Currently, there is a feeling that U.S. agriculture is at the end of a long period of surplus farm production and that all there is to worry about is expansion of farm output to feed the people being created by the population explosion. Others also feel that such drastic structural changes are taking place in the organization of agricultural production and marketing that overcommitted resources are a thing of the past.

In the following pages, I shall speculate as to whether structural changes now occurring in U.S. agriculture will prevent further overcommitment of physical and financial resources. I shall also argue that the international food gap will not reverse the long-standing tendency to overcommit resources.

In so speculating and arguing, I propose first to look briefly at the historical facts. Following this, I will look at the theoretical structures which underlie our reasoning on such subjects. Then I will look at some of the relevant structural characteristics of American agriculture and its producing firms. Following this, I will examine the structural changes which are occurring to see if they are likely to stop the overcommitment of physical and financial resources to agricultural production. Finally, I will sketch out some of the kinds of structural changes still needed to stop the overcommitment to and wastage of resources in U.S. agricultural production which will indicate some needed research in farm management, policy and marketing.

A Look at Some Historical "Facts" 1/

In looking at the history of resource use in United States agricultural production, 1917 to date, 2/ I find it advantageous to break

1/ This section is based largely on Calvin Quance's, "Farm Capital: Use, MVPs, and Capital Gains or Losses, United States, 1917-1964," Unpublished Ph.D. Thesis, Michigan State University, 1966, and an incomplete M.S.U. thesis by Francis Van Gigch.

2/ As part of a study conducted by the author, financed by Resources for the Future and involving the work of Bob Jones, Edward Rossmiller, Arne Larson, William Lerohl, Chenareddy Venkareddy, Calvin Quance and Francis Van Gigch with the advice and assistance, among others, of Dale Hathaway, Lester Manderscheid, David Boyne, Gladys Baker and Marion Clawson.
the period down into sub-periods: 1917 to 1929 -- from War to the Great Depression; 1930 to 1933 -- into the depths; 1933 to 1941 -- from the bottom to World War II; 1942 to 1946 -- World War II; 1947 to 1954 -- from War to Peace to War to uneasy Peace: 1955 to 1965 -- from Korea to the international food gap.

Some Historical Facts -- By Periods

The period from World War I to the Great Depression was characterized by the overcommitment of land, labor and of some forms of capital to agricultural production. The overcommitment of land was both physical -- too much was used -- and financial -- too much had been paid. This excessive commitment led to high output, low farm prices, capital losses and hardship in the rural relative to the non-farm economy. As there were no governmental programs to maintain prices above market-clearing levels, stocks did not accumulate; instead, the burden of adjustment fell on prices, incomes, wealth and hence on farmers and their families. In this period the culprit blamed was World War I which, it was correctly reasoned, had caused farmers to mistakenly "overcommit resources to agricultural production." Having found a whipping boy, few, if any, asked whether it was inherent in the system that farmers overcommit resources to the extent that the resultant output would put such adverse pressure on prices that farmers would fail to recover their expenditures on resources and fail to earn returns comparable to those obtainable in alternative industries.

Then came the 1929-33 slide to the depths of the Great Depression. This world-wide financial collapse deflated the entire economy bringing with it widespread unemployment and loss of domestic demand for farm products. As the Great Depression was international in character, an added loss of foreign demand for farm products accentuated problems for American agriculture. Thus, a new culprit had been found on which to blame the overcommitment of resources; instead of pointing an accusing finger only at World War II, we now blamed the monetary-fiscal system for the hardships experienced by American farmers as a result of producing so much that it could not be sold at prices high enough to cover investment expenditures. The linkage between the Great Depression and rural hardship was obvious. Thus, there was still no compelling need to ask whether the agricultural economy of the United States has inherent characteristics which cause it to overcommit resources to agricultural production.

The 1933 to 1941 period, the period from the depths to World War II, was characterized by governmental programs designed more to alleviate symptoms than to cure the disease of overcommitted resources. As the causes of the disease were taken to be World War I and the Great Depression, it was hard to conceive of doing anything within agriculture about causes. The prevention of wars was left to the diplomats and of
depressions to the monetary/fiscal experts while agricultural economists, trained in static theory, got on with the task of supporting prices and of preventing the use of overcommitted resources -- in short, agricultural economists treated symptoms leaving the disease as they saw it to others.

Then came World War II. Farming did become more profitable and events revealed that despite governmental attempts to restrict use of overcommitted resources, more resources had been committed. Obviously, productive capacity had built up in the inter-war years despite apparently adverse economic conditions for investing in agriculture. Various studies of U.S. capacity to produce agricultural products credited technology, specialization, agricultural education, and land-grant research for the rapid expansion in agricultural production with only modest increases in the use of capital and without much expansion in the use of land and with a reduced use of labor.

In the years 1947 to 1954 -- from World War II to the end of the Korean War -- World War II, the Steagall amendment price supports and the Korean War were blamed for overcommitments of resources to agricultural production. Production expanded rapidly and the stage was set for at least ten more years of over-production. In this period, price supports and governmental storage programs were to mean that the symptoms of overcommitted resources would be enormous governmental stocks of agricultural products rather than reduced prices and incomes and capital losses on investments in agriculture capital and land as in the 1917-30 and 1930-33 periods. Increasingly, these government programs became the culprit blamed by many of the ills of agriculture. The availability of this whipping boy, it seems, explains in part why agricultural economists, farm leaders and USDA officials did not ask themselves the fundamental question of whether inherent characteristics of American agriculture were responsible for the overcommitment of resources irregardless of World War II, the Great Depression, World War I or government programs.

\[3/\] A few studied countercyclical measures largely under the leadership of T. W. Schultz.


\[5/\] The few inadequate explanations which were advanced by laymen and others were rather summarily dismissed by the better-trained theorists among agricultural economists. See John M. Brewster & Howard L. Parsons, "Can Prices Allocate Resources in American Agriculture?" Journal of Farm Economics, November 1946.
The ten to twelve year period terminating around 1965 brought U.S. agriculture to the international food gap. In this period, substantial governmental measures were taken to dispose of governmentally held stocks at home and abroad. These programs were conducted at great cost and expense to the American tax payer and were of questionable value to recipients in the developing countries. As the world demand stiffened for agricultural products, it became easier to export agricultural products and by sometime in 1965, the end of excessive governmental stocks was in sight for everything except cotton. By now, 1967, it appears that we no longer have culprits to blame. In fact some people say that a new era has come. The international food gap and the changing structure of the American agricultural economy, according to these people, now mean that we are through with overcommitting resources. Yet, a very relevant question to ask involves whether or not there are still inherent characteristics in the U.S. agricultural economy which lead to overcommitting resources.

Some Historical Facts -- By aggregated Factors of Production

Another way to look at the historical factors is to look at them from the standpoint of labor, land, and various forms of capital.

From the standpoint of labor, the record 1917 to date is one of almost continuous overcommitment of labor to agricultural production. Table 10.1, by Venkareddy, shows his estimates of the present value of agricultural laborers in five different industries: agriculture, retail services, construction, manufacturing, and laundries. Over the entire period, the value of agricultural laborers has remained rather comparable with that of laborers in laundries, while the value of laborers in construction and in manufacturing has grown steadily relative to the value of agricultural laborers. A number of agricultural economists have analyzed the supply of agricultural operators and laborers by following age groups -- cohorts -- through time. These include Clawson, T. W. Schultz, "Impact and Implications of Foreign Surplus Disposal on Underdeveloped Economies," Journal of Farm Economics, December 1960.

<table>
<thead>
<tr>
<th>Year</th>
<th>Farming Present Value (in current dollars)</th>
<th>Manufacturing Present Value (in current dollars)</th>
<th>Construction Present Value (in current dollars)</th>
<th>Laundries Present Value (in current dollars)</th>
<th>Retail Trade Present Value (in current dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1917</td>
<td>19,381</td>
<td>27,278</td>
<td>27,412</td>
<td>13,007</td>
<td>17,909</td>
</tr>
<tr>
<td>1918</td>
<td>20,706</td>
<td>27,278</td>
<td>27,412</td>
<td>26,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1919</td>
<td>21,810</td>
<td>27,278</td>
<td>27,412</td>
<td>21,810</td>
<td>17,909</td>
</tr>
<tr>
<td>1920</td>
<td>23,917</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1921</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1922</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1923</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1924</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1925</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1926</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1927</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1928</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1929</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1930</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1931</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1932</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1933</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1934</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1935</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1936</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1937</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1938</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>1939</td>
<td>24,733</td>
<td>27,278</td>
<td>27,412</td>
<td>22,206</td>
<td>17,909</td>
</tr>
<tr>
<td>Year</td>
<td>Farming Present Value (in current dollars)</td>
<td>Manufacturing Present Value (in current dollars)</td>
<td>Construction Present Value (in current dollars)</td>
<td>Laundries Present Value (in current dollars)</td>
<td>Retail Trade Present Value (in current dollars)</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>1940</td>
<td>22,575</td>
<td>44,730</td>
<td>54,415</td>
<td>28,518</td>
<td>35,035</td>
</tr>
<tr>
<td>1941</td>
<td>25,946</td>
<td>53,391</td>
<td>61,603</td>
<td>30,046</td>
<td>37,182</td>
</tr>
<tr>
<td>1942</td>
<td>32,049</td>
<td>65,574</td>
<td>70,689</td>
<td>32,775</td>
<td>40,210</td>
</tr>
<tr>
<td>1943</td>
<td>37,625</td>
<td>72,871</td>
<td>68,058</td>
<td>35,902</td>
<td>42,261</td>
</tr>
<tr>
<td>1944</td>
<td>40,288</td>
<td>74,213</td>
<td>68,448</td>
<td>39,247</td>
<td>45,065</td>
</tr>
<tr>
<td>1945</td>
<td>41,789</td>
<td>70,505</td>
<td>71,550</td>
<td>41,217</td>
<td>47,073</td>
</tr>
<tr>
<td>1946</td>
<td>43,827</td>
<td>70,454</td>
<td>82,666</td>
<td>44,733</td>
<td>54,148</td>
</tr>
<tr>
<td>1947</td>
<td>47,559</td>
<td>83,199</td>
<td>98,431</td>
<td>48,770</td>
<td>60,535</td>
</tr>
<tr>
<td>1948</td>
<td>50,168</td>
<td>86,339</td>
<td>104,816</td>
<td>49,680</td>
<td>62,340</td>
</tr>
<tr>
<td>1949</td>
<td>48,112</td>
<td>80,595</td>
<td>96,338</td>
<td>48,428</td>
<td>61,487</td>
</tr>
<tr>
<td>1950</td>
<td>47,129</td>
<td>89,805</td>
<td>104,231</td>
<td>49,377</td>
<td>52,124</td>
</tr>
<tr>
<td>1951</td>
<td>54,824</td>
<td>96,593</td>
<td>114,879</td>
<td>52,518</td>
<td>68,013</td>
</tr>
<tr>
<td>1952</td>
<td>43,242</td>
<td>96,662</td>
<td>113,541</td>
<td>51,477</td>
<td>67,300</td>
</tr>
<tr>
<td>1953</td>
<td>53,068</td>
<td>99,288</td>
<td>119,062</td>
<td>52,087</td>
<td>68,914</td>
</tr>
<tr>
<td>1954</td>
<td>50,680</td>
<td>94,572</td>
<td>115,824</td>
<td>51,516</td>
<td>68,725</td>
</tr>
<tr>
<td>1955</td>
<td>53,255</td>
<td>108,038</td>
<td>127,518</td>
<td>53,787</td>
<td>73,821</td>
</tr>
<tr>
<td>1956</td>
<td>55,560</td>
<td>108,491</td>
<td>134,298</td>
<td>55,237</td>
<td>74,706</td>
</tr>
<tr>
<td>1957</td>
<td>55,698</td>
<td>106,382</td>
<td>131,470</td>
<td>54,143</td>
<td>73,879</td>
</tr>
<tr>
<td>1958</td>
<td>54,756</td>
<td>100,797</td>
<td>128,844</td>
<td>54,047</td>
<td>72,617</td>
</tr>
<tr>
<td>1959</td>
<td>57,062</td>
<td>112,438</td>
<td>141,632</td>
<td>55,150</td>
<td>75,330</td>
</tr>
</tbody>
</table>
Table 10.1 (Continued)

<table>
<thead>
<tr>
<th>Year</th>
<th>Farming Present Value (in current dollars)</th>
<th>Manufacturing Present Value (in current dollars)</th>
<th>Construction Present Value (in current dollars)</th>
<th>Launderies Present Value (in current dollars)</th>
<th>Retail Trade Present Value (in current dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>55,655</td>
<td>106,899</td>
<td>139,271</td>
<td>55,119</td>
<td>74,091</td>
</tr>
<tr>
<td>1961</td>
<td>54,164</td>
<td>105,479</td>
<td>138,592</td>
<td>54,183</td>
<td>72,806</td>
</tr>
<tr>
<td>1962</td>
<td>56,423</td>
<td>117,827</td>
<td>155,543</td>
<td>57,271</td>
<td>78,303</td>
</tr>
</tbody>
</table>

Source: See formulas for present values given in the Methodology chapter. For data on estimates of expected annual wages and unemployment rates see Appendix A and B respectively, for interest rate and expectancy of life, see Chapter III.
Bishop, Tolley, and others. Venkarreddy extended the cohort analyses to estimate how entry rates for young persons and exit rates for old persons are related to the ratios of the values of the laborers in agriculture and relevant non-farm industries for different age groups. Venkarreddy predicted about the same number of farm operators for the 1970's as Clawson, Bishop, Tolley, and others. However, the additional data used by Venkarreddy indicate that the rates of entry of younger persons and the rate of exit of older farm operators should be expected to be lower than these other analysts predicted (See Table 10.2). As a consequence, the age distribution which Venkarreddy predicts is even more skewed to the older age groups than those predicted by Clawson, Bishop, Tolley, et. al. Neither Venkarreddy's nor the earlier estimates indicate that the overcommitment of laborers to agriculture is going to cease in the decade ahead.

For the purposes of this paper, however, we must note that Venkarreddy, as well as Clawson, Bishop, and Tolley have not taken into account significant structural changes which are occurring in the agricultural labor market. Perhaps an extension of their empirical analyses to take these into account would show a different picture. I shall address myself to this question later.

Turning to capital, we find that we must distinguish between durable and expendable forms and between forms specialized and not specialized in agricultural production. Because there are associated differences in behavior of prices over the business cycle, it is also important to distinguish between farm-produced and non-farm produced capital. Still further, it is important to distinguish among capital which (1) substitutes for labor, (2) substitutes for land, and (3) is neutral with respect to land and labor.

---


9/ This section is based largely on Calvin Quance, "Farm Capital: Use, MVPs, and Capital Gains or Losses, United States, 1917-1964," Unpublished Ph.D. Thesis, Michigan State University, 1967. Quance's estimates of MVPs for capital are based on the technique employed by Tyner and Tweeten, in "A Methodology for Estimating Production Parameters," *Journal of Farm Economics*, XLVII, No. 5, (Dec., 1965), pp. 1462-1467, except that Quance's estimates are based on the theory discussed in this paper and hence are related to acquisition prices when use of a resource is expanding and on salvage values when its use is contracting.
Table 10.2: Number of farm operators by age group in the years 1960, 1970 according to 1960 census definition, U.S.

<table>
<thead>
<tr>
<th>Year</th>
<th>Farm Operators</th>
<th>Estimates for 1970 by Different Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Bishop and Tolley (1963)</td>
</tr>
<tr>
<td></td>
<td>(thousands)</td>
<td>Fox (1963)</td>
</tr>
<tr>
<td></td>
<td>1960</td>
<td>Johnston (1963)</td>
</tr>
<tr>
<td></td>
<td>1970</td>
<td>Present Study</td>
</tr>
<tr>
<td>25</td>
<td>3,701</td>
<td>2,654</td>
</tr>
<tr>
<td></td>
<td>2,500</td>
<td>2,593</td>
</tr>
<tr>
<td>25-34</td>
<td>407</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>2,607</td>
<td>26</td>
</tr>
<tr>
<td>35-44</td>
<td>812</td>
<td>235</td>
</tr>
<tr>
<td></td>
<td>2,593</td>
<td>201</td>
</tr>
<tr>
<td></td>
<td>62</td>
<td>56</td>
</tr>
<tr>
<td>45-54</td>
<td>809</td>
<td>401</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>418</td>
</tr>
<tr>
<td></td>
<td>988</td>
<td>382</td>
</tr>
<tr>
<td>55-65</td>
<td>623</td>
<td>398</td>
</tr>
<tr>
<td></td>
<td>692</td>
<td>663</td>
</tr>
<tr>
<td>65+</td>
<td>809</td>
<td>663</td>
</tr>
<tr>
<td></td>
<td>557</td>
<td>704</td>
</tr>
</tbody>
</table>

Present Study estimates for 1970 are

- Linear: 2,607
- Cobb-Douglas: 2,616
Most of the new factors of production making up what we call "advanced technology" are not neutral with respect to labor and/or land, as a great part of our effort to improve technology has been devoted to the saving of labor and land. From 1917 to date there have been few periods in which new forms of capital which substitute for labor and for land have not been relatively profitable. Profitability as used here, includes loss minimization of use as well as profit maximization adjustments.

Farmers have been relatively quick to exploit these profit maximization and loss minimization opportunities. With respect to neutral forms of capital, farmers have tended to vary capital whenever they could maximize profits or minimize losses.

It is also important to remember that there are cycles of overcommitment and liquidation with respect to such forms of capital as beef cows, sows and gilts, and dairy animals which are quite independent of inflations and deflations but which, in total, impose capital losses on farmers.

Over the 1917-65 period, overcommitments of specialized farm or non-farm produced, durable capital have not been followed by liquidations as the salvage value of such capital outside of agriculture is virtually zero. Instead, these items have remained in production at substantial capital losses to farms.

With respect to the expendable inputs produced in the non-farm economy, rates of purchase and usage have changed as profit maximization and loss minimization opportunities have arisen. Consequently, little overcommitment and few capital losses have taken place for these items.

In the case of farm-produced expendables, the prices of these expendables have tended to go up and down in close correlation with the prices of products produced by farmers; hence, profit maximization and loss minimization rates of usage for these items have not changed much as a result of changes in farm product prices. Though, as a consequence, little overcommitment and fewer capital losses have occurred on these items, substantial overcommitment and capital losses have taken place for the durables overcommitted to their production.

It should also be noted that there have been capital losses on storable, expendable inputs produced in the farm economy.
Land, 10/ despite the theoretical difficulties involved in distinguishing between it and capital, does behave differently than many forms of capital -- for one thing, it is hard to reproduce and is highly specialized in agricultural production. For the agricultural economy as a whole, land has a very high acquisition price and a very low salvage value which means that Ricardian rent theory does explain a good part of the variation in the value of land. The characteristics of land make it easier for farmers to pay too much for it rather than over-use it physically.

The development and extensive use of fertilizer as a land substitute has had a profound influence on the land market. Undoubtedly this development has prevented land prices in general from advancing further than they have over the 1917-67 period. This influence has been selective, however, as some land has been rendered virtually worthless while other land amenable both to fertilization and mechanization has increased in value.

There has been a strong demand for land on the part of individual farmers which seems to originate in a desire to minimize losses on previous overcommitments of first labor and then large scale machinery to minimize losses on labor. Once a farmer, who has overcommitted himself to farming, acquires a set of machinery capable of handling 25 to 50 percent more land than he controls, he finds it advantageous to acquire more land often on a loss minimization basis in order to fully utilize his labor and capital equipment. The resultant competition of farmers for land bids up land prices until, eventually, gross farm incomes cannot simultaneously cover the wages of comparable labor in the non-farm economy and what was paid for both the capital and land on the farm. 11/


Some Historical Facts with Respect to Technology, Improvements in the Human Agent and Institutional Change

Throughout the 1917 to 1967 period, important structural changes had been occurring with respect to technology, the human agent, and institutions for controlling prices, production, uncertainty and inflation. Some of these structural changes have been blamed for the overcommitment of resources to agricultural production.

Technological advance, for instance, is viewed by some as a force which enters agricultural production at a predetermined rate with respect to time and expands productive capacity almost irregardless of decisions by governmental administrators or individual farmers. I regard this as an erroneous way of looking at the impact of advancing agricultural technology on production. Instead, I view technological advances as embodied in inputs which cost money. Typically some of these inputs are labor saving while others are land saving. If so many of these inputs are put into use that farmers lose money on them, the rate of adoption of new technologies is excessive. If we want to understand excessive rates of adoption it seems to me that we should look at the forces which cause farmers to acquire excessive quantities of these modern inputs.

The modern factors which carry the new technology are sometimes durable, sometimes expendable. Some are farm-produced; others are not. Some such as hybrid seed corn are highly specialized; others such as pick-up trucks are not.

Viewing the adoption of new technology primarily as an investment and/or expenditure problem shifts the discussion back to the section on capital use and the same conclusions apply.

Neither are improvements in the human agent mystical things. Instead, individuals invest in their own training and once they have done so possess skills which are either devoted or not devoted to

---


13/ At this point in time I regard the lack in T. W. Schultz's modification of Book IV of J. S. Mill's Principles of Political Economy, New York, Longmans, Green & Co., 1936, of an explanation as to why farmers overcommit themselves to the use of capital, as well as labor, as a major shortcoming of his otherwise excellent book, Agriculture in an Unstable Economy, New York, McGraw Hill Book Co., 1945.
agricultural production. If so many of these skills are used in agricultural production that returns are not comparable to what would have been used elsewhere, then these skills are overcommitted. The key question is whether or not individuals overcommit themselves.

The institutional changes in the structure of American agriculture which occurred with respect to price supports and governmental production controls from 1933 on have not been of the type which have prevented the overcommitment of physical and financial resources to agricultural production. The 1917-67 historical record is quite clear -- even when production controls have placed physical restrictions on the use of land, they have not restricted either the use of land substitutes nor the willingness of farmers to pay too much for land and acreage allotments. Excessive commitment of resources has occurred both with and without government controls. Though the record indicates that the overcommitment has been greater since the introduction of price supports and controls than before, overcommitment existed prior to their introduction.

Speculation and Uncertainty as an Explanation of High Land Prices and Overcommitment of Land and other Resources

Some people have argued that inflationary gains from land speculation more than offset the low rates of return resulting from the overcommitment of land and other factors to agricultural production. Over the long sweep of time from 1917 to date there have been about as many periods of time in which farmers have lost from deflation as periods of time in which they have gained from inflation. Even for recent years, research indicates that the stock market has been a better place in which to speculate than the land market. Thus, inflation is not an adequate explanation for the low rates of current earnings on investments in agricultural productivity for returns in farming are reduced still further relative to those in the non-farm sector when returns to speculative activity are included on both sides of the farm/non-farm equation.

Risk and uncertainty have been advanced by many as explanations of the ills of agriculture. Sorenson for potatoes, Hathaway for dry

---


edible beans, and the author for burley, have found that price uncertainty accounted for under-allocation (from the standpoint of average profitability) of resources. This implies above "standard" average actual returns before discounting and as such hardly explains the overcommitment, substandard returns and capital losses so prevalent 1917 to date. More will be said about this matter later after appropriate theoretical issues have been raised.

Some Historical Conclusions

The above historical summary:

1. indicates that the tendency of U.S. agriculture to overcommit resources to agricultural production was aggravated by World Wars I and II, the Korean War, the Great Depression, and government programs but

2. has also existed independently of these events as a fundamental characteristic of U.S. agriculture not explainable by

   a) advancing technology
   b) improvements in the human agent
   c) inflationary gains on rural real estate or
   d) risk and uncertainty

A Look at Theory

One hesitates to consider theoretical concepts among colleagues so well-versed in theory. Yet, it seems that we have not faced up to the theoretical issues which are becoming increasingly relevant as a result of the structural changes now taking place. In view of our historical study, we need to look at theory which contains the possibility of explaining an inherent tendency to overcommit resources.


17/ Glenn L. Johnson, Burley Tobacco Control Programs, Kentucky Agricultural Experiment Station, University of Kentucky, February, 1952.

It is customary for policy and farm business analysts to use a theoretical economic system characterized by (1) perfect knowledge and foresight, (2) resources which are fixed exogenously to the firms and, hence industries, and (3) perfect markets for factors and products in which transfer costs are zero. The third assumption is often made almost unthinkingly by tacitly assuming acquisition costs for resources to be infinite and salvage prices to be zero for fixed resources while assuming tacitly without any more thought, that the variable resources used and products produced by firms are perfectly priced in the sense that they can be bought and sold "at the barn door" at the same price.

The substantive content of our theories, however, is drastically changed if we assume, more realistically, (1) imperfect knowledge, (2) that acquisition prices for many resources (fixed or variable) may be less than infinite and salvage prices greater than zero and (3) that acquisition prices are typically greater than salvage values for most of the resources used in production.

With perfect knowledge, the introduction of more realistic assumptions with respect to acquisition prices and salvage values produces only minor changes in the theory. With imperfect knowledge, however, the differences are great and of important consequence.

I will not burden this conference with the theory and mathematics of theory by attempting to present them from this rostrum. Instead, a mathematical presentation comparing this theory with the more usual form is attached as an appendix. Also, the main characteristics of this theory have been published in a number of places.  

The theory to be used in the remainder of this paper is based on the assumptions, among others, of (1) imperfectly informed managers capable of learning and (2) acquisition prices less than or equal to infinity but greater than or equal to salvage prices which are in turn greater than or equal to zero. Such a modification of ordinary neo-classical theory has many characteristics not present in neo-classical

---

theories based upon perfect knowledge and acquisition prices equal to salvage prices for variable inputs and acquisition prices equal to infinity and salvage prices equal to zero for fixed inputs. One of the characteristics of the modified theory is overcommitment of resources through time. The introduction of errors in combination and levels of resource use by imperfectly informed managers under these price conditions leads to some important conclusions concerning overcommitment of resources:

1. No mistake of overcommitting an input whose acquisition cost exceeds its salvage value is completely correctable.

2. Some mistakes of overcommitment can be partially corrected by loss-minimizing further expansions in resource use and output.

3. On the other side, some mistakes of undercommitment on production can be completely corrected by moving to the optimum level of resource use, while other mistakes of undercommitment can only be partially corrected by a loss minimization adjustment from a point of undercommitment to a level of output which would exceed the optimum had no mistake of undercommitment been made originally.

Conclusions 1, 2 and 3 above result in a tendency towards overproduction leading to capital losses through time with respect to acquisition prices of inputs whose acquisition prices exceed salvage value. The maximum capital losses is the difference between acquisition cost and salvage value. So long as knowledge remains imperfect through time either because farm entrepreneurs have not learned all there is to know about past changes or because new changes have occurred, this bias should be expected to be maintained.20/

Some people have argued that managers would learn how much to discount expected earnings and that they would not over-produce in the long run. This would presume considerable knowledge about the distribution of technical institutional and human change. However, even if managers have such knowledge, Kellogg has demonstrated

mathematically the theoretical consequences of discounting a marginal value productivity of, say, 10% to 6% in the presence of imperfect knowledge with realistic assumptions with respect to acquisition prices and salvage values.\textsuperscript{21} The theoretical consequence is that entrepreneurs would (1) fail to make their discount rate and hence (2) suffer capital losses with respect to the rate of return which they had expected to get to cover their cost of bearing the uncertainty present in the system.

**Characteristics of the Agricultural Economy**

In general, firms of the agricultural economy have the characteristics of atomistically organized firms in any part of the economy; however, the combination of characteristics found among agricultural firms is somewhat unique.\textsuperscript{22}

A characteristic of the agricultural firms is that larger quantities of labor are born into the agricultural household/firm complex than required to supply demand at prices which will cover acquisition costs simultaneously for all inputs.

U.S. farmers operate in an economy characterized by rapidly rising real per capita incomes and wage rates.

Another characteristic of agricultural firms is that they occupy much geographic space. Large numbers of agricultural firms simply cannot be established without creating substantial transportation costs for moving inputs from non-farm sources to the farm and for moving farm products from farm to non-farm consumers. Similarly there is a substantial cost of moving farm-produced inputs from producing farms to utilizing farms. The same is true of second-hand non-farm produced inputs. This geographic characteristic of the agricultural firm introduces wide variations between acquisition and salvage prices for many inputs. For instance, in the case of silage, hay and pasture, which provide a very high proportion of the nutrients consumed by the ruminants of the U.S. agricultural economy, the differentials between acquisition and salvage prices are such that acquisition prices may exceed salvage prices by as much as 1000 percent.

\textsuperscript{21} Earl Kellogg has simulated the operations of an imperfectly-informed discounting entrepreneur producing on a Cobb-Douglas function of unit total elasticity with acquisition costs greater than salvage values subject to a net worth restriction.

\textsuperscript{22} Dale Hathaway, *Government and Agriculture*, the MacMillan Co., 1963, p. 84.
Another characteristic of agricultural firms is that they are operated in a rapidly changing environment by managers who are very imperfectly informed about the macro consequences of their individual actions.

Another characteristic of the environment in which agriculture operates is change -- change with respect to foreign demand, per capita incomes, war demand, technology, institutions and education. These changes, however, occur in the presence of price and income demand elasticities which means that the demand for agricultural products grows slowly relative to (1) capacity to produce (if the required investments are made) and (2) the growth in demand for non-agricultural goods and services.

This set of characteristics combines with the theory considered in the preceding section to explain "the roots of the farm problem" of overcommitting resources to production. This combination of theory and fact implies that the tendency to overcommit has been inherent in the agricultural economy of the U.S. It indicates that World Wars I and II, the Great Depression, the Korean War, and government programs have been aggravating factors but not fundamental causes.

It is now time to look at the likely impacts of current structural changes and the international food gap on this long-standing tendency of U.S. agriculture to overcommit, over-produce and to impose hardship on its entrepreneurs.

Structural Changes Occurring in American Agriculture

For the past half century, important structural changes in agriculture have involved (1) improvements in the human agent, (2) the creation of new technologies, and (3) changes in the institutions which control resource use.

As the educational institutions of the United States have been improved and have been adapted to serve agriculture they have tended increasingly to break the traditional bond between the farm-firm household complex and the farm child. Widespread receipt of general education has made the farm child much more flexible and capable with respect to life occupations. With the passage of time, this structural change may reduce the importance of excess labor being continually born into the farm firm/household complex. The projections of numbers of farm operators made by Clawson, Heady, Bishop and Venkareddy have not taken this structural change into account. There have also been important changes in the labor market which affect the use of both local and migrant hired labor. These changes involve minimum wage rates,
workmen's compensation, social security, medicare, housing regulations, and, increasingly, unionization. The elimination of Public Law 78 arrangements for importing Mexican Nationals has increased the real acquisition cost for migrant laborers, a development further accentuated by minimum wage rates and unionization.

Labor saving technology and the historical ponderance of operator and family labor in the agricultural labor force mean that structural changes involving migrant labor are of little overall significance except for the unmechanized, stoop-labor crops which are dependent upon such laborers. The educational changes which have occurred have probably been important.

Labor-saving technological advance has permitted capital to replace laborers so that the total supply of labor and labor substitutes in American agriculture has expanded rapidly over the years. The introduction of capital substitutes for labor has made it possible for labor to be driven out of agriculture even in periods of low, off-farm salvage values for labor as witnessed by the introduction of the corn picker into the corn belt during the depression years and the "tractoring off of the Okies" even when farm wage rates were at a very low level relative to other prices in the economy.

Similarly, the development of land substitutes has greatly increased the total supply of land and land substitutes in the U.S. agricultural economy. As a result land prices have not advanced as rapidly as they would have in the absence of the creation and use of land substitutes.

Such technological changes should not be expected either to cause or stop the overcommitment of resources to agricultural production. Instead they are changes which imperfectly informed managers have to handle. In the handling, errors are made on the part of managers. The theory looked at earlier in this paper indicates that such errors, though randomly distributed initially with respect to over and undercommitment, should be expected to lead eventually to overcommitment.

When we look to the control institutions, we find that the structural changes which have occurred with respect to governmentally-operated price supports and production controls over the past 30 some odd years have not been of the type which have prevented managers from making mistakes. To the extent they have maintained the marginal value productivity of resources, price supports have become the basis for further mistakes of farmers in capitalizing current income streams into the capital values for acreage allotments, land and durable items of capital such as breeding herds, orchards, irrigation systems and fences. This historical observation on the pricing of acreage allotments will be important later in considering the impact of the international food gap on U.S.
agriculture. Further, these programs have been set up, by and large, to maintain and protect existing farmers and investments in agriculture rather than to (1) liquidate fixed overcommitments of resources to agricultural production and (2) develop organizations for the purpose of controlling, on the basis of improved knowledge, rates of entry of farmers and investments.

In this same 30 year period, a greatly expanded program of governmental sponsored economic research and extension has not been adequate to reduce the imperfections in knowledge faced by individual farm managers to such an extent that their errors of overcommitment have been reduced substantially.

On the private side, one can ask whether institutional changes involving contract farming and vertical integration from input suppliers such as fertilizer, feed and drug manufacturers are likely to stop the overcommitment of resources. A moment's reflection will indicate that such suppliers have very little real motive to reduce the overuse of the supplies they sell. One would expect overuse to be curtailed mainly by structural changes which would make contractors and vertical integrators financially responsible for the losses associated with overuse. If we look to the buyers of farm products -- the processors, distributors, wholesalers and retailers -- we see the possibility that vertical integration, but not contracts, might reduce the overcommitment of resources. However, the general political situation is such that such agencies have to be careful about eliminating large numbers of individually operated family farms. So long as the production of the agricultural products processed and distributed by these agencies remains in the hands of other entrepreneurs there appears to be little incentive for processors and distributors to gain by setting up control mechanisms. Such mechanisms would reduce the volume of business of such firms thereby making it necessary for the controlling agencies to perform the politically unpopular act of increasing prices to consumers while reducing their own volume.

The International Food Gap and Overcommitment

We are now ready to look more analytically at the opportunities and problems likely to be created by the international food gap. Growth in demand is capable, theoretically, of offsetting the tendency toward overcommitment and over-pricing of inputs one expects in U.S. agriculture on the basis of both theory and history.

---

23/ See Dale Hathaway's paper, this conference, for similar views on the private side.
The question is whether this expansion in demand is sufficient to do this in view of (1) the characteristics of U.S. agriculture listed in the next to last section and (2) the structural changes discussed in the last section.

Though the world-wide population explosion is creating a great physical need for food there are serious questions about (1) "effective demand," (2) the ability of the U.S. government to finance foreign consumption of U.S. produced food at costs of production related to advancing U.S. wage rates and (3) cheaper alternative ways of producing food abroad.24/

Unless the expansion in effective demand is steady but almost unanticipated by farmers, the theoretical and historical examination of resource use in U.S. agriculture 1917 to date indicates that U.S. farmers should be expected to use too many resources, pay too much for land and overcommit too much operator and family labor.

With so much of the effective demand determined by U.S. political activity, with Russia overhauling her agricultural production policies and with many undeveloped countries with underutilized productive capacity overhauling their agricultural expansion in foreign effective demand for U.S. farm products. Further, as I read the farm press and observe changes in land value, the expansion in demand is far from unanticipated -- in fact, I fear that it is over-anticipated and that farmers will pay so much for land, invest so much in capital and commit so many people to farming that effective demand will not cover acquisition costs simultaneously for all inputs in the future any better than in the past. This fear is only increased by observation of this rapid current rate of increase in U.S. non-farm wage rates.

The Kinds of Structural Changes and Agricultural Economics Research Needed

When one examines the history of U.S. agriculture and the implications of the theory discussed in this paper and in view of the changing characteristics of American agriculture, it appears that needed additional structural changes involve (1) a reduction of imperfect knowledge, (2) a reduction of differences between acquisition and salvage values, and (3) development of additional control mechanism on entry of men and resources, these controls to be operated by agricultural producers.

24/ Conference on "Alternatives for balancing future world food production and needs," sponsored by Iowa State University, Center for Agricultural and Economic Adjustment, Ames, Iowa, Nov. 8, 1966; particularly the paper by T. W. Schultz, U.S. Malinvestments in Food for the World.
It is my own judgment that the public service organizations for agriculture namely, the U.S.D.A. and the Land Grant colleges and universities have not done an adequate job of reducing the imperfections in knowledge faced by individual farmers. I simply think that we can do much better research on the implications for resource use in agriculture, of technological changes, changes in the human agent, income demand elasticities, foreign demand, etc. than we have done. Currently, for instance, we are doing little that is adequate on the implications of the so-called international food gap. Better specific research is needed as to the quantities of resources which can be committed to agriculture, in the aggregate, without producing so much product that it cannot be sold except at prices which will not cover acquisition costs.

While researchers could do much better than they have done, they probably would not be able to do this job well enough to cure the long-term tendency of agriculture to overcommit resources to agricultural production. Furthermore, even if researchers were able to produce the knowledge, it is questionable whether a greatly expanded and improved extension and information distribution system would be able to get it fully distributed to and used by farmers. A reason for pessimism here involves the atomisic organization of agriculture for which knowledge of macro consequences is of little private personal importance.

If the above conclusions with respect to public reduction of imperfect knowledge are correct, then the theory indicates that steps should be taken to more nearly equate acquisition costs and salvage values for agricultural inputs. However, these differences are due, in the final analysis, largely to the geographic dispersion of farms and transportation costs. Except for expensive subsidies, differences between acquisition and salvage prices are hard to eliminate. This combines with the above conclusions about the difficulty of solving the problem through research and extension to indicate that agriculture needs to seek structural changes involving the creation of control mechanisms.

Control mechanisms are needed to regulate the rate at which resources are committed to agricultural production. Historically, the government appears to be a poor agency for doing this. It has tended to protect the resources, farmers and farm firms already committed to production and has not concentrated on stopping new overcommitments. Private nonfarm input suppliers are unlikely to perform this function well as they simply do not have incentives to control the overcommitment unless they become owners of the agricultural producing firms. Similar conclusions are reached with respect to control mechanisms which would originate on the demand side with the processors and distributors. Though, I hasten to add, that it would not necessarily be wrong for private agricultural entrepreneurs to disappear and become part of either
supplying or distributing firms and agencies, real political problems would be involved. For a long while, people in this country worried about the replacement of the family operated "Pop and Mom" grocery store by the chains. It did disappear, however, and Pop and Mom were replaced by supermarket laborers and managers. As I cannot see how the moral fiber or other aspects of American society were damaged by this transition, I cannot conclude, a priori, that American society would necessarily be damaged by a restructuring of our agricultural society to put agricultural production in the hands of input suppliers of processors and distributors. Actually, such a restructuring might mean that agricultural labor would receive returns commensurate with those received by laborers in the rest of the economy and that investments in agricultural production would earn returns comparable to those in the rest of the economy. If this came about, such a restructuring, like the abandonment of the Pop and Mom grocery store, might be a good thing. However, despite my relative lack of fear on this point, our thoughts on restructuring American agriculture should give considerable attention to the possibility of creating new control mechanisms owned and managed by agricultural producers. After researchers and extension workers have made their best efforts to produce new knowledge and to educate the public and the individual farmers, this same information could be used by organizations of producers in operating controls on (1) the entry of firms into agricultural production, (2) investments of new major pieces of capital equipment such as bulk tanks, power units etc., and (3) the commitment of youths to agriculture.

When the American economy decided to grant similar powers of control to non-farm firms by permitting them to incorporate, sufficient attention was not given to governmental arrangements for maintaining public responsibility on the part of these new institutions. Similarly, when labor was granted the right to organize and bargain collectively, rather than individually, sufficient attention was not given to the regulatory role of government. In both cases, public control of these institutions was extended and further developed subsequent to the legal changes permitting them to be established. If we change our institutional arrangements to permit a development of control structures for agricultural production, a change in the role of government will have to occur. There are reasons for believing that the legal changes providing for the creation of control institutions should simultaneously provide for government regulation of the resultant agricultural monopsonies and monopolies. This area needs much research by agricultural economists, particularly those in the field of policy.

Another comment seems appropriate. Even if expanded and more effective research and extension were provided and even if institutional arrangements to permit producers to develop control mechanisms were developed, it does not seem likely that organizations of producers
would be able to control a commodity so widely dispersed and so diverse, as, say, wheat or pork. Therefore, it seems that there is likely to continue to be a role for government to play in the field of direct price supports and direct production controls despite our rather unfortunate experiences with these institutions to date. Again, more agricultural policy research is indicated.

As a final comment, there are reasons to believe that the solution of the problem of overcommitted resources might eliminate the U.S. family farm's economic "raison d'être." Thus, if the structural changes suggested above should be adopted and prove effective, separate attention should be given to answering the question of whether or not we want to maintain family farms and if so how. As I explored this question in a paper presented at the Rome meeting of the International Economics Association, I merely refer you to that paper at this point as a guide to some relevant research which might be undertaken by farm management personnel.

APPENDIX

Theoretical Notes

At the individual firm level, we are interested in the different consequences of two alternative sets of assumptions for the inputs $X_i$, $i=1, \ldots, n$.

The first set of assumptions is

\begin{align}
\mathcal{O} \geq P_{AX_i} &= P_{SX_i} = 0 \\
\mathcal{O} = P_{AX_i} &= P_{SX_i} = 0
\end{align}

$i = i, \ldots, d$

$i = d + 1, \ldots, n$

$P_{AX_i}$ is the acquisition price of $X_i$ and $P_{SX_i}$ is the salvage value of $X_i$. We assume a one to one correspondence between prices of stocks and service flows for the $X_i$. (See paper for a discussion of consequences).

For set of assumptions (1), let $G$ stand for gain (or loss, if negative) from reorganizing a given firm.

\begin{align}
G &= \sum_{j=1}^{m} P_{y_j} (Y_j - Y_j^o) - \sum_{i=1}^{n} P_{x_i} (X_i - X_i^o).
\end{align}

$Y_j$ are products, $j=1, \ldots, m$. $Y_j^o$ stands for initial output of the product $j$ while $Y_j$ stands for the reorganized output of $Y$ by the reorganized firm. Similarly, $X_i^o$ and $X_i$ stand for the initial and reorganized input of $X_i$, $i=1, \ldots, n$.

The problem of the manager of a firm is envisioned to be that of reorganizing an initial organization to maximize $G$ subject to

\begin{align}
(a) & \quad b_i = \sum_{j=1}^{m} X_{ij} \text{ for } i = d + 1, \ldots, n \\
(b) & \quad X_{ij} \geq 0, \text{ for } i = 1, \ldots, n
\end{align}

\phantom{26/}

where $X_{ij}$ is the amount of the $i$th input used in producing the $j$th product.

$$G^* = \sum_{j=1}^{m} P_{y_j} (Y_j - Y_j^o) - \sum_{i=1}^{d} P_{x_i} \sum_{j=1}^{m} (X_{ij} - X_{ij}^o) \quad \text{Py}_j = \text{price of jth product.}$$

Assuming the law of diminishing returns and independence among the $j$ production functions, (3) can be maximized by methods developed by Kuhn and Tucker. When the Lagrangian function is formed as in

$$L \equiv G^* + \sum_{i=d+1}^{n} \left( X_i^o - \sum_{j=1}^{m} X_{ij} \right)$$

it can be maximized subject to (2)(a) and (b) above "if and only if there is a set of $i$ (for $i=d+1, \ldots, m$) such that (4) is maximized with respect to the $X_{ij}$ and minimized with respect to the $j$.

For each of the variable inputs $(i=1, \ldots, d)$ used in producing a product $j$

$$P \frac{\partial Y_j}{\partial X_{ij}} - P_{x_i} = 0 \quad \text{(for i=1, \ldots, d; j=1, \ldots, m)}$$

for the most profitable reorganization of the firm. For each of the "fixed inputs $(i=d+1, \ldots, n)$" used in producing a product $j$

$$P_{y_j} \frac{\partial Y_j}{\partial X_{ij}} - \lambda_i = 0 \quad i=d+1, \ldots, n; j=1, \ldots, m$$

can be interpreted as the "on-farm" opportunity cost of $X_i$. Off-farm opportunity costs of $X_i$ are assumed zero as $P_{sx_i} = 0$. Acquisition costs for $X_i$ are assumed infinite. Hence, the $X_i^o$ for $i=d+1, \ldots, n$ are fixed regardless of $P_{y_j}$ and of subsequent $X_{ij}$ for $i=1, \ldots, d$ and $j=1, \ldots, m$.

The second set of assumptions is

$$\infty \geq P_{sx_i} \geq P_{sx_i} \geq 0 \quad \text{for i=1, \ldots, n.}$$

---

\[
G = \sum_{j=1}^{m} P_{y_j}(Y_j - Y_i^0) - \sum_{i=1}^{n} \alpha_i \left( \sum_{j=1}^{m} X_{ij} - X_i^0 \right)
\]

if \[\sum_{j=1}^{m} X_{ij} > X_i^0 \] then \[a_i = P_{AX_i}\]

if \[\sum_{j=1}^{m} X_{ij} < X_i^0 \] then \[a_i = P_{SX_i}\]

if \[\sum_{j=1}^{m} X_{ij} = X_i \] then \[P_{AX_i} > a_i > P_{SX_i}\]

Let \(W_j\) = amount of \(X_j\) purchased and \(V_j\) = amount of \(X_j\) sold. Hence

\[
\sum_{j=1}^{m} X_{ij} = X_i^0 - V_i + W_i \quad \text{subject to the}
\]

restriction that \(X_i^0 - V_i \geq \sum_{i=1}^{n} \sum_{j=1}^{m} X_{ij}\)

Equation (8) can be rewritten as

\[
G^* = \sum_{j=1}^{m} P_{y_j}(Y_j - Y_j^0) + \sum_{i=1}^{n} P_{SX_i} V_i - \sum_{i=1}^{n} P_{AX_i} W_i
\]

where \(S_i = a_i = P_{SX_i}\) and \(A_i = a_i = P_{AX_i}\)

When placed in the Lagrangian form, (9) appears as

\[
L = G^* + \sum_{i=1}^{n} \lambda_i (X_i^0 - V_i + W_i - \sum_{j=1}^{m} X_{ij}) + \sum_{i=1}^{n} \mu_i (X_i^0 - V_i)
\]

which is maximized with respect to \(X_{ij}, V_i\) and \(W_i\) and minimized with respect to \(\lambda_i\) and \(\mu_i\), following Kuhn and Tucker. For each product possibly using \(X_i\), the solution involves for all \(i\) and \(j\).
\[(11) \quad \frac{\delta L}{\delta x_{ij}} = P_Y \frac{\delta V}{\delta x_{ij}} - \lambda_i \leq 0, \quad \frac{\delta L}{\delta x_{ij}} x_{ij} = 0 \text{ and } x_{ij} \geq 0.\]

Condition (11) indicates that the marginal value productivity of an input in producing a given product is less than or equal to opportunity cost if none of the input is used in producing that product.

The solution also involves

\[(12) \quad \frac{\delta L}{\delta w_i} = \lambda_i - \mu_i \leq 0; \quad \frac{\delta L}{\delta w_i} w_i = 0; \quad w_i \geq 0\]

which indicates that purchase of \(x_i\) involves an opportunity cost for \(x_i\) equal to its acquisition price at the optimum.

The solution also involves

\[(13) \quad \frac{\delta L}{\delta v_i} = s_i - \mu_i - \lambda_i \leq 0; \quad \frac{\delta L}{\delta v_i} v_i = 0; \quad v_i \geq 0\]

which indicates that sale of \(x^o_i\) involves an opportunity cost for \(x_i\) equal to its salvage value when less than \(x^o_i\) is sold. \(w_i\) is greater than or equal to zero when \(s_i \geq \lambda_i\) and when all of \(x^o_i\) is sold.

The solution also involves

\[(14) \quad \frac{\delta L}{\delta \mu_i} = x^o_i - v_i \geq 0; \quad \frac{\delta L}{\delta \mu_i} \mu_i = 0; \quad \mu_i \geq 0\]

a condition made necessary by the fact that more of \(x_i\) cannot be sold than is on hand. \(\mu_i > 0\) when \(x^o_i = v_i\). \(w_i = 0\) when \(x^o_i > v_i\).

**Differences and consequences of the two sets of assumptions.** The first set assumed acquisition and salvage values of inputs to be either equal or infinite and zero, respectively. The second set assumed acquisition and salvage prices to be unequal.

I. Under the first set of assumptions:

A. Inputs with zero salvage and infinite acquisition prices are priced internally at opportunity costs determined by product prices, initial quantities on these inputs on hand, the nature of the production function using them, and prices (including opportunity costs) of other inputs.
B. Some of the optimizing reorganizations of farmers are reversible. These reorganizations can result from changes in (1) product prices and (2) prices of other inputs. Reorganizations are irreversible which result from changes in initial quantities of inputs on hand with infinite acquisition costs or zero salvage values, as are those resulting from technological change.

C. B, above, implies reversible supply functions of individual firms for products and reversible demand functions of individual firms for inputs.

D. If \( d = 2 \) and \( n = 3 \), the iso-value product and iso-cost map for the \( j \)th product would appear as follows:

LL is a line of least cost combinations. HPP is the high profit point. The cost functions would appear as follows:
E. If imperfect knowledge is assumed, failures to organize at the HPP can be corrected at no cost by selling any of the $X_i$ which are in excess and buying any of the $X_i$ in deficit, $i=1,\ldots,d$. Hence, no capital losses need be incurred on $X_i$ for $i=1,\ldots,d$.

F. Capital losses and gains can occur on the $X_i$ for $i=d+1,\ldots,n$, however. The capital value of any durable in this set of $X$, will be the present value of its expected $\lambda_i$'s and $\lambda_i$ is a function of product prices, technology (nature of the production function), $P_{X_i}$ for $i=1,\ldots,d$, changes in these determining variables can create capital gains and losses for the fixed resources.

II. Under the second set of assumptions, i.e. $\infty > P_{AX_1} \geq P_{SX_1} \geq 0$ for $i=1,\ldots,n$.

A. Inputs with $P_{AX_1} > P_{SX_1}$

(1) were priced internally at opportunity cost, $\lambda_i$ when $P_{AX_1} > \lambda_i > P_{SX_1}$ and are fixed

(2) are priced at $P_{AX_1}$ when $\lambda_i \geq P_{AX_1}$ and are variable

(3) are priced at $P_{SX_1}$ which might be termed an external opportunity cost when $\lambda_i \leq P_{SX_1}$ and are variable

(4) have $\lambda_i$'s (opportunity costs) determined by product prices, initial quantities of the all $X_i$'s on hand for which $P_{AX_1} > P_{SX_1}$, the nature of the production functions using them and the prices (including opportunity costs) of other inputs.

B. The optimizing reorganizations of farms which result from the changes listed in II A 4 are not reversible.

C. B, above, implies irreversible supply functions of individual firms for products and irreversible demand functions of individual firms for inputs. Irreversibility is taken to mean responses to price decreases which are not the exact opposites of responses to increases. Generally, the theoretical output responses to product price increases should be expected to exceed the contractions associated with product price declines.
Similarly, expansions in use of inputs resulting from product price increases and input price decreases should be expected to be greater than the contractions resulting by comparable product price declines and input price increases.

D. If $n=3$, $\pi_1 > 0, \pi_2 > 0$, $\pi_3 > 0$, and $\pi_4 = 0$, then the iso-value product map for the $j$th product will appear as follows:

![Diagram](image)

The line of least cost combination when $X_1$ and $X_2$ are priced at acquisition costs need not be the same as when they are priced at salvage values. Though the first can still be dubbed an "expansion path," the second is better called a "contraction path." At this point it becomes advantageous to introduce the concept of an iso-marginal value product line. Four such lines are of interest in the $X_1X_2$ dimension of the production function under consideration, two for $X_1$ and two for $X_2$. In each case we are interested in all combinations of $X_1$ and $X_2$ for which $\text{MVP}_{X_1} = P_{AX_1}$ and for which $\text{MVP}_{X_2} = P_{SX_2}$. An $X_1X_2$ map of such isomarginal value products for $Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}$ when $\sum_{i=1}^{3} b_i = 1$ and $1 > b_i > 0$ appears as follows:

![Diagram](image)
For the first set of assumptions, the iso-marginal value product lines for $P_{SX_1}$ and $P_{AX_1}$ would be identical. The same would be true for $P_{SX_2}$ and $P_{AX_2}$. Thus areas 2, 4, 5, 6 and 8 do not exist under the first set of assumptions. Area 5 is a point in that case while areas 2, 4, 6 and 8 are lines. While it is interesting to explore the values of $V_1$, $W_1$, $\lambda_1$ and $\mu_1$ for areas 2, 4, 5, 6 and 8, time can be saved and valuable simplicity can be gained by ignoring the iso-product lines which do not border area 5 and erecting perpendiculars and extending horizontals as follows:

\[ X_1 \]

\[ X_2 \]

In addition, one iso-product line represents the HPP output for $P_{AX_1}$ and $P_{AX_2}$ has been added. This is, of course, a reproduction of Figure 4 of the main text. Let $Y_{jA}$ be the output of $j$ at point $A$, $Y_{jB}$ at point $B$, etc. For firms initially organized within area 1

\[ P_{SX_1} > \lambda_1, \ P_{AX_2} < \lambda_2, \ V_1 > 0, \ W_2 > 0 \]

and G is max. at B, $Y_{jB} > Y_{jA}$ even for $Y_j < Y_{jA}$. The capitalized value of $\lambda_1$ after max. G is less than at $X_1^O, X_2^O$ and the capitalized value of $\lambda_2$ after max. G equals the stock acquisition price of $X_2$. At both $X_1^O, X_2^O$ and B the capitalized value of $\lambda_1$ is less than the stock acquisition price of $X_1$. 
If $B = A$, as it would under the first set of assumptions, $Y_{JB} = Y_{jA}$ and the capitalized value $\lambda_1$ and $\lambda_2$ would equal $P_{AX_1}$ and $P_{AX_2}$ for stocks, respectively.

**within area 2**

$P_{AX_1} > \lambda_1$, $P_{SX_1}$ for $X_1^o$ along $AB$, $\lambda_2 > P_{AX_2}$.

$V_1 = W_1 = 0$, $W_2 > 0$, $G$ is max. on $AB$ at $X_1$ and $X_1^o$, and $Y_{jX_1}X_2 > Y_{jA}$ even for $Y_{j} < Y_{jA}$. The capitalized value of $\lambda_1$ after max. $G$ is less than at $X_1^o$, $X_2^o$ and is less than the stock acquisition price of $X_1$ in both instances. The capitalized value of $\lambda_2$ after max. $G$ equals the stock acquisition price of $X_2$. For $B = A$ under first set of assumptions see last sentence for within area 1.

**within area 3**

$P_{AX_1}$ can be made $< \lambda_1$, $P_{X_2}$ can be made $< \lambda_2$.

$V_1 = V_2 = 0$, $W_1 > 0$, $W_2 > 0$ $G$ is max. at $A$ and $Y_j = Y_{jA}^o$. Capitalized values of $\lambda_1$ and $\lambda_2$ are equal to the stock acquisition prices for $X_1$ and $X_2$, respectively at $Y_{jA}$. For $D = C = B = A$ nothing is changed.

**within area 4**

$P_{SX_1} < \lambda_1$, $P_{SX_2} < \lambda_2 < P_{AX_2}$ for $X_2^o$ along $BC$.

$V_1 > 0$, $V_2 = W_2 = 0$, $G$ is max. at $X_2 = X_2^o$ on $BC$ and $Y_{jA} < Y_{jX_1}X_2 < Y_{j}^o$. The capitalized
value of future $\lambda_2$ after max. $G < X_1^0, X_2^0 >$ P$_{SX_2}$ and $< P_{AX_2}$ for stock $X_2$. The capitalized 
value of $\lambda_1$ after max. $G$ equals $P_{SX_1} < P_{AX_1}$ 
for stock $X_1$. For $C = B = A$ see last sentence for within area 1.

within area 5

$P_{SX_1} < \lambda_1 < P_{AX_2}$, $P_{SX_2} < \lambda_2 < P_{AX_2}$, $V_1 = W_1 = 0$, 
$V_2 = W_2 = 0$, $G$ is max. at $X_1^0, X_2^0$ and $Y_j = Y_j^0 > Y_j A$. The capitalized values of $\lambda_1$ and $\lambda_2$ at 
$X_1^0, X_2^0$ are less than $P_{AX_1}$ and $P_{AX_2}$ for stocks,  
respectively. For $A = B = C = D$, see last sentence for within area 1.

within area 6

$P_{AX_1} > \lambda_1$, $P_{SX_2} < \lambda_2 < P_{AX_2}$ for $X_2$ along AD, 
$W_1 > 0$, $V_2 = W_2 = 0$, $G$ is max. at $X_2 = X_2^0$ 
on AD and $Y_j A < Y_j > Y_j^0$ even when $Y_j^0 < Y_j A$.  
The capitalized value of $\lambda_2$ after max. $G >$ at 
$X_1^0, X_2^0, > P_{SX_2}, < P_{AX_2}$ for stock $X_2$. The 
capitalized value of $\lambda_1$ after max. $G$ equals 
$P_{AX_1}$ for stock at $X_1^0 X_2^0$. For $C = A$ under first 
set of assumptions see last sentence for within area 1.

within area 7

$P_{AX_1} < \lambda_1$, $P_{SX_1} > \lambda$, $W_1 > 0$, $V_2 > 0$, $G$ is max. 
at D and $Y_j D > Y_j A$ even for $Y_j^0 < Y_j A$. The
capitalized value of $\lambda_1$ after max. $G$ at $D$ is equal to $P_{AX_1}$ while the capitalized value of $\lambda_2 = P_{SX_2} < P_{AX_2}$ for stocks. For $D = A$ under first set of assumptions, see last sentence for within area 1.

within area 8

$P_{AX_1} > \lambda_1 > P_{SX_1}$ for $X_1$ along $DC$, $P_{SX_2} > \lambda_2$ for $X_2$, $V_2 > 0$, $V_1 = W_1 = 0$, $G$ is max. at $X_1^O X_2$ on $DC$ and $Y_j > Y_j X_1^O X_2 > Y_j A$ \( P_{AX_1} \) capitalized value of $\lambda_1$ after max. $G$ at $X_1^O X_2 P_{SX_1}$ for stock and the capitalized value of $\lambda_2 = P_{SX_1}$ for stock. For $C = D = A$ see last sentence for within area 1.

within area 9

$P_{SX_1} > \lambda_1$, $P_{SX_2} > \lambda_1$, $V_2 > 0$, $W_2 > 0$, $G$ is max. at $C$ and $Y_j A < Y_j C < Y_j^O$. After max. $G$ at $C$, $P_{SX_1} = \text{capitalized value of } \lambda_1$ and $P_{SX_2} = \text{capitalized value of } \lambda_2$ for stocks. For $C = D = A = B$, see last sentence for within area 1.

The cost functions which go with the first iso-product diagram of this section are segmented and irreversible as implied in $C$. For example, output at successive points in time for the firm under consideration for $P_{Y_j t} < P_{Y_j t+1} > P_{Y_j t+2} > P_{Y_j t+3} < P_{Y_j t+4}$ where $t + i$ stands for successive production periods could be as follows:
rather than as follows under the first set of assumptions (see I.D.).

E. The consequences of imperfect knowledge are great.

1. Under perfect knowledge, the firm would organize at A in the third diagram of II. D above. No overproduction, no capital losses, and no disappointed income expectations would follow and the differences between the two sets of assumptions would be slight.

2. Under imperfect knowledge, however, mistakes would be made and the firm would find itself in any of areas 1 to 9 of the third diagram II. D above. A check of what can happen in each of the areas (see D above) supports the statements of the main test. These theoretical events correspond closely with what has happened in agriculture. This in turn focuses interest on:

   a. improving knowledge,
b. preventing mistakes in farm organization which would place farmers in areas 1, 2, 4, 5, 6, 7, 8 and 9. Mistakes in area 3 are easily and costlessly corrected.

F. Capital losses incurred in areas 1, 2, and 4 through 9 are non-Pareto better. Evaluation of circumstances leading to such losses requires, therefore, analytical procedures going beyond modern welfare economics forcing efforts such as made in Chapter 5. Under the first set of assumptions, areas 2, 4, 5, 6 and 8 would not exist and no non-Pareto better losses would occur in areas 1, 7 and 9 on $X_1$ and $X_2$ in the above example. Hence, modern welfare economics is sufficient under these the first set of assumptions for evaluation. Under both sets, capital losses can occur on $X_3$. In theory, $X_3$ is ordinarily treated as land. As both land rent and land values are implicitly regarded as unearned in theory and, hence, as subject to destruction without raising evaluative questions, economists have worried little about non-Pareto better adjustments in rents and land values, however illogical (and unjustified) that may be. This book attempts to remedy this difficulty by not distinguishing between either rental and other incomes or between capital losses and gains on land and other assets.

G. Growth in demand becomes more important for the second than for the first set of assumptions.

1. Under the first, unequal rates of growth in demand and supply have the consequences traced out by T. W. Schultz in Agriculture in an Unstable Economy.

2. Under the second

   a. if the growth in demand exceeds supply, many errors of organizing in areas 1, 2 and 4 through 9 (see second diagram in II. D above) are converted in errors of organizing in area 3 where correction is easy and costless. (Though growth in demand is rapid in the nonfarm industry, agriculture's low income demand elasticity product producers appear to experience only small growth relative to the number and magnitude of their errors in organizing farms.)

   b. when growth in demand lags behind growth in output (partly as a consequence of errors of overproduction) errors of organizing in areas 1, 2 and 4 through 9 are correctable only slowly (less rapidly, perhaps, than new errors are made) and at great cost.
III. Under both sets of assumptions

A. Serious problems exist about the optimum number of units of service to extract from a given durable in a given time period. For instance, in buying tractors 500 hours of use per year might be the optimum rate of usage when buying a tractor, while some other number becomes optimum in successive time periods after it becomes fixed as a result of sequential errors made in organizing and reorganizing the business through time.

B. The aggregation problem going from firm supply and demand functions to industry supply and economy demand functions is obviously greater for the second than for the first set of assumptions. This problem has not been attacked for the second set and involves substantial difficulties for the first set. Some analysts have suggested that aggregate supply and responses would be similar under the two sets of assumptions. The following thoughts are offered:

1. In reality, macro agricultural supply responses are more responsive to increases than to decreases in prices.

2. Net prices received by sellers are not equal to gross prices paid by buyers after transaction and transportation costs are figured.

3. Causes of imperfect knowledge are repetitive and never ending.

4. (2) implies that acquisition and salvage prices never become equal in the long run. (3) implies that errors of production are repeatable in the long run.