This is to certify that the

thesis entitled

SOCIETY IN THE MAKING: THE DEVELOPMENT OF THE SOYBEAN INDUSTRY IN THE UNITED STATES

presented by

Feng-Huang Wu

has been accepted towards fulfillment of the requirements for

M.A. degree in Sociology

Major professor

Date 3/12/95

SOCIETY IN THE MAKING: THE DEVELOPMENT OF THE SOYBEAN INDUSTRY IN THE UNITED STATES

By

Feng-Huang Wu

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Sociology

1995

ABSTRACT

SOCIETY IN THE MAKING: THE DEVELOPMENT OF
THE SOYBEAN INDUSTRY IN THE UNITED STATES

By

Feng-Huang Wu

This paper focuses on the early stages of the soybean industry in the United States in the period between the end of 19th century and the 1970s. Diffusion and adoption of innovation theory, induced innovation theory and actor network theory are used to discuss and analyze how social processes were initiated through the establishment of a variety of institutions, promotional programs, governmental policies and individual efforts, and further to understand how these social processes contributed to the conception and development of the soybean industry. The findings show that the adopting behavior of individuals and the institutional innovations were only partial causes of the success of the soybean industry. More important contributions were the overall social processes initiated by the soybean actors in a social network through interest translation, enrollment of allies, persuasion, negotiation and coercion.

Acknowledgements

There are many people to thank for their support and help. First I would like to thank my advisor, Dr. Lawrence Busch, for guiding me through the whole research process. His ready availability, advice and patience are greatly appreciated.

I also would like to thank my other committee members, Dr. Christopher Vanderpool and Dr. Marilyn Aronoff, for their valuable suggestions and constructive criticism.

Special thanks to fellow graduate students, faculty and friends in the Department of Sociology and MSU community for providing an enjoyable learning environment and support throughout the process.

Finally, and most importantly, I am indebted to my family for their faith, support and encouragement in my studying abroad.

TABLES OF CONTENTS

LIST OF FIGURES

Chapter 1

Introduction

Research inquiries into agricultural development in the United States have been the concern of related disciplinary studies for decades. In many of them, technical determinism is presumed to be the driving force in contributing to the rapid growth of agriculture. For instance, the literature on induced innovation theory (Binswanger and Ruttan, 1978; Ruttan, 1982; Hayami and Ruttan, 1985) reveals the technology-driven characteristic of agricultural development from results of historical analysis among various nations. On the other hand, diffusion and adoption of innovation theory approaches agricultural development from a micro-setting, a farm scale. And individual farmers are considered to be capable of determining the viability of technical change.

Although these theories have tackled technical change in agriculture from both the macro- and micro-level, they fail to elaborate how and in what way dynamics are constructed within subsectors with respect to technical change, and hence how farming is transformed into industrial agriculture. To pursue this inquiry, an historical review of the soybean industry in the period from the end of the 19th century to the 1970s is employed in order to understand how social context chronologically impinges on the process of technical and agricultural development. Therefore, I will examine how social processes (i.e., negotiation, persuasion, coercion) were initiated through the establishment of a variety of institutions, promotional programs, governmental policies and individual efforts, and further to understand how these social processes contributed to the conception and development of the soybean industry.

The main reason to use soybeans as a case study is its economic role. Since the 1960s soybeans have been transformed from a barely known exotic crop into the nation's second most valuable crop. Throughout the process, the versatile usage of the soybean not only has co-evolved with the development of the entire food industry, but it is also utilized in livestock production, the automobile industry and the paint industry. Moreover, the development of the soybean industry parallels that of agricultural industrialization and is involved with the whole spectrum of issues in political, economic, and societal change.

To achieve the objective of this paper, various disciplinary studies are examined to increase our comprehension of the relationship between technical change and agricultural development. They include the diffusion and adoption of innovation theory, the induced innovation model, and social network theory (translation theory). Each theory provides an insightful research methodology to approach the relation between technical change and agricultural development. However, it is my intention to point out that without the dynamic mechanisms among a variety of sales programs, research advances and government policies, which were initiated by subsector actors, the soybean would not have been transformed into a commodity crop. Hence, I intend to argue that technical change in agriculture is constructed as a result of a complex social process among actors linked in a network (Tanaka, 1992).

1.1. The Diffusion and Adoption of Innovation Theory

The diffusion and adoption of innovations dominated the approach to agricultural research taken by sociologists from the 1950s to the 1970s. Taking technical change as a necessity in agricultural development, the strategies of diffusion theory are to employ extension institutions and to improve communication strategies in order to diffuse innovations to farmers. The model focuses at the farm level and farmers are viewed "as actors, at a farm level and community situation, responding to stimuli, concerning what were unquestionably viewed as improvements in agricultural technology" (Fliegel and van Es, 1983: 13-28).

Programmed as top-down strategies for diffusing innovations, the diffusion and adoption of innovation model focuses on three factors which are of concern in determining the viability of innovations throughout the diffusion process: (1) the adopting potentiality of farmers, (2) the characteristics of new practices and (3) the frequency of interpersonal communication. Accordingly, models of farmers' adopting behavior are established to examine their socio-economic characteristics, personality variables, and communication behavior (Rogers, 1983). In addition, the contents of an innovation are studied under the following categories: the degree of complexity of the idea, the divisibility (trialability) of the product or practice, the congruence of the technology with existing practices, the economics of the practices, compatibility with existing values, past experiences and needs, and observability of an innovation to others (Buttel et. at., 1990, Rogers, 1983). Moreover, interpersonal communication among farmers also determines the rate of adoption of an innovation.

With the assumption of a positive correlation between the frequency of interpersonal communication and the rate of adoption, the model is often employed in collaboration with extension agents in order to exercise technical change in agriculture. As a result, it is credited with contributing to the success of the Green Revolution in most developing countries. However, the political and economic impacts on farmers as a result of technical change have been the subject of a variety of debates (Sousa et. al., 1985).

1.2 The Induced Innovation Model

In the discipline of agricultural economics, the induced innovation model first argues that agriculture has been transformed from a resource-based sector to a science-based industry. Therefore, the capacity to develop and manage technologies, which are consistent with physical and cultural endowments, becomes the determining factor in agricultural development (Ruttan, 1982). The development of such capacity includes

> the capacity to organize and to sustain the institutions that generate and transmit scientific and technological knowledge, the ability to embody new technology in equipment and materials, the level of husbandry skill and the educational accomplishments of rural people, the efficiency of input and product markets, and the effectiveness of social and political institutions (Ruttan, 1982: 17).

As to the development of new technologies, there are two characteristics of technical change in agriculture: on the one side, new technology has an exogenous dimension that stems from developments in basic science; on the other side, new technology is an endogenous factor which is influenced by demand, such as the relative scarcities of factors of production (i.e., land, capital and labor) (Busch et al. 1989). For instance, the development of mechanical technology in the United States substituted for an insufficient labor force and biological technology (e.g., high-yielding varieties) substituted for the scarcity of land in countries such as Japan and Taiwan (Ruttan, 1982).

Other than the dimension of technical capacity, the institutional behavior of research institutions contributes by improving the allocation of social resources and represents the critical link among scientific communities, farmers, bureaucrats, and politicians. Demand-induced institutional innovation become an efficient supplier of technical innovation (Binswanger and Ruttan, 1985; Ruttan, 1982). In sum, the theory of induced innovation implies a dynamic and dialectical interaction between technical and institutional change.

1.3. Actor Network Theory (Translation Theory)

Originating in the sociology of science, actor network theory abandons the traditional presumption of technical change on one hand and the social context on the other. Instead, it argues that the technical content is constructed and mobilized by actions taken by scientists, or broadly speaking, the social context. Basically, it claims that the distribution of technoscience[1] is essentially a fact-building process through negotiation, persuasion, and coercion among actors in a network (Busch, 1990; Latour, 1987). The network consists of "actants" including human (e.g., fact builders) and non-human (e.g., technical content) actants in an interdependent relationship, which permits the transformation of technoscience into a fact or an artifact (Gieryn and Figert, 1990). In other words, technoscience does not automatically exist; instead, it is tied to a heterogenous network which functions to settle controversies within the technical content, to construct the fact and to spread the fact over time and space in order to network more allies (Latour, 1987).

Actor network theory makes two central points about expanding and stabilizing the length of networks: "(1) to enroll others so that they participate in the construction of the fact; (2) to enroll their behavior in order to make their actions predictable"(Latour, 1987: 108). Although these claims appear to be contradictory at first, they are two inseparable stages in constructing a fact-building process: translating interests and keeping the interested groups in line.

Translating interests involves relating the interests of fact-builders to those of expected and unexpected actors. First of all, fact builders have to state their claims clearly to fulfill actors' explicit interests. Second, they have to expand their room for

---

[1]Technoscience is defined as "all the elements tied to the scientific contents", which is to distinguish from the concepts of "science and technology". Latour argues that "science and technology" is the outcome of a fact-building process by actants and is what is kept of technoscience (Latour, 1987).

manoeuvering in order to first displace and detour other actors' interests, and eventually to make their expanding interests appealing to these actors. In this way, the fact is reified by collective action and becomes an indispensable passage (Latour, 1987).

Keeping interested groups in line is a second step in creating and consolidating a durable fate for all actors in a network. First, fact-builders have to link the fate of allies together and to resist all trials to break them apart. In addition, as the network expands, there must develop a machination of forces to enlist unexpected allies and consolidate the network (Latour, 1987).

Latour (1987) furthers the applications of network theory in a case study of Pasteurization in France. The success of Pasteurization in France can be not only attributed to the great technical breakthrough invented by Pasteur, but also to Pasteur's ability to mobilize all the social resources to fulfill his needs. As Latour comments, Pasteur was "...an expert at fostering interest groups and persuading their members that their interests were inseparable from his own" (Latour, 1983: 149). For instance, in order to carry out Pasteurization, Pasteurians succeeded in persuading French farmers not only to make their barns physically resemble a laboratory, but also biologically controlled their sheep by vaccination. Hence, Latour argues that Pasteurization in France was a fact-building process of which the success is attributed to allying various interest groups.

The theories discussed above identify the characteristics of technical change in agricultural development. Their relevance will be further analyzed through the following case study.

Chapter II

General Description of the Development of the Soybean Industry

2.1. Period I: 1765-1931

For several millennia, soybeans (Glycine max) have been a major protein source in the Orient, including livestock feed and food products, such as tofu, soybean milk, soybean sprouts, and miso (Windish, 1981). However, they were mainly a curiosity to Americans on their first arrival on a Yankee Clipper boat trip to China in 1804 (Windish, 1981)[2]. In 1854, researchers began to collect soybean varieties in Asia, which were distributed by the US Commissioner of Patents. In 1879 the New Jersey Agricultural Experiment Station and the University of Illinois began testing of several varieties. Later, the USDA introduced varieties from Europe and the Orient, and in 1907[3] published the agronomic characteristics of twenty-three varieties known in the US (Windish, 1981).

The soybean was mainly used as a coffee substitute during the Civil War. Later, it was primarily grown in the Southeast as a hay and pasture crop. In 1911, the first processing business started in Seattle by processing Manchurian soybeans into

---

[2]According to Hymowitz and Harlan (1983), the soybean was first planted in 1765 (Smith and Huyser, 1987).

[3]According to Lockeretz, it was in 1907 (Lockeretz, 1988).

soybean meal and soybean oil. This individual industry did not continue long after the owner passed away. This was attributed to the lack of a market for soybean products other than soybean oil (Windish, 1981). Although soybeans were known for their high protein value, the unfamiliar diets and their incompatibility with milk products limited its market. Processors even sent soy flour to bakers for free and opened sale channels to retailers, but no one wanted it (Windish, 1981). In 1914, the first US-grown soybeans were processed in a mill used primarily for cottonseed in North Carolina.

Then came World War I. It caused a general oil shortage and the United States began to import soybean oil from Manchuria. Yet, polluted Manchurian oil in contaminated containers disappointed Americans so much that the need for domestic production emerged. Meanwhile, natural disasters, such as the corn borer disaster in the Corn Belt, soil deterioration in the rice fields and insect disasters in the cotton fields pointed out the need for an alternative rotation crop.

The increasing demand for a resolution to the farm crisis appeared to be an incentive which led to the introduction of soybeans. However, the process of the introduction was quite dynamic. It involved on-farm and off-farm actors' activities in accumulating, mobilizing and distributing resources, rather than a static formulation of a soybean market. The action was initially taken by individuals (i.e., a researcher and an entrepreneur), and involved with collective institutional behavior (i.e., a research institution and a company).

Researchers

As an unknown exotic crop, the introduction of soybeans to resolve the farm crisis was largely attributed to individual agronomists' knowledge and exploitation of the soybean's agronomic merits. Regarded as grand trailblazers, missionaries and crusaders, agronomists in the USDA and the University of Illinois first enthusiastically promoted the growth of soybeans. An individual agronomist, Dr. Charles Piper of the USDA, was "the first man to see clearly the potential of the soybean in America" and " a man of intense enthusiasm and vision" (Windish, 1981: 2). Dr. William B. Morse of the USDA, influenced by Dr. Piper, "focused his entire life on introducing and popularizing soybeans and soyfoods in America" (Windish, 1981: 6). He also spent years collecting varieties from North China, Japan, Korea and Manchuria to broaden the soybean germplasm base.

These researchers formed a close-knit group to share information on breeding soybean varieties for adaptation to local climate, soil, insects, diseases and photoperiod. The accumulation of knowledge on soybeans began to take the forms of personal affiliation and organization within research community. As a consequence, it not only popularized the merits of soybeans as a soil-building and hay crop to farmers, but also speeded up a variety shift in the field. For instance, in 1922, a pure selection of Manchu soybeans occupied 65-70 percent of the commercial soybean-producing area in Illinois. By 1930, 'Illini' substantially replaced Manchu.

Dr. Morse and The Establishment of the American Soybean Association

Besides networking the research community, researchers also made connections to other resources in order to expand the length of the social network in the form of an organization. In 1919, Dr. Morse established the National Soybean Growers'

Association. Later, it changed its name to the American Soybean Association (ASA), which was to unify soybean growers and to serve growers' needs by directing a forceful soybean research agenda. From the beginning, the University of Illinois was prominent in the affairs of the ASA. Even after the expansion of the interests among various actors, the ASA continued to look to Illinois for leadership and resources. Dr. Morse was engaged in reaching out to farmers, researchers and industrialists, such as I. Clark Bradley, A.E. Staley, Sr., Eugene D. Funk, and Dale McMillian, through government bulletins and hundreds of addresses at conferences. Later on, these individuals played a vigorous role in promoting the soybean industry. As Howell has commented, the success of the soybean processing industry was:

> ...another element, just as important or even more so. First a few and then many more men and women of vision, imagination, energy, dedication- remarkable people and institutions who saw the potential of the soybean and worked hard to make that potential a reality (Windish, 1981: 8).

The Crop Improvement Associations and Seed Certification

Although researchers developed superior varieties to raise soybean production, genetic adulteration in the field deteriorated its performance and discouraged farmers' confidence in the superior varieties. The major reason was the lack of official and unified endorsement of the best varieties, so as to motivate farmers' appreciation of their qualities. The issue was first raised by county farm advisors, who campaigned for pure seeds in order to provide a means of recognizing merit in seed grains. In 1921, the Farm Advisors' Assn. and the Illinois agronomy department began to draw up a practical scheme of work. First, state Crop Improvement Associations collaborated with universities to examine the eligibility of certified seeds. Later, a Farm Advisor's Committee endorsed an agreement on Seed Certification, which was drawn by state Crop Improvement Associations and researchers. The main task was to perform field inspections before planting. Consequently, the seeds reproduced by farmers were forced out of the field and were replaced by the channels of certified seeds (Windish, 1981).

The improvement of the combine

At the early stages, soybeans were harvested with existing equipment: small grain harvesting machines and threshing machinery. The inadequate machinery not only resulted in a 30% loss per harvest, but also created harvesting difficulties. Therefore, custom crews preferred harvesting corn which had the same harvest time as soybeans. However, the increasing plantation of soybeans and technical advances in mechanics assisted in the invention of a small combine.

In 1923, Taylor Fouts, the head of Fouts Brothers, invented a small combine and held a promotion conference for representatives from the largest manufacturing companies. These companies were requested to loan combines to universities for testing their soybean harvesting possibilities (Lehmann and Bateman, 1944). Although initially the small combines were poorly suited to soybeans, the later modified combines and the development of suitable varieties proved its advantages in saving labor and reduction of grain loss (Lockeretz, 1988).

Although the small combine partially solved the harvesting problems among farmers, elevators refused to accept combined soybeans. They were concerned that the heat caused by combines would endanger the operation and storage. However, an exceptionally wet season in 1926 changed elevators' hospitality. The combined soybeans not only resolved moisture problems during the storage period, but also had a higher germination rate and lower moisture content.

The employment of the small combine indicated that the clientele of an innovation was not limited to farmers but included other off-farm actors, who also participated in the formulation of a soybean market. Take combined soybean as an example. Presumably, farmers were the target clientele who had to balance the efficiency and cost of a combine and in turn affected the rate of adoption. Yet, the debate over combined soybeans demonstrated that processors' definitions of what constituted the good quality of postharvest soybeans played a determining role in the viability of the innovation. Without all these actors' agreement on the use of combined soybeans, the diffusion of a combine would have faced difficulty. Put differently, how technical change progressed in the development of the soybean industry largely depended on various actors' attitudes toward an innovation, rather than a single actor such as farmers. This not only challenged the assumption that technical change was an endogenous factor in agricultural development, but also the conceptualization that treating farmers as a sole decision-maker on an innovation, the central themes in the induced innovation theory and the diffusion of innovation theory, respectively.

Promotions by Crushers and Processors

The increasing production of soybeans aroused processors' interests in producing soybean oil for industrial use and soybean meal for feedstocks. However, the processors' interests conflicted with those of farmers' and created competition between soybeans for planting and for processing. First, soybeans were grown as a hay crop; hence, the demand for seed was strong. Processors had difficulties getting soybeans at a price that permitted profitable processing, since the value of soybeans was higher for seed than for processing (Lockeretz, 1988). Second, to make processing profitable required a market for the meal as a co-product. However, there was no rationale for farmers to sell soybeans and buy soybean meal made from the commodity they just sold, since they could produce soybean meal on farms. Feed manufacturers in turn hesitated to add soybean meal to stock feed. Third, the increasing expansion of soybeans made farmers concerned about the capacity of this newly and poorly established processing industry. In comparison with the previous situation where the soybean price was too high for processors to use it profitably, now the concern was that it might become too low for farmers to produce it profitably.

In order to break the uncertainties in the soybean market, processors took the first step to transform soybeans from a farm subsistence crop to a cash crop and at the same time replaced the farm-produced meals by manufactured soybean meal feed.

1. Staley Company

A founder of the soybean processing industry, August Eugene Staley, started his soybean business in the Corn Belt after WW I. In 1922, Staley began a price guarantee program, which was to contract with farmers to purchase all the soybeans they grew. In order to deliver his program, he used public communication channels and gave numerous talks to farmers, grain elevator operators, seedhouses, county extension advisers, bankers and news media (Windish, 1981). In so doing downstream actors were able to connect with each other to nurture the soybean industry.

The guarantee program rapidly stimulated interest among farmers. Letters from farmers swarmed in and Staley replied to them by providing his plan. He also encouraged and referred those interested in soybean culture to the University of Illinois for the best agronomic advice. With Staley's promotion, during that spring, Illinois farmers planted 5 times the area to soybeans as in the previous year.

2. Train tour promotion program

In 1927, a train tour, entitled 'The Soil and Soybean Special', was the highlight of Staley's soybean program. The train was equipped with two exhibiting cars, two motion picture cars, one lecture car and one office car. The content of displays and lectures included information on growing soybeans, utilization of soybean food, industrial products and the soybean grading system, which were partly provided by the University of Illinois and government agencies.

This train trip made 105 stops over 2478 miles at towns along the Illinois Central lines and attracted 33,939 people during the operation (Windish, 1981). "This train furnished a visible demonstration and accomplished more in an educational way than could have been achieved in a year in any other form of agricultural publicity"

(Windish, 1981: 67).

3. Funk Bros.

Eugene Funk, with his early experience in selling soybeans at Funks Bros Seed Company, became a second soybean processor and a pioneer seedsman. The establishment of a processing plant in 1924 complemented Funk's soybean seed trade. Farmers contracted to buy and grow varieties released from the Universities in Illinois and Indiana from Funk Bros Seed Company and sold soybeans back to Funk's processing plant (Windish, 1981).

4. Peoria program

In order to ensure a profitable market for farmers, in 1928 several processors co-initiated the Peoria program, which included Funk Bros., H.G. Atwood of the American Milling Company of Peoria and James A. McConnell of G.L.F., professors from the Agronomy Department of the University of Illinois, county farm advisors, the Farm Bureau, Prairie Farmer magazine, and the Staley Company. Under the program, each farmer could underwrite up to 50,000 acres of soybean fields or 1 million bushels of soybeans with a guaranteed price. In addition, such farmers were not committed to sell soybeans to participating companies if others offered a higher price (Windish, 1981; Lockeretz, 1988).

The Peoria program was rapidly broadcast to farmers and soon its popularity was reflected by the increasing production of soybeans. The statesmanlike promise of "You grow the beans and we will find the market" by the National Soybean Processors Association succeeded in breaking the vicious cycle of uncertainties between farmers' supply and processors' demand, and transformed soybeans from a farm crop to a cash crop (Riegel, 1944).

5. Tariffs

Although production of domestic soybeans increased after the Peoria Program, it could barely compete with cheaper imported Manchurian soybeans. The growers' and processors' groups believed that the United States' farmers could not and should not compete with the cheap soybeans from the Orient. The chief opposition encountered was from soap manufacturers. However, in 1928-29 the ASA representing processors and growers successfully lobbied for strong tariff protection on foreign soybean oil and soybean meal. In 1930, import duties were raised to $1.20/bu for soybeans, $0.035/lb. for oil and $6/ton for meal. For comparison, domestic prices were in the range of $0.50 to $1.30/bu for soybeans, $0.03 to $0.09/lb. for oil, and $20 to $40/ton for meal (Lockeretz, 1988).

Soybean standards

In 1925, the U. S. Department of Agriculture announced soybean standards for the purpose of providing a reliable method for various business transactions. Slight revisions were made in 1926. One change included a super grade to take care of extra high grade demand such as the seed trade (Reigel, 1944).

In sum, the activities generated by industrial entrepreneurs or groups were effective in transmitting scientific and technological knowledge, embodying new technology in equipment and materials, improving the level of husbandry skill, and the educational accomplishments of rural people, the efficiency of input and product markets, and the establishment of social and political institutions (Ruttan, 1982). In other words, the increasing amount of institutions over this period successfully connected the technical change and social resources for the development of a soybean industry.

2.2. Period II 1929 -1939

The Great Depression came in the early 1930s and the whole nation's industries were engulfed in catastrophe. Although the overall economic situation was bad, the soybean industry steadily accumulated technical advances aimed at market opportunities in food industries (Forrestal, 1982). In food products, soybean flour was finally accepted as an ingredient for sausage and the popularity of margarine also ensured a promising market for soybean oil. Continuous improvements in combines and processing equipment increased efficiency in production. In addition, the Chicago Board of Trade provided a futures market opportunity, thereby fostering the input and soybean product market.

In 1934, Funk Bros. company had a processing plant in operation in Bloomington which not only crushed soybeans to produce soybean oil and meal, but also gave soybean meal in exchange for soybeans grown by farmers (Windish, 1981). In the same year, the corn in the Corn Belt was destroyed by a chinch bug invasion. Soybeans were initially advertised as a livestock saver and an emergency crop in order to continue farm operations. Yet, its role was transformed from merely a transition crop to a profitable cash crop as a result of the price guarantee program.

Processing equipment

The expansion and improvement of the processing industry matched the phenomenal growth of soybeans. First the old hydraulic presses were replaced by mechanical expeller and screw presses (Goss, 1944). In 1934, the Archer-Daniels-Midland (ADM) company installed the first solvent-extraction machine, which efficiently divided crude oil into ingredients based on the needs of a variety of industries. This method helped ADM through the economic difficulties of the Depression (Windish, 1981). However, the majority of processors did not use it until the danger of using a flammable solvent was removed in the early 1950s.

Dale W. McMillen, Central Soya Company

Dale W. McMillen, stepped into the soybean industry in 1934 by re-furbishing an old sugar mill as Central Soya Co. at Decatur. McMillen's enterprises were interwoven with the adoption and exploration of processing technologies. In the 1920s, Central Soya Co. was the first to adopt the expeller instead of an hydraulic press and the second to build a solvent extraction plant in the United States in 1936. In addition, in 1942, a technical department with a full-scale biological laboratory was set up. It produced a number of significant advances such as removing the off-color and solvent odor from soybean meal (Windish, 1981).

Henry Ford

The versatility of soybean oil not only appealed to the soybean industry but also to the auto industry. Henry Ford, with the dream of "growing automobiles on farms", envisioned an immense potential for soybean products in automobiles. His loyalty to create "a vegetable car" expanded the utilization of soybean ingredients to paint, plastic, margarine, breakfast food, filler for sausage, printing ink, soap and insecticide (Windish, 1981).

The Bankhead-Jones Act

The promising atmosphere fermented by each actor raised more actors' interests. In 1935, the Bankhead-Jones Act was passed to intensify research on major agricultural commodities. As a result, the U.S. Regional Soybean Industrial Products Laboratory was established at the University of Illinois to ascertain the effects of varietal and cultural difference on the chemical composition of the soybean, to develop new industrial outlets, and to improve present industrial uses for soybeans as well as soybean products (Reigel, 1944).

The Chicago Board of Trade

Since over half of the soybeans were usually sold during the three months of October, November and December, there was a great need for hedging facilities. In 1936, in response to this need, the Chicago Board of Trade opened the futures market to soybeans (ASA, 1958). "The new market in futures will encourage banks to finance investments in soybean crushing capacity due to greater security through the opportunity of hedging" (Forrestal, 1982: 103).

Small Combines

In 1939, an affordable and compatible small combine was produced and soon popularized among small farm owners. Its easy manageability not only facilitated farm operations, but also reduced the problems of the scarcity of custom operators during harvest seasons.

2.3. Period III, WW II (1939-1945) and Postwar (1946-1970s)

WW II (1939-1945)

WW II broke out in 1939. When the military invaded the traditional fat and oil producing countries, such as Norway, South Asian countries and South European countries, oil deficiency became a worldwide problem. The oil shortage made soybeans an alternative crop in producing oil and food. Soy flour was incorporated into military and domestic food products (ASA, 1940). In Germany, the 'Nazi Food Pill' and plastic food were produced by soybean products to serve appropriate calories and nutrients for troops (Doig, 1943).

Commodity Contracts (Commodity Credit Corporation)

The unusual wartime situation legitimated American government intervention in the soybean industry in order to encourage its continuous growth. A comprehensive program which regulated the marketing, storage, and processing problems of four oilseed crops --cottonseed, flaxseed, soybean and peanut -- was under the control of the Commodity Credit Corporation, agencies of the Department of Agriculture, the War Production Board, and the Office of Price Administration. Processors, bean crushers, and country elevators contracted with the government in order to provide a fixed price for soybeans, soybean oil and soybean meal to farmers, and to safeguard continuous soybean production (ASA, 1942; Bunnell, 1944). Under this program, farmers were encouraged to expand the production of soybeans through the price support program, loans and subsidies (Farrington, 1946).

Grades and Standards

The expansion of the soybean industry aroused the need for an adequate grading standard to stabilize each actors' interactions and mobilize the flow of soybeans. The first soybean standards were patterned after the grades applying to cereal grains, and moved soybeans into the grain trade. The standards were revised in 1935 and 1941, and promulgated under the U.S. Grain Standards Act. However, the existing measurement of standards including moisture, test weight, color, dockage and foreign materials, did not reveal the significance of oil content in producing high quality oil and meal. The first problem occurred during the period of 1942 to 1944. Soybeans damaged as a result of an early frost were graded as high quality, according to the existing standard, yet had an oil content below normal, which increased costs to processors and refiners in the production of quality oil and meals (Iftner, 1943; Bunnell, 1944).

It became evident that soybeans could not be properly valued by processors without a determination by chemical analysis of the oil content of soybeans being sold. The unsatisfactory standard led to processors' demand that "soybeans must be treated as an oilseed rather than a grain crop and graded accordingly, with premiums and discounts for fluctuations above and below a basic oil content" (Bunnell, 1944: 13). Accordingly, government agents, with the cooperation of industries and laboratories, developed analysis techniques for the purpose of relating market prices to the oil content of soybeans.

Postwar (1946-1970s)

After WW II, soybeans outgrew its infancy and penetrated into farm programs, edible oil industries, feed manufacture and food manufacture. Soybean processors strongly encouraged the government to return soybeans to a free market in order to enter into an aggressive world marketing program and compete with other domestic vegetable oils (Windish, 1981). As a result, soybeans remained free of government acreage restrictions and other war-time controls, such as the commodity processor contracts and the CCC inventory. The high price support still remained, nurturing the production of soybeans. However, it raised another concern: surplus of soybean production.

To prevent a soybean surplus, government and industry concentrated efforts on research projects to expand its market at home and abroad (ASA, 1958; Iftner, 1944). The soybean successfully made gigantic strides in the domestic vegetable oil industry, and outdistanced cottonseed, flaxseed and peanut, which suffered from economic pressures, high cost in production, and unstable production (Eastman, 1945). In addition, the war-torn countries served as the best opportunity to expand the overseas market in the name of relieving the hungry population. Trade missions by the United States Department of Agriculture, pioneer processors and the American Soybean Association were sent to Western Europe and Japan to analyze market possibilities. Several government programs were generated in response to market enlargement

(Windish, 1981).

Soybean Standards

The mass production of soybeans did not necessarily ensure a profitable market opportunity in the competitive global soybean market. It needed complementary regulations in assisting the mobilization of the commodity at a distinct distance, such as explicit and mutually acceptable standardization. During the 1950s, the higher level of foreign materials and moisture content of American soybeans led to their poor showing in the face of Manchurian soybeans on the European market. This was partly attributed to the incompatibility of domestic standards with those of European buyers. For example, green-coated beans were classified as yellow soybeans when mixed with yellow beans in the U.S. standard; however, Danish producers strictly excluded green-coated beans from yellow beans because green beans made oil quality unstable.

In response to a change in soybean grade standards, soybean actors were divided into two groups to negotiate on a new standard. In early 1955, grain handlers, producers and the ASA submitted a proposal expressing their loss of profit as a result of the need to clean up the foreign materials and objected to the exclusion of green-coated beans in yellow beans. Simply put, it would add more handling expenses on the grower side and increase the complexity of handling. On the other side, the Farm Bureau generated a proposal for lower foreign materials and moisture content, and it gained support from the Farmers Grain Dealers Association of Iowa. Not until September 1955, was a final resolution reached. The new standard for each grade reduced the level of foreign materials, and moisture content, excluded green beans and increased oil content. Under the authority of the U.S. Grain Standards Act, licensed inspectors in the Federal Department of Agriculture were obliged to apply the standard accurately (ASA, 1955; Shaw, 1956; Daily, 1952; Barr, 1955).

Due to the expansion of soybean markets, the status of soybeans as a main agricultural commodity has acquired a nationwide attention. What remained to further the continuous growth of the soybean industry was the dynamic creation, exploration and maintenance of the soybean market by various commodity actors. Throughout this period, government intervention at each stage of soybean production and processing was effective in gluing and stabilizing the commodity chain. It successfully built a network which tied the actors together including farmers, agricultural extension agents, researchers, agricultural engineers, farm machinery manufacturers, processors, retailers, politicians, government bureaucrats, and consumers.

Reciprocally, the network was effective in producing new knowledge, modificating and stabilizating the soybean commodity in order to enroll more allies and to make the network indispensable. The revision of standard and grades well illustrated how the social network got involved with technical change. The change in grades and standards was presumably a technical problem related to measurements and evaluation procedures. Yet, the debate over the changes in measurement was constructed and mobilized by actor's actions in a social context through negotiation, coercion and persuasion, rather than by a simple "objective and static" judgement by technocrats.

Through the process, the new grades and standards became an indispensable point that successfully controlled each actors' behavior and made others' actions predictable. For instance, the standardization of soybean products made purchasing and selling at a long distance possible. In such a way, actors heavily relied on the rules of standardization, and "no matter where you go or what you do, you have to pass through the position, and to help them further their interests" (Latour, 1987: 120). Thus, the longer the soybean market expanded, the greater the number of actors in the network who participated in the construction of the fact (Latour, 1987).

2.4. Period IV, Cold War Era (1970s)

Later came the Cold War era. The globalization of soybeans was contingent on the political and economic expansion of American agriculture into the international food market. In 1954, the Agricultural Trade and Development Act (Public Law 480) authorized programs for sale of surplus agricultural stocks and for constructing the free world as an area for the open flow of goods and foreign currencies. Under this authority soybean surpluses would be sold abroad and moved through commercial channels. The Secretary of Agriculture determined the countries and the commodities with whom agreements would be negotiated and financed (ASA, 1958; Humphrey, 1957).

In order to expand the soybean overseas market, several complementary national policies were launched including the establishment of international research institutions, food aid programs (Food-for-Peace Program), education programs, and bilateral institutional affiliations.

International soybean research institutes were set up by the cooperation of the Agricultural Research Service, USDA and the Soybean Council. They were in Israel, Thailand, France, Italy, Poland, Spain, U.K. and Japan (Hilbert, 1959). One educational program was initiated by the Soybean Council of America in cooperation with the Great Plains Wheat Market Development Association, the U.S. Rice Export Development Association, the Millers National Federation, the U.S. Feed Grain Council, the Dairy Society International, the National Renderers Association, and the Institute of American Poultry Industries. The main objective of the educational program was to teach people how to incorporate the high nutrient value of soybean products into their diets. The worldwide program reached 41 countries with in excess of one billion people (Roach, 1961).

The soybean industry faced the fall of the previous food order during the 1970s. It resulted from agricultural protectionism in the European countries and the competition from new soybean growing countries such as Brazil (Friedmann, 1982). Since then, the structure of the soybean industry is no longer a mixture of technical development, nutrient values and economic growth issues as proposed before. On the other hand, the globalization of the American soybean industry has intertwined domestic and foreign actions, such as food policies, farm programs, national economy, international order, and capital flows (ASA, 1971).

Chapter 3

Conclusion

This paper examined the early stages of the soybean industry in the United States. The introduction of soybeans into US agriculture involved various actors' participation including developing improved varieties, improving processing facilities and planting machinery, planting soybeans and marketing soy products and livestock feed (Lockeretz, 1988). They linked as a network which collectively created the environment for the growth of the soybean industry.

The diffusion and adoption of innovation literature is focused on the relation between adopters and the innovations at the farm level. Farmers' socio-psychological characteristics and the degree of awareness and frequency of personal communication are factors determining the rate of the adoption of an innovation. However, it is not my intention to elaborate how the relationship between farmers' socio-psychological characteristics and adopting behavior affected the soybean industry, but rather to concentrate on the dynamic between off-farm actors and the development of the soybean industry.

Findings have shown that various communication methods (e.g., train tour program, personal contacts...etc.) and education programs (e.g., worldwide program) played an important role in distributing information about the merits of soybeans to farmers and consumers. However, awareness of soybeans is not the key factor to make a farmer want to grow it. Instead, it is the changes in structure which appeal to the actors across the industry, including political, economic, and cultural forces. In other words, without a prospective soybean market ensured by the Peoria program, farmers, processors and feed manufacturers would have hesitated to expand their investment in soybean production. The insensitivity to contextual and social-structural factors in diffusion theory could have caused a lack of understanding in the connections among the farms, the social entities and the development of the industry.

Another problem is its assumption regarding the diffusion of practices as a succession of steps from birth to commercialization by way of a vis inertia (Callon, 1989: Latour, 1987). Once adopters accepted a new practice, the vis inertia of the new practice would automatically reproduce, move and advance the whole industry without the actors' activities that shape and transform it (Latour, 1987). As a consequence, we have the soybean on one hand and social actors on the other; both of them have their own vis inertia as two separate entities. However, the practices employed in developing the soybean from a hay crop to an oilseed commodity involved a spectrum of interactions distributed across the soybean commodity, so as to mobilize and coordinate resources for the purpose of advancing the industry.

On the other hand, the induced innovation model asserts that technical change is an endogenous variable driven by economic forces and is induced through the relative scarcities of factors of production (e.g., land, labor). The changes in institutions are of necessity to increase an industry's capacity to manage new technologies. Findings have shown that the soybean industry has co-evolved with non-governmental organizations (e.g., the ASA, the NSPA), government agencies, and research institutions, which have increased the allocation of social resources and the linkage among scientific communities, farmers and processors[4]. This perspective has provided an advance, connecting social resources and technical change, over that of diffusion theory.

However, induced innovation theory does not examine the dynamic between the establishment of social resources and technical change, which is the key to the development of the soybean industry either. First, the overwhelming reality of governmental intervention and involvement in the industry has denied the assumption of a free market mechanism in explaining its development. Second, actors concerned with soybeans had different perspectives and interests in innovations depending on their expectations of the effects of the innovation and their capacity to appropriate the potential benefit derived from its utilization (Pineiro et al., 1979). Since it involved diverse interests in a society, the final direction taken was a matter of negotiation, persuasion and coercion among actors (Sousa et al., 1981). The induced innovation theory does not much deal with the diversion of actors' interests. For instance, a new grading standard was not induced by a single soybean actor, but rather was a result of a variety of actors' negotiation and coercion.

Third, social, political and cultural mechanisms have significantly affected on the soybean industry. The changes in human diets (e.g., soy flour, margarine, and soy food), farm practices (e.g., manufactured stock feed) and international politics (e.g., WW II and Post War) were interdependent factors in contributing to the rapid

---

[4]Owing to the availability of data and the purpose of this thesis, the numbers of the institutions which have been established and their contribution to the soybean industry are not included.

expansion of the soybean industry.

On the other hand, actor network theory argues that the development of the soybean industry is essentially a fact-building process which is collectively constructed by actors in the soybean commodity subsector. It constitutes a social network that is able to redefine what it is made of by networking heterogeneous elements (Callon, 1989). One way to understand how the network works is to identify how the associations were made by actors in mobilizing and linking the social and technical entities into developing the soybean industry (Murdoch, 1994).

First, agronomists played the important role of revealing the agronomic characteristics of the soybean to a spectrum of industries, which was to link heterogenous allies and create the longevity and solidity of the network. Dr. Morse and his disciples first established the ASA, and then constructed the connections among processors, growers and government agencies.

Second, processing industries successfully transformed the soybean into a cash crop and replaced soybean meal by manufactured stock feed. They not only promoted the expansion of soybean production, but also actively incorporated technical exploration to increase soybeans' usage (Windish, 1981). After WW II, processors were actively in cooperation with government to create a soybean market both domestically and overseas.

Third, the activities of government agents carried out a variety of programs including production, marketing, processing, industrial uses and consumption (Iftner, 1944). They included the price support program, the Bankhead-Jones Act, the extension service, enforcement of grading standards and programs under the authority of P.L. 480. All of them were to encourage the expansion of soybean production.

Fourth, the improvements in farm machinery and processing techniques permitted more efficiency in the utilization of soybeans. For instance, the development of small combines improved the compatibility and interchangeability of harvesting machines among wheat, soybeans and corn.

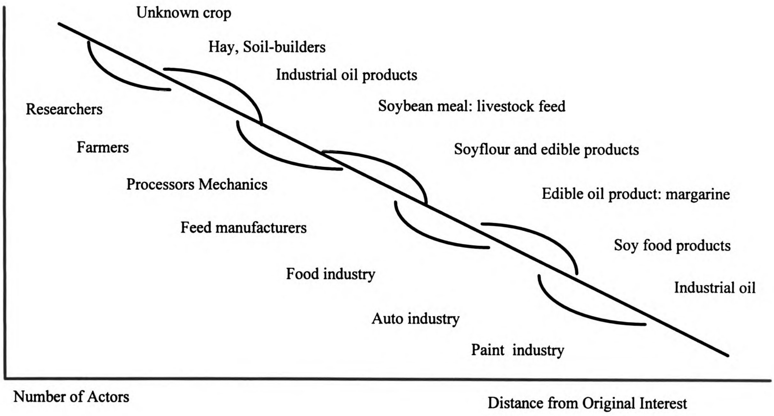
Fifth, non-governmental associations played an important role in linking heterogenous resources. For instance, the ASA helped the expansion of soybean production, assisted in opening overseas markets, and helped in the establishment of the Soybean Council of America, which was a cooperative effort of growers, processors and handlers in expanding foreign outlets. The ASA's official publication, the Soybean Digest, provided a forum to promote the general welfare. Moreover, it maintained a Washington, D.C. staff of two lobbyists and several supporting technicians for undertaking policies related to soybeans (Houghtlin, 1961).

The tasks of the National Soybean Processor Association (NSPA) were to dictate domestic soybean trading and to set up the NSPA Soybean Research Council for providing technical assistance. In addition, an advisory board was formed to distribute soybean knowledge to agricultural teachers, handlers, growers and the public (Houghtlin, 1961).

The development of the soybean industry may be regarded as a process of interest translation among allies in order to enroll more allies' participation and make their actions predictable (Latour, 1987) (Figure 1). First, although there were versatile agronomic merits of the soybean, researchers concentrated on the soil-building character of the soybean and translated it as a corn saver in order to cater to farmers' explicit interest in an alternative crop. In other words, the translation created a tension that made farmers select only what, in their own eyes, helped them reach their goals amongst many possibilities (Latour, 1987). Second, in order to expand the prospect of soybeans, processors first reshuffled farmers' interests in soybeans as an economical farm-produced feed crop, then replaced it by a source of cash income. Eventually, the prototype of the soybean industry was in shape and became an indispensable passage point for the followers. Therefore, a communal fate among actors was built and actors were controlled by the coordinated industry which was assembled by their interests.

The development of the soybean industry serves as a significant example of a planned crop introduction in US agricultural history. This study has shown that the success of introducing the soybean not only stemmed from its intrinsic merits, but also involved the participation of various actors to champion and promote the entire industry. In addition, it consisted of long-term dedication of strongly motivated supporters, early involvement and cooperation of all actors, compatibility of a new crop with established farming systems, development of locally adapted varieties and clear standardized grades and definitions (Lockeretz, 1987).

Figure 1. Interest Translation and the Enrollment of Actors



BIBLIOGRAPHY

"A warning on Protectionist Policies." Soybean Digest (September 1971): 42.

"ASA's Brief at Grade Hearings." Soybean Digest 15(5) (March 1955): 16-18.

Barr, Jason E. "The Revised Soybean Standards." Soybean Digest 15(11) (September 1955): 55-58.

Bijker, Wiebe E.; Hughes, Thomas P.; and Pinch, Trevor. The Social Construction of Technological Systems. Cambridge: The MIT Press, 1987.

Binswanger, Hans P. and Ruttan, Vernon W. "Induced Innovation and the Green Revolution." In Induced Innovation, pp358-407. Edited by H.P. Binswanger and Vernon W. Ruttan. Baltimore: Johns Hopskin University Press, 1978.

Buttel, Frederick H.; Larson, Olaf F.; and Gillespie, Gilbert W. Jr. The Sociology of Agriculture. Connecticut: Greenwood Press, 1990.

Bunnell, D.J. "Problems of the Soybean Processor." Soybean Digest 4(7) (May 1944): 12-14.

Busch, Lawrence. "How to Study Agricultural Commodity Chains: A Methodological Proposal," in Economie des Filières en Regions Chaudes: Formation des Prix et Echanges Agricoles, p13-24. Edited by Michel Griffon. Paris: CIRAD, 1990.

Busch, Lawrence; Bonanno, Alessandro; and Lacy, William B. "Science, Technology, and the Restructuring of Agriculture." Sociologia Ruralis XXIX-2 (1989): 118-130.

Busch, Lawrence; Lacy, William B.; Burkhardt, Jefferey; and Lacy, Laura R. Plants, Power, and Profit. Massachusetts:Blackwell Publishers, 1991.

Callon, Michel. "Society in the Making: The Study of Technology as a Tool for Sociological Analysis," In The Social Construction of Technological Systems, pp83-106. Edited by Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch. Massachusetts: The MIT Press, 1993.

"Commodity Contracts." Soybean Digest 2(12) (October 1942): 9.

Daily, Everett E. "Why We Oppose Changes in the Soybean Grading Standards." Soybean Digest (September 1952): 64-65.

Doig, James L. "Life Raft Ration." Soybean Digest 3(5) (March 1943): 6-14.

Eastman, Whitney H. "The Soybean Industry." Soybean Digest 5(4) (February 1945): 6-8.

Farrington, C.C. "Commodity's Market Program." Soybean Digest 2(12) (September 1942): 5.

Farrington, Carl C. "Government Programs for Soybeans." Soybean Digest 6(11) (September 1946): 47.

Fliegel, Frederick C.; and J.C. van Es. "The Diffusion-adoption Process in Agriculture: Changes in Technology and Changing Paradigms." In Technology and Social Change in Rural Areas, pp. 13-28. Edited by Gene F. Summers. Boulder, CO: Westview Press, 1983.

Forrestal, Dan J. The kernel and the bean : the 75-year story of the Staley Company. New York : Simon and Schuster, 1982.

Friedmann, Harriet. "The Political Economy of Food: The Rise and Fall of the Postwar International Food Order," American Journal of Sociology. 88(Supp.) (1982): S248-S286.

"Free Trade vs. Protectionism." Soybean Digest (June 1971): 30-31.

"Full Soya in the Soldier's Diet." Soybean Digest 1 (November 1940): 4-5.

Gieryn, Thomas F. and Figert, Anne E. "Ingredients for a Theory of Science in Society." In Theories of Science in Society, pp67-97. Edited by Susan E. Cozzens and Thomas F. Gieryn. Bloomington and Indianapolis: Indiana University Press, 1990.

Goss, Kevin F. "Consequences of Diffusion and Innovations." Rural Sociology 44(4) (1979): 754-772.

Goss, W.H. "Processing Soybeans." Soybean Digest 5(1) (November 1944): 6-9.

Hackleman, J.C. "A Change in Grading Standards?" Soybean Digest 3(2) (December 1942): 3-9.

Hayami, Yujiro and Ruttan, W. Vernon. Agricultural development: an international perspective. Baltimore: Johns Hopkins University Press, 1985.

Hilbert, G.E. "The Foreign Agricultural Research Program Under Public Law 480." Soybean Digest 19(11) (September 1959): 46-52.

Houghtlin, Robert G. "Soybean Industry within The USA." 21(7) Soybean Digest (March 1961): 17-18.

Humphrey, H.H. "Public Law 480." Soybean Digest 17(7) (May 1957): 14-16.

Iftner, G.H. "Recent Development and Interpretation of Soybean Grade Standards." Soybean Digest 3(11) (September 1943): 11.

Iftner, G.H. "Government and the Grower." Soybean Digest 5(2) (December 1944): 6-7.

Latour, Bruno. The Pasteurization of France. Massachusetts: Harvard University press, 1983.

Latour, Bruno. Science in Action. Massachusetts: Harvard University Press, 1987.

Lehmann, E.W. and Bateman, H.W. "Contributions of Machinery and Power to Soybean Production." Soybean Digest 4(11) (September 1944): 25-27.

Lockeretz, William. "Agricultural Diversification by Crop Introduction." Food Policy (May 1988): 154-166.

Murdoch, Jonathan. "Weaving the Seamless Web: A Consideration of Network Analysis and its Potential Application to the Study of the Rural Economy." Center for Rural Economy WorkingPaper Series (1994).

Riegel, W.E. "Twenty-Five Years of Soybean Growing in America." Soybean Digest 4(11) (September 1944): 23-24.

Roach, Howard L. "Soybean Council of America- Promotional Progress." Soybean Digest 21(11) (September 1961): 61-64.

Rogers, Everett M. Diffusion of Innovations. New York: A Division of Macmillan Publishing Co., Inc., 1983.

Ruttan, Vernon W. Agricultural Research Policy. Minneapolis: University of Minneapolis, 1982.

Shaw, Elmo A. "Marketing Problems of U.S. Soybeans in Europe." Soybean Digest

16(11) (September 1956): 38.

Smith, Keith J. and Huyser, Wipada. "World Distribution and Significance of Soybeans" In Soybeans: Improvement, Production, and Uses, pp1-22. Edited by J.R. Wilcox. Madison: The American Society of Agronomy and Academic Press.

Sousa, Ivan Sergio Ferire de; Singer, Edward Gerald; and Flinn William L. "Sociopolitical Forces and Technology: Critical Reflections on the Green Revolution." In Food, Politics, and Society in Latin America, pp. 229-245. Edited by J.C. Super and T.C. Wright. Lincolm, Nebraska: University of Nebraska Press, 1985.

Tanaka, Keiko. 1992. Science and Society: The Case of Agricultural Science in Japan. M.A. Thesis. Michigan State University.

"The Soybean: Miracle Crop of the Twentieth Century." Soybean Digest 18(3) (January 1958): 3A-12A.

Windish, Leo G. The Soybean Pioneers, Trailblazers...Crusaders ...Missionaries. Illinois: M & D Printing, 1981.