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ABSTRACT

A CONCEPTUAL MODEL OF TRANSFORMATION OF AGRICULTURE: FORDISM, NEO-FORDISM, AND POST-FORDISM

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This study examines the current transformation of U.S. agriculture. Based on the characteristics of technological development, three models of agricultural production system are delineated. They are termed as Fordism, Neo-Fordism and Post-Fordism.

The Fordist model of agricultural development is largely characterized as large-scale units of production, mechanization, and standardized products. In contrast with this model, alternative models, Neo-Fordism and Post-Fordism, try to find niche market by producing differentiated commodities.

This study is an attempt to understand the implications of different types of technological development in terms of their scientific backgrounds, their effect on the flexibility of farming, market relations, strategies to transform the agri-food system, and prospects and barriers in the future. The findings suggest that U.S. agriculture is becoming more and more heterogeneous than before in terms of technology and farming strategy.

To My Parents

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INTRODUCTION

In their book, "The Second Industrial Divide", which deals with the transformation of the production system in manufacturing industries, Piore and Sabel (1984) show the possibilities of industrial development based on flexible specialization[1] which emphasizes a craft production system. They argue that we are facing the choice of a production system between the mass production system and the flexible specialization. A period during which choices are presented regarding the path of development is referred to as an 'industrial divide'.

> The brief moments when the path of technological development itself is at issue we call industrial divides. At such moments, social conflicts of the most apparently unrelated kinds determine the direction of technological development for the following decades (Piore and Sabel 1984:5).

We are presently going through an agricultural

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[1] "Flexible specialization is a strategy of permanent innovation: accommodation to ceaseless change, rather than an effort to control it. This strategy is based on flexible - multi-use- equipment; skilled workers; and the creation, through politics, of an industrial community that restricts the forms of competition to those favoring innovation. For these reasons, the spread of flexible specialization amounts to a revival of craft forms of production that were emarginated at the first industrial divide." (Piore and Sabel 1984:17)

'industrial divide', where multiple paths are open to us and proponents and opponents are advocating their paradigms. The outcomes of each type of agriculture can have different implications for the structure of agriculture and society as a whole. The objective of this paper is not prediction of the future, but the description and analysis of the implications of different types of agricultural production systems. The future path of technological development relies on the negotiations among various actors, and the possible paths can co-exist. I suppose that this is the plausible case in the future.

The agriculture and food industry in industrial countries changed greatly after World War II. In terms of agriculture, it is largely characterized as high-input of agrichemicals, large-scale units of production, mechanization, and standardized products. The food industry is also characterized as a large-scale industrialized mass-production system which creates an enormous amount of uniform, standardized food commodities. With the help of chemical food additives and preservatives, processed food became available and largely replaced domestic food preparation. The transformation of the agriculture and food industry benefited from some of the fruits of development of chemical and engineering technology.

Such a large-scale mass production system in the agriculture and food industry is called 'Fordist' development (Kenney 1989, Goodman and Redclift 1991). While Fordist development has caused many problems in terms of environment and food safety, consumers also began to search for differentiated, value-added commodities. In short, the mass market became glutted with standardized goods, and, currently, there is a search for new alternative forms of development. At this point in time, we can isolate two alternative paths of development of the 'agri-food system' (Goodman and Redclift 1991) which will be discussed below.

In this paper I will describe three types of agricultural production systems: the Fordist (or Conventional) Model, the Neo-Fordist (or Industrial) Model and the Post-Fordist (or Alternative) Model to be explained below. I develop these concepts[2] as Weberian 'ideal types' through an examination of the current literature. These concepts play a heuristic role in examining the multi-faceted phenomena which occurred, and continues to occur, in the agri-food system.

It is worth noting two points here. Firstly, no actor rigidly adheres to one type of agricultural production system

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[2] According to Burrows et al. (1992), there are three distinct positions on how to understand Fordism, Post-Fordism, and flexibility: i.e., Marxist regulation theory; the notion of flexible specialization associated with the 'new' institutional economics; and the model of the flexible firm derived from the managerialist literature. Our position here is close to the second one, which focuses on changes in the process of production. Piore and Sabel proposed a concept called 'flexible specialization' which refers to "a new form of skilled craft production made easily adaptable by programmable technology to provide specialized goods which can supply an increasingly fragmented and volatile market" (Burrows et al. 1992:3). We owe the conceptualization of Post-Fordism to their idea of 'flexible specialization'.

as its sole survival strategy. Rather, every actor, to a greater or lesser degree, employs a mixed survival strategy. For example, based on a survey, Lasley et al. (1990) found that it is difficult to categorize farmers based on whether they engage in low-input or conventional agriculture. Nevertheless, it is helpful to set up a typology in order to show the different directions and consequences of transformation, where various actors, scientific approaches, and organizational arrangements interact in a coordinated fashion.

Secondly, the three types of production systems are dealt with largely in terms of the direction of technological development. However, I do not support the idea of technological determinism. My position is quite the opposite. Not only do technological options, but also the market, organizational structure, and micro/macro regulation, affect the likelihood of achieving an optimal solution for producing commodities (Piore and Sabel 1984). Busch (1993) argues that "science, technology, government regulations, market rules, land tenure, and legal systems, are different strategies by which individuals and organizations seek to achieve various ends". These factors create the driving forces which organize certain production systems, and when they work together in a coordinated fashion, form a set of systems like a seamless web.

In the first section of this paper, I discuss the basic differences between each model of agriculture and, in the second section, I elucidate the general characteristics of each model. In the third section, I discuss how each model is based on a different scientific background. The transformation of the current agri-food system (Conventional Model) into the Industrial and Alternative Model brings us into a totally different situation in terms of the technology development/transfer system, organizational arrangement, regulation, market relation and so on. The different set of strategies is addressed in section four. In the conclusion, I summarize the above discussion and discuss the policy implications for U.S. agriculture.

I. FLEXIBILITY OF FARMING AND MARKET RELATIONS

There are two key concepts by which the three models of agricultural production are distinguished. The foci of agricultural production models are on the flexibility of farming and the market relations which are targeted by farmers, processors and other actors. The focus on the flexibility of farming and market relations of output is crucial for farming, or any other enterprise, in order to enable adaptation to the variability or fluctuation of the surrounding environment. In the case of farming, there are two sources of variation; one is the physical or biological environment, the other is the economic environment or market condition, which would include consumer demand. Farming has to adapt to both influences, either by changing farming itself and/or managing the environment to be kept under control.

The Fordist Model pursued production extensively and succeeded in providing large quantities of products to the market. However, the market became glutted with standardized products at a certain point in time.

In order to find a niche market, a major shift of focus from quantity to quality is pursued in agri-food system. In other words, product differentiation in terms of quality should be emphasized by people.

I argue there are two ways to achieve product differentiation. The first strategy is to minimize the variability of production (farming, in this particular case). In other words, total quality control within the agri-food system may be pursued as a way of product differentiation. This will minimize the flexibility of farming. The second way to effect product differentiation is a strategy which attempts to adapt the variability coming from production. Farming tries to take advantage of location-specific resources and to create diverse, and value-added products, a strategy which can capture the differentiated market. The agricultural production models are classified according to these two concepts.

(1) Flexibility of Farming

The flexibility of farming refers to the possibility of modifying some, or all, components of a farming system[3]. Flexibility is determined by various factors surrounding farmers, such as the skills of farmers, technological options, organizational arrangements, and policy/regulatory options.

a) Skills of Farmers

Major successes of modern agricultural production are

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[3] A farming system can be defined as "the overall approach used in crop or livestock production, often derived from a farmer's goal, values, knowledge, available technologies, and economic opportunities" (Benbrook 1991:6).

often attributed to technological innovation, such as mechanization, chemical inputs, and modern varieties. These technological developments contributed to increasing labor productivity. Farmers' skills[4] have also been standardized. An example of skill conformity is the practice of pesticide application on a regular schedule, rather than application based on individual farmer discretion. Flexibility of farming requires farmers to have adequate skills, since each farming practice requires appropriateness, timeliness, and so on. For example, if farmers attempt to utilize agrichemicals in a flexible manner (not based on uniformed decisions), they must have the appropriate skills to manage the problem derived from the pest.

b) Technological Options

Technological development does not necessarily result in standardization of farmers' skills or deskilling. However, the technological development of modern agriculture mainly focused on mechanization, chemicalization, and breeding (improving yield and uniformity), and resulted in higher dependence on capital, petroleum, agri-chemicals and limited varieties of seeds (Soule and Piper 1992:52). These technological developments limited flexibility for farming, because these technologies usually don't take into account the diversity of

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[4] The skills of farming can be defined as a producer's capacity to deal with farming based on his or her education, experience, knowledge, management ability, and so on.

ecological conditions, which virtually differ from field to field. The reductionist approach of agricultural science has succeeded in identifying what Latour (1987) calls "immutable and combinable mobiles", information which is invariant through any change in spatial or social location (Kloppenburg 1991:529). Ideally, such information may be valuable when it succeeds in solving farmers' immediate problems. From this standpoint, farming flexibility might be regarded as undesirable variability occurring as a result of an uncontrollable environment.

There are other paths of technological development which were not taken, but there are ways to encourage farming flexibility along with technological development. Later, such possibilities are presented, when I deal with the Post-Fordist, or Alternative, Model of agricultural production system.

c) Organizational Arrangements

In terms of agriculture, organizational arrangements can be less important than other factors, since farmers are usually self-employed and, at least on the farm, do not work within formal organization in the sense that workers of manufacturing industries do. However, contract farming and vertical integration are becoming more and more important organizational arrangements today. Marion (1986) pointed out that "vertical coordination is one of the central dimensions of the organization and conduct of economic activity" for commodity subsectors and "the percentage of total farm output produced either under contractual arrangements or by vertically integrated firms increased from 25 percent in 1960 to 31 percent in 1980" (Myers 1991:31). These organizational arrangements affect farmers' decision making and, therefore, farming flexibility.

d) Policy/Regulatory Options

Government policies, such as fiscal policy, taxation, trade policy, commodity programs, and so on, are important factors which farmers take into consideration when selecting crops and determining management strategy, because governmental policy directly affects the profitability of farming. In particular, commodity programs related to cross-compliance provisions have been criticized as an economic disincentive for farmers to adopt crop rotation (National Research Council 1989:69). This provision offers a limited option of crops and, therefore, limited flexibility of farming. Although the 1990 Farm Bill set up a new rule of "Planting Flexibility", the modification of regulations remains minimal[5]. Financial stress caused by high, real

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[5] The program allows farmers to plant additional crops on the up to 15.0% of Base Acreage, but results in a reduction of Payment Acres. "New Provision in legislation is that farmer may plant other crops on the 15 percent of Crop Acreage Base not eligible for payments without loss of Crop Acreage Base. Other crops which will be 'considered planted' to the program crop include all other program crops, any oilseed crop, any

interest rates during the 1980s (which was caused by monetary and fiscal policy) has also been criticized to discourage farmers from engaging in long-term, environmentally sound agricultural practices (Flora 1990b).

(2) Market Relations

Market relations, in general, refers to the ways in which commodities are sold through the market. In other words, what type of market is targeted by certain commodities. Here, the main focus is on the degree of market specification of commodities, or output of farming. The assumption here is that market specification requires product differentiation as a necessary condition. The degree of market specification becomes very important when the market becomes glutted with unspecified products. The supply side, such as farmers and the food industry, attempts to capture benefits by creating a differentiated market. In short, this is the time when the mass market can no longer expand extensively and people begin to locate niche markets. This change creates a great challenge for producers who have been engaging in conventional agriculture (Fordist agriculture).

Conventional agriculture greatly contributed to increased production along with the development of mass markets and mass consumption. However, these mass production and consumption

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industrial or experimental crop, and any other non-program crop except fruits and vegetables" (USDA, ERS 1990:24).

systems recently became problematic in that the price of agricultural products continuously declined over the last several decades, therefore, resulting in a decline in the portion of value added on the farm[6]. Today many producers feel frustrated with the situation. Market specification and product differentiation are important strategies to adapt to the changing demand for agricultural products.

Agricultural production in the United States may be conceptualized as three distinctive types using this approach.

Agricultural production models are termed Fordist (or Conventional), Neo-Fordist (or Industrial) and Post-Fordist (or Alternative). Classification of three types of agriculture is primarily based on the flexibility of farming and market relations (to be exact, market specification) as previously mentioned[7] (see **FIGURE 1**).

Based on this classification, I examine the characteristics of the three types of agriculture, the strategies to transform current agriculture, and conclude with the different implications and social consequences for rural communities.

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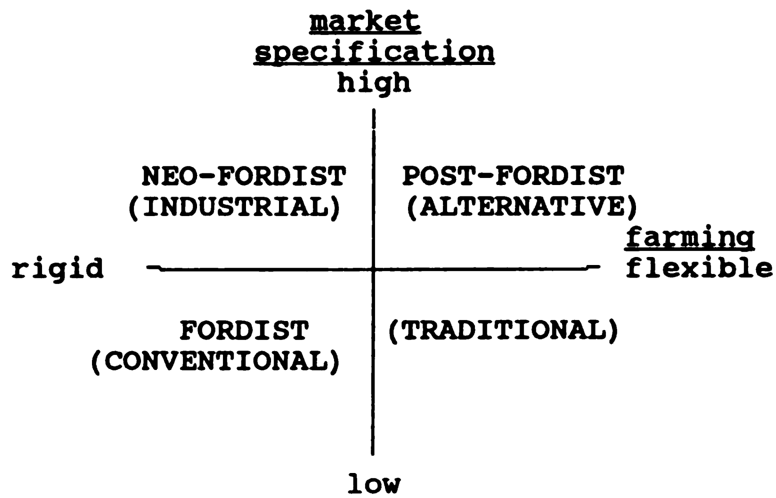
[6] USDA statistics show that "the farmers' share of the consumer dollar spent at the supermarket fell from 51 cents in 1918 to 24 cents by 1990" (Browne et al. 1992:108).

[7] Theoretically 'traditional agriculture' can be characterized as a flexible farming system with lower market specification in the FIGURE 1. I do not deal with this model of agriculture, because the focus here is mainly on the three models of agriculture mentioned above.

FIGURE 1

THREE MODELS OF AGRICULTURE FROM THE VIEWPOINT OF MARKET SPECIFICATION AND FLEXIBILITY OF FARMING



II. GENERAL CHARACTERISTICS OF THREE TYPES OF AGRICULTURE

The historical background and development of the concept of Fordism can be traced back to the Italian Marxist, Antonio Gramsci. The term 'Fordism' was first coined by him. He used this term to show "the new form of interpenetration between the economy and the political and cultural spheres" (Forgacs 1988:275). Gramsci thought that American society in the 1920s and 1930s could be characterized as a new society with a 'rationalized' social structure, in which 'hegemony' originated from the 'rationalized' production system that was typified by the assembly lines established by Henry Ford. In other words, Gramsci coined the term "Fordism" to elucidate a new form of social integration emerging in the early twentieth century U.S.

The concept of Fordism was later developed through the works of French regulationists and other researchers studying the mass production system of the automobile industry. According to Hill (1990),

> Fordism is a historically created and institutionalized profit logic based on economies of scale achieved through the mass production of standardized commodities by a deskilled work force. Productivity increases are generated by annexing workers to single, routine operations. Wage costs are reduced by simplifying labor. Labor control derives from management monopoly over knowledge of

the production process (Hill 1990:66).

The Fordist approach has also been applied directly to the food industry, particularly in fast food chain system. Kenney (1989) uses the concept of Fordism to link the manufacturing with the agricultural sector, and to discuss agricultural/rural issues, particularly those raised in industrial nations.

(1) The Fordist or Conventional Model

According to Kenney (1989), "Fordism [in the manufacturing industry] created an enormous consumer market consisting of relatively undifferentiated workers. The U.S. agriculture responded to this market by producing masses of commodities at uniform quality" (Kenney 1989:135).

Agricultural Fordism can be characterized, as follows, based on specific assumptions. Fordist agriculture is characterized as large-scale production widely used in the U.S. and Canada. Some other characteristics of this type of production are large-scale mechanization, uniform production management based on high chemical input, and standardized output. Agricultural Fordism appeared with the rise of industrial mass production and mass consumption. As U.S. farmers became more integrated into Fordist agriculture, they moved more into monocropping, along with mechanical and chemical inputs, decreasing rotation, crop diversity and flexibility (Kenny et al. 1991:181).

However, this system has come to face two challenges. One has been raised within the agricultural production system itself. The rural population has increasingly raised concerns about the condition of their environment and health effects, as well as their economic well-being. Another challenge concerns changes in consumer demand. Consumers are seeking safer, more varied, and value-added foods in the market. In order to deal with these problems, there are two alternatives that can be pursued.

To make a contrast to the Fordist (or Conventional) Model, we can call the two alternative types of agricultural production system Neo-Fordist (or Industrial) and Post-Fordist (or Alternative). The Neo-Fordist approach corresponds to a biotechnological solution to the current problems. In contrast, the Post-Fordist approach corresponds to sustainable agriculture. Both of them imply a considerable transformation of the current agricultural system. The most important distinction between Neo-Fordism and Post-Fordism is flexibility which farmers can reserve in their farming system, for example, selection of technologies and inputs which could be left to farmers' decision-making.

(2) The Neo-Fordist or Industrial Model

Neo-Fordist agriculture can be characterized as a production system in which product differentiation (or market specification) is pursued by advanced technology, while natural constraints to agricultural production are minimized. However, this system also minimizes the flexibility of farming. For example, farmers' options are not wide in terms of herbicide application if they are growing an herbicide-tolerant crop which is especially tolerant to Monsanto's Roundup. Rather we can see the deskilling of farmers through "seed-embodied technology" (Goodman and Redclift 1991:59).

This Neo-Fordist agriculture is closely related to the development of biotechnology. Junne (1992) argues as follows;

> Neo-Fordist applications try to make agriculture less dependent on time (season) and space (specific climate, soil). 'Neo-Fordist' applications would supply the 'technological fix' with which bottlenecks of 'Fordist' development could temporarily be overcome (e.g., the problem of overproduction by increasing production of biomass as industrial raw material, and the problem of pollution by the treatment of effluent) (Junne:11).

From our viewpoint, Neo-Fordist agriculture has several characteristics as follows;

- Seeking profitability through enhancing labor productivity or value-added products
- Highly standardized and specialized technology is applied (reductionistic science)
- Flexibility is dependent on off-farm sectors (e.g., seed company, contract food industry; e.g., Substitutionism of food industry will undercut farmers' flexibility.)
- Farmers' skills are required in limited areas
- Highly specified output (highly differentiated)
- Specialization toward a specifically targeted market or subcontracted with food industry

(3) The Post-Fordist[8] or Alternative Model

As mentioned before, Post-Fordist agriculture is different from Neo-Fordist agriculture in terms of the flexibility of farming. The Post-Fordist system is supposed to take advantage of location-specific resources and differentiate products with the help of advanced technology, such as the utilization of information systems to support farmers' decision-making, or Integrated Pest Management in which development is location-specific.

Junne (1992) also describes the Post-Fordist approach as follows, "A 'Post-Fordist' research strategy would imply a system of flexible specialization, concentrate on applications which are more site-specific, take the differentiation of markets more into account, and respond to changes of value systems" (Junne:12). We can characterize Post-Fordist agriculture as follows;

- Seeking long-term sustainability (economically and ecologically) and flexibility at the farming level
- Seeking low-input agriculture through utilizing location-specific resources and information
- Flexibility at the production process is high (flexibility is reserved at farmers' level)
- Skillful management is required to take advantage of local resources and information
- Diversity of output will be enhanced through flexible production

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[8] Alfred Sloan's idea of differentiation of the automobile was closely related to the decentralization of management. Additionally, he emphasized other areas of expertise in fields other than auto manufacture, such as finance, and information analysis for long-term strategy. These characteristics may show that Sloan was heading toward a kind of Post-Fordist production system (Collier and Horowitz 1987).

- **Developing diverse marketing channels, such as direct contracts with consumer groups (e.g., community supported agriculture)**

III. SCIENTIFIC BACKGROUND

(1) Fordist and Neo-Fordist Agriculture

Many researchers argue that the development of conventional agriculture (Fordist agriculture) is based on modern science, characterized as reductionism, in which science is oriented toward simplification, quantification, and claiming objectivity (Soule and Piper 1992:72).

However, it is wrong to say modern reductionist science alone is responsible for creating conventional agriculture and, therefore, caused many issues, such as environmental degradation and food safety problems. Many other factors are also working to create Fordist agriculture, these include technology, the research system, the production system, the market mechanism, and regulatory mechanisms. These factors create a kind of seamless web in the sense of creating a 'set of systems'. All these factors contributed to creating Fordist agriculture by coordinating with each other through defining/finding their problems/solutions within the boundary of the 'set of systems'. For example, even in the same discipline, such as entomology, there can be different sets of pest control methods, with different sets of philosophy, strategy and bureaucratic structure, without considerable negotiations with each other (Perkins 1982:265). Science does not stand alone, nor does it indicate the direction of technological development.

(2) Post-Fordist Agriculture

Scientific approaches emphasized in sustainable agriculture stand in contrast to those in conventional (Fordist and Neo-Fordist) agriculture. They are characterized as system-oriented, holistic, multidisciplinary, long-term, and cognizant of local knowledge (Kloppenburg 1991, Harwood 1990).

Modern agriculture needs certain sets of systems or institutions for reductionist science to be effective, while sustainable agriculture also requires some other systems. A decentralized research system and participatory technological development are among the required systems.

In case of Post-Fordist agriculture, participation of various actors can play an important role in research (priority setting, budget allocation, analysis of results, oversight, etc.). The farmers' role is traditionally marginalized in the current research system. Lockerletz and Anderson (1990:179) argue that "the support for sustainable agriculture has in part arisen out of a conscious protest by outsiders, including some farmers and advocates for farmers, against the research priorities of the agricultural mainstream". If we consider such political background of sustainable agriculture research, the participation of farmers will be crucial to technology development in sustainable agriculture.

In his article explaining the history of sustainable agriculture, Harwood (1990) points out the situation of agricultural science around the turn of this century. The idea of sustainable agriculture was developed by the "turn-of-the-century farmer-scientist groups". The path for the Alternative Model was already prepared by them. However, the path was not taken by most scientists of the day, and didn't become mainstream agricultural research because chemical technology looked so promising that they (and other actors) pursued the chemical technology as if it was the only path. During 1960s, industrial agriculture became dominant in agricultural technology and there was no debate on the direction of technological development during those years. "It was a time of scientific euphoria" (Harwood 1990:9).

However, this does not mean industrial agriculture represents the only form of 'scientific' agricultural development, even if some proponents claim that to be the case. Industrial agriculture became dominant not because such technological development was better or more scientifically advanced, but because a new alliance among scientists, engineers, resources (e.g., research funds from agrichemical industry) and institutions (e.g., research programs of land-grant universities) was created. This is the situation which

Latour (1987) calls 'enrollment'.

Today the chemical agriculture characterized by reductionism reencounters holistic, sustainable agriculture and multiple, technological development models are appearing again. In the case of agricultural science, we are going through a kind of transition period, or a scientific divide.

IV. STRATEGIES TRANSFORMING AGRICULTURE

(1) Identity-preserved Crops as an Industrial Model

Strategies to develop the Industrial Model can be illustrated by the case of herbicide-tolerant crops and identity-preserved (IP) crops[9]. However, I will mainly deal with the latter because the concept of "identity-preserved" can have a far reaching impact on the current agri-food system. IP crops can be defined as crops which have an intrinsic value for an end-user in terms of a certain quality trait or combination of traits (Goss 1991:60).

(a) Main Actors in the Transformation and Their Goals

The seed and chemical industry are the main actors to promote this model. The IP crop enables those industries to shift their business opportunities from the input market (seed, fertilizer, and other agrichemicals) to the output

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[9] An example of an identity-preserved crop is the case of Kansas value-added wheat: "Natural S' Wheat" (Freiberg 1991) which was developed through the university-corporation linkage. "Natural S' Wheat" is genetically engineered wheat which is "sweeter (than other varieties of wheat) and requires up to 50 percent less sugar when made into products containing bran. And that can mean ingredient cost savings to bakers, not to mention the fact that 'less sugar' is a powerful purchasing incentive to nutritious-conscious shoppers these days" (Freiberg 1991:6).

market (grain export, animal feed, wet and dry milling products). "The output market [for corn and soybeans] is four times larger than the input market" (Goss 1991:61) and they seek a premium price at the expanded market. This is one of the primary reasons industries promote IP crops.

However, as Goss (1991), of DuPont's Agribiotech Group, points out, there are at least five socio-economic and institutional drives to encourage IP crops: first, development of biotechnology; second, attractive size of business opportunities; third, opportunities to capture a significant portion of added value; fourth, granting of patent right protection to plant products, and, lastly, end-user needs to improve competitive advantage (Goss 1991:60).

(b) Strategies: Reorganization of Vertical Linkages

The Industrial model is expected to transform the traditional commodity system in order to take advantage of newly developed, value-added products. In this section I will examine several strategies to exploit this new opportunity.

In terms of organizational arrangement, the successful development of IP crops requires every actor related to the agri-food business to coordinate with each other in order to keep new crops distinctive from the moment of production to end-use. Frey (Product Management Manager of Pioneer Hi-Bred International) suggested that "everyone needs to work together ... those in the grain trade, transportation, contract producers, and the customers and try to put together a system that will work, and that can grow over time" (Frey 1991:130).

In particular, the current distribution system must be modified to accommodate IP crops because "the current distribution system would have difficulty in determining the presence of the quality trait and in preserving the identity of specific lots of quality grains as they move from on-farm storage to end-user" (Goss 1991:62). Therefore, many end-users of grain products began to integrate production and manufacturing systems vertically, such as milling facilities, and elevators (Goss 1991:62).

(c) A Closed System of Technology Development/Transfer

Many researchers argue that biotechnology changes the dividing line separating public and private research. Such changes are illustrated by "the extensive and varied corporate-university links, including contract research and the formation of research 'clubs' and consortia embracing private industry, universities and public research institutes" (Goodman and Wilkinson 1990:143).

Technological development of IP crops is also promoted based on the same links (Freiberg 1991). However, such university-corporation links will affect the current technology transfer mechanism mainly engaged in by the public extension system. Technology transfer is expected to be a faster and more closed system than the public extension system. Urban (1991) argues that seed companies developing IP crops play a role as the center of technology transfer, and create a closed system of agricultural 'industrialization'. Farmers outside of the system cannot have access to the information generated within this system, unless they are willing and able to pay for it.

(d) Bases of Competition: Added Value and Market Specification

In the case of Fordist agriculture, the basic principle of competition is based on economies and 'power' of scale. By reducing the unit cost of production, entrepreneurs with bigger production units can get more profit to survive than those with smaller farms. In addition to that, Heffernan (1984) argues that the 'power' to dominate the market is more crucial to survival than efficiency, per se. In other words, scale is an important factor, not because efficiency (economies of scale) matters, but economic power to dominate the market does[10].

Compared with Fordist agriculture, Neo-Fordist development, such as promotion of IP crops, tries to create more specialized, value-added products and finds less

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[10] Heffernan makes his argument using the case of poultry industry, but even in the grain market, we can see a similar situation. As the grain price falls continuously, farmers are forced to expand their farming scale, because they cannot achieve economies of scale by further expansion after acreage reaches a certain point (Browne et al. 1992).

competition than unspecified commodities because these products are usually grown under a contract between producers and other industry (seed-chemical companies and the processing industry). The concept of 'value-added' is crucial in the Industrial Model.

(e) Limited Farmers' Role

From the farmers' point of view, the development of IP crops offers complex challenges to growers. Farmers have to make contracts with a certain company to grow them, and the company (seed company, food processor, or whatever) offers a premium price for the products. But farmers have to take certain risks and additional handling costs to grow such crops. According to farmers' comments on IP, such crops sometimes have lower yield than other varieties, and farmers have to keep such crops (especially open-pollinated crops) away from other varieties in the field (Cutler 1991). Also, growers have to clean their harvesters and storage bins to insure separation, thereby keeping them pure. These requirements create additional work for farmers. Furthermore, one farmer mentions the possibility of a great loss of a grower's independence.

> As far as information, you've got to realize if you do grow specialty crops, that you are working for another person and you lose a lot of your independence. You've got to grow a product that these other people want. If you don't, you're not going to get compensated for it (Cutler 1991:157).

Farmers are involved in a more closed agri-food system than conventional agriculture. Their decision-making in terms of farming, such as seed selection, technological options, handling, and marketing, is prescribed by other actors, such as the seed and chemical industries. From the viewpoint of growers, the flexibility of farming becomes more limited than before.

(f) Expected Impacts and Barriers

IP crops will have an enormous impact on the agri-food system because every actor related to the system would be affected and forced to modify the current system. In particular, the vertical integration around special grain crops is expected to be more pervasive. Vertical integration, which has been limited only to the field of meat industries so far, would become a more general type of production than it is presently.

IP crops are a great prospect in the future for the seed and chemical industry. However, there are several perceived hurdles to overcome:

(a) regulatory issues, such as patent protection, (e.g., Patents need to be granted for plants expressing novel or enhanced quality traits.)
(b) public acceptance of products developed by biotechnology,
(c) commodity mind set of end-users,
(d) product distribution system need to be modified. (e.g., vertical integration, selective partnering)
(Goss 1991:62)

(2) Sustainable Agriculture as an Alternative Model

Strategies to transform current agriculture into the Alternative Model can be illustrated by the sustainable agriculture movement promoted by many actors, including farmers, non-profit organizations, land-grant universities, and governmental agencies (e.g., U.S. Department of Agriculture, Environmental Protection Agency). Sustainable agriculture is still a developing concept and the impact from wide diffusion on the agri-food system and rural communities remains to be seen. However, many researchers are trying to infer the economic and social implications of sustainable agriculture, and our discussion in this paper relies on these arguments.

(a) Main Actors in the Transformation and Their Goal

The sustainable agriculture movement is participated in by many private/public organizations and individuals, and they are creating various networks[11] among themselves to promote research, information dissemination and governmental lobbying activity. Although it is very difficult to identify the main actors, public sector research institutes (in particular, the U.S. Department of Agriculture, the Sustainable Agriculture

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[11] For example, a lobbying group, "the Sustainable Agriculture Working Group", is a network of various organizations and individuals who share commitment to help foster a more sustainable agricultural system. Eighteen organizations mainly located in the Midwest and Northern Plains belong to this group (Hoefner et al. 1992).

Research and Education Program, or simply SARE Program) play a crucial role in encouraging and funding research at the regional/national level, and in diffusing information related to sustainable agriculture. This public research program contributed to legitimizing alternative agricultural research and plays an important role as a catalyst in encouraging alternative directions in the public research system.

The sustainable agriculture movement challenges many problems inherent in the current agricultural system. The definition of sustainable agriculture, given by Congress in the 1990 Farm Bill, covers a wide range of goals and tries to achieve multi-faceted objectives[12]. Therefore, the SARE Program is also trying to cover a wide range of fields from agro-ecological research to social impact analysis (U.S. GAO 1992).

According to Babb and Long (1987), there are at least four trends favorable for a shift toward sustainable agriculture. First, continued financial stress in agriculture encourages farmers to seek cost-reducing technologies. Second,

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[12] The 1990 Farm Bill defines sustainable agriculture as an integrated system of plant and animal production practices having a site specific application that will, over the long term;

- satisfy human food and fiber needs,
- enhance environmental quality and the natural resources base upon which the agricultural economy depends,
- make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls,
- sustain the economic viability of farm operations, and
- enhance the quality of life for farmers and society as a whole (Bird 1992:142).

changes in the pattern of food consumption, in particular a demand for food with less health risk. Third, continued large and unpredictable shocks from macroeconomic forces encourage farmers to diversify their enterprises. Fourth, the acceleration of technology development in the field of biotechnology and information technology (Babb and Long 1987:8).

(b) Strategies: Human Capital and Horizontal Linkages

Sustainable agriculture can be regarded as an alternative farming system which takes advantage of site-specific resources by developing on-farm techniques to control pests and weeds. Such techniques are also developed in order to satisfy nutrient requirements and to contribute to the improvement of broader ecological conditions and societal goals. In order to achieve these goals, the SARE Program emphasizes human capital and participation of farmers in research. Both enable farmers to become adequately skilled to deal with the complex agroecological system and, thus, to manage it in a flexible way.

Bird (1993) emphasizes the role of human capital which enables the high level of management skills required by sustainable agriculture.

> Sustainable agriculture places emphasis on equity, empowerment, and high levels of management skills, and is consistent with trends in the business world. The increased knowledge needed to manage resources sustainability suggests a trend toward smaller farms that allow the manager to remain

> personally connected to diversified ecosystems and enterprises (Bird 1993:16).

In order to enhance human capital, the information exchange among farmers and researchers, and on-farm experimentation/education programs are emphasized in the SARE Program. Through such programs, SARE tries to create networks (though not a hierarchy) connecting farmers, researchers, extension agents, and educators (Busby 1990:90).

Considering farmers present tendency towards adoption of labor-saving technologies, agencies that give advice and take over a portion of farm management would be indispensable within the local community (Madden 1988:1171). As adoption of sustainable agriculture affects the quality and quantity of management work, the shift to sustainable agriculture would create a demand for supplemental functions provided by custom service industries. Development of such a custom service industry is an example of change in the regional economy.

Furthermore, widespread diffusion of sustainable agriculture is expected to contribute to the growth of regional economic diversity. Flora (1990a) emphasized this aspect of sustainable agriculture and diversification of regional economy which is assumed to contribute to the sustainability of local community.

In terms of market relations, sustainable agriculture offers producers more diversified marketing channels. Because farm products from sustainable agriculture, in particular organic farming, have more diversity, they are regarded as value-added commodities. They demand the special attention of consumers using other marketing strategies, such as community supported agriculture (Bowman 1991). In other words, the linkage to consumer/market will be diversified through the extensive adoption of sustainable agriculture.

The building of human capital, diversification of rural economy and local value-added through horizontal linkage among actors can be the main strategies of actors promoting sustainable agriculture. In this sense, sustainable agriculture is expected to give various economic opportunities, not only to farmers, but also to non-farm entrepreneurs.

(c) An Open System of Technology Development/Transfer

Practical methods of sustainable farming are being laid down by many researchers, farmers and ranchers. Although they vary from farm to farm and are difficult to generalize, they commonly include certain farming methods which take advantage of biological interaction within the field[13].

However, an important point is that these methods are 'patterns that work' rather than those based on single cause-and-effect relationships (Soule and Piper 1992:81). They are flexible enough to be modified and adapted on farmers' own fields.

The public research system plays an important role in sustainable agriculture because private firms are unlikely to do research on the fundamental agroecosystem knowledge base which is crucial to sustainable farming (Buttel 1986:63). In addition to public institutions, farmers also play a crucial role in terms of their participation in research agenda setting, on-farm demonstrations, evaluation of results, and resource allocation. For example, more than 1,800 farmers have participated in the SARE Program in such ways (O'Connell 1992:6).

In short, the Alternative Model creates a locally-based open system of technology development/transfer in contrast to

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[13] The following methods are commonly included in the sustainable agricultural system:
(1) Crop rotation that mitigates weeds, disease, insect and other pest problems; provides alternative sources of soil nitrogen; reduces soil erosion and risk of water contamination by agricultural chemicals.
(2) Pest control strategies that are not harmful to natural systems, farmers, their neighbors, or consumers.
(3) Increased mechanical/biological weed control; more soil and water conservation practices; and strategic use of animal and green manures.
(4) Use of natural or synthetic inputs in a way that poses no significant hazard to man, animals, or the environment (O'Connell 1992:6).

the closed system of the Industrial Model. Through these technology developments, the SARE Program tries to build the idea that "farmers and ranchers will be in control" (Busby 1990:91) rather than dependent on technology developed by other agencies.

(d) Bases of Competition: Added Value and Economies of Scope

Proponents for sustainable agriculture foresee the increase of the value added on-farm because of "reduced purchases of inputs, less processing, and forward integration by farmers into some off-farm activities" (Babb and Long 1987:11). As we have seen above in the Industrial Model, the concept of 'value-added' also plays an important role in the Alternative Model. This is quite understandable because both Models pursue product differentiation strategies.

When we talk about the concept of "value-added", however, it is important to note which actor captures the added value (e.g., seed industry, growers, processors, etc.) and its distributive consequences (Busch 1993).

Another important concept elemental to the bases of competition is 'economies of scope', rather than 'economies of scale'. Strange (1991) argues that "sustainable agriculture is economically rational at the farm level if internally derived inputs are substituted for externally purchased inputs in a way that: (1) makes more complete use of underused farm resources; (2) improves factor productivity; (3) generates economies of crop-product diversification; (4) preserves capital; and (5) allocates and conserves resources more efficiently than do current programs" (Strange 1991:13). Sustainable agriculture can be competitive when farmers use their whole assets more efficiently through pursuing an optimal combination of enterprises and reduce the purchased inputs by utilizing internal resources. However, in reality, farmers have to face many other hurdles in order to practice sustainable farming and become economically competitive.

(e) Prospects and Barriers

Sustainable agriculture is expected to achieve a wide range of objectives. However, wide adoption remains to be seen and it is very difficult to assess the prospect of, and barriers to, the Alternative Model today. In this respect, O'Connell (1992) suggests several possible barriers which people promoting sustainable agriculture must overcome.

First, the current commodity programs encourage high use of inorganic fertilizers and pesticides (e.g., the cross-compliance provision mentioned above). If certain regulatory measures are taken to encourage farmers to adopt sustainable farming, such regulations need to be established taking into account different regions and commodities. Unspecified regulations could affect farmers differently according to region and commodity group (Young 1989:139). Second, sustainable farming practices require more management inputs and time on the farm. This may be the most difficult measure to overcome because most farmers currently engage in off-farm employment, and 85% of aggregated farm household income is from off-farm sources (USDA, ERS 1993). The problem is whether or not such part-time farmers can respond to the additional labor requirement. Third, many farms do not have technical or economically viable alternatives to chemical intensive farming practices. Fourth, initial investment outlays in a different line of farm machinery are high. Farmers feel a great degree of economic stress during the transition period to sustainable farming (Northwest Area Foundation 1992:2). It is important to provide effective measures for farmers in such a critical period.

(f) Weak Linkage with the Food Processing Industry

In addition to the barriers mentioned above, another serious limitation of sustainable agriculture must be pointed out, namely, the downstream linkage with food processing industries.

Research on sustainable agriculture mainly focuses on the production system. Environmental and food safety concerns are the main drive for this research. As far as I have observed, the current research on sustainable agriculture, downstream impact, such as the impact on the food manufacturing sector, is not thoroughly examined by researchers. When sustainable agriculture is related with organic food production, the food processing sector is generally excluded from the discussion.

Minimal processing is supposed to be an important guideline for the segment of the food industry which responds to sustainable agriculture, but, rather, such processing follows the development of the Neo-Fordist food industry today. As Goodman and Redclift (1991) point out, 'organic' or 'natural' produce can be more technology-intensive than conventional produce. For example, in the field of food processing, the highest priority of research focuses on keeping 'freshness', or the 'appearance of freshness', and various technologies along this line are being developed by researchers (Huxsoll and Bolin 1989).

Sustainable agriculture is expected to provide differentiated 'fresh' products, such as organic food. However, the quantity of such products is limited so far. Therefore, they only create 'thin markets' where the price is much more volatile than that of for conventional produce (Hall et al. 1989:61). This is one reason why farmers engaging in sustainable agriculture sometimes try to build up direct marketing systems where the food industry is excluded.

These problems, in terms of downstream relations, will pose a serious constraint to the development of sustainable agriculture. The reason for this is that the agri-food system is composed of many actors besides farmers and consumers. The agri-food system is constructed from various interactions among seed companies, chemical companies, farmers, transporters, marketers, processors, wholesalers, retailers, consumers, governments, and researchers. If sustainable agriculture endeavors to change the agri-food system, all the actors mentioned above must be taken into consideration, and create a strategy for the transformation of the agri-food system, which is already being pursued by people promoting the Industrial Model. A relevant question is what kind of food processing mechanism can be invented if the new production system does not achieve a certain standardization of fruits or vegetables. It is also questionable how the transportation system can possibly be modified if fresh products are individually different in terms of size, variety, and perishability.

The impact of sustainable agriculture on the agri-food system, and therefore, on the agricultural production system as well, will be limited unless the above problems are well-integrated into the strategy for promoting sustainable agriculture. In other words, the sustainable agriculture system will never have a substantial impact on society without first creating a sustainable agri-food system. In this respect, the production-led approach of current research may end up having limited impact.

V. CONCLUSION AND ITS POLICY IMPLICATIONS

As we have seen in the preceding sections, three types of agricultural production system are characterized as distinctive in terms of their scientific/technological approaches, their effect on the flexibility of farming, market relations, proponent actors, strategies to transform the agri-food system, technology development/transfer system, bases of competition, expected role of growers, and prospects and barriers in the future. They can be summarized as follows (**FIGURE 2**).

(1) The Fordist (or Conventional) Model developed in U.S. agriculture during the past several decades. Farmers produce unspecified commodities in response to the mass consumption market. Reductionist science is the guiding technological principle of this model, reducing the variability of environment and, therefore, the flexibility of farming. However, as the mass market becomes glutted and problems related to health and environment appear, alternative ways of agriculture are pursued. These alternatives are called the Neo-Fordist (or Industrial) and Post-Fordist (or Alternative) Model.

(2) The Neo-Fordist (or Industrial) Model is referred to

FIGURE 2 CHARACTERISTICS OF THREE MODELS OF AGRICULTURE

MODEL	FORDIST (CONVENTIONAL)	NEO-FORDIST (INDUSTRIAL)	POST-FORDIST (ALTERNATIVE)
FLEXIBILITY OF FARMING	LOW	LOW	HIGH
MARKET RELATIONS	UNSPECIFIED	SPECIFIED e.g.,SUBCONTRACT OF THE FOOD INDUSTRY	SPECIFIED e.g.,COMMUNITY SUPPORTED AGRICULTURE
FARMERS' SKILL	DESKILLED	DESKILLED	SKILLED
DIVERSITY OF OUTPUT	LOW UNIFORM	HIGHLY SPECIFIED =DIFFERENTIATION	HIGHLY DIVERSE =DIVERSIFICATION
SCIENTIFIC BACKGROUND	REDUCTIONISM	REDUCTIONISM	SYSTEM-ORIENTED LOCATION-SPECIFIC
EXAMPLE OF THE MODELS	LARGE SCALE FARMING	IDENTITY-PRESERVED CROPS	SUSTAINABLE AGRICULTURE
MAIN ACTORS	CAPITALIZED FARMER	SEED/CHEMICAL INDUSTRY	NETWORKS PUBLIC/PRIVATE
STRATEGIES	CAPITALIZATION	VERTICAL LINKAGE INTEGRATION	HORIZONTAL LINKAGE HUMAN CAPITAL
TECHNOLOGY DEV/TRANSFER	TOP-DOWN EXTENSION	CLOSED SYSTEM	LOCALLY-BASED OPEN SYSTEM
BASES OF COMPETITION	ECONOMIES(POWER) OF SCALE	VALUE-ADDITION MARKET SPECIFICATION	VALUE-ADDITION ECONOMIES OF SCOPE
ROLE OF FARMERS	LIMITED	LIMITED	PARTICIPATION
BARRIERS	DECLINE OF MARKET PRICE GLUTTED MARKET	REGULATION (PATENT) PUBLIC ACCEPTANCE DISTRIBUTION SYSTEM	COMMODITY PROGRAM MANAGEMENT CAPACITY INFORMATION TRANSITION PROBLEMS WEAK LINKAGE WITH FOOD INDUSTRY
PROSPECT	CO-EXISTENCE OF THREE MODELS => NEEDS OF TARGETED POLICIES, REGULATIONS, RESEARCH SYSTEMS FOR EACH MODEL		

as a production system which produces highly specialized commodities with the help of advanced technology. However, flexibility of farming is limited because the problem of variability is technologically fixed (e.g., seed-embedded technology) and farmers receive such technologies as given and not significantly involved in their development. As the case of identity-preserved crops illustrates, the seed and chemical industries try to create vertical integration among various sectors and establish a closed technology development/transfer system within them. While there are still some problems in the foreseeable future, such as regulations and public acceptance, this Model is expected to have an enormous impact on the current agri-food system.

(3) The Post-Fordist (or Alternative) Model is referred to as a production system which produces differentiated and diverse commodities, taking advantage of the development of flexible farming methods. The case of sustainable agriculture illustrates this Model. It emphasizes the human capital of farmers which could be improved through linkages among various actors who are committed to technological development and dissemination. These actors strive to create a locally-based technological development/transfer system and offer farmers the opportunity to achieve on-farm added value and economies of scope in order to be more competitive. The weak linkage with the food processing industry is considered this model's greatest barrier to having impact on the current agri-food

system. However, a viable local society is anticipated through economic diversification[14] and farmers are expected to play a substantial role in this model.

The characteristics mentioned above are closely related within each Model of agriculture. Therefore, it is difficult to decide which factor is the most crucial in each Model. They create a kind of seamless web within the models. However, in reality, these three types of agriculture interact and incorporate certain factors of different types of agriculture into their survival strategies. In particular, it is difficult to find distinct differences among the goals proposed by advocates of each type of agriculture. All of the proponents of the various models advocate benefits to consumers and farmers. We need to be precise in our attempts to assess the difference between the alleged goals and the actual consequences.

The consequences of the development of agri-food system are always multi-faceted, creating winners and losers. This paper constructs ideal types of changing agriculture to assess the implications of the role of producers, such as farming

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[14] Economic diversification, however, is expected to be a long-term adjustment. Based on input/output analysis, a North Dakota study revealed the negative impact of sustainable agriculture on local economic activity (Dahl et al. 1991). I argue this is mainly because new economic activities (emerging as a result of the widespread adoption of the sustainable agriculture) cannot be incorporated in the input/output model. Therefore, from a short-term perspective, the transition to sustainable agriculture could have a negative impact on the local economy.

flexibility, and the technology transfer system. The perspective taken here is mainly limited to these aspects.

Thus far, the heterogeneity of U.S. agriculture has mainly resulted from the size of farm, as well as enterprise. However, in the future heterogeneity, in terms of technology and farming strategy, may become more conspicuous. Each type of farming may need to be supported by different policies, regulations, and research/extension systems based on different goals and philosophies. I delineated the three types of agriculture which could have considerable impact on the present and future agri-food system. However, these types of agriculture seem likely to co-exist in the foreseeable future, and in order to respond to that, different sets of policies, regulations, and technology development systems need to be laid down[15]. Through these differentiated measures, U.S. agriculture can be more flexible, adapting to socio-economic changes, and, therefore, offer wider options to consumers and farmers than is possible today.

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[15] Bird (1993) suggests three models of agriculture (Industrial Agribusiness Farm Model, 21st Century Family Farm Model, and Part-time Farm Model) and points out that different targeted research, education and policy initiatives will be required for each model system. Although the argument in this paper is derived from different premisses and creates a different typology, the conclusion in terms of this point is identical.

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