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A pretension of place: The industrialization of corn belt agriculture, 1940-1965

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A PRETENSION OF PLACE:

THE INDUSTRIALIZATION OF CORN BELT AGRICULTURE, 1940-1965

An Abstract of a Thesis

Submitted

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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ABSTRACT

This study concerns both the causes and effects of the industrialization of Corn Belt agriculture during and after World War II. Although industrialization is certainly a fully cultural phenomenon, with a multiplicity of competing and augmenting causal agents involved in its genesis, industrial processes are the most salient and identifiable bases of modern economies. In their application to the Corn Belt's agricultural structure, techniques of industrial farming revolutionized almost every aspect of the agricultural experience. Farm size, machinery, power sources, capitalization, supplies, and populations have all changed in response to an almost single-minded adherence and adoption of a mechanical-chemical based technological vision of what security, progress, and utopian ideals entail for American culture.

This study identifies and analyzes five capital inputs which were fundamental to the previously mentioned massive transformation of Corn Belt agriculture. First, the development of engine-powered machinery allowed farmers to fully manifest and implement endemic cultural drives to achieve larger output and greater control over the land.

Second, the application of substantial quantities of commercial fertilizers stimulated larger yields from the same amount of land. The ability to manipulate crops and the larger environment was enhanced and forced up production levels. Third, monocultural cropping patterns grew along with farmers' increasing capacity to

"mass produce" field crops. Agriculturalists generally countered rising pest and disease threats with synthetic pesticides discovered shortly before, during, and after World War II.

Fourth, crop technology itself changed with the emergence of hybrid varieties, especially corn and soybean hybrids, and caused some farmers to abandon livestock raising altogether. Specialization produced greater risks.

Fifth, the remaining livestock producers changed to intensive, high energy, chemically-laden factory methods. They sought total control over livestock environments and the animals themselves. Developments in breeding, feeds, animal drugs, and confinement structures drove this shift.

This study suggests a link between a whole host of problems and the adoption of the industrial farming system. It has exacerbated difficulties associated with the traditional "farm problem" and has created new problems such as polluted ground water and disrupted rural communities. Finally, it is felt that this system represents a mere pretense at place construction, and therefore is inherently unstable and destructive of agricultural social ecology.

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CHAPTER 1

INTRODUCTION

It is a generally accepted scholarly position that American agriculture became industrialized (most farming types and areas) after World War II. The adoption of a "package" of inputs and practices such as power machinery, synthetic fertilizers, chemicals, hybrid and improved seeds, pre-mixed feeds and feed additives, selected breeding stock, conservation techniques, and widespread irrigation has been characterized as an agricultural revolution. Moreover, it has been called the second American agricultural revolution, to distinguish it from an earlier period around 1850 when horse machinery was widely adopted.[1]

Each revolution caused dramatic gains in productivity and tended to exacerbate the chronic problem of American agriculture after 1850--overproduction. Related to the new industrial mode of manufacturing and the "farm problem" of overproduction, is the continuing depopulation of the countryside and growing pressures on the viability of an entire way of life--small-town America. A fourth and final theme is the relation of modern agriculture to environmental degradation. It is at the intersection of these four themes, industrial farming, the farm problem, rural decline, and the agricultural contribution to the environmental crisis, that we seek explanations for our agricultural and cultural problems and some semblance of a sustainable farming regime for the future. Ecologically sound and locale-appropriate farming practices would have the potential to bring agriculture into harmony with both the natural and human cultural environment.

The rapid industrialization of Cornbelt agriculture during and after World War II reflected a pervasive, fundamental, American cultural characteristic--a near obsession with power and dominion over nature--catalyzed by war and pre-war social, economic, and political events, and fueled by the predominant vehicle of the American quest for control, technology. Onto an agricultural system already out of balance (by virtue of continued overproduction and low prices) capital-intensive farming methods made it a costly self-employment occupation to enter. Technology, as the predominant expression of the American worldview and style of work, operated (to some extent on an unconscious level) in the post-war era to alter the relationship between farmers and the land. In so doing, farmers, with growing agribusiness and governmental involvement, made more difficult the balancing of agricultural production with ecological sustainability. In short, agricultural place was prorogued. Problems with the traditional farming system persisted and were joined by new difficulties. The present thesis argues that neither the agricultural community nor the larger society engaged the "farm problem" on an essential and fundamental level because it "bought into" the intoxicating promises of progress, prosperity, and plenty offered by the application of industrial technology to agriculture.

Farming has always been an uncertain activity full of risks even in the best of times. Devastations caused by the weather, pests, and low markets were problems seen as not amenable by government or any other institutions. Before 1900, farmers rarely called for direct governmental intervention to the advantage of agriculture only, although they lobbied for cheaper money and lower freight rates which would have aided other business and labor groups.[2]

Between 1900 and 1920, farming experienced its "golden age" as farm prices rose and the difference between farm and non-farm prices held stable. Excess production was not burdensome because most was able to be sold on the world market. World War I added to a growing food demand and prompted a rise in agricultural prices. A boom psychology set in and caused an escalation in land prices and expansion in short-term debt. Markets contracted after the war, however, and markedly lower farm prices hit hard those who had recently expanded their operations. Debts, taxes, inflation, and low prices combined to make the 1920s a period of agricultural depression, while the rest of the economy was still expanding.[3]

During the 1930s the farm sector fell even deeper into depression. Foreclosure, drought, grinding poverty, and extremely low commodity prices forced farmers to turn to government for help. The federal government responded with expanded credit opportunities, commodity loans, and acreage controls. Farmers took action for themselves by organizing protest movements like the Farmers' Holiday Association, and by starting producer and consumer cooperatives owned and originally managed by farmers. Angered by the inequity between farm and nonfarm prices in the 1920s, most rural residents turned to the federal government for relief. Traditionally, farmers had opposed all monopoly control including governmental intervention, which was considered as monopolistic as any consortia of businesses.

> Many of them now swung over to the view that agriculture must adopt policies and practices similar to those used by "big business" and thus put itself in a position to deal on more even terms with other groups in the economy.[4]

Beginning in the early 1940s, the government's farm policy of reducing output turned to the opposite extreme of full and growing production. Various inducements to expand supplies of food and fiber were offered including guaranteed price supports. Output grew enormously and agricultural officials feared a post-war slump in farm prices. Some drop in prices did finally occur in 1949, but the situation was quickly reversed by the advent of the Korean War.[5]

Some of the traditional farm problems such as instability of tenancy and fluctuation in land values were not pressing difficulties in the 1950s and 1960s. The adoption of mechanized and factory-like farming methods accelerated, providing healthy surpluses. Growing conditions generally remained favorable, but the period was dogged with doubts concerning the possibility of a series of bad crop years threatening the adequacy of food supplies. In retrospect, this fear was a needless one because production was at record levels and yields per acre were beginning their steep rise.[6]

> For much of the 1950s and 1960s, U.S. farmers tended to see themselves as victims of their own productivity--taken for granted by consumers, neglected by government, and constantly losing faith in themselves.[7]

During this period the farm problem was generally perceived as one of low farm prices, excess capacity, assets fixed in agriculture, and immobility of labor out of farming. The nature of the problem altered to a more encompassing view as new factors were injected into the agricultural scene. Human-made risks such as government regulations, inflation, international markets, policy swings, and the actions of foreign governments complicated the traditional farming approach which emphasized slow change, financial conservatism, "making do", and waiting out bad times. The cost-price squeeze intensified and pressured many middle-sized farms. They neither had the scale of operations nor the off-farm income of small farmers. The survival of the family farm became more than just rhetoric as young farmers experienced greater difficulties entering farming. Those who had been in farming for some time tended to identify with governmental programs no longer operating or substantially modified.

High worldwide demand in the 1970s cast American agriculture in the role of savior in the fight against world hunger and poverty. Farmers were told to plant "fence row to fence row." Production expanded again and large investments in land, machinery, and automated livestock handling equipment drove both short- and long-term farm debt to record heights. In the 1980s, the agricultural roller coaster ride culminated in the "most severe crisis since the depression."[8]

Having weathered the most recent farm crisis with their numbers reduced, but a semblance of stability regained, farmers continue to face many of the same aspects of the farm problem which have haunted previous generations.

NOTES

1. Wayne David Rasmussen, Agriculture in the United States: A Documentary History (New York: Random House, 1975), 2919.

2. Murray R. Benedict, Can We Solve the Farm Problem?: An Analysis of Federal Aid to Agriculture (New York: The Twentieth Century Fund, 1955), 3-4.

3. Benedict, 5-12. Walter Wilcox, The Farmer in the Second World War (Ames: The Iowa State College Press, 1947), 1.

4. Benedict, 7.

5. Ibid., 13-14.

6. Ibid., 14-15.

7. Andrew Desmond O'Rourke, The Changing Dimensions of U.S. Agricultural Policy (Englewood Cliffs, New Jersey: Prentice-Hall, 1978), 1.

8. O'Rourke, 1. See David Rapp, How the U.S. Got into Agriculture: And Why It Can't Get Out (Washington, D.C.: Congressional Quarterly, 1988), for a discussion of agriculture in the 1980s, "Reaganomics," growing federal involvement in farming, and the "cheap food policy."

CHAPTER 2

THE MATRIX OF PLACE

The American "farm problem" has been of concern to agricultural observers and participants for more than a century. Perennial difficulties such as overproduction, rural poverty, a cost-price squeeze, instability in tenancy, and the survivability of rural communities continue to the present. The dwindling number of full-time farmers face economic, social, and political uncertainties which go well beyond the ordinary vagaries and built-in riskiness of agricultural production. Family farms confront the economic situation of seemingly being forced to either "get bigger or get out" of farming.

Since World War II, an additional issue has taken on critical importance and has added to the overall farm problem. Concern over environmental pollution and degradation caused by the industrialization of agriculture has arisen not only on the farm, but also in urban and suburban areas. In the Corn Belt, drinking water supplies increasingly contain a frightening mixture of agricultural chemicals, both in surface and underground water sources. Chemical residues in and on various foods have become objects of heavy criticism and fear in an increasingly health conscious society. Noxious odors from large feedlots close to residential areas have aroused opposition to local livestock operations and to the very principles of confinement livestock raising. Hence, there no longer exists the old boundary between town and country, especially when environmental problems tend to spill over one milieu to the next with great ease.

The industrialization of agriculture in the "developed" countries of the world has meant a growing human intervention in the environment. Rising dependence on fossil fuels, a shrinking genetic base, and warnings about unhealthy food all point to the expanding interface between agriculture and ecology. The term agroecology has been coined to address ". . . not only natural perturbations [of ecosystems] but also the myriad indirect effects of human economic and social activities."[1] So defined, agroecological analysis touches on a multitude of topics and foci from soil chemistry and conservation to agricultural labor statistics. Rural sociologists have done a great deal of agroecological work lately by stressing the importance of the physical environment in the examination of social phenomena. They have aided in the reemphasis of agriculture as an inherently person-land relationship.[2] Historians have also concentrated on locales and how behaviors and beliefs toward the natural world and farming have changed over time.[3] In addition, other interested observers of sustainable agroecological development have combined agricultural, environmental, creative, moral, and spiritual concerns in concepts such as stewardship, local knowledge, decentralization, homeostasis, appropriate technology, and a balance between rural and urban places.[4]

These concepts are important and heuristic because they challenge our awareness of the innate wholistic, systemic, and interactive nature of agroecology. Such an understanding calls for a theoretical basis that satisfactorily explains the constantly changing, but enduring "farm problem" complex. Noted writer and farmer Wendell Berry defines this state of affairs as a "crisis of culture."

> The concentration of farmland into larger and larger holdings and fewer and fewer hands--with the consequent increase of overhead, debt, and dependence on machines--is a matter of complex significance, and its agricultural significance cannot be disentangled from its cultural significance.
>
> It forces a profound revolution in the farmer's mind: once his investment in land and machines is large enough, he must forsake the values of husbandry and assume those of finance and technology. Thenceforth his thinking is not determined by agricultural responsibility, but by financial accountability and the capacities of his machines. Where his money comes from becomes less important to him than where it is going. He is caught up in the drift of energy and interest away from the land. Production begins to override maintenance. The economy of money has infiltrated and subverted the economies of nature, energy, and the human spirit. The man himself has become a consumptive machine. . . .
>
> The mind of a good farmer is inseparable from his farm, or, to state it the opposite way: A farm, as a human artifact, is inseparable from the mind that makes and uses it. The two are one. To damage this union--as industrial agriculture now threatens to do irreparably--is to damage human culture at its root.[5]

This assessment speaks to the interdependent, pervasive and ultimately, the moral nature of human social difficulties. The farmer is not something apart from the soil, the natural world, but is immersed and enmeshed in its ongoing rhythms and processes. The seasons and their attendant activities follow one another in a natural progression; livestock breed, gestate, give birth, and mature according to the processes inherent in their life forms. This fundamental union, noted by Berry, exists in agriculture between culture and the natural world. Farmers are intimately tied and connected to other life in an organismic manner, which breaks down the notion of separateness and the dualism of objective/subjective.

This union is dynamic, continuous, gestaltic, and experiential in much the way Alfred North Whitehead meant when he spoke of the unity of experience in consciousness. The environment is active in the lives of human beings in terms of its physical demands and the subjective reactions it engenders within consciousness. We know reality as we experience it--as process. All things are in process, unfolding and developing in transition and change. We cannot meaningfully escape the necessity of the process to be active and shape the welter of information (thoughts, feelings, intuitions, impressions, sensations, valuations, and memories) which constitutes our experience. We make sense out of the world in a process that goes well beyond bare Cartesian logic, because understanding is not merely the breaking down of reality into discrete, analytic units, but also a putting-together into a creative, synthetic totality. Human beings are in the process of molding their environment as they themselves are being molded by the community of life based on happenings of the past, events of the present, and expectations for the future. Apropos of the preceding statement is Karl Marx's notion that "men make history," but not under conditions of their own choosing.[6]

The concern for process, organism, and wholistic thinking was part of a larger revolution in thought in the twentieth century. The philosophies of Friedrich Nietzsche, William James, and Henri Bergson reflected the trend toward relativism which extended well beyond Hegelian idealism and Darwinian naturalism.[7] The natural sciences and then the social sciences responded with cosmological tendencies toward viewing scientific knowledge (later on social knowledge as well) as dealing not so much with representations of nature, but with socially constructed interpretations of existence. The publication of Thomas Kuhn's The Structure of Scientific Revolutions ushered in the contemporary period of limited epistemological claims on the truth. A dominant scientific paradigm tends to define what is known about nature at any given time--a relative truth but still a truth about nature.[8] One observer has noted, however, that "more recent social constructivist accounts question the assumption that science is about nature as it exists outside us."[9] They argue that scientific knowledge is a socio-historical construct negotiated out of differing interpretations and interactions over how the world should be creatively reproduced.[10]

Knowledge produced by the social sciences has even more constraints on it. Theories of social reality reflect an involvement in the reality as the objective of explanation. As Anthony Giddens posits:

> There are no universal laws in the social sciences, and there will not be any--not, first and foremost, because methods of empirical testing and validation are somehow inadequate but because, . . . the causal conditions involved in generalizations about human social conduct are inherently unstable in respect of the very knowledge (or beliefs) that actors have about the circumstances of their own action. . . . The theories and findings of the social sciences cannot be kept wholly separate from the universe of meaning and action which they are about. . . . The point is that reflection on social processes (theories, and observations about them) continually enter into, become disentangled with and re-enter the universe of events that they describe. No such phenomenon exists in the world of inanimate nature, which is indifferent to whatever human beings might claim to know about it.[11]

This should not be construed as implying that there is no "otherness." The physical, material world cannot be denied its reality. Yet, social constructivist theory claims that the "natural world" cannot be adequately explained and understood without reference to human organization and human consciousness. Nature is seen as an active agent of change and a "partner" in negotiations over the construction of reality. Plant breeding is an example of an active negotiation between plant life (its genetic inheritance) and scientific researchers; the final "deal" cut in the bargaining is an altered plant and a new range of technical applications and implications.[12]

The science of ecology and its environmental spinoff disciplines bear a special burden in the sense that they claim unique knowledge of nature. But "a social-constructivist perspective implies that we can never refer to nature--something knowable that exists outside us--unproblematically."[13] Ecology, too, is a negotiated, socially constructed set of interpretations with its own political and moral considerations built in. General laws and totally "objective" truth would seem to be unachievable. In this view, Barry Commoner's three laws of ecology in his book <u>The Closing Circle</u> or Eugene Odum's <u>Fundamentals of Ecology</u> are necessarily reduced to ethical or cultural critiques rather than laws universally true for all times and places.[14] Nevertheless, these works and others in ecology and related disciplines are tremendously important because they carry substantial normative influence, and they show how ". . . some segments of society engage in practices that adversely affect other members of society and have the potential to injure the future quality and survivability of the planet."[15]

The challenge for the solution of agroecological problems such as the farm crisis, according to the social-constructivist approach, arises not in our skill in knowing nature, but in our ability as negotiators and our capacity to listen to the needs of our fellow human beings and the needs of nature. All experience is political--debate, conflict, bargaining, and compromise are endemic to the human condition. Insofar as we are apportioned in social and governmental structures and units, we choose overarching organizing principles (paradigms) as cultural guidance systems. This is done on the basis of political choices, not epistemological ones. The problems of agriculture require analyses that uncover their genesis and show how we can work with nature and each other to avoid similar and new problems in the future.[16]

The elucidation of the development of agroecological problems forces awareness of the "predicament of existence." While existence can be very perplexing indeed, we are compelled by our very natures to survive. Still, humans not only try to maintain existence, but try to survive in the best way possible. John Bennett asserts that the "basic value [of humanity] is survival at a reasonable level of security."[17] Survival requires adequate amounts of healthy food and water, climatically appropriate clothing, and shelter from the elements. These requisites combined with interpersonal harmony and safety provide a basic degree of security.

The procurement of the above condition of security obviously necessitates the use of the physical environment. As one of the species at the top of the food chain, human beings alter their environment by feeding on animals and plants lower on the chain and by extracting other organic and inorganic resources from the natural world. Our ancestors learned quickly that through the use of tools they could lower the riskiness of their lives. They fashioned simple machines to increase their supply of food, clothing, shelter, and items of esthetic, leadership, and religious interest and significance. Through the use of tools, as extensions of their bodies, people grew in their ability to change the face of the planet. Tools, however, were undoubtedly not used haphazardly, but played roles in larger plans, schemes, and strategies designed to enhance survival.

Humans have always been active agents of change and builders. Survival needs helped stimulate the development of strategies and tools which impacted the physical environment in and near settlements. To the extent that we are social beings, strategies and tools are presupposed by the existence and politics of community. Today for example, the institutional structure of agriculture initiates, modulates, and mediates much of the flow of information and discourse concerning the policies and technology which are eventually adopted.[18] People have historically been involved in the construction of their realities by means of interaction with their locales, creation of tools, and the planning and execution of survival strategies. But the historical record shows many instances of agroecological carelessness and degeneration. Methodologists seek to enunciate general causal connections between human behavior and the condition of the environment, applicable over long periods of time and also to "discrete," individual events. If we treat technology as a highly significant, critical manifestation of the process and structure of social organization, then a tripartite model of human-ecological relationships based on three concepts--environment (ecology), social organization (human economic relations), and human consciousness (human cognition)--helps explicate the concerns of the social constructivist approach over the problem of the universal and particular.[19]

> Each concept evokes a general process that occurs over time and historians take those into account when reconstructing the particular events they examine. . . . Those processes are interactive: the nature of one changes the others and that change in turn alters the way the three processes interact. By locating the three processes as they occur in a particular place and time, it is possible to translate a logical theory into its particular manifestation . . . . The model is universal in the sense that it asserts that economic, cognitive, and ecological processes will be present in any interaction between humans and the environment, irrespective of time and place. The model incorporates the particular because it recognizes that the nature of the processes themselves will change according to place and time and that they interrelate dynamically.[20]

Through these interrelated processes, humans can be said to order and make sense out of their experiential world. After all, "making sense of reality" is a way of understanding the existential flux and continuity of life; it has survival value. Utilizing Abraham Maslow's concept of a hierarchy of needs, "making sense of reality" is a broad-based individual and social process which simultaneously satisfies many needs: security, emotional stability, intellectual curiosity, and religio-mythic activity.[21] It stands to reason that some individuals, families, groups, institutions, nations, and global consortiums are better at this process than others. We may say that these "organizations" are in closer attendance to and in harmony with their particular life situations--the place or places in which they reside, work, create, and recreate.

By virtue of our standing as agents of ordering, construction, and change, human beings may be said to engage in the creation of place, both intra-psychically and inter-psychically. In this view, place is the outcome and product of the ongoing social construction of reality embedded in a matrix of associated processes. Place is the synergistic totality of all the interactions with the environment; human institutional structures, including technology, the built-environment, political, economic, and social organizations, and population dynamics; and all aspects of consciousness, including cognition, ideation, and mythic creation--the awareness of one's acts and volitions. By means of place construction, we define, identify, categorize, and in general, make sense out of the world.

The process of place construction (may also be thought of as place constitution) may be seen as containing and involving three components endemic in the human condition: the physical, the social, and the psychic. These characteristics are grounded in our dimensional existence in the space/time continuum. They are systems connected by energy flows and exchanges within and among the three components. In agroecological systems, energy moves between and among the land, agricultural inputs, the farming community, and the farmer's belief system.

The first component speaks to human involvement in the material world. By virtue of the fact that we are physical beings, we therefore occupy space. Hence, we are connected to a physical locale, in which other physical beings are also able to participate. Farmers interact with the land by means of their bodies (labor), machines, and interpretations of what the land is and how it should "look" and respond, in terms of crop and livestock production.

The second component of the human condition, the social, addresses the associational, referential nature of our lives. Simply put, we live with and among others like us. We think, feel, and behave in large measure, in relation to others. Social life is predicated on relativity, deriving its significance from the mutuality and reciprocity inherent in the interface of the one and the many. There is a natural propensity to interact with others to form families, groups, and communities. Language, race, customs, religion, ethnicity, gender, political unity, and mythic expressions connect individuals to the species. We create social locales (places) in which we present ourselves to others and the environment, and partake in information exchange, discourse, negotiation, and decision-making. This interrelatedness among and between people and the natural environment manifests itself in a number of structural ways, one of which is the economic.

> By drawing the boundaries within which their exchange and production occur, human communities label certain subsets of their surrounding ecosystems as resources, and so located [sic] the meeting places between economies and ecology.[22]

Large-scale, formal social situations become reified into institutions. Much of the life experience in contemporary post-industrial societies is subject to the "double-edged sword" of mass institutional dominance (much of which is significantly influenced by elites). Many opportunities and resources are mobilized by such organizations, but powerful constraints often operate to subdue creativity and individuality and promote conformity. Massive social changes, such as have taken place on American farms and across the rural landscape, have been destructive of social and physical places; many of them often constituted viable and valuable ways of life for many people on and near the land.

Community is a common expression of the construction of social locale. Yet human actions of the twentieth century, often with the aid of arbitrary and disruptive technologies, have catalyzed cultural forces of change which tended to undercut the supportive and life affirming aspects of social communion. "Our world may suddenly seem senseless to many people because, for the first time in modern history, it is relatively placeless."[23] Whether it is the adoption of electronic information processing capabilities or biotechnology as applied to agriculture, science and technology are intermixed and not abstract functions of knowing and doing. They are socially produced in a variety of cultural circumstances, but in their modern versions tend to undercut and deny our sense of place orientation and rootedness. Technology (technique) ultimately does not stand outside of the social matrix; it is still subject to negotiation, choice, and decision-making no matter how powerful and predominate it becomes.[24] Nevertheless, modern sets of technologies tend to take on "lives of their own;" people become servants of their own tools. The organized use of machines in the industrial mode spawned an "ecological revolution" in American agriculture during and after World War II. It represents a major transformation in human relations with non-human nature.[25]

The third component of place is our awareness of time through experience, consciousness, and its historical life. Consciousness equips us with the ability to perceive and conceive patterns through the multitude of shifting perceptions in our lives. We are aware of a past (many pasts), a present, and possible futures. Through the process of ordering sensations, thoughts, emotions, intuitions, and instinctual hunches, we engage in the social organization and reorganization of reality. These "orderings" and "organizings" coalesce into worldviews which inform and give meaning to our existence. They help us make sense out of the infinity of stimuli and sense data that bombard our awareness on a daily basis. They also help us in categorization and identification of important facts, arguments, and perspectives in the process of reality construction. Worldviews are made possible by group consciousness.

> Group consciousness is a collective awareness by an aggregate of individuals. Both environments and culture shape individual and group consciousness. In different historical epochs, particular characteristics dominate a society's consciousness. Those forms of consciousness, through which the world is perceived, understood, and interpreted, are socially constructed and subject to change.[26]

Indeed, not only is consciousness subject to change, but it, as an agent of change, can alter the structure and course of the environment and social organizations. It is an active formulator of hopes, dreams, ideals, values, paradigms, and cosmologies. Beliefs affect thought, behavior, and even health.[27] We weave webs of significance which touch and connect consciousness and institutions into a seamless cultural amalgam. This social web is muscular, dynamic, and always in flux. Ronald G. Walters interprets anthropologist Clifford Geertz's conception of culture as:

> . . . a kind of context, or limiting condition, molding the way people perceive themselves, others, society, and the universe. Culture is _in_ action (embodied, after all, in symbolic expression); yet rather than rigidly governing what each and every human does, it defines and limits choices. It sets the range of possibilities, marking out what _can_, not what _will_, happen.[28]

Elsewhere Geertz referred to culture as:

> an historically transmitted pattern of meanings embodied in symbols, a system of inherited conceptions expressed in symbolic forms by means of which men communicate, perpetuate, and develop their knowledge about and attitudes toward life.[29]

In the wholeness of our experience, it is place which we encounter. A meeting with a towering redwood, a field of golden wheat, a group of vital and committed people, a technology to use fuel more efficiently and safely, or legislators negotiating a better conservation bill are all examples of the social basis of place in human existence. Place is the background expression of the multi-faceted nature of all human life. Place is the cultural phenomenon resulting from the convergence of interactions in space, social relativity, and time. It is a matrix made up of bundles of organized energy grounded in locales--physical, social, and psychic. This ontological matrix provides the building blocks for the social construction of reality. This process of system creation takes place by tectonic combination of ecosystems, institutions, and worldviews. Place, as a human-created reality, is in process and is replete with dynamic ecological exchanges. As the balance between these processes increases, the systemic stresses and strains decrease. As a result, quality of life tends to increase. In general, the human condition is markedly advanced and improved when sufficient attention is paid to place reality. Our experience of place in balance is harmony and happiness. Balances are rightly understood as dynamic equilibria, always changing around a focal point, which itself is subject to change. The history and explication of these changes in place reality can decidedly broaden our understanding of what particular societies and social problems are like. An understanding of history "clues us in" to the reality of place; in this manner it can provide us with (to use Geertz's term) "thick descriptions."

In contemporary American agriculture, place reality is dominated by an industrial consciousness which permeates most agroecological decisions and actions. Machines and machine-like characteristics of other capital inputs pervade thought and behavior in modern farming practice. This epoch is dominated by the industrial mode of thought, and its propensity to trust machines as the symbols of a successful, prosperous, progressive place. The dimensions of our collective psychic place have been symbolically bounded by the edifice of the modern factory/processing center. We are drawn like moths to a light--the techno-positivist legacy of Francis Bacon, Rene Descartes, John Locke, Isaac Newton, and Adam Smith--which we repeatedly circle, paying homage to the god in the machine.[30] The mechanical/industrial mindset tends to ignore limitations and corequisites implied by the dimensions of place--space, relativity, and time. Its consequences for agroecological reality are not simply manifested in a series of separate crises: continuing overproduction, the family farm, depopulation of rural areas and the demise of the small town, continued centralization and control of agricultural production and distribution, mounting environmental and health problems associated with exploitive and out-of-balance farming techniques.[31] The farm problem is unitary in that it stems from a lack of sustainability--of the land and soil, of technologies and populations and social arrangements, and of open, tolerant, sensitive minds. It is a crisis of place.

NOTES

1. C. Ronald Carroll, John H. Vandermeer, Peter Rosset, eds., Agroecology (New York: McGraw-Hill, 1990), x.

2. See Frederick H. Buttel, and Oscar W. Larson III, "Farm Size, Structure and Energy Intensity: An Ecological Analysis of U.S. Agriculture," Rural Sociology 44 (1979): 471-488; Riley E. Dunlap and Kenneth E. Martin, "Bringing Environment into the Study of Agriculture: Observations and Suggestions Regarding the Sociology of Agriculture," Rural Sociology 48 (Summer 1983): 201-218; Donald R. Field and William R. Burch, Jr., Rural Sociology and the Environment (New York: Greenwood Press, 1988); Craig R. Humphrey and Frederick R. Buttel, Environment, Energy and Society (Belmont, California: Wadsworth, 1982).

3. See the following: Albert E. Cowdrey, This Land, This South: An Environmental History (Lexington: University of Kentucky Press, 1983); William Cronon, Changes in the Land: Indians, Colonists and the Ecology of New England (New York: Hill and Wang, 1983); Carolyn Merchant, Ecological Revolutions: Nature, Gender, and Science in New England (Chapel Hill: University of North Carolina Press, 1989); John H. Perkins, Insects, Experts, and the Insecticide Crisis: The Quest for New Pest Management Strategies (New York: Plenum Press, 1982); Walter Prescott Webb, The Great Plains, 1931 (New York: reprinted 1973); Donald Worster, Rivers of Empire: Water, Aridity, and the Growth of the American West (New York: Pantheon, 1985).

4. See the following: Wendell Berry, The Unsettling of America: Culture and Agriculture (San Francisco: The Sierra Club, 1977); Murray Bookchin, The Ecology of Freedom (Palo Alto: Cheshire Books, 1982); David Ehrenfeld, The Arrogance of Humanism (New York: Oxford University Press, 1978); Wes Jackson, Altars of Unhewn Stone: Science and the Earth (San Francisco: North Point Press, 1987); Aldo Leopold, A Sand County Almanac (New York: Sierra Club/Ballantine, 1970); Joe Paddock, Nancy Paddock, and Carol Bly, Soil and Survival (San Francisco: Sierra Club, 1986); E. F. Schumacher, Small is Beautiful: Economics as if People Mattered (New York: Harper and Row, 1973).

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7. Paul K. Conkin and Roland N. Stromberg, Heritage and Challenge: The History and Theory of History (Arlington Heights, Illinois: Forum Press, 1989), 87-88.

8. Thomas S. Kuhn, The Structure of Scientific Revolutions, 2nd ed. (Chicago: University of Chicago Press, 1970).

9. Elizabeth Ann R. Bird, "The Social Construction of Nature: Theoretical Approaches to the History of Environmental Problems," Environmental Review 11 (Winter 1987): 256.

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11. Giddens, xxxii-xxxiii.

12. Bird, 258-259.

13. Ibid., 260.

14. Barry Commoner, The Closing Circle (New York: Alfred A. Knopf, 1971). Eugene P. Odum, Fundamentals of Ecology (Toronto: W. B. Saunders, 1971).

15. Bird, 261.

16. See Bird, 261-262, for the concept of negotiation and interaction with humans and the environment. See William Ophuls, Ecology and the Politics of Scarcity: Prologue to a Political Theory of the Steady State (San Francisco: W. H. Freeman, 1977), for the viewpoint, along with Aristotle, that politics is inherent in the human condition and at the foundation of all societies. See R. D. Laing, The Politics of Experience (New York: Ballantine, 1967), for a radical, psychological approach to the notion that since all reality is relational (people relating to people), therefore all experience is political.

17. John W. Bennett, The Ecological Transition: Cultural Anthropology and Human Adaptation (New York: Pergamon Press, 1976), 3.

18. See the Conference on Goals and Values in Agricultural Policy, Farm Goals in Conflict: Family Farm, Income, Freedom, Security (Ames: Iowa State University Press, 1963); Bruce L. Gardner and James W. Richardson, eds., Consensus and Conflict in U.S. Agriculture: Perspectives From the National Farm Summit (College Station, Texas:

Texas A & M University Press, 1979); David Grigg, The Dynamics of Agricultural Change: The Historical Experience (New York: St. Martin's Press, 1982), especially Chapter 5, Agricultural Systems as Ecosystems; Wyn F. Owen, ed., American Agriculture: The Changing Structure (Lexington, Massachusetts: D. C. Heath, 1969). All note to one degree or another the power of institutional arrangements--markets, agribusiness organizations, and government--to drive, circumscribe, and define agricultural development.

19. Barbara Leibhardt, "Interpretation and Causal Analysis: Theories in Environmental History," Environmental Review 12 (Spring 1988): 24-25, elucidates Arthur McEvoy's (his terms are in parentheses) description of the problem in his "Toward an Interactive Theory of Nature and Culture: Ecology, Production, and Cognition in the California Fishing Industry," Environmental Review 11 (Winter 1987): 289-305. See also Arthur McEvoy, The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850-1980 (New York: Cambridge University Press, 1986).

20. Leibhardt, 24-25.

21. Abraham Maslow, The Farther Reaches of Human Nature (New York: Viking, 1971).

22. Cronon, 165.

23. Joshua Meyrowitz, No Sense of Place: The Impact of Electronic Media on Social Behavior (New York: Oxford University Press, 1985), argues that electronic media has decreased the significance of physical presence in the experience of people and events, opening up new creative possibilities, but increasing the potential for mass control. See also Theodore Roszak, Where the Wasteland Ends: Politics and Transcendence in Postindustrial Society (Garden City, New York: Anchor, 1973); Daniel Bell, The Cultural Contradictions of Capitalism (New York: Basic Books, 1976); and Andrew Hacker, The End of the American Era (New York: Atheneum, 1971), for other types of technological threats to community.

24. See Jacques Ellul, The Technological Society (New York: Random House, 1964), for the most radical critique and pessimistic view of technology as an increasingly independent and dominating force. See Victor Ferkiss, Technological Man: The Myth and the Reality (New York: New American Library, 1969), for a more moderate and optimistic evaluation of modern technology.

25. Merchant, Ecological Revolutions, 1-26, 261-270. Although she develops the notion of a contemporary "global revolution" in Chapter 8, it does not speak much to agricultural problems nor does it address the problems of industrialization of all major types of work.

26. Carolyn Merchant, "The Theoretical Structure of Ecological Revolutions," *Environmental Review* 11 (Winter 1987): 272.

27. A. T. W. Simeons, *Man's Presumptuous Brain: An Evolutionary Interpretation of Psychosomatic Disease* (New York: E. P. Dutton, 1960).

28. Ronald G. Walters, "Signs of the Times: Clifford Geertz and Historians," *Social Research* 47 (Fall/Winter 1980): 549.

29. Clifford Geertz, "Religion as a Cultural System," *The Interpretations of Cultures* (New York: Basic Books, 1973), 89.

30. For the (by now) standard critiques of the history of "technocratic" thought and its consequences for modern society, see the following: Theodore Roszak, *Where the Wasteland Ends*; Lewis Mumford, *The Myth of the Machine*, vols. I, II (New York: Harcourt Brace Jovanovich, 1967, 1970); E. F. Schumacher, *Small is Beautiful*; Hazel Henderson, *Creating Alternative Futures: The End of Economics* (New York: Berkley Windhover, 1978); Robert L. Heilbroner, *An Inquiry into the Human Prospect* (New York: W. W. Norton, 1975); and Herbert Marcuse, *One-Dimensional Man: Studies in the Ideology of Advanced Industrial Society* (Boston: Beacon Press, 1964).

31. Wendell Berry's definition of a sustainable agriculture "is one that does not deplete soils or people", in Wes Jackson, Wendell Berry, Bruce Colman, eds., *Meeting the Expectations of the Land: Essays in Sustainable Agriculture and Stewardship* (San Francisco: North Point Press, 1984), x.

CHAPTER 3

TECHNOLOGY TAKES COMMAND

During and after World War II, the heartland of the United States, that agricultural area known as the Corn Belt, participated in a pervasive, rapid transformation of farming techniques and lifestyles. Hand labor was largely replaced by machine work; land was utilized more intensively and extractively, requiring the application of commercial fertilizers; pesticides promised protection from insects, weeds, and fungi; hybrid seeds delivered sharply higher yields and resistance to certain diseases; and livestock raising practices altered in response to the adoption of improved breeds, fortified feeds, growth-shaping and health-supporting drugs, and tighter controls over animal environments. At the center of all these changes was a massive shift in cultural and agricultural outlook which focused on technology.[1]

As implied by the above, these changes were not just part of a mechanical revolution of tractors, trucks, combines, and automated feeding systems, but they joined in ongoing revolutions in agricultural science and business management. Together, these three dramatic shifts in farming methodology constituted a larger, more fundamental rearrangement (re-creation) of agricultural place.[2]

This process of reconstruction of place reality depended on a technological, more precisely, an industrial vision for its organizational dimensions and cultural edification. Basically, the factory system (the "arsenal of democracy" in the war years) was injected into the American agricultural structure at its base. Technology, as the sum of the methods by which a social group provide themselves with the material objects of their civilization, vaulted well beyond the material plane of life into the position of an essential and crucial characteristic of the dominant social paradigm.[3] This socially common stock of beliefs, habits, and values about what is real came to revolve around the mechanical model of human-environmental interaction. Agriculture is part of culture, and thus, machines and machine-like technologies have entered the farm scene in an industrial context, often mimicking the factory structure.

Like an energy-impelled machine, America is a driven culture. Jules Henry observes its psycho-social implications:

> It is driven on by its achievement, competitive, profit, and mobility drives, and by the drives for security and a higher standard of living. Above all, it is driven by expansiveness. Drives like hunger, thirst, sex, and rest arise directly out of the chemistry of the body, whereas expansiveness, competitiveness, achievement, and so on are generated by the culture; still we yield to the latter as we do to hunger and sex. . . . If you put together in one culture uncertainty and the scientific method, competitiveness and technical ingenuity, you get a strong new explosive compound . . . technological drivenness.[4]

Human beings have always had to choose how they would view, approach, and deal with the environment. There is danger in not having a sense of place and belonging.

> The relations between man and his environment are subject to continual and restless change; from generation to generation, from year to year, from instant to instant, they are in danger of losing their equilibrium. There is no static equilibrium between man and his environment, between inner and outer reality.[5]

For people without enough to eat or who are constantly ravaged by pestilence, nature appears to be frightening and immensely threatening.

Physiological drives become the main motivators vis-a-vis the environment. Europe in the early Middle Ages was such a place. The deep, dark forest was immense; human settlements were small and could not match nature's power. In societies with greater abundance and stability, nature recedes as a threat. In fact, with a more developed technology and the promise of the scientific method, Europeans came to believe that nature could be mastered, not just defended against. Francis Bacon's dictum "knowledge is power" may be considered the rallying cry for the entire early modern period.

Enlightenment thinking spawned legions of writers who believed not only that technology could help to master nature, but that it could "improve" humanity by ushering in an age of abundance and harmony--a golden utopia. Nineteenth century thinkers on the human condition as diverse as Etienne Cabet (Voyage to Icaria), Edward Bellamy (Looking Backward), William Morris (News From Nowhere), and even Karl Marx, all believed in technology as a "savior" from all the evil to which humanity is heir.[6]

The optimistic intellectual climate of opinion produced by the scientific revolution in the seventeenth century stimulated the appearance of the modern idea of progress. Bernard de Fontenelle, for one, believed that social and moral improvement based on the accumulation of knowledge was possible. Soon, others like A. R. J. Turgot and the Marquis de Condorcet espoused the notion of inevitability, and joined it with the ameliorative aspects in the concept of progress to become a secular substitute for the Christian

Millennium. A final element in the evolution of the belief in progress emerged in the writings of Jean-Jacques Rousseau, who called for the creation of small agrarian, utopian communities in which the "general will" would be available and flower in all citizens.[7]

It is herein the contention that Western civilization, as manifested in the United States of America, has taken to heart the positivist promises of the Industrial Revolution and abundance, beliefs in natural law and the ideal of progress, and the perennial utopian urge to remake the nation and/or the planet into an earthly paradise. The mystique of industrial/technical expansion has become the foundation of the capitalist political economy and is the cornerstone of America's dominant ideology. It also functions, to some extent, as the collective wish-dream--a utopia of material abundance, social harmony, democratic government, and perpetual scientific progress and productive growth.[8] In a sense, the drive for prosperity is built into the system. The final causal chain in the American Creed reads: technological change causes economic growth, which yields prosperity, which in turn creates democratic conditions, which equals freedom and the American utopia. This legacy of the techno-industrial utopian vision moved quickly into American/Corn Belt agriculture after World War II.

By virtue of choices made by the agricultural community--farmers, suppliers, agricultural processors, scientists, the farm press, the U.S.D.A., and so on--the adoption of a technological "package" of agricultural inputs occurred almost completely within the span of one generation. Between 1940 and 1965, the very fabric of farm and rural life in the Corn Belt was transformed by decisions made by numerous actors (humans as active co-participants), in various settings, and at assorted levels of individual, group, and institutional behaviors.

For the purposes of this study, what is sometimes called the human drama, will be called the social construction of reality. By means of actions taken to make sense out of life experiences, people build up "explanations" that become translated into varied levels of social orderings by processes of interpersonal negotiation. These "agreements" constitute accepted interpretations of social reality, and tend to coalesce into "organizations" ranging in size and complexity from families, groups, and communities to institutions, nation-states, and international organizations. This approach emphasizes the interrelatedness of all life, the heritage or history carried by all life forms (whether it be genetic, memories, socialization, habituation, etc.), and their abilities to "work collectively" to create a shared reality. Since the main concern here is human farm communities, the focus is on how these places of farm activity are constructed by human beings, and what happens when one aspect of social reality is out of balance with the others.[9]

Human beings exist in space, time, and community. These dimensions correspond to specific types of locales maintained in common by people. Space refers to physical locales or places. The analytical unit for space is usually a particular environment. Time refers to the changes in the cognitive realm of human experience--

psychic place or consciousness. Community points to the social locale or place. As part of their life in the community dimension, people also participate in two other causal categories--population dynamics and technological change. Each of these latter two causal forms are related to and are subsets of the community dimension because all three are types of social organizations. But population and technology are independent enough so that it is advantageous to speak of them separately. They can and do become forces of change with their own subtle, interlinked webs of action.

The interdependent nature of all social problems, including environmental and agricultural predicaments, may be symbolized by a representation (Fig. 1) of the theory of associated processes.

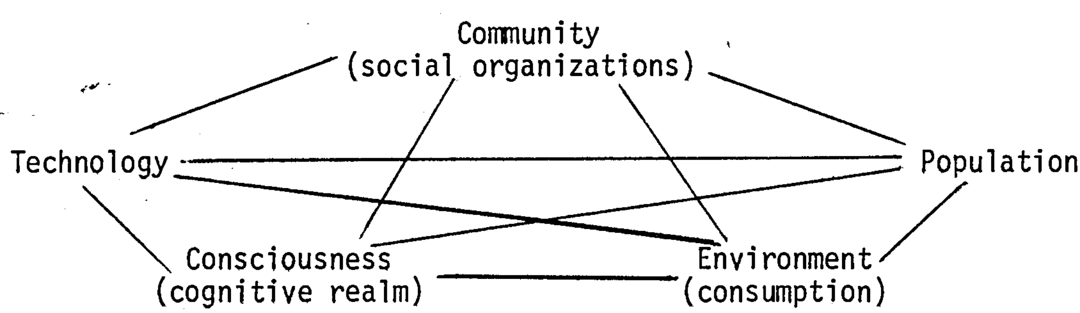


Fig. 1. Multiple causation inherent in associated processes. Adapted from Jerry Stockdale, Environment, Society, and Quality of Life: Basic Concepts and Issues (unpublished, Jan. 1988), 2.

Briefly stated, any one factor or a combination of two or more causal factors can stimulate changes in the matrix of place (the socio-cultural experience). For example, all other things being equal, changes in population (increases mainly) can wreak havoc on the quality of the environment and the ecosystem's carrying capacity. Similarly, the increasing technological capacity to manipulate nature can have direct effects on the health of the environment and populations, and the stability and effectiveness of social organizations. The old proverb of not being able to change just one thing is clearly germane here.

The nature of all life lies in its interconnectedness; after a threshold is reached, a change in one factor will necessitate a change in all factors. That is the basic quality of a system; its coherence springs from the interrelatedness of its parts. All factors not only impact one another, but are themselves influenced by "outside" forces. Hence, all social events have multiple causes which are themselves reciprocal in their impacts. In this approach, there is no one cause or causal complex which is so dominant as to warrant the role of determining factor in all times and all places. In certain situations one factor may be more important than others, but there is no secret motive, no sole source of human actions like Marxian class interests, the Freudian "sexual drive," or Nietzsche's "will to power."[10]

In the case of Corn Belt agricultural place, what was it in the American experience that drove all five causal factors toward fruition (combination) in a kind of technological ascendency over all aspects of life? Why were certain sets of technology selected to take command of American society? More specifically, why has American society, when faced with almost continual overproduction in the agricultural sector throughout the last one hundred years, opted for constant application of improved technology into farming practices when the main results are an exacerbation of the oversupply problem and a diminution of the role and number of farmers. Each of the five causal factors cited previously contributed to the industrialization of Corn Belt agriculture. An analysis of each force in the context of its stance toward technology reveals how each contributed something toward a desired techno-industrial utopia.

As much as any other factor, the physical conditions of the land and its resources set parameters on the basic material "stuff" with which a society has to work. The American environment, of course, gave an industrializing nation everything it needed for technical and economic development: seemingly unlimited mineral resources, huge expanses of "open," fertile land, natural communication and transportation routes on the inland waterways, abundant energy in the form of wood, coal, waterpower, and oil, and a number of climatic zones which promised near national self-sufficiency in food and fiber.

Midwestern soils, created out of the glacial periods and nourished by the life continuity of thousands of years of prairie grasses, was "virgin ground," with deep topsoils rich in minerals and humus. Pioneer farmers brought their steel "prairie breakers" to that land, along with many hopes and fears. They brought an ideology composed of many parts: republican, democratic, commercial, libertarian and individualist, and egalitarian and cooperative. They also brought a deep environmental ambivalence, which in part, allowed them to subdue their environment faster than any other people in history. Contradictory feelings for the same thing at the same time caused them to build farmsteads and rural communities in the spirit of

Jefferson's "empire of liberty" (the virtuous, long-lived, ever-widening republic), but also to exploit the land by means of farming techniques which were fertility depleting over the long term.[11] In addition, they paid little attention to soil and water conservation needs and methods.

American farmers in general wanted both to preserve the pristine quality of a given locale and to humanize the same terrain. Of course, some farmers emphasized the latter against the former. A good example is from a Missouri farmer's memoirs:

> . . . That land was just plumb worn out and I didn't have sense enough to know it. In those old days farmers used to brag about how many farms they had worn out. Those old boys used to say, "Why son, by the time I was your age I had wore out three farms."[12]

Humanizing the land meant essentially making it productive of marketable commodities. This in turn would create a settled, property-owning, civilized group of people and an attendant set of institutions.

Admittedly, most Midwestern farms were not "worn out" as quickly as in the above instance; most Corn Belt farmland returned "adequate" yields for over one hundred years with moderate applications of manure and the traditional corn-oats-hay crop rotation. Only in the 1930s and 1940s was major concern expressed over declining soil fertility levels and imbalances in soil acidity levels.[13] It should be noted that these were times of rising production expectations. In order for the new hybrid seeds to "work," they needed higher fertility levels. The newer conventional scientific wisdom called for nature to produce to its maximum capacity, not just the "average" amount considered normal by traditional farming methods.

Industrial beliefs existed side by side with attitudes of conservation. Americans believed that the abundance of resources existed in an unclaimed state. These resources seemed inexhaustible and were thought best used immediately. Capitalism's emphasis on quick profits argued against long-term calculations. But these beliefs were somewhat balanced by values of conservation. Clayton Koppes identifies three themes in American conservation thinking which reflected the dual-purpose ambivalence inherent in their overall attitude toward the environment. One strain in Progressive Era conservation thinking was that of efficiency. The environment should be managed like a machine or factory to produce the greatest amount of goods with the least investment of energy. A second, less popular attitude was that of equity. Some people believed that the riches of the land should be widely distributed as benefits to all. The third theme was esthetics--preservation of the great scenic wonders.[14]

Another aspect of America's relationship with its environment arose in the process of treating the land like a speculative commodity. By ignoring the physical characteristics of the land, its innate carrying capacity, and agricultural potential, land speculators and the railroads conveyed an insensitive, unecological attitude to the public at large. Land speculation, however, was nothing new to Americans and was common in all regions of the country.

> Land speculation--the acquisition of land not for its use but for its resale value as a commodity in a rising market--was no special activity of absentee capitalists in the colonial period, and the western settlements were no agrarian preserves unsullied by commerce. Speculative commercial operations had been part and parcel of the settling of the earliest North American villages--of the founding of the very first Puritan New England towns, as well as those that followed in the eighteenth century.[15]

Unstable land prices were another consequence of allowing regulation of the environment by the marketplace. Uncertainty and boom times, followed by dramatic swings into bust periods in the 1890s, 1920s through the 1930s, and again in the 1980s have plagued farmers, especially those who expanded greatly just prior to the economic downturns. Many who "got bigger" then, still had to "get out" no matter how hard or intelligently they worked. In 1933, the worst year for farmers in the Depression, over 50 per 1000 farms changed hands due to bankruptcy or foreclosure in every Midwestern state. Iowa led the nation in rising tenancy rates by totaling over 78 per 1000 farms lost in 1933.

> The farm debtor was a speculator, but not necessarily a greedy one whose only objective was to make a killing through increments in land value. Many were young farmers, thrifty enough to have saved money a few years earlier to buy a farm of their own.[16]

Agriculture is ineluctably a person-land relationship which ideally seeks long-term production through basic soil health. Success in farming is thus enhanced by the establishment of sustainable, ecological production practices. What efforts that have been implemented to increase stability in land and commodity markets, in an already risky business, have not always met with success since their first major application as part of the New Deal. As a result, farmers since World War II have not waited for downturns with the expectation simply to ride them out, but have pushed for maximum crop and livestock production every year despite what the market does. Such a strategy, it is hoped, produces greater certainty and stability despite driving up production costs and the capital costs of already inflated land prices and modern large machinery.

The buying, selling, and controlling of more land was just one aspect of America's expansion from the Atlantic Ocean to the Pacific. The wilderness also had to be populated for it to become civilized. Literary historian Henry Nash Smith claims that it was the farmers who were the main force for expansion. A great many people, it would seem, participated in the peopling of the continent. Everyone from newspapermen like Horace Greeley to railroads and immigrant-laden steamship lines implored young men (and women) to go west. Many of the people who did go west became farmers. Wherever they went, they pushed for the stability of statehood and the rights it conferred.[17]

The rapidity and extensiveness of the settlement of the continental United States is a characteristic typical of American society. Its remarkable dynamism explains in part why within only one hundred years (1790-1890) the frontier was essentially closed. Expansion, change, and progress were and still are American shibboleths. An unrestrained behavior knowing few limits characterized much of the settlement of this country, and its subsequent development as a growing industrial power. Added to that was an unplanned, sometimes random quest for novelty, sensationalism, and bigness. Alexis de Tocqueville wrote:

> No sooner do you set foot upon American ground, than you are stunned by a kind of tumult; a confused clamor is heard on every side, and a thousand simultaneous voices demand the satisfaction of their social wants. Everything is in motion around you. . . .[18]

This human hubbub is apparent too in industrialized Corn Belt agriculture, but in this case it is not so much the movement of people, but the movement of farm machines, equipment, and agribusiness information. Inputs in the form of fuels and lubricants, feeds, seeds, fertilizers, pesticides, machinery, and marketing advice all roll onto farms in a procession that celebrates quantity and the commercial conquest of the agrarian myth, but which often fails to observe the limits set by the ecosystem within which those inputs function. "The whole thrust of industrial capitalism has . . . placed the highest premium upon ingenious methods for circumventing those limits."[19]

In the quick-step march and advance of technology as a causal agent (much like the inertial nature of a modern mass army fighting a mechanized battle along a well-defined front), complex sets and combinations of tools, knowledge, common practice, and inspiration merged into technologies which sought to surmount environmental constraints. Although the full industrialization of Corn Belt agriculture lagged behind that of the larger economy due to the agricultural depression of the 1920s and the general depression of the 1930s, the speed with which it swept through the Midwest and the rest of the nation after World War II captured the attention of many interested parties.

One such person was architect and historian Siegfried Giedion, who sought reasons for the massive shift of population away from farms during and after the war, within the context of sustained mechanization of modern society. The agricultural focus in Giedion's Mechanization Takes Command traces the tenacious development of grain harvesting machinery from simple grain mowers to the advent of motorized combine harvesters. In the span of one hundred years, grain harvesting changed from a community event requiring a substantial number of farm laborers to a somewhat routine farm operation performed by one person with a tractor-pulled or self-propelled combine. Giedion notes the irony in the democratization of grain harvesting offered by individual combine ownership and its concomitant minimal need for outside labor. Combines and other labor saving machinery arrived just in time to eliminate life places for some of the farmers and their neighbors who began to use these implements, or who refused to invest in the new "higher profile" management and capital style. Giedion depicts the result: "During and after the Second World War the violent uprooting of millions has become a coolly accepted practice."[20]

The notion that the machine should turn on its master is not a common one in American history until lately. Historian Leo Marx attributes this to the idea that the machine is fulfilling an old prophecy of a special affinity between it and the new Republic. The machine was seen as an American birthright. [The] "pastoral ideal enabled the nation to continue defining its purpose as the pursuit of rural happiness while devoting itself to productivity, wealth, and power."[21]

The development of all technology in America has been suffused with a certain haste, inexorability, and necessity which can only be explained by an appeal to multiple sources--that is, a multitude of participants "devoted" to a common objective despite differing interests, motives, and backgrounds. T. C. Byerly provides a concise overview of some of the many sources of technological development:

> Technology is based on scientific discovery, chance discoveries, experience, invention, ingenuity, hard work and motivation. Men seek profit; they seek recognition of their peers for their achievements; they seek opportunities for themselves, their families, their communities. They seek to reduce the burden of stoop labor. They seek the satisfaction of service.
>
> And finally, farmers, scientists, industrialists, everyone seeks to satisfy an insatiable curiosity. Jules Verne said, "What the mind of men can imagine, some man will do."[22]

What Byerly does not explain is why an entire society embraced a system of providing for its material needs that necessarily destroyed a seemingly revered lifestyle--that of the agrarian myth and the hard-working yeoman farmer.

The process of industrialization (Giedion calls it "mechanization") described here as impacting agriculture, is one whereby the characteristics of a machine (of a machine-inspired method) become translated into social and cultural experience. Even the products of the farm have been changed to suit industrial processes. In the case of bread, modern white bread is a recent invention, substantially different from the firm, dark, nutritious, heavy whole-wheat bread of pre-industrial times. White flour is degermed and bleached and the bread so made is full of air and additives; it satisfies the created needs of a mass market for convenience and shelf life. Even farm folk, formerly the premier producers of food for the market, and home, use have now quite cheerfully become model consumers, delighting in their ability to buy "store-bought" goods. Vegetables no longer come from well-tended gardens, but are bought in the can.

In contrast to Giedion's emphasis on the internal dynamic of mechanization, Lewis Mumford views technology ("technics") from the point of view of the machine as a product and a problem of our culture and history.[23] Both agree, however, that once the process of mechanization of a particular tool begins, it was usually not deflected before it could reach a final or at least, an advanced state of development. Such was the case in the development of grain harvesting machines, where one advance often led indirectly, if not directly, to the next "breakthrough". Harvesting grain was traditionally a hand operation. Around 1850, the scythe gave way to the McCormick Reaper. About twenty years later hand-binding was added to the reaper, with mechanical knotting of grain bundles achieved by 1880. The mechanical standard was attained in only thirty years. The appearance of the combine waited fifty more years, but then quickly and decisively automated and revolutionized grain harvesting. Giedion's rendition of mechanization as an intoxicating force with overtones of inevitability is moving but not completely convincing. He ignores the human factor in the many "dead investigative ends" and inventive "defeats" suffered by equipment inventors. Giedion fails to give sufficient importance to the ideal of mechanical progress as held by those inventors.

Mumford, however, recognizes human loyalties and motives, in the cultural context, as sources for technical change. In the example of grain harvesting machines, inventors made choices and decisions that pushed them through adversity to the attainment of objectives which went well beyond the design of a special part or a particular new machine. They participated in a culturally-based evolution of a mechanical "vision" or "imagination", which acted as a guide in their experimental searches. Openness to new "interpretations" of reality were rewarded by discoveries which achieved their goals. These "ontological prescriptions" were joined to sets of interrelated machines and machine-like functions which produced a systematic and system-circumscribed (rule and principle bound) industrial matrix for the practice of agriculture after World War II. But Mumford also observed that our ability to develop and ameliorate our social structures has not kept pace with our technological capacities.[24]

> Like a drunken locomotive engineer on a streamlined train, plunging through the darkness at a hundred miles an hour, we have been going past the danger signals without realizing that our speed, which springs from our mechanical facility, only increases our danger and will make more fatal the crash.[25]

Our mechanical facility Mumford refers to also finds support in the institutional or community structure of our society. Technology in the form of agricultural machines and the energy of patriotic loyalties were enlisted to provide "power for peace." Ever larger quantities of food were seen as increased power which could be used to create peace. A tractor advertisement in a 1950 issue of Successful Farming insisted that

> hungry nations are not happy nations . . . nor are they the most cooperative in matters relating to the continuation of peace. . . . The progress agriculture makes may well determine the fate of the world.[26]

How much impact global tensions and world uncertainty had on American/Corn Belt farming is unclear. Increasingly in the twentieth century however, American farmers were called on to "feed the world" during times of trouble.[27] The federal government called for increased production during World War II and received an increase of 50 percent over World War I production levels. This was accomplished with 10 percent fewer farm laborers than in the earlier war.[28] Federal and state governments continued to institutionally support and invest in "modern" farming research based on heavy inputs of energy, chemicals, and high producing seeds through the land-grant colleges, experiment stations, and extension agents. The federal government from one point of view had a vested interest in high production levels because food offered a bargaining chip, some leverage usable in the geopolitical realm.

Burgeoning food sales abroad during the 1960s and 1970s brought agribusiness giants into the food production enterprise in a big way. In a magazine advertisement as late as 1976, Monsanto (one of the leaders in farm chemical production) used war-like and battlefield language and metaphors in talking about ways to raise more food. Monsanto's Report No. 8 on Current Technology was entitled "More Food? Here's How Monsanto is Pressing the Attack."[29] Important and influential sectors of the economic system apparently believed that working with the land was a violent confrontation, a struggle of life and death proportions. Furthermore, technological means would provide the margin of victory and produce the bounty that a genuine technocratic utopia requires. Socio-political and corporate structures have institutionalized technology as an ordering process of the world to make it accessible, in Martin Heidegger's words, as a "standing reserve," available for problem solving and goal fulfillment. This standing reserve of accepted techniques and standard operating procedures lends to mature systems the high levels of momentum that make them appear autonomous--seemingly beyond the reach of even the mass institutions which helped create them.[30]

The interactive nature of associated causal processes makes it difficult sometimes to pinpoint the particular driving force(s) most responsible for changes in social places. The growth in irrigation, for example, has its roots in both technological advance and institutional support. As of 1985, irrigated land in the United States totaled sixty million acres, representing tripling of such acreage since 1940. "Center-pivot irrigation" equipment, in particular, brought deep well pumping and "wet land" crops such as corn, potatoes, and sugarbeets to drier areas of the western Corn Belt in Nebraska, Kansas, and the Dakotas. In ten years, these great circle-traversing "revolving pipes on wheels" have grown in number from 2500 to 24,500 by 1983 in Nebraska.[31]

> In some states, with the help of non-farm investors, federal tax laws, and major corporate development projects, hundreds of pivot systems have been installed over thousands of acres, often dramatically changing local farming patterns.[32]

Much of the push for the industrialization of agriculture comes from outside the traditional farm sector. Do these sources of capital have the best interests of the farmer at heart? Will they be responsible and accountable to the local environment; will they act in ecologically sound ways?

Two consequences of the growing phenomenon of western Corn Belt and Great Plains irrigation activities stand out as ecologically suspect. One problem is that neither sources of the water, the Missouri River or the Ogalala Aquifer, can stand up to sustained high levels of pumping and still fulfill their other varied biological and geological roles. The second negative consequence of this situation is that most of the crops produced (and they are usually bumper crops too) are already in surplus nationally. Taxpayers then end up paying higher farm subsidy payments and price supports so a handful of farmers (and sponsors) can make extra money from an environmentally dubious practice. Again, technology has been applied in such a way as to be counter-productive to any larger social purpose, and the causal nexus is constituted by a number of forces, co-supporting and interdependent.

Many observers have analyzed the American national character in hopes of penetrating this psyche or consciousness we sometimes refer to as the American Creed, American Mind, or the American Dream.[33] Some authors have located this ethos or creedo in the desire for power or the urge for mobility and change.[34] This study posits that the fountainhead of the American "collective mind" resides in the Idea of Progress leading ultimately to creation of a technologically based utopia--a material heaven on earth.[35] Ironically, many of our material, physical goals have been met quite satisfactorily for a large majority of the society. Yet, much of our progress has been jejune, shallow, and counterproductive. Whole minorities and groups with special needs have been largely left out of this "technical" triumph. Unforeseen problems have mushroomed into view as fast as older ones were "solved."

In his Letters From an American Farmer (1782), J. Hector St. John de Crevecoeur wrote of what these new Americans were like by the ways they viewed their world. His choice of the word "new" to describe Americans was astute, and he used that epithet repeatedly to characterize their manners, government, social status, ideas, opinions, and attitudes. Americans were of a different nature and would be paid according to their ingenuity and industry. Implicit in this view was that all Americans had to do was apply their labor and tools to the environment and they would be amply rewarded.[36] Americans needed only to hold fast to the incongruous, and for the most part, contradictory visions of the pastoral ideal and the progress-induced utopia.

The result of this deep ambivalence is, as Wendell Berry points out, a crisis of culture and agriculture. For Berry:

> [An American] is probably the most unhappy citizen in the history of the world. He has not the power to provide himself with anything but money, and his money is inflating like a balloon and drifting away, subject to historical circumstances and the power of other people. From morning to night, he does not touch anything that he has produced himself, in which he can take pride. For all his leisure and recreation, he feels bad, he looks bad, he is overweight, his health is poor. His air, water, and food are all known to contain poisons. There is a fair chance that he will die of suffocation. He suspects that his love life is not as fulfilling as other people's. He wishes that he had been born sooner, or later. He does not know why his children are the way

> they are. He does not understand what they say. He does not care much and does not know why he does not care. He does not know what his wife wants or what he wants. Certain advertisements and pictures in magazines make him suspect that he is basically unattractive. He feels that all his possessions are under the threat of pillage. He does not know what he would do if he lost his job, if the economy failed, if the utility companies failed, if the police went on strike, if the truckers went on strike, if his wife left him, if his children ran away, if he should be found to be incurably ill. And for these anxieties, of course, he consults certified experts, who in turn consult certified experts about <u>their</u> anxieties. In living in the world by his own will and skill, the stupidest peasant or tribesman is more competent than the most intelligent workers or technicians or intellectuals in a society of specialists.[37]

Currently, the agricultural community is "debating" another new technology (a genetically manufactured bovine growth hormone) with the potential to produce 40 percent more milk on less feed. The question must be asked: of what possible use is it to anyone? Those familiar with the operations of a capitalist economy will know the answer to the query. If historical trends hold (there's no reason for them not to), when applied this new technology will provoke effects similar to previous "advances" in machinery, chemical catalysts, and techniques: it will spur further overproduction, drive more farmers out of business, and allow more small towns and villages to wither on the rural economic vine. But, the conditions for production, progress, and prosperity will have been satisfied. The objective at the end of the utopian road of material abundance will be one giant step closer.

NOTES

1. See John L. Shover, First Majority--Last Minority: The Transforming of Rural Life in America (De Kalb, Illinois: Northern Illinois University Press, 1976); Barry Commoner, The Closing Circle (New York: Alfred A. Knopf, 1971); Wendell Berry, The Unsettling of America: Culture and Agriculture (San Francisco: The Sierra Club, 1977); Richard D. Rodefeld, et al., eds., Change in Rural America: Causes, Consequences, and Alternatives (St. Louis: C. V. Mosby, 1978).

2. By "agricultural place", the author means the totality of the farming experience as manifested (largely) in agricultural structures and systems. Some examples of agricultural systems and structures are the traditional mixed crop-livestock farming system; farming communities including towns, villages, and neighborhoods; farmers' cooperatives, and the land-grant college complex, to name a few. Furthermore, (and most importantly) generic place is the ongoing process of reality construction. In the agricultural context, place is the experience, methods, and means by which farmers define and create their existence.

3. A dominant social paradigm is a symbolic representation of cultural reality which tends to define expectations and attitudes in social intercourse.

4. Jules Henry, Culture Against Man (New York: Vintage Books, 1965), 13, 15.

5. Siegfried Giedion quoted in William Kuhns, The Post-Industrial Prophets: Interpretations of Technology (New York: Harper and Row, 1971), 65.

6. See Marie Louise Berneri, Journey Through Utopia (New York: Schocken Books, 1971), for specific references to particular author's views on the "utopian" potential of machinery.

7. Gilbert F. LaFreniere, "World Views and Environmental Ethics," Environmental Review 9 (Winter 1985): 307-322.

8. See Karl Mannheim, Ideology and Utopia: An Introduction to the Sociology of Knowledge (New York: Harcourt, Brace and World, 1936), for the concepts of social fictions ("ideologies") which maintain social wish-dreams ("utopias") which are applied in transformations of the social order. The two concepts, however, are not mutually exclusive in that American society, in particular, is predicated on progress, in which change (with some utopian elements) is inherent in the "right and proper" functioning of the social order.

9. See Walt Anderson, A Place of Power: The American Episode in Human Evolution (Santa Monica, California: Goodyear Publishing, 1976),

for an interpretation of the technologically determined society by means of the use and abuse of power. For the theory of the social construction of reality, see Anthony Giddens, The Constitution of Society Outline of the Theory of Structuration (Berkeley: University of California Press, 1984). The perspective from environmental history is given by Elizabeth Ann R. Bird, "The Social Construction of Nature: Theoretical Approaches to the History of Environmental Problems," Environmental Review 11 (Winter 1987): 265-274. The genesis of technological systems is treated in Wiebe E. Bijker, Thomas P. Hughes, Trevor J. Pinch, eds., The Social Construction of Technological Systems: New Directions in Sociology and History of Technology (Cambridge, Mass.: MIT Press, 1987).

10. For the theory of associated processes see Arthur McEvoy, "Toward an Interactive Theory of Nature and Culture: Ecology, Production, and Cognition in the California Fishing Industry," Environmental Review 11 (Winter 1987): 289-305; and Charles E. Rosenberg, No Other Gods: On Science and American Social Thought (Baltimore: The Johns Hopkins University Press, 1976).

11. On the idea of a fundamental environmental ambivalence see Leo Marx, The Machine in the Garden: Technology and the Pastoral Ideal in America (New York: Oxford University Press, 1964); and Bruce Piasecki, "Environmental Ambivalence: An Analysis of Implicity Dangers," Kendall E. Bailes, ed., Environmental History: Critical Issues in Comparative Perspective (New York: University Press of America, 1985).

12. Leo E. Olivia, "Our Frontier Heritage and the Environment," American West 9 (January 1972): 62.

13. J. B. Peterson and A. J. Englehorn. "The Soil That Grows the Crop," Iowa State College and the Iowa Agricultural Experiment Station, eds., A Century of Farming in Iowa, 1846-1946 (Ames: the Iowa State College Press, 1946), 18-31.

14. Clayton R. Koppes, "Efficiency, Equity, Esthetics: Shifting Themes in American Conservation," Donald Worster, ed., The Ends of the Earth: Perspectives on Modern Environmental History (Cambridge: Cambridge University Press, 1988), 231-233. See also Samuel P. Hays, Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890-1920 (Cambridge, Mass.: Harvard University Press, 1959).

15. Bernard Bailyn quoted in Patricia Nelson Limerick, The Legacy of Conquest: The Unbroken Past of the American West (New York: W. W. Norton, 1987), 69.

16. John L. Shover, Cornbelt Rebellion: The Farmers' Holiday Association (Urbana: The University of Illinois Press, 1965), 17.

17. Henry Nash Smith, Virgin Land: the American West as Symbol and Myth (New York: Vintage Books, 1950), 41.

18. Alexis de Tocqueville quoted in Leo Marx, "American Institutions and Ecological Ideals," Science 27 (Nov. 1970): 947.

19. Leo Marx, "American Institutions and Ecological Ideals," 948.

20. Siegfried Giedion, Mechanization Takes Command: A Contribution to Anonymous History (New York: Oxford University Press, 1948), 168.

21. Leo Marx, The Machine in the Garden, 201, quote on 226.

22. T. C. Byerly quoted in Shover, First Majority--Last Minority, 143.

23. Lewis Mumford, Technics and Civilization (New York: Harcourt, Brace and World, 1963).

24. Lewis Mumford quoted in Kuhns, 32. Ibid., 33-56. For a discussion of systematization, see Alan I. Marcus and Howard P. Segal, Technology in America: A Brief History (San Diego: Harcourt Brace Jovanovich, 1989), 180-195.

25. In The Myth of the Machine, 2 Vols. (New York: Harcourt Brace Jovanovich, 1967, 1970), Lewis Mumford became more pessimistic about technological society, feeling that humans had lost to the megamachine.

26. Successful Farming 48 (Jan. 1950): 2.

27. During World War I, World War II; and large amounts of food went onto the regular market for foreign sales during the 1960s and 1970s.

28. Walter W. Wilcox, The Farmer in the Second World War (Ames: The Iowa State College Press, 1947), 3.

29. Scientific American 235 (Sept. 1976): 124-125.

30. Thomas P. Hughes, "The Evolution of Large Technological Systems," Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch, eds., The Social Construction of Technological Systems (Cambridge, Mass.: MIT Press, 1987), 53-54.

31. Jack Doyle, Altered Harvest: Agriculture, Genetics, and the Fate of the World's Food Supply (New York: Viking, 1985), 114-118.

32. Ibid., 115.

33. Henry Steele Commager, The American Mind (New York: Bantam, 1970); William Carlos Williams, In the American Grain (New York: New Directions, 1956).

34. Walt Anderson, A Place of Power; Alvin Toffler, Future Shock (New York: Bantam, 1970).

35. Philip Slater, Earthwalk (Garden City, New York: Anchor Books, 1974).

36. J. Hector St. John de Crevecoeur, Letters From an American Farmer, Warren Barton Blake, ed., (London: Everyman's Library, 1912).

37. Wendell Berry quoted in Jeremy Rifkin, Entropy: A New World View (New York: Viking Press, 1980), 252.

CHAPTER 4

BY YOUR MACHINES WILL YE BE KNOWN

By 1940, Corn Belt agriculture had long been a mechanized activity. It was the heir to a machine-filled legacy some three hundred years long, including such noteworthy advances as John Deere's steel plow and Cyrus McCormick's reaper. The legacy of gradual, irregular, but sustained development of farm machinery came to fruition in the fully mechanized farm. As one Corn Belt booster put it, "For every essential task there was an appropriate machine, . . . [and] the most determining addition was that of power--the perfected and adapted tractor."[1] The fifty year interval from the invention of the internal combustion tractor to its "perfected" state, witnessed a rapid acceleration in the rate of technological change, compared to the preceding years.

But this change went well beyond simple tool substitution to the establishment of a new psychic, social, manufacturing, and economic base (place), from which the entire agricultural system was restructured along industrial lines. The development of the tractor represented the pervasive application of a technological, mechanical mentality to one of the last main areas of human endeavor not fully industrialized--agriculture. A desire for more power and control, which larger generations of tractors have tended to symbolize, has dominated the farm scene and has driven the expansion of the process of mechanization.

In earlier eras, however, especially the colonial period, agricultural tools were more akin to simple machines (i.e., with few moving parts). Tillage implements were rudimentary wooden affairs, cumbersome and heavy. Change took place slowly and haphazardly. In the early national and antebellum periods (1783-1865), improvements to farm implements began to take on more "modern" characteristics. Refinements in equipment design, materials (from wood to iron and later, steel), and in the manufacturing process brought standardized factory-produced goods to the farmer at lower costs. The pull of virgin land and the push of expansionistic thinking and Eastern "crowding" stimulated farmers to apply their new machines to the tough, but rich, prairie soils of the Midwest.[2] These horse and mule-powered

> . . . machines--plows, harrows, planters, reapers, mowers, threshers,--whenever invented, first came into widespread use about the same time in the 1840s and 1850s. Advances in one aspect of husbandry required advances in other aspects. If one operation became easier and quicker, it made little economic difference to the farmer unless he also could speed up other parts of production. By the 1850s, farmers had achieved a fair balance among all elements of grain production.[3]

Tillage, planting, and harvesting equipment gradually evolved in strength, size, and efficiency. But the major development in terms of the actual industrialization of agriculture came with the advent of engine power.

By 1900, horses and mules, the most common suppliers of agricultural traction power, faced competition from two types of engine power. The first was the external combustion steam engine, which derived its power from the burning of traditional fuels (wood, coal, or straw) in a boiler. The second type was the internal combustion engine which produced power by means of controlled explosions of a fuel-air mixture (initially kerosene, later gasoline, diesel, and L. P. fuels) within a cylinder.

At the beginning of its agricultural development, the external combustion steam engine supplied only belt power from a rotating exposed flywheel, acting as a stationary energy source. In the 1870s, the steam engine became self-propelled and began to provide draft power for pulling plows. Giant forty ton, 150 horsepower engines dragged plows of up to twenty-four bottoms on big Plains states farms by the turn of the century. But steam engines were put to greatest use in threshing and sawmill operations where their power was best adapted and their enormous weight and poor field maneuverability were of little consequence. Thousands of steam engines of all sizes were built, but they had additional drawbacks such as heavy fuel and water consumption, dirtiness of the exhaust smoke, the need for constant attention during operation, the need for careful and timely maintenance, and the time necessary to "get up a head of steam;" all were reasons why the steam traction engine never replaced horses on most small and mid-sized farms in the Cornbelt.

> [Also], fear of steam without doubt played an important part in farmers' reluctance to accept these engines as regular farm equipment, and accounted for much of the alacrity with which they jumped all the way from horses to gas engines, thus bypassing steam in the farm mechanization process. Along with fear of explosions came the fear of fire. Snorting engines would throw sparks from their stacks in spite of screened bonnets.[4]

The use of gas powered tractors grew rapidly from their inception in 1892. These early models were based largely on steam engine designs and were nearly as heavy as the steam units they replaced. The first useful tractor put together by John Froelich of Iowa weighed in at 9000 pounds. But its thirty horsepower output was still better than a comparable steam engine putting out fourteen horsepower and weighing 12,000 pounds. This new technology was quickly commercialized; the first tractor company to produce a line of really practical tractors was the Hart-Parr Company organized in 1903 in Charles City, Iowa. One of their salesmen was credited with coining the word "tractor" in 1906. The designation previously was "gasoline traction engine."[5]

From the very beginning of the modern tractor industry, however, more than just machines were produced; a complex and extensive structure of sales, marketing, distribution, service, education, and image-shaping was brought into being. Implement manufacturers, especially tractor makers, brought their machines directly to farms and demonstrated, explained, educated, enticed, and to some extent created, the names of many implements and agricultural practices, needs, desires, and fortunes of farmers in an interactive process of agricultural place formation. Inanimate machines replaced animate, organic animal power; horses depended on the county of the locale for their sustenance, while tractors relied on some far-off oil well for their fuel. On the one hand, the draft horse had been around for centuries and seemed to have reached its genetic peak. On the other hand, the advent of tractors produced hope and optimism concerning the improvement of farming conditions, progress, and enhanced prosperity. Gas tractors were in their developmental infancy; agriculturalists assumed a bright and promising future full of innovation and development.[6]

The world of mechanization in general promised to deliver farmers from some of the vagaries of an unpredictable and sometimes cruel world of nature. The power of tractors in particular allowed farmers to stand "outside" of nature and even a degree above it. High powered machinery broke down traditional limits on how agricultural place was organized and experienced, and further stimulated the search for technological solutions to the problems of survival in a natural world which played by its own rules.

Major improvements in engine design and gearing set the stage for the development of a positive, even enthusiastic, attitude. Farmers looked more favorably on the tractor as the horsepower-to-weight ratio climbed, efficiency and reliability rose, and ease of operation improved; sales accelerated and the number of tractor manufacturers grew quickly. In 1912, twelve thousand tractors were built. Most of them, however, were the heavy, hard-starting, large tractors, only suited to belt work and plowing on large farms. Dissatisfaction mounted with tractors that ran poorly or even refused to start. Some were even abandoned in the fields where they had stopped running. Manufacturers actually sent mechanics out to farms to start balky tractors during this "wide open" early period, but soon realized the necessity of a radical program of tractor redesign.[7]

Spurred on by the agricultural prosperity of the war years, competition, the economies of mass production, and the introduction of small tractor designs, the manufacturers started to produce small, lightweight tractors for ordinary sized farms between 100 and 240 acres. These machines were only capable of pulling two or three bottom plows, but could be attached to all horse-drawn equipment and better handled the small fields then common to Midwest farms. The adoption of the four cylinder automotive engine type of that era produced a high enough RPM to power belt jobs like silo filling, feed grinding, corn shredding and shelling, and so on. Even threshing could be accomplished with the smaller tractors (provided access to a proportionately sized thresher). The demand for these tractors soared, and by 1920 there were an estimated one hundred tractor manufacturers turning out 200,000 units.[8]

By the middle of the 1920s, the gas tractor swept the steam engine out of the competitive ranks of traction providers, and there was no doubt that it would do the same with horses. This occurred in part because of increased reliability and versatility in gas tractors. Public trials and demonstrations such as the Champaign, Illinois trial in 1915, sponsored by the University of Illinois, Prairie Farmer magazine, and farm organizations, helped "weed out" inferior tractor lines through head-to-head comparisons. Even governments participated in these trials; the long running Nebraska tests, beginning in 1920, were under the auspices of the State of Nebraska, assisted by the University of Nebraska, and various farm organizations.[9]

But the changeover to tractors was uneven and did not eliminate horses all at once; as the principal suppliers of motive power, horses lasted on some farms into the late 1930s mainly because an older generation of farmers refused to put their large draft animals "out to pasture." Keeping the horses on also meant fewer out-of-pocket expenses and the security of raising their "fuel."[10] Moreover, research by Robert E. Ankli reveals

> that the great range of results that are reported in studies in the corn belt indicates that the ability to organize and to farm were more important in determining profitability than the decision to buy a tractor or to continue relying on horses.[11]

Some farmers actually switched to tractors at the prodding of their sons (who often were more mechanically inclined), only to change back to horses after the boys went off to school.[12]

Nevertheless, the changeover to tractors proceeded irregularly but rapidly, stimulated by falling prices and more flexible, adaptable machines. For example, the price of a mid-'20s Fordson tractor was $495 (fenders were $35 extra), compared to an earlier La Crosse "Happy Farmer" tractor retailing at $1075. In fact, large tractors became even less costly relative to small tractors, but these were not bought in large numbers. The agricultural structure could only change so fast; their time would come soon. Not only did general purpose tractors decline in price, but they became cheaper to operate over most Corn Belt conditions in comparison to horses. Operating costs were kept low in part due to very cheap fuels (ten cents per gallon throughout the first quarter of the twentieth century).[13]

Improvements in tractor design and performance continued at a swift pace. In the 1920s the major innovation was the power take-off shaft. It enabled tractor power to be applied directly to harvesting implements, eliminating the need for auxiliary engines. The power take-off shaft also allowed the development of a variety of tractor powered spreaders and sprayers that would later revolutionize fertilizer and pesticide application procedures. Oddly enough during the Great Depression of the 1930s, pneumatic rubber tires replaced the steel lugs on tractors, decreasing rolling resistance and allowing higher field speeds. This changeover was extremely rapid: only 14 percent of new tractors were equipped with tires in 1935, but this rose to 47 percent by 1937. Tractors were thus able to travel on hard surface and gravel roads without fear of "chewing up" the top layer. This advance, in turn, allowed gear ratios to be stepped up, giving tractors highway speeds of up to twenty miles per hour.[14]

Improvements in fuel technology increased octane levels in gasoline, and tractors were redesigned to take advantage of this with high compression engines. Increased starting resistance necessitated the addition of electric starting motors. Other accessories soon became standard equipment such as lights and hydraulic lifts. By 1940, the tractor had assumed its modern form and was poised for the adoption of more powerful engines and the incorporation of a number of important safety, handling, comfort, and hitching features.[15]

The increased versatility, speed, weight, stamina, strength, and durability of tractors, compared to animal power, must have in the end swayed many farmers' minds towards tractors. In the annual struggle with the demands of timely planting and harvesting, the weather, recalcitrant soil, and stubborn and/or poorly performing horse teams, modern tractors opened up heretofore unimagined possibilities.

Reasoning that if they could acquire more power in the form of mechanization, they would be able to make a better, easier living because the land would do what it should--the odds against success would be shortened; the farmer/manager would be on a more even footing with the land. The following quote from Curtis Stadtfeld aptly describes the frustration and emotional misery of farming unforgiving soils without substantial power, and in the process, says something significant about the relationships between agriculture, technology, and place.

> He had worked hard; God, he had worked hard. He had run the thresher, he had hired out by the day, he had worked by hand when he could not afford to repair broken machinery. The horses had not always been able to cope with the hard clay. When it had turned up rough and lumpy, too coarse for planting, he had gone out with a wooden mallet and walked around the knoll behind the windmill, breaking up the clods, hoping to subdue the earth by his own muscle when the strength of the horses and their machinery had not been enough. Once when I was small and knew nothing of these particular agonies, I ran up behind the barn to bring him home to supper and found him sitting on a clod of clay, mallet handle between his knees, face in hands, sobbing softly to himself, defeated, humiliated by the nature he had believed himself to be in partnership with. I had the child's wisdom to know that this was not a time to help, so I waited until he seemed to have settled his spirit a little, and then I ran to him as a child will. He threw me up on his strong steaming shoulders and carried me to the house, tossing the mallet in the tool shed as we came by, and I held on to his hair and his forehead, drinking in the rich smell of my father, smell of earth and sweat and cattle and straw hat and work, and I knew the world was in place.[16]

But was the world really in place for this Michigan farmer? He appears to have defined his farm ground (place) in terms of a partnership that was unequal, heavily weighted in his favor. Nature in this situation was perceived as an object, to be subdued and dominated. This farmer knew all about the difficulties of forcing heavy clay soil into intensive row crop use. He knew that it presents a small "window" of workability when it has the correct range of moisture present: too much moisture and it becomes soupy and slippery and turns up in big slabs that dry to rock hardness; too dry and it shatters into unbreakable clods and unplantable lumps of soil.[17] Even large horsepower tractors and large plows have difficulty working clay soils that are too wet or too dry.

One must conclude from anecdotes like the above and the experts' exhortations that the primary focus and thrust of American agriculture has been a fixation on obtaining maximum yields from nature, no matter what environmental conditions were encountered (climatic, soil types and fertility, native ground covers, typography, drainage characteristics), and no matter what the costs.

The alternative to the brutal subjugation of nature is to use what it gives and abstain from forcing it into place conformations for which it is unsuited. In the above circumstances, the farmer would have expended less energy, caused less erosion, and probably reaped a greater quantity of feed by placing the heaviest of the clay land into improved permanent pasture and/or high yielding hay crops. Such a strategy would have obviated the need for annual tillage, saving fuel, machinery wear and tear, and frustration. A true partnership with place necessitates taking into account its environmental prerequisites. In this scenario, mechanization takes its role as a facilitator of nature, not as a warrior and conqueror of nature.

Besides mastery of nature, the technocratic worldview expected progress, not only material, but cultural and educational as well. As Figure 1 indicates, mechanization was viewed as providing hard pressed farmers' sons a full and "real education." Farmers were urged to "keep the boy in school" by making an investment in machinery, thereby investing in the boys' future--giving them something their dads may have missed.

It soon became apparent that investments in machinery for other areas of the farm were necessary. Wind and weather were never as dependable as farmers would have liked. As some parts of agriculture became more reliable and controllable (chiefly due to mechanization and its power to make timely crop interventions--in planting, cultivation, harvesting), it simply "wouldn't do" to have some parts of the farming system relatively "reliable" and others literally at the mercy of the wind. Pumped water was essential for livestock producers without access to surface water, but was obtainable only on an intermittent basis from windmills. In this regard, Figure 2 provides a look at early attempts at making nature more predictable. Later, electricity, either on-farm generated (Figure 3) or supplied by rural electric cooperatives allowed farmers to replace higher maintenance gas engines with electric motors. Dairy farming was most affected by the advent of electricity. The danger of fires from kerosene lanterns was eliminated by electric lights; milking machines, cream separators, water pumps, milk cooling tanks, silo unloaders, barn cleaners, feeding

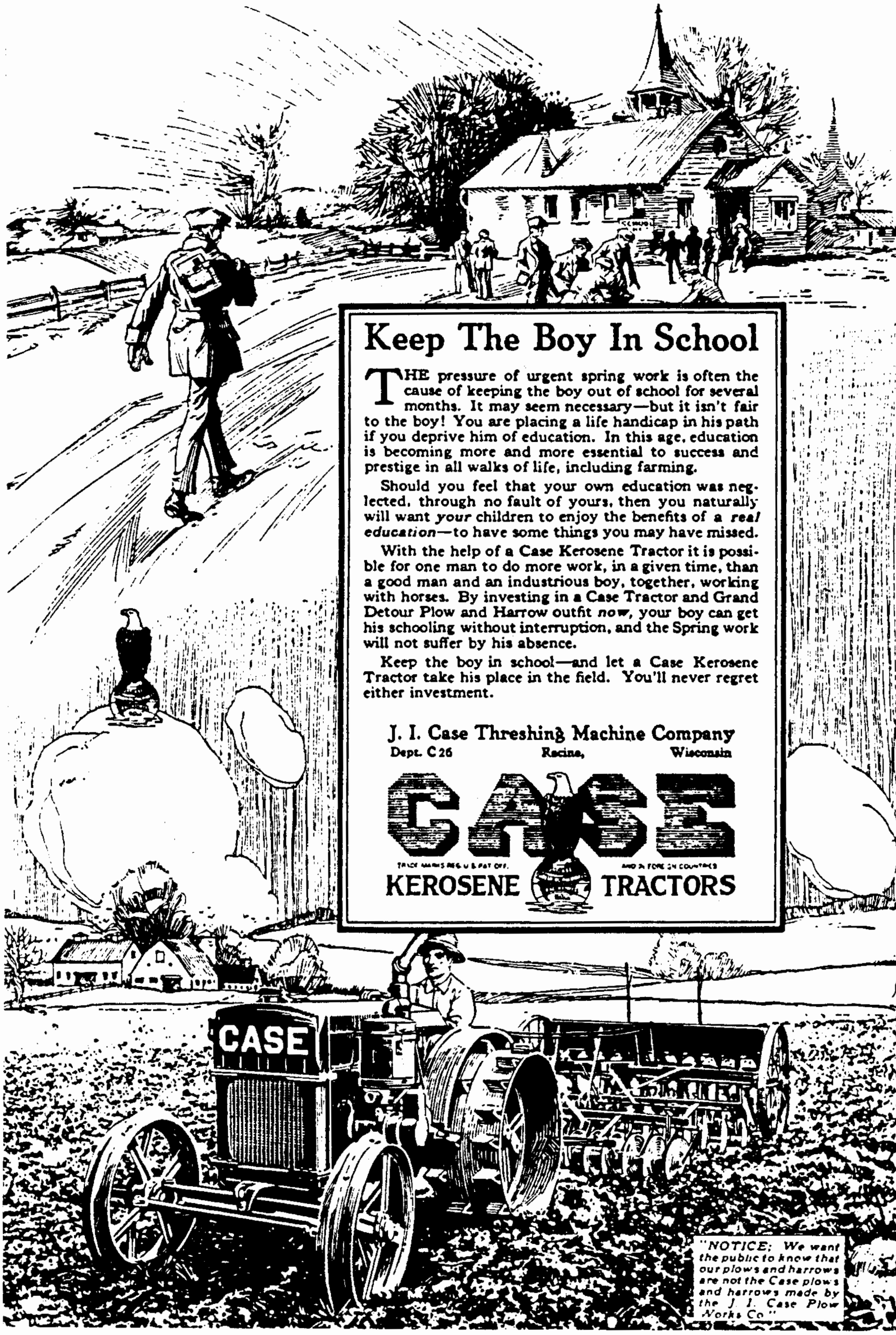
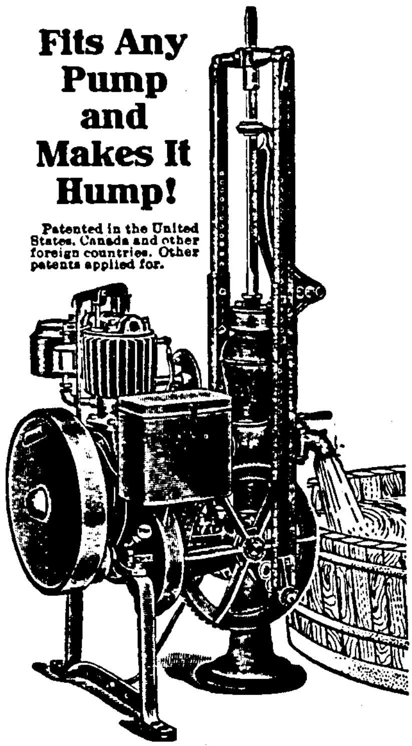
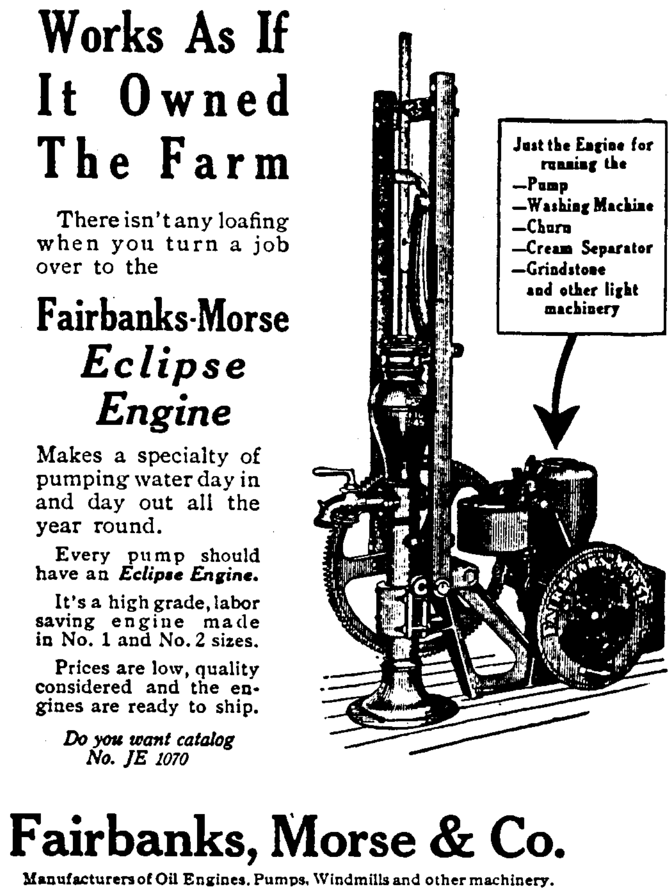
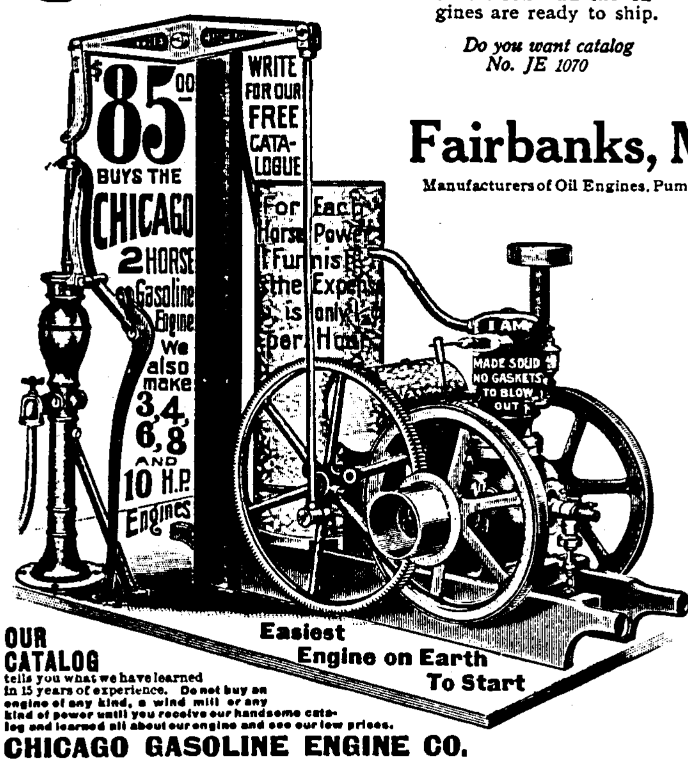


Figure 1. Case tractor advertisement. From Paul C. Johnson, Farm Power in the Making of America (Des Moines, Ia.: Wallace-Homestead, 1978, 58.







TAKING OVER from the unreliable windmill to assure a steady water supply for the farmstead and household was the chief responsibility placed on the small engine; hence many engines were built specifically with pump jacks included. The author spent many a cold morning as a boy on the farm trying to coax the Fuller and Johnson engine (upper left) into reluctant action. These little engines were about as simple as gas engines could be, but they still drove the women folks to tears.

Figure 2. Advertisements for gas-driven water pumps. From Paul C. Johnson, Farm Power in the Making of America (Des Moines, Ia.: Wallace-Homestead, 1978), 67.

Figure 3. Farm generator advertisement. From Paul C. Johnson, Farm Power in the Making of America (Des Moines, Ia.: Wallace-Homestead, 1978), 69.

systems, all were either updated or made possible by electric motors. Even the milk house wash water came to be heated in electric heaters.

With respect to the five capital inputs on which this study focuses (machinery, chemical fertilizer, pesticides, hybrid seeds and improved plant varieties, and feeds and improved livestock breeds), which in combination, comprise the industrialization of Corn Belt agriculture, mechanization has been the leader and most visible of all. The machines themselves have become more obvious in the fields and around the farmstead. Special buildings--machine sheds--were needed to store implements out of the weather, and provided a place for their maintenance and repair. Motorized farming required more operating capital than did horse farming, so it is somewhat surprising that the process of mechanization accelerated during the Depression and Second World War years. The first period was characterized by a lack of money in circulation and the second period struggled with shortages and rationing. Nevertheless, tractor numbers surged upward and so did other equipment that was adapted for use with them. It is no coincidence that the main rural-to-urban migration began during the 1940s and became a permanent feature of Iowa's cultural landscape.

TABLE 4.1

SELECTED EQUIPMENT TOTALS IN IOWA, 1930-1964

	Tractors	Electricity	Combines	Trucks
1930	66,258	46,042	N/A	32,669
1940	128,516	86,786	N/A	26,352
1945	179,615	129,001	23,678	37,386
1950	232,304	184,760	52,275	62,375
1954	279,015	188,028	88,318	84,648
1959	327,863	*	99,709	99,759
1964	329,172	*	86,178	106,699

Sources: 1964 Census of Agriculture, Vol. 1, Pt. 16, 11; 1954 Census of Agriculture, Vol. 1, Pts. 9-10, 16.

Note: * denotes no separate category for households without electricity.

Mounted and tractor drawn corn pickers became common in this era, as well as the combination corn picker and sheller. The self-propelled corn picker, however, did not appear until after the war. The power take-off also allowed corn to be chopped whole and stored as silage. The field ensilage chopper nearly eliminated all hand labor and reduced the time necessary to produce a ton of silage. Silos had been around since 1870, but they were small and took great amounts of hand labor to fill (hand labor applied to the field harvesting of the corn plants; silo fillers were powered either by horse treadmills, sweeps, steam engines, and later, gas engines). Improved blowers came into use during World War II and combined with field choppers to greatly reduce labor. Increased productivity in forage harvesting stimulated construction of taller and wider silos. With a greater feeding value than hay, silage allowed farmers to carry more cattle over the winter, and avoided the usual winter drop-off in milk production. But a greater reliance on corn depleted the fertility of the land. For every jump to a higher level of energy usage, there were unintended, negative consequences.[18]

The same process was at work in grain harvesting as it was revolutionized by the combine. Small models were built so individual farmers could own them, and their numbers grew from 4,000 in 1920, to 90,000 in 1937. They speeded up the work and almost overnight made the separate thresher and its operation by neighborhood groups obsolete. Corn harvesting, especially, was speeded up, with shelling taking place in the field. This method of harvesting, however, required expensive grain dryers and grain storage bins, plus the high-priced combines, auger wagons, grain trucks, and the fuel and maintenance outlays to keep them running; dependence on agribusiness suppliers continued to grow. Tractors rose sharply in price as diesel-powered and four wheel drive models grew in prevalence. Pulling power increased as a result of their adoption. Advances in haymaking equipment further reduced the need for labor. Powered side delivery rakes and field pickup balers became the standard after 1945.[19]

Nowhere was the shortage of labor more than made up for as in the adoption of the milking machine. As with most other agricultural machines, it had been on the market for some time (since it initially appeared in 1905), but its greatest increase came during World War II. In addition, larger dairy operations were made possible by automatic feeding systems and automatic barn cleaning machines. Bulk handling of milk was another labor saving device and ultimately produced substantial savings. "Although some of the savings went to farmers, most went to the dairy processors," who no longer wanted to bother with individual milk cans.[20]

The availability of labor saving technology interested everyone in the emerging agribusiness system. Farmers themselves chose mechanization for a number of reasons, thereby becoming major agents of agricultural and rural change. But they were also recipients of the consequences of changes brought about by other agribusiness actors and market forces.

Mechanization, as pointed out previously, has not been the only kind of technology to impact Corn Belt agriculture. Other technologies and sets of technologies have interacted with each other in ways that have not been just additive, but multiplicative in their outcomes. For example, the emergence of one cash crop, soybeans (a kind of technology of its own), had an enormous impact on the Corn Belt (growing conditions were ideal); it influenced the rapid development and acceptance of the self-propelled combine and hastened the adoption of straight grain farming. Livestock were eliminated and limited corn-soybean rotations were substituted for the traditional corn-oats-hay rotation. By 1955, about one half of the world's production of soybeans was grown in the United States.[21]

Furthermore, in this case, soybean crop technology spurred the development of combines because soybeans were mostly suited to machine harvesting and reduced labor costs from two to five man-hours per acre. Among all agricultural machines, the combine is one of the most expensive and the race to build bigger and better ones pushed their cost up to heights that often required farmers to seek credit for their purchase. For farmers who had scrimped and saved and never bought anything major on credit, except their land, it took great managerial skill to handle a substantial debt-load and put them in a position that was somehow foreign to them; it took away some of their independence and further integrated them into the commercial economy.[22]

A cycle that had innocently begun with the introduction of a new crop in the 1920s (soybeans), helped induce combine development, which in turn made available more nutritious soy-based feed, boosting livestock numbers, and allowed other farmers to abandon livestock raising altogether in favor of strictly grain farming. This, in turn, stimulated the creation of larger farms, which encouraged manufacturers to offer bigger, costlier combines (whole lines of costlier equipment, for that matter), which forced some farmers out of the business entirely and made the rest dependent on financing and its attendant interest charges. Costs started to skyrocket!

There were, in addition, countless other changes that took place as consequences of the above cited causative agents. Soybean varieties, to give just one example, were developed to resist shattering, lodging (stalks tend to bend toward the ground when mature or get blown over by winds), and to promote high pod placement enabling more efficient combine harvesting (plant breeding and seed research technology will be more fully addressed in Chapter 7). In conclusion, no single change or one technology developed alone or in isolation, but cumulatively and interactively in an institutional, technological, and manufacturing matrix, out of which came an industrial farming system. The problem is, as Murray Bookchin argues, that agriculture is a form of culture; but food production (since 1940) has been reduced to a mere technique. The skills to manipulate the mix of massive machinery and other technological inputs can force the production of vast amounts of food and fiber much as a factory turns out widgets, but at what cost?[23]

Technical knowledge and skills alone are not enough to sustain a society; there must be an esprit de corps and a formidable respect for the natural world. In agriculture, technique has proven not to be enough--bigger and more powerful machines did not bring increased prosperity to farmers. Rather, agricultural place has become a function of industrial control and concentration, than cultivating the life function itself. Farmers, themselves, have become mini-industrialists, concerned almost exclusively with short-term perspective manifested by an obsession with maximization of production (crop yields and head fattened per unit of time or per unit of feed) and the "bottom line." This has been a self-defeating strategy since 1940, because they have adopted a production system fundamentally made possible by large capacity, high powered machinery that has pushed costs beyond the ability of the land to pay for them, and has created the need for huge debt loads which are not very conducive to the maintenance of the medium-sized farm.[24]

Engine-powered machinery has fundamentally altered the way farmers interact with agricultural place. Their event horizon changed to expect swift conditioning of the soil and rapid crop harvesting. Less and less time was spent per crop acre. Each bushel harvested became less important as yields soared and total production per farmer increased tremendously (Table 4.2). Time became a critical factor as each hour in the farm day became more valuable and crucial. Higher

TABLE 4.2

PERSONS SUPPLIED WITH FOOD
BY ONE FARMWORKER, 1945-1965

Year	At Home	Abroad	Total
1945	12.87	1.68	14.55
1950	13.79	1.68	15.47
1955	17.32	2.17	19.49
1960	22.30	3.55	25.85
1965	30.79	6.23	37.02

Source: Harold D. Guither, Heritage of Plenty (Danville, Illinois: Interstate Printers and Publishers, 1972), 227.

operation speeds were required to cover the growing size of farms and the rising proportion of row-crop ground, some released from forage acreage set apart to feed horses and mules. Average Iowa farm size rose from 160 acres in 1940 to 262 acres in 1974; nationally, 415 acres in 1978.[25] Farmers had both the power and speed to farm more acreage.

The drive for a more complete mechanization of the farm seemed desirable and safe for those who participated in it before and after World War II. It certainly reduced the strenuous nature of the work and decreased the drudgery of large amounts of repetitive motions involved in hand labor. At the time, mechanization seemed innocuous and benign. Before 1940, it was the only capital input beyond land purchases of any substance in Iowa agriculture. Moreover, statistics indicate that average farm size held steady from 1890 to 1940 (Table 4.3). Thus, at least until 1940, mechanization alone did not

TABLE 4.3

NUMBER OF FARMS, AVERAGE ACRE PER FARM AND PERCENTAGE OF TOTAL AREA OF IOWA FARM LAND

Year	Number of Farms	Average Acres per Farm	Farm Land % of Total Area
1850	14,805	185	7.6
1860	61,163	165	28.1
1870	116,202	134	43.4
1880	185,351	134	69.1
1890	201,903	151	85.1
1900	228,622	151	96.5
1910	217,044	156	94.7
1920	213,439	157	93.4
1930	214,928	158	94.9
1940	213,318	160	95.3

Source: W. G. Murray, "Struggle for Land Ownership," Iowa State College and the Iowa Agricultural Experiment Station, A Century of Farming in Iowa, 1846-1946 (Ames: The Iowa State College Press, 1946), 11.

produce any appreciable increase in farm size or decrease in the number of farms. The farm observers of the time were very optimistic about the chances for the family farm: "It is clear that the family-sized farm has won a clean-cut victory over the large-scale unit."[26] Agricultural experts were, however, premature in this assessment.

These observers were unaware of the potential synergistic effects that the combination of capital inputs in place of labor and land could produce. A resounding victory in World War II and acceptance of the role of superpower by the United States generated unsurpassed optimism all the way to the heart of the Corn Belt. Very few people anticipated that the combination of multiple advances in machine, fertilizer, chemical, crop, and feed technology would have an outcome that was unpredictable from the vectors of its component parts. But industrial agriculture did not have much involvement with how hard farmers worked or how low a return on investment they would accept. It had to do with establishing control over nature by taking the risk out of farming to the fullest possible extent; in the process of implementation of that objective, farmers were caught up in the internal logic and dynamics of technological innovation.

American farmers have historically (in the last one hundred years anyway) taken to heart the admonition to make two blades of grass grow where before only one grew. They gradually gained the technology and combined it with the belief that they should make the continent better than it was.[27] Farming has always been a business in the Corn Belt--for most of its history linked to points east by a spiderweb of rail lines. Before World War I, almost all cattle raised in Iowa were marketed via the railroads.[28] Iowans linked business to the land and were willing to sacrifice almost anything to retain ownership of their place because it symbolized independence and a society of equals. Farms long owned by one family came to be known as that family's "place;" for example, even after the Olsons moved from their farm, it was still referred to by neighbors as "the Olson place". That same sense of independence and ego satisfaction of ownership arose from the acquisition of tractors and attendant equipment. The new engine-powered implements were something of marvels in their day.

Just as farmers had gathered to talk about horseflesh, so too did they talk shop about their new tractors and other bright, shiny equipment.[29]

Yet, the myth of the strength and independence of the Midwestern yeoman farmer was contradicted by tenancy statistics which showed that up to half of Iowa farms in 1935 were run by tenants (higher than the national average). In every year from 1920 to 1940 the percent of tenant-run farms was over 40. Even in 1974, over 20 percent of Iowa farms were run by tenants.[30]

For tenants especially, machinery must have posed a powerful solution to their lack of land ownership. For those farmers whose land was already paid for, a bigger and better line of equipment was a status symbol which was more affordable than land, and could be bought with exactly all the right options, features, and accessories the farmer desired. Like the auto industry, the farm implement industry changed and updated models annually and encouraged "trading up" as often as possible. In all this, the simple thrill of ownership and possession cannot be overlooked. All of these psychological reactions were grounded on the basic belief that these technological advances (including all the innovations in feed, genetics, fertilizers, and agricultural chemicals) really did constitute progress--a better standard of living and a higher quality of life, or at least, the matching of the industrial sector's wage levels.[31]

Farmers saw progress in their ability to "buy new," rather than get by with constant repairs, home-made devices, and old-fashioned ways of doing things. It was progress, perhaps even affluence, to buy food in cans in a store, rather than raise large time-consuming gardens, berry patches, and orchards. Even the time-honored woodlot disappeared from many Corn Belt farms along with wood burning stoves and/or furnaces after World War II.

The belief in progress extended to matching certain types of equipment with other types of machines. For example, horse-drawn implements, of which there were many around in 1940, were designed to be pulled at one to three miles per hour. Tractor drawn machines were designed to be drawn at between three and five miles per hour. Farmers moved to take advantage of the higher tractor speeds by buying new equipment designed for those faster speeds. The old horse implements just did not fit the nascent picture of what modern farming should be.[32]

Technological advance seems to have an internal logic of its own, not only in the sense that every invention and/or innovation is based on a previous invention and/or innovation, but that advances in one area are often contingent for their most efficient use on the use of technologies in other areas. The process/experience in agricultural machine advance was a

> . . . cycle of the new machinery [that] fed on itself. Once you had the faster mower, you found yourself bottlenecked by the old hay loader, for there was no point of laying down more hay than could be brought to the barn in a day of work. But the fast mower had intruded itself; it led to the purchase of the baler, where a gang of men and later on a man alone could package his entire hay crop in a day or two. The logic was relentless. The hay crop could be expanded to make use of the ability of the machinery. This meant more acres, either bought or rented from an older farmer ready to stop working, and with his sons gone away to the city.

> But what to do with the hay? More cattle, the milking machines, more crops, which meant bigger machinery, more powerful tractors, a whole cycle.[33]

In addition to "delivering the goods" (this is not an unqualified success though, as shown before) there are two other benefits that accrue in the use of modern farm machinery. One is the creation of fine, level seedbeds that hasten seed germination and produce higher yields. A second, more important attribute is the ability to contribute to soil and water conservation. The introduction of the chisel plow and other conservation tillage implements has enabled farmers to partially incorporate crop residues, aerate the soil, and yet leave some stubble on the surface to impede soil erosion and catch and hold snowfall. These machines were not usable before the advent of high horsepower tractors with which to pull them.

A potentially even more significant type of conservation equipment are the minimum tillage and no-till planters now being introduced into the Corn Belt. These machines reduce the amount of tillage necessary to put the seed in the ground, and therefore, reduce fuel and machine costs substantially. Historically, however, this mode of planting often requires sizeable quantities of herbicides and pesticides to kill weeds and insects formerly eliminated by early season tillage with the traditional equipment: plow, disc, and harrow. Yet, one of the best hopes for an evolution to a sustainable agriculture lies with a new kind of minimum tillage row crop planter--the ridge till planter.[34]

Although the shift to high-powered mechanization of Corn Belt agriculture has brought some benefits, these are overshadowed by numerous negative consequences. Machines are the prime broadcasters of water polluting fertilizers and pesticides; small tractor-drawn rigs all the way up to monstrous, flotation-tired spreaders do not discriminate between highly erodable land and level land.

Soil erosion continues at unacceptable levels despite the best intentions of soil conservation programs and plans, and despite the availability of conservation tillage equipment. The original prairie depth of Iowa topsoil averaged fifteen inches, while the average for today is about six inches, depending on soil type and location within the state. The tendency with large tillage implements is to do away with cross fencing and till large fields with long slopes. This allows water to gain momentum across the length of the field, accelerating the rate of soil erosion. Sometimes, grassed waterways and filter strips, basic soil and water conservation procedures, are omitted, even though hydraulically-equipped tractors allow machinery to be raised effortlessly and precisely; using machinery in the wrong way can hasten soil erosion too. Farmers often have a short time horizon and do not think far enough into the future to realize that two bushels of soil lost for every bushel of corn grown is simply unacceptable over the long-run. Decreases in yields have routinely been countered by increased fertilizer application made easy with modern machinery.[35]

Destruction of valuable places in the ecosystem continues in the conversion of woodlands, pastures, and wetlands to cropland. Modern farming equipment has made seedbed preparation "non-problematic" in almost any soil type or terrain situation. Also, machinery's ability to stir the soil to great depths and so completely may well be masking (with the addition of great amounts of fertilizers and chemical inhibitors) the process of mineralization of the soil--the oxidation of humus and its non-replacement because of monocropping and continuous row cropping planting patterns.

Modern machine agriculture in Iowa (as in most of the United States) is built on a resources consumptive basis; few of these resources are produced on the farm anymore. Moreover, this resource base is an artificial one because the costs of these inputs have been unnaturally and temporarily low (fuel, fertilizers, pesticides, hybrid seed, etc., were relatively cheap until the mid-'70s).[36]

The most troublesome, pervasive, and beguiling of all farm problems is the one of overproduction. How big a role mechanization plays in overproduction is difficult to judge with any accuracy. Marty Strange and other observers believe that chemicals play a larger role in the production of surplus crops, and mechanization only assists in this process. Indeed, there does seem to be some limit to machinery size--the limitation to tractor size is traction. Top horsepower has been reached at three hundred hp. Increasing horsepower causes the wheels to slip; if additional wheels are added the operator tends to run out of turning room.[37] Bigness and power in machinery may tend to act as a reinforcer or proponent of industrial agriculture because it supports practices that concentrate on the production phase of the natural cycle; the return side of the cycle is severely diminished and in some instances has lost stature in the realms of farming wisdom (in large feedlots manure has become a nuisance rather than a valuable soil-building resource). This is agriculture out of balance--at its worst.

American society as a whole, not just farmers and agribusinesses, have made certain decisions based on choices about the kinds and mix of technologies they prefer. The result is an agriculture in the Corn Belt and most of the rest of the United States that is not responsive or responsible to place. The environmental requisites of place have been suspended, postponed until a later day of reckoning. Meanwhile, advocates (many large farmers, farm equipment manufacturers, the financial community, and until recently, most of the land grant universities, agricultural experiment stations, and extension agencies) of industrial agriculture attempt to make farming an engineering science.[38] Yet it has always been, since Neolithic times, a personal and communal science of practice.[39]

No universal, master agricultural formula has been developed to control for differences in climate, soils, precipitation, topography, and the native relationships between flora and fauna. In spite of the continuing mechanical drive to regularize, homogenize, and routinize the complex natural patterns of a living land, industrial agricultural place has failed to solve for and make predictable, a truly sustainable natural and social ecology. It is unlikely that any machine-based model will provide an adequate paradigm for the human ecological mileau because any system is more than just the sum of its parts. The environment cannot be separated from interaction with human institutions or human consciousness. Agricultural place is the product of all three associative processes and their interactive natures. Technology is just one aspect of the process of social organization, and human beings allow it to dominate the social construction of reality at their own peril and that of the material world.

NOTES

1. Earle D. Ross, *Iowa Agriculture: An Historical Survey* (Iowa City: State Historical Society of Iowa, 1951), 178-179.

2. John T. Schlebecker, *Whereby We Thrive: A History of American Farming, 1607-1972* (Ames: Iowa State University Press, 1975), 112. Alan I. Marcus, *Technology in America: A Brief History* (San Diego: Harcourt Brace Jovanovich, 1989), 116.

3. Schlebecker, 120.

4. Paul C. Johnson, *Farm Power in the Making of America* (Des Moines, Ia: Wallace-Homestead, 1978), 56.

5. Schlebecker, 202. Johnson, 85.

6. Johnson, 85. Schlebecker, 202. Donnell Hunt, *Farm Power and Machinery Management* 6th ed. (Ames: Iowa State University Press, 1973), 190.

7. Johnson, 86.

8. Hunt, 190. Johnson, 86, 91.

9. Johnson, 93.

10. Robert E. Ankli, "Horses vs. Tractors on the Corn Belt," *Agricultural History* 54 (January 1980): 134-148.

11. Marty Bender, "Industrial Versus Biological Traction on the Farm," ed. Wes Jackson, Wendell Berry, and Bruce Coleman, *Meeting the Expectations of the Land: Essays in Sustainable Agriculture and Stewardship* (San Francisco: North Point Press, 1984), 89.

12. Johnson, 103.

13. Ankli, 134-148. Johnson, 64, 93, 103. Peter Berch, "A Note on the Real Cost of Tractors in the 1920s and 1930s," *Agricultural History* 59 (Jan. 1985): 66-71.

14. Hunt, 191. Schlebecker, 249.

15. Hunt, 191.

16. Curtis K. Stadtfeld, *From the Land and Back* (New York: Charles Scribner's Sons, 1972), 177.

17. The author speaks from experience on this point. From 1977-1979, he farmed in the unglaciated hills of southwestern Wisconsin. On the ridges overlooking the Kickapoo River, he learned the heart-rending realities of working heavy clay soil. The stubbornness and "staying power" of this soil type is often compounded by the resistance offered the plow from thick alfalfa tap roots. This combination is sometimes enough to bring a 40-60 horsepower tractor and plow rig to nearly a complete stop. This soil, however, withstands drought and produces excellent quantities and quality of hay.

18. Schlebecker, 183, 252-254.

19. Ibid., 247, 253-254.

20. Ibid., 303.

21. Walter Ebeling, The Fruited Plain: The Story of American Agriculture (Berkeley: University of California Press, 1979), 190-191.

22. Schlebecker, 247. Carl Hamilton, In No Time at All (Ames: Iowa State University Press, 1974).

23. Murray Bookchin, "Radical Agriculture," ed. Richard Merrill, Radical Agriculture (New York: New York University Press, 1976), 3-13.

24. See the following for a discussion of the toll taken by an economic and industrial vision as applied to American agriculture: Wendell Berry, The Unsettling of America: Culture and Agriculture (San Francisco: Sierra Club, 1977). Marty Strange, Family Farms: A New Economic Vision (Lincoln: University of Nebraska Press, 1988).

25. U.S. Bureau of the Census, 1974 Agricultural Census, Vol. 1, Pt. 15 (Washington, D.C.: U.S. Government Printing Office, 1977), 7. In addition, over 99% of large farms (sales of over $100,000) were on acreages of over 500 acres in 1974.

26. Iowa State College and the Iowa Agricultural Experiment Station, A Century of Farming In Iowa, 1846-1946 (Ames: Iowa State College Press, 1946), 11.

27. Walt Anderson, A Place of Power: The American Episode in Human Evolution (Santa Monica, California: Goodyear Publishing, 1976), 40. A majority of scholars hold to the view that most American farmers have always been basically entrepreneurial and not particularly agrarian in spirit. In this respect, Schlebecker's Whereby We Thrive is representative; for the Middle Western farmer in particular see John Fraser Hart, The Land That Feeds Us (New York: W. W. Norton, 1991).

28. Iowa State College, plate xxvi.

29. Hamilton, 181-186. Stadtfeld, 152-174. Harold Warp, Over the Hill and Past Our Place (New York: Vantage Press, 1958), 57-59.

30. Iowa State College, 12-13. 1974 Census of Agriculture, Vol. I, Part 15, Ch. 1, Table 28.

31. Johnson, 80-105. Stadtfeld, 170-194. See Byran Jones, The Farming Game (Lincoln: University of Nebraska Press, 1982), 39-40, for firsthand observations on the psychology of "trading up." Of particular interest is the description of the attitude of buying new rather than fixing even little mechanical or comfort features like a leaky tractor cab, for example. Appearance of new tractor features, such as the hydro-static transmission becomes the occasion for trading up, but may sacrifice efficiency as opposed to the older gear shift and clutch transmission.

32. Schlebecker, 249. Stadtfeld, 187-188.

33. Stadtfeld, 188-189.

34. National Research Council, Alternative Agriculture (Washington, D.C.: National Academy Press, 1989), 162, 314-316. "Ridge tillage is a form of conservation tillage with significant erosion control benefits that overcomes some of the soil temperature, weed control, and soil compaction problems associated with untilled systems." (p. 162)

35. William J. Brune, Soil--Iowa's Underrated Resource (Des Moines: USDA, Soil Conservation Service, 1977). Hubert W. Kelley, Keeping the Land Alive: Soil Erosion--Its Causes and Cures (Rome: Food and Agriculture Organization of the United Nations, 1983), 33.

36. Strange, 1-40.

37. Ibid., 1-40. Mark Kramer, Three Farms: Making Milk, Meat, and Money from the American Soil (Boston: Little, Brown & Co., 1977), 236.

38. Richard S. Kirkendall, "The Agricultural Colleges: Between Tradition and Modernization," Agricultural History 60, (Spring 1986): 19-21. Jim Hightower, Hard Tomatoes, Hard Times (Cambridge: Schenkman Publishing Co., 1973).

39. Wendell Berry, Recollected Essays, 1965-1980 (San Francisco: North Point Press, 1981), 161.

CHAPTER 5

PLANTFOOD

Petroleum-powered mechanized agriculture finally provided farmers with the ability to "get a firmer grip on" and equalize the perennial struggle with nature in the twentieth century. In response to the land's natural movement toward homeostasis and a "fully clothed" landscape, farmers countered with the increasing power, weight, and handling capacities of traction units, tillage equipment, and harvesting implements. With these machines, they covered more ground in the same amount of time, but crop yields often did not improve.

Most farmers understood some of the benefits of fertilization, but early commercial fertilizers like marl, gypsum, lime, and bone meal were not cheap, often unavailable in sizeable quantities, and difficult to transport on bad roads and sometimes dubious trucking rigs. Manure was for the most part returned to the fields, but it was a strenuous job loading the spreader by hand and the temptation was to put off that task. Much manure was handled carelessly by allowing it to sit outside, where it is susceptible to leaching by the rain. The soil building qualities of the manure that did get returned were often vitiated by cropping practices (multiple straight year cropping of corn, for example). Until after World War II, few commercial phosphorous or potassium fertilizers were used in the Corn Belt because they had to be transported in from other regions. In addition, there was no quick method of knowing which soils needed it and which did not, and farmers were habituated to not buying external inputs.[1]

Farmers seemingly lacked the ability to control and manipulate soil fertility the way they did ground cover, crop planting, and crop harvesting with machines. The same mastery was sought in relation to soil fertility and crop yields, which in some instances had decreased from the levels first obtained on the virgin prairies (e.g., corn, 1870-1935; and potatoes, 1870-1900, in Table 5.1).

TABLE 5.1

YIELDS PER ACRE OF FOUR IMPORTANT CROPS, 1870-1970

Year	Wheat (bu.)	Corn (bu.)	Potatoes (cwt.)	Cotton (lbs.)
1870	12.7	26.1	52.6	174.2
1900	13.2	24.8	49.9	182.6
1930	14.5	23.6	65.9	177.6
1935	12.3	20.5	66.3	185.4
1940	15.4	30.0	77.4	240.8
1945	17.3	34.4	97.7	263.1
1950	15.7	37.8	145.0	273.4
1955	19.4	42.9	165.6	389.0
1960	24.0	56.5	188.2	448.3
1965	26.2	69.7	203.3	508.0
1970	31.8	80.8	226.3	436.7

Source: Willard W. Cochrane, The Development of American Agriculture (Minneapolis: University of Minnesota Press, 1979), 128.

From 1935 a revolution took place in chemical technologies and in crop yields so produced. Through 1970, the greatest source of increasing yields per acre was the burgeoning use of commercial fertilizer. The "big three" of plant nutrients, nitrogen, phosphate, and potassium, became well known to almost all farmers.[2]

Every year, yields climbed and along with them the agriculturalists' expectations. Higher applications of fertilizer tended to produce higher yields. Commercial fertilizer seemed to be a cheap, almost magical, crop catalyst. No longer was it taken for granted that "the application of power to farming has to be the crowning achievement of the last century of agriculture."[3] Soil conditioners seemed an equally powerful production tool in the overall "food and fiber factory." Increasingly the central belief of modern farming was that "agriculture creates wealth largely in proportion to the amount of energy intelligently applied to the soil."[4] This then, is the archetypal industrial statement, advocating power, concentration, and technique, and ignoring carrying capacity, the nutrient return cycle, and the social dislocations caused by labor displacement and the export of capital and the "common wealth" out of the community.

The requirements of industrialization demand a radical indifference to place, because it is rooted in technological processes that are thought to be universally applicable, not bound by time and space except for the energy available to transform one thing into another.

> The industrial mentality allows no restrictions on choice of technique beyond how much "toil and trouble" is caused for humanity. Industrial production processes are completely unrelated to the natural living cycles of nutrients (and other chemical compounds) which would otherwise be occurring in those places; thus what happens to Nature is utterly beside the point--Nature remains wholly external to any so-called rational calculus in which we might be indulging. There is hubris in this story of course, as we now realize. At the very least, all industrial processes always produce waste in addition, to the wanted products. These wastes tend to accumulate, since they are mostly unconnected with natural cycles or if capable of integration are liable grossly to overload them. In Nature by contrast there is no such thing as waste. All non-geologic (and much geologic) matter is cycling

> continually; in a tropical rain-forest at a prodigious rate, in a temperate forest rather more slowly.[5]

This sort of industrial mentality appeared on the farm scene, as technological control over nature developed. Machinery and fertilizers gave farmers the means by which to manipulate the soil and crops to build products in an almost factory-like manner. Instead of an assembly line bringing the work to stationary farmers, they took the work to an immobile soil and applied energy and seeds to it in a way that was often in conflict with the basic "goals" of nature (the ways in which nature, when left to its own devices, would go about creating a growth of flora).

So it was that agriculturalists hit upon fertilizers as crop catalysts, and their use soared.

> Few industries have undergone as much change in the volume and quality of product as the fertilizer industry did in the 1950s and 1960s. During the ten-year period 1956-1966, dollar sales of fertilizer to farmers increased by 64 percent, gross fertilizer tonnage consumed increased 56 percent, but the amount of primary plant nutrients consumed increased 106 per-cent.[6]

In the period 1950-1970, usage grew from 2,772,000 tons to 12,805,000 tons, or an increase of 360 percent. Agronomists estimated that 30-50 percent of yield increases since 1945 were attributable to rapidly growing usage of commercial fertilizers.[7]

Farmers have been especially willing to take the message of increased yields to heart when it was shown that heavy commercial fertilizer applications ameliorated (to the extent of at least marginal profitability) the effects of topsoil loss due to erosion.[8] Marginal and highly erodible land was thus kept in production postponing and/or ignoring its ecological limitations and unsuitability for row cropping.

The search for an agricultural panacea drew nearer to a close, as commercial fertilizers atoned for the heavy environmental sins of the past and set a new standard for "modern, scientific farm management."[9] The adoption of heavy fertilizer use, especially nitrogen, tended to go beyond supplemental needs to supercession of rotation-based fertility methods. Also, hybrid crop varieties, especially corn, required greater amounts of nitrogen if they were to produce up to their full potential. Little thought, however, was given to what types and quantities of fertilizers would provide optimal crop and livestock production in the fullest environmental sense of place. The reigning philosophical outlook appears to have been one of "more is better." One potentially disruptive side effect of massive and continuous use of nitrogen fertilizers especially, is the possible destruction of naturally occurring nitrogen-fixing bacteria in the soil. Land with severely reduced populations of microflora does not speak well of overall soil health and the integrity of the food raised on that ground.

The following table demonstrates the massive and rapid adoption of fertilizers in relation to other inputs.

TABLE 5.2

QUANTITIES OF SELECTED FARM INPUTS, 1950-1970 (USA)

(1950 = 100)

Year	Labor	Farmland	Machinery	Fertilizer	Other
1950	100	100	100	100	100
1951	100	101	106	112	104
1952	96	100	113	122	107
1953	92	101	114	131	108
1954	88	102	114	134	109
1955	85	102	115	141	113
1956	80	100	115	138	116
1957	75	100	114	144	115
1958	72	99	115	150	121
1959	70	99	116	169	127
1960	67	98	115	169	129
1961	65	98	114	181	134
1962	62	99	115	194	137
1963	60	101	116	219	139
1964	58	103	118	238	143
1965	55	104	122	250	145
1966	51	104	127	281	151
1967	50	105	127	312	157
1968	48	105	129	334	163
1969	49	106	130	344	165
1970	46	107	130	353	170

Source: Harold D. Guither, Heritage of Plenty (Danville, Illinois: Interstate Printers, 1972), 257.[10]

In the same time period as the above table, the price of commercial fertilizer remained almost constant relative to other capital inputs (Table 5.3). That made it the best production bargain around. Low cost induced higher usage, which stimulated greater yields. Agricultural academicians recognized that since the early 1950s, long established cropping systems underwent major changes in the Midwest. Cash crops requiring high fertility like corn and soybeans began to be grown in several consecutive years, replacing traditional crop rotations. The general availability of relatively

TABLE 5.3

PRICES OF SELECTED FARM INPUTS, 1950-1970 (USA)

(1950 = 100)

Year	Farm Wage Rates	Farm Machinery	Fertilizer	Farm Real Estate
1950	100	100	100	100
1951	111	108	106	115
1952	118	111	108	126
1953	121	112	109	128
1954	120	113	110	126
1955	121	113	108	131
1956	126	118	106	137
1957	131	123	106	146
1958	135	129	106	152
1959	144	134	106	163
1960	148	138	106	171
1961	151	141	107	172
1962	155	144	106	182
1963	159	146	106	189
1964	163	149	105	202
1965	171	154	106	214
1966	185	160	106	231
1967	199	167	106	246
1968	216	175	103	262
1969	238	184	99	275
1970	255	194	103	286

Source: Harold D. Guither, Heritage of Plenty (Danville, Illinois: Interstate Printers and Publishers, 1972), 257.

cheap sources of fertilizers, primarily nitrogen, and pesticides later on combined with the already existing propensity for unlimited gross manipulation of the environment to generate this shift in crop production techniques.

The result was that a publication like Midwest Farm Handbook (1969) proclaimed that "high grain yields can be maintained with heavy fertilization and no legumes."[11] At the same time one observes little awareness of how fertilizer technology exacerbated the farm problem and helped lay the basis for community-busting rural depopulation. The following paean to American farming represents the simplistic and mono-dimensional thinking which characterized the advent of industrial farming.

> The technological revolution in agriculture, which has resulted in surplus production and in surplus farmers, is partly genetic and chemical. Better plants and better animals as well as advanced knowledge about feeding them both have made it profitable to use better machines. While the new machines may reduce unit costs by mass production, the mass itself is possible only because better germ plasm and better nutrition are also there. Plants as well as animals must be fed for maximum growth . . . .
>
> Good seed does not result in miracles of production unless the soil is fertilized. The achievements of modern agriculture are the consequence of a complex chain of scientific discoveries and technological advances. If a farmer disregards any link his crop may be a failure. That is why the example of American excellence in farming has not been copied widely elsewhere in the world. The agricultural achievement of this country, no less than its industrial ability, is the product of the total economic and social environment. It does not stand alone and cannot be exported as some diplomats have dreamed that it might be.[12]

The previous quotation is illustrative of the "all or nothing" attitude that underlies industrial farming. Agricultural production is seen as manufacturing output irrespective and unconnected to the physical place in which those activities occur. The land is the factory and fertilizers, seed, and chemicals are the raw materials which enter the soil in the spring; in the fall, the end product (crops) exit the land in the form of a harvest.

American society opted for mass produced, cheap food and fiber; the agribusiness complex complied by supplying inexpensive raw materials; and farmers followed through with the consistent overproduction of a few basic agricultural commodities marketed at supply-swamped low prices. In much the same manner as conventional manufacturing operations, the environmental costs of industrial farming have been externalized to the society as a whole.

> Adoption of industrialized technology is the method we chose to minimize the market value of resources devoted to agriculture. In that regard we have been effective. But the extra-market values sacrificed for cheap food and economic growth have not been as consciously economized, if at all. Our streams and lakes are muddy and contain a variety of man-made chemicals. Our groundwater is suspect and the disposal of animal and processing wastes in certain localities impinges upon the natural environment in an unsatisfactory way. Communities have been depleted of their people as economic growth has spurred urbanization. At least part of our economic growth has been provided by living off the depreciation of both the countryside and the cities. Yet due to our method of measuring our material well-being, the maintenance activities required to correct the former shortsightedness results in increasing GNP.[13]

There are two major environmentally disruptive consequences of this shift to a capital intensive, resource extractive type of agriculture. One is that modern farming has become more dependent on finite reserves of fossil fuels. The primary constituent of fertilizers with regard to productivity is nitrogen. Although nitrogen exists in practically unlimited supplies in the air, it is only available commercially in conjunction with other elements, chiefly in the form of ammonia. At least 88 percent of American ammonia comes from the use of natural gas. The second primary plant nutrient is phosphorous, which is found naturally in all rocks. Old fashioned agricultural practice relied on the return of manure and the subsoil nutrient "tapping" ability of crops, especially alfalfa, to bring to the surface phosphorous and other minerals. Today about 80 percent of phosphorous sold in the United States is mined in Florida by a small number of firms. The third major plant nutrient, potassium, is extracted from mines in the form of potash, a substantial portion of which is imported from Canada.[14]

Once mined, fertilizer components must be blended and transported. The entire fertilizer distribution system runs on fossil fuels. Indeed, it was the introduction of complete, pre-mixed dry fertilizer materials ready-made for direct application by truck or spreaders that made their use so convenient. Bulk blending caught on rapidly in the 1950s, and exceeded the use of bagged materials by 1970.[15] These methods of fertilizer application (especially the high horsepower requirements of anhydrous ammonia application--necessitated by the need to knife it into the soil in a gaseous state) has furthered the dependence on fossil fuels by modern agriculture. This is specifically true for the Corn Belt, whose primary crop, corn, requires enormous amounts of nitrogen fertilizer.

The second major environmental external cost is extensive pollution of surface and ground water sources by fertilizer contamination. Agriculture contributes one-half of all nonpoint (most from feedlots) surface water pollution. Ironically, the very materials and technology that brought bountiful harvests on a near-continuous basis for almost fifty years have disrupted the viability and sustainability of important natural systems upon which rural populations depend. Nutrient loading of lakes, rivers, and bays has hastened their eutrophication (aging process).

But in an even more direct manner, farmers are threatened by fertilizer runoff and leaching that has reached groundwater supplies and contaminated many shallow rural water wells in the Midwest. The introduction of rural water systems in Iowa since the 1970s has been one of the most visible signs of the cost of agricultural pollution externalized to the community. Even large urban water systems are not immune--The Des Moines Water Works installed (1992) a $4 million ion exchanger to purge potentially dangerous nitrates (caused primarily by agricultural runoff) from the city's drinking water.[16]

The health of watersheds have been casually and deliberately sacrificed in the name of a system of interlocking technologies whose highest goal is the maximization of production in a marketplace that has generally been battling an agricultural commodities glut ever since World War II. In focusing on production as the solution to farm problems, all interested agricultural parties have failed to consider the ecological interactions of technologies and the environmental requisites of place, and so bear the consequences of low commodity prices, high production costs, and poisoned wells. They also have to bear the burden of "expert" pronouncements on the relative value of naturally occurring fertilizer--manure.

> In 1977, it was concluded that the value of animal manures could not justify much investment in processing, distribution, or hauling costs. Although manures add organic matter and humus to the soil, and water and nutrient holding capabilities, these benefits also can be obtained by incorporating cover crops or crop residues. Manures should, of course, be used as fertilizer materials whenever feasible.[17]

Society as a whole has ended up paying for decades of such "official advice", some of whose consequences have been excess agricultural production, nonpoint pollution, and substantial profits for a minority of large farmers and agribusiness firms; it has abrogated the right to require its agriculture to be conducted in places that are in harmony with natural environmental processes and the land, people, social institutions, worldviews through which they flow.[18]

But the drive to create an industrial agriculture is found not just in a cheap resource base or even in the ideology of technological progress, but in human-made institutions like the marketplace, which tend to be internally supporting, self-validating, and self-defining. Ever decreasing numbers of farms and farmers have demarcated a process of concentration of control in agriculture, which has recapitulated the historical concentration of all industries that started out in a free market economy. The Corn Belt has witnessed its share of government programs designed to correct for the unchecked nature of the marketplace (e.g., the Soil Bank; deficiency payments; set-aside acres; payment in kind, PIK; the conservation reserve program), but none of them have slowed the trend toward the oligopolization of agriculture. Well capitalized, credit-rich farmers and speculators have bid up the price of land and taken the additional acreage for larger farms from their neighbor's side of the fence. Donald Worster observes how short-sighted policies have poorly served society in terms of its institutional basis:

> [Agriculture] cannot evade the bitter disappointment over shrinking promises that is endemic in marketplace societies. All individuals cannot maximize their wealth; some people have to give up something in order for others to get all they want . . . . The public good cannot be realized in agriculture, therefore, by the untrammeled workings of the market economy and the endless striving for private profit that it institutionalizes. The market creates wealth all right, but its wealth cannot satisfy; it holds up an ideal that is

> never really achieved, receding indefinitely before our eyes. A farm policy defined only in market terms inevitably must destroy the agricultural community to make it prosper. It must lead to disillusionment and frustration, uprooting and alienation, wearing farmers out, then casting them off.[19]

Furthermore, it has not really paid in the long run for farmers to have rushed out and adopted new technologies (like fertilizers), both from a standpoint of psychic cost in terms of uncertainty, anxiety, and the tension associated with risk, and from the perspective of economic return per unit and a market free from overproduction. Willard Cochrane captures this situation well in his "treadmill" theory:

> . . . the aggressive, innovative farmer is on a treadmill with regard to the adoption of new and improved technologies on his farm. As he rushes to adopt a new and improved technology when it first becomes available, he at first reaps a gain. But, as others after him run to adopt the technology, the treadmill speeds up and grinds out an increased supply of the product. The increased supply of the product drives the price of the product down to where the early adopter and all his fellow adopters are back in a no-profit situation. Farm technological advance in a free market situation forces the participants to run on a treadmill.[20]

Once on the treadmill, the only way to stay in business is to keep forcing up production along with one's competitors. But for those who never got on the treadmill, they sustained losses that forced them into bankruptcy and ultimately out of the business of farming. The "earlybirds" benefitted from the temporary gains of improved production technologies, while the less "aggressive" farmers suffered from the "cannibalism" of their neighbors. Even small, but efficient, farmers have succumbed to these near-predatory characteristics of the marketplace.[21]

An incomplete theory and practice of place creation has led to social, economic, political, and environmental dislocations, disjunctions, and instabilities. Reliance on technology, backed by the marketplace, produced progress only in a very narrow sense of the word, and then only for a very narrow segment of the population (a population that continues to diminish year by year).

NOTES

1. Iowa State College and the Iowa Agricultural Experiment Station, A Century of Farming in Iowa, 1846-1946 (Ames: Iowa State College Press, 1946), 28.

2. Willard W. Cochrane, The Development of American Agriculture (Minneapolis: University of Minnesota Press, 1979), 127.

3. Paul C. Johnson, Farm Power in the Making of America (Des Moines, Ia.: Wallace-Homestead, 1978), 8.

4. Wheeler McMillen, The Farmer (Washington, D.C.: Potomac Books, 1966), 21.

5. Colin A. M. Duncan, "On Identifying a Sound Environmental Ethic in History: Prolegomena to Any Future Environmental History," Environmental History Review 15 (Summer 1991): 13.

6. Cochrane, 229.

7. Sandra S. Beattie, and Robert Healty, The Future of American Agriculture as a Strategic Resource (Washington, D.C.: Conservation Foundation, 1980), 100.

8. Beattie and Healty, 106.

9. A casual perusal of a farm magazine of the period, like Wallace's Farmer, reveals that the message from the scientific, educational, financial, and business communities was one of maximum production utilizing heavy applications of fertilizer, especially nitrogen. Informed opinion said that the individual farmer could not afford to do otherwise, faced with rising costs and stagnant commodity prices.

10. Harold Guither obtained his data for Tables 5.2 and 5.3 from the Agricultural Finance Review, Vol. 32 Supplement, January 1972.

11. Iowa State University Agricultural Staff, Midwest Farm Handbook (Ames: The Iowa State University Press, 7th ed., 1969), 130.

12. Edward Higbee, Farms and Farmers in an Urban Age (New York: Twentieth Century Fund, 1963), 24-25.

13. Charles J. Headley quoted in Anton D. Meister, et al., U.S. Agricultural Production in Relation to Alternative Water, Environmental and Export Policies (Ames: Iowa State University Press, 1976), 10.

14. Cochrane, 239.

15. Richard C. Sheridan, "Chemical Fertilizers in Southern Agriculture," Agricultural History 53 (1979):308-318.

16. Cochrane, 309-310. National Research Council, 98-108. Cynthia Hubert, "Huge New System to Clean Nitrates from D.M. Water," The Des Moines Register (January 26, 1992), 1.

17. Beattie and Healty, 107.

18. See Wendell Berry, "Solving for Pattern: Standards for a Durable Agriculture," David Brewster, Wayne D. Rasmussen, Garth Youngberg, eds., Farms in Transition: Interdisciplinary Perspectives on Farm Structure (Ames: Iowa State University Press, 1983), 37-46, for a discussion of how solutions to food production problems created patterns out of which more problems emerged.

19. Donald Worster, "Good Farming and the Public Good," Wes Jackson, Wendell Berry, Bruce Colman, eds., Meeting the Expectations of the Land (San Francisco: North Point Press, 1984), 36-37.

20. Cochrane, 389.

21. Ibid., 390.

CHAPTER 6

THE MAGIC BULLETS

The advent of cheap, plentiful commercial fertilizers made crop raising more prolific, less risky, and simpler in the sense that crops received measured amounts of plantfood at convenient times, in a less smelly, easy spreading inorganic form, and in a way that provided dramatic results in yield increases. They tended to obviate the traditional need for manure, green manures, crop rotations, and use of nitrogen-fixing legumes. The medieval practice of fallow became literally a thing of the past (except in the drier, western plains) and the concept of long rotations including pasture and woody regrowth was unthinkable. Due to the demands of World War II, Corn Belt agriculture was under pressures to produce, and it did, year after year. After the war, the cost of land, capital inputs, and operating expenses were such that no land could be spared on the average farm by remaining "unproductive" for any amount of time.

Powered machinery gave farmers the ability to handle more land and the larger yields produced by fertilizer application. But some of the same old threats to agriculture had not gone away, nor had technology been able to mount much of a counterattack. Pests in the form of insects, weeds, and disease bearing/causing pathogens caused crop destruction much as they had in ancient times.

By the 1920s, the eastern Corn Belt had already dealt with a severe infestation of the European corn borer. The U.S. Department of Agriculture's Bureau of Entomology conducted a widespread campaign designed to stop its spread to the west. The Bureau advocated the simple cultural practice of plowing under cornstalks in which borer larvae overwintered. No insecticides were utilized mainly because the corn borer stayed inside corn stalks, remaining unexposed to external counter-measures. Despite a Congressional appropriation of $10 million, coupled with a massive "clean up" campaign in 1927 (mostly in Michigan, Ohio, and Indiana), the effort had only a limited success and was dropped after the first year.[1]

Other insects, weeds, and plant diseases took their toll in the Corn Belt. Most, but not all, were adequately controlled by combinations of cultural practices, crop rotations (effectively stopped the corn rootworm), the use of many different varieties of the same crop, and diversity of crop types and even whole ecosystems. Traditional woodlots, hedgerows, gardens, orchards, waterways, pastures, and wetlands all acted as buffers and "barriers" to the spread and growth of pests.

Where pest plagues did break out, they were usually localized and confined to areas no larger than counties or groups of counties. Anti-pest measures were designed more to halt migration of the insects rather than kill them. This was the case in the longest and most severe outbreak of cinch bugs in Iowa history which began in 1931, and reappeared on and off through 1945. Creosote line barriers, and later creosote-treated paper fence barriers, became the treatment of choice. But this and other situations were the exceptions and pest damage to crops usually fell within "survivable" limits in the Corn Belt.[2]

By 1930 the pesticide industry developed to the point where it was able to deliver millions of pounds of both chemical and botanical insecticides. The arsenicals like calcium arsenate, lead arsenate, and Paris green, and newer synthetics, of which PDB was the first manufactured on a large scale, were used in large amounts, but only on a few selected crops such as cotton, fruits, and vegetables. Corn Belt farmers, however, made little use of these compounds.[3]

Three sets of reasons stood in the way of greater pesticide use. The first centered around a controversy over lead residues in fruits and vegetables. The second revolved around simple economics and technical efficiency. That generation of arsenic-based pesticides simply did not work very well. Third, attitudes were more relaxed when it came to how fields "looked" with respect to insects, weeds, and plant diseases. Moderate weed or insect damaged fields were nothing to be ashamed of, because everyone suffered some pest damage to crops--all farmers were pretty much in the same position; they tried to minimize pest problems with "tried and true" cultural practices, and pests generally did not threaten the continued viability of farms as economic units, unless the outbreaks were catastrophic. But as agricultural debt load grew after World War II, reduced yields due to pest damage were perceived as threatening to the farmer's continued ability to stay in business.[4]

Other developments in entomology before 1945 concerned changes in the professional, institutional, and regulatory structure. Entomology became a recognized, distinctive scientific area and its research was bolstered by the land-grant universities. Through their actions, greater instruction was given in entomology, and their research and development arm--the experiment stations--established the role of the public sector in insect control. Scientists interested in biological pest control lost out to "chemical" researchers in the race for funding and support, even though many important and crucial "biological control" discoveries were made during this same era. Finally, commercial insecticides existed and were used on some crops to such an extent that a controversy developed over lead and arsenic residues, and provoked litigation which partially stimulated the passage of the Federal Food, Drug, and Cosmetic Act of 1938.[5]

> The major features of disputes about insecticides were thus all present in America before 1945: the financial pressures of commercial agriculture, a dynamic community of professional entomologists employed largely in the public sector, government sponsored control programs, insecticides, and disputes over the safety of the chemicals. The controversies changed and grew after 1945, but they were clearly grounded in trends and traditions that had emerged much earlier.[6]

Any equilibrium that might have existed in matters of insect control was quickly upset by the invention of DDT in 1939 and policy changes stimulated by World War II. It became available to American farmers after the war and was adopted rapidly and on a large scale. Historian John Perkins notes how DDT's effectiveness caused a euphoria among government chemists and entomologists. They finally had a "magic bullet" with which to combat insect depredations in a wide variety of crops. The enormous power of DDT to suppress insect populations also motivated the chemical industry to investigate other molecular combinations in hopes of competing with the DDT biocides.[7]

High wartime demand for agricultural goods and high prices stimulated a rural recovery in the Corn Belt. With higher incomes and greater credit available, farmers could afford the new technology. They responded to government calls for expanded production, but there was fear among farmers and farm leaders of a post-war price decline similar to that of the post-World War I era. The government answered with a two year price guarantee, which was augmented by continued strong foreign demand. Prices finally fell in 1949, but only slightly. The outbreak of the Korean War forced them back up and some observers were concerned that prices would rise out of control. But agricultural officials were confident in farmers' new abilities, both managerial and technological, to grow more food and fiber. Years of chemical research by the Department of Agriculture and the colleges of agriculture seemed to pay off just at the right time (Table 6.1). Public research expenditures generally doubled between 1945 and 1950, as the land-grant universities assumed a key role.[8]

The extension service and farm newspapers and magazines also bombarded farmers with encouragement and information on the new agricultural technologies, especially the "miracle" pesticides. While total acres farmed remained stable, the net weight of active ingredients in pesticides applied increased by 170 percent between 1964 and 1982. Since World War II, more and more farm-consumed pesticides have been herbicides. Today herbicides comprise 51%, insecticides 35%, and fungicides 14% of all farm-applied pesticides. American farmers

TABLE 6.1

PUBLIC EXPENDITURES IN MILLIONS OF DOLLARS FOR RESEARCH AND EXTENSION IN AGRICULTURE, 1915-70.

Year	State Agricultural Experiment Stations	U.S. Dept. of Agriculture	Federal-State Extension
1915	4.6	6.0	3.5
1920	5.0	7.7	14.7
1925	7.3	9.3	19.3
1930	13.1	15.5	24.3
1935	11.1	11.4	20.4
1940	16.8	22.1	33.1
1945	19.8	22.9	38.2
1950	48.2	46.8	74.6
1955	73.8	53.4	100.7
1960	120.3	105.2	141.7
1965	181.8	192.5	188.9
1970	296.1	238.7	290.7

Source: Willard W. Cochrane, The Development of American Agriculture (Minneapolis: The University of Minnesota Press, 1979), 247.

obviously responded positively to these calls; they enjoyed twelve straight years of essentially uninterrupted prosperity before prices started to edge downward.[9]

This period lasted long enough, claims agricultural historian Willard Cochrane, to cause the younger generation of farmers to forget all about the economic hardships of the 1930s.[10] But problem-free profit-making on the farm did not last for long; by August 1955, hog prices fell to their lowest August levels in ten years, almost as low as the $15.25 per hundredweight price in January 1950, before the outbreak of the Korean War. The hog oversupply problem loomed so large that it prompted The Des Moines Register to run a multi-part weekly series on the situation.[11] The old nemesis of Corn Belt farmers, overproduction, returned with a vengeance. But they refused to be daunted by such "temporary" negative news and moved ever closer to the emerging industrial mixture of agrochemical production technologies.

The new production technologies, however, simply exacerbated the problem of oversupply, and squeezed profit margins by making the cost of farming more expensive. Moreover, no individual farmer could do much about the oversupply problem and he feared his neighbors would not cut back on plantings and thus reap profits from any higher prices; so, the strictly economic answer to this dilemma was the further adoption of agrochemically based farming practices.[12] Anti-pest chemicals, in a sense, completed the movement toward monocultural agriculture begun by mechanization and stimulated by massive injections of commercial fertilizers. Cheap, effective pesticides allowed farmers to efficiently cover much larger crop acreages because they were no longer limited by time constraints produced by mechanical cultivation. Monocultural conditions too, have tended to escalate pest and pathogen problems, making increased biocide purchases imperative.

The whole process of replacement of land and labor by capital inputs "has tended to lead to an incentive to farmers to expand in order to spread the fixed costs of machinery over larger acreages."[13] Increases in spring planting costs have had the same effect--operating costs involving seed, fuel, parts, fertilizer, chemicals, and interest charges on bank loans that are often necessary, make "mass production" of staple crops with known markets a virtual imperative. Once adopted, this technological system allows little deviation from dependence on purchased petrochemical inputs, and actually fosters specialization in certain crops and/or livestock species in order to make maximum use of particular machinery and facilities. Specialization, in turn, requires increased dependence on petrochemical inputs because all the production "eggs are in one basket". In this situation, farmers cannot financially stand to lose one crop or lose too many animals to pests or disease.

The logic of technological extension (capital inputs--machinery, seed, fertilizer, pesticides, and chemical-based factory livestock raising--now all interact so completely and so interdependently that they have become an interlocking complex, a technological system with its own logic and rules) demands that they act in ways that may not be environmentally sound, but which supposedly "safeguard" their sizeable investments. Farmers have become captives of their own technological, business, and financial systems. In the final analysis, we, as a culture, have participated in an experiment--the creation of a new agricultural place. In thirty short years (1940-1970), it has triumphed over the pre-World War II agricultural practice of place, almost completely superceding it in the Corn Belt. Gone are most of the old crop rotation systems with their water and soil holding pastures and hay lands, the more extensive use of the land, the mixed crop and livestock systems, and the independence which came from a greater degree of diversity and self-sufficiency. The labor requirements of the many faceted, traditional farming enterprise tended to balance out the seasonal distribution of work and kept the farmer occupied for much of the year.

Although the technological system may well have been the most important element in the revamping and repatterning of agricultural place in the Corn Belt, it was certainly not the only operative causative factor. This shift from a labor and land intensive system to an energy intensive agriculture was not a simple reflection of technological development or the inherent superiority of a special set of interlocking agro-technologies. As shown previously, the technological basis for petrochemically-powered machinery, inorganic fertilization, and commercial pest control was present several decades before the massive deployment of these techniques in the post-World War II era. The mere availability of technology is not enough to explain the sudden and pervasive change outlined above. That accelerated pace of technological change was suffused with a cultural melange of social, intellectual, economic, and political influences, all catalyzed by the global upheaval set off by World War II. Automated technology was a necessary, but not sufficient cause for the drastic changes that ensued.

The war ended the Great Depression once and for all, and unleashed an economic leap forward, which gradually engendered a new social optimism. The end of poverty, both urban and rural, and the attainment of higher and higher standards of living seemed not only possible, but probable. The United States had emerged as the strongest power in the world. America had truly demonstrated that it was the "arsenal of democracy." It was commonly believed that American capitalism had the ability to produce so much abundance that social problems would be smothered under an avalanche of resources. Technological innovations, huge wartime savings, the G.I. Bill, and housing loans for veterans attested to the readiness and capability of the socio-economic-political system to "deliver the goods" and leave the gloom and pessimism of the 1930s behind.[14]

As the only industrialized nation in the world with its industrial plant still intact, the United States owned or controlled a disproportionate share of the world's wealth and manufacturing capability.

> In 1947, with postwar recovery under way everywhere, the United States produced about one half of the world's manufactures: 57 per cent of its steel, 43 per cent of its electricity, 62 per cent of its oil. It owned three quarters of the world's automobiles and was improving on that show by manufacturing well over 80 per cent of the new cars built in the world that year.[15]

On the farm, World War II and its aftermath produced a time of unbridled optimism. The grinding poverty, soil erosion, inadequate living conditions, and low prices which had their beginnings in the 1920s and worsened throughout the 1930s were not reversed overnight. But price supports and subsidies from the federal government quickly raised farm incomes. Emphasis was placed on boosting the output of dairy and livestock products, feed crops and oil bearing crops.[16]

With increased disposable incomes, farmers accelerated their rate of mechanization. Although not many new implements were built during the war years, farmers took advantage of the availability of good used equipment, which enabled them to get bigger equipment sooner than would have been expected. Overseas experience and the mammoth scale on which the war effort was conducted helped millions of young men, (some of them would-be farmers) become practiced in using big machines in big ways in expansive settings. They became used to rapid action and "getting things done." In addition, military experience convinced them to "buy new" and throw away the old. The war helped to change people from savers to consumers; once the war ended, the whole society fed on the pent-up demand for goods formerly in short supply. The affordability of cars made a whole generation immediately more mobile and aware of new places and new techniques. The virtues of technology were extolled and "the habit of buying gadgets" was deemed acceptable.[17]

Other major factors which pushed increased production were seen ultimately in the same mechanical mode. Commercial fertilizers were concentrated and could be "plugged in" to the industrial crop raising process like a plug into an electric outlet. They were mechanical in the sense that they were just another part to be purchased and installed at the right time and place into the larger agricultural machine.

The agricultural community, urged on by a younger, increasingly college educated generation, came to view these and other capital inputs (e.g., improved seed, insecticides, livestock disease control medicines and improved feed rations, and even conservation practices) like they did their tractors and other labor reducing machinery. These inputs were, in general, rational, predictable, and straightforward in their application and immediate consequences. They seemingly acted to give farmers "complete" control over, for the most part, uncontrollable forces and processes.

In accordance with the image of farms as machines, pesticides have been employed as hardened cogs to grind out of existence competing organisms--weeds, insects, and pathogens.

> They [pesticides] are purchased inputs, designed to be used in an algorithmic manner, in order to make a farmer's operations predictable. . . . Where the chemicals remain effective, they continue to function as a simple, cheap reliable tool that fits easily into a production process perceived as mechanistic.[18]

The capitalist myth of the "free market" has also provided a mechanistic vision of the farm and its inputs for the economic, social, and political perspectives of society. Farms were ideally seen by market theory as discrete, mechanical, entrepreneurial units, rationally managed and employing the latest in scientific technology. The conventional wisdom of the post-war era held that pesticides should be applied at the rates supplied by the manufacturers so as to generate maximum production per acre and the greatest possible profit. Estimated returns were generally pegged at \$3-\$5 per \$1 invested.[19] Implicit in this view, any cost incurred from negative environmental consequences was understood to be externalized to the general population or to consumers. Now, adverse environmental results have grown to boomerang back on farmers themselves, and they have begun to pay extra for the privilege of using pesticides and other hazardous materials.

The same vision of farms as atomistic economic units held true under American political philosophy. Insecticides were compatible with this pattern. They tended to slip into general use between the regulatory activity of government and the free enterprise, decentralized (in the early years of the industry, that is) chemical industry's and retailer's profit-oriented promotional activities. It was assumed that insect control was ultimately not fundamentally a public responsibility. Farmers were expected to handle their own individual insect problems, although government would disseminate as much information as was deemed practical and beneficial. Insecticides provided the "perfect" match for this system because each particular agricultural problem was theoretically capable of "solution" based on its individual circumstances; insecticides supposedly targeted those individual problems and eliminated them.[20]

World War II ended in 1945, but on the farm the battle against bugs, weeds, and plant and animal pathogens began to heat up with the introduction of new and deadly weapons of destruction. There had always been an adversarial motif to American agriculture going all the way back to colonial farming. Forests were cut down to drive away the animal competitors of corn and small grain crops. Deer, raccoons, squirrels, wolves, foxes, birds, insects of all kinds, diseases, the weather, and even brush fires that "got away" ravaged crops and livestock on a regular basis. One such "crop raider" was hunted to extinction--the passenger pigeon.[21] The modern day correlate was manifested in the U.S.D.A.'s program for specie-specific insect eradication called Total Population Management. TPM conceived of utilizing every available anti-pest technique (from biological controls such as sterile insect releases to the most toxic chemical pesticide) in an all out war of extermination against any pest which threatened commercial crops on a sizeable scale. The crusade against the boll weevil demonstrated TPM's closeness to chemical control strategies and its reliance on the conflict mode of interaction.[22]

Insecticides appealed to the battle mentality on the farm. These were readily available, potent killing compounds which required minor management and application skills. The pesticides introduced in the late 1940s and early 1950s such as DDT, lindane, aldrin, chlordane, toxaphene, and dieldrin were fast acting, lethal tools of death. They also appealed to the conception of the farmer as an active, involved, interventionist, "taking care of business" rather than the more passive image of the nurturer who lets nature take its course. Pesticide applications gave rapid results, whether they were dead insect bodies littering the ground or "burned down" weed stalks. Farmers were no longer "helpless" against pest onslaughts with these tools.

Socially, pesticides fit in well with the modern American agricultural structure. They provided the tools which enabled each farmer to compete on an equal footing with all the other farmers for a share of the market. The fundamental fact of this farming system was that farmers competed against each other in spite of the continuing myth of noble and honorable cooperation. "Competition through technological advance, rather than cooperation, was the hallmark of American farming."[23]

Although competition has been one of the prime means by which American agriculture has defined its place and identity, it has been just one of several methods subsumed under a general cultural, perhaps even civilizational movement toward human mastery over nature. All human beings, both ancient and modern, have modified their environments in the quest for survival. But only modern western man, as a number of cultural critics have claimed, has systematically attacked the ecosphere, under the influence of a "technological drivenness," in a never ending search for not only survival, but a guaranteed security for an ever rising standard of living. Through the power of rational thought, the scientific/technocratic method, the exploitation of natural resources on a gigantic scale, and the organization of human activity within mass, hierarchical, bureaucratic structures, the Western industrialized nations have succeeded in lowering the levels of risk and uncertainty endemic to human life. But this has been accomplished at a cost of staggering insults to the planetary environment and both material and psychic shocks to societies around the world and to their individual members. For over two hundred years, from this perspective, the only good nature is a subdued nature--one that cannot fight back.[24]

American agriculture has the same philosophical base and has attempted to conquer nature and attain mastery over it using an arsenal of advanced technological tools, pesticides being just one example.

But problems have developed with these agricultural techniques because their application has created new place matrices that are "out of sync" and incongruent with the requirements of an ecologically sound place. Concerns about farm related and agriculturally-caused environmental, community, and health damage continue to grow. Pesticides in particular pose a threat to the stability and sustainability of the environment.

Problems associated with pesticide use have been noticed from their inception. In the 1920s, residues from the lead arsenates then in use sparked a national controversy. In 1950, only five years after the arrival of DDT on the farm, partial resistance to it was observed in flies and other insects.[25] Five years later, in the grip of one of the hottest Augusts on record, a farm advice column in a Midwestern newspaper noted the trouble with insecticidal sprays evaporating because of the hot weather. Specialists advised frequent and heavy applications if the grasshoppers became too bad.[26]

Concerns over heavy and indiscriminate pesticide usage prompted passage of a federal law in 1952 creating tolerances for certain pesticides. Growing pesticide use had other unexpected side effects that threatened to destroy reliance on their use, and legislation seemed unable to counter these new tendencies.

> Insect populations were changed in important ways by the continued uses of insecticides. First, continued killing of individual insects that were susceptible to poisoning resulted in the increase of individuals that were more tolerant of the toxic substance. Resistance, in other words, developed in treated insect populations. Second, insecticides applied broadcast against a pest species also killed large numbers of the pest's predatory and parasitic insects (natural enemies). As a result, populations

> of the pest species or of another previously innocuous species erupted into large and damaging numbers. "Resurgence" and "secondary-pest outbreaks" respectively, were the names established for these phenomena.[27]

The chemical industry responded to resistance to the chlorinated hydrocarbon insecticides with the newer carbamates and organophosphates; the ban on DDT and some related insecticides in the early 1970s also caused this shift. Some resistance to these have been noticed as well. Many newer insecticides will likely lose their target toxicity in the near future.

Weed resistance to herbicides, especially to atrazine, although not as serious as in insecticides, began to be observed after twenty generations.[28] This is important in the Corn Belt because corn uses more herbicide than any other single crop in the nation.[29]

Pesticides also seem to have properties that can contribute to a breakdown in soil-fauna integrity.

> The use of fungicides may contribute to pest problems by reducing populations of entomogenous fungi. The application of benomyl, toxic to these fungi, results in increased survival of velvet bean caterpillars and cabbage loopers in soybeans and eventually leads to reduced crop yields. . . . Application of Furadan to soil probably alters the microflora, resulting in more rapid biological degradation of carbamate insecticides, which would reduce their effectiveness on soil insects like the corn rootworm complex.[30]

Persistence in pesticides is another problem that directly affects farmers and their choice of crops. Failure of pesticides to breakdown and their carryover to the next planting season can sometimes preclude planting a different crop in that particular field.

Quite often pesticides are applied as a vapor; as such they can drift on the prevailing wind and often do serious damage to adjacent crops. Aerial application increases the amount that drifts. Anywhere from 20-80% of the pesticides applied from the air can miss their target. A total cost for losses attributable to herbicide drift and persistence in Illinois was given as $60 million in 1977.[31] Total cost for the entire Corn Belt would be many times higher.

An additional potentially expensive and worrisome problem concerning herbicides is the change in weed species promoted by the weed killers. Perennial weeds seem to be replacing annual weeds; the perennials are generally more vigorous and harder to kill. Thus, they will cost more in terms of their control.[32]

A whole host of further indirect and external costs created by pesticide use exist which have not been precisely quantified. These include residues on human food and exposure in pesticide workers and applicators, animal poisonings and contaminated livestock products, honey bee poisoning and reduced pollination, fishery and wildlife, and microorganism losses, and expenses for pollution control by government.

In one of the greatest ironies of Corn Belt farming, the very technological tools that have created a highly productive agriculture have also polluted groundwater supplies farmers and their livestock need to exist. "In nearly all respects agriculture became an industry, sharing with the traditional manufacturing industries the problems of waste byproducts disposal."[33] As a result of "routine" farming practices, pesticides of varying concentrations have been detected in the groundwater of twenty-six states. Ninety-seven percent of all rural drinking water comes from these underground sources. The highest concentrations are attributable to the herbicide atrazine and the insecticide aldicarb. Little is known about the long-term effects of low dosage exposure to pesticides. Less is known about the interactive biochemical effects of various mixtures of these chemicals.[34]

In the final analysis, pesticides have not turned out to be magic bullets that simply slay farm pests and then quietly disappear. The mounting evidence suggests that they cannot be turned on and off like a switch. Continued heavy dependence on pesticides would imply furtherance of the clash of the industrial agricultural system with nature's system of entropy, diversity, stability, and interdependence. Maintenance of such a conflict will require increasing levels of energy, and seriously block efforts to develop sustainable agroecosystems. Agricultural place cannot be prorogued forever; already limits have appeared concerning the costs society will accept. A restoration of ecological health to American agriculture awaits the realization of the irrationality of the mechanical-chemical consciousness applied to farming. In the following quotation, Lewis Mumford speaks to the counter-productive nature of mechanical-chemical farming systems and offers a more biologically-based stewardship.

> With the mechanization and prospective automation of farming, the aim is not to improve the life of the farmer but to augment the profits of the megatechnic corporations that supply the machinery and the power needed for large-scale monoculture, with the smallest possible use of human labor. Though this monoculture, through excessive use of chemical fertilizers and pesticides, deteriorates the environment and creates health hazards, it produces crop surpluses that then draw forth from a compassionate government extravagant subsidies for non-production. A biotechnic economy would reverse these irrational methods by restoring manpower for mixed farming, horticulture, and rural industries, reclaiming the countryside for human occupation and continuous cultivation.[35]

NOTES

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2. Carl J. Drake, "Man and Nature Battle Injurious Insects," ed. Iowa State College and Experiment Station, A Century of Farming in Iowa, 1846-1946 (Ames: Iowa State College Press, 1946), 76-88.

3. Perkins, 625-627.

4. Ibid., 627-628.

5. John H. Perkins, "The Quest for Innovation in Agricultural Entomology, 1945-1978," ed. David Pimental and John H. Perkins, Pest Control: Cultural and Environmental Aspects (Boulder: Westview Press, 1980), 24-33. Even though chemical pesticide research was dominant at federal agencies, biological control research continued with some impressive results and kept a tradition alive which later became known as Integrated Pest Management, a more ecologically sound method of pest control. But, John Cochrane observes that the "production of science and technology" was the basic job of the agricultural colleges and experiment stations in the period 1897-1933, in The Development of American Agriculture (Minneapolis: University of Minnesota Press, 1979), 107.

6. Perkins, 1980, 26. For the long history of the experiment stations dating back to the Hatch Act (1887) and the land grant colleges starting with the Morrill Act (1866), see Alan I. Marcus, Agricultural Science and the Quest for Legitimacy: Farmers, Agricultural Colleges, and Experiment Stations, 1870-1890. (Ames: Iowa State University Press, 1985), and Norwood Allen Kerr, The Legacy: A Centennial History of the State Agricultural Experiment Stations, 1887-1897 (Columbia: Missouri Agricultural Experiment Station, 1987).

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20. Perkins, 1982, 271-272.

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22. John Perkins has done superb studies of competing pest control strategies and the federal/state governments' involvement in these strategies and their agribusiness backers. See his Insects, Experts, and the Insecticide Crisis for a book length treatment.

23. Ibid., 272.

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CHAPTER 7

THE MACHINE IN THE PLANT

Unlike the other capital inputs so far considered--machinery, fertilizers, and chemicals--improved seed is not an energy related or dependent technology. In comparison to other technological factors, minimal energy is required to produce and apply improved crop varieties in an agricultural context. No massive foundry, petrochemical, or complex molecular operations are required to produce improved crop varieties. They do, however, fit easily into the structure of industrial farming, in a way that sustains and advances a high technology, intensive-energy agricultural practice.

In fact, the use of high yielding seeds tends to promote heavy consumption of expensive machinery, concentrated commercial fertilizers, and toxic chemicals. Such consumption fosters a farming regime with high built-in expenses and tends to ignore or externalize environmental costs and damages. Moreover, improved crop varieties fit into the mechanical agricultural scheme and integrate the inputs in a way no other single factor could. Furthermore, the Corn Belt (mainly through the efforts of agricultural scientists and commercial seed companies) has largely defined itself by growing one particular crop, hybrid corn, and its concomitant production technologies. Through government research efforts in agricultural colleges and the experiment stations, public desire for growth and progress was manifested. Thus, the causal agents of technique and technocratic institutions drive, shape, and structure the development of modern agricultural place.[1]

Of all the crops grown in the Corn Belt, corn predominates to such an extent that its history is essentially the history of the agricultural area bearing its name. From the beginning of settlement in all the Corn Belt states, corn was a very significant crop. Even in the northern states of the Midwest, such as Wisconsin, Michigan, and Minnesota, early cash wheat raising eventually gave way to a corn-based farming system. As early as 1860, the leading corn producing states were Illinois, Ohio, and Missouri, and the center of corn production continued to shift westward. The cost of growing corn was only a fourth of that of the eastern seaboard, but little of the crop was marketed nationally; it was utilized locally in feed as the basis of a burgeoning livestock industry. Attractive as a crop that would grow well in newly-turned prairie sod (wheat did not do well in these conditions), Midwest corn production "exceeded that of wheat from five to eighteen times."[2]

Early on, farmers recognized the almost perfect fit between the environmental conditions of the Midwest and the particular needs of the corn plant. The Corn Belt provided a fortuitous combination of rich soil conditions, temperature, sunshine, and rainfall (approximately forty inches/year) which make it ideally suited for corn. The relative flatness of the terrain also promoted less soil erosion when planted to row crops such as corn and beans than the rougher lands of the eastern United States.

In addition to becoming the dominant grower of feed grains, the Midwest quickly became the dominant force in food marketing and distribution. Established in 1848, the Chicago Board of Trade became the leading market for corn and other grains; with Illinois and nearly all Corn Belt states achieving preeminence in feed grains and livestock, Chicago by 1870 was a thriving center of food marketing. In that year, the U.S. corn crop totaled 1.5 billion bushels. By 1899, the figure was 2.7 billion bushels, of which Illinois and Iowa accounted for more than 25 percent. By the 1940s, three billion bushel corn crops were the norm and the first four billion bushel crop (4.4 billion bushels) was achieved in 1959. Of the 4.081 billion bushel U.S. corn harvest in 1963, Iowa and Illinois together contributed an impressive 40 percent of the total. The ten states of the Corn Belt accounted for about 3.5 billion bushels or approximately 86 percent. The average yield per acre of corn increased from 26.1 in 1870 to 118 bushels in 1985. Since 1948, average annual yields have increased by 2 percent.[3]

Thus big corn crops and big yields are a twentieth century phenomenon. In this respect, substantial corn development in particular and sizeable crop advances in general, appeared rather recently in the time scale of agricultural history. Their appearance coincides with the revolution in the use of capital inputs. Most of the gains in corn development emerged as a result of the process known as hybridization. It was an invention that was based on the discoveries of a handful of researchers and investigators, some amateur and some professional. The two hundred year period from 1694 (when a Dutch botanist, Camerarius, observed corn pollen and its fertilization function) to the early 1900s when true corn hybrids were first produced, was a time of stage-setting in terms of botanical knowledge and agronomic practice. Technically speaking, the early dent corn (a hard, yellow, starchy field corn that dents in on the top of the kernel when dry) planted by nineteenth-century American farmers (the basis of today's seed corn industry) was itself a hybrid (cross of varieties) consisting of two Indian corn varieties: "gourdseed corn" from the Southeast and "flint corn" of the Northern tribes. This cross made a more productive corn, but not nearly on the scale of modern hybrid varieties.[4]

The importance of hybrid corn to the Corn Belt cannot be underestimated. In genetic terms, the technique of hybridization represented a "quantum leap" beyond the traditional method of biological fertilization--open pollination. The product of modern hybridization embodies the principle of "controlled combinations" of genetic material. Understanding the importance of hybridization to the Corn Belt necessitates understanding both the biological (in terms of technique) and institutional foundations of how this control came about.

Corn existed for millennia in varied, usually small, but recognizable forms. Its method of reproduction--pollen from the tassel (male) is carried on the wind to silks (female) growing out of the ear, and fertilizing the egg cells at the base of the silk pollen tubes--has not changed during its historical existence.

> Throughout the centuries corn has been fertilized by wind-borne pollen from the tassels of many plants dropping on the silks of many other plants. This haphazard fertilization has been known as "open pollination." In its resulting kernels or seeds only the female parent is known. Hence all corn plants, prior to the controlled hybrids, have been chance-born hybrids bearing the characters of numerous varieties or strains.[5]

This open pollinated corn was the parent or basic material upon which corn breeders worked. The first stage in the process of producing hybrid seed was to breed a pure strain or variety. This was accomplished by inbreeding or "selfing". Botanists used paper bags to cover tassels and ear shoots to protect them from interacting with any other individual corn plants. Then each plant was self-fertilized by taking the pollen from the tassel and placing it on the silks of the same plant. The bags were replaced to prevent outside pollen from mixing with the already fertilized plant. Each plant thus became both the male and the female parent of the resulting inbred ear.[6]

Misshapen and runty ears are often the result of this first-generation inbreeding, and these ears are discarded; the best are saved as seed for the next inbred generation. The process of selfing is performed again, and the second generation ears so produced are examined. Unacceptable ears are again discarded, and the process repeated for several more generations. Eventually, no further reduction in vigor is apparent and all the ears are relatively uniform. Such seed is considered a "pure" strain and is ready for the production of "single-cross" hybrids.[7]

Two inbred strains with the most desirable qualities are then crossed, with one strain (A) retaining its tassels as the male parent and the other strain (B) being detasseled as the female parent. This

B x A single cross now has hybrid vigor and can be used for seed or to produce a double-cross hybrid (which constitutes most of the seed corn planted today in the Corn Belt). The double-cross is created by mixing two single hybrids, i.e., (B x A) x (D x C). The double-cross ears tend to keep the large size and other characteristics of the single hybrids. Thus, given the availability of proven inbred strains, it takes three years before double-cross hybrid seed will make a crop. Of course, seed corn companies continuously develop inbred strains and then single crosses so that there is always a supply of double-cross seed on hand for the next growing season.[8]

The key to hybridization then is systematic control over genetic materials. Basically the process speeds up what nature would do in thousands of years. Prior to hybridization, farmers and agricultural associations used the more primitive crop improvement methods of selection and varietal crossing. Not all farmers used selection or crossing, and one observer claims that only the more affluent even considered such practices.[9] But logic and eyewitness accounts argue for the case that most farmers participated to some extent in at least the thoughtful selection of seed corn.[10]

The process of seed corn selection involved saving the most promising looking ears from the fall harvest. In the spring the ears were shelled and most of the seed (except the butt and tip end kernels) was mixed together and then planted. Thus, slow, minor increases in yields were achieved along with improvements in other characteristics like standability and drought resistance. But the whole process was very much a "hit or miss" affair, because the parents of any particularly productive ear were never known. The selection of any particular ear of open pollinated corn, no matter how large and well-filled out, was not always an improvement, because hidden traits or characteristics from unknown parents might show up in subsequent generations. An additional impediment to real corn improvement was the "scorecard" ideal promoted at corn shows and competitions in the latter nineteenth and early twentieth centuries. It was a list of features that judges thought corn should have. The outward appearance of corn ears or kernels, however, did not always correspond to its productive potential.[11]

The lack of control and predictability over crop genetics, especially corn, led scientists at the land grant colleges and experiment stations to choose the more scientific Mendelian approach to genetics around 1900; the pace of change accelerated rapidly from that point and institutional expertise became the foundation of modern crop breeding.

> Whereas farmers could still practice corn improvement if they wished, seed producers and breeders were gradually joining the ranks of an emerging scientific group that espoused the apparently more scientific Mendelian approach. Over the next twenty years, such simple methods as selection and varietal crossing would give way to inbreeding and crossing, and the change in method itself would change the social organization of agriculture. No longer would farmers use their experience and expertise to establish and maintain their own high-yielding strains of corn; instead, plant breeders would become the new experts not only on which corn lines were better but on how to create them.[12]

Despite rapid development of techniques for corn improvement, culminating in the invention of double-cross hybrid corn in 1918, the scorecard standards for corn persisted. Corn Belt boosters like Iowan Henry A. Wallace and Illinoian Eugene Funk, however, constantly exhorted farmers to continue selection as a viable improvement method and select for yield instead of appearance. By 1919, World War I was over and the high production levels stimulated by the war quickly became levels of overproduction. Prices rapidly became depressed and the "Golden Age" of American agriculture was over by 1922. But the same boosters of greater yields and better seed still called for higher yields, which only could lead to further overproduction and lowered prices. There is little evidence to suggest that they made such a point out of calling for greater corn plant standability at harvest, or greater resistance to insects and disease, or greater nutritional quality. For Wallace, in particular, maximum production was almost an obsession, for he preached it in many issues of Wallace's Farmer, and made it his standard for agricultural performance.

In this endeavor, he and other hybrid seed company pioneers were aided by discoveries and claims emanating from the public sector. In 1896, Cyril Hopkins of the Illinois Agricultural Experiment Station invented the "row-to-ear" method of selection and improvement. By this method, parentage of any particular row could be tracked back to the mother ear and checked for performance. George Shull developed the first successful explanation of inbreeding or "selfing" in 1908. This was followed by Donald F. Jones' invention of modern hybridization and a mechanism to make it commercially practical.[13]

Sold by the Funk Brothers in 1929, they called the first commercially introduced corn hybrid in Illinois "Pure Line Double Cross No. 250." Two other Illinois seed companies, Pfister and DeKalb, quickly entered the hybrid seed competition. The first corn hybrids issued in Iowa arrived in 1932 and 1933.[14] This new industry initially experienced farmer resistance to buying seeds when they could grow their own. Interestingly enough, it may not have been mainly the increased yield ability that sold hybrid corn to the farming community. The ability to withstand lodging probably interested farmers more than increased yield. Early hybrid increases were sometimes less than ten percent over conventional seed. Farmers did not have wagon scales and could not tell if yields were higher or lower until they surpassed a ten percent difference. Most farmers still picked corn by hand, and any ear that was on or near the ground due to stalk breakage was just more weight to lift a longer distance into the wagon.[15] "But shrewd marketing techniques, such as entering corn-yield tests or planting a patch of hybrid corn on farmers' land at company expense, established the superiority of hybrids and converted many farmers before World War II."[16]

The following figures indicate the rapidity with which the shift to hybrid corn took place. Hybrids were such an obvious sign of progress that their value was not contested. Heavier seeding rates (the thickness of corn plantings) also jumped as familiarity with hybrids increased (Table 7.1).

TABLE 7.1

CORN SEEDING RATES AND HYBRID SEED PLANTINGS

Year	Seeding Rate(kg/acre)	Percentage of Acreage Planted to Hybrids
1945	3.5	64.7
1950	3.4	78.0
1954	3.4	87.3
1959	3.9	94.9
1964	4.2	100.0
1969	4.9	100.0
1974	5.8	100.0

Source: Vaclav Smil, Paul Nachman, and Theras V. Long II, Energy Analysis and Agriculture: An Application to U.S. Corn Production (Boulder: Westview Press, 1983), 128.

Adoption of hybrid corn in Iowa was even more rapid than the average for the nation. Ten years after its introduction, hybrid seed corn usage stood at 99 percent. Corn yields jumped from 40 to 60 bushels/acre in those ten years, or an increase of 50 percent. This rapid adoption can be attributed in large part to the general lack of any seed corn (open pollinated or hybrid) in the 1930s due to recurring droughts, and the extraordinary sales efforts of Iowa seed corn pioneers like Henry Wallace and Roswell Garst. Garst, in particular, drove the backroads of Iowa and the eastern areas of the plains states, selling and/or giving away bags of hybrid corn out of the trunk of his car. He devised many schemes to get farmers to try hybrid seed, one of which involved sending two small bags of seed to every bank in targeted counties. The banks were asked to give the seed to the two most prominent farmers in their trade area. Through this method of making customers out of the habitual innovators in these areas, Garst and others induced many more farmers to try hybrid corn much more rapidly than even door-to-door sales could achieve.[17]

Another reason for the rapid adoption and success (besides the obvious lure of uniformity of stands and higher yields) of hybrid corn seed must be attributed to the close working relationship that developed between the agricultural colleges, experiment stations, and agribusiness companies. Historian Irvin May observes:

> Corn is an example of the use of experiment station research by commercial companies to achieve practical results unobtainable by either the experiment stations or the scientists themselves.[18]

While it is not at all clear that experiment stations could not have brought hybrid seed to market readiness, the above assertion reinforces the perception that there existed a substantial connection between the private and public spheres. Henry Wallace, for example, developed and promoted his research on corn hybrids only after reading of the advancements being made at the public agricultural institutions.[19] Not much time elapsed between the invention of hybridization at government research institutions and the rise of large seed corn corporations. Over the last twenty years, analysts such as Jim Hightower have blasted this close, often intimate relationship between the public scientific establishment and the giant agribusiness interests. He accuses the public research institutions of serving the needs and desires of agribusinesses and not those of individual farmers and small suppliers.[20]

While rejecting Hightower's assessment that land-grant institutions "are little more than handmaidens of agribusiness, providing companies with expertise and research that is neither scientifically nor socially justifiable", historian Deborah Fitzgerald believes there was a great deal of ambiguity in the relationships between farmers, commercial seed producers, and public research institutions. Also, the hard research choices made were seldom guided or even legitimized by long-term policy commitments from the federal government or the larger society. Large commercial research centers like Funk Brothers were able to take advantage of cooperative research projects with the land grant institutions and their bureaucratic squabbles and internal conflicts over mandates and long-term institutional goals, to initiate a decided shift in leadership and authority in their favor. In the short, but intense history of hybrid corn development, only the large seed companies remained largely untouched by various controversies and disturbances within the agricultural arena, allowing them to concentrate their power and legitimacy, and expand their expertise and voice over farming matters.[21]

Corn and other crop hybrids may well produce much greater yields, promote ease of harvesting through their greater uniformity of growth, and offer a standardization and predictability of product previously unattainable, but their costs, while sometimes subtle, are significant. Fitzgerald spells out some of these costs and benefits.

> Clearly, hybrid corn was not a uniform benefit to all. Large seed companies were enormously strengthened, while smaller seed producers were often absorbed by large producers or squeezed out of the market entirely. The benefit to farmers, moreover, has been mixed. Hybrids bred to withstand specific adverse field conditions have made corn growing a more stable and predictable

> venture, but the social and economic costs have been considerable. Not only must farmers buy new seed each year, but hybrid corn introduced an array of corollary farm products such as fertilizer, insecticides, herbicides, and other pesticides; the equipment used to apply these chemicals; and the enormous (and enormously expensive) machinery used to plant and harvest corn. In the past thirty years such additional "inputs" have attained the status of farming necessities for all but a tiny minority of agriculturalists. Further, the higher yielding capacity of hybrid corn, which initially increased farmers' production and income, has had the overall effect of sustaining chronic overproduction and declining farm prices.[22]

Thus, for the Corn Belt, hybrid corn has truly been a revolutionary causal agent. It has not only produced the expected yield increases of 20 to 30 percent, but it has intruded upon a relatively stable agrarian system and prompted multiple interactions among techniques and cultural practices, culminating in a systemic shift to a new mode of production--industrial agriculture. The impact of hybrid corn has been much greater than the simple increases in yield brought about by its genetic makeup. Farmers have been urged by agribusinesses, agricultural officials, and the lending community to combine it with other technologies such as fertilizers, chemicals, gigantic irrigation systems, narrow row spacings, high plant populations, and highly specialized, large planting and harvesting equipment.

Hybrid seed and chemical inputs have developed a close working "symbiosis" and this tandem is considered the technological standard. Increases in corn production have thus been multidimensional; they have been made in the names of technological efficiency, progress, the "rightness" of human mastery of the land, institutional optimism and inertia (both public and private), simple greed, and a psycho-cultural drivenness to realize a termination of uncertainty by means of continual material increases.[23]

The mechanism by which uncertainty would be ended was "certainty-producing" technology. Nature reduced to the nuts and bolts of a machine would have little choice in its operation and would have to comply with the desires of human beings. In the case of hybrid corn, one booster saw humanitarian consequences in its technological application (in addition to risk reduction), when he exuberantly exclaimed in 1947 that "the principles and practices first discovered and developed by the hybrid-corn makers are destined . . . to banish hunger and want."[24]

The impact of corn hybrids extended to many aspects of farming practice including the virtual cessation of crop rotation activities, forcing further reliance on weed and pest killing chemicals. Soybeans, another hybridized cash crop, has been teamed with corn to provide some rotational relief from continuous corn regimens. But back-to-back row crop plantings coupled with huge field dimensions (on cash grain farms the first structural change from the older mixed-livestock farm was often the complete elimination of internal fences . . . seen as barriers to easy planting), have often undercut measures taken to prevent soil erosion. In general, farmers now act in ways unthinkable a few decades ago when their dependence on commercial firms was less. No longer able to select their own seed, dependency on hybrids have obliged them to accept advice on the proper variety from the seed companies.[25]

The new status of corn and soybeans as cash crops has allowed and often encouraged a massive shift away from livestock farming to cash-crop enterprises. The value of corn no longer resides solely in its value as livestock feed on the farmstead where it was produced. Cash grain farms have largely abandoned the mixed livestock type of farming; their grain crops are shipped off the farm, and 90 percent becomes animal feed. Another unintended effect of hybrid corn vis-a-vis livestock is that some of the new hybrids have such hard kernels that hogs' mouths get sore chewing them.[26] Hence, feed grinding is almost an absolute necessity, raising the cost of livestock farming and injecting a complication that rarely existed in older farming systems based on non-hybridized corn. The move toward greater grinding of feed (as opposed to livestock doing much of the harvesting and masticating of uncracked corn and other grains) and purchasing of commercial feed and feed additives helped spur the transition to intensive, factory-style confinement in livestock raising methods.

For those farmers who shifted to cash grain growing without livestock, hybrid corn has also reduced labor requirements of Midwestern farming and has thereby contributed to rural population loss and the "unsettling" of traditional farm communities, regions, and even whole states.[27] Yet, it is difficult to blame farmers for the demise of rural society when just about all agricultural institutions called for this transition to industrial farming at one time or another. Whereas it may well be true that a study such as the one done by Zvi Griliches found that the process of hybrid corn innovation, adaptation, and rate of acceptance by entrepreneurs was "amenable to economic analysis," it also shows how easy it is to reduce causes other than rational economic self-interest to insignificance or ignorance.

Powers and pressures from within and without the agricultural community shaped farmers' views, perceptions, and behaviors concerning how they should farm and what kind of seeds they should plant. Title holders of twenty percent of Iowa land, insurance companies in the 1930s exercised coercive power over tenants and sharecroppers. Referent power was held by neighbors who acted as innovators and spread the "hybrid word." The land grant complex acted on the basis of expert power, exhorting farmers to switch to hybrid seed, in spite of the fact that overproduction was the main agricultural problem and hybrid yields would simply exacerbate that situation. Finally, bankers used their legitimate and reward powers inherent in the financial requirements of loans to encourage maximum production and hoped-for means of repayment. Farmers, like everyone else with loans, have legal and moral obligations to repay them on time. They can also be rewarded for timely payment by being granted more money for the next year's crop or particular farm improvement. Ultimately, the decision to adopt hybrid corn had many motivational sources, only one of which was profitability, and it may well not have been the most important cause either.[28]

Another concern about crop improvement is that yields may well be approaching their genetic limits. If that is the case, the fundamental standard for the measurement of agricultural success, continually bigger yields, will have to be reexamined and probably redefined. Regarding plant genetic limits, Vernon Ruttan claims that:

> . . . all that we have been doing in the last 80 years since Mendelian plant breeding started was to recover more and more of the dry matter in the form of grains. We are simply redistributing dry matter in the plants. In fact, if I were to be slightly cynical, I would say that in the last 30 years . . . in a biological sense--we have not increased crop yields at all.
>
> Now, it is obvious that there is a limit to improvement in the harvest index--the grain/straw ratio. In many crops that limit has already been reached: in wheat and rice. . . . I don't clearly see that in the next century we will be increasing yields; it is arithmetic--we will be reaching the limits of harvest index improvement.[29]

Thus, the adoption of hybrid crop varieties, especially corn hybrids, has catalyzed the shift to a new system of production, herein referred to as industrial agriculture. Hybridized crops have tended to behave like and be applied like machines, without consideration for the type of work they do, how much work they do, and what role their work plays within the larger agricultural and social system. Multiple interactions have taken place not only between farming technologies, between agricultural institutions, and between and among both groups of causal factors, but also between this new farming synthesis and the natural environment. The reciprocal nature of this relationship has sparked new concerns and controversies over the sustainability and ultimate desirability of an industrial farming system. Additionally, participation by both private and public institutions in agricultural goal articulation and technological development has structured the function of crop production techniques in such a way as to postpone or ignore consideration of their environmental impacts.

Inasmuch as sets of technology and institutions tend to take on lives of their own, especially when they function on large scales (as they do in mass societies), they act as causal agents, with their consequences manifested as both direct and indirect (inter-mixed) effects. Only when the operations of all major causal factors in place construction are analyzed and their holistic, synthesizing activities are observed can we begin restoring ecological health. In the case of hybrid crops, we must critically examine the appropriateness of Corn Belt monocultures of corn and soybeans before we can hope to develop sustainable agroecosystems. The development of long-term policy considerations is essential in this regard, for appropriate technologies and their mixtures need to be selected with caution and wisdom to insure the minimization of negative, unintended consequences. Finally, the effects of technological application need to be ascertained in regard to the issues of fairness, justice, and communitarian stability and harmony. After all, place is a collective and interdependent construct embodied simultaneously in both the natural environment and the social/institutional world of human beings.

But somehow, the legacy of agricultural place construction has not spoken to the values listed above. The historical inertia of technological advancement, deference to profitability, and the siren talisman of the "free" marketplace have dominated the discourse and debate concerning agriculture's direction. The third element of the troika of reality construction, consciousness, cannot be denied its due. There is little surprise in all this: organic outlooks produced organic places; the modern mechanical mindset produced a massive, monodimensional agricultural machine that has gone beyond any one capital input such as hybrid seeds to envelop and alter (almost to extinction) an entire way of life. Those looking for the machine in the organism have apparently found it in the operations and forms of industrial agriculture. It is difficult to conceive of or call this machine a place. So it is that modern agricultural place has been propounded and accepted with little concern for its natural and social ecological consequences.[30]

NOTES

1. Notable works concerning the development of corn and modern farming are: Richard Crabb, The Hybrid Corn Makers: Prophets of Plenty (New Brunswick, N.J.: Rutgers University Press, 1948); Jack Ralph Kloppenburg, First the Seed: The Political Economy of Plant Biotechnology, 1492-2000 (Cambridge: Cambridge University Press, 1988); and Deborah Fitzgerald, The Business of Breeding: Hybrid Corn in Illinois, 1890-1940 (Ithaca: Cornell University Press, 1990).

2. Walter Ebeling, The Fruited Plain: The Story of American Agriculture (Berkeley: University of California Press, 1979), 176.

3. Howard T. Walden, Native Inheritance: The Story of Corn in America (New York: Harper and Row, 1966), 21-22, 36. The ten states comprising the Corn Belt are Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, South Dakota, and Nebraska. The National Research Council, Alternative Agriculture (Washington, D.C.: National Academy Press, 1989), 34, provides figures on yield increases.

4. Walden, 41-42, 50-51.

5. Ibid., 43.

6. Ibid., 43.

7. Ibid., 43.

8. Ibid., 44-45.

9. Fitzgerald, 10.

10. Carl Hamilton, In No Time At All (Ames: Iowa State University Press, 1974). Henry C. Taylor, Tarpleywick: A Century of Iowa Farming (Ames: Iowa State University Press, 1970), 32-33.

11. Fitzgerald, 11-12. G. F. Sprague, and J. C. Cunningham, "Growing the Bumper Corn Crop," ed. Iowa State College Staff and The Iowa Agricultural Experiment Station, A Century of Farming in Iowa, 1846-1946 (Ames: Iowa State College Press, 1946), 36-41.

12. Fitzgerald, 10.

13. Ibid., 18-22, 49-57. Alan I. Marcus, Technology in America: A Brief History (San Diego: Harcourt, Brace and Jovanovich, 1989), 278-279.

14. Fitzgerald, 126. Sprague and Cunningham, 39.

15. Sprague and Cunningham, 40-41.

16. Marcus, 280.

17. Sprague and Cunningham, 41. Harold Lee, Roswell Garst: A Biography (Ames: Iowa State University Press, 1984), 40-45.

18. Irvin M. May, "Research in Land Grant Universities: The Agricultural Experiment Station," ed. Trudy Haskamp Peterson, Farmers, Bureaucrats, and Middlemen: Historical Perspectives on American Agriculture (Washington, D.C.: Howard University Press, 1980), 188.

19. Ibid., 188.

20. Jim Hightower, Hard Tomatoes, Hard Times (Cambridge: Schenkman Publishing Co., 1973).

21. Fitzgerald, 222-223. William Cochrane, The Development of American Agriculture (Minneapolis: University of Minnesota Press, 1979), 105, tends to excuse the public agricultural institutions, especially the U.S.D.A., observing that ". . . the department was not ready to, nor did the research personnel have the capacity to, embark upon action programs to deal with economic problems besetting farmers."

22. Fitzgerald, 223.

23. Howard F. Gregor, Industrialization of U.S. Agriculture: An Interpretive Atlas (Boulder: Westview Press, 1982), 50-51.

24. A. Richard Crabb, The Hybrid-Corn Makers (New Brunswick: Rutgers University Press, 1947), 318.

25. Gregor, 50-52. Fitzgerald, 221.

26. Gene Logsdon, "The Importance of Traditional Farming Practices for a Sustainable Modern Agriculture," ed. Wes Jackson, Wendell Berry, and Bruce Colman, Meeting the Expectations of the Land: Essays in Sustainable Agriculture and Stewardship (San Francisco: North Point Press, 1984), 12.

27. See Wendell Berry, The Unsettling of America: Culture and Agriculture (San Francisco: The Sierra Club, 1977); Marty Strange, Family Farms: A New Economic Vision (Lincoln: University of Nebraska Press, 1988); Gordon K. Douglass, ed., Agricultural Sustainability in a Changing World Order (Boulder: Westview Press, 1984), 1-30, 203-276; and Wes Jackson, New Roots for Agriculture (San Francisco: Friends of the Earth, 1980), for a discussion of sustainability as food sufficiency, stewardship, and community.

28. Zvi Griliches, "Hybrid Corn: An Explanation in the Economics of Technological Change," Econometrica 25, (Oct. 1957): 501-522.

29. Vernon W. Ruttan, quoted in Iowa State University Research Foundation, Farming Systems for Iowa: Seeking Alternatives (Ames: Leopold Center for Sustainable Agriculture, 1990), 17. Some observers have offered biotechnology as a promising process for reversing the decline in the rate of crop yield growth. But these high-tech molecular biological processes and potential products may end up creating more problems than they solve. In this regard, technological development is fraught with examples of problematical "advances": DDT, nitrates in drinking water, massive soil erosion due to progressive farming with large equipment, and so on.

30. See Miguel A. Altieri, Deborah K. Letourneau, and James R. Davis, "Developing Sustainable Agroecosystems," Bioscience 33, (Jan. 1983): 45-49, for an agroscientific perspective on the requirements for developing a blend of sustainable agriculture and healthy ecosystems. See also the National Research Council's Alternative Agriculture. Especially noteworthy are the eleven case studies featuring alternative agroecological systems--three of which are located in the Midwest.

Barry Commoner speaks concisely about the dynamic interaction of modern humans' machines, machine mentality, and growing environmental crisis afflicting the entire culture, including agriculture in The Closing Circle (New York: Alfred A. Knopf, 1971); see also The Subversive Science by Paul Shepard and Daniel McKinley, editors (New York: Houghton Mifflin, 1969).

CHAPTER 8

ANIMALS INTO BIOMACHINES--THE INDUSTRIALIZATION OF LIVESTOCK RAISING

The final element operative in the transformation of Corn Belt agricultural place is in the area of livestock and poultry raising. After World War II, rapid changes occurred in breeding, feeding, control of growth and general animal behavior, and in housing and care of animals. These changes helped stimulate the transition from traditional farming methods based on low energy, semi-extensive, mixed practices (crops and livestock together) to those of high energy, intensive, highly capitalized and specialized industrial farming. This aspect of agriculture, of all the types of capital inputs so far considered, comes the closest to the industrial model.

The "look" of confinement animal raising is that of a factory, with machinery and animals hidden inside of large buildings (often windowless). Typically, at one end of these buildings raw materials enter, such as feed, and waste materials exit from the other end. Like the industrial process, bulky raw materials are "machined" into less bulky finished goods. The animals usually lose their mobility in cages, and themselves become machine-like in their activities. The scale of operations tends to be large and products are standard and homogeneous. Even in open-air, semi-confinement facilities like feedlots, the "look" and operation is like a factory, only in the open air. Finally, ownership arrangements tend toward corporate control in terms of either direct ownership, contractual agreements, or managerial oversight, thus often reducing farmers (such as most poultry growers) to the "rural equivalent of a factory worker."[1]

Statistics showing the increases in production and consumption of livestock products and the decrease in labor required in their production give an initial indication of some of the parameters involved in the transformation of the livestock production industry. In the period 1940 to 1977, the production of poultry and eggs rose 197 percent, while that of meat animals increased 75 percent. The production of dairy foods went up 27 percent in that same period. Per capita meat consumption rose 57 percent for that period. Total farm labor used for livestock production fell by 75 percent from 1940 to 1977. Greater availability of corn and other feed grains and dramatically lower real prices over this time period helped fuel the growth in production, numbers of livestock, and productivity. The <u>real</u> price of corn in particular fell steadily from $6.43 per bushel in 1947 to $1.12 per bushel in 1977.[2]

Prior to 1940, however, livestock farmers were not much concerned with the price of corn in terms of how much it would cost to feed their livestock (in the context of minimal purchases of external inputs). Most of their livestocks' feed requirements were grown right there on the farm, so very little commercial feed was needed. The typical Corn Belt pre-war farm was a diversified family operation with small quantities of many different animals and crops--dairy cows, beef cattle, hogs, sheep, chickens, corn, oats, and hay. High density animal confinement was uncommon. Farmers relied more heavily on the use of pastures, harvested forages, and small grains, which required longer crop rotations and less use of some purchased inputs, particularly fertilizers, herbicides, and pesticides. It was a land and labor intensive enterprise, and it did not rely on one or even two product lines for its survival. If hog cholera struck, for example, the other animals would survive and provide food for the family and income to cover cash expenses.[3]

Not only were individual farms diversified and more independent, but entire rural communities were part of larger networks, themselves diversified and, to some extent, decentralized. Thus, having some independence from the larger society, they were afforded a degree of stability and retained some autonomy in the face of potential threats from the dominance of the marketplace. Jobs were not tied to the fates of giant, distant corporations or that of a sole large scale provider of employment in a particular community. Neighborhoods "looked out for" people in dire straits.

The technology of traditional livestock raising in the Midwest centered around the time honored combination of permanent pasture, corn, and hogs. Hogs were known as the "mortgage-lifters" and for good reason. Where other crops and livestock might experience poor production years or depressed commodity prices, hogs were relied on to pay off long-term debt year in and year out. Sows lived and farrowed (gave birth) out of doors or in cheaply constructed huts out on permanent or semi-permanent pasture ground. Small amounts of corn were brought to the enclosures and the rest of their diet consisted of whatever they could root and forage. When placed on alfalfa, sows made excellent use of that high quality legume.

Although primitive in appearance, this method, known as the "clean ground system", was actually a fairly sophisticated practice. It isolated the mothers and their young from older stock, reducing disease transmission. Pigs raised on pasture were cleaner, got more exercise, and were in general healthier than hogs raised in confinement. In addition, hogs on pasture were less subject to the stress of crowding than those in confinement. No expensive buildings or manure handling systems were required--the main costs accrued in labor and fencing. Although outdoor farrowed pigs had smaller litters than those farrowed indoors, the pasture pig system was not under the burden of high capital and overhead costs. A variation of this system allowed older pigs to harvest ("hog-off") a small field or fields of unharvested corn. Although somewhat wasteful of grain, it suited the labor regime of most farmers at the time. In addition, it was an ecologically balanced practice, for while the hogs harvested corn, they also inexpensively fertilized the land.[4]

The hogs were usually followed by the beef cow herd which cleaned up corn left by the hogs and fed on the corn stalks, sometimes overwintering on field stubble, perhaps supplemented with hay. In the northern part of the Corn Belt, severe weather forced farmers to bring stock cows into three sided cattle sheds for most of the winter. There they were protected from fierce winds and provided with dry bedding. Calving took place in the spring, and the calves were either sold for veal or as feeder cattle, or were fed to maturity on the same farm as their birth.[5]

Almost from the beginning of Corn Belt farming, this region has been the leader in grain-fed beef cattle. Most farms fattened calves from their own stock cows in addition to fattening feeder cattle bought from cow-calf operations in the Great Plains and the Southwest. Most of these operations finished fewer than one hundred head per year. Purebred herds based on breeds such as the Angus and Hereford achieved prominence and profitability because of their higher weight gaining ability with heavy corn and protein supplemented feeding programs.[6]

Sheep, poultry, and other fowl occupied smaller niches on the traditional Corn Belt farmplace, but important nonetheless. Sheep helped utilize pastures (they will eat certain grasses other grazing animals will not); lambs turned into August cornfields cleaned up stray weeds before they went to seed; sheep were used to trim up fencerows and around buildings and roads. They also contributed mutton for the family table and wool for the manufacture of clothing and off-farm sale. The mindset that operated in this labor intensive, earthy, physically demanding partnership with livestock was one of not letting anything go to waste. Iowan Carl Hamilton remembers when one of his family's sheep bucks was killed by the other buck; nothing was wasted--the buck's fat was made into soap and the meat eaten.[7]

It was taken for granted that chickens would be raised for their meat and eggs, the sale of which brought the woman of the household her money for the purchase of grocery items not produced on the farm and for a few luxury items or material for clothing, bedding, etc. Although usually a sideline, flocks of one hundred to two hundred hens were not uncommon. Although there were commercial hatcheries where baby chicks could be purchased, most farmers had their own roosters and raised their own replacement hens. Chickens were rarely the main farm activity unless a farmer close to a major city specialized in their raising. Hence, they received the least amount of management and planning, often running free around the farmstead and roosting in the trees. Although nuisances at times, free ranging chickens acted as scavengers and cleaned the farmstead of spilled grain and ground hugging insects. Of course, they were put in a hen house for the winter, although getting them there was not particularly easy. Not all farmers allowed their chickens free range in the summer, but then they also had to face the dirty, dusty, cramped, miserable job of cleaning the chicken house more often. For reasons of low monetary return and lack of interest, the raising of chickens, and other fowl like geese, ducks, and turkeys was often the first part of the traditional farm scene to be abandoned when the process of industrialization impacted the mixed crop and livestock farm.[8]

Nevertheless, the traditional farming methodology was a logical business response to limited labor and capital, and it was a way of life that was essentially environmentally sound and in harmony with nature's place.* To some extent, the raising of livestock forced

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*Admittedly, pre-war farms, many in the Midwest, suffered greatly from soil erosion. This indeed, was their main failing. But farmers to take nature's return cycle seriously. Manure was either perceived as a nuisance or as fertilizer free for the hauling (although at times probably both). Livestock completed the agroecological connection between cropland, hay ground, and pasture by consuming the products of each at the appropriate (and different) times and by returning to each fertility and the requirement of rotational stability and continuity. The major ecological consequences of this intermeshing of objectives and activities is a balance of forces and resources and a healthy diversity of crops and livestock, and ideally, vital and wide ranging communities of micro-flora/fauna and wildlife.

In addition to being basically synchronous with nature's rhythms and ecological communities of minerals, microbiotics, plants, and animals, traditional farmers demonstrated other characteristics indicative of communitarian harmony within the remaining realms of place--institutional constructions and worldview edifices. As Gene Logsdon notes, traditional farmers did not keep all their resources in one operation or enterprise, and the communities in which they lived supported them in that method of production by providing a market for the sale of small quantities of many varied items. They generally did not incur large start-up costs or go heavily into debt, especially at the high interest rates which prevailed in the 1970s and 1980s. Those

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with the coming of soil conservation practices (most common-sense in nature and relatively easy to implement) such as contour plowing, strip cropping, terracing, and grassed waterways, soil conditions could have been stabilized without changing to industrial agricultural methods (which have not exactly eliminated soil erosion either).

decades saw many highly leveraged farmers fail due to one bad year of weather. Historically, traditional farmers were able to endure more than one year of bad crop and/or livestock setbacks precisely because they were not overcapitalized or overburdened with debt. A second characteristic of this type of farmer is the acquisition of a multitude of skills which tend to make him more self-sufficient than the highly specialized industrial farmer. A third characteristic is that the traditional farm is a place of a diversity of commercial and subsistence activities that make it less susceptible to the inevitable "ups and downs" of the commodity markets and the boom and bust cycles of the capitalist economy in general. Cash flow tends to even out on such a farm, and the pressure on any one operation to produce more than a marginal profit is reduced. Livestock were not rushed through their growth cycles, fattening more slowly on cheaper feed sources at hand that kept costs down and provided timely, cash flow producing marketings. Ultimately, such conservative financial behavior presupposes the conservation of an ethic of environmental health and stability.[9]

It is important to see pre-war traditional farming as a system, complete and for the most part, ecologically sound. All systems are composed of parts, which are interrelated. The greater their interrelatedness, the greater the coherence of the system. "In highly coherent systems a change in one part can be expected to have repercussions throughout the system."[10] So it was that the traditional agricultural system which existed in the Corn Belt prior to World

War II was undercut and disrupted by a relatively non-selective, nearly simultaneous, rapid adoption of varied agricultural technologies. The new system aimed at maximum productivity and maximum profits, whereas the old system depended on the interaction of many operations, each with their own special place in the whole. Its aim was continuity and symbiosis. The systems' parts meshed evenly and the system "worked" (high coherence existed) mainly because it upheld the principle of sustainability--the ecological aspect of place was supported. Although there were hints of moderate, latent commercialism and monodimensional profit thinking inherent in this traditional worldview, it generally sought a fair return plus an occasional respite from the hard physical labor. Labor-saving devices were accepted, but hard work was rarely shirked or escape from it sought. Thus, the consciousness aspect of place manifested by traditional farmers was basically in harmony with agricultural reality as its construction unfolded and developed.

As previously mentioned, however, this agricultural system was not without its problems. In this regard, its main defects appeared in its institutional infrastructure. Market forces and governmental policies were not adequate counter-balances to the problems of overproduction and rural poverty, which plagued Corn Belt farmers for much of the post-Civil War century. Governments, especially, were reluctant to help farmers limit their production (from the Depression onwards there have been government-sponsored compensatory programs in place, although the reluctance has remained), so agricultural prices never really reflected the value of farm commodities (this was particularly true in the twentieth century, except of course during the "Golden Age" of agriculture; and that was produced by an extraordinary event--World War I). Demand seldom kept up with supply, and farmers' organizations such as the Grange, National Farmers Union, Farm Bureau, and the most militant, the National Farmers Organization, have proven unable to affect levels of production or the structure of American agriculture over the long term.[11]

The trauma of the Great Depression left the Corn Belt agricultural system vulnerable to wholesale change; its high coherence worked against itself as many externally introduced changes ramified throughout the system, disrupting its innate balances.[12] Local communities were virtually helpless to compensate for the enormous downturn in fortunes. They suffered substantial shocks in the 1930s and again in the 1970s.[13] But the decline of the farm population and the erosion of the business base of small market towns has been a steady, gradual phenomenon, reducing the quality of life for people who thought they had the permanent benefits of a good life amidst a good place. The steady disappearance of many dairy cows, beef cattle, sheep, and chickens from a substantial number of Corn Belt farms reflected changes in technology, institutional choices, and consciousness.

The industrialization of the livestock industry began at different times for different species. The chicken industry moved first into factory farming, even before World War II in some cases.

The demand for eggs and meat in large cities caused nearby farmers to specialize in year-round production of chickens. Egg production always had fallen off during winter confinement, but the discovery of vitamins beginning in 1907 (especially vitamins A and D) and their use in fortified feeds, enabled not only continued broiler and layer production during the winter, but also year-round confinement operations.[14] As production expanded, the tendency was to build bigger buildings and increase the number of birds per building. The resultant crowding produced stress and exacerbated unsanitary conditions; when combined with poorly ventilated buildings, diseases multiplied and contributed to growing losses--in some cases entire flocks died. Some shakeout took place in the industry, but the potential for profits from large-scale production was not lost on well capitalized farmers, investors, and industry executives.[15]

Higher demand during the war years boosted interest in the chicken business by the largest feed and drug companies. They began a technological search for the solutions to problems that had heretofore stymied the growth of large scale poultry production. Confined birds often showed losses due to pecking and cannibalism. Debeaking was the solution, either by burning off the beak tips, or by the use of the newly developed automatic debeaking machine. Feeding and watering became mechanized and the operation of lights and fans became automatic. The problem of manure accumulation was "solved" by confining chickens in wire cages, with the number per cage quickly surpassing the solitary chicken initially placed in each cage. Rows of cages were suspended above the concrete floor, across which moved a motorized scraper or one pulled by a cable; manure removal no longer disturbed the animals and could be accomplished any time, not only between batches of broilers. Meanwhile, pharmaceutical companies introduced sulfa drugs and antibiotics to chicken feeds in an attempt to counter disease outbreaks. In addition to controlling diseases, the new drugs proved to stimulate chickens' growth rate.[16]

The chicken itself was not immune from redesign. In 1946, the Great Atlantic and Pacific Tea Company (A & P grocery chain), in cooperation with the U.S. Department of Agriculture, the Land Grant complex, and the poultry industry, started the search for a "Chicken-of-Tomorrow." It would combine a rapid rate of growth and economy of feeding with a meaty-breasted carcass.[17] Genetic manipulation soon created such a bird, one so top-heavy it had trouble walking without toppling over.[18]

With red meat rationed during the war, the nation's tastes turned more toward chicken.[19] From about 100 million pounds liveweight of chicken raised in 1934, broiler production rose to more than eleven billion pounds in 1973.[20] Although egg production has not shown the phenomenal growth of broiler numbers, egg numbers rose from approximately 42 million in 1942 to about 72 million in 1973. In 1930, laying hens averaged 100-120 eggs per year. Today, average hens lay over twice that many.[21] Egg laying flock sizes have also increased, rising from twenty thousand to eighty thousand birds per house between 1955 and 1975. Today, about 95 percent of all egg production comes from automated factory buildings in which the birds have been caged their entire one to two year life span, at which time they literally "wear out" (egg production drops) and are made into processed foods.[22]

Not only is the chicken industry dominated by large scale production operations, ownership of that industry is mainly controlled by large corporations, either poultry processors or agricultural conglomerates.[23] This development began in the 1950s and 1960s as part of a second shakeout wave (recall the first took place just prior to and during the Second World War). Highly capitalized corporations bought up and expanded some of the numerous small chicken-processing plants around the country. Next, they moved into the actual raising of chickens to assist in the control of supplies. These "integrators" either bought out or forced out of business (by means of years of glutted markets and low prices) most of the small and medium sized producers. "And one more opportunity, once taken as a matter of course--for supplementing farm income with a labor-intensive, quality small-scale enterprise--had become impossible."[24]

This type of rampant consolidation of chicken operations--both the broiler and to a lesser extent, egg industries--has revolutionized the poultry industry and all but removed it from the Corn Belt. Almost all broiler operations are now located in the South, and a great many egg farms are outside of the Corn Belt. To a large extent, technology and capital caused this transformation and shaped the resultant agricultural structure. Managerial and technological "modernization" have fostered a shift of massive proportions in terms of control, power, and decision-making in the poultry industry. Jack Doyle observes that:

> Since 1954, for example, more than 40 percent of the nation's broiler farmers have gone out of business, and most of those that remain now produce for large poultry processors. These companies are "vertically integrated"; that is, they produce and supply the chicks and feed to farmers, buy back the finished birds, and process them for market. "Already in South Dakota," says farm extension economist Mark Edelman, "you can't sell or produce poultry products on any sizeable scale unless you're under contract to a processor. There just isn't any open market available."[25]

Capital, corporate contracting, and technology contributed to the development of the factory system for poultry nationwide and its substantial diminution in the Corn Belt. In addition, the development of an industrial agricultural consciousness acted in both the roles of cause and effect of this transformation. It was manifested in the modern mechanical mentality:

> The modern layer is, after all, only a very efficient converting machine, changing the raw material--feedstuffs--into the finished product--the egg--less, of course, maintenance requirements.[26]

This mindset functions well irrespective of the particular farm animal under consideration.

> Forget the pig is an animal. Treat him just like a machine in a factory. Schedule treatments like you would lubrication. Breeding season like the first step in an assembly line. And marketing like the delivery of finished goods.[27]

Livestock have been turned into biomachines in the thoughts of the agri-business mind, external to and apart from the concept of the farm as a place, whole and complete.

> The breeding sow should be thought of as, and treated as, a valuable piece of machinery whose function is to pump out baby pigs like a sausage machine.[28]

The factor farm mindset has been enhanced by the power and allure of money-making based on the idea of profitability accruing from the mass production of goods at minimal cost per unit. The standard of success in this type of farm operation is measured by how far the farmer moves away from the dynamics and structure of the "old" traditional farm, and how much of the "new" mechanical apparatuses and formal managerial techniques are adopted.

> Regardless of the type of animal confined or the commodity purchased, all factory systems are designed to make more money from more animals. Instead of hired hands, the factory farmer employs pumps, fans, switches, slatted or wire floors, and automatic feeding and watering hardware. The factory farmer is a capital-intensive farmer whose greatest investment is in time- and labor-saving equipment. Success in farming is not achieved by direct care for the animals. It does not depend on the well-being of individual animals or even on individual productivity. Success comes from maximally efficient use of equipment. It is measured by year-end production records. Like managers of other factories, capital-intensive farmers are principally concerned with cost of input and volume of output. A certain amount of wastage doesn't matter if the product wasted is cheap by comparison with overheads and if eliminating the wastage would raise costs or reduce output. All this is as true of animal factories as of any other factory; the difference is that in animal factories the product is a living creature capable of pain and fear, a creature worthy of moral consideration that inanimate objects neither require nor could benefit from.[29]

The mentality of factory farming subsumes the machine orientation, while itself being a subset of the larger industrial worldview. The modern weltanschauung seeks to redesign the environment for maximum production; Corn Belt agriculture is no exception to this tendency. Environmental alterations and the concomitant effects on livestock are visible in each of five areas of animal production analysis: (1) breeding (2) feeding (3) housing (4) growth/health and behavior (5) and marketing.

Farmers have for centuries bred livestock for certain desirable characteristics. Those that had the time, money, and inclination tried to achieve greater production, combined with traits that were place specific; that is, attributes were sought that would allow livestock to survive well according to the demands of different climatic and terrain conditions. The great number of sheep and cattle breeds in the British Isles, for instance, attest to that fact.[30] But a great deal of this Old World genetic diversity is not found in the New World, and less and less in its original range.

Industrial farming generally bred out remaining "survival" characteristics in favor of those more conducive to enhanced production--meatiness, rapid rate of growth, feed to weight conversion rate, and so on. In so doing, it has come to rely on a very narrow genetic base. In the dairy industry, the Holstein cow now constitutes 70 percent of the nation's herd.[31] The Holstein itself is commonly seen as an overbred animal, no longer able to run and burdened with a distended udder which at times drags on the ground or is kicked and gouged by the cow's rear hooves. It is a high-strung breed, more disease prone than other dairy breeds. Overall, milk production per cow in the United States has doubled since 1950, and one expert attributed 33 percent of this increase to breeding improvement.[32]

Much the same is true of other livestock. Among beef cattle, Angus and Hereford breeds comprise more than 80 percent of all registered breeds. Crossbreeding with breeds like the Brahman and others produced "new" lines of cattle like the Saint Gertrudis, Beefmaster, Brangus, and McCan. Such breeding was enhanced and made easier by the introduction of artificial insemination techniques. Begun in the late 1930s, this technology allowed these breeds to flourish and spurred swift genetic improvement not only in beef cattle, but in all livestock species. More than 90 percent of all hogs are bred from eight purebred lines, with estimates of over 60 percent accounted for by two breeds in the United States--Duroc and Hampshire. In the broiler industry, growers pick the Rock Cornish hen most often. The egg industry favors the White Leghorn, and the turkey industry relies on the broad-breasted white breeds for their genetic base.[33]

Breeding for desirable characteristics like faster growing and meatier hogs has tended to create unforeseen negative consequences like aggravating foot and leg complications. These problems have been exacerbated by the newer factory growing environments with their wire-mesh, concrete-slab, and metal-slat floors of confinement buildings. It is estimated that approximately 50 percent of all confinement-raised hogs are lame by the time of slaughter.[34]

The heavy emphasis placed on rapid growth and other profit-producing animal characteristics forces other desirable traits into secondary statuses, often to the detriment of the livestock. Beef cattle bred for maximum feed efficiency tend to lack the favorable trait of easy births. Also, the most efficient converters of feed to meat are not always the fastest gainers. Breeds of hogs which produce larger than normal litters tend to show poor mothering traits and high birth mortality. Fast growing hogs and chickens have skeletons which tend not to keep up with growth in their fleshy bodies. In sows, this characteristic tends to allow mothers to crush or smother their offspring accidentally.[35] Breeding for man-made, inorganic environments has replaced selection for more naturally occurring, organic places like pastures, fields, forests, streams, ponds, and tree-shaded lanes.

Advancements in breeding may be fast approaching production limits other than genetics:

> Some of our highest producing cows and hens have higher capacity [sic] for production of milk or eggs than they can physically sustain by feed intake and digestion. Many cows which yield 100 pounds or more of milk during the first third of a lactation period do so by using body reserves of protein, energy, minerals, and vitamins as well as from current feed intake. As feed intake approaches maximum, digestibility diminishes. They may restore these reserves during latter portions of lactation and the "dry" period before the next parturition.[36]

Improvements in livestock feeding have contributed enormously to the higher productivity of market animals. Mention has been made of the discovery of vitamins and their use in chicken feed. The feed mixing industry grew rapidly during World War II; many Corn Belt farmers who had been using unmixed protein supplements, switched to mixed feeds (obtained from feed distributors and mills) which contained added vitamins and trace minerals.[37] Suggestions for better feeding programs often reached the farmer by means of the newspaper.

In a Des Moines Register article from 1950, the author espoused feeding vitamins, especially vitamin B-12 to pigs, because it made them gain weight faster and helped runt pigs do better. The same article also advocated feeding non-food compounds to pigs because it had the same effect as the vitamins: antibiotics.[38]

Of course, antibiotics were designed to combat disease, but it is a testament to monodimensional thinking (seeking profit first, foremost, and at times, blindly) that the original intent stemming from their invention was subverted to the demands of feeding programs that pushed livestock to market weight in the least time possible. Subtherapeutic use of antibiotics in feed turned out to indeed promote faster growth in most livestock types, but it seemed to work well only for animals raised under suboptimal conditions, and then to ironically leave them more susceptible to illness by killing the beneficial organisms in their digestive tracts.[39] Livestock antibiotic use in the United States rose from 265,000 pounds in 1951 to 12.3 million pounds in 1978.[40] Concern over residues from growth stimulants rose in response to a reaction against impurities in food and the environment in general.

After the war, people who advocated the traditional wisdom of the mixed crop and livestock farm quickly became minority voices, although they were still heard in popular publications. In one article, the author called for more balanced and nutritive feeding of sows, whether bred or unbred. Healthier, better pig litters would be the result of a consistent, high-quality sow feeding program.[41]

In 1950, such a voice began to be drowned out by a chorus of factory farm advocates. The new conventional wisdom advised farmers to "limit feed" their relatively inactive sows once every two or three days to hold down weight gain and feed costs.[42]

Other types of specialized farmers like cattle raisers, as A. L. Neumann pointed out, were not particularly concerned with the cost of basic feedstuffs in the decade of the 1960s because they went down along with the costs of more efficient feed rations, feeding and breeding programs, labor, mechanization, and general economies of scale. What concerned them the most was that the costs of land, buildings, feedlot equipment, tools, taxes and credit seemed to go up faster than the sale prices of cattle.[43] This cost/price squeeze was partly responsible for the movement of a substantial portion of the cattle feeding industry out of the Corn Belt to the Great Plains states and the Southwest. This resulted in a decrease in "the diversity that characterized agriculture in the 1960s for Iowa and the Midwest."[44]

Another force that propelled a portion of the livestock industry out of the Corn Belt was the relative costs of transporting livestock, live or in carcass, compared to the cost of transporting grain to finishing operations close to population centers. In the 1970s, the cost of transporting grain fell against that of livestock, and many new feeding facilities were constructed near cities in the Southwest, South, and East coast regions. These feeding operations were often very large feedlots or extensive confinement complexes which utilized economies of scale, extreme specialization, and rising productivity in terms of man-hours produced by massive mechanization of animal factory operations.[45]

While most Corn Belt livestock operations that remain in business have not moved completely into a total confinement mode, factory farming and specialization is on the upswing. For example, most hog farms were farrow-to-finish operations--pigs were raised from birth all the way to market weight. But the trend is to specialize in farrowing, if one is interested in spending a large amount of time in the birthing process, or in finishing feeder pigs, if the growing aspect is more attractive. The big advantage of specialization comes in the rapid turnover of livestock and a chance to make higher overall profits. The disadvantages include increased costs (especially capital costs for special buildings, equipment, and interest charges on the usually large amounts of credit required), more transportation of animals, increased vulnerability to business fluctuations, decreased control over quality, and greater operation on borrowed capital.

Nonetheless, another advantage to this system of livestock specialization that often tips the balance toward it in the farmer's mind is the tax benefits of specialization, large scale production, and incorporation. But, it should be noted that it is seldom the case that high-capital methods of livestock raising use capital more efficiently than traditional means. To the contrary, capital invested in full life-cycle production resists specialization by balancing a variety of inputs such as land, labor, feed, animals, and manure handling equipment rather than concentrating just on buildings and hardware and retaining control and profits on the "home place" as opposed to dependence on outside managerial and financial expertise and regulations. As Extension experiment station research shows, updated traditional farming systems use capital efficiently, stimulate profits, and maintain ownership and control within the family farm or small corporate farming unit. Despite this demonstration, Mark Kramer believes that it is the tax structures which "invite the transformation of ownership of this crucial agricultural resource."[46]

Besides the tax structure itself driving the trend toward bigness in the livestock industry, the myths of "bigger is better" and "get bigger or get out" seem to have played a large role in perpetuating the idea that larger farms are necessarily more efficient farms. Many Corn Belt farmers heeded that advice and expanded, discontinued livestock raising and specialized in crop farming, or quit farming completely. But soon, evidence arose contradicting the large-farm mystique. Angus McDonald summarizes a 1967 U.S.D.A. report by economist J. Patrick Madden that found one- and two-person mechanized farms to be consistently most efficient. For example, Iowa cash grain and crop-livestock farms showed lowest costs in southern Iowa for 360 acre units; in northeast Iowa the same was true for farms between 400 and 800 acres. For feedlots lowest costs accrue in a size range between 1500 and 5000 head. Midwest dairy farms are most efficient with herds between 48 and 87 cows and sizes between 290 acres and 490 acres.[47]

Size of livestock operation and the confinement type of animal housing tend to go together. Problems with animal health which were seldom seen in traditional agriculture tend also to go together with the factory farming regime.

> High incidences of pneumonia, septicemia, abcesses in pigs, and arthritis, accounted for approximately 150,000 animals being condemned annually. One to two thousand calves are also condemned annually because of injuries, and 4,000 cattle because of emaciation. While the rates of condemnation make up a relatively small fraction of the millions of animals slaughtered each year, these figures do show that a great many animals are sick and in poor condition if not dead on arrival at the slaughter plant.[48]

Early on, most people involved in agribusiness realized that confinement housing adversely affected livestock health. Despite advantages in the control of air pollution in housing units, sanitation, and the ability to isolate herds from specific pathogens, factory farming environments tended to create problems as fast as original ones were solved. Increased stress levels, lack of exercise, unnatural high-energy, fast-growth diets, and debilitating side effects of narrow, super-specialized breeding programs all contributed to the deleterious nature of high volume, confinement feeding conditions. It was found that close confinement conditions promoted the swift spread of illness and diseases throughout whole herds. As has been observed, drug companies, feed distributors, scientists, and farmers responded with the invention and application of a multiplicity of feed additives, antibiotics, growth modulating hormones, and pesticides that facilitated the commercial viability of factory farming systems.

The livestock industry has become highly dependent on drugs, additives, and general chemical compounds. An American doctor, Michael W. Fox, estimates that over twenty thousand brands of animal drugs are currently used to spur livestock productivity and control disease.[49] The "drug-store approach," rather than preventative medicine has been taken with regard to all aspects of animal life, not just growth and feed efficiency.[50] Color enhancing chemicals are used to make chicken skins and egg yolks more yellow. Fungicides like malathion reduce grain spoilage. Various flavoring agents can either turn on animal appetites or turn them off. Pesticides are routinely utilized to combat flies, fleas, ticks, mites, and many other pests that thrive in closed housing areas.

As already noted, disease control has been sought by means of a vast variety of antibiotics, sulfa drugs, and other anti-bacterials. Bacterial resistance to these drugs is growing. Concern has been voiced over the possible transmission of antibiotic resistant pathogens to humans. Antibiotics and hormones have gained widespread use in boosting production in broilers, pigs, and cattle. Finally, a multifarious batch of miscellaneous chemicals have grown in popularity because they act in specialty areas or enhance the effects of other chemicals. Some augment sexual interest, boost chances of fertilization, or control digestive reactions in livestock. In total, the FDA has approved over one thousand different drug products and an equal number of chemicals for the livestock industry. Since the late 1950s, there has been growing concern over the issues of chemical residues in meat, milk, and eggs, and the degree to which these are dangerous to humans.[51]

The use of one drug in particular generated a lengthy controversy illustrative of the growing awareness over chemical residues in food. In 1947, the FDA granted approval for the use of the growth promotant diethylstilbestrol (DES) in chickens. DES implants in chicken necks were discontinued ten years later when residues were demonstrated in chicken meat. In the meantime, approval was given for use in feed and implants in beef cattle. By 1957, the estrogenic hormone was allowed in lamb raising. In that same year, however, a more sensitive method of testing for chemical residues was developed. In 1958, the positive results generated by this new testing procedure stimulated the passage of the Food Additives Amendment to the Food, Drug, and Cosmetic Act of 1938. Included in this legislation was a clause which prohibited any traces of carcinogenic agents in food--the Delaney Amendment.[52]

DES was shown to cause cancer in both animals and humans; the Department of Health, Education, and Welfare moved to ban it in 1959. The livestock and pharmaceutical industries objected vehemently and launched court appeals to overturn the ban. Court challenges postponed a final decision until 1979 when DES was finally and officially banned. "Yet, in spite of this ban, over 400,000 cattle have been impounded by the government because they were given illegal DES implants."[53]

Interestingly enough, in the case of DES, the very fountainhead of enlightened, scientific, and progressive research whose mission was to help agriculture and society was the source of that "wonder" drug. Iowa State University discovered, developed, patented, and promoted DES--all with tax dollars. In the process it earned $2.9 million.[54]

The final area of livestock production analysis is marketing. The goal of industrial farm marketing is to bring animals to sale weight as quickly and inexpensively as possible. In so doing, however, the agribusiness community has managed to externalize some costs onto the consuming public. Soil and water pollution, foul odors, possible cancer-causing residues in livestock products, and the demise of the family farmer and associated communities have in part been caused by the mechanization and industrialization of American and Corn Belt agriculture. It has been argued here that not only do the ends not justify the means modern factory farming utilized in the raising of livestock, but that the ends themselves, when taken to the extremes witnessed in factory farms, are highly undesirable and counter-productive in the long run for the larger society.

In all of the mechanisms designed to accelerate growth in livestock, their promoters exhibited a consistent energy of will and philosophical stance which strove to ". . . free animals of their environmental limits. These investigators considered growth, health, and feed relative phenomena, their parameters adjustable to the purposes and situations at hand."[55] They treated interdependent critical parts as independent variables manipulable at will with no regard for the integrity and literal wholesomeness of livestock products, or potential negative consequences of irresponsible meddling with coherent systems of livestock raising and community health. Outcomes other than growth and increased feed efficiency were seen as unrelated irritations to be overcome with a new machine or the machine-like action of a new drug or chemical.

The mechanical model of production has been applied to organic, non-mechanical creatures. The physical, ecologic, institutional, and cognitive aspects of place have all been ignored to one extent or another in the drive to put into place an industrial system of agriculture. The factory farming methodology set in motion forces (dating back to the late 1930s and on into the war) destructive of natural balances and rhythms in livestock, farmers, and farming communities. Corn Belt agricultural place has been prorogued in the sense that the factory system of animal raising can exist only so long as enough energy is pumped into it, and as long as consumers tolerate continual ingestion of chemical residues and known and potential carcinogens contained in animal food products. The postponement of agricultural place in the 1940s has bommeranged in the dramatically rising incidences of various cancers and other environmentally related maladies. The price of place intervention in this case is large and certain to grow larger. No pretense about the "rightness" or necessity of the industrial/factory system of the present agricultural place can change the evolving awareness of its inefficiencies, inequities, and dangers.

NOTES

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9. Logsdon, 9-11. Gene Logsdon, *Homesteading: How to Find New Independence on the Land* (Emmaus, Pa.: Rodale Press, 1973), 9-28. John Fraser Hart, *The Land that Feeds Us* (New York: Norton, 1991), 112; even an apologist for industrial agriculture, or at least an agricultural "realist" like Hart, admits that the basic crop rotation

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17. Mason and Singer, 2. Byerly, 265.

18. C. David Coats, Old MacDonald's Factory Farm (New York: Continuum, 1989), 123.

19. Kramer, 159.

20. Byerly, 264.

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CHAPTER 9

EPILOGUE--A NEW SENSE OF PLACE

It is said that every generation writes its own history. It can also be stated that every generation constructs its own cultural experience through its collective interactions with and within place. Meaning and identity constitute themselves within the flux of space, time, and community. These categories undergird and give coherence to human existence--they allow us to realize order and meaning in an otherwise ephemeral world. We achieve understanding of reality in an extended social context which we may refer to as culture. Culture is based on our rapport with experiential matrices of place, which necessarily involve our physical bodies and the material world, the organizational structures of societies, and the realm of consciousness. It is this totality and interdependence of experience which enables us to socially construct reality.

By virtue of the corporeal dimension of our existence, we are intimately tied to the land that feeds us. Despite an ever decreasing percentage of people involved in agriculture in the industrialized countries of the world, the practice of farming still makes important contributions to, and is in turn constituted by, its associations with its larger cultural background. This study claims that since the Second World War, the industrial model of environmental usage, economic organization, and symbolic/mythic orderings has increasingly tried to manipulate and control some aspects of the agricultural landscape to a degree that has produced serious disruptions and disconnections in the ecologies of physical places, social places, and psychic places. American/Corn Belt agricultural place has been subjected to "unsound" farming practices which are not sustainable in the long run and are destructive of soil, water, independent livelihoods, traditional ways of life, rural communities, the esthetics of living landscapes, and possibly even the food there raised. This "splendid fixation", almost intoxication with a machine-based technological posture fits poorly with nature, and runs roughshod over all life which does not fit its rigid parameters.

We can no longer afford, in too many ways, to be so callous and indifferent to the environment, because our very lives depend on it. We cannot ignore, put aside, adjourn, or postpone the circumstances and limitations imposed on us by Nature. By prorogating our existential requirements, we simply surrender to all that which is most base, vile, crass, and insidious within the human race.

There is evidence, however, that the industrial mentality as applied to American agriculture is shifting toward a sounder ecological approach. The concept of sustainability has entered into the agroecological debate at a fundamental level. We have begun to pay attention to holding the soil in place. Awareness of locale-dependent differences in fertility, soil tilth, climate, terrain, and soil-crop-livestock interactions are growing. Concern for a reduction of external inputs into the farming system is expanding (low input sustainable agriculture goes by the acronym "LISA"). In some Midwestern states, legislation has been passed dealing with ground and surface water quality and restrictions on the placement of feedlots and other intensive feeding systems. Limitations have been placed on the use and disposal of pesticides and their containers. Programs have been started to aid young people seeking to enter farming. At the federal level, the 1985 Farm Bill, with its emphasis on cross-compliance in agriculture and natural resource conservation policy is a good example of the beginning steps toward a more sustainable agriculture. Hopefully, the above taken together with future means and knowledge enabling us to live lightly and benignly on the planet Earth will herald the emergence of a new sense of place.

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