Working Paper WP06-1 June 2006

Center for International Food and Agricultural Policy

Research, Food and Nutrition, Commodity and Trade,
Development Assistance, Natural Resource and Environmental Policy

AGRICULTURAL ECONOMICS: A BRIEF INTELLECTUAL HISTORY

by

C. Ford Runge

Center for International Food and Agricultural Policy
University of Minnesota
Department of Applied Economics
1994 Buford Avenue
St. Paul, MN 55108-6040
U.S.A.

Working Paper WP06-1 June 2006

AGRICULTURAL ECONOMICS: A BRIEF INTELLECTUAL HISTORY

by

C. Ford Runge*

* C. Ford Runge is Distinguished McKnight University Professor of Applied Economics and Law, and Director of the Center for International Food and Agricultural Policy at the University of Minnesota.

This article was prepared at the request of Steven Durlauf in the Department of Economics at the University of Wisconsin for inclusion in a revised edition of *The New Palgrave Dictionary of Economics*. Thanks for comments and suggestions to Dan Bromley, Willard Cochrane, Jay Coggins, Brian Fisher, Glenn Fox, Sharon Kill, Rob King, Louise Letnes, Dick Levins, Phil Pardey, Steve Polasky, Philip Raup, Vernon Ruttan, G. Edward Schuh, Ben Senauer and Brian Wright.

All errors remain the responsibility of the author.

Information on other titles in this series may be obtained from Waite Library, University of Minnesota, Department of Applied Economics, 1994 Buford Avenue, 232 ClaOff, St. Paul, MN 55108-6040, U.S.A. The Waite Library e-mail address is: lletnes@umn.edu. This paper is available electronically from AgEcon Search at http://agecon.lib.umn.edu.

Agricultural Economics: A Brief Intellectual History

Abstract:

Agricultural economics arose in the late 19th century, combined the theory of the firm with marketing and organization theory, and developed throughout the 20th century largely as an empirical branch of general economics. The discipline was closely linked to empirical applications of mathematical statistics and made early and significant contributions to econometric methods. In the 1960's and afterward, as agricultural sectors in the OECD countries contracted, agricultural economists were drawn to the development problems of poor countries, to the trade and macroeconomic policy implications of agriculture in richer countries, and to a variety of issues in production, consumption, environmental and resource economics.

Agricultural economics arose in the late 19th century, combined the theory of the firm with marketing and organization theory, and developed throughout the 20th century largely as an empirical branch of general economics. This emphasis was due to the historical importance of agriculture, and in the United States was made possible by the rich data compiled by the U.S. Department of Agriculture (USDA) beginning in the mid-19th century. The discipline was closely linked to empirical applications of mathematical statistics and made early and significant contributions to econometric methods. In the 1960's and afterward, as agricultural sectors in the OECD countries contracted, agricultural economists were drawn to the development problems of poor countries, to the trade and macroeconomic policy implications of agriculture in richer countries, and to a variety of issues in production, consumption, environmental and resource economics. This ramified the subject and enlarged its international focus, at the same time that its microeconomic, empirical and policy orientation distanced it from developments in general equilibrium theory, macroeconomic modeling, game theory and axiomatic social choice, which preoccupied many departments of economics throughout the late 20th century.

Retracing the evolution of agricultural economics, especially in the United States, requires an explanation of institutional innovation in 19th century America (see Taylor and Taylor, 1952). In the midst of the Civil War, President Lincoln created the Federal Department of Agriculture (later the U.S. Department of Agriculture – USDA), empowered to collect a wide range of farm statistics. At the same time, legislation introduced by Vermont's Justin Morrill (previously blocked by the seceded South) was signed in 1862 by Lincoln. The Morrill Act established the Land Grant Colleges

(financed through sales of government land) especially in the states of the Old Northwest Territory: Illinois, Indiana, Michigan, Ohio and Wisconsin. Their creation reflected both vast surpluses of land, and the drive to improve plant and animal husbandry through applications of chemistry and biology. Eventually, the land grant model was replicated in every state as well as in some other countries. In 1887, the Hatch Act created the Agricultural Experiment Stations of USDA, which functioned together with the Land Grant Colleges to form a system of research, instruction and outreach to farmers (Cochrane, 1993; Kerr, 1987; Moore, 1988). In 1914, Extension education and outreach was formalized under the Smith-Lever Act. By the beginning of the 20th century, the application of scientific management to agricultural production created the foundations of the discipline.

Agricultural economics in the United States derived from two intellectual streams. The first was neoclassical political economy and the theory of the firm applied to farm production. The second, borne of an economic crisis in American agriculture in the late 19th century, focused on strategies for organized marketing of agricultural commodities through collective bargaining and cooperatives. The first stream may be traced to the 18th century enlightenment and a preoccupation with land as a factor by the French Physiocrats. Francois Quesnay's "*tableau economique*" (1758) organized a logical explanation of the conversion of land inputs to agricultural outputs and profit, anticipating modern production economics, input-output analysis and general equilibrium theory. His emphasis on surplus production was a touchstone of classical economics and exercised a direct influence over Adam Smith (Eltis, 1975; Smith, 1776, Book 2, Chapter 9).

Like all 18th century political economists, Smith could not ignore agricultural questions, even if he gave them less primacy than the Physiocrats. He, together with Ricardo, Von Thünen and Malthus, provided commentary on the difficulties of agricultural specialization, returns to land as a factor, issues of space and distance to market, and the long-run relation between arithmetic increases in food supply and geometric increases in demand due to population growth. Many pages of the *Wealth of Nations* (1776) dealt with agricultural questions, including the differential capacity for specialization and routinization of agriculture versus industry and the arts of husbandry at the microeconomic level (pp. 16; 143). Echoing the Physiocrats, Smith emphasized the central role of agriculture as a store of national wealth, and noted that compared to manufacturing, agriculture "is much more durable, and cannot be destroyed by [the] violent convulsions" of war and political instability (p. 427). In the same period, Arthur Young assembled comprehensive data on production, rents and land tenure in Great Britain. Serving as editor of the *Annals of Agriculture* from 1768-1770, he collected his data and observations into nine volumes of 4,500 pages, which have proven of continued value especially to economic historians (eg., Allen, 1992). Ricardo (1821) was famously concerned with returns to land as a fixed factor "for the use of the original and indestructible powers of soil" (p. 44). He also distinguished between productivity enhancements due to augmentation of the soil and improvements in machinery and the capitalization of various investments or policies (eg., taxes) into the value of land (pp. 57-61; 246). Von Thünen's (1828) analysis of the extensive margin and the relationship between distance to market and rent made him, in Marshall's view, the first agricultural

economist among economists, who with Cournot provided the inspiration for marginalist economics (Day and Sparling, 1977, p. 93).

It was the neoclassical developments of the late 19th century, however, that provided the main foundations for agricultural economics. Marshall's *Principles* (1890) first clearly established the link from diminishing marginal utility in exchange to decreasing marginal productivity on the supply side. Veblen (1900) dubbed Marshall's work "neoclassical" to distinguish it from classical labour theories of value. The elaboration of Marshall's theory of the firm, and attempts to measure and statistically validate the relationship between input costs, output prices, and farm profits distinguished agricultural economics well into the 20th century, and linked it firmly to the neoclassical syntheses of Hicks (1939) and Samuelson (1947).

To this was added a second stream of marketing and organizational issues growing out of the extended farm depression of the 1870's-1890's. Joined with labor interests, farmers sought marketing outlets and modes of organization that would give them greater bargaining power, notably cooperatives popular in Northern Europe and Scandinavia, where many recently arrived American farmers originated (Jesness, 1923). Even after the business cycle turned upward after 1897, an emphasis was given in the Land Grant colleges to farm management. The result was the organization in 1910 of the American Farm Management Association. Farm managers were focused on the physical, technical and scientific aspects of production, especially the new field of agronomy.

Many early agricultural economists regarded farm management as a subfield, and agricultural economics as an applied version of general economics. Beginning in 1907, at the tenth American Economic Association (AEA) meetings, a session was devoted to

"What is agricultural economics?" Thereafter, the AEA regularly included sessions on the economics of agriculture. In 1915, the National Association of Agricultural Economists was formed. In 1917, the AEA meeting was held jointly with the National Agricultural Economics Association and the American Farm Management Association, and talks began on a merger of the last two. This was realized in 1919 as the American Farm Economics Association, with Henry C. Taylor of the University of Wisconsin as President (Taylor, 1922; Cochrane, 1983). It retained this title until 1968, when it became the American Agricultural Economics Association (AAEA).

As Cochrane observed, "the first flowering of agricultural economics as an applied field of economics occurred at the University of Wisconsin in the period of 1900-1920. The second flowering occurred at the University of Minnesota in the period of 1918-1928" (1983, 66). A department of agricultural economics was organized at Wisconsin in 1909 by Henry C. Taylor and colleagues such as Benjamin Hibbard. Taylor's text, *An Introduction to the Study of Agricultural Economics* (1905) applied Marshallian principles to farm production, and developed production functions showing increasing, steady and diminishing returns. Among the most influential leaders in the young subject was Taylor's student at Wisconsin, John D. Black, who also studied under John R. Commons and Richard T. Ely (who himself authored an influential, though unpublished, 1904 study on the economics and property rights of irrigation). Their emphasis on land and institutions permeated the discipline and was reflected in the journal *Land Economics*, which began publication at Madison in 1925.

Black, a follower of Marshall and John Bates Clark, received his Ph.D. in 1918 and moved to the University of Minnesota, where he remained a dominant force until

hired by Harvard in 1927. By the mid-1920's, Black's leadership marked him, together with George F. Warren of Cornell and Edwin G. Nourse of Iowa State, as "the most influential economist in the United States dealing with the problems of agriculture" (Galbraith, 1959, p. 10). Together with a cadre of other young economists working with the Bureau of Agricultural Economics (BAE), created in USDA in 1921, Black set the tone for research in the field from the 1920's until the advent of World War II.

Black's text, *Introduction to Production Economics* (1926), became the standard. His emphasis on the theory of the firm was complemented by his colleague Holbrook Working's econometric explorations. Working's 1922 bulletin, *Factors Determining the Price of Potatoes in St. Paul and Minneapolis*, was among the first to derive an empirical demand curve (H. Working 1922; 1925). It was followed by his brother E. J.'s widely cited 1927 article, "What Do Statistical 'Demand Curves' Show?" The Workings and colleague Warren Waite continued to expand research into price analysis in the interwar years. Minnesota's Frederick V. Waugh contributed the first quantitative study of quality characteristics as determinants of prices, recognized as a forerunner of hedonic price analysis. Appearing as "Quality Factors Influencing Vegetable Prices" (1928), it noted that if "a premium for certain qualities and types of products is more than large enough to pay the increased cost of growing a superior product, the individual can and will adapt his production and marketing policies to market demand" (quoted in Berndt, 1991, p. 106).

Taylor, Black, Warren and Nourse were followed by a group of young empiricists and econometricians who continued to develop the USDA Bureau of Agricultural Economics (BAE). Tolley, Black and Ezekiel (1924) showed how production surfaces in three-dimensions could express diminishing returns to inputs, a concept readily grasped

by agricultural field scientists. They then derived cost surfaces showing the relationship between costs, relative prices, and profit-maximization. Ezekiel followed this empirical work with his 1930 volume, *Methods of Correlation Analysis*, which became a standard text on regression analysis, and in 1938 with a state-of-the-art description of cobweb and recursive models illustrated by the corn/hog cycle**.** Leontief (1971, pg. 5) would call this and other early agricultural economists' work "An exceptional example of a healthy balance between theoretical and empirical analysis . . ." and "the first among economists to make use of the advanced methods of mathematical statistics."

By the 1930's departments of agricultural economics were established in many U.S. universities, where technical and institutional issues affecting agricultural production formed the core subjects. In addition to the leading roles played by Cornell, Illinois, Iowa State, Minnesota, Purdue and Wisconsin, a major research program was established at the University of California-Berkeley (and a later campus at Davis) with the endowment of the Giannini Foundation. At Iowa State, future Nobel Laureate T.W. Schultz arrived in 1930 with a Ph.D. from Wisconsin, then served as department head from 1934-1943 until leaving for Chicago. Schultz attracted numerous talents including Kenneth Boulding, George Stigler, D. Gale Johnson and Earl O. Heady, several of whom would also leave for Chicago following controversy surrounding oleomargarine and the Iowa butter industry (Beneke, 1998). The butter/margarine dispute was typical of agricultural economists' conflicts with interest groups in a profession seldom sheltered from political winds, especially at state universities. Partly for this reason, several private universities also made substantial contributions to agricultural economics research. In addition to Black (and later Galbraith) at Harvard, the University of Chicago remained a

center of research excellence. At Vanderbilt, Nicholas Georgescu-Roegen, a demand theorist and econometrician, expressed path-breaking insights into the physical process underlying economic activity, and contributed a deep critique of Agrarianism and Marxian misunderstandings of agricultural production (Georgescu-Roegen, 1960).

Earl O. Heady remained at Iowa State, creating a postwar engine of applied research, the Center for Agricultural Research and Development (CARD) in 1957. He pioneered the application of programming methods first developed for war planning, analyzing how inputs could most efficiently be employed in producing agricultural outputs. This made the discipline a center for research in applications of optimization theory. Heady authored or oversaw hundreds of mainly empirical production studies, exemplified by Heady and Dillon (1961) and Heady and Candler (1958). He also pioneered the application of computing power to problem-solving in applied economics. This included work on human and animal diet rations and consumption (eg., Waugh 1951; Heady 1951). Farm management also saw optimization applications in work by Hildreth (1957a) among others. By the late 1950's Bellman's dynamic programming principle was applied to optimal wheat rotations by Burt and Allison (1963). Agricultural economics also began to grapple empirically with uncertainty through stochastic programming methods, including Hildreth's (1957b) work and Hazell's applications (1971). French economists Boussard and Petit applied Shackle's "focus loss" concept of uncertainty to agriculture (1967). The application of subjective probability concepts to agriculture was surveyed by Dillon (1971) and Anderson, Dillon and Hardaker (1977).

Yet another outgrowth of optimization theory was analysis of the growth and decline of farms in modern economies, including contributions by German agricultural

economists Heidhues (1966) and De Haen (De Haen and Heidhues, 1973). Behavioral adjustment ("supply response") in agriculture was studied using recursive programming models (Henderson, 1959), and generalized by Day (1963), following the path set by Nerlove (1958). Optimal storage rules were analyzed by Gustafson (1958). Spatial issues in agriculture analyzed best-location decisions (Egbert and Heady 1961), and interregional supply/demand equilibrium issues (eg., Fox 1953). An extensive bibliography of spatial and temporal equilibrium models was published by Judge and Takayama (1973).

Two additional applications of optimization theory pushed agricultural economics in the 1960's and 1970's toward new frontiers: natural resources and agricultural development in developing countries. These helped attract a new generation of economists concerned less with domestic farm production than with environmental issues and poverty alleviation in the Third World. Natural resources were analyzed as problems of materials shortages and treated as a form of capital, following the early analytical leads of Hotelling (1931) and Ciriacy-Wantrup (1952). Especially after the Paley Commission Report of 1952 led to the creation of Resources for the Future in Washington, D.C., a new group of economists applied themselves to these issues. Fisheries were studied by Scott (1955) and Crutchfield and Zellner (1962); groundwater allocation over time was considered as a dynamic program with stochastic state variables in a series of articles by Burt (eg., Burt 1966; Burt and Cummings, 1970). These dynamic models were extended to interregional investments in water in studies such as Cummings and Winkelmann (1970). By the 1970's, environmental pollution became a major subject of applied economics, pulling many in the profession away from a restricted view of agricultural

issues as matters of yields and production in acknowledgement of the sector's negative external effects and market failures.

Agricultural development in developing countries, meanwhile, was an important area of applied economics in project evaluation, supported by multilateral and bilateral aid agencies such as the World Bank, the Food and Agriculture Organization of the U.N. (FAO) and U.S. Agency for International Development. At Stanford, the Food Research Institute (1921-1995) established an internationally-focused research program. The development problem in the Third World was seen largely as an imbalance between agricultural and manufacturing sectors, with a need to right this balance by drawing low-productivity resources out of agriculture (Lewis, 1954; Mellor, 1966; Timmer 2002). Hollis Chenery at the World Bank exemplified the analysis of agriculture's sectoral role (Chenery and Syrquin, 1975). However, unlike the U.S. and some other OECD countries, data limitations in poor countries restricted the early application of optimization models at the microeconomic level. Indeed, T.W. Schultz's famous *Transforming Traditional Agriculture* (1964) relied mainly on stylized representations of "rational but poor" farmers and descriptive analysis from anthropologists.

Throughout the 1950's and 1960's the agricultural sector continued to contract in the OECD countries, setting the tone for policy debates. Many agricultural economists saw the "farm problem" as one of surplus labor supplying farm commodities in excess of domestic demand. Analyzing low agricultural prices as a matter of chronic oversupply, aggravated by rapid technological improvements and productivity gains in the face of inelastic demand, Cochrane (1958) proposed his treadmill hypothesis: rapid and early adopters of productivity-improving technology will reap the lion's share of rents to

innovation, as laggards are forced off the farm, while Brewster (1959) considered the social and policy implications of these trends. In the early 1960's, serving as presidential advisor, Cochrane advocated a solution to excess production in the form of federally mandated supply control. When it became clear that the major commodity groups would vote down the enabling referenda, and that its success would raise prices to consumers, President Kennedy abandoned the scheme. Thereafter, although mandated supply-control retained adherents (not including Cochrane), U.S. agricultural policy shifted toward exports as a vent-for-surplus.

This opened the way to consideration of agriculture in an open economy, and a new policy emphasis on the macroeconomics of the food sector (Schuh, 1974, 1976; Cochrane and Runge, 1992; Ardeni and Freebairn, 2002; Abbott and McCalla, 2002). In the 1980's, this open economy analysis was supported by the development of large-scale computable general equilibrium models linking agriculture to trade (eg., Hertel, 1997) as well as more traditional macroeconomic sectoral forecasting models (eg., Myers, et al., 1987). Together, the large-scale models allowed alternative trade and agricultural policy approaches to be simulated and compared to the ***status quo*** (eg., Cochrane and Runge, 1992).

The intellectual antecedents of agricultural economics make clear that the field has never been restricted to the United States. In 1905, the International Agricultural Institute was founded in Rome as the forerunner of the FAO. In Great Britain, an Agricultural Economics Research Institute was established at Oxford in 1913, and in 1945 became part of the School of Rural Economy, merging with Queen Elizabeth House and the Institute for Commonwealth Studies in 1986. Oxford led the creation of the

International Association of Agricultural Economists and helped coordinate its first conference in 1929 at Dartington Hall, Devon and a second in 1930 at Cornell. These were largely Anglo-American meetings, although by the third meeting in Germany in 1934, 19 different countries were represented. At Cambridge, a Department of Estate Management was transformed into a Department of Land Economy in the 1960's. At Wye, an agricultural college was founded in 1894. The college was awarded a royal charter in 1948 and in 2000 its agricultural economics department became part of Imperial College London.

On the Continent, followers of Von Thünen had developed marginalist principles and farm accounting methods in the late 19th and early 20th century represented by the Laur School in Switzerland and the Sering and Serpieri Schools in Germany and Italy. However, their capacity was limited by poor data, few marketing studies, and a weak connection to production economics (Nōu, 1967; Raeburn and Jones, 1990, p. 13). In 1948 a French professional association began, and a Department of Agricultural Economics was created at the Institut National de la Recherche Agronomique (INRA) in 1955 (Petit, 1982). A European Association of Agricultural Economists was founded in 1975 in Uppsala, Sweden. By the late 1980's, it was estimated that 3,000-5,000 European professionals were engaged in full-time agricultural economics research dispersed in hundreds of research institutes, universities and government offices (Hanf, 1988). Among the leaders were the French government's INRA, the Universities of Goettingen and Kiel in Germany, the University of Padova in Italy, Wageningen University in the Netherlands, and the aforementioned activities in Great Britain.

In Canada, agricultural economics began at the Ontario Agricultural College (now the University of Guelph) in 1907. Noteworthy research departments of agricultural economics were established at the University of Guelph, Ontario, McGill University in Montreal, Laval University in Quebec, and the Universities of Manitoba, Alberta, Saskatchewan and British Columbia.

The Australian Agricultural Economics Society was founded in Sydney in 1957, following the models of the U.S., British and Canadian associations. In 1975, a New Zealand branch of the association was established at a meeting in Christchurch. The leading Australian institution in creating a separate department was the University of New England at Armidale, which in 1958 began a four-year course. Supported by grants from the Commonwealth Bank, a chair of agricultural economics was appointed at the University of Sydney in 1951 (Campbell, 1985). While maintaining the specialty within economics rather than as a separate department, major research was also undertaken beginning in the 1950's and 1960's at the University of Adelaide and at the University of Melbourne, and later at the Australian National University in Canberra and the University of Western Australia in Perth. All of these universities were closely linked to the national Bureau of Agricultural Economics (BAE), which became the Australian Bureau of Agriculture and Resource Economics (ABARE) in 1987 (Miller, 1985).

In Russia, interest in agricultural economics may be traced to the establishment in 1865 of the Moscow Agricultural Academy. In 1929 Lenin created the Russian Academy of Agricultural Sciences, following conflicts between Chayanov and Marxist agriculturalists. After Stalin's rise to power in 1930, agricultural research was fully politicized with well-known results, including the purge of many academic researchers

(Nazarenko, 2004). In the 1950's, concepts such as profit and cost were revived, and central planners embraced modeling and forecasting. Since the 1990's, agricultural reforms have led to dissension in the Russian discipline (Klyukach, 2004).

In Brazil, the Rockefeller, Ford Foundations and the U.S. Agency for International Development provided core support for agricultural economics research, beginning in the late 1950's. Four U.S. universities were directly involved: Purdue, Wisconsin, Ohio State and Arizona.

In India, a Society of Agricultural Economics was established in 1939. The advent of indicative economic planning in the 1950's stimulated analytical studies to assist in the Plan (Sen, 1959). Due to the overwhelming importance of agriculture as a supplier of wage goods, the sector attracted considerable analysis, in which Indian agricultural universities, established on the land-grant model, consciously borrowed methods from their U.S. counterparts, notably Earl O. Heady and the CARD group at Iowa State (Bhide, 1994, p. 119).

In China, missionary efforts to promote agricultural research and development by the Presbyterian Church of New York during the first quarter of the 20th century resulted in a Cornell University – University of Nanking collaboration, led beginning in 1914 by John Lossing Buck (Buck, 1973). J.L. Buck's contributions included early agricultural surveys and analysis of Communist production into the 1960's (Buck, 1943; Buck, et al., 1966).

Since the 1970's, seven broad subjects have defined the most distinctive contributions of agricultural economics: technical change and the returns to human capital investments; environmental and resource issues; trade and economic

development; agricultural risk and uncertainty; price determination and income stabilization; market structure and the organization of agricultural businesses; and consumption and food supply chains.

The study of technical change, innovation and returns to investments in human capital in agriculture attracted some of the most talented economists of the postwar generation, such as Zvi Griliches **(**1957; 1958; 1963; 1964). Anticipating debates among economic growth theorists over "embodied" technical change due to improvement in the quality of capital inputs (versus "disembodied" changes without new net capital investments), Cochrane (1953) criticized Schultz (1953) for failing to account for capital requirements in agriculture and resulting overemphasis on weather variations in describing growth in yields. Focusing on the direction of agricultural innovation, Ruttan (1956) and Hayami and Ruttan (1971) emphasized the Hicks-non-neutrality of technical change in both labour-saving U.S. and land-saving Japanese agriculture. This approach was extended in a formal framework by Binswanger (1974). Based on Hicks' (1932) analysis of relative factor prices as the inducement to alternative paths of innovation, the induced innovation argument was extended into an explanation for priority-setting by public sector agencies, leading research toward abundant factor use that lowered social costs of production (Peterson and Hayami, 1977, p. 504). How to measure productivity and technical change in agriculture using alternative index numbers attracted both theorists and applied econometricians (eg., Jorgenson and Griliches, 1967; Lau and Yotopoulos, 1971). Finally, analysts considered the welfare gains and losses resulting from farm mechanization (Schmitz and Seckler, 1970).

Agricultural economists also delved into the role of productivity embodied in labour as "human capital," a natural reflection of the huge public investments in research and education by the U.S. land grant system. Surveyed by T. W. Schultz (1971), this line of research attracted work by Peterson (1969), Huffman (1974), general economists such as Nelson and Phelps (1966), and led to widening emphasis on private and social returns to research including Peterson (1967), Evenson (1967), Evenson and Kislev (1976) and Alston, et al. (2000). It also led to analysis of how research ought to be organized in order to maximize its aggregate benefits. Alston, Norton and Pardey (1998) developed a comprehensive summary of this priority-setting problem (see Huffman, 2002; Sunding and Zilberman, 2002).

Environmental and resource issues, as noted, became a significant focus of the profession in the 1970's and beyond, partly in recognition of the pollution and species losses resulting from modern agricultural systems. Surveyed by Lichtenberg (2002), the economics of agriculture and the environment analyzed the perverse incentives created by agricultural subsidies and the agency problems of monitoring agricultural practices (eg., Chambers and Quiggin, 1996; Just and Antle, 1990; Segerson, 1988). Induced innovation theory was broadened to explain how technical innovations such as irrigation might give rise to new water quality issues and thus new institutional responses (eg., Runge, 1987; Caswell, et al., 1990). Apart from specific agriculture-environmental interactions, resource economists emphasized the critical role of property rights in the use and management of resources, especially those held publicly or in common, notably in developing countries (Runge, 1981; Bromley, 1991; Walker, et al., 2000).

Trade and development also dominated agricultural economics research, especially after the mid-1980's, as global trade negotiations increasingly hinged on struggles between heavily subsidized farm sectors in OECD countries and the highly taxed sectors of the developing world (Anderson and Hayami, 1986; Kreuger, Schiff and Valdès, 1991-92; Sumner and Tangermann, 2002). An overview of postwar agricultural trade policy was given by D. G. Johnson (1977); a synthetic treatment of agriculture-trade interactions was provided by Karp and Perloff (2002). Meanwhile, a major share of agricultural economics literature was devoted to microeconomic studies of agricultural change and food insecurity in developing countries, and to macroeconomic linkages with other sectors and global trade (eg., Barrett, 2002; Runge, et al., 2003).

Risk and uncertainty are inherent in agriculture and their relevance has drawn interest from many agricultural economists especially in developing country decision environments (see Moschini and Hennessey, 2002). Roummassett (1976) conducted an early assessment of risk aversion and the adoption of hybrid rice in the Philippines. Dillon and Scandizzo (1978) analyzed risk preferences among small farmers in Brazil, while Moscardi and de Janvry (1977) analyzed Mexican maize production and the response to risk. Antle (1987) and Myers (1989) provided econometric tests for risk aversion by farmers while Goodwin and Smith (1995) and Miranda and Glauber (1997) considered why crop insurance contracts fail effectively to pool risk without reinsurance.

Price determination and stabilization of agricultural prices as a focus of research arose as a direct consequence of widespread instability in agricultural commodities markets. Tomek and Robinson (1977) surveyed the postwar literature through the 1970's, including the analysis of Cochrane (1958) and Gray and Rutledge (1971). In

response to widespread calls for buffer stocks and other mechanisms to affect prices countercyclically, Newberry and Stiglitz (1981) offered a comprehensive (and skeptical) assessment of the advantages of stabilization policy. A more recent survey was developed by Wright (2002).

The organizational structure of farms and the role of economies of scale, scope, technological change, capital and labour mobility were reviewed by Chavas (2002). Farm size was analyzed as a function of the opportunity cost of labour and the price of machinery (Kislev and Peterson, 1982). Farm structure and the economics of contracting was also an additional area of risk and agency studies (Allen and Lueck, 1998; Heuth and Ligon, 2001; Knoeber and Thurman, 1995). Despite their declining importance in many rural markets, cooperatives continued to attract analysis (eg., Sexton, 1990).

A final area of broad interest was food consumption and supply chains in the food industry. Taking an industrial organization approach, Sexton and Lavoie (2002) provided an overview, emphasizing vertical and horizontal integration and imperfect competition as forces driving the sector, with implications for consumer choice, nutrition and health.

In the 21st century, the profession has continued to reach beyond the agricultural sector, expanding its scope through numerous applications of relevant economic theory. Meanwhile, the high level of abstraction in economics characteristic of the last half of the 20th century appears to have given way to new interest in empirical and experimental studies, suggesting that the distance between agricultural economics and its mother discipline may narrow in the years ahead.

C. Ford Runge

Note on Sources: This entry can only gesture to the agricultural economics literature. The reader is referred to L. R. Martin (general editor) and the four volume *Survey of Agricultural Economics Literature*, Minneapolis, University of Minnesota Press, 1977-1987, and Wallace C. Olsen, et al., 1991, *Agricultural Economics and Rural Sociology: The Contemporary Core Literature*, Ithaca: Cornell University Press. A compilation of analytical and interpretive essays is B. L. Gardner and G. C. Rausser (eds.), *2002, Handbook of Agricultural Economics*, Volumes 1A, 1B, 2A and 2B, Amsterdam: Elsevier. An internet-based open source of information is AgEcon Search, maintained at the University of Minnesota (http://www.apec.umn.edu/AgEcon.html).

References

Abbott, P. and A. McCalla. 2002. "Agriculture in the Macroeconomy." In *Handbook of Agricultural Economics*, Vol. 2A. B.L. Gardner and G. Rausser (eds.). Amsterdam: Elsevier.

Allen, R.G. 1992. *Enclosure and the Yeoman*. Oxford: Clarendon Press.

Allen, D.W. and D. Lueck. 1998. "The Nature of the Farm." *Journal of Law and Economics* 41:343-386.

Alston, J.M., C. Chan-Kang, M.C. Marra, P.G. Pardey and T.J. Wyatt. 2000. "A Meta-Analysis of Rates of Return to Agricultural R&D." Research Report 113. International Food Policy Research Institute (IFPRI). Washington, D.C.

Alston, J.M., G.W. Norton and P.G. Pardey. 1998. *Science Under Scarcity: Principles and Practices for Agricultural Evaluation and Priority Setting*. New York: CAB International.

Anderson, J., J. Dillon and B. Hardaker. 1977. *Agricultural Decision Analysis*. Ames, IA: Iowa University Press.

Anderson, K. and Y. Hayami. 1986. *The Political Economy of Agricultural Protection: East Asia in International Perspective*. London: Allen and Unwin.

Antle, J.M. 1987. "Econometric estimation of risk producers' risk attitudes." *American Journal of Agricultural Economics* 69:509-522.

Ardeni, P.G. and J. Freebairn. 2002. "The Macroeconomics of Agriculture." In *Handbook of Agricultural Economics*, Vol. 2A. B.L. Gardner and G. Rausser (eds.). Amsterdam: Elsevier.

Barrett, C.B. 2002. "Food Security and Food Assistance." In *Handbook of Agricultural Economics*, Vol. 2B. B.L. Gardner and G. Rausser (eds.). Amsterdam: Elsevier.

Beneke, R. 1998. "T.W. Schultz and Pamphlet No. 5: The Oleo Margarine War and Academic Freedom." *Choices*. Second Quarter:4-8.

Berndt, E.R. 1991. *The Practice of Econometrics: Classical and Contemporary*. Reading, MA: Addison-Wesley.

Bhide, S. 1994. "The Science of Agricultural Economics in India: Implications of Heady's Contributions." In J. Langley, G. Vocke and L. Whiting, *Earl O. Heady: His Impact on Agricultural Economics*. Ames, IA: Iowa State University Press.

Binswanger, H.P. 1974. "A Microeconomic Approach to Induced Innovation." *Economic Journal* 84:940-58.

Black, J.D. 1926. *Introduction to Production Economics*. New York: Henry Holt and Co.

Boussard, J.M. and M. Petit. 1967. "Representation of Farmers' Behavior Under Uncertainty with a Focus Loss Constraint." *Journal of Farm Economics* 49:869-880.

Brewster, J.M. 1959. "The Impact of Technical Advance and Migration on Agricultural Society and Policy." *Journal of Farm Economics* 41:1169-1184.

Bromley, D.W. 1991. *Environment and Economy: Property Rights and Public Policy*. Blackwell, Oxford.

Buck, J.L. 1943. *An agricultural survey of Szechwan province*. Farmers Bank of China: Chungking.

Buck, J.L., O.L. Dawson and Y. Wu. 1966. *Food and Agriculture in Communist China*. New York: Praeger.

Buck, J.L. 1973. "Development of Agricultural Economics at the University of Nanking, Nanking, China 1920-1946." Cornell University Agricultural Development Bulletin 25. Ithaca, NY.

Burt, O.R. 1966. "Economic Control of Groundwater Reserves." *Journal of Farm Economics* 48:632-647.

Burt, O.R. and J.R. Allison. 1963. "Farm Management Decisions with Dynamic Programming." *Journal of Farm Economics* 45:121-136.

Burt, O.R. and R.G. Cummings. 1970. "Production and Investment in Natural Resource Industries." *American Economic Review* 60:576-590.

Campbell, K.O. 1985. "Some Reflections on the Development of Agricultural Economics in Australia." In S. Bearman (ed.), *Agricultural Economics in Australia*. Department of Agricultural Business and Management, University of New England, Armidale.

Caswell, M., E. Lichtenberg and D. Zilberman. 1990. "The Effects of Pricing Policies on Water Conservation and Drainage." *American Journal of Agricultural Economics* 72(4):883-890.

Chambers, R.G. and J. Quiggin. 1996. "Non-point-source Pollution Regulation as a Multi-task Principal-agent Problem." *Journal of Public Economics* 59:95-116.

Chavas, J.P. 2002. "Structural Change in Agricultural Production: Economics, Technology and Policy." In B.L. Gardner and G.C. Rausser (eds.), *Handbook of Agricultural Economics* Vol. 1A. Amsterdam: Elsevier.

Chenery, H.B. and M. Syrquin. 1975. *Development, 1950-1970*. Oxford: Oxford University Press.

Ciriacy-Wantrup, S.V. 1952. *Resource Conservation – Economics and Policies.* Berkeley, CA: University of California Press.

Cochrane, W.W. 1953. "Professor Schultz Discovers the Weather." *Journal of Farm Economics* 35(2)(May):280-283.

Cochrane, W.W. 1958. *Farm Prices: Myth and Reality*. Minneapolis: University of Minnesota Press.

Cochrane, W.W. 1983. "Agricultural Economics at the University of Minnesota 1886-1979." Miscellaneous Publication 21. Institute of Agriculture, Forestry and Home Economics, Department of Agricultural and Applied Economics, University of Minnesota.

Cochrane, W.W. 1993. *The Development of American Agriculture: A Historical Analysis*. Minneapolis: University of Minnesota Press.

Cochrane, W.W. and C.F. Runge. 1992. *Reforming Farm Policy: Toward a National Agenda*. Ames, IA: Iowa State University Press.

Crutchfield, J. and A. Zellner. 1962. *Economic Aspects of the Pacific Halibut Industry*. Fishery Industrial Research 1. United States Department of the Interior, Washington, D.C.

Cummings, R.G. and D.L. Winkelmann. 1970. "Water Resource Management in Arid Environs." *Water Resources Research* 6:1559-1568.

Day, R.H. 1963. *Recursive Programming and Production Response*. Amsterdam: North-Holland.

Day, R.H. and E. Sparling. 1977. "Optimization Models in Agricultural and Resource Economics." In L.R. Martin (ed.), *A Survey of Agricultural Economics Literature*, Vol. 2. Minneapolis: University of Minnesota Press.

De Haen, H. and T. Heidhues. 1973. "Recursive Programming Models to Simulate Agricultural Development—Applications in West Germany." Institute for Agricultural Economics, Working Paper 18, Göttingen.

Dillon, J.L. 1971. "An Expository Review of Bernoullian Decision Theory in Agriculture: Is Utility Futility?" *Review of Marketing and Agricultural Economics* 39:3-80.

Dillon, J.L. and P.L. Scandizzo. 1978. "Risk attitudes of subsistence farmers in Northeast Brazil: A sampling approach." *American Journal of Agricultural Economics* 60:425-435.

Egbert, A.C. and E.O. Heady. 1961. *Regional Adjustments in Grain Production: A Linear Programming Analysis*. USDA Technical Bulletin 1241.

Eltis, W.A. 1975. "François Quesnay: a reinterpretation. 1. The Tableau Economique." *Oxford Economic Papers* 27(2)(July):167-200.

Evenson, R.E. 1967. "The Contribution of Agricultural Research to Production." *Journal of Farm Economics* 49(December):1415-1425.

Evenson, R.E. and Y. Kislev. 1976. "A Stochastic Model of Applied Research." *Journal of Political Economy* 84:265-281.

Ezekiel, M. 1930. *Methods of Correlation Analysis*. New York: Wiley.

Ezekiel, M. 1938. "The Cobweb Theorem." *Quarterly Journal of Economics* 52(February):255-80.

Fox, K.A. 1953. "A Spatial Equilibrium Model of Livestock-Feed Economy in the United States." *Econometrica* 21:547-566.

Galbraith, J.K. 1959. "John D. Black: A Portrait." In J. P. Cavin, ed. *Economics for Agriculture*. Cambridge, MA: Harvard University Press.

Georgescu-Roegen, N. 1960. "Economic Theory and Agrarian Economics." *Oxford Economic Papers* (New Series) 12:1-40.

Giles, A.K. 2000. "The AES, 1926-2001: A View from the Archives." *Journal of Agricultural Economics* 52:1-19.

Goodwin, B.K. and V.H. Smith. 1995. *The Economics of Crop Insurance and Disaster Aid*. Washington, D.C.: AEI Press.

Gray R. and D. Rutledge. 1971. "The Economics of Commodity Futures Markets: A Survey." *Review of Marketing and Agricultural Economics* 39:57-108.

Griliches, Z. 1957. "Hybrid Corn: An Exploration in the Economics of Technological Change." *Econometrica* 25(4):501-522.

Griliches, Z. 1958. "Research Costs and Social Returns: Hybrid Corn and Related Innovations." *Journal of Political Economy* 66(5):419-431.

Griliches, Z. 1963. "The Sources of Measured Productivity Growth: United States Agriculture, 1940-1960." *Journal of Political Economy* 71(August):331-346.

Griliches, Z. 1964. "Research Expenditures, Education, and the Aggregate Agricultural Production Function." *American Economic Review* 54(December):961-974.

Gustafson, R.L. 1958. "Implications of Recent Research on Optimal Storage Rules." *Journal of Farm Economics* 40:290-300.

Hanf, C.H. 1988. "Adjustment necessities in European agricultural economics research." *European Review of Agricultural Economics* 15:ix-xvi.

Hayami, Y. and V.W. Ruttan. 1971. *Agricultural Development: An International Perspective*. Baltimore: Johns Hopkins University Press.

Hazell, P.B.A. 1971. "A Linear Alternative to Quadratic and Semivariance Programming for Farm Planning under Uncertainty." *American Journal of Agricultural Economics* 53:53-62.

Heady, E.O. 1951. "A Production Function and Marginal Rates of Substitution in the Utilization of Feed Resources by Dairy Cows." *Journal of Farm Economics* 33:485-498.

Heady, E.O. and J.L. Dillon. 1961. *Agricultural Production Functions*. Ames, Iowa: Iowa State University Press.

Heady, E.O. and W. Candler. 1958. *Linear Programming Methods*. Ames, IA: Iowa State University Press.

Heidhues, T. 1966. "A Recursive Programming Model of Farm Growth in Northern Germany." *Journal of Farm Economics* 48:668-684.

Henderson, J.M. 1959. "The Utilization of Agricultural Land: A Theoretical and Empirical Inquiry." *Review of Economics and Statistics* 41:242-259.

Hertel, T.W. (ed.). 1997. *Global Trade Analysis Modeling and Applications*. New York: Cambridge University Press.

Hicks, J. 1932. *The Theory of Wages*. London: Macmillan.

Hicks, J. 1939. *Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory*. Oxford: Clarendon Press.

Hildreth, C. 1957a. "Problems of Uncertainty in Farm Planning." *Journal of Farm Economics* 39:1430-1441.

Hildreth, C. 1957b. "Some Problems and Possibilities of Farm Programming." *Fertilizer Innovations and Resource Use*, E.L. Baum, E.O. Heady, J.T. Pesek, and C.G. Hildreth, eds. Ames, IA: Iowa State College Press, pp. 243-260.

Hotelling, H. 1931. "The Economics of Exhaustible Resources." *Journal of Political Economy* 39:137-175.

Hueth, B. and E. Ligon. 2001. "Agricultural Markets as Relative Performance Evaluation." *American Journal of Agricultural Economics* 83:318-328.

Huffman, W.E. 1974. "Decision Making: The Role of Education." *American Journal of Agricultural Economics* 56(February):85-97.

Huffman, W.E. 2002. "Human Capital: Education and Agriculture." In B. L. Gardner and G.C. Rausser (eds.), *Handbook of Agricultural Economics*, Vol. 1A. Amsterdam: Elsevier.

Jesness, O.B. 1923. *The Cooperative Marketing of Farm Products*. Philadelphia: J.B. Lippencott.

Johnson, D.G. 1977. "Postwar Policies Relating to Trade in Agricultural Products." In L.R. Martin (ed.), *A Survey of Agricultural Economics Literature*. Minneapolis: University of Minnesota Press.

Jorgenson, D.W. and Z. Griliches. 1967. "The Explanation of Productivity Change." *Review of Economic Studies* 34(July):249-283.

Judge, G.G. and T. Takayama. 1973. *Studies in Economic Planning over Space and Time*. Amsterdam: North-Holland.

Just, R.E. and J.M. Antle. 1990. "Interactions Between Agricultural and Environmental Policies: A Conceptual Framework." *American Economic Review* 80(2):197-202.

Karp, L. and J. Perloff. 2002. "A Synthesis of Agricultural Trade Economics." In B.L. Gardner and G.C. Rausser (eds.), *Handbook of Agricultural Economics*, Vol. 2B. Amsterdam: Elsevier.

Kerr, N.A. 1987. *The Legacy: A Centennial History of the State Agricultural Experiment Stations 1887-1987*. Columbia, MO: Missouri Agricultural Experiment Station.

Kislev, Y. and W. Peterson. 1982. "Prices, Technology and Farm Size." *Journal of Political Economy* 90:578-595.

Klyukach, V.A. 2004. "Stages in the formation and modern development of Russian agricultural economics." *Ekonomika Sel'skokhozyaistvennykh I Pererabatyvayushchikh Predpriyatii* 5:10-13.

Knoeber, C.R. and W.R. Thurman. 1995. "'Don't Count Your Chickens . . .': Risk and Risk Shifting in the Broiler Industry." *American Journal of Agricultural Economics* 77:486-496.

Kreuger, A.O., M. Schiff and A. Valdés. 1991-94. *The Political Economy of Agricultural Pricing Policy* (4 volumes). Baltimore: Johns Hopkins University Press.

Lau, L.J. and P.A. Yotopoulos. 1971. "A Test for Relative Efficiency and Application to Indian Agriculture." *American Economic Review* 61(March):94-109.

Leontief, W.W. 1971. "Theoretical assumptions and non-observed facts." *American Economic Review* 61(March):1-7.

Lewis, W.A. 1954. "Economic Development with Unlimited Supplies of Labour." *The Manchester School* 22:3-42.

Lichtenberg, E. 2002. "Agriculture and the Environment." In B.L. Gardner and G.C. Rausser, *Handbook of Agricultural Economics*, Vol. 2A.

Marshall, A. 1890 (First Edition). *Principles of Economics*. London: MacMillan and Co.

Mellor, J.W. 1966. *The Economics of Agricultural Production*. Ithaca: Cornell University Press.

Miller, G.L. 1985. "Agricultural Economics in Canberra." In S. Bearman (ed.), *Agricultural Economics in Australia*. Department of Agricultural Business and Management, University of New England, Armidale.

Miranda, M.J. and J.W. Glauber. 1997. "Systematic risk, reinsurance, and the failure of crop insurance markets." *American Journal of Agricultural Economics* 79:206-215.

Moscardi, E. and A. de Janvry. 1977. "Attitudes toward risk among peasants: An econometric approach." *American Journal of Agricultural Economics* 59:710-716.

Moschini, G. and D.A. Hennessey. 2002. "Uncertainty, Risk Aversion and Risk Management for Agricultural Producers." In B.L. Gardner and G.C. Rausser (eds.), *Handbook of Agricultural Economics*, Vol. 2B. Amsterdam: Elsevier.

Moore, G.E. 1988. "The Involvement of Experiment Stations in Secondary Agricultural Education: 1887-1917." *Agricultural History* 62(2):164-176.

Myers, R.J.. 1989. "Econometric testing for risk averse behavior in agriculture." *Applied Economics* 21:542-552.

Myers, W.H., A.W. Womack, S.R. Johnson, J. Brandt and R.E. Young. 1987. "Impacts of Alternative Programs Indicated by FAPRI Analysis." *American Journal of Agricultural Economics* 69:972-979.

Nazarenko, V.I. 2004. "Conflict in Soviet Agricultural Economics in the 1920s and 1930s." *Ekonomika Sel'skokhozyaistvennykh I Pererabatyvayushchikh Predpriyatii* 6:8-11.

Nelson, R.R. and E.S. Phelps. 1966. "Investment in Humans, Technological Diffusion, and Economic Growth." *American Economic Review* 56(May):69-75.

Nerlove, M. 1958. *The Dynamics of Supply: Estimation of Farmers Response to Price*. Baltimore: Johns Hopkins University Press.

Newbury, D.M.G. and J.E. Stiglitz. 1981. *The Theory of Commodity Price Stabilization – A Study in the Economics of Risk*. Oxford: Clarendon.

Nōu, J. 1967. *Studies in the Development of Agricultural Economics in Europe*. Uppsala: Almquist and Wiksells.

Olsen, W. C., et al. 1991. *Agricultural Economics and Rural Sociology: The Contemporary Core Literature*. Ithaca: Cornell University Press.

Peterson, W.L. 1967. "Return to Poultry Research in the United States." *Journal of Farm Economics* 49:656-669.

Peterson, W.L. 1969. "The Allocation of Research, Teaching and Extension Personnel in U.S. Colleges of Agriculture." *American Journal of Agricultural Economics* 51(February):41-56.

Peterson, W.L. and Y. Hayami. 1977. "Technical Change in Agriculture." In L.R. Martin (ed.), *A Survey of Agricultural Economics Literature* Vol. 1.

Petit, M. 1982. "Is There a French School of Agricultural Economics?" *Journal of Agricultural Economics* 23:325-337.

Raeburn, J.R. and J.O. Jones. 1990. *The History of the International Association of Agricultural Economists.* Brookfield, VT: Gower Publishing Company.

Ricardo, D. 1821. *The Principles of Political Economy and Taxation*. London: M. Dent & Sons, 1911.

Roumasset, J. 1976. *Rice and Risk: Decisionmaking Among Low Income Farmers.* Amsterdam: Elsevier.

Runge, C.F. 1981. "Common Property Externalities: Isolation, Assurance and Resource Depletion in a Traditional Grazing Context," *American Journal of Agricultural Economics* 63:4.

Runge, C.F. 1987. "Induced Agricultural Innovation and Environmental Quality: The Case of Groundwater Regulation." *Land Economics* 63(3):249-258.

Runge, C.F., B. Senauer, P. Pardey and M. Rosegrant. 2003. *Ending Hunger in Our Lifetime: Food Security and Globalization.* Baltimore, MD: Johns Hopkins University Press.

Ruttan, V.W. 1956. "The Contribution of Technological Progress to Farm Output: 1950-75." *Review of Economics and Statistics* 38(February):61-69.

Samuelson, P. 1947. *Foundations of Economic Analysis.* Cambridge, MA: Harvard University Press.

Schmitz, A. and D. Seckler. 1970. "Mechanized Agriculture and Social Welfare: The Case of the Tomato Harvester." *American Journal of Agricultural Economics* 52:569-577.

Schuh, G.E. 1974. "The Exchange Rate and U.S. Agriculture." *American Journal of Agricultural Economics* 56:1-13.

Schuh, G.E. 1976. "The New Macroeconomics of Agriculture." *American Journal of Agricultural Economics* 58:802-811.

Schultz, T.W. 1953. *The Economic Organization of Agriculture*. New York: McGraw Hill.

Schultz, T.W. 1964. *Transforming Traditional Agriculture*. New Haven, CT: Yale University Press.

Schultz, T.W. 1971. *Investment in Human Capital*. New York: Free Press.

Scott, A. 1955. "The Fishery: The Objectives of Sole Ownership." *Journal of Political Economy* 63:116-124.

Segerson, K. 1988. "Uncertainty and Incentives for Nonpoint Pollution Control." *Journal of Environmental Economics and Management* 15(1):87-98.

Sexton, R. 1990. "Imperfect Competition in Agricultural Markets and the Role of Cooperatives: A Spatial Analysis." *American Journal of Agricultural* Economics 72:709-720.

Sexton, R. and N. Lavoie. 2002. "Food Processing and Distribution: An Industrial Organization Approach." In B.L. Gardner and G.C. Rausser (eds.), *Handbook of Agricultural Economics* Vol. 2B. Amsterdam: Elsevier.

Smith, A. 1776. *An Inquiry into the Nature and Causes of the Wealth of Nations.* Liberty Classics Edition (1981). Indianapolis, IN.

Sumner, D. and S. Tangermann. 2002. "International Trade Policy and Negotiations." In B.L. Gardner and G.C. Rausser (eds.), *Handbook of Agricultural Economics* Vol. 2B. Amsterdam: Elsevier.

Sunding, D. and D. Zilberman. 2002. "The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector." In B.L. Gardner and G.C. Rausser (eds.), *Handbook of Agricultural Economics*, Vol. 1A. Amsterdam: Elsevier.

Taylor, H.C. 1905. *An Introduction to the Study of Agricultural Economics*. New York: MacMillan.

Taylor, H.C. 1922. "The History of the Development of the Farm Economic Association." *Journal of Farm Economics* 4(2)(April):92-100.

Taylor, H.C. and A.D. Taylor. 1952. *The Story of Agricultural Economics in the United States, 1940-1932.* Ames, IA: Iowa State University Press.

Timmer, C.P. 2002. "Agriculture and Economic Development." In *Handbook of Agricultural Economics*, Vol. 2A. B.L. Gardner and G.C. Rausser (eds.). Amsterdam: Elsevier.

Tomek, W. and K. Robinson. 1977. "Agricultural Price Analysis and Outlook." In L.R. Martin (ed.), *A Survey of Agricultural Economics Literature* Vol. 1. Minneapolis: University of Minnesota Press.

Tolley, H.R., J.D. Black and M. Ezekiel. 1924. "Input as Related to Output in Farm Organization and Cost of Production Studies." Washington, D.C.: USDA. Bulletin 1277.

Veblen, T.B. 1900. "The Preconception of Economic Science: III." *Quarterly Journal of Economics* 14:240-69.

Von Thünen, J.H. 1828. *Isolated State.* Translated to English (1966). Oxford: Oxford University Press.

Walker, J.M., R. Gardner and E. Ostrom. 2000. "Collective Choice in the Commons: Experimental Results on Proposed Allocation Rules and Votes." *The Economic Journal* 110:212-234.

Waugh, F.V. 1928. "Quality Factors Influencing Vegetable Prices," *Journal of Farm Economics* 10(2):185-196.

Waugh, F.V. 1951. "The Minimum-Cost Dairy Feed." *Journal of Farm Economics* 33:299-305.

Working, E.J. 1927. "What Do Statistical 'Demand Curves' Show?" *Quarterly Journal of Economics* 41(February):212-35.

Working, H. 1922. "Factors Determining the Price of Potatoes in St. Paul and Minneapolis." University of Minnesota Agricultural Experiment Station Technical Bulletin 10. October.

Working, H. 1925. "The Statistical determination of demand curves." *Quarterly Journal of Economics* 39(August):503-43.

Wright, B. 2002. "Storage and Price Stabilization." In *Handbook of Agricultural Economics*, Vol. 1B. B L. Gardner and G.C. Rausser (eds.). Amsterdam: Elsevier.