to advise them on important agricultural matters. Within a few years, these farmer committees had federated themselves into a major political organization that became known as the American Farm Bureau Federation. Extension agents were partially paid by this private organization, and partly by the public. Indeed, during the 1920s, unless an individual were a member of the Farm Bureau he could not have access to the extension agent. This private usurpation of a public enterprise helped the Farm Bureau to increase its membership

substantially. Later, when it lost the right to prevent access to the agent, the Farm Bureau found another device to increase membership: by taking advantage of the laws permitting cooperatives, the Bureau established many cooperative enterprises that sold farmers inputs at costs below those of the rest of the private sector. To be eligible for these services, a farmer had to pay dues to the Farm Bureau; hence individuals had large economic incentives to join the organization (see Olson, 1965). However, even though the Farm Bureau was able to claim a membership of large numbers of small farmers, its basic philosophy was oriented toward the largest and most progressive farmers and to the agribusinesses that serviced farmers.

Therefore, because of the Extension Service, a powerful political interest group was established that represented the interests of the relatively few prosperous farmers who adopted the latest technologies, grew larger and dominated commercial production. In the 1920's and 1930's, the Farm Bureau was the chief political force shaping the emerging agricultural policy of the nation. It worked in close relationship to the Experiment Stations, providing advisory services and helping to lobby for much needed government revenues. As a consequence, the interests of the Farm Bureau were dominant in the research agendas of the various state Land Grant Colleges as well as at the Department of Agriculture.

During the New Deal years, a major threat emerged to the dominance of the Land Grant College System, the Farm Bureau, and the Department of Agriculture in the rural economy. President Roosevelt set up an independent agency known as the Resettlement Administration, and directed it to deal with the profound problems of rural poverty that were found all over the nation. In charge of this organization was Rexford Tugwell, an urban, liberal, social planner. He

set up a new network of agencies in rural America that identified a very different client -- the poverty-stricken, subsistence farmer, who was, by far, more numerous than the clients of the Farm Bureau and the Land Grant Colleges (Baldwin, 1967). This agency was thus immediately perceived as a threat by the traditional rural power structure, and a major political campaign was launched to eliminate the agency. In 1937, Tugwell resigned, and the agency was placed within the Department of Agriculture, where it could be more closely watched.

However, the activities of the Farm Security Administration, as it was then called, were no less suspect, especially in California, where it set up farmworker camps to aid the immigrants from the Dust Bowl. These camps were regarded by California interests as subversive, because they provided a higher quality of living than was generally available, and also served as a starting point for much of the union organizing activity that prevailed. The California Farm Bureau was fond of describing the activities of the FSA as being inspired by the "communists". When World War II diverted attention away from the poor whites in the fields of California, the Farm Bureau led a successful campaign to disband the FSA, and replace it with a much more conservative institution, the Farmer's Home Administration, whose purpose was to lend money to farmers. In this way, the Farm Bureau was able to eliminate the only public agency to take on the problems of the non-prosperous farmers and farm workers. The FSA served to pacify these downtrodden groups during a period of national emergency, but with the whites out of the fields, it could be safely eliminated, without incurring the possibility of a major outbreak of social instability.

Selznick (1949) provides another very similiar example of the influence of the Farm Bureau, in alliance with the leadership of the Land Grant College

Complex, in shifting the progressive intentions of the Tennessee Valley Authority toward the interests of the "local grass tops" as opposed to the "grass roots." Here again, an agency threatened to invade the territory of the traditional rural power structure, but whereas the FSA was eliminated for its actions, the leadership of the TVA allowed itself to be "co-opted" by conservative interests who were able to benefit from its policies. Hence there was no need to eliminate the TVA.

Conrad (1965) adds yet one more piece to the overall picture of the methods by which power was consolidated at the federal level of government by this rural power structure. The New Deal cotton programs were extremely detrimental to the sharecroppers who produced the cotton, because while they were required to plow up their crops, the government payments went to the landowners, who in most cases did not share the payments with the sharecroppers. The adverse social implications of these policies became widely recognized as a consequence of publicity in the Eastern press; a small group of liberal, urban bureaucrats in the Department of Agriculture, who were not raised in the Land Grant tradition, attempted to address this problem by challenging the local administrators of the programs to see that the payments were directed to the sharecroppers. This interference in local affairs, by "outsiders," led to a profound crisis within the Department of Agriculture. Henry Wallace, regarded by many as a liberal, nevertheless was forced to "purge" this entire cadre of Eastern liberals by the internal politics of the agricultural establishment. This was the last time that the farmworker, the subsistence farmer, and the rural poor had a voice in the making of national policy, at least until very recent times, when farmworker and small farm interests have begun to receive a somewhat sympathetic hearing by some in

Congress and in the USDA.

Theories of the State and the Bias of Technology

These stories are intended to provide some insight into the forces that shaped the orientation of those who were charged with designing, advocating, and administering agricultural polices and research. They provide anecdotal information that is useful in seeing broad patterns of influence and control over the State. In recent years, there have been attempts by political scientists and economists to give some theoretical basis to this kind of privatization of the public policy process. Lowi (1967), McConnell (1964), Ferejohn (1971), Niskanen (1971), Bartlette (1973), and Olson (1965) have all contributed to an emerging theory, which is popularly known as the theory of the "iron triangle."

This is a theory that attempts to explain a widely observed political domination of state policy by decentralized, yet well organized producer groups. In this theory, the dominance of special interests, such as those represented by the Farm Bureau, is explained in terms of relationships between producers, politicians, bureaucrats, and consumers evolving out of rational, self-interested behavior of social groups. The analysis begins with the assumption that groups of individuals have incentives to invest in influencing the policy process, just as they might take part in other economic activities which benefited their economic interests. Political activity becomes simply a particular mode of economic activity. However, the incentives to organize are subject to various constraints (particularly related to group size) so that producer groups have the greatest incentives to form pressure groups. That is, producer groups are smaller, and have greater perceived individual incentives

to organize; hence they overcome the costs of collective action, and come together in coherent political pressure groups. Issues affecting consumers, farmworkers, or other large groups who lack both the incenitves and the resources to undertake effective political organization, do not have the same representation in the various legislatures, federal and state.

Legislators, the second corner of the triangle, are predisposed to the influence of such producer groups because of their need of resources to run political campaigns. An organized producer group can be counted upon to provide these resources in return for favorable legislation; the general public, or interests with weak organizaton, are not as likely to produce the needed resources because the benefits of a policy to any individual in these large groups will be relatively small and will not lead to contributions. Moreover, because the general voting public is "rationally ignorant" when it comes to voting (i.e. there is little economic incentive for any one indivdual to invest in finding out about a particular candidate, given the small impact of his vote), the public is susceptible to "subsidized" information provided by political advertising. Therefore, a politician can use resources derived from the pressure groups to finance a media advertising campaign to convince the general public that it should return him to office.

The susceptibility of the public to "subsidized information" makes it very feasible for the politician to generate a network of protective ideologies that allow him to justify to all of his constituents his support of policies that in fact benefit only a very few of his most powerful supporters. The politician cannot afford to neglect his important constituents, for they will otherwise support someone else in the next election. Neither can the politician obviously help one class or strong group to gain at the general

expense; therefore he must have some means of "mystifying" the nature of his support for various policies.

For example, a common method of mystifying the impact of policies detrimental to the welfare of agricultural labor is to characterize them as necessary to keep food prices low or to encourage the sale of U.S. productions overseas, even though the prime beneficiaries of these policies are large-scale capital, and not the general public.

The legislative process is so organized to facilitate the development of broad coalitions of legislative support for particular local interests. The committee structure of decision-making allows each representative to sit on those committees having oversight on programs of greatest importance to his constituents. Thus, rural representatives dominate the agricultural committees, while urban representatives dominate other committees. This tends to predispose the decisions of the Congress to favor special interests, even though these poltical interest groups do not have direct influence over most Congressmembers. Log-rolling between committees allows for the formation of the needed overall support, and thereby permits policies with narrow and concentrated benefits (which may far outweigh the costs of these policies) to become politically feasible.

This analysis of the iron triangle is completed by an examination of bureaucratic behavior. Bureaucracies are needed to administer the programs of legislators. In delegating authority, legislators help to facilitate the operation of the iron triangle. The agency becomes concerned about the political implications of its programs because of its desire to grow and prosper. Bureaucrats want job security, promotions, higher status and other benefits associated with the growth of their agency's budget. Since the budget

is controlled by the legislature, and since the legislature is sensitive to the interests of the most organized political groups, the bureaucrat cannot afford to neglect these interests. Thus, in designing the agency's program and in administering the laws, bureaucrats have strong incentives to let the needs of powerful political interests dominate their decisions.

What makes this analysis of the iron triangle appealing is that it explains how the state assists in the accumulation of capital and regulates intra-capitalist conflicts without reference to conspiracy between the various actors or to any conscious class behavior. Instead, these important functions are performed automatically, as it were, as each group pursues its own interest as defined by its position within the overall structure of the system. In short, "special interest" politics, as we have observed in agriculture, arises out of the class nature of society but does not depend upon conscious class behavior for its success.

The Limits of the Iron Triangle Analysis:

There are limits to the explanatory power of this theory, however, for it is not a class theory and neglects important attributes of capitalist class power, including the conscious use of this power. Obviously, large landowners and other capitalist interests derive their political power from more than simply low transactions costs of political organization. And they exercise that power in many other ways than organizing and lobbying their legislators and friends in the bureaucracy. For example, these interests typically attempt to define the whole political and ideological context in which the affected agency operates, and need not continually intervene to direct its program. Thus, through a process of socialization, individuals within the bureaucratic system know what is appropriate and what is not appropriate -- they do not even

consider alternatives.

An excellent example of this kind of socialization can be seen in the comments of a high level University administrator who, in discussing the responsibility of the University for the social impacts of mechanization, is reported to have said that the problem is "...the responsibiity of some part of society's institutional arrangements, but not the university's. The university can retrain unemployed aerospace engineers, but other people have to take care of the sweepers" (quoted in Schrag, 1978, p. 28). The university administrators of the agricultural research program have been so conditioned by the past concerns to maintain an abundant and cheap source of labor for agriculture that they do not hesitate to identify their interests with those of large-scale capital. In sum, as long as the ideological orientation of the University, its administrators and its researchers continues to reflect this strong bias against the interests of agricultural labor, there need be no overt control over research by outside interests to insure that the University produce useful information to these interests. And because there need be no overt control, the subtle operation of the power of large-scale capital cannot be easily observed or documented. Therefore the institution can appear to be neutral, while it pursues biased research and development programs.

However, we must be careful in using this theory of the iron triangle, for its underlying relationships are not static. Iron triangle relationships have not existed throughout history; they have become strong since the New Deal and their existence therefore is related to a particular era and stage of development of U.S. capitalism. Moreover, the pressures and aid to the development of these relationships came, above all, from OUTSIDE the state (e.g. the power of private landowners, the imperitives imposed by economic

crisis, as during the Depression of the 1930's), and cannot be explained solely by reference to the internal structure of government, as many conventional observers imply. That is, the organization of the state into bureaucracies, Congressional committees, local representation and the Presidency has proven adaptable, even conducive, to the iron triangle, but these factors play no CAUSAL role apart from their actual relation to the structure of American capitalist society and the history of accumulation and political struggle.

These previous points can be related to some of the events we have discussed above. For example, California agricultural interests were unable to maintain their power to protect their labor supplies through the formal government policy of the Bracero Program. Thus, while the basic political and bureaucratic relationships were not altered, other forces became increasingly important, and effected change. In this case, it was the growing power of organized labor and the loss of support from Texas because of the successful mechanization of cotton, that proved too strong for California interests to overcome. Today, the growing power of organized agricultural labor and the emergence of environmental pressure groups who have challenged the university's (as well as the Federal Government's) priorities in its agricultural research and development constitute a similar threat on a state level to the traditional power of large agribusiness over the university.

More generally, the iron triangle relationships may well be suited to a particular era in U.S. economic development, for they helped to rationalize and direct the competition between capitalists during a period of very rapid growth. But in an era of limits, when the competition can no longer be mediated with measures that ensure rapid economic growth with a sufficient product to keep everyone, including both capital and organized labor,

satisfied, the continued operation of these relationships may prove to be counter-productive and obstacles to effective development and mediation of conflict. Indeed, the stagnation of the American economic system over the past decade may be one of the forces that has given rise to a new level of politicization of many groups, including environmentalists and consumers, whose new found power is increasingly being directed at these traditional relationships, making it difficult for business as usual (Thurow, 1980).

In recent years, we have witnessed a paralysis of the policy process and have seen that the political process appears less and less capable of making creative responses to the problems posed by a new international economic order, rising energy prices, environmental degradation and social decay. Clearly, some other form of State control is necessary if the process of capital accumulation is to be restored on the one hand, and if there is to be a greater social acceptance of the policies necessary to this process on the other. Given the highly politicized environment, the ability of many groups, including those hostile to capital, to gain access to the policy process, it is not at all clear how or whether the American State can reconcile the conflicting demands placed upon it.

What we have observed in the case of California is the growing awareness of the class-bias of the public institutions and the increasing difficulties of these institutions in fulfilling their functions in an environment wherein they do not enjoy the protection of protective myths. Anyone who would attempt to understand the future course of agricultural technology and the public sector must come to an understandng of these very substantial political problems facing all of our contemporary public institutions.

The University and the Bias in Technological Change

Given the above general analysis of the political forces influencing both the legislative and administrative branches of government, it is not difficult to account for the evident bias in the policy and the research that helped to shape the development of California agriculture. Put quite simply, the University had little choice but to provide the kind of support for the organized agricultural interests that we have observed in the above case study. The wealth that was created by the large landholdings, when subsidized water and cheap labor were added, was used to insure a political environment favorable to the reproduction of this system. These forces were and are stronger at the level of the local and state government than at the federal level, although California has been remarkably successful in obtaining favorable federal water and agricultural policies through alliances with other Western states (Hawley, 1966).

Influences on the University from organized agricultural interests are directly expressed to the leadership of the institution through advisory groups which they dominate, and indirectly through the legislative process, which determines the University's budget. Ultimately, the influence of these interests is through the budgetary process, for without their active support the funds for agricultural research would be used for many other purposes. Thus, were the University to define its client group to consist of consumers, environmentalists and farmworkers it would find its research budget diminished very rapidly, for these groups do not have powerful representation in the legislative process. Insofar as the concerns of these groups are incorporated into the research agenda (and, in recent years, they have been so incorporated) they are generally given low levels of funding but high visibility to project a

more favorable public image. For example, after examining criticisms of the University's failure to serve the interests of a majority of California's rural population, the University accepted the recommendation of a specially appointed committee, and announced its intentions to increase its "people oriented" research effort. That was in 1971, but in 1974 an analysis of the effort indicated that the increase amounted to an addition of only 3 scientific person-years while conventional research support added over 45 years of labor (Fisk, 1977).

An event of considerable importance in the shaping of the University's research agenda occurred just after World War II, when the California legislature, on the urging of the Farm Bureau, decided to appoint a committee to make recommendations for future directions of the institution's research. The Farm Bureau was particularly concerned about research in the University that was not supportive of the efforts to introduce a large reclamation project in the San Joaquin Valley, and was particularly angered by recent research that was favorable to the interests of small farmers and farmworkers (Fisk, 1978). The Farm Bureau labeled the research an attempt to "socialize agriculture". The concern was that indutrial agriculture was losing its influence on the University; a common pattern of response during such threats has been to lable the threat as "socialist," for such terms have strong negative ideological connotation and help to divert the attention of those in the agricultural community (who have been conditioned to respond adversely to the cry of "socialism") away from the true meaning of the threat. In this case, large-scale agricultural capital was successful in having an oversight committee established. The Agricultural Research Study Committee was formed in 1946. Its membership included high ranking officials of the various related

state agencies, including the University, members of the most important agricultural associations, including the Farm Bureau, and members of legislative oversight committees. Two members of the "public" were included, the head of the Bank of America and the head of the State Federation of Labor. The committee held hearings, obtained exhaustive lists of existing research projects and desired research efforts. It made recommendations for considerably increased funding levels and internal reforms to insure that the research would be undertaken (State of California, 1946). The legislature responded by allocating $1 million to the budget, a 25 percent increase. The Committee remained in operation, continuing to hold hearings in subsequent years, monitoring the research effort of the University, and continuing its efforts to increase the research budget. In 1948 it issued its last report. It had done its job well, for the problems that prompted the legislature to convene it were no longer present by 1950.

Having discussed the kinds of pressures that forced the University to recognize certain kinds of research problems and not others, we now briefly describe some of the internal mechanisms that have been established to insure that the individual researchers do in fact produce the desired results. Sufficient to say that the internal reward structures of the University are such that individual researchers have every incentive to undertake appropriate projects, and strong disincentives to undertake unwanted research projects.

There is, first of all, an important socialization process that takes place during the training of graduate students; this process involves showing the individual student what kinds of research are considered worthy and what kinds are not. Students are rewarded by how well they learn their lessons. Thus, by the time they become professional researchers, they have accepted the

basic orientation of their discipline and department. If they have not, then they are not promoted, or tenured (Fugimoto and Fisk, 1978).

Surveys of the motives for choosing research projects, conducted at the University's Davis campus reveal that the major determinant for selection of research is the availablity of funds (Fugimoto and Fisk, 1978). Academic departments receive sufficient funds to cover salaries of permanently employed researchers, but much of the support for the research itself, including the costs of laboratories, research assistance, any other apparatus required, must be obtained from other sources, whether from private industry of from government grants. Thus, the allocation of this "soft" money plays a major role in determining how the researchers will use their time.

One study of this process found that Marketing Orders (which are associations of growers, authorized by law) are permitted to tax the output of their industry for the purpose of conducting research and carrying out promotion. These marketing orders contribute roughly five percent of the agricultural research budget of the University, but since these funds are available to support the acquisition of needed research facilities and assistance, they carry considerably more weight than this small sum would imply (Fugimoto and Kopper, 1975).

There are other, less important incentives that serve to complement these mechanisms. One of these is a positive incentive of particular importance to agricultural engineers. If they successfully develop a machine, they can share in the royalties that the University may earn. Another is a negative incentive. If an individual researcher is considered an "enemy" of California agriculture, he can be denied (through informal processes) access to data or other needed supports for his reseach (Van Den Bosch, 1978). Some researchers

have been physically threatened (Goldschmidt, 1978).

Perhaps one of the most subtle and effective means of punishment is to deny an individual access to publish his material in academic journals. Editors are aware of the ideological orientation of the manuscripts, and reviewers can be chosen to insure rejection. Without sufficient publications, promotions can be denied and the researcher eventually is thrown out of the system.

In summary, it is not surprising that farmworkers received so little attention during most of the past 100 years of the University's existence, nor is it a surprise that when the Bracero Program was threatened with termination, University economists provided projections of economic collapse to support the efforts to continue the program (Turner, 1965; Draper and Draper, 1968). Finally, it hardly needs to be explained why the department of agricultural engineering has placed so much emphasis on developing labor-saving harvest technologies. To have done otherwise would have insured replacement of the individual researchers or the demise of the department.

CITATIONS: PART VIII

Baldwin, S., Poverty and Politics, The University of North Carolina Press, (North Carolina, 1968).

Bartlett, R., The Economic Base of Political Power, Free Press, (New York 1973).

Castells, M., The Economic Crisis and American Society, Princeton University Press, (New Jersey, 1980).

Conrad, D., Forgotton Farmers, University of Illinois Press, (Urbana, 1965).

Draper, A. and H. Draper, The Dirt on California: Agribusiness and the University, Independent Socialist Clubs of America, (Berkeley, 1968).

Ferejohn, J., Pork Barrel Politics, Stanford University Press, (Stanford, 1974).

Fisk, E., "Rural Development at the University of California: Perspective, Practice & Prospects," unpublished paper, Dept. of Applied Behavioral Sciences, University of California, Davis, 1977.

Fisk, E., "From Communities to Commodities: The Private Domination of Agricultural Research Policy in California 1942-1948," paper presented at the annual meetings of the Rural Sociological Society, San Francisco, California, September, 1978.

Fugimoto, I. and E. Fisk, "What Research Gets Done at Land Grant College: Internal Factors at Work," paper presented to the annual meetings of the Rural Sociological Society, San Francisco, California, 1975.

Fugimoto, I. and W. Kopper, "Outside Influence on What Gets Done at a Land Grant School: Impact of Marketing Orders," in U.S. Congress, Senate, Subcommittee on Administrative Practice and Procedure of the Committee of the Judiciary, Priorities in Agricultural Research of the U.S. Department of Agriculture, Part 2, Appendix, 95th Congress, 1st Session, 1978.

Gold, S., et. al., "Recent Developments in Marxist Theories of the Capitalist State," Monthly Review, Oct., 1975.

Goldschmidt, W., As You Sow, Allanheld, Osmun (New Jersey, 1978).

Hawley, E., "The Politics of the Mexican Labor Issue, 1950-1965," Agricultural History, Vol. xl, no. 3, (July, 1966).

Lowi, T., The End of Liberalism, Norton & Co., (New York, 1967).

McConnell, G., The Decline of Agrarian Democracy, University of Califonia Press (Berkeley, 1953).

McConnell, G. Private Power and American Democracy, Alfred Knopf (New York, 1964).

Niskanen, W. Bureaucracy and Representative Government, University of Chicago Press (Chicago, 1973).

O'Connor, J., The Fiscal Crisis of the State, St. Martins Press (New York, 1973).

Olson, M., The Logic of Collective Action, Schocken (New York, 1965).

Schrag, P., "Rubber Tomatoes," Harper's, June, 1978.

Selznick, P., TVA and the Grass Roots, University of California Press, (Berkeley, 1949).

State of California, Agricultural Research Study Committee, Report on Agricultural Research in California, presented to the Governor of California and the Fifty-Seventh Regular Session of the California Legislature in Accordance with the Provision of Senate Bill 124, Chapter 144, Statutes of 1945, Parts I and II. Sacramento, California State Printing Office, 1946.

Thurow, L., Zero Sum Society, Basic Books, (New York, 1980).

Turner, W., "No Dice for Braceros," Ramparts, Vol. 4, No. 5, Sept. 1965.

Van den Bosch, R. The Pesticide Conspiracy, Doubleday (New York, 1978).

PART IX

CONCLUSION

We can now use the information derived from the case study developed above to extract a set of guidelines useful to advance the development of a theory of the political economy of technological change in agriculture that could be proposed as an alterantive approach to the theories of induced innovation and of the technological treadmill. These guidelines are evidently conditioned upon the particular case study chosen -- the mechanization of harvesting in California canning tomatoes -- so that their validity will have to be confirmed by other studies of technological change in the context of political economy.

****

(1) A critique of the market theories of technological change -- induced innovation and the technological treadmill -- has been advanced for Latin America by Pineiro, Trigo, and Fiorentino (Food Policy, August 1979), based on the idea that market mechanisims do not operate in the Third World. Consequently, they suggested that the process of technological change in Latin American agriculture needs to be understood in terms of political economy and the role of the state. Owing to the highly unequal distribution of political power in these societies, they look at the state as having minimal autonomy and as being a captive instrument of specific interest groups in a "Balkanized" fashion. These groups are, in turn, able to direct unilaterally the public sector towards satisfying their particular technological demands.

Our study of technological change in California agriculture sugggests that the general criticism advanced by Pinero et. al. is equally valid for the advanced countries, even if the state mechnanisms affecting California are very different from those of Latin America. The market analysis of technological change at best captures the visible epiphenomena of the underlying social processes while leaving these social processes unexamined. In a sense, these conventional theories are merely the "reduced form" expressions of a structural model that might be employed to explain social processes and that, consequently, need be formulated in terms of political economy.

(2) A theory of the political economy of technological change must rest on an analsis of conflict between social groups and classes as the most important dynamic force in society. Technology arises out of efforts of some groups or classes to assert control over others. This approach is in direct contraposition to the postulate of social harmony which underlies the market theories of technological change: in those, technological adjustments to price signals are said to lead to fair returns to factors of production (in the sense that each factor is rewarded according to its marginal productivity) and competition is the process whereby inequalities of factor rewards are equalized through reallocation of resources.

We have seen in the present case study that the conflicts between capital and labor and between different fractions of capital, and the way in which these conflicts materialize at the level of the state, are essential determinants of the rate and bias of technological change. In the conflict between capital and labor, the mechanization of harvesting was introduced as a means of both controlling the labor prcess and counteracting the rise in wages resulting from a conjuncture of growing labor scarcity (end of the Bracero Program) and rising wages (unionization of farm workers). By pacing the rate of work of harvest

crews, mechanization allowed the elimination of piece-rate incentives and supervisory expenses; by substituting unskilled female labor as sorters on the machine for semi-skilled male pickers, it also permitted access to a cheap and docile labor pool. Under the continued pressure of unionization and higher wage demands, the introduction of electronic sorting was able to create a substanital reduction in labor use without compensatory employment increases in other sectors of the economy.

The conflicts among branches of capital -- growers, processors, banks, and merchants — over the control and appropriation of the agricultural surplus and the suprplus created by technology are also key determinants of the rate and bias of technological change. This occurs in a context which is neither one of "coordination" in an agribusiness system as claimed by Goldberg, nor one of functional domination of industry over agriculture as conceptualized by Friedland. A more useful approach is to understand the relations among branches of capital in the context of conflict and decentralized adjustments. While the mechanical harvester was thus developed and disseminated in a joint effort by growers, machine companies, processors, and bankers to counteract labor demands and the potential loss of the tomato industry to Mexico, the technological changes also enhanced conflicts among these actors: the rate of displacemnt of small by large growers was accelerated; concentration of production reinforced the bargaining capacity of growers with processors; increased specialization of the product raised the importance of contracting and, eventually, led to increasing appropriation by growers of processing facilities under cooperative arrangements.

(3) Because the state plays such an important role in the generation and diffusion of agricultural technology, a theory of political economy of technological change must incorporate a <u>theory of the state</u>. Of particular

importance is for the theory to explain the trade-offs and complementarities among economic and technological policies. In our case study, public policies favorable to mechanization only came about once policies influencing the orgaization and control of the supply of labor became inapplicable.

As we have seen above, the primary concern of the state in specialty crop production was, until the early 1960's, the regulation of labor supply in order to insure low wages and reliable delivery of harvest crews. This orientation of public policy owed to the fact that control over labor was politically feasible as it had a long history and a large support system in the local political economy of California. Furthermore, this set of policies was economically effective for agricultural labor markets could be successfully segmented from the rest of the economy and replenished through entry of foreign migrants. By contrast, the development of a mechanization alternative appeared as more complex and uncertain since it required high costs, a long gestation period, and coordination of numerous research efforts. For growers, mechanization implied high fixed costs and hence greater risks, as well as increasing subordination to industrial capital. For processors, it implied lower product quality and the need for investment in different methods of handling and processing. Mechanization thus displaced the arena of conflict from the relation of capital and labor to conflict within the capitalist class.

(4) The theory of the state used as part of a general theory of the political economy of technological change must explain not only the trade-offs and complementarities between technological and economic policies, but also the <u>degree of relative autonomy of the state</u> in handling the technological question. That is, the theory must deal with the question of the degree to which state policy reflects the particular interests of certain groups or the more general interests of the society as a whole. What can be observed from the above

case study is that the degree of autonomy of the state regarding mechanization is both different at different levels of government and has been increasing over time toward greater autonomy from grower interests.

At the level of the State of California, agricultural interests appear to have had historically a strong instrumental hold over the state apparatus. This resulted in the capacity to orient land, water, labor, and technological policies ery much in the favor of these interests. But these policies are circumscribed by limits imposed by the federal system of government, and at that level, the state has either enjoyed greater autonomy or responded instrumentally to dominant interests beyond those of California agriculture. Thus, California agricultural interests have been involved in a constant struggle to maintain favorable national labor policies, without lasting success as evidenced by the anti-Chinese Exclusion Act, the Immigration Act of 1924, and finally the loss of the Bracero Program in 1964. The recent USDA prohibition of the use of federal funds to support research on labor-saving mechanization is another indication of the limits of instrumentalist politics at the level of the Federal government.

The relatively greater domination of State and local government by agribusiness however appears to be diminished by events of the past decade. The "one-man-one-vote" ruling of the mid-1960's reduced the power of rural constituents and gave more power to urban interests at all levels of government. Urban liberals, allied with organized labor in industry, did much erode the power of agribusiness over rural labor in the 1960's and, now, as a result, labor legislation has spread to agriculture. Similarly, environmentalist interests have become increasingly powerful and promote other demands with which agribusiness must deal, even at the level of California and local politics. The recent California Agrarian Action Project suit against the University of California's research on mechanization was fundamentally organized

by urban groups. Thus, even where agricultural interests had their most secure hold over the policy process, recent events indicate a break down in the power of these special interest groups and, at least, a displacement of instrumental dominance away from merely local agribusiness interests.

(5) A political economy of technological change needs also to incorporate the law of uneven development. While deprived of much predictive power, this law is useful in understanding how the dialectic of contradictions negates the linear evolution of society. In capitalist society, in particular, where both the generation and appropriation of surplus is based on exploitative relations, the contradictions implied by these relations and the reactions they engender lead to uneven development. In our case study, we observed that technological change both occurred in the context of and reinforced uneven development among crops, stages of production, producers, and regions.

Thus, we saw that in California, the responses to the labor crisis of the early 1960's were quite varied among crops. Lettuce and citrus growers met the crisis by reorganizing the labor process to allow for higher wages. Labor rationalization schemes allowed them to stabilize the labor force, reduce needed employment, and raise productivity by at least as much as wages. Continuous employment was thus provided to a small number of highly paid workers. Strawberry growers, by contrast, adjusted to the labor crisis by converting farmworkers into sharecroppers. The institution of sharecropping did not serve the usual purpose of capturing the totality of family labor, including that of women and children, but instead served as an intermediary access to the secondary labor market as the sharecroppers, in turn, recruited cheap Mexican illegals and relatives. For other crops, like asparagus, local adjustments to higher wages were not possible and the activities were moved to Mexico where cheap labor was available.

The case of canning tomatoes, like the earlier example of sugar beets, provides an instance where higher labor costs were met through labor-saving mechanization. The effect on labor costs resulted from both sharply reduced labor needs and from the use of a different secondary labor force of women and youth whose work was being deskilled and paced by the machine.

Uneven development also occurred among stages of the production process and this had sharp implications for the structure of the labor market. Some stages of production of specialty crops were easier to mechanize than others: the preparation of the soil and cultural practices were mechanized early while harvesting of tomatoes had remained manual. The result was a concentration of labor requirements for very short periods of the production cycle and the consequent need to rely on a highly seasonal and abundant labor force. The labor structure of California agriculture thus became transformed into a combination of family and corporate enterprises with a minimum number of permanent employees to perform the mechanized and supervisory tasks and a seasonal labor force of semi-proletarian Mexican peasants to insure the harvest. It is this sharp peak of seasonal demand that became compromised by the termination of the Bracero Program and for which a variety of alternative solutions had to be devised.

We have also seen evidence of the law of uneven development at work in the evolution of state policy toward immigrant labor. The mechanization of the cotton harvest in the 1950's freed producers in Texas and other cotton-growing states from dependence on the Bracero Program, and consequently, political support for the program was gradually based on non-mechanized specialty crops. Moreover, because specialty crop production was increasingly concentrated in California during the 1950's and 1960's (because of changes in transportation technology and the particular requirements of processors), most of the political support for the Bracero Program came from only California. Without a broader

national constituency, the Bracero Prorgram ceased to be politically viable.

Finally, we have seen that uneven development occurred among regions and growers. California's dominance in the canning tomato industry was reinforced by mechanization. Tomato producing regions in the Midwest were eclipsed by this technological development. Within California, large growers in the southern part of the San Joaquin Valley, whose land had been recently irrigated with heavily subsidized water, were in a position to make use of the new machines and were the main beneficiaries of the technology among California growers.

(6) Since the public sector play an important role in the generation of agricultural technology, a theory of the political economy of technological change must also contain a theory of decision-making in public research institutions and of the interactions of these institutions with both the public and private sectors involved in technological research and development. we have touched on several important aspects of such a theory in our own case study.

One is the nature of the external and internal control mechanisms that bear on the definition of the activities of public research institutions. We have seen that these institutions tend to respond effectively to the needs and desires of the dominant social groups, even though they apparently enjoy a substantial degree of autonomy. This relationship occurs partially through the budgeting process. On the one hand, the executive and legislative branches of government can make special appropriations to the University's budget in order to put it to work on specific issues, such as agricultural mechanization in the early 1960's. On the other hand, private donations for particular research activities, even if in relatively small amounts, have large internal multiplier effects since they divert the use of fixed costs by covering some of the variable cost of research. These private interests are consequently able to

orient the course of agricultural research to their own benefit. The other mechanism by which this occurs is through internal socialization rules, promotion criteria, and the quest by researchers of personal financial gain.

Other aspects of public research that were evidenced by this case study are the interactions between biological and mechanical research and between public and private sectors. Thus, the University was brought into research on tomato harvesting through its development of new varieties of tomatoes amenable to mechanical handling. Engineering research was undertaken in order to adjust the mechanical properties of the harvester to the specific features of the new tomato plants. This points out that role of the public sector in agricultural research remains essential when coordination among different branches of research must be insured. According to our case study, the future evolution of agricultural research would thus appear to be one where there is increasing privatization of specialized applied research (machinery, patents on seeds), where the public sector's role remains fundamental in basic research and for the development of complex technological packages, where direct instrumental control of agribusiness interests over State funded research is increasingly challenged by urban-industrial groups, and where Federal control remains the instrument of relative autonomy of the State in dealing with broader economic and political issues.

(7) This distribution of welfare gains from mechanization of tomato harvesting evidences the fact that the market theories of technological change which limit the relevant social actors to Schumpeterian farmers and responsive scientists are definitely insufficient. On the contrary, an adequate theory of the politcal economy of technological change needs to incorporate a much broader spectrum of social agents and specify the nature of their conflicts and common interests. In this particular case study, the role of consumers in

the process of technological change and the benefits to them of the change were quite irrelevant due to the relative unimportance of processed tomatoes in consumers' budgets and their more general lack of political organization, especially with regards to the policies affecting agriculture. By contrast, growers, processors, suppliers of agricultural inputs, and bankers all had actively influenced the generation and diffusion of the innovation through their political organizations, which took a great interest in the mechanization of tomatoes. These fractions of capital could influence machanization policy because they did not meet opposition from consumers or from industrial employers (since mechanization did not threaten real wages or industrial profits) and, because of the lack of effective union organization of agricultural workers, they did not meet opposition from labor. Thus, when faced with the serious political threats posed by industrial labor to the continuation of the Bracero Program, these interests had to turn to the mechanization strategy.

In handling the labor crisis via mechanization, the barriers these fractions of capital faced in the early 1960's were both overcome and recreated under new forms. It is also this dialectical transformation of barriers, and the conseqent social and technological dyanamic that it creates, that an adequate theory of technological change must incorporate. Here, new contradictions are emerging as a consequence of concentration of production and increasing organization of growers in relation to processors; relocation of domination over agriculture from industrial (processing) to merchant capital; increasing dependency on energy-intensive solutions in an era of energy crisis; increasing competition with industry for access to a minority of skilled workers; and weakening of labor segmentation and anti-union mechanisms of labor control. Created or reinforced by mechanization, these contradictions also set the background for new advances in agricultural technology.

APPENDIX ON FARM LABOR IN CALIFORNIA

Because of the nature of the agricultural labor process, it is difficult to measure or quantify. There are thousands of farmers who employ labor, there are hundreds of thousands of individuals who do some amount of farm work during the year, usually on several farms for short work periods. Many of these farmworkers are foreign to the U.S. and are not aware of their rights; in the past, farmworkers were the object of hostitity by the mainstream society and hence tried to keep a low visibility. Today, many of the workers are apparently illegally in the U.S. and are even less interested in having their presence known. In short, even today, with all of the sophisticated survey proceedures of the government, we do not have a very complete understanding of who performs farm labor, what they are paid, how long they work, how long they remain in agriculture, etc. It goes without saying that our understanding of the farm labor markets of the past decades must be even less complete, given the lack of any major effort to survey this labor force. We therefore must depend on partial surveys, on educated guesses, on incomplete government records, on testimony, etc. to gain an understanding of who performed the farm labor. That is the purpose of this appendix.

The Chinese

The first Chinese immigrants to California began arriving during the late 1840's, in response to work opportunities in the gold mines. Later they were recruited by the railroads to help in the dangerous work of completing the

transcontinental railroad through the Sierra Mountains. The Census of Population indicates that by 1860 there were approximately 35,000 Chinese in California, of which 33,000 were male. Net immigration continued to increase the size of the population, so that by 1880 it had reached a peak of about 75,000. With the passage of the Exclusion Act, the population began to decline and by 1900 it was down to 46,000.

While the Chinese never amounted to more than 10 percent of the State's population, there is considerable evidence that they contributed more than proportionately to the agricultural labor force. The Census of 1870 found that only 10 percent of those reporting agricultural work were Chinese, though this estimate very likely understates their importance. During the debates over the Chinese Exclusion Act we find references to "surveys" of the farm labor force indicating that the Chinese provided at least 80 percent of the seasonal labor. These studies may have confused the importance of the Chinese in some specific labor-intensive crops with their overall contribution to the entire agricultural system. Most believe that a reasonable estimate of the Chinese contribution in the 1880's was about 50 percent of the seasonal, hired labor force (Fuller, 1940, p. 131). The Chinese continued to play an important role, even after the Exclusion Act, though by the beginning of the 20th Century, they had become a minor part of the agricultural labor force.

The Chinese farmworkers performed the most difficult tasks that paid the lowest wages. Thus, while there is considerable testimony that they were paid a much lower wage that whites, at least part of this difference can be accounted for by the kinds of jobs performed. Fuller believes that the discount in wages was less than 20 percent, when the nature of the work is taken into account (Fuller, 1940, p. 121). The most important advantages of the Chinese to their agricultural employers were that they would accept temporary and difficult work,

perhaps at at a lower cost than what white labor would have implied, and also, that they would accept much less expensive room and board. Fuller estimates that they chinese workers cost one third less for room and board than their white counterparts (Fuller, 1940, p. 133).

The Japanese

While we lack precise information as to the number of Japanese in California, we know that in 1900 the Census found only 24,000 in the entire United States. By 1909 this number had increased to well over 100,000 of which it is estimated that about half lived in California (State of California, 1936, p. 20). Thus, these data indicate that the immigration of Japanese workers was substantial during the first decade of the 20th Century. Because of growing anti-Japanese hostitility, the U.S. government was forced to negotiate a "gentleman's agreement" with the Japanese government to stop further immigration from Japan. In return the U.S. promised to treat Japanese in the U.S. more fairly (Matsui, S., 1922, p. 73). This agreement effectively reduced immigration from Japan, but Japanese immigrants from Hawaii, Mexico and Canada continued to enter the U.S. until 1924, when the Immigration Act specifically excluded all Japanese-born immigrants.

According to immigration records there were about 80,000 more Japanese migrating to the U.S. than away from it between 1909 and 1924. Most of the immigrants came from agricultural regions in Japan and naturally gravitated toward farming, at first as farm workers and later as farmers. The movitation behind these immigrants in coming to the U. S. was to repay family debts (Ichihashi, 1932, p. 67). By 1909 it is estimated that as many as 30,000 Japanese were employed as laborers in California agriculture -- this probably represent the peak year for Japanese labor. A 1910 survey of 2,400 farms by the

California State Bureau of Labor Statistics found that 47 percent of the hired labor force were white, 42 percent were Japanese, 4 percent were Chinese, 3.5 percent were Mexican, and 3 percent were of other minorities (see Fuller, 1940, pp. 158-160).

Japanese workers played particularly important roles in labor-intensive crops. Thus, according to another survey, by 1910, 86 percent of all labor in berry production was Japanese, as was 54 percent of labor picking grapes, 66 percent of all labor in sugar beets, 47 percent of of vegetable pickers, and 46 percent of deciduous fruit labor (State of California, 1936, p. 24). It thus is very apparent that the Japanese had become an extremely important component of the agricultural labor force.

Just as with the Chinese, the Japanese were initially willing to accept lower wages in order to find employment. The U.S. Immigration Commission reported that Japanese wages were approximately equal to those of the Chinese, though substantially below those of the whites (Fuller, 1940, p. 165). Strong Japanese labor contractors were responsible for improving the wages of the Japanese, and by 1920 it is reported that white and Japanese wages were equal, although by this time the number of Japanese workers in the fields had been reduced to half the number working in 1909 (Fuller, 1940, p. 166; Matsui, 1922, p. 73).

The Mexicans -- Pre-1930

California farmers had rejected the Mexican as a possible source of farm labor on the grounds of his alleged unwillingness to work hard. The Chinese worker had always been held up as the ideal worker, and when labor shortages developed during World War I, California farmers went to Washington to plead for permission to begin importing more Chinese workers. They were unsuccessful in

their efforts, and only then did they turn to Mexican workers. Mexicans had first been used by the railroads in the Southwest in building new roads. The primary advantage of Mexican workers was the low wages at which they were willing to work. In 1909, Mexicans were employed for $1.00 per day, cheaper than the going rate of $1.25 to $1.45 paid to members of other races at that time (State of California, 1936, p. 26).

There are no reliable data on the rate of immigration of Mexicans to California, although according to a report to the State of California, the number of persons born in Mexico and residing in California grew from 7,000 in 1890 to 34,000 in 1910 to 89,000 in 1920 (State of California, 1936, p. 28). By 1930, the Census of Population indicated that over 368,000 persons of Mexican origin were living in California, making them the largest minority group with over 6.5 percent of the entire population. We do not know the proportion of workers employed in California agriculture; one indicator of the rising importance of Mexicans in agricultural labor comes from the changing ethnic composition of the labor camps run by California. In 1915, only 7 percent of all inhabitants of these camps were Mexican. By 1930, close to 30 percent of the inhabitants were Mexican (State of California, 1936, p. 29). During the 1930's, Mexicans were not needed in the fields and efforts were made to send them back home. As we shall see, after 1942 the use of Mexican labor again became important to California.

Post-War Labor Force

As pointed out at the outset, we lack detailed data on the composition of the agricultural labor force, even today. At the time of the termination of the Bracero Program in 1964, however, the State of California commissioned a detailed survey of the labor force in order to support its claimed need of continued Bracero labor. This survey was a systematic sample of the 1965 agricultural labor force -- this was the first year without large supplies of Bracero labor. Because this sample represents the only detailed analysis of this labor force, we present some of the important conclusions to illustrate the nature and socioeconomic characteristics of the highly mechanized agricultural system that emerged after World War II.

Table A1 illustrates the important components of the labor force. As can be seen, of the entire hired labor force, the average employment of seasonal, temporary workers is roughly equal to the employment of permanent workers. It is this seasonal group that is of immediate interest, since it corresponds to that part of the labor pool with which this study has dealt. The seasonal workers can be subdivided into a relatively small number of workers who enter agriculture only at the peak season, in search of very temporary employment, and a larger group that searches for employment (often unsuccessfully) most of the year. The first group consists of students, housewives and others attempting to supplement a family income; the second group consists of individuals who are primary wage earners, whose only activity is farm labor, and who depend on their earnings for survival. This latter group we can call the "full-time" seasonal labor force.

During the years of the Bracero Program, an important part of this seasonal labor force was made up of contract workers from Mexico. As can be seen from Table A1, a relatively large portion of the labor force came from this source. However, the true importance of Bracero labor is understated in this

table, because Bracero workers filled a very specific role in the overall labor process. That role was to fill the peak demand for labor, which lasted only a short period in any single crop. Therefore, if we were to look at the importance of Braceros at the peak week, we would find that Braceros supplied roughly 85 percent of peak harvest labor in tomatoes; 69 percent of peak labor in strawbrries; 79 percent of peak harvest labor in lettuce; 44 percent in melons; 70 percent in lemons; and important percentages of orange, celery, sugar beet, grape, aspargus, and cotton labor requirements in 1963 (see Table VI.1). Not only does Table A1 fail to indicate the true importance of the Bracero worker to California agriculture, but also it gives a distorted view of the number of workers that actually participate in the industry. That is, because the numbers on this table refer to the average annual employment, they both miss the peak employment and they fail to capture the importance of seasonality in the labor process. These numbers refer to the number of jobs, not to the number of individuals employed over the year. Because a job is arbitrarily defined as a given number of hours of available work per month, or per year, there may be several individuals holding that "job" which is, in fact, a series of short term employments on several different farms, each peformed by a different person. Thus, while the table indicates that only 30,000 foreign contract workers were employed in California in the early 1960's, the actual number of individuals involved was at least 100,000 workers

Further evidence of this discrepancy between the number of jobs and the number of workers is found in the 1965 survey of the farm labor force which found that about 742,000 individuals reported some farm employment in that year, while, the total hired labor force averaged only about 225,000, with a peak employment of 380,000 during the period of one week. Thus in general there are roughly two to three workers for each job.

Table A2 helps to disaggregate the composition of the labor force according to the nature of the commitment to farm work. Of the 742,000 reportng some employment in 1965, those earning $100 or more totalled 486,700. Of this group, 176,500 had less than three months of full employment in agriculture. Many of these individuals with less than three months employment wanted more work than they found. If we subtract from this number those who were students or who derived more than 50 percent of their income from non-farm sources, we still find over 56,000 who depended entirely on agriculture for income. Virtually all of the members of this group could be considered underemployed, since they would have accepted more work, had it been available.

The remaining portion of the full-time seasonal labor force consists of those who were employed for more than three months, but not permanently, who depended on agricultural work for most of their income. This group totalled roughly 271,700 in 1965 (including the 56,000 underemployed workers discussed above).

The significance of this analysis is clear in the income data of Table A2. The earnings of those with between three and ten months's full employment in agriculture were $2,250 in 1965. Comparable earnings for similarly skilled workers in the nonfarm sector averaged about $5,000 in 1965. The rural poverty level was set at about $3,000, so by these two standards, farmworkers were very poorly paid. The 1965 survey also provides evidence on <u>family income</u>, which differs from individual earnings in that families may have more than one wage earner. Of those families surveyed, which excluded students and housewives, who did not head up families, 41 percent had incomes less than the $3,000 poverty level.

Table A3 provides some information on the socioeconomic characteristics of the farm labor force. Thus, in comparison with the nonfarm labor force,

farmworkers are older, with over 60 percent over the age of 35, as compared with 55 percent for the nonfarm sector. Farmworkers are much less educated; median years of education of farmworkers was 7.3 years, as compared with 12.4 years for the rest of the state. Interestingly, the 1965 survey found that neither literacy nor previous training in the specific job had any impact on earnings; if skills can be equated with previous training and experience, we can conclude that skill had little effect on farm earnings (of course, on a piece-rate basis the more experienced workers, who can work faster, may earn more, but this is not reflected in the wage itself). This socioeconomic data indicates the continued dependence on minorities in California agriculture, and particularly on foreign-born workers, even after the termination of the Bracero Program.

Finally, the 1965 survey provides a short analysis of the job histories of the low-income workers within the agricultural labor force. Table A4 summarizes this data for a three year period, with the following results:

Of those remaining in the California labor force, all but about 15 percent remained in agriculture after three years; another 17 percent dropped out of the California labor force altogether.

Second, of those remaining in agricultural employment, roughly 55 percent continued to remain in the low-income (less than $3,000 total earnings) sector after three years. For most of those who improved their agricultural incomes, the increase was of a marginal magnitude.

Third, very small percentages of those remaining in the active California labor force moved into the nonfarm labor markets, and of those who did make this transition out of agriculture, many (46 percent of the Mexican-American, and 25 percent of the whites) did not improve their earnings.

Last, those with the greatest propensity to leave agriculture were the youngest members, and those improving their earnings the most were also the

youngest members, especially young white workers. Generally, a larger fraction of the white workers who left farmwork found high wage employment than did Mexican-Americans. This is consistent with the notion that minorities are more likely to be trapped in farmwork because of barriers such as racial discrimination.

But, even if it is difficult for most workers to leave agriculture, the survey indicates that more than 30 percent of the initial low-income workers were no longer engaged in agriculture after three years. This means that just to maintain its size, at least ten percent more workers must be brought into farmwork each year.

In summary, this evidence supports the contention that there exist important barriers between labor markets, even between markets for unskilled labor. Agricultural workers have been successfully partitioned into a very low wage, low income market; escape is possible, but only a relatively few do find higher wage employment outside of agriculture. Of those who do escape, more than fifty percent improve their earnings; a significantly higher percent improve their earnings than is true of the group that remained in agricultural employment. It should be recalled that the period of this analysis, 1965 to 1968, was characterizedby increased labor organization, improving wages in agriculture, and, presumably, better employment opportunities, given the tight labor conditions that characterized the termination of the Bracero Program. In other words, this should have been a period of relative prosperity for agricultural labor; the depressed incomes and underemployment conditions are therefore all the more profound.

TABLE A1

Annual Average Employment of Farm Workers
California, 1951-1975

Year	Total	Farmers and unpaid family	Hired workers		
			Year around	Temporary	Foreign contract
1951-1955	357,197	118,945	102,872	107,873	27,146
1956-1960	349,580	105,575	105,573	96,485	48,242
1961-1965	318,240	93,880	91,970	106,928	30,551[a/]
1966-1970	293,840	83,156	93,440	116,950	[b/]
1971-1975	284,320	72,500	97,237	114,580	

a/ Average over four years, 1961-1964, since Bracero Program ended December 31, 1964.

b/ Blanks indicate not applicable.

Source: State of California, Farm Labor Report, 1975 (Sacramento, 1976).

TABLE A2

Employment and Earning Characteristics of the California Farm Labor Force, 1965

Description of work force category	Median California earnings	Size of labor force	Percent of all workers	Man weeks contributed	
	dollars			thousands	percent
All reported workers[a]	[b]	742,300	100.0	12,690	100.0
Less than $100 farm earnings		255,600	34.4	250	2.0
More than $100 farm earnings	1,388	486,700	65.6	12,440	98.0
All workers surveyed (full employment)	1,388	486,700	100.0	12,440	100.0
Less than 3 months	510	176,575	36.3	1,007	8.1
3-10 months	2,250	198,184	40.7	5,045	40.6
More than 10 months	4,255	111,941	23.0	5,388	43.3
All Mexican-American and Mexican workers (full employment)	1,472	218,200	45.8	5,037	40.5
Less than 3 months	512	78,660	36.1	455	9.0
3-10 months	2,350	100,840	46.2	2,760	55.0
More than 10 months	4,051	38,700	17.7	1,812	36.0
All Anglo, Filipino, and other workers (full employment)[c]	1,320	262,812	53.8	6,403	50.5
Less than 3 months	500	97,587	37.1	552	8.6
3-10 months	2,100	91,984	35.0	2,275	35.5
More than 10 months	4,365	73,241	27.9	3,575	55.8
All students (full employment)	443	83,300	17.1	462	3.7
Less than 3 months	430	68,970	82.8	369	79.9
3-10 months	1,800	13,430	16.1	51	10.4
More than 10 months	2,500	900	1.1	45	9.7
All migrant workers, intra- and interstate (full employment)	1,624	145,000	30.0	3,404	26.8
Less than 3 months	630	37,120	25.7	257	7.5
3-10 months	2,450	90,680	62.4	2,354	69.3
More than 10 months	3,865	17,200	11.9	793	23.2
Workers with less than $1,000 California earnings		201,980	41.5	1,838	14.5
Mexican-American and Mexican workers' earnings		84,225	41.7	629	34.2
Anglo, Filipino, and Black workers' earnings		117,755	58.3	1,209	65.8
Workers with $5,000 and more California earnings		36,989	7.6	1,784	14.1
Mexican-American and Mexican workers' earnings		9,500	30.0	452	25.4
Anglo, Filipino, and Black workers' earnings		27,489	70.0	1,332	74.6
Workers reporting partial employment[d]		372,812	76.6	1,000	8.0
Total available labor force (full employment)[e]		486,700	100.0	20,140	100.0
Less than 3 months		66,500	13.7	532	2.5
3-10 months		124,600	25.6	4,645	23.2
More than 10 months		295,600	60.7	14,963	74.3

(Continued on next page.)

TABLE A2—continued.

a/ The survey was based upon state disability records. Not all workers are recorded in these records because employers may not accurately report all hired workers; nevertheless, this is the most complete source of information regarding the number of individuals hired (see Appendix A for a current example of these reports).

b/ Blanks indicate no data available.

c/ The percentages of these ethnic groups in the total labor force are as follows: Anglos, 43.7 percent; Blacks, 3.3 percent; Filipinos, 3.4 percent; other Oriental, 2.1 percent; and American Indian, 1.3 percent. Therefore, the estimates of this group refer mainly to the Anglo farm workers.

d/ The definition of partial employment is any week worked three days or less. All but 23.6 percent of the workers surveyed had, in addition to full employment earnings, some amount of partial employment, though most of it was less than two months (only 14 percent of all workers reported more than two months of partial employment). Earnings from this employment are included in the median income estimates given in the first column of the table.

e/ These estimates are based upon labor force participation rates, that is, the number of weeks of the year the individual worker reported himself in search of work.

Source: Advisory Committee on Farm Labor Research, The California Farm Labor Force: A Profile, Report to the Assembly Committee on Agriculture, prepared by Cheryl Petersen (April, 1969).

TABLE A3

Socioeconomic Characteristics of the Farm Labor Force in California, 1965

Sex	Percent
Male	78.1
Female	22.0

Ethnicity	Percent
Anglo	43.7
Mexican-American	45.6
Black	3.3
Filipino	3.4
Other Oriental	2.1
American Indian	1.3

Age	Percent
Under 20	22.9
20-24	12.1
25-34	16.5
35-44	19.2
45-54	12.5
55-64	11.9
65 and over	5.0

Median age: 34 years

Education	Percent
None	5.6
Grades:	
1-7	32.5
8	13.0
9-11	16.9
12 or higher	14.6
Still in school	17.3

Median years of education for those out of school: 7.3 years

Household status	Percent
Head of household	42.0
Member of household but not head	42.4
Lives alone	15.6

Family size (number of persons)	Percent
1	30.1
2	18.4
3	12.1
4	12.5
5-6	15.4
7-8	6.6
9-10	3.4
11 and more	1.5

Median size: 2.2 percent

Family wage earners	Percent
1	71.0
2	23.5
3	3.1
4 or more	2.4

Family income distribution	Percent
Less than $1,000	7.5
$1,000-$1,999	14.5
$2,000-$2,999	18.9
$3,000-$3,999	20.2
$4,000-$4,999	13.9
$5,000-$5,999	9.3
$6,000-$6,999	6.1
$7,000-over	9.6

Median income: $3,444

Source: Advisory Committee on Farm Labor Research, The California Farm Labor Force: A Profile, Report to the Assembly Committee on Agriculture, prepared by Cheryl Petersen (April, 1969).

TABLE A4

Low-Income Farm Worker Employment and Earnings Histories, Mexican-American, Mexican, and Anglo Workers, Selected Age Groups, 1965-1968

	Mexican-American and Mexican				Anglo			
	Age group				Age group			
	All	Under 24	24-44	45 and over	All	Under 24	24-44	45 and over
Total number of each group in sample	413	123	163	127	192	37	59	96
Percent in each group	100.0	29.0	40.0	31.0	100.0	19.0	31.0	50.0
Total percent of each age group of low-income worker in 1965[a]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percent remaining in low-income farm work after three years	29.1	15.5	34.0	36.1	28.0	16.2	16.7	40.2
Percent in short-term agricultural employment earning less than $1,000 after three years	12.9	17.1	9.3	13.4	14.4	10.8	20.0	12.4
Percent in farm work employment earning more than $3,000 after three years	26.0	24.4	31.5	20.5	21.7	18.9	23.3	21.6
Percent remaining in all kinds of agricultural employment after three years	69.0	56.9	74.8	70.1	64.1	45.9	60.0	74.2
Percent in low-income (less than $3,000) nonfarm employment after three years	6.8	11.4	3.1	7.1	3.7	10.8	5.0	0.0
Percent in nonfarm employment earning more than $3,000 after three years	8.7	15.4	8.6	2.4	13.4	32.4	13.3	6.2
No longer in California labor force after three years	16.5	16.3	13.6	20.5	18.7	10.8	21.7	19.6
Percent who improved their income after three years	34.7	39.8	40.1	23.0	35.1	41.3	36.6	27.8

a/ The sample of farm workers was selected from the larger sample surveyed in 1965 as reported above. The definition of "low income farm worker" used to determine the sample was individuals earning more than $1,000 but less than $3,000. Female workers, students, and nonfarm workers doing occasional farm work were excluded.

Source: California Department of Human Resources Development, The Low Income Worker in the California Farm Labor Force, a supplement to Advisory Committee on Farm Labor Research, The California Farm Labor Force: A Profile, Report to the Assembly Committee on Agriculture, prepared by Cheryl Peterson (April, 1969).

CITATIONS FOR APPENDIX

Fuller, V., "The Supply of Agricultural Labor as a Factor in the Evolution of Farm Organization in California," Ph.D. dissertation, University of California, Dept. of Agricultural Economics, Berkeley; printed in U.S. Congress, Senate, Committee on Violations of Free Speech and Rights of Labor, Pt. 54, 1940, Washington, D.C.; U.S. Government Printing Office.

Ichihashi, Y., Japanese in the United States, Stanford University Press, Stanford, California, 1932.

Matsui, S., Economic Aspects of the Japanese Situation in California, unpublished Master's Thesis, University of California, 1922.

State of California, State Relief Administration, Migratory Labor in California, prepared by M. Lewis, Special Surveys and Studies Division, San Francisco, California, 1936.

University of California, Division of Agricultural Sciences, California Agricultural Labor Requirements and Adjustments, September, 1964.

FECHA DE DEVOLUCION			


IICA
PM-223
MECHANIZATION IN CALIFORNIA AGRICULTURE: THE CASE OF CANNING TOMATOES.
Autor
Título
Fecha Devolución
Nombre del solicitante