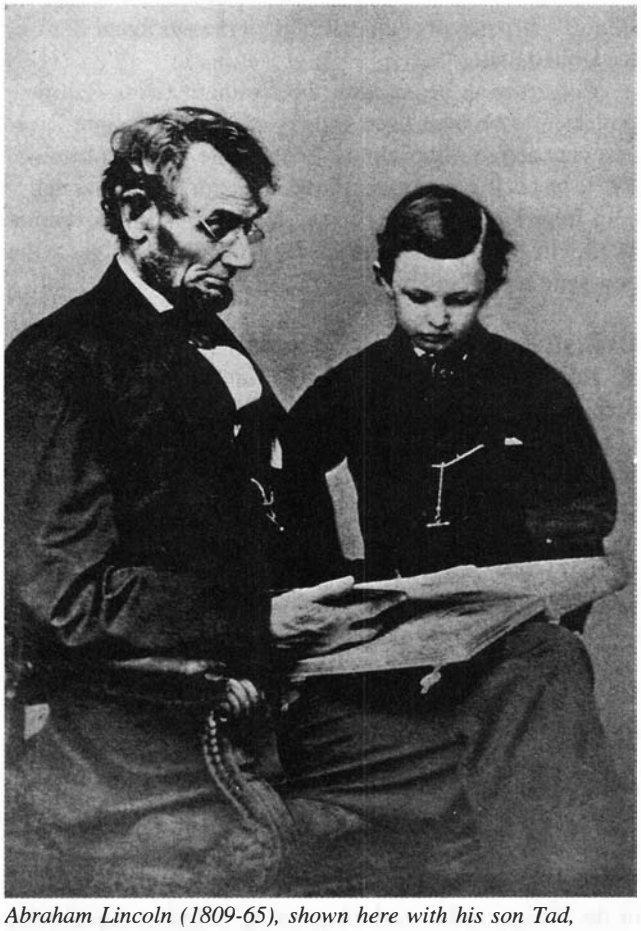

Abraham Lincoln (1809-65), shown here with his son Tad, revolutionized the U.S. economy at the same time as he led the Union to victory in the Civil War. Lincoln's "statist" measures built the great railroads and heavy industries that made the country a superpower.

and "the restless haste and hunger to rise which is the source of much that is good and most that is evil in American life."

Lincoln's opposite worldview was expressed to a German group in Cincinnati in 1861: "I hold the value of life is to improve one's condition. Whatever is calculated to advance the condition of the honest, struggling laboring man . . . I am for that thing."

Hay later became famous as an atrociously Anglophile diplomat and secretary of state. Hay expressed his own sense of identity in 1898, as U.S. ambassador to Great Britain: "Knitted as we are to the people of Great Britain by a thousand ties . . . there is a sanction like that of religion which binds us to a sort of partnership in the beneficent work of the world. . . . No man and no group of men can prevent it. . . . We are bound by a tie which we did not forge and which we cannot break."

His "definitive" biography of Lincoln, published in 1886, does not even mention Lincoln's role in building the Pacific railway, next to nothing on his economic measures, and not a hint of the lifetime of dirigist philosophy behind them.

Moving mountains

In August 1859, a year before Lincoln was elected to the Presidency, he visited Council Bluffs, Iowa, meeting privately there with a young railroad engineer/surveyor named Granville Dodge, who, as Lincoln's Army officer, was to be the chief engineer of the Pacific railroad.

As Dodge wrote later, Lincoln asked "what I knew of the country west of the Missouri River. He greatly impressed me by the marked interest he displayed in the work in which I was engaged, and he expressed himself as believing that there was nothing more important before the nation at that time than the building of a railroad to the Pacific Coast. He ingeniously extracted a great deal of information from me about the country beyond the river, the climate, the character of the soil, the resources, the rivers and the route. When the long conversation was ended, I realized that most of the things that I had been holding as secrets for my employers in the East, had been given to him without reserve. . . ."

Dodge continued that there was "a high bluff known as Cemetery Hill, just north of town. . . . He was greatly impressed with the outlook; and the bluff from that time has been known as Lincoln's Hill. . . . From here he looked down upon the place, where by his order, four years later, the terminus of the first trans-continental railway was established."

Lincoln signed the Pacific Railway Act July 1, 1862, authorizing huge government land grants to finance the construction. Two years later a second bill doubled the land grants and sweetened the other terms. Altogether *45 million acres of land were given away, and the government laid out some $60 million in cash, compared to only $4 million invested from private capital.*

Lincon was determined to "conquer space" to the west. At one point, when the project seemed dead for lack of funds, he arbitrarily redefined the Rocky Mountains as starting in their foothills, so that more money could be paid to the builders under the legislated formula—$32,000 in the mountains, as against only $16,000 per mile in the flatter land. It was said at the time, "Abraham's faith moves mountains."

6. How Lincoln made farmers scientific

The power of the Union's arms abolished black chattel slavery, the legal remnant of the British imperial past. But America still had to construct a positive alternative to the colonial plantation system. Abraham Lincoln's abiding passion for the protection and productivity of labor, shows up boldly in his Presidential action to bring scientific thinking into agriculture. To modernize America's farms, Lincoln's administration organized a national teaching apparatus run

largely by students of the pioneering German chemist Justus von Liebig. We will consider, below, Liebig's resolute Christian humanism and his contribution to America.

British imperial apologists Thomas Malthus and David Ricardo posited fictitious "natural resources," whose depletion by agriculture must deprive land of its natural, original value, making poverty and hunger inevitable. Colonial or other production-depressing regimes are beneficial, by this doctrine, since they delay the depletion of nature. Environmentalism is just a twentieth-century variant on this old theme.

But a nation mobilized in a war for freedom could not tolerate the blasphemous notion that God's laws consign man to perpetual scarcity and backwardness. Under Lincoln's leadership, Americans created a system to render farming so successful, so powerful and productive, that the lie of inevitable poverty was forever dispelled.

Millions of new private farms were created, by government land grants to households, and to railroads, which obtained credit by selling their grant-lands to new farmers. Farm families were educated at government expense. Government scientists supplied them with the latest intelligence on fertilizers, soil chemistry, and crop management. New farmlands opened up by government-organized railroads allowed for production economies of scale. Farmers with cheap, government-supplied credit, bought machinery, produced by patent-protected inventors using tariff-protected American steel. Diseases of livestock were conquered and eliminated by the vigorous prosecution of government science and federal law.

Lincoln's advocacy of human advancement would put him beyond the pale in today's politics. A visit to Niagara Falls set off reflections which led to his patenting an "improved method of lifting vessel[s] over Shoals," while a fellow visitor to the falls complained of Lincoln's alleged lack of a sense of wonder.

Neither did he romanticize or otherwise propitiate farmers; no farmer asked him beforehand to create the Agriculture Department or America's farm-centered state college systems.

Addressing the Wisconsin State Agricultural Society at its annual fair in Milwaukee on Sept. 30, 1859, Lincoln reprised the argument laid down by Gottfried Leibniz in his "Academy Proposal," on the motivation for work, and the increase of productivity by the elevation of the worker's mind: He began, "I presume I am not expected to [engage] . . . in the mere flattery of the farmers, as a class. My opinion of them is that, in proportion to numbers, they are neither better nor worse than any other people."

Lincoln praised the fair, rather than the farmers, for "exciting emulation, for premiums, and for the pride and honor of success . . . to stimulate . . . discovery and invention into extraordinary activity. In this, these Fairs are kindred to the patent clause in the Constitution of the United States; and to the . . . practical system, based upon that clause."

He warned that current agricultural practices were producing the very low grain yields, 8-18 bushels per acre, compared to the possibility for 50 to 100 bushels, from merely applying available methods. "What would be the effect upon the farming interest," he asked, "to push the soil up to something near its full capacity? . . . Unquestionably, thorough cultivation will require more labor to the *acre;* but will it require more to the *bushel?* . . . It would [uncover] those unknown causes, which of late years have cut down our crops below their former average . . . in the deeper plowing, analysis of the soils, experiments with manures, and varieties of seeds. . . . [T]horough cultivation would spare [at least] half the cost of land, simply because the same product would be got from half, or from less than half the quantity of land. . . .

"Again, a great amount of 'locomotion' is spared by thorough cultivation. Take fifty bushels of wheat . . . [on] a *single* acre, and it can be harvested . . . with less than half the labor which would be required if it were spread over *five* acres. This would be true, if cut by the old hand sicle; true, to a greater extent, if by the scythe and cradle; and to a still greater, if by the machines now in use . . . [which] substitut[e] animal power for the power of men. . . .

"The effect of thorough cultivation upon the farmer's own mind, and, in reaction through his mind, back upon his business, is perhaps quite equal to any other of its effects. Every man is proud of what he does well . . . his heart is in his work; and he will do twice as much of it with less fatigue. . . . The man who produces a good full crop will scarcely ever let any part of it go to waste. He will keep up the enclosure about it, and allow neither man nor beast to trespass upon it. He will gather it in due season and store it in perfect security. . . .

"The successful application of steam power to farm work, is a desideratum—especially a steam plow. . . . To be successful, it must . . . plow better than can be done with animal power . . . and cheaper; or more rapidly." Lincoln proposed the necessity of self-propelled farm machinery, before any such had been invented. But, he then pointed out, accurately, that steam-power was impracticable for this purpose, despite the success of the railroad and steamship, because of the weight of fuel and water a steam vehicle must carry over farmland. This problem was solved a generation later by the use of gasoline engines.

Lincoln then proposed the family farm as one of the means for upholding the freedom and dignity of labor; he went on to describe the problem-solving mentality of the scientific farmer, so different from the ignorant peasant:

Free labor, he wrote, "insists on universal education.

". . . I know nothing so pleasant to the mind, as the discovery of anything that is at once new and valuable—nothing that so lightens and sweetens toil, as the hopeful pursuit of such discovery. [For the] mind, already trained to thought in the country school, or higher school . . . [every] blade of grass is a study; and to produce two, where there was but one, is both a profit and a pleasure. And not grass alone: but soils, seed, and seasons—hedges, ditches, and fences, draining,

droughts, and irrigation . . . saving crops, pests of crops, diseases of crops, and what will prevent or cure them . . . the thousand things of which these are specimens—each a world of study within itself. . . .

"Population must increase rapidly—more rapidly than in former times—and ere long the most valuable of all arts, will be the art of deriving a comfortable subsistance from the smallest area of soil. No community whose every member possesses this art, can ever be the victim of oppression in any of its forms. Such community will be alike independent of crowned-kings, money-kings, and land-kings. . . .

"It is said an Eastern monarch once charged his wise men to invent him a sentence . . . which should be true and appropriate in all times and situations. They presented him the words, 'And this, too, shall pass away.'. . . And yet, let us hope it is not quite true. Let us hope, rather, that by the best cultivation of the physical world, beneath and around us, and the intellectual and moral world within us, we shall secure an individual, social and political prosperity and happiness, whose course shall be onward and upward, and which, while the earth endures, shall not pass away."

Lincoln and continental European science

The natural science, which was to revolutionize agriculture, was itself the work of opponents of colonial Malthusian doctrines. This is perhaps best exemplified by the successes of Justus von Liebig (1803-73), a chemist who grew up in Beethoven's Germany. Liebig's work would be brilliantly realized in Lincoln's agricultural program.

Liebig identified the mineral nutrients required for the growth of plants; he created the analytical and educational methods that made modern biochemistry and such things as artificial fertilizer possible. Liebig described his own early development as "the reading of books without any system . . . just as they stood on the shelves" of the library, and "thousands of essays and treatises." This "developed in me the faculty . . . of thinking in terms of phenomena. . . . Most closely akin is the peculiar power of the musician, who while composing thinks in tones which are as much connected by laws as the logically arranged conceptions in a conclusion or series of conclusions. There is in the chemist a form of thought by which all ideas become visible to the mind as the strains of an imagined piece of music."

At age 17, he went to Paris, and exhibited his talents under the tutelage of Joseph Louis Gay-Lussac and Alexander von Humboldt. By 1820 the French Ecole Polytechnique, whose educators had virtually founded America's early engineering and military science, was already more or less destroyed. So Humboldt used his influence to set up Liebig in his own chair of chemistry at a small German college, at Giessen, in May 1824.

Here organic chemistry was born; and for the first time, teaching took place in a chemical laboratory.

As Liebig described it, "a kindly fate brought together the most talented young men from all the countries of Europe [and America!]. . . . Actual teaching in the laboratory . . . was only for the beginners; the progress of my special students depended on themselves. I gave the task and supervised the carrying out of it. . . . I received from each individual [a daily report about what] he was engaged upon. I approved or made many criticisms . . . by each participating in the work of all, every one learned from the others. . . . We worked from break of day till nightfall. . . . The only complaint . . . was that of the attendant . . . who could not get the workers out of the laboratory in the evening, when he wanted to clean it." Liebig's fame grew as his published works brought before the world the new agricultural and pharmaceutical sciences he and his colleagues were inventing.

Liebig wrote of "the present conflict between practical agriculture and scientific Chemistry." It "concerns the weightiest material interests and the fundamental prosperity of the state. The most urgent problem which the present day has to solve, is the discovery of the means of producing more bread and meat on a given surface, to supply the wants of a continually increasing population," a problem "which science is expected to solve."

Liebig attacks the empiricist, who, with only practical experience and no understanding of the underlying laws of nature, must fail. At the heart of Liebig's worldview is the unique dignity of man, whose creativity is potentially limitless. Man at first "sees everything around him bound in the chains of invariable, immutable, fixed laws. Within himself alone he recognizes a *something* which may govern these effects, a will which has the power to rule over all natural laws, a spirit which, in its manifestations, is independent of these natural powers, and which, when it is in its conceivable perfection, is subject only to its own laws.

"The . . . knowledge of nature forces upon us . . . the conviction that [beyond] this *something* within us . . . there exists [something] similar or more perfect [which] affirms the existence of a higher, indeed of an infinitely exalted Being, to contemplate and to comprehend whom our senses are too feeble, and of whom, in his greatness and sublimity, we can only form some conception by the highest cultivation of every faculty of our minds."

The Agriculture Department is born

On May 15, 1862, President Lincoln signed into law a bill creating the Department of Agriculture, "to acquire and to diffuse among the people of the United States useful information on subjects connected with agriculture . . . to procure, propagate and distribute . . . new and valuable seeds and plants . . . to acquire . . . all information . . . by means of books and correspondence and by practical and scientific experiments . . . employees [to include] chemists, botanists, entomologists, and other persons skilled in the natural sciences pertaining to Agriculture."

The first scientist appointed by the department was Justus von Liebig's student, Charles M. Wetherill.

On May 20, Lincoln signed into law the Homestead Act, giving to any head of a family or to anyone 21 years of age, one-quarter square mile of free land for farming. For the remainder of the century, the act transferred millions of acres of the public domain to private ownership. With the first Lincoln-organized Pacific Railroad completed in 1869, settlers poured into newly opened western lands. Between 1870 and 1880, some 128 million acres were added to U.S. farmland, 49 million acres between the Mississippi River and the Rocky Mountains. The total amount of improved farmland increased 50%, from 189 million to 285 million acres.

On July 2, 1862, Lincoln signed the Land Grant College Act. The same legislation had been vetoed by "free enterprise" radical President James Buchanan, Lincoln's immediate predecessor. The act donated federal land which the states would sell, establishing a perpetual endowment for public colleges in each state. The curriculum, besides military tactics, and "other scientific and classical studies," was to "promote the liberal and practical education of the industrial classes," in areas relating to agriculture and the mechanical arts.

The Land Grant schools, such as Iowa State, Ohio State, and Pennsylvania State colleges, and the older universities which shared in the federal largesse, such as Yale and Harvard, became in the late nineteenth century the potent center of agriculture-related research.

Evan Pugh, the founder of Pennsylvania State College, was a student of Liebig. Another Liebig student, Eben Horsford, returned to America to open a pioneering laboratory at Harvard for teaching analytical chemistry. Horsford's innovations spanned the field from condensed milk to fermentation of bread and alcohol. Horsford's successor at Harvard's Lawrence Scientific School was Prof. Oliver Wolcott Gibbs, another Liebig pupil, and a member of Alexander Dallas Bache's "Lazzaroni" inner circle.

Liebig student John A. Porter, the first dean of the Sheffield Scientific School of Yale, helped develop its courses in agriculture and nutrition. Another pupil of Liebig, William H. Brewer, was professor of agriculture in the Sheffield Scientific School from 1864 to 1903.

Brewer's colleague, S.W. Johnson, returned from Europe and his studies with Liebig in 1856. He then began teaching at Sheffield and translating the latest European works on chemical analysis for American chemists. In 1869, with Johnson's urging, Connecticut passed its Fertilizer Law requiring accurate labeling of contents, to be determined by state chemists. This was soon copied by the other states, realizing in America Liebig's proposal for such government regulation of a field that had been entirely unknown to the previous generation. In 1877, Johnson became director of the new Connecticut Experimental Station, emulating the 100 such stations which Liebig's influence had already established in Germany, Italy, and Austria. With Johnson's lobbying, the U.S. Congress passed the Hatch Act in 1887, creating a national network of experimental stations.

A rich harvest

For about 35 years after the end of the Civil War in 1865, government-sponsored science and government-protected industry guided an immense increase in American agricultural productivity.

After World War II's immense economic mobilization, America used the agricultural institutions founded by Lincoln to take another leap ahead in farm productivity. Science in fertilization, breeding, soil analysis, and heavy mechanization caused record crops, and gave promise for the end of world hunger.

We must still consider that one last burst of technological progress, in the two decades 1866-86, which was necessary to create the "modern times" witnessed in the twentieth century. America's amazing post-Civil War development was instigated and guided by the Philadelphia-based nationalists who had tutored and sponsored Abraham Lincoln. As we shall see, the spread of modern conditions to Japan and some other nations, and the electrification of the planet associated with the name of Thomas A. Edison, were both part of this last nationalist enterprise.