REPLACING PEOPLE WITH PETROLEUM:

ENERGY AND LABOR IN U.S. AGRICULTURE, 1900 TO 1978

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ABSTRACT

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In this century, American agriculture has undergone a rapid transformation. While it is widely recognized that the introduction of energy inputs into agricultural production processes has entailed the large scale displacement of farm labor, little attention has been paid to the process involved in the substitution of inanimate energy for human energy. The basic task of this project is to address this shortcoming by examining the historical development of the energy/labor relationship in U.S. agriculture from 1900 to 1978.

The energy/labor relationship in U.S. agriculture is explored through the use of census reports, government surveys and other sources of documentary data. The findings of this investigation are organized into three sections - information on the structural transformation of agriculture, data on the changing use of energy and labor, and an examinataion of the relationship of energy and labor in specific commodity production systems.

The study concludes that while energy has displaced labor, i.e. reduced the number of farm units needed to

produce the nation's food and fiber, the relationship between energy and labor in farm production is not linear. While energy did play a role in removing farm family members from production, the role of hired farm labor was strengthened. In addition, energy and labor intensity vary by commodity production systems. Both high and low energy intensities are found in production systems with high labor intensities, thus energy does not simply replace workers in agricultural production.

For the E-Team:
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who taught me patience.

And for
Butch and Edna
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Chapter One:
INTRODUCTION

What is the role of energy in agriculture? Concern with this question has emerged from a wide variety of areas and interest groups. A growing body of literature attempts to document the extent and effect of the increasing reliance of United States agriculture upon nonrenewable energy inputs. While there is wide recognition that one of the major impacts within the transformation of American agriculture to its present capital and energy intensive structure has been the large scale displacement of farm labor, little attention has been paid to the process involved in the substitution of inanimate energy for human energy. The basic thrust of this project is to address this shortcoming by analyzing the historical development of the energy/labor relationship in agriculture. The following questions provide guidelines which focus this inquiry:

1. The overall structure of agriculture has changed. In what ways? With what effects on the organization of agricultural production?

2. How has the use of energy and labor been affected by the structural transformation? Do energy inputs replace labor? Whose labor, i.e farmers', family farm members', hired farm workers'? What forms of energy?

3. What are the labor consequences for workers both in work opportunities and in the organization of the labor process?

4. Does the relationship between energy and labor vary by sector or farm type? by market size of farm?

These questions are explored through the use of census reports, government surveys and other sources of documentary data to begin unravelling the complexities of the energy/labor relationship in United States agriculture.

Three related themes underlie the analysis of the answers to these questions. The first theme involves documenting the overall historical patterns in agricultural structure and energy and labor use in agricultural production processes. In terms of agricultural structure, facets examined include the commercialization of production, market concentration, and specialization. Within these structural changes, trends in energy and labor are delineated. Energy trends are outlined for mechanical and biochemical energy production inputs. Corresponding information for the same period is presented for agricultural labor. The historical evolution of the magnitude (how many workers), and the composition (whose labor), is drawn.

The second theme involves exploring the relations of agricultural production. Both household (or family) and capitalist relations of production exist in U.S. agricultural production. The implications of changes in energy and labor inputs are explored both in terms of changes within each form of relations of production and in terms of changes in the distribution of each type of production relations.

Finally, the third theme that underlies the analysis in this project, is the specification of the relation of energy and labor in commodity production systems. Differences in structure, energy, and labor use are explored for farms specializing in the production of different commodity groups.

The project is organized into two sections. The first section, the exploration of existing insights into agricultural production, --contains chapters on agriculture and energy literature, theoretical observations about farm labor processes, agricultural market relations and energy in production; and a section on definitional and data concerns of the project.

In the second section, historical data is compiled to present a picture of the structural transformation of agriculture, the increased use of energy in agricultural production, the changing magnitude and composition of the farm labor force, and the role of labor and energy in specific farm production organization. This section concludes with a discussion of insights gained from the data presentation about the nature of the energy/labor relationship in agricultural production.

Chapter Two:
IS AMERICAN AGRICULTURE ENERGY EFFICIENT: A LITERATURE REVIEW

Three major theoretical perspectives dominate the energy and agriculture literature. Each approach focuses upon different dimensions of energy within agricultural production. The first, energy analysis, is concerned with documenting energy systems. The second, energy economics, focuses upon energy in relation to other production inputs. The third framework, energy structural critiques, asks questions about the relationship of energy use to social structure. As a result contrasting answers to the question, is U.S. agriculture energy efficient, are reached.

Energy Analysis

The economic disruption caused by the 1974 oil embargo and the subsequent dramatic increases in petroleum prices brought energy issues to the forefront in the study of U.S. agriculture. Many questions were raised. What is the role of energy in agricultural production? What impact could be expected from increasing prices and limited supplies of energy, upon the highly mechanized and industrialized farm system? Could increases in yields be maintained? What implications did energy constraints have for agricultural modernization attempts in developing countries? From attempts to grapple with the issues raised by changes in non-renewable[1] energy sources, a dominant perspective, energy analysis, emerged.[2]

While the focus of the studies varies - e.g. the entire U.S. food production system (Hirsh, 1974; Steinhart and Steinhart, 1973, 1974a), specific crops (Smil, 1982; Pimentel, 1973a, 1973b), or regions of the country (Lee, 1977; Patrick, 1977; Lockeretz, 1977) - the emphasis is upon analyzing societal use of natural resources by documenting and measuring energy inputs. Many of the studies focus upon simply specifying the total amounts of energy involved in a food production system. Direct energy inputs such as fuel for tractors and farm transport vehicles and electricity for irrigation and other farm processes, as well as 'embodied' or indirect energy inputs, e.g., the amount of energy involved in producing farm machinery and fertilizers, are calculated and converted to energy equivalencies using a common denominator of BTU's or kilocalories per unit. In their disaggregate form, energy measurements are used to locate areas of potential conservation. When the energy inputs are added, the total energy input can be contrasted with the energy output of the process, e.g., the number of BTU's contained within a bushel of corn. These input/output ratios yield measures of the energy efficiency in agricultural production (Hirsh, 1974; Leach, 1976; Pimentel, 1973).

Together these studies contribute to our understanding of the magnitude and location of energy intensity in contemporary farm production. Yet at this level, the perspective is little more than a description of amount and component elements of energy involved. The studies offer neither insights into the dynamics of the relationships between the elements nor historical illumination of past trends or directions of these patterns.[3]

More promising are the few energy analysis studies that focus upon process, i.e., the historical patterns involved (Heichel, 1980; Pimentel, 1974). One of the most well known is a study by Pimentel (1973b) of the energy input changes in U.S. corn production between 1940 and 1970. By comparing energy inputs and outputs of corn production in two different years, Pimentel is able to outline the relationship between energy intensity and production yields:

> "In 1970, about 2.9 kcal (equivalent to 80 gallons of gasoline) were used to raise an acre of corn. From 1945 to 1970, while corn yields increased about 2.4 fold, the mean energy inputs increased 3.1 fold. Hence the yield of corn calories per one fuel kcal decreased from 3.7 kcal to 2.8 kcal -- a 24 percent decline."(1973b:67)

While corn production has involved increasing quanities of energy inputs, corn yields per unit of energy added have declined. Other attempts to illuminate further the relationship between energy intensity and agricultural yields compare industrialized agriculture with labor intensive systems (Leach, 1976; Pimentel and Pimentel, 1974;

Slesser, 1973). For example, in Chinese rice production 50 calories of food are produced for each calorie of human energy expended; in U.S. rice fields, one-sixth of a food calorie is produced per calorie of energy added (Rappaport, 1967). Observations of this type are offered as supporting the position that increased yields may be obtained from less energy 'wasting'. In a summary of this literature, Slesser found:

> "The greater the intensity the less increase in yield that is obtained per unit increase in energy subsidy."(1973:1199)

In other words, the relationship between energy inputs and productivity is not linear. More energy added does not necessarily mean more food produced.[4]

However, neither the parameters of this relationship nor the process which led to increased energy intensity in U.S. agriculture is investigated. This lack of attention to specifying social relationships underscores an important limitation of this perspective. While energy analysis studies of agriculture provide many insights into the magnitude and location of energy consumption in food production, the framework has several inherent drawbacks for examining social processes. These revolve around the common denominator approach which establishes energy equivalencies in terms of B.T.U.'s or kilocalories for all forms of energy utilized in production. By focusing on composite energy totals, issues of social or physical usefulness are obscured. Energy consumption within agriculture is located squarely in a set of social and physical relationships that determine substitution values and complementary exchanges. Fifty kilocalories of energy from fertilizers is not interchangable with 50K of 'embodied' energy in machinery. Nor can 100 Btu's of sunlight (solar energy) provide the nutrition of 100 Btu's of corn.

The importance of this lack of structural relationships within the framework is underscored in the area of human labor. Human work takes place in a complex context of social relations. The amount and type of labor (human energy) involved in a production process is not a universal given for a set task, but the result of a specific form of economic and technical organization. Indeed, measurement of human labor has been problematic for those attempting to use the energy analysis model. At least five different standards have been used to measure the energy input of human labor into the farm production process:

1)The mechanical or heat energy expended on a given task,

2)The energy equivalence of the food needed to support a farm worker,

3)The food and auxiliary energy needed to maintain a farm worker , 4)The total energy cost of a worker as part of society, and

5)The total energy cost of a worker plus his/her family as members of society (Pimentel, 1983).

Recently, the most common decision, within energy analysis studies, has been not to include the energy component of human labor when calculating agricultural energy inputs (Fluck, 1980; Smil, 1982; Pimentel, 1983). Justification for this omission centers on the negligible part the human labor energy component contributes to the overall total. This apparent measurement dilemma stems from the inability of the perspective to take into account social relations. Of the five methods used to calculate human energy input clearly all but the first, the physical amount of energy expended, are tied to social structure. The cultural context influences everything from the worker's source of calories, i.e. whether you eat steak or rice, to the worker's role in production. Therefore this is not simply a measurement problem but an analytic limitation of the framework. While this perspective can be used to document the centrality of energy in U.S. agriculture (e.g. to answer questions of how much, where and degree of change), the question of why these changes occurred cannot be addressed. Changes in energy use cannot be located within a given social context using this perspective.

Energy Economics

The second theoretical orientation, energy economics, is based upon the inclusion of energy factors into traditional economic analysis. In the work of Berndt and Wood (1975), Dvoskin and Heady (1976, 1977), and Norsworthy and Harper (1980), econometric methodology is used to determine the relationship of energy to the market and other factors in the production process. Much of this literature emerged in response to the absence of market relations within energy analysis literature.[6] These criticisms are summarized by Hill and Erickson:

> "Attempts to evaluate performance of a price-oriented market by measuring ratios of non-price inputs (e.g. calories, BTU's or energy) not only misleads the casual readers, but may result in erroneous policy recommendations....Efficiency comparisons that exclude price relationships ignore the primary function of a market to allocate scarce resources to their most valuable uses."(1976:2)

In direct contrast to energy analysis models, energy economic studies argue U.S agriculture is energy efficient.[7] This efficiency measure is derived by comparing the price of energy inputs to the monetary return. As explained by Hill and Erickson:

> "Substituting chemical fertilizers and fossil fuels for land and labor in agricultural production has been in response to the rate of return per dollar invested per unit of each of these resources."(1976:2)

The low cost of energy relative to other production inputs is the central factor. Low energy prices are also used to explain the development of the contemporary energy intensive structure of U.S. agriculture (Norsworthy and Harper, 1980).

On a macro level, one of the major contributions of this literature has been to document the imbeddedness of energy within agricultural production. As Dvoskin and Heady found in their study:

> "Even a 10% national energy reduction for agricultural production leads to a sharp increase in food costs. However, doubling energy prices results in a much smaller increase in food costs. This phenomena is explained by a very low demand elasticity for energy; since doubling energy prices caused only a 5% reduction in the total energy use in agricultural production." (1977:3)

In other words, energy use in agriculture takes place in a specific structure or organization of production which determines the kind and amount of energy input needed.[8] In order to change the kind or amount of energy used, and maintain the same level of production, the structure must also be changed.

Labor (as a factor of production) occupies a central role in this model. Studies analyzing energy and labor components of farm production have characterized this relationship as one of substitution (Littleman, 1980; Bernt and Wood, 1975). A substitution relationship implies that one factor within a production process can be used to replace another factor. In this context then, more energy in farm production means less labor or vice versa. According to this model, historically low energy prices explain labor reductions in U.S. agriculture. Future projections about labor and energy within agriculture are extrapolated. Norlund and Robson explain:

> "When the price of one factor of production increases relative to others it is to a firm's advantage to substitute the less expensive factor for the more expensive one.... In any case, even though labor costs have been rising during the last decade, it appears energy prices have been rising at an even faster rate. As a consequence, it seems logical to argue that firms will, if possible, substitute the lower priced labor resource for the relatively high energy resources." (1980:55)

Other probable options that have been suggested for farmer facing high energy prices include changing their crop mix to less energy intensive crops (Lehrman, 1976), adopting new energy sources and conservation practices (Gissner and Willet, 1980; Bohl and Russel, 1973), or, conversely, leaving farming (Connor, 1976).

While any of these theoretical predictions is possible their feasibility is constrained by structural factors. Herein lie the limitations of this perspective. An examination based solely upon the price and quantity of energy contains few tools for analyzing structural dimensions. This is especially important in light of the structural constraints of farm production changes that are widely discussed throughout the literature (Norlund and Robson, 1980; Connor, 1976; Dvoskin and Heady, 1976; Bernt and Wood, 1975; Bohl and Russel, 1973). A quotation from Carter and Youde summarizes some of these structural limitations:

> "...the capital stock for agriculture and other basic industries was built during a period when current and expected energy prices were low relative to other production factors. Machines would need to be redesigned with respect to energy consumption. Even if large energy price increases relative to labor and other capital inputs justified a radical retooling, long lead times would be required to change agriculture's technological configuration. Further, the pattern of land ownership and tenancy developed during the last century is not adaptable to labor intensive production, except for limited acreages of high value specialty crops. " (1974: 879)

In other words, the existing technical and political structure of agriculture delimits market choices. In addition some recognition has been given to factors outside farm production processes which constrain farm operators' decisions. Carter and Johnson explicate this dimension:

> "It is our contention that the driving forces effecting future change are coming from outside agriculture rather than from decisions made within. Control relates to control over decisions. There is a steady erosion or shifting of the power structure or control away from the farmer."(1978: 739)

Energy economic models recognize these structural constraints yet can only approach them in terms of supply or price of relative elements of production or in terms of constraints upon market relations. This stems from a lack of recognition that market relations are reflections of larger social relations present in any economic organization. The social dimensions of control are underdeveloped within this model. Every production system has a social basis -- i.e. people organized in specific relations to one another to produce. The dynamics of a system are based in these relations of people to other people -- in a capitalist system, the class relations between workers and capitalists. This broader approach locates social structure in a context of power relations between people. A quotation from Kelly illustrates the implications of this orientation:

> "In class societies, the forces of production develop within antagonistic social relations between the ruling class and the producing class. The ruling class attempts to define the relationship the producers have with one another (acts as a coordinating agency), whereas the producing class attempts to set its own hours, pace of work, division of labor, etc..... The struggle between the ruling and the producing classes over the organization of work, the conditions of work, and the results of work is the key to understanding how a mode of production develops as a historical process." (1977:14)

Thus relations of differential power and control and the resulting conflicting dynamics which are central to understanding changes in social structure are unexamined in a market focus. Market relations are only one part of a production for profit system.

In this context, of underlying social relations, the role of labor within this model merits examination. A focus upon the supply or price of labor yields observations on the reduction of labor within U. S. agriculture. These observations of fewer human labor hours and a reduction in numbers, obscure the social dimensions of this process. Whose labor has been reduced or replaced? That of farmers, or that of hired farm workers? This is an important distinction in terms of control and power. People within each of these social categories occupy different class positions within a system of production. For example, self-employed farmers replaced in agricultural production would be forced to relinquish production control and join the wage labor force. A reduction in the amount of hired wage labor needed would increase the power of farm operators in respect to farm workers in terms of reduced demand and increased control over the production process. In addition, reducing wage labor in the production process improves a farmer's competitive position relative to other farmers. A focus upon market relations provides no conceptual basis to identify or understand these dimensions.

Correspondingly, the issue of how and why the specific capital and energy intensive structure of U.S. agriculture developed as it did is unexamined. Recent studies of organic farms (Oelhaf, 1978; Lockeretz et al., 1976; Kraten, 1979) suggest that farmers who use organic methods - i.e. reliance upon biological controls and inputs rather than chemical fertilizers and pesticides - are able to realize equal if not greater returns on their investments. In conjunction, these studies showed that organic farms tended to use more labor than conventional farming methods. The question, why did the current dominant capital and energy intensive production system develop in the U.S. rather than the more labor intensive yet equally profitable organic methods, cannot be addressed from within an energy economics model.

In summary then, energy economic models contribute to our understanding of the close relationship between the quantity of labor and the quantity of energy in agricultural production. However the underlying social relations involved and the structural dimensions which emerge from these relations are beyond the scope of this perspective.

Energy Structural Critiques

Two of the few attempts to analyze the connection between energy use and social structure are found in the work of Commoner (1968, 1977) and Perelman (1975, 1977). Similar to energy economic models, this perspective focuses upon the relationship of energy to the economic system - production for profit. However, their concerns are very different. Instead of market relations and market efficiency, they propose the criteria of social efficiency, i.e., the rationality of current social organization in relation to human and ecological goals. As a quotation from Perelman explains:

> "A realistic measure of the efficiency of a system must be based upon consideration of its overall impact on the present quality of life as well as its potential for the future."(1977: 3)

Commoner and Perelman attempt to gauge the social efficiency of contemporary agriculture through two different approaches - Commoner through constructing social efficiency measures of different production factors, and Perelman by documenting the social costs of an agriculture based upon production for profit.

Commoner begins his analysis by conceptualizing the connection of energy to social organization. Commoner argues that an understanding of the role of energy in our society can only be gained by using a perspective which accounts for the:

> "... complex interactions among the three basic systems - the ecosystem, the production system, and the economic system- that, together with the social or political order, govern all human activity." (1977:1)

In other words, relationships between the natural resource base, the processes through which resources are converted into products for human use, and the organization for the distribution of those products govern the way energy is used in any given society. According to Commoner, energy plays a central role in these relationships:

> "Energy radiated from the sun, drives the great ecological cycles. Energy, derived from fuels, powers nearly every production process. Most of the recent increases in the output of production systems and in the rate of economic growth are due to intensive use of energy."(1977:3)

To evaluate these energy connections in contemporary society, Commoner proposes extending thermodynamic concepts developed within physics - which focus on energy relationships - to analyze production and economic factors. To establish a basis for comparing the different elements of production, he creates efficiency measures of capital, labor, and energy.

A brief discussion of thermodynamics is necessary to present Commoner's argument framework.[9] The First Law of Thermodynamics states energy can neither be created nor destroyed. In other words, the total amount of energy in any given system is constant. The Second Law deals with the form of energy. Briefly, different forms of energy - mechanical, heat, etc. - involve different degrees of intensity and dispersion. The potential to do work is constrained by the ability to harness energy in a process. More concentrated types of energy like petroleum products are readily converted into work. As these are used the energy contained within is dispersed into less accessible forms. Herein lies the Second Law of Thermodynamics, increasing entropy, the tendency from order or concentration to disorder or the dispersion of the energy sources available to do work. Taken together, the laws of thermodynamics demonstrate limits of energy accessible of human use.[10]

In terms of the connection of these energy laws and social structure, Commoner points out:

> "The chief practical purpose of thermodynamics is to learn how energy can best be harnessed to work-requiring tasks."(1977:21)

Ratios of energy productivity can be created to tell us how energy efficient a given process is. Each law yields different insights. The First Law directs us to examine the efficiency of the process. The Second Law efficiencies focus our attention on larger concerns of the relation of the process to the social task or goal at hand. Efficiency ratings based upon the First Law of Thermodynamics are common. For example, EPA gas mileage ratings evaluate the efficiency of automobiles - the amount of work (distance) per input of energy (gallons of gasoline). Commoner argues, that it is the Second Law focus, the availability to do work, which provides the connection between social structure and energy, and thus should be at the basis of social efficiency calculations.

First Law efficiencies assume the given social organization of production and ask for any given <u>technique</u> , how efficiently is energy used. Commoner argues that this is not the right question, the social organization of production must also be subject to evaluation. This can be done by incorporating the Second Law of Thermodynamics into energy efficiency measures:

> "The definition of the Second Law efficiencies is the ratio between the <u>minimum</u> amount of work required for a given task to the amount of work represented by the energy <u>actually used</u> to accomplish the task"(1977:156)

Returning to the previous example of automobiles, a wholly different focus emerges. The goal or task involved in using a car is transportation, getting from one place to another. There are various ways this can be achieved ranging from airlines to walking. These options vary tremendously in terms of energy efficiency. As Commoner documents:

> "Railroads and buses have the highest energy productivities for passenger traffic: 630 and 340 passenger - miles per million BTUs of fuel, respectively, as compared with 110 for auto travel and 120 for airlines. Railroads also have the highest energy productivity for general freight: 1300 ton-miles per million BTUs as compared with 360 for intercity trucks and 20 for airlines."(1977:169)

Conservation efforts derived from First Law efficiencies would be directed toward improving gasoline mileage of private automobiles while Second Law considerations would be directed toward revitalizing and expanding the railroad system.

Similarly, principles contained within the Second Law are applied to the other basic factors of production - labor and capital. From the resulting productivity calculations, a picture emerges about the relationship between labor, energy and capital. U.S. production technology is characterized by low energy and capital productivity and high labor productivity. In other words, historically, the amount of energy and capital used in production have increased while the amount of labor has declined.

U.S. agriculture is no exception to this characterization. Within agricultural production, labor efficiency is high and capital and energy productivities are low. Commoner outlines the impact of this production organization:

> "....It displaced farm labor with energy-dependent inputs: machines, power, and chemicals. As the amount of labor involved in farming went down, the amount of capital went up: the assets used in agriculture, per farm worker, rose from 9400 in 1950 to 53,500 in 1970.... Since 1950, agriculture has joined the ranks of those sectors with the highest capital/labor ratios."(1977:159)

Up to this point, in regard to agriculture, Commoner's findings are similar to the discussion within energy economic models. However, he locates these findings in the context of larger structural implications. For Commoner, the energy and capital intensive structure of production creates contradictions for the economic and ecological systems. A quotation from Commoner illustrates this relationship:

> "The amount of energy and capital needed to accomplish the same task has increased; the

> amount of labor used to produce the same output has decreased; the impact on the environment has worsened."(1977:212)

In addition to environmental degradation and resource depletion, he discusses the problems of unemployment and capital shortage that result for society as a whole.

Commoner argues that these problems emerge from an economic system organized to produce commodities for money rather than goods for societal use. The role of labor within a production for profit system plays a central part in his critique. Commoner points out that the key characteristic of contemporary technology is that it is labor saving and thus profit enhancing:

> "Most of the newly introduced production technologies have reduced capital productivity (i.e., output/dollars of capital invested) and have increased labor productivity (i.e., ouput/manhours of labor used). Energy links the two effects, for it is used to run the new, much more capital-intensive machinery that produces goods with much less participation of labor than before. As new production technologies have displaced the older ones, energy has displaced human labor."(1977:212)

New production technologies, Commoner argues, are attractive to capitalists because of short term profit considerations. If one worker can produce ten units with the aid of a machine, instead of one unit in the same time, the capitalist stands to gain both in terms of more production to realize profits from and in terms of reduced labor production costs.

For agriculture, specifically, he discusses the impact of labor saving technology on farmers. These problems revolve around the changing locus of control from inside the farm to off-farm industrial concerns. As Commoner explains:

> "Agribusiness has forced the farmer to operate at a higher economic scale, taking greater economic risks, with no real gain in net income." (1977:150)

Issues of both loss of control and loss of opportunity stem from this process. In terms of loss of opportunity, Commoner points to the reduction in the number of farms and the number of farm workers. In addition, large capital outlays are needed to engage in agricultural production. This produces barriers to entry. In terms of loss of control, Commoner argues, credit institutions and agribusiness have tremendous impact upon farm decisions:

> "...in becoming dependent on industrial inputs, agriculture has contributed to the importance of precisely those industries that are characterized by high capital/low labor ratios - petroleum and chemicals. The economic power is largely held by the petrochemical industry; inevitably, the farmer suffers."(1977:159-60)

Therefore, agriculture contributes to the larger social problems of umemployment, capital shortage, and environmental disruption.

What Commoner does through his thermodynamic efficiencies is to connect social structure with social problems. What is missing is a sense of the dynamics of the process involved. This perspective appears to direct us to the dominant form of economic organization to understand the use of energy in agriculture. Unfortunately, this directive is not upheld in the study. Analyses of why or how these structural changes came about is mired in a sort of individual causation. The underlying causes of social change in this study seem to be greedy farmers or unscrupulous industrialists as the following quotation illustrates:

> "One can almost admire the enterprise and clever salesmanship of the petroleum industry. Somehow it has managed to convince the farmer that he should give up the free solar energy that drives the natural cycles and, instead, buy the needed energy - in the form of fertilizer and fuel - from the petrochemical industry."(1977:161)

Much of this stems from Commoner's focus on social efficiencies to reflect the connections between the three spheres of human organization. In elaborating these connections, he concentrates upon contemporary social organization. As a result, the examination of the transformation of agriculture to its current structural organization is limited. The historical context is treated in a 'snapshot' manner; i.e., this is how farming was then, this is how farming is now, without tracing the social evolution of these changes.

Some of these problems are remedied in Perelman's work (1975, 1977). Perelman expands Commoner's analysis by historically examining the increased social costs of an agriculture based upon profit seeking. Production for profit is at the center of his critique:

> "No matter how disruptive capitalist production methods may be, farmers in this society are still highly efficient in maximizing profits. They carefully apportion fertilizers, pesticides, labor and all other inputs according to their relative prices in the market. The market dictates the spraying of toxic chemicals, even though the full extent of their effects is not known. The market demands the adoption of technologies which squander resources and hurl workers into the depths of unemployment. When social benefits do occur, they are incidental to the mad rush for profits"(1977: 229).

He extensively documents the social costs of this organization for farmers and for society. These include, for the farmer, loss of self-sufficiency and reliance upon agribusiness, and for society, the depletion of natural resources, energy wastefulness, water pollution, and reduced nutritional value of foods. In addition , he examines the implications of a U.S. model of agriculture for developing countries.

Perelman touches upon many issues of the relationship of energy use to agricultural structure. However, these insights are not integrated into an overall framework. For example, Perelman concurs with Commoner's observation about the labor saving character of modern agricultural technology. He goes beyond Commoner's observation of reduced opportunity to highlight the social context of agricultural technology changes, as the following quote illustrates:

> "Whenever the bargaining power of farm labor improved, farmers responded to the demands for higher labor with a burst of mechanization."(1977:73)

More than market relations is implied here. Perelman continues:

> "...The use of a tractor shifts labor from the field to the factory. Instead of breeding, raising and caring for animals, workers under the strict supervision of the factory assemble tractors. Since the factory worker is more easily disciplined than the farm worker, transferring work to the factory increases the amount of work that employers can extract from workers."(1977:43)

Thus the issue of labor control is important in understanding work organization changes. This entails changing conditions of work to the highly structured and regimented factory setting and greater control for the employer.

However, when Perelman discusses people who work on the farm, this element is missing. Specific changes in the agricultural labor process are not examined. In his discussion, we return to the often cited reduction in the number of farmers and farm workers. There is no sense of what the changes have meant for the structure of agricultural work, i.e., how work is done, who does what work and who controls the process. In addition, agriculture is treated as an uniform entity. This presents several problems. While Perelman talks about how vegetable and fruit production in California differs in terms of labor and energy use, he never integrates an explanation of this difference into his analysis. We need to understand the underlying dynamics which led to this differentiation.

In a sense, Perelman's and Commoner's work directs us to important issues that need further investigation. The social dynamics which lead to the introduction of labor-saving technology need further exploration. In addition, the relationship between agribusiness and farm production changes merits further consideration. The energy and structural critiques literature demonstrates the importance of these issues for understanding the connection between energy use and agricultural work organization but does not contain a developed framework for expanding these insights.

Summary

Many insights are contained within the energy and agriculture literature. The extent and the imbeddedness of energy within the agricultural production process is well documented. Throughout the literature, the relationship between energy and labor is discussed in terms of a reduction in the numbers of farm workers with a corresponding increase in the amount of energy. The impact of agribusiness upon farm structure is also noted.

However, the question, is American agriculture energy efficient, dominates the approaches. Concern with answering this question and documenting support for the position leads to a neglect of the important structural connections involved. Therefore the frameworks presented have only limited usefulness for the project at hand. Several components of a structural analysis of the relationship between energy and labor need further development. In particular these center around the following issues: the differentiation of farm labor and the historical process. It is important to understand the energy/labor relationship beyond simply fewer farm workers or farmers. Who have been the workers affected? With what results? How has farm work organization been changed? The second area for further examination is the historical process of this relationship. In what social context did this emerge? What is the role of economic factors in promoting agricultural technology change? How did this process differ for different kinds of agricultural production? These issues need to be further explored before an analysis of the data is begun.

Chapter Two Notes

1.The renewable/nonrenewable designation of energy types refers to the potential for replacement of a resource. Solar power and wood are examples of renewable energy sources. The sun continues to shine and trees can be replanted. In contrast, non-renewable energy sources are those which because of the extremely long period of time required for geophysical replenishment, are considered to be available in fixed amounts. Non renewable energy sources include petroleum, natural gas and coal.

2.The term 'energy analysis' which has been widely adopted, was first suggested at the First Workshop on Energy Analysis held in Solna, Sweden in 1974 (Smil et al., 1982).

3.There is a lack of congruence between boundaries used in the analyses, i.e., within the farmgate, or from manufacture of machinery through planting and harvesting to the table. As a result, comparison between these studies is often difficult.

4.Some have suggested that this is not the case, that methodological flaws, not actual energy/yield relationships produce this observation. See Connor (1976) and Fluck and Baird (1980) for an elaboration of this point.

5.While this differs by study, the energy cost of a worker in society usually includes government expenditures such as for education and defense. The national energy consumption for these facets is divided by the population. As such this is clearly a social measurement of a given culture and not in any form a measure of biological energy demands.

6.For a survey of this debate, one can glance through the issues of Science magazine between 1974 and 1976. For a thorough critique of energy analysis from an energy economics perspective see Huettner (1976).

7.While most studies from an energy economics perspective assert that U.S. agriculture is energy efficient, some studies from this perspective qualify this statement. For example, in terms of an artificial market price see Heady et al. (1965) and Bohl and Russel (1973), or in terms of the economy of natural resource use see Griffin (1980).

8.Note that not all forms of energy are accounted for. Many of these studies focus solely upon direct energy inputs, i.e., fuel. See, for example Littleman (1974).

9.See Commoner (1977) pages 49-52 for an elaboration of thermodynamics.

10.For an expanded explanation of the Laws of Thermodynamics see the work of Georgescu-Roegen (1974, 1975, 1977a, 1977b) or the studies by Cardwell (1971).

Chapter Three:
ENERGY AND LABOR IN AGRICULTURE: THEORETICAL CONSIDERATIONS

The introduction of nonrenewable energy inputs into U.S. agriculture occurred in a historically specific socioeconomic context. An understanding of the changes in the labor process which accompanied energy intensification must also be grounded in an understanding of the prevailing social structure. Commoner's three sphere model of societal organization presented in the previous chapter provides a good starting point for such an analysis. Central to the production system within agriculture is the labor process, or which people are organized in what ways to produce products. Within the economic system, a farmer's production takes place within a set of market relations which condition his or her ability to realize a profit from the farming endeavor. Lastly, the ecosystem provides the material base for agricultural production. Agricultural production and thus realization of a profit for the farmer depend upon a complex of supportive natural forces, i.e. a beneficial environment of climate, weather, soil fertility, etc. Structural changes in agriculture can be understood as results of interactions of various elements within and between these three dimensions.

The Agricultural Labor Process

Two elements are central to an understanding of the agricultural labor process --the role of labor within farming and the social relations of production. There are elements within farming which differentiate farming from nonagricultural production. First of all, agriculture involves a long fixed production time. Physical maturation rates of crops and livestock are largely outside the control of the farm operator. As a result there are constraints on the rate of capital turnover (Mann and Dickinson, 1978). Closely related is the gap between production and labor time in agricultural production. A longer time is needed for the production cycle, the planting of seed to harvesting, than the time when labor is actually applied to the process. As Mann and Dickinson explain:

> "...production time consists of two parts: one period when labor is actually applied to production and a second period when the unfinished commodity is abandoned to the sway of natural processes." (1978:472)

In other words, a time disjuncture exists between production and labor time. The order of agricultural production processes is also determined. Farming, unlike industry is done at the same place at different prescribed times. Plowing, planting, harrowing and harvesting must be done sequentially, as opposed to simultaneously (Brewster 1950). A quote from Madden emphasizes these differences:

> "One crucial difference between factory and farm production is the relationship between stages. In a typical factory operation, the object being processed flows through a series

> of stages, all of which can proceed simultaneously at spatially separated points. In farm production, the stages are typically separated by waiting periods, but occur in the same areas. For example, many stages occur on an acre of corn, ... but the stages are separated by waiting periods because the biological processes take time to complete." (1967:9)

In addition, demand for agricultural labor is seasonal. Concentrated inputs of labor are required at the beginning and end of the production cycle with little labor needed until the start of the next growing season.

An important qualification must be noted here. Livestock production, in contrast to crop production involves a less segmented labor process (Coughenour, 1980). Animals need continual care in terms of feeding and other maintenance aspects. The amount and timing of the labor involved varies from range fed cattle, which more closely approximates the labor process in crop production, to dairy farming, which involves a highly scheduled daily labor input. However, while the labor process within livestock production is not seasonal, the other special characteristics of agricultural production still apply. Labor within livestock production is still sequential and a time disjuncture between labor time and production time is present. Therefore it is accurate to discuss these characteristics as being applicable to some degree to all forms of agricultural production.

These physical characteristics within agricultural production set constraints, different limitations and options in the organization of the labor process than are available in most manufacturing processes. As Pfeffer argues:

> "Essentially, the labor management problems associated with these characteristics of crop production are problems of securing an adequate workforce at the critical point in the production cycle."(1982:542)

Conversely, the work force must be maintained during periods of labor inactivity which occur both within the production time and seasonally, from one growing season to the next.

This interim maintenance has occurred in at least two distinct ways in U.S. agriculture depending upon the source of labor involved - either on the farm in the form of family labor or resupplied through the labor market in the case of wage labor. This observation points to the centrality of the second element of the agricultural labor process under consideration, the relations of production. Relations of production refers to the organization of people within the production process: who produces, who controls production, and who controls the end product. In other words, relations of production are a specific social organization of control, ownership and mode of production, i.e. the organization of surplus extraction. Two distinct types of mode of production with corresponding relations of production do exist in U.S. agriculture.[1] Simple commodity production, the production of commodities to sell to buy other products, is the organization of the family labor farm.[2] On the family labor farm those who do the work also own the means of production and therefore control the process and the product of their labor.

In contrast, farms organized under the capitalist mode of production, the production for profit, entail a split between those who produce and those who control the process and the profit. Under a capitalist mode of production, the social organization of production is based upon two distinct classes, capitalists who buy other's labor power to accrue profits, and wage laborers who must sell their labor time to them to survive. The tensions inherent in such an organization set the parameters for the organization of work. A quote from Edwards illustrates the implications of capitalist relations of production:

> "Workers must provide labor power in order to receive their wages, that is , they must show up for work: but they need not necessarily provide labor, much less the amount of labor that the capitalist desires to extract from the labor power they have sold. In a situation where workers don't control their own labor process and cannot make their work a creative experience, any exertion beyond the minimum needed to avert boredom will not be in the worker's interest. On the other side for the capitalist it is true without limit that the more work he can wring out of the labor power he has purchased, the more goods will be produced: and they will be produced without any increased wage costs. It is this discrepancy between what the capitalist can buy in the market and what he needs for production that makes it imperative for him to control the labor process and the worker's

activities." (1979: 12)

Thus, changes in the labor process are located in this 'contested terrain' between the forces (existing techinques, machinery and labor in the production process) and the relations (the class based organization of these material elements of production). Exploitation of wage labor is the mechanism of surplus extraction. In contrast, in simple commodity production, changes in the production process are made and surplus realized by the actual producers.[3] This dichotomy can be thought of as a continuum on which farms can be located. For example, sharecropper tenant farms can be conceptualized, to some extent, as family labor farms in terms of the source of labor and internal labor control, while decisions about what to produce and the marketing of their product are contractually controlled.

The difference in the source of labor or relations of production is an important distinction in examining impact of changes in production organization. Considering the source of the labor or the class position, i.e., how a farm worker stands in relation to the means of production is central to analyzing the labor process. There are different options and implications for the handling of the 'labor management problem' which emerge from the special characteristics of agricultural production for family labor farms and capitalist farmers.

Dramatically contrasting mechanisms are in operation. For a family labor farm, the issue is one of mobilizing the unit's resources either through authoritarian patriarchal control or cooperative relations within the family or with other family farm units. For a capitalist farmer, the problem is to ensure the availability of labor sequentially (during planting and harvesting) and seasonally (for next year's crops) without having to maintain the labor force during the time gaps involved. The basis of the former relationship is reciprocal, albeit often asymmetrical, the latter instrumental.

The substitution of inanimate energy sources for human labor can be formulated as a response to labor supply problems (Perelman, 1977). During periods of inactivity a tractor or a harvester consumes no fuel. (Although payments to the bank are constant pressures, credit can often be organized to correspond with the seasonal agricultural cash credit flow.) The use of a tractor can be understood as an attempt by farm operators to utilize most efficiently available resources with both forms of production relations. The apparent outcome, labor time savings is the same. However, the rationale, the goals and impetus for this mechanization and the impacts on the labor involved are different. For a family labor farm, mechanization implies the most effective use of family resources to produce family benefits. Increasing the farm productivity can yield reduced self-exploitation - a reduction in the amount and difficulty of the work done by family members to produce their crops and possibly increase the income of the family unit. In a wage labor system, mechanization is a way to insure labor supply by reducing overall demand for labor and driving down wages by reducing demand, and complementarily to increase surplus extraction by increasing the intensity of the exploitation of variable capital (human labor). Although the workers under this system may also benefit from a reduction in the arduousness of the task, clearly the main beneficiary is the capitalist farmer, in terms of reduced labor costs, greater control and increased productivity. In a family labor farm, if the number or hours of family workers are reduced they still accrue benefits. If wage labor is reduced or replaced, the worker no longer has any claim on the production unit - the farm - and must seek other employment.

These facets -- the special characteristics of agricultural production and the socially determined organization of these constraints through different relations of production -- are central to an analysis of energy and farm work organization.

Market Relations and Agricultural Production

Regardless of the relations of production on any single farm, U.S. agriculture operates in a capitalist economy, a system based upon production for profit. The organization of production does not evolve in a vacuum. Two levels of competitive market relations affect the direction of changes within the organization of production in agriculture. The socioeconomic context set by both internal commodity markets (i.e., the position of a farmer relative to other farmers consuming the same inputs and producing the same type of crop), and external market relations (i.e., the structure of the enterprises which supply inputs to the production process and the structure of the market in which farm products are sold), set parameters for the individual farmer's production organization.

The interplay of these factors revolves around the issue of control. Control can be separated into different levels in a capitalist economy (Wright, 1976, 1977). As clarified by Gilbert in relation to agriculture:

> "The social relations of production under capitalism consist of three interdependent processes or dimensions: social relations of control over money capital (flow of investments and the accumulation process); social relations of control over physical capital (use of actual means of production); and social relations of control over labor (authority in the work process)." (1983:52)

A farmer's ability to exercise control in these three dimensions of social relations of production is structured by reliance upon off-farm organizations for production inputs and product markets. A farmer's class position within agriculture also affects the power of the farmer relative to these enterprises. Food production in the United States can not be solely understood in terms of on-farm production. American agriculture is not a self-sufficient endeavor. Both in terms of off-farm inputs and in terms of markets for products, events within the farm gate operate in an expanded economic environment. This environment includes credit institutions; industries which manufacture farm machinery, fertilizers, pesticides, and other raw materials utilized in the production process; food processing industries; marketing; and transportation between and within each sector. The term agribusiness will be used to denote this complex of connections. The concentrated character of these organizations is widely recognized.[4] Given the competitive internal structure, the result of these monopolies for the farmer has been higher prices for inputs and lower prices for products. Thus due to the structure of U.S. agribusiness, a farmer's ability to exercise control over one of the dimensions of social relations of production, money capital, is constrained (Martinson and Campbell, 1980). The costs of production, in terms of constant capital (the forces of production except for labor or variable capital), are determined to high degree outside the farm. The process whereby profit is realized - the selling of the product - is also dominated by off-farm interests. A 'sellers' market' dominates the purchase of production inputs and a 'buyers' market' the selling of the commodity produced.

The relationship between changes in the structure of agriculture and agribusiness is well documented (Buttel, 1980a, 1980b, 1982; Burbach and Flynn, 1980; Fluck and Baird, 1980). In general, agribusiness favored the development of on-farm organization that parallelled the large scale, capital intensive production of contemporary industry. Consequently the options available for farm production process are constrained. The kinds of technology developed (Hightower, 1975), the tax structure and state policies (Schultze, 1971; Friedmann, 1982; Robinson, 1980; USDA, 1981a, 1981b), the availability of credit and volume discounts for agrichemicals (Perelman, 1977) all promote capital and energy intensive agricultural production and restrict the farm operator from alternatives.

Control over the social relations involving labor became the main option of the U.S. farmer. As Perelman states:

> "Farmers, relatively devoid of any real power compared to their suppliers or the great agribusiness middlemen, continued to fall behind in the competitive world. Only one avenue lay open - new technology. Modern labor saving devices promised to cut costs and improve their profit position. Work of every sort was mechanized." (1977:23)

In other words, due to external market relations, farmers were forced to "rationalize" production organization

(Braverman, 1974), to cut production costs through their remaining dimension of control -- over labor. In a capitalist production system, rationalization implies greater control over labor. This involves two steps: 1) Management systematically analyzing the processes of production into component tasks and 2) assigning each component task to a worker to achieve the maximum utilization of labor time. Thus, on a capitalist or corporate farm, labor process changes were made to maximize surplus extraction (increase profits) and to further class hegemony (increase control over workers). For hired farm labor this has meant both reducing the total amount of work available and increasing the intensity of the process - that is getting more work done for a unit of time or money (Buroway, 1976). As previously noted, rationalization on a family labor farm involves not surplus appropriation but surplus labor production. This surplus labor could be allocated according to the decisions of the family unit (Friedmann, 1976,1978; Hedley, 1980). For example, the family unit could decide to use the surplus labor for more leisure of the family members or conversely for the expansion of the farm unit.[5]

As outlined in the previous discussion, agribusiness market relations set parameters for the individual farmer's ability to survive. While lack of competition characterizes these external relationships, the farmer's competitive position vis a' vis other farmers is central within the farm gate. In order to realize profits, a farmer must sell his or her product. The ability to market a commodity can be understood through an examination of competitive position. Both control of market share - concentration - and costs of production are important aspects of this. The intersection of two related elements is central for differentiating an individual farmer's competitive position: the class relations of agriculture, and the nature of the commodity produced.

The duality of the class structure of U.S. agriculture is well established (Rodefeld, 1978; Goss, 1976; Mooney, 1981; Brewster et al., 1983). While a growing proportion of farms (and amount of food produced) is organized under capitalist or corporate relations, a large number of farms remain family labor farms (Rodefeld et al., 1978; USDA, 1976a, 1979, 1981a). These different types of farms contain different class relations which have divergent impetus for technological change. As the preceding discussion of rationalization indicates, choosing a tractor holds different implications for a capitalist and a family labor farm. On both, the tractor could reduce the amount of labor needed to prepare the land for planting. Within capitalist farm production relations, this would eliminate some portion of the unit's wage labor needed. While on a family labor farm, this might mean that the family's children might attend school throughout the spring rather than needing to miss school to help prepare the fields for planting. In one situation, the replaced worker benefits, in the other, the tractor costs a livelihood.

Thus, an understanding of the role of the family farm in the class structure of U.S. agriculture is central to the project at hand. However, there is no conceptual agreement on this issue. The discussion revolves around the relationship of a system of self-employment and ownership of the means of production , simple commodity production, and a system of wage labor, management hiearchy, and capitalist ownership of the means of production. The debate can be divided into roughly two camps: those who argue the eventual disappearance of simple commodity production (family farms) and those who argue for the continuing existence of family farms in U.S.agriculture.

Closely following the work of Kautsky and Lenin, de Janvry (1978, 1980) argues simple commodity production is a remnant of past class structure and will eventually decompose with the increasing centralization and concentration of capital. He predicts agricultural social relations will polarize into two classes: workers and capitalists.

Analyses which postulate the continued existence of simple or independent commodity production within U.S. agriculture focus upon the role or benefit family farms provide for capital. Davis (1980) asserts the 'propertied laborers'of family farms provide corporate agriculture with opportunities for intensive exploitation without capital input. Mann and Dickinson (1978, 1980) point to the physical characteristics of food production (seasonality, production time lag, etc.) which place obstacles to capital accumulation. They argue that areas of production where these limit profitability are left to family farms. Friedland et al. (1980) propose a two sector model similar to O'Connor's (1973) monopoly/competitive model of industrial capitalism. Family farms within the competitive sector play various roles which support the capital accumulation of the monopoly sector both in terms of super-exploitation (for example lowering the reproduction costs of labor and the intensification of work) and in terms of system legitimation (agricultural ideologies of independence and Jeffersonian democracy).

In short, U.S farms are organized along different class relations. The class structure of agriculture is based upon the relations of production - whose labor is used in what ways. Illumination of the class nature of U.S. agriculture must be based upon an examination of empirical information in a historical context. As the previous discussion of technological changes in agriculture suggests, an examination of the historical evolution of agricultural production relations is in order. A recent approach to the issue is presented by Pfeffer (1980, 1981, 1982). Pfeffer argues that the social origins must be considered when examining the class relations of U.S. agriculture:

> "...variables in farm structure are explained by differences in economic, social, and political factors present at a particular time and place"(1982:540).

He examines two elements, available work force and level of risk. These vary by region - his unit of analysis. While California, the Great Plains, and the South historically all had a high concentration of land ownership, each currently has a different agricultural organization or relations of production: a capitalist wage labor system, family farms, and tenant sharecropping respectively. According to Pfeffer:

> "Corporate farming in California is the prototype of a fully developed capitalist agriculture. Land is highly concentrated, and farm labor takes the form of wage labor. Wage workers in agriculture, like those in urban industries, own no means of production (including land, i.e. they are landless) and are forced to rely on the sale of their labor to secure their livelihood."(1982:542)

This development was possible, he argues, because farmers in California, in the 1880's, were able to minimize their risks by switching from wheat production to fruit and then later to vegetable production.[6] Central to the success of this transition was the availability of a suitable large workforce. Vegetable and fruit production, especially at harvest time, are labor intensive crops. Pfeffer identifies two intertwined elements which operated to maintain this labor supply: insurance of a disciplined labor source through state policies and active labor control efforts which used racism to create an agricultural reserve labor force. He comments:

> "The effect of racism was to create a work force marginal to the industrial workforce in California. The farm work force had little chance of entering the industrial workforce and was restricted to employment in the fields" (1982:544).

Similar efforts to create corporate agriculture in the South and the Great Plains did not succeed. In the Great Plains, the greater natural risks, i.e., drought, insect plagues, etc., coupled with a different labor source, domestic or Caucasian immigrants, circumvented these efforts toward concentration. Family labor farms became the predominant form in Great Plains agriculture. Although the South had a large supply of Black agricultural labor, wage labor contracts were not sucessful in insuring adequate supplies at low prices after emancipation.[7] Tenant sharecropping, in the South, emerged as a way both to insure an agricultural labor force by tying Blacks to the land and to diffuse the high risks of cotton production caused by tight credit markets and falling cotton prices.

Pfeffer's discussion clearly illustrates that historically, regional social and economic conditions in terms of labor supply and control and market and natural risks set important constraints upon capitalists' attempts to organize corporate agricultural production. Out of these social origins, dominant regional types of agricultural social relations emerged. Equally clear is the need to continue this disaggregate examination of agricultural production. Examining agricultural production as a whole masks the evolution of the contrasting production organizations . However, Pfeffer's focus upon region as a unit of analysis must be examined, He clearly demonstrates how fruit and vegetable production in California differs from grain production in the Great Plains and cotton production in the South. Implied are not only regional differences in the organization of production but commodity differences also.

The regional divisions he presents are historically accurate but as a model for further investigation, a regional emphasis has drawbacks. Presently, while the Pacific region is predominantly fruit production, over one-third of the farms in the region are grain farms (USDA, 1975). Two sets of concerns emerge from this observation. Does the corporate farm model hold for grain farms in California? And is the organization of fruit and vegetable farms in other regions similar to the capitalist relations of production Pfeffer found in California?[8] These questions point to the importance of examining commodity type when focusing on the organization of labor in the labor process. Farm commodities differ in terms of market relations, i.e., degree of production concentration, scope of market (local, national, or international), and production characteristics - labor intensity and land intensity (yields per acre). In a sense region plays a role in the range of commodity choice through climate and labor availability but competitive pressures to rationalize production operate within a specific commodity market. Wheat farmers in California compete with wheat farmers in the rest of the country. The nature of the commodity produced cannot be ignored. A fully articulated model needs to incorporate commodity differences along with regional preconditions when examining the labor process.

Agricultural Production and Natural Forces

Much of the previous discussion touches upon points of intersection of the ecological sphere and the production and economic spheres within agriculture. Farming, both in terms of process and in terms of product, is intertwined with the interplay of natural forces, i.e., climate, maturation processes, biological threats, etc. Within the sphere of production, the use of labor and the organization of the labor process are constrained by the natural processes involved. Similarly, natural forces create high levels of uncertainties related to market relations. The role of energy within agricultural production must be understood within the context of these constraints and interrelationships.

Traditional agricultural methods are based on fostering the natural ecological cycles. As Commoner explains, traditional agriculture involves the changing forms of organic matter in a cyclical process:

> "Thus, carbon and nitrogen move in a cycle from plants to animals, to a series of soil bacteria, and back again to plants.... Organic matter is the fuel that drives the great cycles of the ecosystem, which support not only agriculture but all life. Solar energy, trapped by living plants, produces that fuel."(1977:153)

Modern agricultural practices involve shifting from a renewable and <u>nonmarket</u> energy cycle to a nonrenewable energy basis that must be purchased in the market place. Perelman (1977) labels this disruption of natural ecocycles the 'industrialization of natural processes'. This refers to the replacement of self-sufficient ecological cycles with technologies that displace parts of the cycle and that are imbedded in market relationships. The ecological impacts of this process in agriculture are well documented.[9]

Three interconnected dynamics can be located within the 'industrialization of natural processes' in agriculture. These can be catergorized as attempts 1) to gain control over natural processes, 2) to enhance market characteristics and market chances, and 3) to expand capitalist market relations.

As previously noted, farming occurs in the context of many risks or uncertainties beyond the control of the farmer. These uncertainties stem from both natural processes and the larger socio-economic climate in which agricultural production is situated, a system based upon a market economy or production for profit.

Technologies and therefore increased nonrenewable energy inputs are introduced toward minimizing the risks of operating in this natural and social setting of production. Energy intensive technologies can be identified which are directed toward maximizing the farm operator's control over these dimensions. For example, replacing field drying of corn with propane fueled drying ovens circumvents the possible hazards of inclement weather destroying the crop before it can be harvested. Other technologies applied to agriculture are directed toward enhancing the profit potential of the crop. The rapid field cooling of lettuce (Friedland et al., 1981) and the chemical treatment of fruit trees to facilitate same-time ripening (Barnett, 1975) improve the marketability of crops. While these technologies illustrate ways farmers have adopted strategies which manipulate natural processes, i.e. technologies which help insure the outcome of agricultural production, the specific choice must not only be ecologically successful, it must be economically consistent -- compatible with the existing mode of production. Thus, risk aversion is undertaken in a broader economic context.

What is at stake is not efficient production of food but the production of food to produce a profit. In this process labor control and competition with other farmers are central. Farmers need to reduce not only the threat of natural risks but make money in the process. In short, energy intensive technologies are adopted which seek to control natural risks, i.e., ensure the success of production; but this isn't the whole picture. Pressures to produce a profit structure the methods used.

Energy Technology Characteristics

It is in this context then of production, economic, and ecological forces that labor has been reduced in U.S. agriculture. In addition, labor has not simply been replaced by energy in the production process. The structure and conditions of farm work have changed. The preceding discussion of important structural dimensions of energy and labor in the agricultural production process is not complete. The framework must be enlarged to include an analysis of the role of critical raw materials (such as energy). In particular, the preceding discussion focuses upon exchange values -- the impact of class struggle upon the accumulation process as mediated by the relative exchange values of constant and variable (labor) capital. In other words, the price of energy relative to labor is the focus of the analysis. While such a treatment is essential to an adequate understanding of the role of energy in production, it is important to recognize that the unique and central role played by energy is a reflection of its use value, its physical characteristics, which must be explicitly included before the analysis can be complete (Grimes and Macheski, 1979).

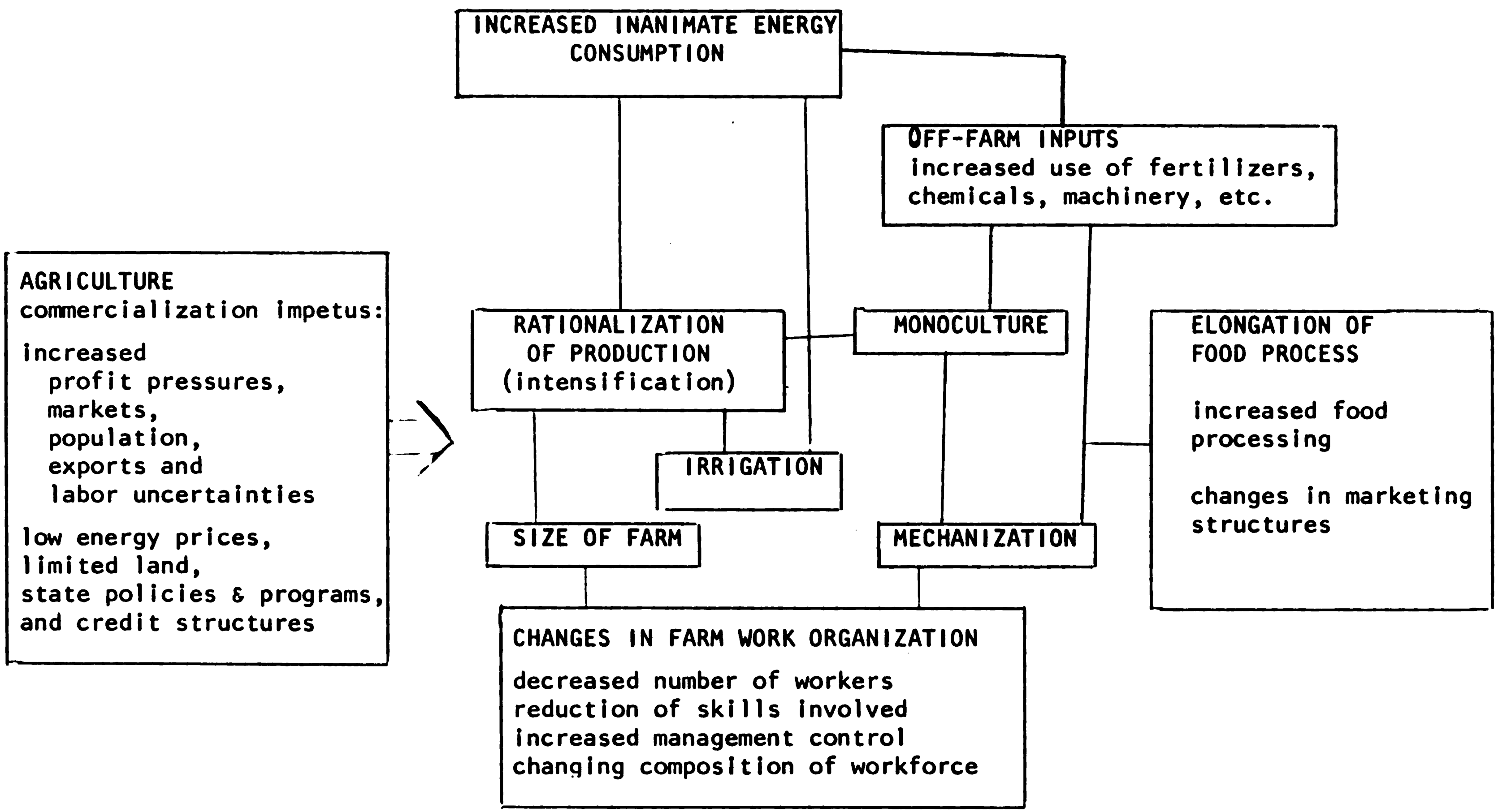
Without a ready source of cheap, high intensity energy to replace human labor, the contemporary structure of agricultural production could not have been developed. Energy for capitalist farms is the intervening variable which made possible the capitalist transformation of agricultural social relations with the resulting impact on farm labor of reduced opportunity and skills and increased management control over the labor process. Energy for family labor farms might have ensured their continued existence by more efficiently utilizing family members' labor.

Two types of energy technology have been utilized in agricultural production - mechanical and biochemical. The adoption of self-propelled mechanical devices such as tractors, harvesters, and combines resulted in the direct reduction of the amount of human labor needed to farm an acre of land or conversely enabled a larger area to be farmed with the same labor input. Increases in the size and power of these machines eventually made the second option, the expansion of land farmed, the most economically viable. The second form of energy technology, biochemical, directly increased the intensity of agricultural production. Hybrid seeds, fertilizers, and other petrochemical inputs dramtically increased yields per acre which further reduced the labor needed per unit of production. Although the two types of energy are interrelated, the dynamics involved can be separated. Buttel summarizes the differential timing and impact of the different energy forms:

> "Biochemical energy inputs have thus provided the main basis for social differentiation among family labor farmers at the same time that mechanization has provided the impetus whereby the differentiation could lead to larger, nonfamily farm types." (1981;31)

The differential impacts outlined by Buttel occured within a different time frame for different commodities. While grain production was highly mechanized by the late 1930's (Cochrane, 1979; David, 1971), mechanization in fruit and vegetable production is a more recent phenomenon (Friedland and Barton, 1975). However, some general observations about the role of energy can be made. Both of these kinds of energy were adopted to strengthen and protect the individual farmer's position in an unstable market economy. In addition, the adoption of these technologies entailed dramatic changes in the structure of agriculture. Figure 1 presents a composite sketch of the relationships suggested by

FIGURE 1. AGRICULTURAL STRUCTURE RELATED TO ENERGY AND LABOR



the literature (Army and Smith, 1965; Baron, 1980; Bell, 1972, Buttel, 1977, 1981; Buttel and Kinney, 1981; Buttel et al., 1980; Dovskin and Heady, 1976; Davis, 1980; Feise, 1978; Friedland et al., 1978; Goss et al., 1980; Perelman, 1977; Rodefeld et al., 1978). Structural changes directly tied to energy technology include increased dependence of agriculture on off-farm inputs, increased farm size, specialization and monoculture of individual farms, and each of these has important implications for changes in farm work organization (changes in the amount and kind of farm labor). The resulting structure is imbedded in energy dependence.

It is within this increased energy dependence that the issue of use value is paramount. There are geophysical limitations inherent within the contemporary structure of agriculture. The amount of any natural resource is finite. While the timing of the depletion of each energy source is open to debate, the eventual outcome is inevitable. As natural gas and petroleum become scarcer and more expensive, the ever present 'cost-price squeeze' every farmer operates under will tighten. It must be noted that it is possible to change from one energy source to another. However, this change is undertaken in the existing structural relations. Energy forms are not directly interchangeable. Farmers can not simply replace one tractor with five solar collectors. In addition, increasing labor intensity would be constrained by current class relations. Specific physical characteristics are built into the structure of production. A wholesale change to other energy forms would entail structural changes as well as lengthy time lags and high implementation costs, in short, an expensive reorganization of production (Abelson, 1979).

This reorganization of production would occur within the context of political economic relations. In a sense, this discussion brings us full circle. An analysis of the use value characteristics of energy plays a central role in understanding the important consequences energy substitution for labor has had in establishing inherent physical contradictions within agriculture. This understanding, coupled with structural analysis which illuminates the dynamics of energy technology adoption into the production process, forms the theoretical underpinning of the project at hand.

Research Questions

The relationship between energy and labor in agricultural production must be understood within the social context in which it is located. The preceding discussion delineated important structural dimensions of this context. Within the production sphere, the role of labor is set by special characteristics of agricultural production. In addition, how this labor is organized, i.e., the relations of production form the beginning point of understanding of the relationship of energy and labor. Factors within the economic sphere, internal and external market forces which differ regionally and by commodity, develop systemic pressures within which changes in the labor process, in terms of both introduction of energy technology and labor reorganization, occur. Attempts to control uncertainties within the ecological sphere through the industrialization of the natural processes are shaped by both physical and economic considerations.

Changes in energy inputs in U.S. farming were mediated through these dimensions. Increasing energy intensity of American agriculture is not an independent force but located squarely within the political, socioeconomic organization of contemporary society. Energy is a tool to gain control. This cursory examination of the literature has pointed to the tremendous effect on farm labor. Exploring the full impact of this process is the goal of this study. The task is to locate these theoretical insights in a specific historical examination of changes in farm work organization. Two levels of analysis are used to structure the inquiry: a general delineation of the historical trends in labor use and energy consumption in all of U.S. agriculture, and, more concretely, an examination of the development of specific relations of production within commodity groups to explain the relationship of energy and labor in the evolving process. The following questions will guide the analysis.

Energy/Labor Relationships in U.S. Agriculture. Questions in this section seek to document overall trends and broad relational factors between energy, social structure, and farm work organization.

1)How has energy consumption in U.S. farming changed in the period 1900-1980? How much of what kinds of energy is involved? Can these changes in amount and kind be separated into historical periods?

2)How have the relations of agricultural production changed over the same time period? Are there corresponding changes in farm class relation and market structure?

3)In what ways has the agricultural labor process changed? How much labor has been replaced? Whose labor - farmers, farm family workers, or hired workers? What are the implications for the people involved in this process?

4)A related concern focuses on the transformation of agriculture from household to capitalist production relations. How many farms are family labor farms? How do these differ from wage labor farms?

5)In general, what connection can be made betweeen changes in energy and labor in the agricultural production process?

Commodity Sector Analysis. Concerns in this section are directed toward locating the broad historical trends outlined in the general section in a specific historical context.

1)In what ways do the production processes differ between commodity groups? How do commodity groups vary by internal market relations, i.e., concentration of production? By structure, i.e., the organization or relations of production? By degree of energy intensity/labor intensity?

2)How have these differences emerged historically? What social factors are important in this process?

3)To what degree do the energy inputs account for the reduction of agricultural labor for each commodity? In what structural context did energy substitution occur? In what form? Which dimensions of labor force are central? How do these differ by commodity group?

4)What is the relationship between large market and small market farms within each commodity group? Does the relation between energy and labor differ among small and large market farms?

These questions, then, form the basis for an examination of the relationship of energy and labor within U.S. agriculture. While not exhaustive, together they form a framework for connecting social structure, energy and labor within farm production. We can now turn to the empirical investigation of these dimensions.

Chapter Three Notes

1.Clearly, this dichotomy is an oversimplification. First, all farms in the contemporary U.S. are enmeshed in a production for profit system to varying extents. Even if not internally organized along capitalist relations of production, U.S. farms are still involved in a capitalist market economy in terms of purchased inputs and markets for their products. The effects of this encirclement are discussed in the next section, Market Relations and Agricultural Production. In addition, the two type model represents more the extreme endpoints of the range of U.S. farm types rather than providing a categorical model that all farms can be located within. Many variant relations of production exist within U.S. farms. (See Gilbert (1983), Buttel (1980a,1980b), Mooney (1979,1982,1983), Goss et al.(1980), and Rodefeld (1978) for different models of the full range of the contemporary class structure of U.S. agriculture.) However, this oversimplification is useful in pointing to the differential impacts of changes in farm work organization depending upon the source of the labor.

2.The term 'family labor farm' as opposed to family farm, was first presented in Rodefeld's work (1976) and later adopted by Buttel (1980a) among others. The importance of this distinction here, for our purposes, revolves around distinguishing the source of labor and control within farm units.

3.Here it is important to recognize that power relations do exist within simple commodity production systems or family labor farms. Family labor farms <u>do</u> contain exploitative relationships among the people involved, but these are based upon gender, age, and other family relationships, not class dynamics. Family relationships are ascribed statuses. This is not meant to imply that no power differential is involved of men over women, or old over young, or to portray co-operative rather than authoritarian organization. The point being made is simply that the benefits accrue to the unit of producers, albeit unequally distributed labor and rewards. See THE INVISIBLE FARMERS, WOMEN IN AGRICULTURAL PRODUCTION by Carolyn Sachs (1983) or articles by Hedley (1980, 1981) for an interesting discussion of the patriarchal organization of family farms.

4.Numerous references are available which discuss the concentration of U.S. agribusiness. For example, for studies which focus upon the entire agribusiness system and the entailing impacts on farming see Martinson and Campbell

(1980), Adams (1971), and Briemeyer (1965, 1973). For discussions of the concentration of farm inputs see Markham (1958); for fertilizer see Allaby (1974); for pesticides see Moore and Walsh (1966); and see Barber(1973) for farm machinery. For discussion of concentration in industries that deal with the purchase of farmer's production see Scoffeild (1979), Macauley (1963), Vogeler (1981), Hildreth et al. (1973), Imel et al. (1973), and Campbell and Emerson (1978).

5.This does not mean that other systems of domination did not exist on family labor farms. For example, the reduced need for women's labor often meant they were further stereotyped into domestic activities. See Flora and Johnson (1978) or Hedley (1980, 1981) for discussions of this element of family farm organization.

6.This was a period when wheat prices were fluctuating drastically with catastrophic consequences for many wheat farmers. See McWilliams (1939) and Friedmann (1979) for discussions of this period.

7.Abuse of the wage contract, new found freedom of movement and the attraction of higher wages in the near West are all cited by Pfeffer as some of the reasons Southern agriculturalists were unable to sustain a wage labor force of previous slave labor.

8.In fact, there may exist different production organizations among producers of the same product. Wells (1981, 1984) suggests that the organization of strawberry production differs for large, middle and small market strawberry farms.

9.These ecological impacts include depletion of soil through erosion and loss of fertility (Grant, 1975; Ridgeway, 1971,1975), increased health hazards to farm workers (Smith, 1959; Schwartz and Sinclair, 1975; Howitt and More, 1975; Wasserstom and Wiles, 1985), increased chemicals in our food (Turner, 1970), depletion of water supplies and pollution (Wright, 1975; Perelman, 1977), and the increased susceptibility of crops and livestock to blight and disease (Horsfall, 1975; Carecraft and Sprott, 1967).

Chapter Four:
METHODOLOGICAL AND DATA ISSUES

Delineation of the Research Project

Scope of Investigation The time frame and scope of this study of agricultural production is U.S. agriculture during the period 1900-1978. The selection of this time frame is based upon several factors. First, by the late 1800's, free or cheap land to farm was largely exhausted. This limitation on the availability of land for agricultural expansion set the stage for the transformation from extensive to intensive farming. To maintain their market position or to increase profits, farmers were forced to rationalize production processes, to adopt methods which increased the intensity of production to obtain higher yields on the land they controlled. In this context, the early 1900's marked the introduction of an important change in agricultural technology. Machines powered by non-renewable energy sources began to replace human and animal power on the farm. In addition, by this time the nation's infrastructure of rail transportation and communication was in place. Encouraged by increased population, farmers now had the opportunity to expand rapidly the scope and the volume of their markets. These factors combined provided strong impetus for the commercialization of farming and the subsequent rationalization of farm production. Consequently it is during this time period, that the dynamics of the energy/labor substitution can best be located and understood.

Definition of Agriculture: Numerous sectors are involved in the production of food and fiber in the United States. These include the industries which manufacture farm machinery, fertilizers, seeds and other raw materials utilized in the production process; actual on farm production; food processing businesses; marketing companies; and transportation between and within each sector. The term agribusiness will be used to denote this complex of connections. This project concentrates on one sector within agribusiness - within the farm gate. For the purposes of this study, agriculture will refer to the actual production of foodstuffs on the farm. However, American agriculture is not a self-sufficient endeavor. Both in terms of off-farm inputs and in terms of markets for products, agriculture operates in an expanded economic environment. Larger political and economic processes or connections are only dealt with in terms of their impact upon on farm production.

Labor and the Labor Process: The major focus of this project is upon the intersection of labor and the labor process with increased energy inputs. Labor is human energy or work. The labor process is the social organization of this human input in the structure and process of production. This includes the source of labor, the management structure under which work occurs, and the nature and conditions of the work involved. In agriculture, important characteristics of the farm labor force are reflected in the changing composition of labor among farm operators, family farm members, full time hired labor, part time hired labor; and along the lines of gender, race and ethnicity.

Energy and Energy Technology: A formal definition of energy is the ability to do work. In the context of this study, the meaning of energy is more limited. Clearly, any production input in the most general sense might be considered an energy input. Indeed measurements of this kind are what is attempted by those who use the previously discussed energy analysis model. However, for the purposes of this project, energy, energy input or energy technology refers to inanimate production inputs that substitute or supplement organic cycles of plant growth and animal maturation. Thus commercial fertilizer, if it excludes purchased manure, is an energy input, while commercial feed mixes or purchased seeds are not. The latter involve changing commercial or market relations, not different organic relations.

Differentiation of Agriculture

Most studies of agriculture and energy have concentrated upon energy as a whole. There is not a commonly accepted typology or framework for breaking down farm production into sectors or types (Pretzer and Finley, 1974). This presents several problems. First of all, much of the data is presented in aggregate format, which provides little or no information about divergent production processes within agriculture. For other data unrelated typologies are used which hinder comparability. As a result, processes that vary historically are often masked.

For example, looking at energy and labor statistics for a series of years, we would see a dramatic decrease in the labor involved and a similar increase in the amount and kinds of energy used. However, this broad overview does not provide a basis for understanding the context of this exchange which has varied both historically in changing political and economic conditions and specifically for different crops. Early mechanization of wheat production allowed family farms to compete sucessfully with large capitalist Bonanza farms (Friedman 1978). Later mechanization of vegetable production in Ohio was initiated in the context of unionizing among farmworkers (Hightower, 1980). Both resulted in an increase in energy inputs and a decrease in labor. Aggregate data, while showing overall trends, obscures these important differences.

Food is grown through a variety of different production processes. Farms vary in terms of size, ownership and management structures, degree of market concentration, profitability, and labor source, and the kinds and amounts of production inputs. All these factors have impacts upon the motive and timing of technology changes which increase energy consumption and decrease human input.

To examine the possible different relations of production between kinds of agricultural production, a typology is needed which delineates farming endeavors according to type of production. In the U.S. Census of Agriculture, Standard Industrial Classifications, S.I.C., have been used to develop a 14 category model of farm types based upon major product. Basically, the S.I.C. model assigns farms to a category based upon the criterion of major product group sold (50 percent or greater for most years). The categories in 1978 include: cash grain crops; cotton; tobacco; sugar crops, Irish potato, hay, peanut, and other field crops; vegetables and melons; fruit and tree nuts; horticultural specialties; general farms, primarily crop; general farms, primarily livestock; poultry and egg; dairy; livestock, except poultry and dairy; animal specialties; and farms not classified.

The S.I.C. scheme has been used since 1945 to report census data by farm type. In 1940, 1930, and 1900, some census information was presented by farm type using a more limited model. Documentation is available to determine comparability and inconsistencies in the composition and application of categories.[1] From 1959 to the present, most census information is presented by S.I.C. farm type. In 1969, some farm characteristics are given for farm type by economic class. Since 1974, most farm characteristics are presented in a farm type by economic class breakdown. Despite these fluctuations in application of categories and in the presentation of information, the S.I.C. model provides a strong basis for making comparisons among different production organizations.

A decision was made to eliminate seven of the S.I.C. categories from the field of inquiry. This decision was based upon considerations of relevance to the research questions, the relatively small number of farms contained within some of the categories and inconsistencies in application of the category.

The category of "sugar crop, Irish potato, hay, peanut, and other field crops" was eliminated based upon the extremely varied historical composition of the category. The second set of categories excluded were tobacco and cotton. The project focuses upon the production of foodstuffs, and in addition these crops have historically had very different production organizations (based upon early cash crops and slave production systems) from most agricultural production (Billings, 1982). The rest of the excluded categories contain relatively small numbers of farms and have been somewhat inconsistently applied. They are general farms, primarily crop; general farms, primarily livestock; horticultural specialties; animal specialties; and farms not classified.

Data Sources

The primary source of data for this study is documents from the U.S. Census of Agriculture. This census was conducted every ten years from 1850 until 1930 and every five years thereafter. An extensive examination of the census schedules determined that information about production organization, labor and energy was available for most years. A further consideration is availability. The M.S.U. Documents Library has virtually all the published census reports. Copies of unpublished census information, where relevant, were also obtained.

Two additional sources were relied heavily upon, Farm Labor Reports and the Hired Farm Working Force series. Farm Labor Reports are the published results of a quarterly labor survey of the agricultural labor force. Published since the early 1900's, this source includes adjusted figures for the number of family workers, hired workers, and agricultural wage levels.

The Hired Farm Working Force is a series from the U.S.D.A.'s Economic Reporting Service that is published irregularly. Based upon a survey of use of wage labor by farms, the documents provide information on number of hired farm workers, age, sex, days worked, and other characteristics of the labor force. A comparable earlier series, The Farm Working Force, provides the same type of information for both family and hired labor combined up until 1943.

These three basic sources were supplemented by additional U.S.D.A. reports and other published studies.

Data Strengths and Problems

One of the major strengths of the data used lies with the use of census information. The U.S. Census of Agriculture yields population data and, consequently, issues of representativeness and sampling error are minimized (Camelari 1955). In addition, the long series of census administration allows for changes in the population to be followed over a long period of time.

However, there are problems inherent in use of this data. The census is reconstructed before each administration. Questions are added and deleted and definitions are reformulated.[2] Clearly, this is a legitimate endeavor for any ongoing research process. Different concerns emerge while others are rendered obsolete by changing circumstances. For example, in 1964 the first questions about the use of agricultural chemicals other than commercial fertilizer were added to the census schedule. However, a certain amount of arbitrariness seems to operate in the fluctuations of the agricultural census and hinders analysis. For example, contract production is cited throughout the literature as an important emerging structural change in agricultural production relations. A question concerning contract production was added in 1969 and then dropped thereafter.

The form of data presentation also varies greatly. Between 1954 and 1974, characteristics by farm type were only presented for commercial farms, farms with over $2500 in sales of agricultural products. In 1978, prior practice was resumed to and farm type information was presentd for all farms. This type of fluctuation greatly limits historical comparability.

Farm Labor Statistics Problems The greatest problem with data in both the U.S. Census of Agriculture and the other sources mentioned revolves around farm labor statistics. The weaknesses of farm labor data can be summarized into five related sets of concerns. The first is loss of important information. Beginning around 1950, most studies of farm labor do not address family or farm operator labor and examine only hired workers. Census questions on family labor and operators' hours were dropped after 1964. The one remaining source of this information, the Farm Labor Reports, only includes numbers of family workers with no distinction made between operators or other family members. In addition, this source has no information about any other aspects of the labor process except wage levels.

The second issue is the practice of using synthesized estimates of labor input. Many U.S.D.A. studies examining farm input relationships rely upon elaborate engineering models to calculate labor input hours and changes. Needless to say, using these sources in a study which attempts to explore rather than assume production changes and differences is problematic. This problem is exacerbated because many of the farm input studies provide much of the information on energy changes. This hinders comparability of these two dimensions.

A third source of problems with farm labor statistics is in the lack of agreement between sources. Data reported from different surveys undertaken the same year have varied by as many as two hundred thousand in their overall total number of workers. For example, between 1945 and 1975, reported numbers of hired farm workers from the Farm Labor Reports and the Hired Farm Working Force vary by 33 percent to 50 percent. In these instances, the more conservative number was used in this project.[3]

A fourth source of tension in labor statistics revolves around the isolated collection of much of the labor data. Since 1949, the Hired Farm Working Force series has given fairly detailed information about the characteristics of hired farm workers. However, these workers can not be connected to actual farms, i.e., which farms have which labor composition? As a result we have few ways of knowing the relationship between the changing production characteristics of a group of farms, for example large market farms, and the wage labor on these farms. Using agricultural census data, farm characteristics can be connected to dollars spent on hired labor but not to the characteristics of the workers.

The final issue in regard to farm labor statistical problems is in changes in definitions, data collection and data presentation procedures. For example, Hired Farm Working Force reports vary between presenting farm workers' characteristics for all farm workers and for only for those farm workers who have worked more than 25 days in farmwork. These fluctuations make comparisons for some years impossible. A related concern is with race. Prior to 1969, distinctions were only made between White and Negroe (sic) and other. When Hispanic was added as another category in 1974, it became apparent that the categories of Negroe(sic) and other and White had sometimes included and other times excluded Hispanics. Thus any historical comparison of farm workers by race and ethnic category is seriously flawed.

This discussion of problems with the available farm labor statistics illustrates the general concerns of comparability, connectedness, and consistency that occur in any project that relies upon documentary sources. Awareness of these limitations does not preclude using documentary material. Rather this awareness can be used to develop strategies to minimize the effect of these limitations. In this project, numerous indicators of each dimension examined were collected. In addition, effort was made to sort through possible data sources and select the strongest source for each dimension examined.

Data Analysis

The data collected was organized according to a three fold framework. First information about structural changes in agriculture was compiled to provide an overall context for further elaboration. Secondly, information about the overall general trends in farm energy and labor were examined. Finally, structure, labor and energy use in production systems of different farm types were examined.

Chapter Four Notes

1.For a discusssion of these changes in the application of the S.I.C. categories, see Table 1 in U.S. Census of Agriculture, Summary by Farm Type, 1974 , pp.6-7.

2.For example, see the above mentioned source for how the category of farm type has changed throughout the census application.

3.A recent U.S.D.A publication, Counting Hired Farm Workers: Some Points to Consider (Whitener, 1984) outlines some of the problems that result from different methodological procedures used in surveying the number of farmworkers. According to Whitener, surveys based on weekly counts, such as the Farm Labor Reports, are likely to undercount significantly the yearly totals of farmworkers.

Chapter Five:
SETTING THE STAGE: CHANGES IN THE STRUCTURE OF AGRICULTURE

Farm Efficiency

Fairly often in the newspaper we read observations about the tremendous productivity of farming in the United States. As often, recently, we are informed about the financial crisis facing farmers. We are left with a sense of productive efficient farmers who can't make ends meet. This apparent contradiction comes in part from the way these separate dimensions of the farm experience are examined.

TABLE 1

PERSONS SUPPLIED FARM PRODUCTS BY ONE FARMWORKER, SELECTED YEARS, 1900-1978

Year	Persons Supplied per Farmworker[1]		
	Total	At Home	Abroad
	.... number	....	
1900	6.9	5.2	1.7
1910	7.1	6.1	1.0
1920	8.3	6.9	1.4
1930	9.8	8.8	1.0
1940	10.7	10.3	.4
1950	15.5	13.8	1.7
1960	25.8	22.3	3.5
1970	47.1	39.9	7.2
1978	65.0	46.5	18.5

Source: USDA, 1979, Changes in Farm Production and Efficiency, Statistical Bulletin No. 628, Table 56.

1. Includes the farmworker.

Observations of U.S. agricultural efficiency focus upon increased yields of farm products. One way this process is often stated is by looking at how many people one farmer can provide with food. For example, in 1900, a farm worker in the United States could grow enough food to provide for 5.9 others. (See Table 1.) By 1978, a farm worker could grow enough food to feed 64 other people, an increase of 1280 percent. Another way this increased farm efficiency is shown is by looking at the output produced per hour of labor. Again we see a tremendous change. Between 1910 and 1978, an index of farm output per labor hour increased 1408 percent, from 13 to 183 respectively (Table 2).

In short, both measures document a tremendous increase in labor productivity. Farmers and farm workers are producing much more food. Clearly farm labor is more efficient. But how was this increase in labor productivity accomplished? As the discussion in Chapter Three outlines, labor is just one element of many in farm production. What other production changes accompanied this change and how has labor changed? Are the same people producing farm products? These questions lead us to the need to examine the structure of agricultural production.

The structure of agriculture is the result of the complex and interconnected set of economic and political pressures which affect who produces food, how that food is produced and for whom the food is grown. During the same period when agricultural efficiency was being increased, the structure of agriculture underwent a dramatic transformation. Within this transformation the role of labor and the use of energy within farm production have been dramatically reversed. Energy use has skyrocketed while labor declined. In order to understand this reversal, we must have some understanding of the direction and the dynamics of the changes in farm production. The following discussion is a brief summary of those structural changes.

TABLE 2

LABOR INDEX OF FARM PRODUCTION PER HOUR, SELECTED YEARS, 1910-1978

Year	Farm Output (1967 = 100)
1910	13
1920	14
1930	16
1940	20
1950	34
1960	65
1970	115
1978	183

Source: USDA, 1979, Changes in Farm Production and Efficiency, Statistical Bulletin No. 628, Table 45.

TABLE 3

CROPLAND USED FOR CROPS AND INDEX OF CROP PRODUCTION PER ACRE, SELECTED YEARS, 1910-1978

Year	Cropland Used for Crops Total (million acres)	Index of Crop Production per Acre (1967=100)
1910	330	56
1920	368	61
1930	382	53
1940	368	62
1950	377	69
1960	355	89
1970	332	104
1978	368	121

Source: USDA, 1979, Changes in Farm Production and Efficiency, Statistical Bulletin No. 628, Table 13.

The first dimension under consideration is land. This facet of on-farm production has changed relatively little during the period under examination. By the early 1900's areas suitable for cultivation were largely settled (Cochrane, 1979). The number of acres used for crop production has fluctuated between a low of 330 million acres planted in 1910, to a high of 382 million acres cultivated in

1930. In 1978, the number of acres planted was 368 million (Table 3). Thus the amount of land available for food production is limited.

However, the amount of food farmers could produce on that acreage has grown. Overall, from 1910 to 1978, land productivity, or the amount of crops harvested per acre has increased by 216 percent. (See Table 3.) This increase in land productivity can be roughly separated into two periods. From 1910 to 1950, the amount of crops harvested per acre rose roughly 10 percent per decade.[1] The overall increase for this forty year period was 40 percent. During the next twenty-eight years, changes in on-farm production gave rise to much greater increases in yields. From 1950 to 1978, crop production per acre rose 75.4 percent (Table 3).

These changes in land productivity and farm production occurred in the context of continued commercialization of American agriculture. During this period, U.S. farming changed from simple commodity production to farming as a business, as a capitalist enterprise. On farm production was commercialized. The path toward commercialization was characterized by limited land, export markets for farm products, increasing profit pressures, state policies and credit practices which favored commercial farmers, and the expansion of agricultural production beyond the farm gate.

Farm markets, while notoriously unstable, continued to expand.[2] A well-developed national transportation network and an ever increasing urban population pushed the horizons of the market available for farmers from local or regional boundaries to expand across the nation and eventually create a world market for U.S. farm products. In 1910, 325 million acres of cropland was harvested. (See Table 4.) Two hundred million acres of this was used to produce products for domestic consumption. Thirty seven million acres or 11 percent were cultivated for export. The remaining 27 percent were worked to produce food for workstock, the animals needed to provide farm power and transportation. By 1978, while only eleven million additional acres were harvested, the destination of the products had changed dramatically. Farmers no longer grew their fuel in the form of feed for workstock. The acreage formerly planted for this production input had been freed up to produce products for sale. In 1978, 223 million acres of cropland or 66 percent of all cropland harvested was used to produce food for the domestic population.[3] One-third of all cropland harvested was for export. This expansion from local and regional markets to national and world markets placed farmers in an expanded context of competition. The orange grower in California competes with the orange grower in Florida, or more recently Mexico or Brazil, to sell his or her product.

TABLE 4

ACREAGE OF CROPS HARVESTED AND USED FOR SPECIFIED PURPOSES, SELECTED YEARS, 19010-1978

		Acreage Used to Produce Products for:		
Year	Crops Harvested(1)	Exports(2)	Domestic Use	
			Feed for Workstock(3)	Other(4)
	..................million acres..................			
1910	325	37	88	200
1920	360	60	90	210
1930	369	39	65	265
1940	341	8	43	290
1950	345	50	19	276
1960	324	64	5	255
1970[5]	293	72	-	221
1978	336	113	-	223

Source: USDA, 1979, Changes in Farm Production and Efficiency, Statistical Bulletin No. 628.

1.Area in principal crops harvested as reported by SRS plus areages in fruits, tree nuts, and farm gardens. 2.Acreages for exports relate to exports for year beginning July 1. 3. On farms, in cities, mines, etc. 4. Includes products used by our military forces in this country and abroad and by our domestic civilian population. 5.Data for horses and mules discontinued after 1964.

The market for the corn farmer in Kansas depends not only upon good growing conditions in Kansas to realize a profit from his or her production but also on a poor yield in the Soviet Union or other parts of the world to have a market for the crop produced. The response of farmers to these competitive pressures and often tenuous market conditions has been to attempt to rationalize on-farm production. In the simplest sense, rationalization of production is applying analytical methods to production to attempt to utilize most efficiently all elements of production to reach a goal.[4] In a capitalist or production for profit economy, rationalization of production becomes an attempt to utilize most efficiently all elements of production to reach the highest profit possible.[5] The element of control is central throughout this rationalization process. As discussed in Chapter Three, farmers do not operate in a vacuum. Decisions are made based upon a complex set of political and economic forces which limit the degree of control farmers have in determining the direction and extent of rationalization of the production process. As outlined, the nature of the labor process, the source of production inputs, the individual farmer's market position and natural forces all constrain and direct a farmer's options. With these constraints in mind, the following discussion outlines some of the major structural changes in on-farm agricultural production in the United States.

The first is the commercialization of production. Commercialization of production refers to the intrusion of market relations within the farm gate. Farmers no longer produce fertilizers from their workstock or livestock. Farmers no longer produce 'fuel' for their farm power. They purchase both from petrochemical companies. Thus this commercialization is the interweaving of market relations into farm production.

Both the source and the composition of farm inputs have undergone dramatic transformation in this process. As seen in Table 5 the total amount of farm inputs has increased only slightly, less than 20 percent, from 1910 to 1978. What has changed is where the inputs come from. The amount of non-purchased inputs, or inputs produced on the farm, has declined over 44 percent, while the amount purchased off farm has more than tripled. Farmers now rely upon others to produce the materials they need to grow food and must acquire cash or credit to procure these supplies. Even products like seed, farm livestock, and food for livestock are now purchased rather than produced on the farm. Farmer's purchases have increased 510 percent between 1910 and 1978 for these basic materials.

TABLE 5

INDEXES OF TOTAL FARM INPUT AND MAJOR INPUT SUBGROUPS, SELECTED YEARS, 1910-78

(1967=100)

	TOTAL INPUT									
	ALL 1/	NON-PURCHASED 2/	PURCHASED 3/	FARM LABOR 4/	FARM REAL ESTATE 5/	MECHANICAL POWER AND MACHINERY 6/	AGRICUL-TURAL CHEMICALS 7/	FEED, SEED, & LIVESTOCK PURCHASE 8/	TAXES & INTEREST 9/	MISCEL-LANEOUS 10/
1910	86	158	38	321	98	20	5	19	51	75
1920	98	180	43	341	102	31	7	25	61	89
1930	101	176	50	326	101	39	10	30	75	83
1940	100	159	58	293	103	42	13	42	72	78
1950	104	150	70	217	105	84	29	63	82	87
1960	101	119	86	145	100	97	49	84	94	105
1970	100	97	102	89	101	100	115	104	100	109
1978	103	88	119	67	98	120	145	116	100	124

Source: USDA, 1979, Changes in Farm Production and Efficiency, Statistical Bulletin No. 628, Table #57.

1. Measured in constant dollars. 2. Includes operator and unpaid family labor, and operator-owned real estate and other capital inputs. 3. Includes all inputs other than nonpurchased inputs. 4. Includes hired, operator, and unpaid family labor. 5. Includes all land in farms, service buildings, grazing fees, and repairs on service buildings. 6. Includes interest and depreciation on mechanical power and machinery, repairs, licenses, and fuel. 7. Includes fertilizer, lime, and pesticides. 8. Includes nonfarm value of feed, seed, and livestock purchases. 9. Includes real estate and personal property taxes, and interest on livestock and crop inventory. 10. Includes such things as insurance, telephone, veterinary, containers, and binding materials.

The composition of materials or inputs used in agriculture has also changed. The structure of production has undergone dramatic transformation. Labor inputs have declined 379 percent while other inputs have skyrocketed. Purchases of mechanical power and other machinery and agrichemicals have increased 500 percent and 2900 percent respectively. A picture can be drawn of the changes in farm production from these brief observations. From a production system that was relatively self-contained, contemporary farm production has developed into just one stage of a series of industries involved in the production of food. As with other modern manufacturing concerns, components are purchased from suppliers, the product is 'grown' from these purchased supplies and these products are distributed to other concerns for further processing and distributing. The on-farm stage within food production has changed from labor intensive with few capital purchases to a capital intensive production stage encompassed on both sides by oligopolistic sectors.

Agricultural production in the United States has become agribusiness with three distinct phases - farm input industries, the production of food and fiber, and food processing and distributing industries. As seen in the previous discussion, contemporary on-farm production relies heavily upon inputs produced off the farm. The concentrated market structure of these industries sets up a situation of resource dependency for farmers which limits their control over the elements of production inputs. For example, in 1972, 47 companies produced nitrogenous fertilizer. Twenty of these controlled 84 percent of the shipments (Table 6). The situation is similar with farm machinery and equipment. While more companies produced these inputs, 1465, the top 20 firms accounted for 69 percent of the market .

TABLE 6

CONCENTRATION OF SELECTED FOOD SYSTEM INPUT INDUSTRIES, 1972

Industry Title	Number of Companies	CR41	CR20
Nitrogenous fertilizers	47	35	84
Phosphatic fertilizers	66	29	83
Fertilizer mixing	442	24	69
Farm machinery and equipment	1,465	47	69
Farm products and machinery	636	18	42

Source: Census of Manufacturers, 1972.

1.Percentage share of value of shipments accounted for by the four largest companies. 2.Percentage share of value of shipments accounted for by the largest 20 companies.

The implications of this economic concentration of farm input industries are twofold. The cost of production inputs and the kind of inputs available are affected by this market structure. In a limited competitive environment, the cost of farm input products rises. In addition, the oligopolistic conditions affect the product mix available (Martinson and Campbell, 1980). While the competitive structure of farm markets dictates ever increasing technological advances in attempts to maintain farm income or even survive as a farming endeavor, both these facets limit the potential or scope of decisions farmers can make in the area of production inputs.

In a sense, farmers choose new technologies to increase labor efficiencies or yields but within this choice lies increased reliance upon expensive inputs which further accelerates the cost-price pressures of farm production.

<u>Concentration of Agricultural Markets</u>

A parallel change that occurred concurrently with the commercialization of on-farm production is the concentration of farm production. Two elements are involved here. Farm markets have become more concentrated and on-farm production has become increasingly specialized. Fewer farms control larger shares of each commodity and farms are more likely to specialize in one or a few commodities.

In the context of uncertain markets and less control over production inputs, one strategy for minimizing market risk or the ability to be able to sell what has been produced at a profit is to control a larger share of production. One observation that can be made about the

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extent of concentration in U.S. food and fiber production revolves around the declining number of farmers and increasing farm size. The number of farms in the U.S. has dramatically declined during the latter half of this century.

TABLE 7

NUMBER OF FARMS AND COMMERCIAL(1) FARMS AND AVERAGE ACRES PER FARM, SELECTED YEARS, 1910-1978

Year	Number of Farms	Average Acres	Number of Commercial Farms	Average Acres	Percent Commercial Farms
1910	6,361,502	138.1	--	--	--
1920	6,448,343	148.2	--	--	--
1930	6,288,648	156.9	--	--	--
1940	6,096,799	174.0	--	--	--
1950	5,379,250	215.6	3,706,412	275.0	68.9
1959	3,707,973	303.0	2,416,017	404.5	65.2
1969	2,770,000	393.7	1,733,683	529.7	64.2
1978	2,476,340	393.0	1,864,687	522.2	75.3

Source: U.S. Census of Agriculture.

1.Farms with over $2,500 in sales.

In 1910, there were 6.3 million farms (Table 7). By 1978, only 2.4 million farms were reported, a decline of 62 percent. In concert, the size of the average farm in 1910 was 138 acres while by 1978 this had grown to 393 acres, a 185 percent increase. In short, one outcome of the processes of rationalization of farm production has been that land or farm acreage has been reorganized. Larger farms are being run by fewer farmers.

Increased size of farms has had both positive and negative results for farmers. Economies of scale realized by extending acreage give large farms higher rates of return than small farms on labor and other capital inputs (Goss et al., 1980; Quance and Tweeten, 1972). Large farms also disproportionately benefit from state policies and credit practices (Quance and Tweeten, 1972; Mann and Dickinson, 1980; Sinclair, 1980). However these benefits are circumscribed by the extent of agribusiness involvement in supplying farm inputs and marketing farm output. Large farms entail increased risks, i.e., a larger investment is needed in the form of increased capital and credit requirements. This increased flow of money may or may not increase a farmer's income but it does increase the amount of money s/he needs to receive in order to break even (Commoner, 1977), and thus dramatically escalates the risk involved in farming.

Regardless, farm acreage is only an approximation of a farmer's market position. Farm size may obscure differences among farms and differences between products. For example, a western livestock ranch may be very large in acreage compared to a midwestern cattle feedlot, but the feedlot may produce more cattle for sale. In addition several studies have suggested that focusing upon the growth in average farm size obscures a polarizing trend occurring within the structure of farming. While the average size of farms is increasing there remains a relatively stable proportion of small farms in agricultural production (Rodefeld, 1978; Chapman and Gross, 1978). Even more than volume of sales, share of market represents a more traditional economic measure of control. Whether a farmer cultivates 10 or 10,000 acres, if he or she sells 25 percent of the market of agricultural products tells us more about his or her market position vis a' vis other farmers.

With these considerations in mind, we can now turn to an examination of the changes in the market position of farmers. One way of examining a farmer's position in market relations is by looking at the concentration of agricultural production. A farmer can obtain greater control over the outcome of production by improving his or her market position. This can be accomplished in two ways - gaining greater control over external or gaining greater control in internal market relations. Vertical integration is a strategy that involves external market relations, a farmer might expand into inputs and output markets. Horizontal expansion is directed toward internal market relations -

capturing a larger share of a product market.

There is little evidence that farmers or on farm production is undergoing vertical integration. As established in the previous section on the commercialization of farm production, farmers have become a specialized step in the production of food and fiber. Farmers increasingly purchase rather than produce inputs and sell raw products for further processing by other industries. The trend in recent years has been away from the vertical integration of on farm production of inputs and food processing. A related concern revolves around the expansion of agribusiness corporations into food production. If a meat packing company operates livestock farms, this would also be vertical integration.[7] While the coordination of production and processing does appear to be increasing in the form of farm contract production, actual ownership of farms by corporations does not (Ottoson and Vollmar, 1972). A USDA study found that in 1970, non-family held corporations represented only about 0.2 percent of all commercial farms in the U.S.[8] In addition, these corporate farming operations accounted for less than 2 percent of total agricultural product sales (Scofield, 1970).

In contrast, agricultural markets have become more concentrated as a result of horizontal integration. Fewer farmers control a larger share of agricultural sales. There are several useful statistical tools available to chart this process of horizontal concentration. One, a Lorenz curve, is a mapping of the distribution of a resource within a population. In this context, the resource is market sales. If sales were equally distributed among farms, the Lorenz curve would be a 45 degree line between the x and y axis of a graph. A ratio of deviation from this line, of the difference between equal or balanced distribution of the resource and actual distribution, is generated by a Gini coefficient.[9] A Gini coefficient is a measure of twice the area between the Lorenz distribution curve and the line of equality. Gini coefficients range from 0 to 1. In this application, a Gini of 0 would represent a balanced distribution of market share and a Gini approaching 1 would indicate a high concentration of agricultural markets.

To assess market concentration within agricultural production, Gini coefficients were calculated based upon the percent distribution of all farms by percent of market value of products.[10] The results are as follows (Table 8). In 1889, the Gini coefficient was .5003. By 1978, this had increase 51 percent to .7573 (Table 8). In other words, during this period of time, market concentration within agriculture had increased substantially. This increase in concentration was not a smooth gradual progression. Between 1889 and 1930, concentration rose only 6.3 percent. The next twenty years, 1930 to 1950, saw an almost sextupling of this rate of increase to 17.7 percent. Subsequently between 1950 and 1969, agricultural market concentration declined 5.8 percent. Between 1969 and 1978, this trend was reversed. By 1974, market concentration had surpassed the previous high levels of the 1950's. Overall between 1969 and 1978, market concentration increased 28.5 percent.

Thus an important change has occurred in the structure of agricultural markets. Market power is less equally distributed among farms. Relatively fewer farmers account for a larger share of the production and sales of agricultural products.

However, similar to the discussion the relationship between increased size and farmer's market position, these aggregate measures of concentration are only approximate indications of the relative position of farmers with respect to other farmers. Farmers are not in direct competition with all other farmers to sell their products. Agricultural markets are commodity based. The market for cash grains is different from the market for fruits. A person who produces vegetables competes primarily with other vegetable farmers to sell his or her production and not with a livestock farmer (Hannon et al., 1976).

Further clarification of a farmer's market strength can be gained by specifying markets. One way to begin this sorting out of farm markets is to look at farms producing the

TABLE 8

AGRICULTURAL MARKET CONCENTRATION, OVERALL AND BY FARM TYPE, SELECTED YEARS, 1889-1978.

Year	(# of categories)	Gini Coefficient[1]
1889[2]	(6)	.5003
1930	(11)	.5317
1950	(4)	.6256
1959	(4)	.5940
1969	(6)	.5891
1974	(7)	.6472
1978	(9)	.7573

S.I.C. Farm Type	1959 (6)	1964 (6)	1974 (6)	1978 (7)
Cash Grain	.4434	.4709	.5547	.5969
Vegetable and Melon	.7214	.7250	.7347	.8226
Fruit and Tree Nut	.6034	.6607	.6868	.8039
Poultry and Egg	.5337	.5370	.4487	.4622
Dairy	.4221	.4446	.4545	.4336
Livestock, other than poultry and dairy	.6108	.6609	.7346	.8074

1. Gini coefficients are based on percent in economic class by percent of value of agricultural products produced.

2. In 1889, share of market is based upon the value of farm products not fed to livestock on the farms where produced.

same product group. Standard Industrial Classification (S.I.C.) categories give us a way to distinguish farm types on the basis of what is produced. A farm is assigned to a category based upon the product which accounts for the majority of the farm's sales of agricultural products. Six categories or types of farms will be examined here:[11] cash grain farms, vegetable and melon farms, fruit and tree nut farms, poultry and egg farms, dairy farms, and livestock (except poultry and dairy) farms. These divisions according to product group give us a basis for examining differences in market concentration among farm types.

As seen in Table 8, market concentration differs significantly among farm types based upon products. The production of vegetables, fruit and livestock are highly concentrated. The Gini coefficients are over 0.8 for these three farm types. Market concentration in vegetables, fruit and livestock is higher than the Gini coefficient of .7573 for all farms. The 1978 Gini coefficient for cash grain farms is .5969. Poultry and egg and dairy farms are lower still with Gini coefficients of .4622 and .4336 respectively. Historically, with the exception of poultry and egg farms, market concentration has steadily increased. Fewer farms are controlling a larger share of agricultural production for each product type.

TABLE 9

MARKET SHARE ACCOUNTED FOR BY TOP ECONOMIC CLASS, BY FARM TYPE, 1978

S.I.C. Farm Type	Percent of Farms	Percent of Value of Agricultural Sales
Cash Grain	10.1	46.5
Vegetable and Melon	11.8	86.5
Fruit and Tree Nut	9.3	74.1
Poultry and Egg	45.2	89.4
Dairy	18.0	51.0
Livestock, other than Poultry and Dairy	6.1	67.0

Source: U.S. Census of Agriculture

1.Farms with over $100,000 in sales of agricultural products.

These Gini coefficients illuminate two important differences among farm types in terms of a farmer's market position. First, the competitive environment differs for farm types. A low Gini score indicates a higher degree of competition. High Gini coefficients indicate a situation of restricted competition. Table 9 shows that the top 10 percent of cash grain farmers accounted for less than half of all sales of cash grain farms. In contrast, the farmers in the highest economic class operating fruit and tree nut or vegetable farms accounted for 86 percent and 74 percent respectively, of all sales from those type farms. This translates, for farmers in the top economic class, into a strong market position. Farms that control a large share of a product market are able to set the standards of production or production efficiencies that all other farms producing that product must match. In addition, restricted competition creates barriers to entry into production of these products by future farmers. A person who wished to begin vegetable or fruit farming would be in direct competition with these economically more powerful farms or with the other 90 percent of the farmers in that product farm type for the remainder of the market. In contrast, on cash grain farm, there are more opportunities for entry. Over half of the market is not contolled by the larger economic enterprises.

Put another way, dairy farmers are more equal in terms of market power than are vegetable farmers. For example in 1978, 11.8 percent of all vegetable and melon farms produced 86.5 percent of the value of all agricultural products produced on vegetable farms. The remaining 88 percent of the farmers accounted for less than 14 percent of the products sold. On dairy farms, 18 percent produced 51 percent of market value. Thus a smaller dairy farmer has a stronger position vis a' vis other dairy farmers than do small vegetable farmers. However, relatively similar market concentrations may obscure important differences in farmers' market positions within and between farm types. Farm types differ in terms of size of product market and number of farms within a type.

TABLE 10

POULTRY AND EGG FARMS AND DAIRY FARMS: VALUE OF AGRICULTURAL PRODUCTS BY ECONOMIC CLASS, 1978

	Poultry and Egg Farms		Dairy Farms	
Economic Class	% farms	% value	% farms	%value
Class I (over $100,000)	45.2	89.4	18.0	51.0
Class II (40,000 to 99,999)	22.5	9.1	43.1	37.2
Class III (20,000 to 39.999)	6.0	1.0	23.0	9.3
Class IV (10,000 to 19,999)	3.3	0.3	9.9	2.0
Class V (5,000 to 9,999)	3.0	0.07	3.5	0.4
Class VI (2,500 to 4,999)	3.0	0.06	1.4	0.07
Class VII (under 2,500)	18.0	0.07	1.1	0.03

Source: U.S. Census of Agriculture.

The clearest example of similar Gini coefficients masking very different market relationships can be seen by comparing poultry with dairy farms. The Gini coefficients in 1978 for these farm types were .4622 and .4336 respectively. These indicate relatively low market concentrations within each of the farm types. However, the distribution of economic classes within each of these farm types contrasts greatly. The top economic class (over $100,000 in sales) represents almost half of all poultry farms. These farms account for 89.4 percent of agricultural product sales on poultry farms (Table 10). In comparison, only 18 percent of all dairy farms produce over $100,000 of agricultural products. This top economic class accounts for slightly over half of all the market value of agricultural products produced on dairy farms. Thus the size of the market for poultry and egg farms is larger than for dairy farms with correspondingly larger opportunities for profit.

In addition the number of farms within a farm type has important ramifications for the environment of market competitiveness for farmers. In 1978, there were over four times as many dairy farms as poultry farms, 166,569 and 41,947 respectively (Table 11). More farms mean an expanded competitive environment. Each dairy farmer competes with more other dairy farms to sell their product.

Specialization

Increased specialization of production has further defined farm markets. By producing a smaller crop mix, a farmer can devote a larger share of his or her resources to one product. This reduces the diversity and number of tasks to be done and potentially can increase the share of a

TABLE 11

NUMBER AND PERCENT OF COMMERCIAL[1] FARMS BY S.I.C. FARM TYPES, 1950-1978

YEAR	CASH GRAIN	VEGETABLE AND MELON	FRUIT AND TREE NUT	DAIRY	POULTRY AND EGG	OTHER LIVESTOCK
	........................number of commercial farms.....................					
1950	430,389	46,415	82,178	602,093	175,876	806,080
1959	398,047	21,912	61,419	428,293	103,279	616,902
1969	369,312	19,660	53,754	260,956	57,545	568,201
1978	525,572	25,507	57,507	166,569	41,947	704,860
	...................percent of all commercial farms......................					
1950	11.6	1.3	2.1	16.3	4.8	21.8
1959	16.5	.9	2.5	17.7	4.3	25.5
1969	21.3	1.1	3.1	15.1	3.3	32.8
1978	28.3	1.4	3.1	8.9	2.3	37.8

Source: U.S. Census of Agriculture.

1 Farms with over $2,500 in sales of agricultural products.

particular product's market a farmer controls. Product group in these dimensions refers to the set of agricultural products used to categorize the farm into the S.I.C. farm type. For example, cash grain products like corn, soybeans and wheat, are the product group for the cash grain farms.

There are three interrelated dimensions within specialization. The first, market specialization, is the proportion of an agricultural product group produced by a particular type of farm. For example, market specialization is the precentage of all cash grains sold accounted for by the sales of cash grain farms. Farm specialization, the percentage of sales accounted for by the product group of total sales by farms of that type is the second dimension of specialization. In other words, on vegetable and melon farms, the proportion of total sales accounted for by sales of vegetables and melon products is the measure of farm specialization. The third dimension of specialization is product specialization - the proportion product-type farms are of all farms producing the product group. The percentage poultry and egg farms represent of all farms producing poultry and egg products is the dimension of agricultural specialization. As seen in Table 12, all three dimensions of this process of agricultural specialization have historically increased.

TABLE 12

FARM SPECIALIZATION BY MARKET, FARM AND PRODUCT,

SELECTED YEARS, 1940-1978.

S.I.C Farm Type	Market(1) Specialization	Farm(2) Specialization	Product(3) Specialization
	................percent	....	
Vegetable and Melon			
1940	66.2	73.6	17.5
1950	69.9	83.6	--
1959	71.2	81.7	--
1969	79.1	85.5	28.5
1978	82.0	86.0	43.0
Fruit and Tree Nut			
1940	85.5	83.9	20.0
1950	88.2	92.1	--
1959	91.1	93.3	--
1969	92.5	94.6	62.6
1978	93.8	95.5	73.6
Dairy			
1940	68.1	62.7	23.4
1950	75.7	69.4	--
1959	85.6	72.6	--
1969	93.0	86.2	72.5
1978	91.8	82.4	76.0
Poultry and Egg			
1940	46.8	72.3	6.2
1950	58.2	88.2	--
1959	80.1	90.9	--
1969	97.0	95.8	29.2
1978	97.7	95.0	35.4
Cash Grain			
1940	--	--	--
1950	--	--	--
1959	35.5	83.5	--
1969	66.7	81.1	36.0
1978	77.6	85.0	56.0
Livestock, except poultry and dairy			
1940	13.9	13.5	16.0
1950	70.7	79.8	--
1959	63.8	81.4	--
1969	73.3	84.2	--
1978	85.3	88.5	--

1.Market specialization is the percent of total product sales produced on the farm type farms. 2.Farm specialization is the percent the product sales are of total farm type production.

3.Product specialization is the percent of the number of farms, farm type farms are of all farms producing that product.

The indicator, market specialization, demonstrates that the production of agricultural products is increasingly done on specialized farms. For example in 1940, 66.2 percent of all vegetables and melons were produced on vegetable and melon farms. By 1978, 82 percent of all vegetables and melons were produced on vegetable and melon farms. Even greater increases in specialized production can be seen in the case of poultry and eggs. In 1940, less than one-half of all poultry and eggs were produced on poultry and egg farms. By 1978, this increased to over 97 percent. Even in the least specialized product share market, cash grain production, cash grain farms in 1978 accounted for 77.6 percent of all cash grain sales.

In short, by 1978, over three-quarters of every product group was produced on the S.I.C. type farms. This trend in specialized production indicates increasing dominance of product markets by specific groups of farmers. As seen in the dimension, product specialization, fewer farms outside farm type groups are competing with product-type farms in their specialized market. For example in 1940, fruit and tree nut farms were only 20 pecent of the number of all farms producing fruit and tree nut products. By 1978, fruit and tree nut farms accounted for 73 percent of all farms producing this product group. Though less dramatic, similar trends of reduced competition from other farms exist for the other farm types.[12] Even in the case of poultry and egg production, where farm type production specialization only increased from 6.2 percent to slightly over one third of all farms who produce poultry and eggs, these 35.5 percent poultry farms sold over 97 percent of poultry products. In other words, specialized farms dominate product markets.

In addition, the third dimension of specialization, farm specialization, has also increased historically. Agricultural production within farms has become less diversified. Product groups account for an increasing share of farm type sales. For example, the product group for dairy farms is milk and other dairy products. Dairy products, in 1940, made up only 62.7 percent of the value of all agricultural sales made by dairy farms. By 1978, a much larger portion, 82.4 percent, of dairy farms' sales came from dairy products. Clearly dairy farm production is more specialized. The product mix within dairy farm production has narrowed. Production on other product-type farms underwent a similar transformation. By 1978, over four-fifths of each farm type's total sales came from the farm's product group.

Summarily, agricultural production is specialized. First, farm type production is less diversified, e.g., cash grain farms produce mostly cash grain crops. Secondly, product production is more concentrated, e.g., vegetable and melon farms account for a greater proportion of all farms producing vegetables and melons. And finally, product markets are dominated by product-type farms, e.g., fruit and tree nut farms produce most of the fruits and tree nuts.

Summary

As we have seen, the dramatic increases in labor and land efficiency within U.S. agriculture this century have been accomplished in the context of an equally dramatic structural transformation. Rationalization of production has meant an increasing commercialization of agricultural production and a changing mix of production inputs. Farmers increasingly rely upon concentrated agribusiness concerns to supply these production inputs. Rationalization of agricultural production has also entailed a reduction in the diversity of products on any given farm. Farms are specialized both in terms of on-farm production and product group markets.

In terms of market distribution, agricultural production has been polarized. Fewer farmers operate large market share farms while a stable portion of small farms have survived. Thus a situation of unequal market power exists among U.S. farms. With these changes in mind, we can now turn to an examination of energy and labor within this context.

Chapter Five Notes

1.An exception must be noted here. During the decade, 1920 to 1930, agricultural yields declined. This can be attributed to the depression, which hit agriculture earlier than the rest of the U.S. economy, and to the increased use of farmland for subsistence (Cochrane, 1979).

2.See Cochrane (1979) and Friedmann (1978) for a summary discussion of these market fluctuations.

3.Clearly some land is still used to produce feed for animals. During this period, consumption of meat in the American diet has increased (Perelman, 1977).

4.See Braverman (1974) and Edwards (1979) for extended treatments of rationalization of production.

5.Profit in a capitalist system comes from the appropriation of surplus labor. Therefore control over the labor process to extract as much surplus labor as possible is central to the rationalization of production.

6.The idea of farmers having a choice in this process may be a generous interpetation. With the external context of oligopolistic conditions, constraining state policies, and limiting credit practices, this may have been the only avenue left for farmers. See for example Buttel and Newby (1980), and Dvoskin and Heady (1976).

7.In a sense there are two possible forms of vertical expansion possible for food production - one done by farmers (farms producing inputs or controlling output markets), and one done to farmers (food processing or agricultural input industries expanding into on-farm production). A related issue is the expansion of non-farm corportations into food production. While not an example of vertical integration, this type of expansion would further threaten farmers' control.

8.There is concern with this dimension of the connection of on-farm production to off-farm concerns. Contract production involves the negotiation of price, amount, and production inputs between the farmer and the food processors. The result is less control over actual production for the farm operator. There is evidence that this form of vertical 'connection' is expanding (Rodefeld et al., 1976), especially in regard to processed vegetables (Hightower, 1975) and in regard to poultry production (U.S.D.A., 1975).

9.See Duncan and Duncan (1955) and Allison (1978) for a general discussion of Gini coefficients.

10.The Gini measure is especially sensitive to two data distribution characteristics that mean these Gini's are probably on the low side. Both a bell shaped or mid-range distribution and the number of categories or use of aggregated data tend to underestimate the degree of inequality (Hoivik, 1978; Alker, 1965; Duncan and Duncan, 1955; Bornscier and Ballmer-cao, 1979; Allison, 1978).

11.See the preceding methodology chapter for a discussion of the differences in applying these S.I.C. categories historically.

12.Similar data on product specialization is not available for livestock, except poultry and dairy farms. However, it is reasonable to conclude that similar specialization patterns are occurring within the production of livestock, i.e., that fewer farms are producing livestock for sale. However, the magnitude of this aspect of specialization for livestock (except poultry and dairy farms) cannot be ascertained.

Chapter Six:
ENERGY AND LABOR IN AGRICULTURE: A HISTORICAL OVERVIEW

> "The unique achievement of American agriculture is not to increase yields but to harness fossil fuels to replace labor." (Perelman, 1977 :41)

Few would quarrel with the statement that increased energy inputs into agriculture have coincided with reductions in farm labor. However this general statement lies within a complexity of methodological and conceptual issues that hinder the construction of neat conceptualizations and further clarifications of this relationship. Many of these revolve around the question: How do we measure energy?

Contemporary Energy Picture

The most comprehensive attempts to deal with this issue involve computing the number of B.T.U.'s (British Thermal Units) involved in agricultural production. A report, Energy Use in the Food and Fiber System, by the F.E.A. (1976), summarizes the findings of the most recent of these studies. Energy use in agricultural production is slightly over 2400 trillion B.T.U.'s. This energy input total is computed by looking at four components of energy consumption (direct, indirect, capital and transportation) in each of five stages of agricultural production (farm production, food manufacturing, wholesale and retail, consumption, and transportation). The total energy consumption of all five stages accounts for 16.5 percent of the total U.S. energy budget (Table 13). In terms of the different sectors, on-farm production uses slightly over 15 percent of all the energy used in the production and distribution of food and fiber. The preparation and consumption of foodstuffs uses over twice as much energy as on-farm production.

TABLE 13

AGRICULTURAL ENERGY CONSUMPTION
BY SECTOR AND COMPONENTS, 1973

	Food System	U.S. Total
	.........percent.........	
Sector		
Agricultural production	15.15	2.9
Manufacturing	26.67	4.8
Wholesale and retail trade	7.88	1.3
Consumption in and out of home	35.15	7.1
Transportation	15.15	0.4
Total	100.0	16.5
Components		
Direct	53.3	8.8
Indirect	26.7	4.4
Capital	7.3	1.2
Transportation	12.7	2.1
Total	100.0	16.5

Source: F.E.A., 1976, ENERGY USE IN THE FOOD SYSTEM, May.

Energy use can also be examined in terms of the distribution of energy consumption between the different components of production. These components give us an idea of at what point the energy was used. Direct energy use is the fuel and power used within the production stage to run machinery. Indirect energy is the energy stocks used to produce sector inputs, while the capital component measures the energy used to produce the machinery that is used in the production of the sector examined. The component of transportation includes the energy expended transporting materials and products within and between sectors.

TABLE 14

ENERGY USE IN AGRICULTURAL PRODUCTION SECTORS, 1973

	Energy Use (trillion BTU's)
Total[1]	2401.7
Sectors[2]:	
Cash Grain	364.4
Vegetable and Melon	15.4
Fruit and Tree Nuts	21.5
Livestock, other than poultry and dairy	147.4
Poultry and Egg	20.1
Dairy	57.5

Source: F.E.A., 1976, ENERGY USE IN THE FOOD SYSTEM, May.

1. Includes direct, indirect, and capital energy inputs.
2. These figures are for direct energy inputs only.

Overall in the U.S. food system, direct energy consumption accounts for over half of the total energy used in production (Table 13). For the sector of on-farm production, this relationship is different. On the farm, only one-third of all energy used is used directly, while 37.9 percent is consumed indirectly in the production of farm inputs (F.E.A., 1976). Direct energy consumption in agricultural production also varies by farm type. Cash grain farms, in 1973, used 364.4 trillion B.T.U.'s, while vegetable and melon farms used only 4 percent of that, 15.4 trillion B.T.U.'s (Table 14). Therefore farms differ in terms of energy consumption depending upon what they produce and how it is produced.

The distribution of B.T.U.'s among sectors is a reflection of a number of factors - the number of farms, the scale of production the structure of production (i.e., what production inputs are used), and the structure of the labor market. The distribution of B.T.U.'s between components is also a reflection of the social relations of production. The structure of production - who owns and controls what facets of production in what kind of market environment and who does what work using what resources - affects both the amount and the distribution of energy used. These categories of direct, indirect, capital, and transportation obscure the production relations involved, i.e., the structure in which the energy is consumed, with no way to address the underlying dimension.

In addition, labor or energy from labor is not included in these accounts. The components focus upon fuel or power for machinery, but not why a tractor instead of labor or whose labor runs that tractor. While this omission of labor probably affects the final B.T.U. figures and percentages very little (Pimentel, 1980), for the purposes at hand, this type of categorization is severely limited.

These components tell us where the energy was consumed but not how it was used nor why sectors differ. We can impute differences in production processes among the sectors but can not discuss what these differences might be. While the general computations of percentage of B.T.U.'s used tell us the magnitude of energy consumption and can help us locate areas for energy conservation, we get little sense of the underlying dynamics: Who is producing in what way. What is needed is a way to measure energy inputs into farm production that can be related to specific production changes.

One typology used in some of the energy and agriculture literature (Pimentel, 1978; Commoner, 1975) is based upon the possibility of energy replacement. Energy is divided into renewable and nonrenewable forms. Nonrenewable energy is considered to be available in finite amounts. For example, to create more petroleum or coal would take many centuries of very specific geophysical conditions making these nonreplaceable resources. In contrast, solar energy, biomass forms of energy like wood and crop residues, and even human energy are considered renewable. Supplies of these energy forms can be replenished in a relatively short geophysical time frame. Clearly farming in the United States has undergone a transformation in terms of the replacement potential of energy sources. Nonrenewable petroleum as fuel for tractors, both nonrenewable forms of energy inputs, has replaced feed for workstock, both of which are renewable forms of energy inputs.

A rough approximation of the degree and direction of this change can be seen by looking at indexes of changes in purchased and nonpurchased farm inputs. If an energy source is produced on the farm, it can be considered a renewable energy form. As the discussion on the capitalization of farm production noted, farmers now produce fewer inputs and purchase many more of their production materials. If farmers were merely buying the same inputs from other suppliers, rather than producing these for themselves, this wouldn't represent a switch from a renewable to a norenewable production base. For example, if a farmer now buys manure for fertilizer rather than producing it from his or her own livestock, this would still be a renewable input.

However this is not the case: the production components have also changed. Farming has switched to a nonrenewable base. Inputs of the nonrenewable types such as mechanical power and machinery, and agricultural chemicals, have increased steadily between 1910 and 1978, 500 percent and 2220 percent respectively (see Table 5 on page 85).

Thus the production structure of farming has shifted to a base of limited resources. Several observations about the relations of production can be drawn from this energy typology. The transformation of the farm energy base has diminisheded the degree of farmers' control over production in terms of reliance upon the market and in terms of eventual geophysical limitations. Both of these have resulted in higher costs of production for agricultural products. Between 1960 and 1980, the price of petroleum increased over 300 percent (Tanzer, 1974, 1978). Prices of farm inputs rose correspondingly. Farmers had little choice but to buy the expensive inputs.

If you work the land by using tractors, combines, and machine harvesters, you must purchase both the machines and the petrol to fuel these machines. If a farmer relies upon commercial fertilizers to feed crops and herbicides and pesticides to ensure a harvest these must also be purchased. Thus reliance upon nonrenewable resources has meant increased capital needed for production costs.[1] With limited control over product markets this exacerbates the cost-price squeeze in which farmers perpetually find themselves.

Future implications that stem from the reliance upon a nonrenewable resource base are equally dismal. Implicit in the categorization of a resource as nonrenewable is the understanding that the amount of the resource is limited. Despite recent settling of the price of petroleum, the stock of petroleum will eventually be depleted.[2] As this depletion evolves, farmers will be caught within a production structure that is no longer viable both in terms of cost and availability.[3]

In light of these drawbacks that have accompanied an increased reliance upon fossil fuels in agriculture, we must ask why farmers made this choice. The answer to this question is found in the dynamics of capitalism. To remain competitive or to improve his or her competitive position in the context of expanding markets, a farmer needed to expand the share of production. Land was limited. Efforts to produce more or to rationalize farm production revolved around one renewable agricultural energy input: labor. Concern with the availability of, cost of, and control over labor dominated farm rationalization.

Before we can proceed with a discussion of the role of labor relative to changing sources of energy , the types of energy under discussion need to be further delineated. While the dimension of renewability provide some insights, energy inputs can be further explored by looking at two forms of energy technology - mechanical and biochemical. Each type differs in terms of impact on labor (Lu, 1978), strategy for improving a farm's competitive position and relative historical timing. Mechanical energy technology refers to farm power, machines introduced to do farm work and the energy that powers them. Encompassed within this form of energy use is the machinery that was used to replace human and animal power on the farm and the energy to fuel those machines. The introduction of mechanical energy technology can be seen as an extensive strategy of resource utilization. Farmers who use tractors can cultivate the same amount of land in much less time, or use the same labor time to cultivate a larger acreage and thus potentially control a larger portion of his or her crop's market.

In contrast, biochemical forms of energy technology, which include commercial fertilizers and other agricultural chemicals, are used to increase the amount of product obtained from a given plot of land. This result of increased yields is an intensive strategy of resource utilization. Given the limited amount of land available for agricultural production, farmers strive to increase yields from that land by adding biochemical inputs into production processes. In addition, biochemical energy inputs reduce natural risks by insuring a supply of nutrients and competing weeds, insects , and disease.

Mechanical Energy Inputs

The adoption of machine powered farm implements in farm production began at the turn of the century. By 1920, reliable diesel powered tractors were widely available (Cochrane, 1979). Gradually farmers began to switch from animal and human power to machines. Between 1920 and 1940, farm inputs of mechanical power and machinery increased 35 percent. (See Table 5 on page 69a.) During the next decade, 1940 to 1950, this process was accelerated; mechanical farm inputs increased 100 percent. In the next twenty-eight years, farm use of machinery continued to increase at a slower rate, 30 percent between 1950 and 1978.

These changes in farm inputs reflect two interrelated changes in on-farm production - the purchase and use of farm machinery and the purchase of petroleum products to fuel the machines. In 1930, less than 15 percent of all farms owned tractors (Table 15). In 1940, this had increased to just under one-quarter of all farms. The decades between 1940 to 1960 mark the consolidation of this production change. In the ten years between 1940 and 1950, tractor ownership rose 156 percent. Farmers quickly phased out animal power. Between 1950 and 1954, the percentage of farms reporting no use of horses or mules for farm power increased to almost one half of all farms (Table 16). By 1959, 82.6 percent of all farms reported owning tractors. This increased only slightly

TABLE 15

PERCENT OF FARMS AND FARM TYPE OWNING TRACTORS, SELECTED YEARS, 1930-1978

YEAR	TOTAL[1]	CASH GRAIN	VEGETABLE AND MELON	FRUIT AND TREE NUT	POULTRY AND EGG	DIARY	LIVESTOCK OTHER THAN POULTRY & DAIRY
1930	14.6	--	--	--	--	--	--
1940	23.0	--	--	--	--	--	--
1950	58.9	85.6	61.2	61.5	41.5	72.2	68.5
1960	82.6	94.0	88.0	79.0	64.3	93.6	88.1
1969	89.0	91.9	90.9	81.2	76.1	94.0	98.4
1978	89.1	92.1	88.1	79.5	78.6	95.4	86.6

Source: U.S. Census of Agriculture.

[1]Data for Total is for all farms. Data for Farm Types refer to commercial farms only.

through the next period. In 1978, 89.1 percent of all farms reported owning tractors. Thus by the 1960's, tractors had become the power source on farms in U.S. agriculture.

TABLE 16

PERCENT OF FARMS AND BY TYPE OF FARM, REPORTING TRACTOR WORK POWER WITH NO USE OF HORSES OR MULES, 1950 AND 1954

	Year	
	1950	1954
All Farms	27.4	45.3
Farm Types:		
Cash Grain	51.2	69.7
Vegetable and Melon	38.9	55.2
Fruit and Tree Nut	48.1	55.1
Poultry and Egg	29.0	35.8
Dairy	31.5	55.9
Livestock other than poultry and dairy	24.1	44.7

Source: U.S. Census of Agriculture.

The number of tractors on farms more than tripled between 1910 and 1920 (Table 17). This trend of rapid increase continued with a 274 percent increase in the number of tractors in the next decade.[4] The rate of increase slowed during the Depression and years to 70.3 percent for the decade. By 1960, the number of tractors had reached a high of over 4.6 million. After 1960, the number of tractors began to decline slightly each decade.

TABLE 17

FARM MACHINERY: NUMBER OF SPECIFIC KINDS ON FARMS AND TRACTOR HORSEPOWER, SELECTED YEARS 1910-1978

Year	Tractors[1] (thousands)	Horsepower (millions)	Grain Combines[2] (thousands)	Field Forage Harvestors3 (thousands)
1910	1	--	--	--
1920	246	10	--	--
1930	920	25	61	--
1940	1567	42	190	--
1950	3394	93	714	81
1960	4688	153	1042	291
1970	4619	203	790	304
1978[3]	4370	243	538	272

Source: USDA, 1979, CHANGE IN FARM PRODUCTION AND EFFICIENCY, Statistical Bulletin No. 628, table 31.

1.Includes wheel and crawler type tractors, exclusive of steam and garden tractors.
2.Data for 1970 and after are for self-propelled combines only.
3.Data for 1978 does not include flail type forage harvesters.

This decline in the number of tractors does not represent a reversal in the importance of tractors as a source of farm power. Several factors are operating here --

most importantly, fewer farms and more powerful tractors.

Prior to 1940, there was a larger increase in the number of tractors than in tractor horse power, 539.9 percent and 320 percent respectively. Between 1940 and 1978, there was a larger increase in tractor horsepower, 478.6 percent, than in the number of tractors, 178.8 percent (Table 17). This indicates that more powerful machinery which could do more work was replacing older tractors.

In addition, specialized types of farm machinery were being developed and rapidly adopted. For example, grain combines were introduced in the 1930's and rapidly spread. From 1940 to 1960, the number of grain combines rose from 61,000 to over one million, an increase of 1608 percent. Field forage harvesters also were rapidly adopted; from 1950 to 1978, the number of these machines increased 275 percent.

In addition to this changing mix of farm machinery the decline in the number of farm tractors is related to the reduction in the number of farms that occurred in this period (see the discussion on page 89). Fewer farms combined with increased horsepower translate into a need for fewer tractors.

The data in Table 17 show us the change over time in the amount of farm machinery. The numbers indicate the centrality of energy in the rationalization of farm production. Rationalization of farm production entailed a shift from animal and human power to mechanical energy inputs. To understand how these amounts relate to the structure of farm production, we need to look at the distribution of these resource technologies among farms. Looking at the resource in terms of farm use gives us an indication of the relative position and importance of mechanical energy in farm production.

TABLE 18

EXPENDITURES FOR PETROLEUM1 PRODUCTS, SELECTED YEARS, 1940-1978

Year2	Farms Reporting Expenditures	Percent of All Farms	Expenditures ($1,000) (Reported in 1967 dollars)	Average Expenditures per Farm (Reported in 1967 dollars)
1940	2,886,614	47.3	133,821	46
1950	2,575,279	69.5	1,163,848	45
1959	2,342,933	96.9	1,406,060	60
1969	1,721,670	99.3	1,917,675	111
1978	1,861,498	99.9	12,627,991	678

Source: U.S. Census of Agriculture.

1.This includes deisel fuel, gasoline, LP gas, fuel oil, natural gas and other petroleum distillates.

2.For 1940, this includes all farms. For 1950-1978, data refers to commercial farms only.

Information about petroleum purchases confirms the centrality of mechanical energy inputs into farm production. In 1940, less than one half of all farms reported purchasing petroleum products (Table 18). By 1959, 96.9 percent of all farms bought fuel. Thus farm machinery and fuel to power those machines had become a standard facet of production. Individual farm gas pumps became a feature of the American farm.

Irrigation is also a mechanical energy technology. Pumps are used to extract and distribute water down conduits to crops or pasture. These pumps are diesel or electrically powered. However, irrigation differs from other mechanical energy inputs in that it can be used in either an intensive or an extensive way. Previously unused land can be brought into production through adding water, or cropland can be irrigated to improve yields and reduce uncertainty. Early irrigation appeared to be part of an extensive strategy of expanding farm land (Cochrane, 1979). More recent use of irrigation seems to be intensive in nature. According to the Land Ownership Survey in 1978 by U.S.D.A. (Slogget and Dougherty, 1980), 71 percent of the land brought into irrigation between 1974 and 1977 was cropland previously.

Regardless of the intent of the process, irrigation by farmers has increased as a component of production. In 1900, two percent of all farms irrigated a total of 7.7 million

TABLE 19

IRRIGATION: NUMBER OF FARMS AND ACREAGE IRRIGATED, SELECTED YEARS, 1900-1978

YEAR	NUMBER OF FARMS	PERCENT OF ALL FARMS	NUMBER OF ACRES IRRIGATED (thousands)	PERCENT OF ALL FARMLAND HARVESTED
1900	113,849	2.0	7,745	0.9[2]
1910	162,723	2.6	—	—
1920	220,789	3.5	—	—
1930	265,147	4.2	14,633	2.9
1940	299,604	4.9	17,983	3.4
1950	306,617	5.7	25,833	7.5
1959	312,217	8.4	33,419	10.7
1969[1]	213,162	12.3	38,196	14.6
1978[1]	247,838	13.3	49,697	15.8

Source: U.S. Census of Agriculture.

[1]Data for 1969 and 1978 are for commercial farms only.
[2]For 1900, this figure is percent of all farmland.

acres (Table 19). By 1978, 13.3 percent of all farms irrigated 49.7 million acres of farm land. This is 15 percent of all cropland harvested. A twenty year period, 1950 to 1970, showed the greatest increase, 115.8 percent, in the number of farms using irrigation.

Biochemical Energy Inputs

Biochemical energy inputs include commercial fertilizer, pesticides, herbicides and other agricultural chemical compounds. While mechanical energy inputs are largely extensive production techniques, biochemical energy technologies increase the intensity of agricultural production. The use of agrichemicals is directly tied to increased yields and reduced natural risks. Inputs that create less insect and weed competition or provide more readily available plant nutrients contribute to minimizing catastrophic losses and increase production per acre or animal.

Agrichemical inputs were gradually introduced. Use of this form of biochemical energy resources increased roughly 40 percent a decade from 1910 to 1940 (see Table 5 page 85.) Much of this increase probably represents the gradual adoption and spread of commercial fertilizers. In 1909, 28.7 percent of all farms reported purchasing commercial fertilizers (Table 20). This gradually increased each decade to 40.6 percent in 1939.

TABLE 20

FERTILIZER USED IN DOLLARS AND TONS (1889-1978)

YEAR	DOLLAR EXPENDITURES				AMOUNTS OF FERTILIZER			
	% FARMS REPORTING EXPENDITURES FOR FERTILIZER	AMOUNT SPENT[1] FOR FERTILIZERS (Reported in 1967 dollars)	AVERAGE EXPENDITURE PER FARM REPORTING	AVERAGE PER ACRE	TONS OF FERTILIZER PURCHASED	AVERAGE TONS PER FARM	AVERAGE POUNDS PER ACRE	NUMBER OF ACRES FERTILIZED
1899	--	42,156,980	--	--	--	--	--	--
1909	28.7	77,086,184	42.27	.08	--	--	--	--
1919	35.2	212,159,870	93.60	.42	--	--	--	--
1929	37.0	146,913,800	65.58	--	7,535,022	3.36	--	--
1939	40.6	90,087,729	38.50	--	7,003,826	3.80	--	--
1954[2]	68.9	1,005,671,500	34.09	8.58	17,811,999	7.76	307	116,212,488
1959[2]	71.8	--	--	--	19,802,175	8.33	290	133,258,950
1964[2]	77.4	1,596,389,600	975.33	11.11	21,990,956	13.43	306	143,762,751
1969[2]	79.2	2,298,607,100	1811.06	14.78	27,222,348	21.45	350	155,549,632
1974[2]	80.4	9,437,796,300	7380.36	51.11	29,333,869	22.94	318	184,642,504
1978[2]	92.2	13,334,112,000	7877.38	59.39	--	--	--	224,695,460

Source: U.S. Census of Agriculture.

[1]For 1889 this includes only fertilizer, 1909 and 1919 expenditures for manure and other fertilizers, 1929 includes expenditures for commercial fertilizer, manure, lime and ground stone lime, 1939 only commercial fertilizer, 1954-1964 commerical fertilizer and lime, 1969-1978 commercial fertilizer expenditures only. [2]From 1954-1978, only commercial farms are included in the percentage.

This period of gradual introduction of biochemical inputs was followed by two periods of accelerated increases. In the years between 1940 and 1950, and 1960 and 1970, the rates of increase in biochemical inputs were 120 percent and 135 percent respectively (see Table 5 on page 85.) The first surge between 1940 and 1950 paralells the increased use of commercial fertilizer. Tons of fertilizer purchased more than doubled between 1939 and 1954 (Table 20). In addition, there was a 70 percent increase in the percent of farms using commercial fertilizers. By 1954, over two thirds of all commercial farms reported fertilizer purchases.

Increases in fertilizer use continued gradually over the next twenty five years. During this time, the percent of farms reporting fertilizer expenditures slowly rose from 68.9 percent to 92.2 percent. Thus by 1978, commercial fertilizer was a production input on most farms. The amount of farm land the fertilizer was used on also increased. Between 1954 and 1978, the number of fertilized acres almost doubled. In 1978, almost three-quarters of all harvested cropland was fertilized (see Table 20).

The second period of increased use of biochemical energy use in agriculture, 1960 to 1970, is more closely tied to increased use of other agricultural chemicals. While the number of farms using these inputs slowly increased, the expenditures for these production inputs skyrocketed (Table

21). By 1969, 59.6 percent of all farms reported purchasing agricultural chemicals other than fertilizers. By 1978, almost 70 percent of all farms bought these inputs.

TABLE 21

AGRICULTURAL CHEMICALS: EXPENDITURES, PERCENT OF FARMS, AND ACRES USED ON, 1964, 1969, AND 1978

Expenditures for Agricultural Chemicals[1]	1964	Year 1969	1978
Percent of all farms	--	59.6	69.9
Expenditures($1,000)	--	860,047	6,112,190
Percent increase in expenditures (1969-1978)	--	--	610.7
Agriculutural Chemicals Used For:			
Control of Insects and Disease:			
acres used on (million)	38.1	44.4	98.4
percent of cropland harvested	13.9	18.0	30.2
increase in acreage	--	--	158.3
Control of Weeds, Grass, and Brush:			
acres used on (million)	63.3	89.9	163.9
percent of cropland harvested	23.1	34.4	52.1
increase in acreage	--	--	159.1
Insect Control on Livestock and Poultry:			
number of farms (thousands)	--	352.1	511.1
increase in use	--	--	45.2

Source: U.S. Census of Agriculture.

1. Reported in 1967 dollars.

During this period, 1969 to 1978, the number of dollars used to purchase the agricultural chemical inputs increased 610.7 percent. Clearly part of this increase in expenditures is attributable to the price increases resulting from the energy crisis. According to the Producer Price Index (U.S.D.L., 1980:336), the cost of agricultural chemicals roughly doubled between 1960 and 1978. This meant that farmers paid twwice as much for the same amount of resources. Thus, less than one-sixth of the increase shown in Table 21 can be attributed to rising prices. Use of agrichemicals such as herbicides and pesticides continued to grow as a factor of production. Between 1964 and 1969, use of agrichemicals for insect and disease control increased from 13.9 to 30.2 percent of all farms. In additon, the acreage treated by these inputs increased 158.3 percent.

Similiar patterns of expanded usage occurred for other forms of agricultural chemical use. By 1978 nearly half of all harvested cropland was treated with chemicals for weed control. The number of farms using biochemical energy inputs for insect control on livestock and poultry also increased dramatically. Between 1969 and 1978, almost twice as many farms reported using agrichemicals for this purpose.

In summary, U.S. agriculture in the period 1910 to 1978 is characterized by the increasing use of both mechanical and biochemical energy inputs. This change in energy production

TABLE 22

FARM LABOR FORCE: PROPORTION FAMILY AND HIRED
CHANGE BY DECADE 1910-1978

YEAR	TOTAL FARM WORKERS [thousands]	ALL FARM WORKERS	FAMILY[1]	HIRED WORKERS	FAMILY WORKERS	HIRED WORKERS
		.........index 1910=100		....	...percent	.....
1910	13,555	100	100	100	75	25
1920	13,432	99	99	100	75	25
1930	12,497	92	92	94	75	25
1940	10,979	81	82	79	76	24
1950	9,926	73	77	69	77	23
1960	7,118	52	52	55	74	26
1970	4,523	33	33	35	74	26
1978	4,152	31	28	38	69	31

PERCENT CHANGE BY DECADE

DECADE	# FARMS	ALL FARM WORKERS	FAMILY WORKERS[1]	HIRED WORKERS
1910-1920	+ 1.5	- 0.9	- 1.3	+ 0.3
1920-1930	- 3.1	- 7.0	- 7.3	- 5.9
1930-1940	- 3.2	-12.2	-10.8	-16.0
1940-1950	-11.5	- 9.6	- 8.5	-13.0
1950-1960	-31.5	-28.3	-30.9	-19.8
1960-1970	-27.0	-36.5	-36.2	-37.0
1970-1978	- 7.4	- 8.2	-14.7	+10.3

Source: THE FARM LABOR REPORT, USDA, Agricultural Marketing Service, various years.

[1]Includes farm operators, paid and unpaid family labor.

inputs restructured the role of labor in the farm production process. Use of tractors for power rather than horses and mules meant that both less labor and a different set of skills were needed. Similarly, while use of herbicides meant fewer hoers, it presumably entailed more skilled labor to apply the chemicals.[5]

Farm Labor

Fewer people work on farms. The decline in the farm work force between 1910 and 1978 is well documented (Lianos, 1971; Jenkins, 1975, 1978; Jenkins and Perrow, 1977; Davis, 1980). In 1910, 13.5 million people were involved in the production of food and fiber in the United States. By 1978, this number had declined to slightly over four million farm workers.[6] Each decade of this period saw fewer people engaged in farm labor. The decline during the first half of the century was gradual. Between 1910 and 1950, the number of people in the farm labor force dropped slightly over one quarter. Two periods of dramatic reduction followed. Between 1950 and 1960, the farm labor force declined 28 percent followed by a further 36.5 percent drop in the decade between 1960 and 1970. Since this period of precipitous decline, the rate of decrease has diminished. Between 1970 and 1978, the farm labor force fell 8.2 percent. As a result of the combination of these changes, in 1978 two thirds fewer people are involved in agricultural production than at the turn of the century (Table 22).

Who are these people who are no longer doing agricultural work? Clearly farm labor is not done by just one set of people with the same interests, commitment and responsibility to the farming endeavor. Rather farm work is done by contrasting groups located in different forms of production and within different relations of production. Farm operators, farm family workers, full time hired workers, and part time wage laborers all occupy contrasting positions in the farm labor force. Each sector of the farm work force experienced the decline in labor opportunities differently. For example, 7.3 million people of the 9.5 million farm workers who were displaced were family farm workers (see Table 22). This means both fewer self-employment opportunities (more past and would be farmers must enter the wage labor market rather than farm), and, more positively, less arduous physical labor for the farm operator and his or her family. For the 2.2 million displaced hired farm workers the decline in farm employment opportunities might mean migration to more lucrative industrial employment, or conversely unemployment or loss of the opportunity to make extra cash for the short harvest season.

One way that has been used to differentiate this complex of differing groups is to distinguish between internal and external groups of workers (Friedland et al., 1978).

Internalized workers are people occupying regular positions within the organization of the farm. External workers are people drawn from a surplus labor force at various points in the production cycle. They have no claim on, or relationship with, the farm beyond the duration of their brief employment. The difference between these two groups of workers must be underscored. It is not the overall number of days worked that determines which classification a particular worker falls into, but the connection to the specific unit of production.

For example, harvest workers, by migrating to different areas of agricultural production, may work close to year round in agricultural jobs. Yet harvest workers rarely work more than a few weeks on any one farm; thus in most cases they are external workers in that they have no claim to the resources of the farm beyond their wages. In contrast, farm family members are also drawn into production during periods of high labor demand. Despite the relatively few days these family members are actually engaged in farm work, by virtue of their position as family members, they are entitled to put claims on the resources of the production unit throughout the year. Thus family members are part of the internal labor force. Farm operators, farm family members, and workers employed in regularized positions are internalized workers. The remaining hired farm working force makes up the external farm labor force.[7]

Sorting out the impact of changes in energy technology upon these disparate groups is a difficult process. This process is made more difficult by the sparse and sketchy data available on the farm labor force. As noted in Chapter Four, farm labor data, as it has been collected, limits specific analysis due to problems that stem from lack of comparability, little agreement between sources, synthesized estimates, and the lack of connection to specific production units.[8] Nevertheless, some important trends in the farm labor force are discernable.

Farmers Perhaps the internal sector easiest to understand is that of farm operators. The person in charge of day to day farm production is the farmer or the farm operator. One less farm should by definition, mean one less farm operator.[9] By 1978, there were less than one half the number of farms that existed in 1910 (Table 23). This trend started slowly, with a four percent decrease in the decades between 1910 through 1940. As with the overall labor force, the major amount of decrease occurred during two decades, 1950 to 1970. In this period, the number of farms fell by 54 percent. Put another way, one of every two farmers operating in 1950 were no longer farming in 1970. From our discussion of increases in mechanical technologies and the extensive (land increasing) strategies that accompanied them, this decrease in the number of farms is a reflection of the growing size of the average farm. During these two decade, average farm size rose by 82.6 percent. (See discussion page 89.) Farming became a viable occupation for fewer people.

TABLE 23

TENURE OF FARM OPERATOR, SELECTED YEARS 1910-1978

Year	Full-Owner	Part-Owner	Hired Manager	Tenant	Total Number of Farms (million)
	...............percent...............				
1910	52.7	9.3	0.9	37.5	6.4
1935	47.1	10.0	0.7	42.6	6.8
1950	57.4	15.3	0.4	25.9	5.4
1959	57.1	25.4	0.6	20.0	3.7
1969[1]	62.4	24.5	--	12.9	2.7
1978	58.4	28.8	--	12.7	2.5

Source: U.S. Census of Agriculture.

1. The definition of farm operator was changed in 1969, therefore data for 1969 and 1978 are not comparable to pre-1969 figures (see Rodefeld, 1976.)

In addition, different classes of farmers were affected by this decrease in opportunities. After 1940, tenant farm operators were disproportionately displaced. Between 1940 and 1950, the number of tenant farms declined 40 percent while the number of part-owners and full-owners increased slightly. Between 1950 and 1959, tenant farmers continued to decline faster than other tenure classes. In this period, tenant farms declined a further 47 percent as compared to a 30 percent decline for full owner farmers. Overall between 1910 and 1978, the number of tenant farms decreased 87 percent while the number of full owner farms declined 53 percent. In this same time period, the number of part owner farmers rose 21 percent.[10]

TABLE 24

PART-TIME FARMERS, SELECTED YEARS, 1949-1978

Year	All Farmers Reporting More Than 100 Days Work Off-Farm	Commercial Farmers[1] Reporting More Than 200 Days Work Off-Farm
	..............percent..............	
1949	23.3	--
1959	29.1	10.1
1969	--	20.8
1978	44.4	29.4

Source: U.S. Census of Agriculture.

1.Farms with over $2,500 in sales are commercial farms.

A related phenomenon in regard to farming as an occupation is the increasing incidence of part-time farmers. Not only are fewer people farmers, but those who are farmers must increasingly work at wage labor jobs also. A part-time farmer is a farm operator who works 100 or more days per year off his or her farm. Table 24 indicates the growing prevalance of part-time farmers. In 1949, around 23 percent of all farmers reported working 100 or more days off the farm. By 1978, this percentage had almost doubled. Forty-four percent of all farmers reported 100 or more days of off-farm work.

The trend toward part-time farming is was as characteristic of commercial farms, as of farms in general. Commercial farms are farms with over $2500 in sales of agricultural products. On commercial farms, more and more farmers are reporting 200 or more days of off-farm work. In 1959, ten percent of all commercial farm operators indicated this experience. By 1978, farmers reporting working 200 or more days off their farms had tripled to just under 30 percent of all commercial farmers. Either this means that three out of ten commercial farmers worked more days off their farms than they did on their farms, or, more likely, that having two or more jobs is fast becoming the norm for farmers. Apparently farmers have become more reliant upon outside sources not only for farm inputs but also for subsistence of the farm unit in the form of labor wages as a supplementary capital input.

<u>Family Farm Labor</u> Fewer farm operators and more off farm

work by these remaining farmers aren't the only changes that occurred within the family labor component of the farm workplace. The labor contribution of other family members has also changed. Very little information has been collected in regard to other farm family members' labor.[11]

From the one set of statistics available, farm family labor, the work of spouses, sons and daughters, has decreased. Family members make up the labor force on family labor farms. This form as a unit of production has been declining. More farms are hiring labor. In addition family members' contribution to the farm work force has been declining both absolutely and proportionately to hired labor and to the number of farms (see Table 22 on page 131).

The number of family members in the farm work force declined 72 percent between 1910 and 1978 (see Table 22 page 131), from a high of over ten million in 1910 to just under 2.8 million family members in 1978. However, these figures include farm operators as well as other family members. There were 3.9 million fewer farms so we may assume that of the 7.3 million fewer farm family members, 3.9 million were farm operators and the remaining 3.4 million were family members.

Looked at another way, if the change in family members in the farm workforce were equal to the change in the number of farms, we might conclude that the production organization remained the same, that there were fewer farming units, and that family labor use remained the same. However, this is not the case; family members of the farm workforce declined at a greater rate than the decrease in the number of farms, 72 percent and 56 percent respectively. Thus family members were being replaced in production systems.

Family farm workers averaged 1.6 persons per farm in 1910 (Table 22). By 1978, the figure dropped to 1.1 workers per farm, while hired labor remained a stable 0.5 persons per farm. Family farm members have acted as a reserve or surplus labor source on the farm. Spouses, children and other relatives were brought into farm production during periods of high demand. Apparently changes in farm production processes have reduced the need for family members to act as a ready surplus supply of labor.

The proportion of family to hired labor in farm production has been slowly but steadily changing. Hired labor makes up a greater share of the farm work force. In 1910, only 25 percent of all farm labor came from wage labor. By 1978, 31 percent of all farm labor comes from wage labor.

These trends, while sketchily documented, point to an important change in our understanding of the family farm as a unit of production. Household production, in terms of labor, involves most household members actively in production activities. The fruits of this labor are used to provide subsistence for the household members. The gradual displacement of farm family members from the internalized labor force brings both the family structure and the production structure of farms closer to the industrialized capitalist forms.

The continued decline in participation of farm family members in farm production brings farm families closer to what Zaretsky (1972) calls the capitalist family. Important elements of the capitalist family-type include separation of household from production, and the emergence of a male 'breadwinner' role and privatized female consumption and nuturant functions. Farm operators are not, at least on their own farms, wage laborers. However, changes in energy technology have reduced the contribution of other family members to the farm endeavor. In this context, the economic operation of the farm became the responsibility of the farmer.[12]

Two elements are involved here. The increasing mechanization of farms extended the farmer's arms or increased the scope of what individual farmers could accomplish (Cochrane 1979), and relatedly, enabled small family labor farms to compete successfully with large capitalized farms (Friedman, 1978). In addition, increased specialization of farms reduced the overall number and diversity of tasks that were involved in the farm's production processes. Therefore fewer tasks needed to be done on the farm, and family labor was no longer needed.[13]

However, even when engaged in subsistence farming, farm men and women did not do the same tasks (Bentley and Sachs, 1984; Buttel and Gillespie, 1984; Coughenour and Swanson, 1983; Bokemeier et al., 1983). Men were more often involved in field and large livestock activities. Women and children were only pulled into these activities in brief times of high labor demand like planting, harvesting or birthing. Women's activities were more closely tied to the production and preservation of family foodstuffs, i.e., the family garden, butter making, or raising poultry. These are precisely the activities that specialization has tended to render economically less viable. Fewer farms produce these additional products for sale. (See the discussion on specialization of farm production on page 103.)

As farm women's role in economic subsistence declined, farm women's function in the domestic sphere as a procurer of consumption goods and a caretaker of children increased in importance. Thus, as is true of non-farm women in capitalist systems, consumption and reproduction labor on behalf of the entire family increasingly occupies her time and links the family more tightly to the market economy (Zaretsky, 1972; Bentley and Sachs, 1984).[14]

Hired Farm Work Force We have seen important changes in the farm operator and farm family worker components of the

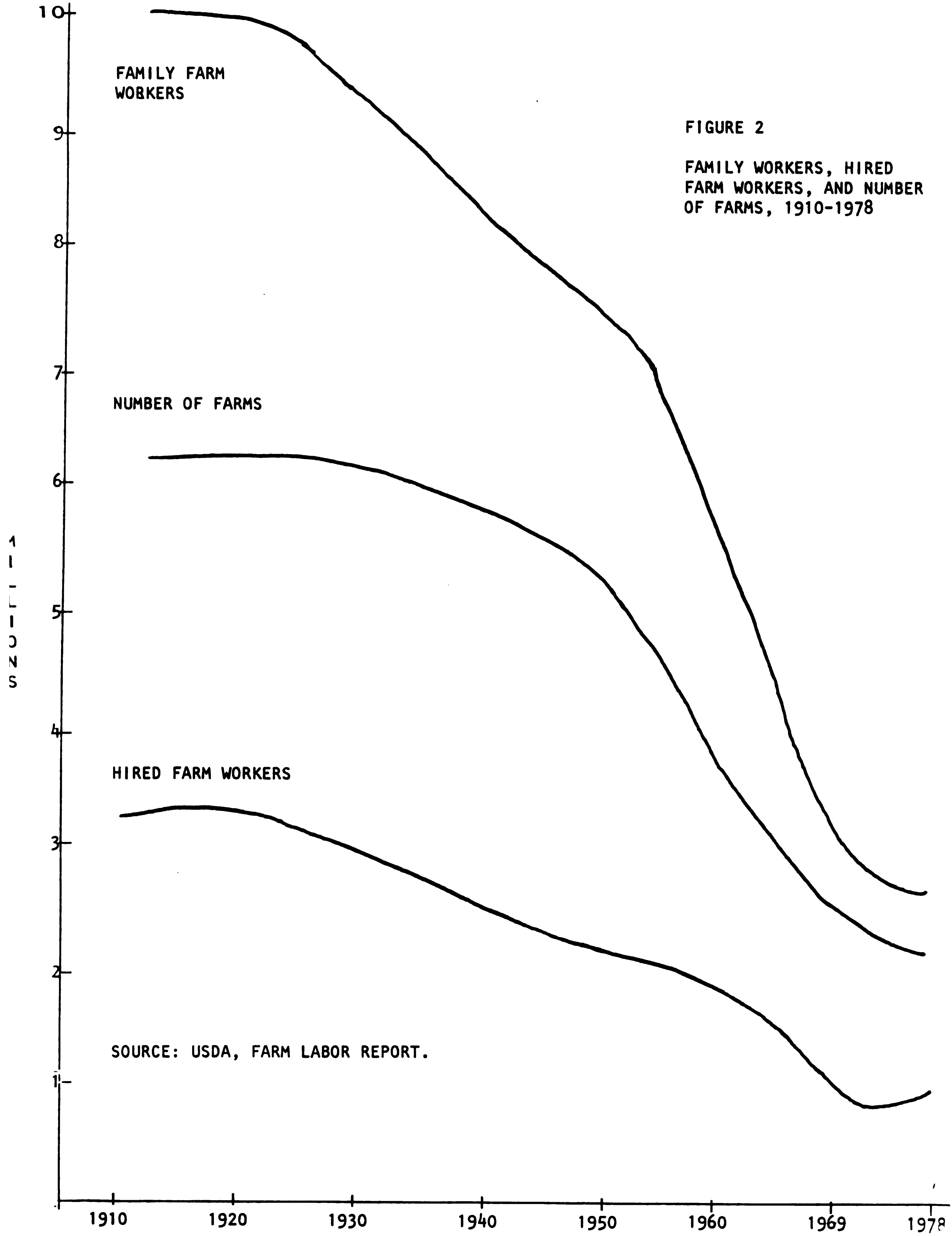

FIGURE 2

FAMILY WORKERS, HIRED FARM WORKERS, AND NUMBER OF FARMS, 1910-1978 internalized farm labor force. Equally striking are the changes in hired farm working force. The rationalization of production which entailed increasing inputs of mechanical and biochemical energy to the farm production process also changed the availability and the nature of farm work for the hired farm working force.

Overall, between 1910 and 1978, there are 2.3 million fewer hired farm workers. Initially, the gradual introduction of mechanical energy technologies, i.e., tractors and harvesters, affected family farm members more than hired farm workers. From 1920 to 1950, the number of wage labor farm workers declined faster than both the number of farms and the number of family farm workers (see Figure 2). With the addition of labor extending technologies and the accompanying crop specialization, fewer hired workers were needed to supplement the household structure of production.

Between 1950 and 1960, the position of hired workers relative to both the number of farms and the number of family farm workers reversed. During this period, farm wage workers declined 20 percent while family farm workers declined 31 percent. During the next decade, 1960-1970, a period of increased biochemical inputs, the number of all components of the farm workforce, both family and hired, declined almost 40 percent faster than the number of farms. Thus, less labor of all types was needed for agricultural production. (See Table 22 on page 131.)

TABLE 25

FARM WORKFORCE, FAMILY AND HIRED BY PERCENT OF PERSON DAYS AND GENDER, 1943 AND 1969

	Total		Farm Family(1) Labor		Hired Worker(2)	
	Work Force	Person Days	Work Force	Person Days	Work Force	Person Days
	......................percent....................					
1943	100.0	100.0	79.0	84.3	20.0	15.7
Men	70.9	88.4	55.0	74.8	15.0	13.6
Women	29.1	11.6	24.0	9.5	5.0	2.1
1969	100.0	100.0	74.0	75.0	25.0	25.0
Men	--	--	--	--	19.0	21.8
Women	--	--	--	--	7.0	3.2

Source: R. McElroy, THE HIRED FARM WORKING FORCE OF 1969, USDA, Economic Research Service, and L. Ducoff and M. Hagood, THE FARM WORKING FORCE OF 1943, USDA, Bureau of Agricultural Economics.

1.Farm family labor includes the farm operator, and paid and unpaid family labor.
2.Non-family wage workers.

By 1960, there were 45 percent fewer people engaged in hired farm work (Table 22). Encompassed within this declining number of workers is a change in the labor composition of the farm labor force. While farm operators and their families continued to do the majority of agricultural work, the proportion of person days contributed by wage laborers increased. In 1943, hired workers were one-fifth of the agricultural workforce and contributed almost 16 percent of the person days worked (Table 25). By 1969, the hired workforce increased 30 percent to slightly over one-quarter of the workforce and contributed one-quarter of the person days worked. This trend toward the hired work-force accelerated during the next decade. Between 1970 and 1978, while the number of farms and family farm workers continued to decline (albeit at a slower rate), the number of hired farm workers actually increased 10 percent. By 1978, the hired workforce increased to 31 percent of the overall farm labor force. These trends are consistent with the discussion of the changing nature of the family farm as both a family structure and a unit of production. Family farms may increasingly be in the position of selling labor power to supplement the income of the family structure while buying labor to run the production unit.[15]

Composition of the Hired Farm Workforce: Part-Time/Full-Time Workers

Just as the changes in family farm workers affected people within this group differently, segments of the hired farm workforce have also been differentially affected. There are fewer and different opportunities for people engaged in hired farm work.

TABLE 26

HIRED FARM WORKFORCE, BY DURATION OF WORK, SELECTED YEARS, 1965-1979

Year	All Hired Workers (thousand)	Casual(1)	Part-Time(2) Workers	Full-Time(3)
		....	percent	....
1965	3,128	40	79	21
1969	2,571	43	81	19
1975	2,638	45	78	22
1978	2,652	34	71	29

Source: THE HIRED FARM WORKING FORCE, Agricultural Economic Report, Economic Research Service, USDA, various years.

1.Casual workers were in the agricultural labor force less than 25 days.
2.Part-time workers were employed 149 days or less.
3.Full-time workers includes workers employed more than 150 days.

In this century, most of the hired farm labor force has been external to the production unit. Workers were hired seasonally to help with planting, or more commonly in larger groups on a short term basis to assist in harvesting. In 1945, 75 percent of the farm working force worked part-time, i.e.,less than 150 days (Table 26). As gradual mechanization of agriculture production enabled farm operators to do more and more of the routine activities, farmers increasingly utilized external short term labor to supplement this process at peak labor periods. Between 1945 and 1969 the demand for hired farm workers dropped 20 percent. However, the demand for full-time workers declined almost thrice as fast (39 percent) as for part-time workers (13.5 percent). Part-time workers rose to 81 percent of the hired farm workforce in 1969. In addition, over half of these workers were casual workers, or people who worked less than 25 days during the year on farms. Demand for this group of workers fell the least during this time period, 12 percent (Table 26). These workers represent the classic reserve labor force. In general, they are less committed to the workforce, being younger males, women who seek only short-time wage labor employment, students, or housewives seeking to supplement their personal incomes (Pollack, 1981).

Although this group of part-time workers accounts for an increasing share of the hired work force, at no time did they account for the majority of days worked. In 1960, when part-time workers made up almost four-fifths of the hired farm work force, they accounted for 49 percent of all person days worked (Table 27). This proportion soon began to decline. In 1969, the percent of part-timers rose to 81 percent while their share of labor dropped to 34 percent. By 1975, both the proportion of part-time workers and their proportion of days worked had declined. These trends continued through 1979 when the number of part-time workers dropped to 71 percent of the workforce and they contributed only 27 percent of person days worked.

TABLE 27

HIRED FARM WORKING FORCE BY DURATION AND PERCENT OF PERSON DAYS WORKED, SELECTED YEARS, 1943-1979

	Part-Time(1) Workers		Full-Time(2) Workers	
Year	Work Force	Person Days	Work Force	Person Days
	....................percent....................			
1943(3)	63	35	37	65
1949	76	34	24	66
1960	78	49	22	51
1965	79	34	21	66
1969	81	34	19	66
1975	78	32	22	68
1979	71	27	29	73

Source: USDA, Economic Research Service, THE HIRED FARM WORKING FORCE, various years.

1.Part-time workers includes both casual worker (less than 25 days) and seasonal workers (25-149 days).
2.Full-time workers include both regular (150-250 days) and year-round (over 250 days) workers.
3.The data for 1943 includes paid and unpaid farm family labor.

These changes suggest a changing structure of labor use in agricultural production processes. While part-time workers still constitute a majority of all farm workers, the percentage of part-time workers is declining (9.6 percent between 1969 and 1979). In contrast, the number of full-time workers increased 57 percent during this same period. Full-time workers in 1978 accounted for 29 percent of all agricultural workers and almost three-quarters of person days worked. Thus, opportunities for full-time agricultural workers appear to be increasing. Several studies (Friedland et al., 1978; Perry, 1981) with similar findings have suggested that these trends represent an internalization of hired farm workers. The problems with agricultural data emerge again here.[16] The data do support claims of increasing opportunities for full-time employment but little is available to connect the full-time employees to specific units of production. We know that large market farms are more likely to use regular workers (Buttel, 1981), that mechanization of some crops entailed increases in year round employees (tomatoes - Friedland and Barton, 1975; Hightower, 1975; and lettuce - Barnett, 1975; Friedland et al., 1978), and that pressures of unionization and the end of the bracero program reduced the availability of seasonal labor for some areas (Wise, 1974; Jenkins, 1975, 1978). Yet, these observations cannot be spread across the spectrum of all farm types.

[17] One can see two patterns: fewer opportunities (a reduction in number of agricultural jobs), and a different structure of opportunities. Both these dimensions also

differ in terms of the characteristics of the people who hold these jobs. The kinds of activities farmworkers engage in differ by race and gender. Hired women farm workers are constrained by a similar sex specialized or sex segregated organization of agricultural work as family women (Buttel and Gillespie, 1984). In contrast, the range of activities available to male farm workers is wider. Just as family farm women have formed a reserve labor force for periods of high demand, hired women serve a similar role.[18]

While changes in production organization can only be suggestd at, more can be done in regard to specifying the groups of people affected. We have already seen that, during the period of gradual farm mechanization, initially full-time hired workers and family members were displaced. With the onset of increased biochemical inputs, the continued decrease in family farm workers was joined by decreases first in part-time hired farm workers and, more recently, by increases in the opportunities available for full-time hired agricultural employment (see Figure 3).

Both historically and currently, as discussed above, the majority of hired farm workers have been part-time workers. Casual workers (those who work less than 25 days per year) make up half of the part-time labor force. Women hired farm workers are disproportionally represented in both groups. From 1949 to 1969, 95 percent to 96 percent of all hired

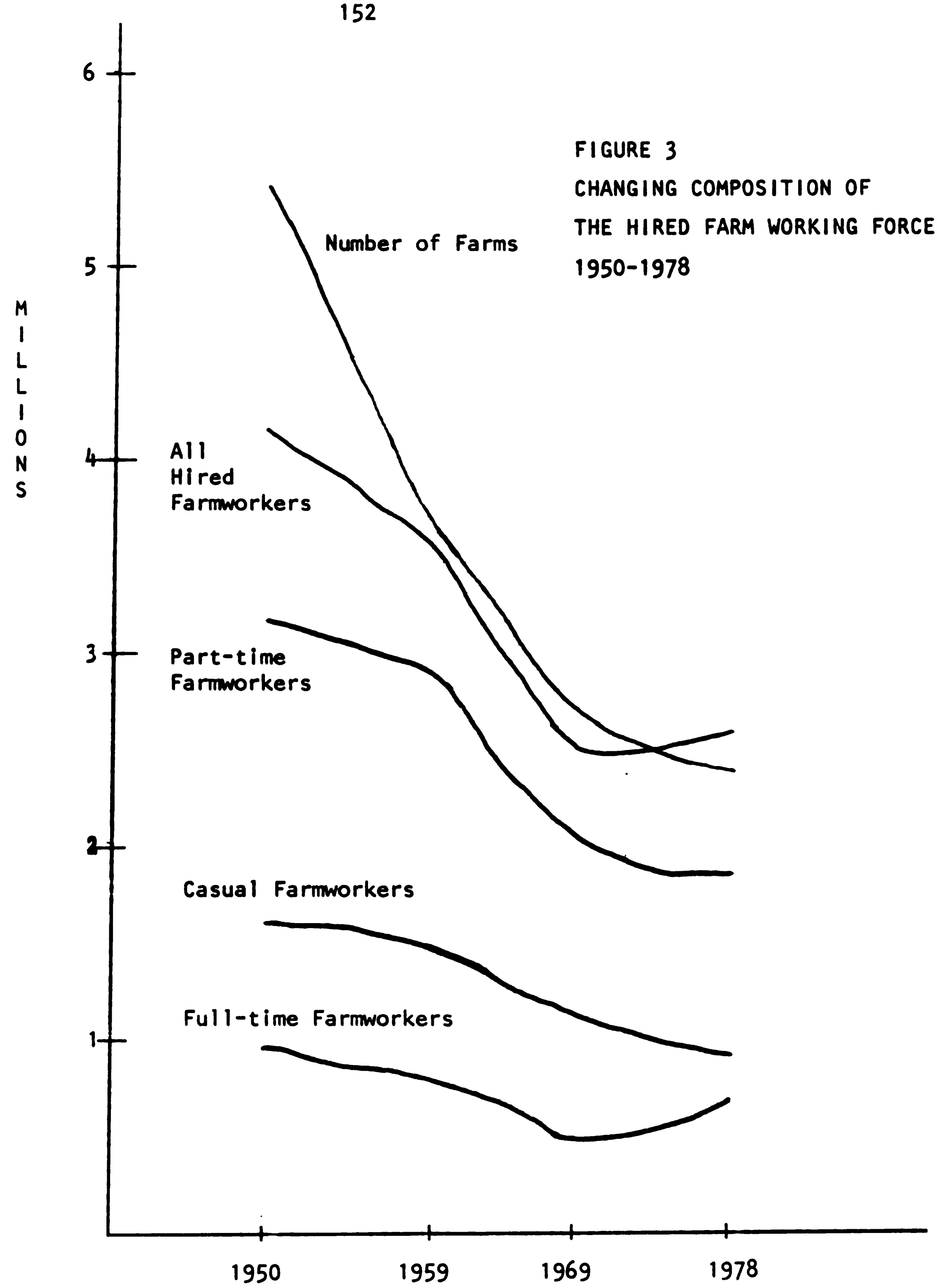

FIGURE 3
CHANGING COMPOSITION OF
THE HIRED FARM WORKING FORCE,
1950-1978

Source: The U.S. Hired Farm Working Force and the U.S. Census of Agriculture.

women farm workers worked less than 150 days, while only 75 percent or less of the men were part-time workers (Table 28). Over half of all women workers were casual workers, while only 34 percent to 39 percent of men were casual workers. As part-time opportunities declined, so did the number of women farm workers - between 1949 and 1979, women farm workers declined 48.5 percent versus 31.3 percent for men.

The period between 1969 and 1978 brought two changes for male farm workers. The overall number of male farm workers increased by 169,000 workers or almost 9 percent, and the percentage of full time male workers rose to one-third. In contrast, the number of women farm wage laborers continued to decline. In 1978 there were 13.4 percent fewer women farm workers than there had been in 1969. The duration of farmwork for women changed also. While women still are largely in the part time job category, proportionately fewer women are casual workers or part time workers and more women are employed as full-time farm workers, 12 percent as opposed to four percent.

However, during this time period, women as a proportion of the farm work force declined from 26 percent to 23 percent. Thus even though more women were full-time farm workers in 1978 as compared to 1969, they have only increased from 6 percent of the full time farm work force to 9 percent.

TABLE 28

HIRED FARM WORKING FORCE BY DURATION OF FARM WORK BY GENDER, SELECTED YEARS, 1945-1979

YEAR	ALL HIRED FARM WORKERS (thousands)	CASUAL[1] WORKERS	PART-TIME[2] WORKERS	FULL-TIME[3] WORKERS	PERCENT TOTAL MEN	PERCENT TOTAL WOMEN
1945	3,212	39	75	25	74	26
1949	4,140	39	77	23	73	27
1960	3,693	41	78	22	72	28
1969	2,571	43	81	19	74	26
1975	2,638	44	78	22	77	23
1979	2,652	34	71	29	78	22

					PERCENT ALL CASUAL WORKERS	PERCENT ALL PART-TIME WORKERS	PERCENT ALL FULL-TIME WORKERS
		...percent...					
Men							
1945	2,375	—	—	—	—	—	—
1949	3,021	34	70	30	63	67	94
1960	2,664	36	71	29	63	66	94
1969	1,907	39	76	24	67	69	94
1975	2,036	41	73	27	71	73	93
1979	2,076	32	67	33	74	73	91
Women							
1945	873	—	—	—	—	—	—
1949	1,119	55	95	5	37	33	6
1960	1,029	55	95	5	37	34	6
1969	665	54	96	4	33	31	6
1975	602	57	92	8	29	27	7
1979	576	40	88	12	25	27	9

Source: USDA, Economic Research Service, THE HIRED FARM WORKING FORCE, Agricultural Economic Reports, various years.

[1]Less than 25 days farm work.
[2]Less than 150 days farm work.
[3]More than 150 days farm work.

In summary then, women have been disproportionately displaced from hired farm labor opportunities. In addition, there have been some suggestions in the literature that within the category of full-time workers women workers continue to be segmented in lower paying agricultural jobs (Friedland et al., 1978; Thomas, 1981).

TABLE 29

CROP OR LIVESTOCK ACTIVITY BY RACIAL/ETHNIC COMPOSITION OF HIRED FARM WORKFORCE, 1979

Activity	White	Hispanic	Black & Other	Total
	................percent................			
Grain	91	4	5	100
Vegetable	41	40	19	100
Fruit and Nuts	53	30	17	100
Dairy	96	2	2	100
Beef Cattle	88	4	8	100
Other Livestock	90	5	5	100
All Farm Workers	75	12	13	100

Source: Pollack, 1981, THE HIRED FARM WORKING FORCE, Agricultural Economic Report #473, Economic Research Service, USDA, p.14.

In addition to gender, race or ethnicity also plays an important part in determining the opportunities available to hired farm workers. White farm workers tend to be male, younger, less geographically specific, more educated, and working fewer days, and are more likely to be casual workers (Pollack 1979). Conversely, Hispanic, Black, and other farm workers are more equally distributed in terms of both gender and age, and are more likely to be full-time workers.

However to trace the impact that various farm wage labor trends have had on these disparate groups is problematic. This is another glaring problem that has resulted from inadequate farm labor data collection procedures. Prior to and including 1969, data for racial or ethnic background was dichotomized into "White" and "Negro (sic) and other" categories. 1975 was the first year that data was available for Hispanics who were apparently included either in one or both categories depending upon region.

This discrepancy is especially important in light of the information collected on crop activity in the 1978 Hired Farm Working Force survey (Pollack 1981). Agricultual labor activities are segmented by race and ethnicity. Blacks and Hispanics do different farm work than do white farm workers. Twenty nine percent of all farm workers were employed on vegetable farms and fruit and nut farms, but 58 percent of all Hispanic farm workers worked on these two types of farms, 26 percent of all Black and other farm workers, and only 13 percent of all white farm workers. In contrast, 25 percent of white laborers, seven percent of all Hispanic workers,and eight percent of all Black and other farm workers work on cash grain farms, which employ 21 percent of all farm workers (Pollack, 1981:14). As seen in Table 29, almost 90 percent of all hired farm workers on grain farms, dairy farms, beef cattle farms, and other livestock farms are white. In contrast, on fruit and nut and vegetable farms nonwhite farm workers make up 47 percent and 59 percent of the hired workers.

In summary, the changes in energy technology had multiple effects on people in the labor process. For farmers it meant fewer opportunities and supplemental wage labor. The changing form of household production meant fewer farm family members are engaged in farm production. The effects of the process on hired labor need to be separated into two periods. Prior to 1969, there was a declining demand for hired farm labor and an increase in the use of part-time labor. The second more recent trend is toward increasing use of full-time farm wage labor.

Chapter Six Notes

1.Clearly farmers can take some energy cutting measures. For example, they might use more careful application techniques for fertilizers, combine operations to conserve fuel, or adopt no till practices. However, there are limits to these conservation measures. Therefore the point still holds.

2.While we can not predict the precise moment when a resource will be depleted, Hubbert curves give us some indication of the timing (Hubbert, 1973; Pazik, 1974).

3.This happened on a small scale in the mid 1970's, when fuel could not be guaranteed to be available for farmers in time for havesting activities and transporting crops. This shortfall played an important part in the allocation farmers were to receive when and if energy rationing was put into place.

4.These changes may reflect changing ownership patterns, i.e., smaller farms dropping out of production, as well as an increased use of tractors. However, this still would indicate the increased importance of tractors as a standard feature of farm production.

5.The use of herbicides has a more serious implication for farm workers - increased health risks. Wasserstone and Willes (1985) document the dramatic effects of increased use of herbicides upon the health of farm workers.

6.The category of farm worker includes farm operators, farm family workers, and hired farm laborers, unless otherwise indicated.

7.Note, farm worker unions seek to give external (harvest) labor the benefits of internalized workers, i.e., some control or input into wages and the conditions of work. Friedland et al. (1978) refer to these unionized workers as semi-internalized workers.

8.Friedland et al. (1978) suggest a political underpinning for this lack of coherent data collection of farm labor statistics. In their view, the tendency to underestimate, etc. serves to justify the need for importing workers with less power and options to help keep the labor force large and to keep wages low as the bracero program served California agriculture.

9.For most census purposes, the number of farm operators equals the number of farms. There are two instances when one farm does not equall one farmer. In the case of partnerships, the census schedule (U.S.D.C., 1978:A-6) instructs the partners to designate one person as the farm operator. In this sense, there may actually be two or more farmers per farm. Conversely, there also may be cases where there are fewer farmers than farms. Each enterprise a farm operator runs that maintains separate records is counted as one farm (U.S.D.C., 1978:D-6). Neither of these cases is numerous and they should balance each other out.

10.Maybe some tenants became part-owners but the more likely senario is for some full-owners to rent additional land in their expansion strategies and thus become part-owners.

11.The Census of Agriculture in 1950 and 1954 did ask questions regarding family labor, but these questions only referred to people working the preceding week on the farm. The early <u>Farm Working Force</u> studies did look at family labor, but this practice was discontinued by 1944.

12.An important distiction must be made here. Farmers or the male head of the rural household had economic responsibility for the farm operations but intially in the U.S. it was daughters who first left the farm to seek off-farm employment to contribute to the overall family support (Bentley and Sachs, 1984).

13.This is an important topic for future research especially in the context of the polarized nature of farms. It is very likely that women and children may be more active on smaller farms than on larger farms. Relatedly there is the issue of farm women's economic contribution from off-farm jobs. Do farm women parallel non rural women's employment patterns?

14.A related piece of anecdotal evidence supporting this increased consumption rather than production role of farm women is seen in the Social Security Administration's decision in the mid-1970's to discontinue using the rural/urban dimension in calculating the need for food stamps. Prior to this decision, it was assumed that except in years of agricultural diaster, rural families would produce a substantal proportion of their families' food subsistence, thus reducing the amount a social welfare grant needed to be to provide minimum subsistence for the family. Whether this decision was based upon a changing understanding of rural women's role or other factors, we do not know, but it supports a recognition of the fact that farm families buy food at the supermarket just like urban folk.

15.This seeming inconsistency may be resolved in at least two ways. One way is farmers with higher skills and more education may be able to command higher salaries off-farm than hired farm workers can command on-farm. If these farmers hired labor to replace part of their contribution, there still would be a plus in the family budget. The second revolves around the sex-specialization of farm (as well as non-farm) work. Ideological and market forces may dictate the "inappropriateness" of tasks that need to be done on-farm for farm women, i.e., run large machinery, etc., so they join their sisters off-farm in sex segragated labor markets available to their gender (Thomas, 1981; Buttel and Gillespie, 1984).

16.These full-time workers may be replacing part-time farmers, but with the data available we cannot make this connection. Other possibilities include the increase in full-time workers reflecting the polarization of agriculture, i.e., the middle farms dropping out, or variations among farm types, (see the following chapter for a discussion of this possibility).

17.For example, fruit and tree nut farms and vegetable and melon farms are the types most represented in these studies. These two types of farms represent less one quarter of all farms. In addition, Wells (1981) suggests that all fruit and tree farms are not alike. She outlines the different labor processes on strawberry farms according to market size.

18.See for example, Friedland et al. (1978), on pay levels for women's agricultural jobs or Thomas (1981) for a discussion of sex segragation of farm jobs.

Chapter Seven:
ENERGY/LABOR RELATION IN SPECIFIED PRODUCTIONS SYSTEMS: FARM TYPE ANALYSIS

Agricultural Product Sectors

The discussion in the previous section on farm labor focused more upon changing characteristics of the farm labor force than upon the organization of production. Questions like which laborers worked on what farms, and with what other resources, can only be speculated at. One way to achieve closer insight into these issues is to examine farm types. As seen in the previous discussion, we know farm types have historically varied in terms of both degree of market concentration and the extent and timing of product specialization.

While census data in regard to farm type has been collected since 1910, very little information was presented by farm type -- mostly percentages of farms and share of agricultural sales. Beginning in 1950, more information in regard to farm type comparisons became available. In addition, in 1974 and 1978, information was organized that allowed a farm type by economic class comparison. Thus we have data which cover 1950 to 1978, the important periods for both the introduction of biochemical and mechanical energy technologies and the concurrent reorganization of the farm labor force.

In this section we will examine three dimensions for each of the six farm types. The first dimension is overall farm production structure - this includes the number of farms, the average farm size, and legal organizational structure and market factors such as the proportion of total agricultural sales, concentration, and specialization. Labor use is the second dimension. This includes information on the composition of the farm labor force in terms of part-time farmers, full or part-time hired labor and contract labor. The third dimension is energy use. Here mechanical energy inputs of work power, purchased fuel, and irrigation practices along with biochemical energy indicators of commercial fertilizer and agrochemical use are presented.

The information covered by these dimensions will be presented to highlight two facets: 1) the outstanding or type specific production characteristics and 2) the important trends within farm type production. Before this comparison is begun, it is useful to provide some basis of overall comparison for the farm type characteristics and trends. Table 30 summarizes aspects of the three dimensions (structure, labor, and energy) for all commercial farms.

Characteristics of Commercial Farms

Structure Commercial farms are all farms with sales of over $2500 in agricultural products. Between 1950 and 1978, the number of commercial farms declined 50 percent from 3.7 million to 1.8 million farms. Correspondingly, the average

TABLE 30

SELECTED STRUCTURE, ENERGY, AND LABOR CHARACTERISTICS OF ALL COMMERCIAL FARM, 1950-1978

	1950	1959	1969	1978
Structure:				
# Commercial Farms (million)	3.71	2.41	1.73	1.86
average size	275.0	404.5	529.7	531.6
Organization:				
% family	—	—	85.3	85.6
% total acres	—	—	72.5	65.5
Concentration:				
Gini Co.	.6256	.5940	.5891	.7573
Labor:				
part-time farmers:[1] % farms	9.3	14.5	27.3	37.0
hired labor: % farms	62.5	60.4	61.7	46.9
contract labor: % farms	—	—	8.0	8.3
full-time workers:[2] % farms	—	—	14.3	16.7
part-time workers:[3] % farms	—	—	55.6	39.9
Energy:				
mechanical work power:[4]	27.4	—	—	—
energy products:[5] % farms	69.5	96.6	99.3	99.8
commercial fertilizer: % farms	—	71.7	79.2	76.5
other agricultural chemicals:	—	—	59.6	69.9
irrigated land: % farms	6.6	10.2	12.3	13.3
% acres	—	3.2	4.2	5.1

Source: U.S. Census of Agriculture.

[1]Farmers who reported working 100 or more days off their farm.
[2]Hired farm workers who are employed 150 or more days.
[3]Hired farm workers who work less than 150 days.
[4]Only mechanical work power used on farm. No use of horses or mules.
[5]Includes electricity, petroleom products, natural gas and other fuels.

size of commercial farms nearly doubled from 275 acres to an average of 532 acres. Legal organizational structure has remained stable, 85 percent of all commercial farms remain family organized. However, there has been a slight decline in the proportion of total acreage that these family organization farms encompass. Market concentration among commercial farms has increased. In 1978, market concentration was high with a Gini coefficient of .7573.

Labor On commercial farms, in 1978, over one of every three farm operators was a part-time farmer. This represents a 298 percent increase from 1950 to 1978, in the off farm work commitments of farmers. In addition, in 1978 fewer farms reported hiring labor. Between 1950 and 1969, roughly three out of five farmers reported expenditures for farm worker wages; this dropped 24 percent in 1978 to slightly under half, 46.9 percent. The proportion of commercial farms reporting expenses for contract labor remained around eight percent from 1969 to 1978.

Not only are fewer farmers hiring labor but the composition of the hired work force has changed. The use of full time workers increased 16.8 percent, from 14.3 percent in 1969 to 16.7 percent in 1978. In contrast, the use of part-time workers fell. In 1969, over half of all commercial farmers reported using part-time labor. By 1978 this had decreased almost 30 percent to roughly 40 percent of all commercial farms reported using part-time workers.

Energy In 1950, only 27.4 percent of all commercial farms reported relying solely upon mechanical power. In the same year, around 70 percent of the farms reported expenditures for fuels. By 1959, virtually all commercial farms reported fuel purchases. In contrast, use of another mechanical energy input, irrigation, is less centrally connected to commercial farms' production systems. Between 1950 and 1978, use of irrigation increased gradually. During this period, the proportion of farms irrigating land doubled from 6.6 percent to 13.3 percent. This was accompanied by a corresponding doubling in the proportion of land irrigated. In 1950, two percent of all land in farms was irrigated. By 1978, 5.1 percent of all farm land was irrigated.

Use of biochemical energy inputs also is central in commercial farm production organization. By 1959, almost three-quarters of all farms report expenditures for commercial fertilizers. Relatedly, by 1969, three out of five commercial farms reported purchasing other agricultural chemicals. Use of other agricultural chemicals increased by 1978 to almost 70 percent of all farms reporting purchases.

This summary of production characteristics and trends within commercial farms for the period 1950 to 1978, provides a basis for contrasting the same dimensions and patterns within farm type farms. We can begin this comparison by looking at cash grain farms.

Commercial Cash Grain Farms

Structure Cash grain farms are farms on which the combined sales of corn, sorghums, small grains, soybeans, popcorn, cowpeas, dry beans and peas accounted for 50 percent or more of total agricultural sales. Between 1950 and 1969, the number of farms within this category declined 14.3 percent (Table 31), as compared with a 50 percent decline in the number of all farms. As a result, cash grain farms increased in terms of proportion of all farms to over one fifth of all commercial farms. While the total number of farms continued to decline between 1969 and 1978, cash grain farms increased both numerically and proportionately. In 1978 cash grain farms were 28.2 percent of all farms. However, the proportion of market share did not rise as fast as the proportion of farms.

Cash grain farms are on the average smaller than the average commercial farm; cash grain farms average slightly over 400 acres per farm. As with all commercial farms, family organizational structure dominated this farm type's organization. Eighty-six percent of all cash grain farms are family farms; they control around four-fifths of the land in the farm type as compared to the 65 percent of land so organized in all commercial farms. In addition, cash grain farms are highly specialized. Since 1959, over eighty

TABLE 31

STRUCTURE, LABOR, AND ENERGY CHARACTERISTICS FOR COMMERCIAL CASH GRAIN FARMS

	1950	1959	1969	1978
Structure:				
Number of Farms	430,389	398,047	369,312	525,572
% all farms	11.6	16.5	21.3	28.2
average size	401.0	441.0	503.6	488.2
% total agricultural sales	14.5	15.0	14.9	22.3
Organization:				
% family	—	—	85.8	85.9
% total acres	—	—	81.2	79.2
Concentration:				
Gini Coefficient	—	.4434	—	.5969
Specialization:				
% market	—	35.5	66.7	77.6
% farm	—	83.5	81.7	83.0
Labor:				
part-time farmers:[1] % farms	10.1	15.1	26.7	32.9
% total part-time farmers	12.5	17.2	20.8	23.5
hired labor: % farms	67.0	55.1	55.5	38.7
% total dollar expenditures	8.9	7.9	10.3	14.9
contract labor: % farms	—	—	4.9	4.9
% total dollar expenditures	—	—	5.1	7.2
full-time workers:[2] % farms	—	—	10.5	11.9
% total full-time workers	—	—	10.3	14.3
average full-time workers per farm	—	—	1.736	1.934
part-time workers:[3] % farms	—	—	50.8	33.4
% total part-time workers	—	—	11.3	15.5
average part-time workers per farm	—	—	3.093	3.712
Energy:				
mechanical work power:[4] % farms	51.2	—	—	—
energy products:[5] % farms	88.7	98.9	98.9	99.9
% total dollar expenditures	22.3	22.9	25.9	31.5
commercial fertilizer: % farms	—	68.6	84.5	85.9
% total dollar expenditures	—	—	28.5	44.2
other agricultural chemicals: % farms	—	—	67.8	82.7
% total dollar expenditures	—	—	25.4	39.3
Irrigated Land: % farms	7.3	8.9	9.9	9.8
% farm type acres	—	—	5.0	6.0
% total irrigated acres	—	—	24.5	30.3

Source: U.S. Census of Agriculture.

[1]Farmers who reported working 100 or more days off their farm.
[2]Hired farm workers who work 150 or more days.
[3]Hired farm workers who work less than 150 days.
[4]Only mechanical farm work power. No use of horses or mules.
[5]Includes electricity, petroleom products, natural gas and other fuels.

percent of all sales from cash grain farms have been composed of cash grain products. Correspondingly the market for cash grain crops is increasingly dominated by farms from this category. In 1959, only 36 percent of all cash grain sales were made by cash grain farms. This proportion more than doubled through 1978 when around 78 percent of the product group sales were from cash grain farms.

Related to this increased specialization, is the increase in market concentration among cash grain farms. In the roughly twenty year period between 1959 and 1978, market concentration, although low compared to other farm types, increased 35 percent.

<u>Labor</u> Few observations can be made about farmers and farm family labor in regard to farm type categories. As was noted previously, a parity can be assumed between the number of farms and the number of farm operators. In this sense, during the period under examination, opportunities for cash grain farmers increased. There were 42 percent more cash grain farms and thus 42 percent more farm operators in 1978 than in 1950. However, these farmers are increasingly likely to have off farm wage responsibilities. In 1950, ten percent of all cash grain farms were run by farm operators who worked 100 or more days off the farm. This number continued to grow. By 1978, almost one third of all cash grain farmers were part-time farmers. In addition more cash grain farms

are family labor farms, i.e., they rely solely on farm family workers for farm labor, than on all commercial farms.

In 1978, 61.3 percent of all cash grain farms reported no expenditures for hired labor. This is the continuation of a trend away from hiring labor on these farms. In 1950, over two thirds of the cash grain farms reported purchasing hired labor. This continued to decline until, in 1978, less than two-fifths (38.7 percent) of all cash grain farms reported wage expenditures as compared to 47 percent for all commercial farms.

However those cash grain farmers who do hire labor, account for a greater proportion of the total farm wage bill than market share alone would lead us to expect. This is explained in part by the changing composition of the cash grain farm labor force. Slightly more farmers within cash grain farms are using full-time hired workers, a 13.3 percent increase, and these farmers are using a greater proportion of all full-time farm labor, a 29.1 percent increase. Cash grain farmers who employ full-time labor use slightly more full time workers per farm, from 1.7 to 1.9 in 1978. In contrast, fewer cash grain farmers reported using part-time labor. However, those cash grain farmers who do use part-time labor use more part-time workers per farm in 1978 than in 1969, 3.7 and 3.1 respectively. Regardless of the composition it is important to keep in mind that few cash grain farmers used hired labor, less than one in nine for full-time workers and one in three for part-time workers.

In summary, in 1978, on cash grain farms: One of every three farmers was a part-time farmer. Less than forty percent of cash grain farms used hired labor. These trends are consistent with trends in all farms with more use of full-time workers and still a heavy reliance upon seasonal labor in times of peak demand. The majority of cash grain farms rely solely upon family labor. The next largest group brings in some part-time labor with full-time workers being used on only 11 percent of all cash grain farms.

Energy This low reliance upon purchased labor is in striking contrast to the heavy reliance upon mechanical and biochemical energy inputs on cash grain farms. By 1950, 51.2 percent of all cash grain farms relied solely upon mechanical power with no use of horses or mules, twice as many as for all commercial farms. The same year, 88.7 percent of cash grain farms reported some expenditures for energy and petroleum products for farm use. In 1959, and there after nearly 100 percent of all cash grain farmers reported these types of purchases. In addition cash grain farms accounted for a disproportionate amount of total farm purchases of energy products. In other words, growing cash grain crops is a mechanically intensive endeavor. The exception to this statement is within the mechanical energy technology of irrigation. Less than ten percent of cash grain farms irrigate cropland.

The picture for biochemical energy use is similar, though it occurred in a slightly different time frame. In 1959, 68.6 percent of all cash grain farms reported expenditures for commercial fertilizers. By 1978, this had increased to 85.9 percent. In 1969, over two thirds of all commercial cash grain farms reported purchasing other agricultural chemicals. In 1978, this had risen to 82.7 percent of all the farms. For both forms of biochemical energy inputs, the proportion of amount purchased was greater than the proportion of market value produced by these farms. In addition, cash grain farms exceed commercial farms in use of both forms of biochemical energy inputs. Therefore production on cash grain farms is biochemically as well as mechanically energy intensive.

Commercial Vegetable and Melon Farms

Structure As with cash grain farms, both the number and the proportion of vegetable and melon farms increased during the period under examination (Table 32). The average vegetable and melon farm, although increasing to 211 acres in 1978, is small in comparison to all commercial farms. Vegetable and melon farms continue to account for a disproportianate market share. However, this has declined.

Specialization on vegetable and melon farms is advanced.

TABLE 32

STRUCTURE, LABOR, AND ENERGY CHARACTERISTICS FOR COMMERCIAL VEGETABLES AND MELON

	1950	1959	1969	1978
Structure:				
Number of farms	46,415	21.912	19,660	25,567
% all farms	0.9	0.9	1.1	1.4
average size	116.6	186.9	236.3	211.0
% total agricultural sales	2.3	2.2	2.6	2.9
Organization:				
% family	—	—	81.4	82.3
% total acres	—	—	35.7	49.0
Concentration:				
Gini Coefficient	—	.7214	—	.8226
Specialization:				
% market	69.9	71.2	79.1	82.0
% farm	83.6	81.7	85.5	86.0
Labor:				
part-time farmers:[1] % farms	11.9	10.7	29.2	34.5
% total part-time farmers	1.6	0.9	1.2	1.4
hired labor: % farms	67.2	76.3	75.2	56.2
% total dollars expenses	5.7	7.4	8.0	8.6
contract labor: % farms	—	—	23.3	20.8
% total dollar expenditures	—	—	21.3	17.5
full-time workers:[2] % farms	—	—	29.5	25.9
% total full-time workers	—	—	7.9	8.9
average full-time workers per farm	—	—	28.579	23.350
part-time workers:[3] % farms	—	—	69.4	49.2
% total part-time workers	—	—	7.3	6.7
average part-time workers per farm	—	—	8.937	12.630
Energy:				
mechanical work power:[4] % farms	38.9	—	—	—
energy products:[5] % farms	72.8	97.3	99.5	98.9
% total dollar expenditures	1.7	1.7	1.9	2.3
commercial fertilizer: % farms	—	91.9	96.5	90.3
% total dollar expenditures	—	—	4.2	3.3
other agricultural chemicals: % farms	—	—	77.8	85.6
% total dollar expenditures	—	—	7.3	5.1
irrigated land: % farms	28.4	42.3	28.1	45.6
% farm type acres	—	—	24.1	39.5
% total irrigated acres	—	—	4.2	4.2

Source: U.S. Census of Agriculture.

[1]Farmers who reported working 100 or more days off their farm.
[2]Hired farm workers who work 150 or more days.
[3]Hired farm workers who work less than 150 days.
[4]Only mechanical farm work power. No use of horses or mules.
[5]Includes electricity, petroleom products, natural gas and other fuels.

Vegetable and melon farms account for over 80 percent of all sales of vegetable and melon products. The family organizational form is slightly less prevalent on vegetable and melon farms. Over 80 percent of all vegetable and melon farms have family organization structures. Yet this organizational form accounts for less than half of vegetable and melon acreage. This is probably a reflection of the high degree of market concentration within vegetable and melon farms. Production of melons and vegetables is highly polarized; slightly over ten percent of all vegetable and melon farms account for 85 percent of sales. (See discussion on page 80.) These farms tend to be larger in size and to have other than family forms of organization.

Labor Historically, vegetable and melon farms rely heavily upon wage labor. Between 1950 and 1969, the percentage of farms reporting expenditures for hired labor rose from 68 percent to 75 percent. While this dropped dramatically to 56.2 percent in 1978, vegetable and melon farms are more likely to use hired labor than all commercial farms. In addition, the 56.2 percent all the vegetable and melon farms that used hired labor account for over three times the proportion of dollars spent on wages with respect to market share.

Similar pictures emerge in regards to the composition of the hired farm working force. Fewer vegetable and melon farms report using full-time workers in 1978 than in 1969, yet nearly twice as many vegetable and melon farms use full-time workers than all commercial farms. In 1978, one-quarter of all vegetable and melon farms, which represent less then 0.4 percent of all farms, used 8.9 percent of all full-time hired workers. In 1969, vegetable and melon farms who used full-time labor used an average of 8.9 full-time workers per farm. This rose to 12.6 workers per farm in 1978.

Fewer vegetable and melon farms in 1978 than in 1969, also report using part-time hired labor. In contrast, the average number of these workers per farm of these workers used also dropped. Seventy percent of all vegetable and melon farms in 1969 reported using part-time labor. This decreased to 50 percent in 1978. In 1969, vegetable and melon farms who employed part-time labor used an average of 28.6 part-time workers per farm. This decreased to an average of 23.4 part-time workers per farm in 1978. In spite of this decline, vegetable and melon farms account for a disproportionate use of part-time labor. Vegetable and melon farms that use part-time labor are less than 0.6 percent of all farms, yet they use 6.7 percent of all part-time workers.

Parallel trends exist in regard to contract labor use. Between 1969 and 1978, the percentage and proportion of use of contract labor declined for vegetable and melon farms. However vegetable and melon farms use a disproportionate amount of contract labor. Although the vegetable and melon farms that use contract labor are less than 0.3 percent of all farms, they account for 17.5 percent of total expenditures for contract labor.

In summary, while overall use of hired labor on vegetable farms has declined, the majority of vegetable and melon farms continue to use some form of hired labor. In other words, vegetable and melon farms are larger than family operations. In addition, disproportionate amounts of all forms of hired labor, relative to both the numbers of farms and to market share, are used on vegetable and melon farm production. Vegetable and melon farms are labor intensive.

Energy Contrary to the dictum that high labor use means low energy intensity, vegetable and melon farms use disproportionate amounts of some forms of energy inputs as well as the high consumption of hired labor. In terms of the data available for examining mechanical energy inputs, the picture is two fold. Virtually all vegetable and melon farms report expenditures for petroleum and other energy products. Yet the proportion of dollars spent on these products is slightly less than the proportion of sales (2.3 percent versus 2.9 percent).

In contrast, vegetable and melon farms are the second most likely to irrigate. Vegetable and melon farms are over three times as likely to irrigate land as all commercial farms. Over 45 percent of all vegetable and melon farms report irrigating land. Almost 40 percent of all land in vegetable and melon farms is irrigated. A similar energy intensive picture emerges with biochemical energy inputs. In 1978, most vegetable and melon farms used both commercial fertilizers and other agricultural chemicals in disproportionate amounts. For commercial fertilizer, 90 percent of all vegetable and melon farms, 1.3 percent of all farms, spent 3.3 percent of all commercial fertilizer dollars. Correspondingly, 85.6 percent of all vegetable and melon farms or 1.2 percent of all farms, purchased 5.1 percent of the other agricultural chemicals.

Commercial Fruit and Tree Nut Farms

Structure Farms with combined sales of products totalling fifty percent or more of total sales from berries, grapes, tree nuts, citrus fruits, deciduous tree fruits, avocadoes, dates, figs, olives, pineapples, and tropical fruits are classified as fruit and tree nut farms. These relatively small sized farms average around 140 acres and make up 31 percent of all commercial farms (Table 33).

Fruit and tree nut farms are highly specialized and increasingly concentrated in terms of market share. Since 1950, over 90 percent of the sales of agricultural products on these farms have come from fruits and tree nuts. In addition over 90 percent of all fruit and tree nuts are

TABLE 33

STRUCTURE, LABOR, AND ENERGY CHARACTERISTICS FOR COMMERCIAL FRUIT AND TREE NUT FARMS

	1950	1959	1969	1978
Structure:				
Number of farms	82,178	61,419	53,754	57,507
% all farms	2.2	2.5	3.1	3.1
average size	96.2	140.4	144.3	141.5
% total agricultural sales	3.4	4.5	3.8	4.2
Organization:				
% family	—	—	82.0	79.0
% total acres	—	—	56.0	47.2
Concentration:				
Gini Coefficient	—	.6034	—	.8039
Specialization:				
% market	88.2	91.1	92.5	93.0
% farms	92.1	93.3	94.6	95.5
Labor:				
part-time farmers:[1] % farms	21.5	27.2	40.7	44.4
% total part-time farmers	14.6	4.8	4.6	3.5
hired labor: % farms	78.2	86.5	77.0	64.2
% total dollar expenditures	9.7	12.5	12.8	12.7
contract labor: % farms	—	—	36.3	38.5
% total dollar expenditures	—	—	36.2	37.7
full-time workers:[2] % farms	—	—	25.9	27.9
% total full-time workers	—	—	10.0	10.2
average full-time workers per farm	—	—	4.727	5.968
part-time workers:[3] % farms	—	—	71.8	58.1
% total part-time workers	—	—	17.8	18.8
average part-time workers per farm	—	—	25.686	24.568
Energy:				
mechanical work power:[4] % farms	48.1	—	—	—
energy products:[5] % farms	72.6	95.6	95.9	97.2
% total dollar expenditures	2.6	2.7	2.9	3.5
commercial fertilizer: % farms	—	80.3	98.5	95.0
% total dollar expenditures	—	—	4.2	3.8
other agricultural chemicals: % farms	—	—	81.4	93.1
% total dollar expenditures	—	—	13.2	7.3
irrigated land: % farms	53.8	55.2	61.4	67.7
% farm type acres	—	—	29.8	37.1
% total irrigated acres	—	—	6.1	6.0

Source: U.S. Census of Agriculture.

[1]Farmers who reported working 100 or more days off their farm.
[2]Hired farm workers who work 150 or more days.
[3]Hired farm workers who work less than 150 days.
[4]Only mechanical farm work power. No use of horses or mules.
[5]Includes electricity, petroleom products, natural gas and other fuels.

produced on these farms. Production on fruit and tree nut farms is polarized with the top 20 percent accounting for 85.6 percent of sales within the category (see discussion page 95). This is reflected in the relatively high Gini coefficient of concentration of .8039. Another indication of this polarization is that, while 79 percent of the farms operated under a family organization in 1978, these farms accounted for only 47.2 percent of all the acreage in fruit and tree nut farms.

Labor One striking characteristic of the farm labor composition of fruit and tree nut farms is the increasing number of part-time farmers within the category. In 1950, only about one in seven fruit and tree nut farmers reported working 100 or more days off their farms. By 1978, this had exceeded the trend for all commercial farms and increased to three out of seven or 44.4 percent of all fruit and tree nut farmers reporting working 100 or more days off farm that year.

Fruit and tree nut farms also make extensive use of hired labor. As with all commercial farms, fewer farms reported using hired labor in 1978 than in 1950. However in 1978, almost two-thirds of all fruit and tree nut farms still report expenditures for hired labor, and the proportion of the wage bill has remained relatively constant since 1959. The composition of this wage labor force in production has also changed. Slightly more fruit and tree nut farms report using full-time workers and contract labor while 19 percent fewer farms report using part-time workers. However, average workers per farm in both categories has increased.

Regardless, fruit and tree nut farms continue to use disproportional amounts of all these labor groups in comparison to market share. The most striking example is in the case of contract labor. Contract labor is most often used as seasonal or harvest labor. Around two fifths of all fruit and tree nut farms report its use. Fruit and tree nut farms, 1.2 percent of all farms, account for 37.7 percent of the dollars spent on contract labor. These figures coupled with the disproportionate use of part-time workers indicate that a large percentage of part-time or seasonal workers are involved in the production of fruit and tree nut farms.

<u>Energy</u> Again, contrary to expectations that high labor use would corespond to low energy use, the intensive use of hired labor on fruit and tree nut farms parallels the use of most biochemical and mechanical energy inputs. Fruit and tree nut farms are more likely to report using these production inputs than all commercial farms. However, while over ninety percent of fruit and tree nut farms report purchasing petroleum and other energy products, commercial fertilizers, and other agricultural chemicals for use in production, only in the last category, other agricultural chemicals, do

purchases of fruit and tree nut farms account for a disproportionate amount of dollars spent on this resource by all farms. However , the proportion used by fruit and tree nut farms of this resource declined 45 percent between 1969 and 1978.

One mechanical energy input, irrigation, plays an especially important part in production on fruit and tree nut farms. Fruit and tree nut farms are the most likely farm type to use irrigation. In 1950, 8.8 percent of fruit and tree nut farms reported some use of irrigation. By 1978, slightly over two thirds of fruit and tree nut farmers irrigated 37 percent of all land in fruit and tree nut farms. Thus irrigation is a standard feature of fruit and tree nut production.

Commercial Dairy Farms

Structure Dairy farms - farms on which 50 percent of sales were from milk, cream, milk cows and calves - declined both numerically and as percentage of all farms. In 1978, there were almost three quarters fewer dairy farms than in 1950 (Table 34). The remaining farms nearly doubled in size from an average of 161 acres in 1950 to an average of 296.9 acres in 1978.

Dairy farm production has been increasingly specialized. Over ninety percent of all dairy products are produced on dairy farms, up from only 76 percent in 1950, and dairy

TABLE 34

STRUCTURE, LABOR, AND ENERGY CHARACTERISTICS FOR COMMERCIAL DAIRY FARMS

	1950	1959	1969	1978
Structure:				
Number of farms	602,093	428,293	260,956	166,491
% all farms	16.2	17.7	15.1	8.9
average size	161.4	208.2	248.8	296.9
% total agricultural sales	15.4	15.7	14.8	11.7
Organization:				
% family	—	—	85.4	84.1
% total acres	—	—	81.3	77.9
Concentration:				
Gini Coefficient	—	.4221	—	.4336
Specialization:				
% market	75.7	85.6	93.0	91.8
% farm	69.4	72.6	86.2	82.4
Labor:				
part-time farmers:[1] % farms	10.2	12.7	14.7	12.4
% total part-time farmers	18.2	15.6	8.1	2.8
hired labor: % farms	65.8	59.4	64.8	63.0
% total dollar expenditures	13.7	12.9	12.1	10.7
contract labor: % farms	—	—	4.8	5.5
% total dollar expenditures	—	—	2.7	2.9
full-time workers:[2] % farms	—	—	18.8	36.2
% total full-time workers	—	—	13.6	14.1
average full-time workers per farm	—	—	1.807	2.199
part-time workers:[3] % farms	—	—	54.8	45.5
% total part-time workers	—	—	9.2	6.5
average part-time workers	—	—	3.309	3.795
Energy:				
mechanical work power:[4] % farms	31.5	—	—	—
energy products:[5] % farms	83.3	98.9	99.9	100.0
% total dollar expenditures	15.0	15.6	12.7	11.4
commercial fertilizer: % farms	—	77.5	84.4	86.8
% total dollar expenditures	—	—	10.9	8.2
other agricultural chemicals: % farms	—	—	61.9	79.8
% total dollar expenditures	—	—	5.4	5.0
irrigated land: % farms	5.2	5.9	5.2	5.9
% farm type acres	—	—	2.2	2.9
% total irrigated acres	—	—	3.8	2.8

Source: U.S. Census of Agriculture.

[1]Farmers who reported working 100 or more days off their farm.
[2]Hired farm workers who work 150 or more days.
[3]Hired farm workers who work less than 150 days.
[4]Only mechanical farm work power. No use of horses or mules.
[5]Includes electricity, petroleom products, natural gas and other fuels.

products account for 82 percent of all sales on dairy farms, up from 69 percent in 1950. Regardless of this high degree of specialization, the market for dairy farms remains the least concentrated of all the farm types examined. In 1950, the Gini coefficient for market share of dairy farmers was .4221 by 1978 this had increased only to .4336.

Labor In direct contrast to the other farm types examined thus far, dairy farmers are rarely part-time farmers. Only one-eighth of the farmers reported working more than 100 days off their farms. In addition to the farmer's labor, dairy farms continue to use others' labor. In 1978, 63 percent of all dairy farms reported wage expenditures, only a slight decrease from previous years.

The composition of this hired working force has changed. Roughly ten percent fewer dairy farms use part-time labor, 45.6 percent in 1978 as compared 54.8 percent in 1969. This decline masks a slight increase in the average number of part-time workers per dairy farm that employs part-time labor. In 1969, the average number of part-time workers per farm was 3.3; this rose in 1978 to 3.9 workers per farm.

In addition, the use of full-time workers increased. The number of farmers reporting use of full time workers nearly doubled between 1969 and 1978. More than one third of all dairy farms in 1978 reported hiring full-time workers. This is a clear example of Friedland et al.'s (1978) proposed internalization of labor. The full-time employment opportunities for wage labor in dairy production have expanded.

Energy Dairy farms offer an example of relatively high labor intensity in terms of full-time farmers and full-time employees and a low energy intensity. Dairy farms are mechanized with electrical milking machines, coolers, sterilizers and feeders. Yet dairy farms do not use a disproportionate amount of power for these machines relative to share of sales.[1] While most dairy farmers purchased petroleum and other energy products, commercial fertilizer, and other agricultural chemicals, they did so in relatively small amounts. In addition, few dairy farmers reported irrigating land.

Commercial Poultry and Egg Farms

Structure. Poultry and egg farms, like dairy farms are declining both numerically and as a proportion of all commercial farms. In 1978, there were 75 percent fewer poultry and egg farms than in 1950 (Table 35). While declining in numbers, the market share of poultry and egg farms increased. In 1950, poultry and egg farms, 4.7 percent of all commercial farms, produced 5.5 percent of all sales of agricultural products. By 1978, poultry and egg farms were 2.3 percent of all farms but market share had increased to 8.2 percent.

TABLE 35

STRUCTURE, LABOR, AND ENERGY CHARACTERISTICS FOR COMMERCIAL POULTRY AND EGG FARMS

	1950	1959	1969	1978
Structure:				
Number of farms	175,896	103,279	57,545	41,947
% all farms	4.7	4.3	3.3	2.3
average size	72.6	96.5	130.3	125.4
% total agricultural sales	5.5	6.8	8.9	8.2
Organization:				
% family	—	—	88.2	86.1
% total acres	—	—	81.4	77.2
Concentration:				
Gini Coefficient	—	.5370	—	.4622
Specialization:				
% market	58.2	80.1	97.0	97.7
% farm	88.2	90.9	95.8	95.5
Labor:				
part-time farmers:[1] % farms	18.2	28.8	34.3	36.2
% total part-time farmers	9.5	8.5	4.2	2.1
hired labor: % farms	44.9	51.2	59.3	53.5
% total dollar expenditures	2.9	3.7	5.4	4.9
contract labor: % farms	—	—	8.2	9.2
% total dollar expenditures	—	—	2.5	0.1
full-time workers:[2] % farms	—	—	20.8	26.2
% total full-time workers	—	—	6.2	5.0
average full-time workers per farm	—	—	3.390	4.242
part-time workers:[3] % farms	—	—	48.9	43.4
% total part-time workers	—	—	2.9	11.5
average part-time workers per farm	—	—	5.210	5.642
Energy:				
mechanical work power:[4] % farms	29.0	—	—	—
energy products:[5] % farms	60.9	95.7	99.8	98.7
% total dollar expenditures	2.4	2.2	3.4	3.5
commercial fertilizer: % farms	—	43.1	44.2	38.2
% total dollar expenditures	—	—	1.1	0.9
other agricultural chemicals: % farms	—	—	37.3	40.1
% total dollar expenditures	—	—	1.0	0.8
irrigated land: % farms	5.2	4.5	3.1	3.0
% farm type acres	—	—	1.1	1.4
% total irrigated acres	—	—	0.2	0.2

Source: U.S. Census of Agriculture.

[1]Farmers who reported working 100 or more days off their farm.
[2]Hired farm workers who work 150 or more days.
[3]Hired farm workers who work less than 150 days.
[4]Only mechanical farm work power. No use of horses or mules.
[5]Includes electricity, petroleom products, natural gas and other fuels.

Much of this increase is probably tied to the increased specialization of poultry and egg production.[2] In 1950, poultry and egg farms accounted for less than 60 percent of all sales of poultry and egg products. This increased dramatically; inn 1978 poultry and egg farms accounted for almost 98 percent of all sales of poultry and eggs. The declining market concentration among poultry and egg farms masks the strong economic position of most of the farmers within this farm type. Forty five percent of all poultry and egg farms reported sales of over $100,000 as compared to less than twenty percent for the other farm types (see concentration discussion page 95).

Labor Poultry and egg farmers are similar to all commercial farmers in that one of three poultry farmers is a part-time farmer. In contrast use of hired labor has declined less than for other farm types. Fifty-four percent of poultry and egg farms use some form of hired labor. Poultry and egg farmers who report using hired labor use both more full-time workers and more part-time workers per farm in 1978 than in 1969.

While fewer poultry and egg farms report using part-time labor, these farms account for a larger proportion of all part-time workers. Between 1969 and 1978, the proportion of all part-time workers that were employed in poultry and egg production tripled from 2.9 percent of all part-time workers to 11.5 percent. In summary, much of the labor for poultry and egg production comes from part-time farmers and part-time hired farm workers.

Energy Poultry and egg farms use few energy inputs. Similar to dairy farms in this respect, poultry and egg farms are likely to have a highly rationalized system of production. Yet while most poultry and egg farmers purchase petroleum and energy products to power these systems, expenditures represent a low proportion of total resource use compared to market share. In addition less than forty percent of all poultry and egg farmers report purchases of biochemical energy inputs.[3]

Commercial Livestock except Poultry and Dairy

Structure Livestock farms include all farms with 50 percent or more combined sales from cattle, calves, hogs, sheep, goats, goat's milk, wool, and mohair.[4] This group of farms accounts for a steadily increasing percent of all farms. By 1978, 37.8 percent of all commercial farms were livestock farms (Table 36). These farms have been increasingly specialized and operate in a market context of high concentration (Gini coefficient equals .8074). Over eighty five percent of all livestock products, excluding dairy and poultry products are sold by livestock farms. These products make up just under 89 percent of the products produced for sale on livestock farms.

Labor As with cash grain farms, the labor process on

TABLE 36

STRUCTURE, LABOR, AND ENERGY CHARACTERISTICS FOR COMMERCIAL LIVESTOCK, EXCEPT POULTRY AND DAIRY FARMS

	1950	1959	1969	1978
Structure:				
Number of farms	806,080	684,061	647,884	704,860
% all farms	21.8	28.3	37.4	37.8
average size	625.5	797.9	828.2	745.8
% total agricultural sales	28.9	27.4	34.1	34.3
Organization:				
% family	—	—	86.1	87.3
% total acres	—	—	78.6	64.6
Concentration:				
Gini Coefficient	—	—	—	.8074
Specialization:				
% market	70.7	63.8	73.3	85.3
% farm	79.8	81.4	84.2	88.5
Labor:				
part-time farmers:[1] % farms	9.5	15.4	30.4	44.6
% total part-time farmers	22.7	27.1	36.4	42.9
hired labor: % farms	66.3	57.4	58.4	40.3
% total dollar expenditures	18.1	13.3	14.4	16.5
contract labor: % farms	—	—	5.9	7.1
% total dollar expenditures	—	—	7.4	9.4
full-time workers:[2] % farms	—	—	9.9	11.4
% total full-time workers	—	—	13.6	3.8
average full-time workers per farm	—	—	1.699	2.050
part-time workers:[3] % farms	—	—	25.5	34.8
% total part-time workers	—	—	9.2	19.4
average part-time workers per farm	—	—	3.140	3.453
Energy:				
mechanical work power:[4] % farms	24.1	—	—	—
energy products:[5] % farms	78.6	98.4	100.0	100.0
% total dollar expenditures	26.1	25.3	27.7	26.3
commercial fertilizer: % farms	—	62.5	75.9	63.9
% total dollar expenditures	—	—	25.5	21.3
other agricultural chemicals:% farms	—	—	54.4	54.2
% total dollar expenditures	—	—	16.4	16.4
irrigated land: % farms	5.3	6.5	7.6	8.7
% farm type acres	—	—	4.9	2.6
% total irrigated acres	—	—	30.8	25.5

Source: U.S. Census of Agriculture.

[1]Farmers who reported working 100 or more days off their farm.
[2]Hired farm workers who work 150 or more days.
[3]Hired farm workers who work less than 150 days.
[4]Only mechanical farm work power. No use of horses or mules.
[5]Includes electricity, petroleum products, natural gas and other fuels.

livestock farms is dominated by family labor. Almost sixty percent of all livestock farms report no expenditures for hired labor in 1978. In spite of this apparent reliance upon family labor, over forty percent of all livestock farms were run by part-time farmers in 1978. These numbers are the result of divergent trends. Between 1950 and 1978, the percent of livestock farms using hired labor fell 40 percent while the number of farm operators reporting 100 or more days of work off their farms more than tripled.

Within the overall decline in the percentage of farms using hired labor, there was an decrease in the percentage of farms using part-time labor and an increase in the percent of farms using full-time workers. The number of workers in both categories, i.e. full and part-time workers, per livestock farm increased slightly. Regardless of these changes, production on livestock farms involves little purchased labor in terms of market share produced.

Energy Use Contrary to expectations of high energy use, the relatively low labor inputs on livestock farms correspond to relatively low energy use. Few mechanical or biochemical energy inputs are used in livestock production. While all livestock farms report purchases of energy and petroleum products, these 37.8 percent of all farms only account for 26.3 percent of the dollars spent on these mechanical energy inputs.

Fewer than two-thirds of all livestock farms reported purchases of either commercial fertilizers or other agricultural chemicals with a correspondingly low proportion of overall expenditures in these categories.

<u>Energy and Labor Inputs in Farm Type Production</u>

The preceding brief descriptions illustrate the different use of labor and some forms of energy inputs among various farm types. For example from these descriptions, it is clear that cash grain and livestock farms make the least use of hired labor. Less than 40 percent of all farms in these two categories use hired labor (Tables 31 and 36), while over two thirds of all dairy farms and fruit and tree nut farms purchase hired labor (Tables 32 and 34). Thus family labor farms are more likely to be cash grain or livestock farms.

We can also make observations about the relative intensity of use of a resource as compared to market share within and among commodity production systems. Table 37 gives us a way to examine the range and and the extent of differences in resource use among the six farm types based upon input indices. The input indices in this table are based upon a ratio of the proportion of a resource used divided by the market share of that commodity type farm's agriculutural sales. In other words, an input index of hired labor tells us the relationship between the portion of

TABLE 37

INPUT INDICES[1] FOR LABOR AND ENERGY RESOURCES
BY FARM TYPE, 1969 AND 1978

	FARM TYPE					
1969	CASH GRAIN	VEGETABLE & MELON	FRUIT & TREE NUT	DAIRY	POULTRY AND EGG	LIVESTOCK EXCEPT POULTRY & DAIRY
Labor inputs indices						
part-time farmers[2]	1.40	.46	1.21	.58	.47	1.07
hired labor[3]	.69	3.08	4.89	.82	.61	.45
contract labor[4]	.34	8.19	9.53	.18	.28	.22
full-time workers[5]	.69	3.08	2.68	.92	.70	.40
part-time workers[6]	.76	2.81	4.68	.62	.33	.27
Energy inputs indices						
energy products[7]	1.73	.73	.76	.86	.38	.81
commercial fertilizer[8]	1.91	1.62	1.11	.74	.12	.75
other agricultural chemicals[9]	1.71	2.81	3.47	.36	.11	.48
irrigated land[10]	1.64	1.61	1.61	.26	.22	.90
1978						
Labor inputs indices						
part-time farmers[2]	1.05	.48	.83	.24	.26	1.25
hired labor[3]	.67	2.97	3.02	.92	.58	.48
contract labor[4]	.32	6.03	8.98	.25	.01	.27
full-time workers[5]	.64	3.07	2.43	1.21	.61	.11
part-time workers[6]	.69	2.31	4.48	.56	1.40	.57
Energy inputs indices						
energy products[7]	1.41	.79	.83	.97	.43	.77
commerical fertilizer[8]	1.98	1.14	.66	.70	.11	.62
other agricultural chemicals[9]	1.76	1.75	1.74	.43	.09	.48
irrigated land[10]	1.36	1.45	1.43	.24	.03	.74

Source: U.S. Census of Agriculture.

[1] Proportion of resource used divided by market share.
[2] Percent of number of farmers reporting working 100 or more days off farm.
[3] Percent of total dollars spent on hired labor.
[4] Percent of total dollars spent on contract labor.
[5] Percent of number of hired farm workers used who worked 150 or more days.
[6] Percent of number of hired farm workers used who worked less than 150 days.
[7] Percent of total dollar expenditures for energy products including electricty, petroleum products, natural gas, etc.
[8] Percent of total dollars spent on commercial fertilizers
[9] Percent of total dollars spent on other agricultural chemicals including lime.
[10] Percent of total acreage of irrigated land

dollars spent on wages in terms of the farm type's market share. An input index of one illustrates a situtation of parity between resource use and market share. Using the example of hired labor, an input index of one would tell us that within that farm type, the percentage of the total overall dollars spent on hired labor was used to produce the same percentage market share of farm output. An input index greater than 1.0 indicates a disproportionate use of that resource relative to market share, while an input index substantially lower than 1.0 demonstrates little reliance upon that resource to produce agricultural products. Correspondingly, input indices can be equated with intensity of the resource use in the farm type's production system. Low input indices demostrate low intensity of resource use in the production organization, while high input indices (greater than one) indicate high resource intensity. In this context, input indices around 1.0 can be called equivalent intensity illustrating parity in the use of a resource per market share produced.

Table 37 shows that few differences are found between 1969 and 1978 in labor and energy input indices within farm type production systems. While the ratios for many variables fluctuate slightly in the period examined, for most indices in all the farm types the direction of the intensity, i.e., high , equivalent or low, did not change. Overall there appears to be a slight decrease among the six farm types for most of the input indices. This may indicate more efficient resource use.

There are two discernible trends within this period: 1) slightly lower proportionate resource use of most energy and labor inputs in 1978 than in 1969 among fruit and tree nut farms and vegetable and melon farms, and 2) a small increase of both full time hired workers and contract labor on dairy farms. Again, these trends may reflect changes in product price relationships, i.e. dairy product prices may have dropped relative to the cost of other products or more efficient production.

Despite these minor fluctuations, Table 37 shows that intensity of resource use among farm types differs dramatically. Production on cash grain farms is characterized by low labor intensities and the highest energy input indices of all farm types. In other words, cash grain farms use little purchased labor and a disproportionate amount of both mechanical and biochemical energy inputs. On livestock farms, labor indices are low for all types of labor with correspondingly low biochemical and mechanical energy resource use.

Production on poultry and egg farms can be characterized by low labor input in all hired labor categories except part-time workers. A disproportionate number of part-time workers are employed on poultry and egg farms. In addition poultry and egg farms are characterized by the lowest energy input indices of all the six farm types examined.

Dairy farms fall in the middle of the range of input indices among the six farm types. For both energy and hired labor, dairy farm production approaches parity in terms of proportion of resource use per market share with the exception of full time hired labor. More full time workers are used in dairy production than were previously used.

In contrast with the farm production systems that are characterized by low or equivalent energy intensities are vegetable and melon farms and fruit and tree nut farms. Both these farms are characterized by very high labor input intensities. For all forms of farm wage labor, the input indices are greater than twice parity levels and indeed range up to an input index of 8.98 for contract labor on fruit and tree nut farms. Therefore production on these farm types uses a disproportionate amount of wage labor.

Vegetable and melon farms and fruit and tree nut farms are both also characterized by high use of energy in the form of irrigation and in terms of use of other agricultural chemicals. In addition vegetable and melon farms use greater than equivalent amounts of another energy input, commercial fertilizer.

In summary, different degrees of energy and labor resource use are found in the production systems of the six farm types examined. Various combinations of energy and labor intensities occur: production systems with high energy intensity may have either high or low labor intensities. This underscores the complexity of the labor/energy relationship within agriculture. There is a great discrepancy in the use of hired labor among farm types than for the use of energy inputs. Hired labor indices range from 0.40 to 3.02 while the input indices for commercial fertilizer have a much smaller range, 0.11 to 1.98 .

TABLE 38

ENERGY AND LABOR INTENSITY BY FARM TYPE

S.I.C. Farm Type	Labor Intensity	Energy Intensity
Cash Grain	LOW	HIGH
Livestock, except poultry and dairy	LOW	LOW
Poultry and Egg	LOW	LOW
Dairy	EQUAL	EQUAL
Vegetable and Melon	HIGH	HIGH
Fruit and Tree Nut	HIGH	HIGH

As shown in Table 38, the relation between energy and labor use in agricultural production is not linear. If energy simply replaced labor than combinations of high labor and low energy intensities, low labor and high energy intensities and equivalent intensities would be expected. Only two of the six farm types fit this model, cash grain farms with low labor and high energy intensities, and dairy farms with equal labor and energy intensities. The other four types diverge from this pattern.

Scale, Energy, and Labor

These observations have important implications for the relevance of size as an important variable in understanding resource use on farms. Many studies have suggested that large farms are both more energy and labor intensive than are smaller farms (Lianos,1971; Rodefeld, 1978; Goss, 1976; Buttel, 1980). While it is clear that farm production systems differ in scale or acreage, these size differences may be masking the different production relations among farm types.

Acreage varies by crop or livestock activity. For example, livestock farms are large with an average acreage of over 746 acres (Table 36), while the smaller poultry and egg farms average only 125 acres per farm (Table 35). Despite this discrepancy in scale both production systems are characterized by low labor input indices and low energy input indices. Studies focused upon size would mask the production similarities of these two farm types.

A refinement on this examination of agricultural scale is made by Buttel (1981). He suggests that it is not land size but market size that is the important dimension in the big/small dichotomy. This analysis suggests that "large market" farms differ from "small market" farms in terms of resource use. In other words, this argument directs us to the understanding that production on large market share farms is organized differently than production on small market share farms. For example, small market share farms are more likely to rely solely upon family labor, be run by part-time farm operators, and use fewer energy inputs. Clearly this is common sense, smaller market farms produce less market value and thus need fewer production inputs to produce the smaller proportion of products.

Two important questions emerge from this this observation: Do large market share farms within farm types use disproportionately more resources? Is the resource use of large market farms between farm types more similar than between large market and small market farms within the same farm type? In other words, is market scale more important for distinguishing use of resources in production than farm type?

In answer to the first question, the difference in resource use between large and small market farms, Table 39 shows a disproportionate distribution of some production

TABLE 39

CHARACTERISTICS OF MAJORITY[1] OF PRODUCT PRODUCING COMMERCIAL FARMS BY FARM TYPE, 1978

	CASH GRAIN	VEGETABLE & MELON	FRUIT & TREE NUT	DAIRY	POULTRY AND EGG	LIVESTOCK EXCEPT POULTRY & DAIRY
Structure:						
% of farm type	30.9	11.8	20.6	61.1	45.2	15.0
% total farm type agricultural sales	78.1	85.6	88.1	88.2	89.4	62.6
average size (acres)	926.0	845.0	331.4	366.8	169.0	2,139.9
% of farm type land	65.2	61.3	75.2	76.5	74.2	66.2
Organization:						
% family	80.7	49.0	62.2	80.5	81.5	76.5
% partnership	14.4	24.5	20.8	16.7	8.6	16.2
% corporation	4.2	22.5	15.8	2.8	9.5	6.8
Labor:						
part-time farmers:[2] % farms	10.8	10.3	26.2	5.1	29.2	14.7
% farm type part-time farmers	11.5	4.4	18.9	32.8	44.4	7.2
hired labor: % farms	64.0	91.7	84.0	74.4	65.7	63.9
% farm type dollar expenditures	87.2	91.2	92.3	93.6	95.3	82.2
contract labor: % farms	7.4	45.9	43.2	6.1	11.7	9.6
% farm type dollar expenditures	75.7	90.8	88.7	89.3	90.9	62.8
full-time workers:[3] % farms	30.6	79.5	59.7	49.9	39.6	33.8
% farm type workers	85.3	90.3	91.4	90.3	93.7	77.5
part-time workers:[4] % farms	51.7	76.8	74.2	51.6	51.7	49.5
% farm type workers	56.9	71.2	74.5	73.0	75.4	37.2
Energy:						
energy products:[5] % farms	100.0	99.4	99.2	100.0	99.7	100.0
% farm type dollar expenditures	70.3	76.4	81.3	81.9	82.8	63.1
commercial fertilizer: % farms	95.8	98.1	93.0	92.0	43.3	81.1
% farm type dollar expenditures	74.3	80.8	84.7	88.5	86.1	69.9
other agricultural chemicals:						
% farms	94.9	97.3	99.6	87.0	49.0	79.4
% farm type dollar expenditures	76.6	87.2	85.6	88.5	88.1	73.7
irrigated land: % farms	17.4	82.9	45.7	6.0	3.8	10.0
% farm type irrigated land	86.9	87.9	84.5	92.3	89.4	75.5

Source: U.S. Census of Agriculture, 1978.

[1]Farms which produce seventy five percent or more of the agricultural sales for the farm type.
[2]Works more than 100 days off-farm
[3]Hired farm worker who works 150 or more days.
[4]Hired farm worker who works less than 150 days.
[5]Energy products include electricity, petroleum products, natural gas, etc.

resources. The farms which produce the majority of a product within a farm type classification are less likely to be operated by part-time farmers, are more likely to use hired labor, and account for a slightly higher proportion of all full-time farm workers. However for other resource categories, i.e., part-time hired workers, contract labor and all forms of energy inputs, this is not true. Within farm type categories, many dimensions of production inputs are similar.

The issue is further resolved by examining the input indices reported in Table 40 and Table 37. Table 37 contains input indices for all farms within a farm type while Table 40 lists input indices for the large market farms, those farms that produce 75 percent or more of the agricultural sales within the farm type's total sales. Comparing the two sets of indices shows there are fewer differences within farm types than between large market farms of all types. The greatest difference between the two tables is in terms of part-time farm operators. As discussed previously, fewer farm operators that run large market farms report working 100 or more days off their farms.

TABLE 40

INPUT(1)INDICES FOR LABOR AND ENERGY RESOURCES BY MAJORITY(2) OF PRODUCTION FARM TYPE FARMS, 1978.

S.I.C. Farm Type	Cash Grain	Vegetable and Melon	Fruit and Tree Nut
Percent all farms	8.7	0.16	0.64
Percent market share	17.4	2.5	3.7
Labor Input Indices:			
Part-time farmers(3)	.16	.02	.07
Hired labor(4)	.74	3.12	3.17
Contract labor(5)	.31	6.36	9.04
Full-time workers(6)	.70	3.22	1.91
Part-time workers(7)	.51	1.91	3.79
Energy Input Indices:			
Energy products(8)	1.27	.71	.76
Commercial fertilizer(9)	1.89	1.07	.87
Other agrochemicals (10)	1.73	1.77	1.69
Irrigated land (11)	1.51	1.39	1.37

S.I.C. Farm Type	Dairy	Poultry	Livestock, except poultry and dairy
Percent all farms	5.4	1.0	5.7
Percent market share	10.3	7.3	28.3
Labor Input Indices:			
Part-time farmers(3)	.09	.26	.11
Hired labor(4)	.97	.64	.48
Contract labor(5)	.25	.01	.21
Full-time workers(6)	1.24	.64	.10
Part-time workers(7)	.46	1.19	.26
Energy Input Indices:			
Energy products(8)	.91	.39	.59
Commercial fertilizer(9)	.70	.11	.61
Other agrochemicals (10)	.43	.09	.43
Irrigated land (11)	.34	.03	.68

1.Proportion of resource divided by proportion of agricultural sales. 2.Farms that account for 75% or more of the sales within a farm type. 3.Farmers who report 100 or more days off farm work. 4.Dollars spent on hired labor. 5.Dollars spent on contract labor. 6.Hired farm workers employed 150 or more days. 7.Hired farm workers employed fewer than 150 days. 8.Dollars spent on energy products including electricity, petroleum products, natural gas, etc. 9.Dollars spent on commercial fertilizer excluding manure. 10.Dollars spent on all other agrochemicals including lime. 11. As proportion of all irrigated land.

However, while the index numbers vary between the two tables, all farms within a farm type and the majority of product producing farms of that farm type, several important dimensions of comparison remain the same. For any given input index there are slight differences in the numbers reported but the magnitude, range, and direction of intensity of the resource use are comparable between all farms in a farm type and the majorty producing farms. For example, the range of the hired labor input index for all commercial farms is 0.48 to 3.02. The range for the same variable in majority producing farms is 0.48 to 3.17. Similarily, the range of commercial fertilizer input indices spanned 1.87 for all farms and 1.78 for majority producing farms. In addition the rank ordering of the farm types for most input categories is the same. For example, vegetable and melon farms rank second in commercial fertilizer use and second in use of hired labor for both sets of indices.

More importantly, both groups of farms can be categorized by the same degree of resource intensity. For example, cash grain farms have low hired labor intensities for both the large market and overall market farms. Similarily livestock farms, in both categories, have low labor and low energy input indices.[5]

The similar characteristics of the indices in these two charts underscores the importance of farm type in understanding resource use in agricultural production. Focusing upon scale, whether in terms of acres or market share, obscures this important dimension in the relationship of energy and labor. The relationship of these two variables is clearly not linear for all production systems, i.e., more labor does not mean less energy use in production. As we have seen, a variety of compositions are possible including both high energy and labor intensities in vegetable and melon farms and low energy and labor intensities in poultry and egg production.

Chapter Seven Notes:

1.This is not to say that these are not capital intensive, i.e all that machinery entails a substantial investment of capital. But in terms of the three energy input expenditure measures, this form of production requires relatively little energy input. In addition, it must be recognized that for livestock farms, one big production expense, commercially mixed feeds are not included. Purchasing feed instead of growing it clearly shows a commercialization of agricultural production but not a changing form of energy technology.

2.By 1950, poultry and egg farm production was fairly specialized. Over 88 percent of the sales on poultry and egg farms were from the sales of poultry and egg products. Farm specialization increased to 95 percent in 1978. However in this same period, market specialization increased dramatically, from 58 percent in 1950, to 97 percent in 1978. Thus poultry and egg farms produce more of these products.

3.Some biochemical use in the form of agrochemicals may be masked in the production on poultry and egg farms. Drugs for animals may be included in commercially mixed feed. Similar pictures may be accurate for dairy and livestock farms.

4.The category of livestock except dairy and poultry farms has undergone the most changes of the six farm types examined here. See Table 1 in the 1974 Census of Agriculture, Summary by Farm Type, for an overview of those changes in definition.

5.Indeed this parity in production forms between large and small market farms within a farm type is to be expected. The large market farms set the conditions under which the small market farms must produce in order to be competitive.

Chapter 8:
DISPLACEMENT AND REPLACEMENT: A DISCUSSION OF FINDINGS

Summary of Findings

In the period examined, the structure of agriculture underwent dramatic transformation. Two facets of this transformation are especially striking - farm market relations and agricultural production organization.

In terms of farm market relations, U.S. agriculture has become increasingly polarized. There are fewer farms and competition among these farms is unequal. Fewer farms control an ever increasing share of agricultural sales. This increased concentration means more barriers to entry for many would-be farmers, a stronger competitive position for a minority of farmers, and more cost-price pressures on the vast majority of farms which compete for a diminishing proportion of the food market.

Equally striking is the rationalization of farm production. The range of on-farm production has narrowed both in terms of the scope of production activities and in terms of range of commodity production. Farm production is commercialized: both the mix and the source of inputs have changed. Farmers no longer produce their inputs. The farm unit is enmeshed in larger market relations. Materials for production are purchased and the raw product is sold for further processing. In addition, farm production is specialized. Farmers concentrate on producing specific product groups rather than a broad range of commodities.

Within the rationalization of farm production, changes in the role of two production inputs - energy and labor - are striking. More energy and less labor is used in U.S. agriculture. Between 1940 and 1960, mechanical energy inputs became the dominant source of farm power. With this new power source, farmers were able to extend the scale of their activities. Farms became larger. The introduction of biochemical energy inputs furthered the production transformation. In the first period, 1940-1950, farmers were able to increase dramatically the intensity of their production units by adding commercial fertilizers. The later period of increased biochemical energy inputs, 1960-1970, entailed the use of agrichemicals to reduce natural risks and further increase yields.

Parallel changes in farm labor occurred. The agricultural labor force declined dramatically. The composition of the farm work force also changed. Farmers and farm family workers were disproportionately affected. Opportunities for women as agricultural workers declined faster than for male farm workers. Little is known about the effect on the racial and ethnic divisions in the farm labor force. While part-time hired workers still comprise the majority of hired farm labor, more recently, opportunities for full-time workers have increased. However, overall, there are fewer farm operators, farm family members and hired workers in the agricultural work force.

Energy/Labor Relation in Agricultural Production

An important element of this project has been the delineation of production systems for farm types. Farm types differ in terms of overall structure and in terms of energy and labor use within production.

On the surface, the relationship between farm labor and energy use seems to be linear. In other words, it appears that energy was substituted for labor. There clearly were increases in energy use and decreases in labor use in U.S. agriculture between 1910 and 1978.

However, as the preceding discussion of energy and labor use in commodity farm types shows, this model of input substitution of energy for labor is not accurate. We must distinguish between two factors, the role of energy and labor in production systems and the role of energy in increasing overall production. In other words, has energy replaced labor within production units or has energy fostered production increases which have reduced the overall need for farm units?

The answer to the latter question is clear, increased scale and production efficiencies reduced the number of farms needed to produce food for the U.S. population. In this sense, energy has displaced labor. If fewer farms are needed to produce food, the people whose labor ran these farms is also no longer needed.

This displacement of labor by energy affected different groups of the agricultural work force disproportionately with differing consequences. Both forms of energy inputs displaced household production units. Early mechanical energy inputs, while 'extending the arms' of some farmers and enabling them to compete with large capitalist farming concerns, 'cut off the arms' of other farmers whose land was incorporated into another unit's production. The increased intensity of production which accompanied later biochemical energy inputs further intensified competition among farmers and resulting market forces pushed other farmers from agriculture. Clearly, the farm family workers and hired workers on these defunct units were also displaced. In addition the remaining farms had less control over production due to the commercialization of production.

The issue of replacement, the relationship between energy and labor within production units, is less clear. There is some evidence that within farm production, early mechanical energy inputs replaced the need for some farm family members' labor and a small portion of full-time hired workers' labor. However, more recently, full-time farm workers have increased while farm family workers have not.

There is one point that must be stressed here - the fallacy of the average farm and the standard farm production organization. As addressed throughout this project, farm structure and production organization differs substantially by commodity. In regard to the replacement of labor by energy, only for one is this relationship accurate. On cash grain farms, high energy use is related to low labor use. For other commodity farm types, there are low energy and labor relationships, as well as high energy and high labor production systems. In other words, increased use of energy has not meant a reduction of labor use within production processes. Increased efficiencies and market relations have displaced farm units and the corresponding workers - farm operators, farm family workers, and wage labor - on those units. Within the remaining production organizations family labor has been replaced by hired labor.

<u>Changes in Production Relations</u>

This is not to argue that farm production relations have remained unchanged. By removing the need for farm family members' labor, the labor organization of family labor farms - household production relations - has changed. Farm families now more closely approximate the dichotomized spheres of production activities separate from reproduction activities of the larger society. Relatedly, farmers are more likely to have multiple occupational commitments, i.e., a wage labor job as well as farming. Off-farm employment as well as farm profits are needed for farm families' economic subsistence. In addition, recently, the relations of production for farm wage workers have changed. The increasing internalization of hired farm workers, i.e., more full-time employment, suggests an improvement in the opportunities for some hired labor.

Regardless, the relationship between energy and labor in U.S. agricultural production is best understood as displacement of units not substitution in the labor process.

Suggestions for Further Research

These observations suggest several areas for further work in both in terms of improved data collection and in terms of research projects.

The first is in the area of agricultural labor information. Much work needs to be done in improving both collection procedures and the types of data gathered. Accurate farm labor data which tells us whose labor, and how much labor, that is tied to farm production organizations is sorely needed to further our understanding of farm production relations.

Secondly, the task of differentiating agricultural systems of production must be continued. Further specification of energy and labor use in commodity production systems, the historical evolution, of these systems and the implications of their differences, need to be explored.

More specifically, work needs to be done that locates the overall production changes sketched in this project to the actual on-farm experience of farmers and farm workers. What have these energy changes meant for the ongoing labor process on farms? For the conditions of work? For the skills and opportunities of the farm workforce?

A related topic that merits examination is the changes in farm household production systems. To what extent do farm families comprise units of production? The distinction between productive and reproductive activities within farm family organization is central here.

In short, the displacement of labor by energy in agricultural production is clear. Further work needs to look at the context of the replacement of labor by energy within specific agricultural production systems.

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