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Competition for Land and the Future of American Agriculture

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of American Agriculture

by

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Competition for Land and the Future of American Agriculture*

Philip M. Raup**

Introduction

The nature and intensity of competition for land in the United States has undergone a dramatic change in the last three decades. Throughout the era of new land settlement, competition was first between trees and crops. Later, as settlement moved west into the Great Plains, it was between grass and crops. This era ended in the 1930's, with the exception of timbered portions of the lower Mississippi Valley and scattered areas of the Mountain States and the Northwest. The Taylor Grazing Act of 1934 symbolized a policy change in resource management, with the determination that some grassland areas should remain permanently in grass. This coincided almost exactly with the inter-war peak in cropland acreage of 384 million acres in 1931-32 (USDA, Changes in Farm Production and Efficiency, 1978, p. 19).

Although distorted by depression and wars, competition for land from the mid-1930's to the mid-1950's was confined primarily to competition among sown crops. With forest-farm and cropland-rangeland boundaries reasonably well-defined and stable, the land-use arena in which competition occurred was dominated by crop agriculture.

Aided by irrigation and mechanical pickers, cotton boundaries migrated westward from the Old South, to the Texas high plains, Arizona and California. Quick-maturing hybrids moved potential corn boundaries several hundred miles

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northward, and the soybean was just emerging as a major competitor for Corn Belt cropland. Up to the end of the Korean War, the major causes of current interests in competition for land had not yet commanded public attention.

The trends and events that generate this current interest have multiple roots. The maturity of the United States as an urban society is undoubtedly the most important of these causal factors. In 1950, only 5 states had over 80 percent of their population classified as urban, and 20 states had half or more of their population classified as rural. In 1970, there were 12 states with 80 percent or more of their population classed as urban, and only 6 in which half or more of the population was rural (Statistical Abstract of the United States, 1965, 1979). In 1960, Standard Metropolitan Statistical Areas (SMSAs) included 8.7 percent of the land area of the United States. By 1974, this percentage had nearly doubled, with SMSAs accounting for 16.7 percent of the total area (Coughlin, p. 30). In 1980 it is estimated that one fifth of the land area of the contiguous states is within the boundaries of SMSAs (New York Times, March 24, 1980, p. D-9).

This rapid expansion of urbanizing areas was associated with an accelerated conversion of agricultural land to non-agricultural uses. Utilizing a stratified sample of 9 locations per county (typically quarter-sections of 160 acres), for 506 counties, the Soil Conservation Service estimated that 16.6 million acres had been converted to urban uses between 1967 and 1975. An additional 6.7 million acres of land had been converted to water (USDA, Potential Cropland Study, 1977, p. 16). This total of 23.3 million acres converted to urban uses or water in 8 years is apparently the source of the frequently quoted estimate that "each year three million acres of farm land are lost to development" (The New York Times, June 18, 1979, p. B-8). It is important to note that only 4.8 million acres or 29 percent of the 16.6 million acres converted to urban uses were classified as cropland. This yields the less startling but still significant estimate of 600,000 acres of cropland transferred to urban uses annually, between 1967 and 1975 (USDA, Potential Cropland Study, 1977, p. 1). Although this is only 0.15 of one percent of the 400.4 million acres classified as cropland in 1975, the highly aggregated nature of the data masks the impact that this steady loss of cropland has had on specific regions and localities. It is the irreversibility of this conversion, and not alone its magnitude, that provides the strongest root for current public concern over the nature of competition for land.

In acre terms, a less visible but much more significant shift in competitition for land has been generated by the rapid growth of agricultural exports. In 1950, crops grown on 50 million acres were exported, equivalent to 14.5 percent of the cropland harvested. By 1975, export crop acres doubled to 100 million, and reached 133 million acres in 1978, or 33.6 percent of the 336 million acres of harvested crops in that year (USDA, Changes in Farm Production and Efficiency, 1978, p. 18). In the marketing year 1979/80, wheat exports are projected to equal 62 percent of 1979 production. Comparable figures for corn are 31 percent, for sorghum, 34 percent and for barley, 13 percent (USDA, Foreign Agricultural Circular, Grains, FG-13-80, April 14, 1980, p. 21). In fiscal 1979, soybean exports were 56 percent of production, cotton exports 54 percent, and rice almost 50 percent (USDA, 1979 Handbook of Agricultural Charts, p. 77). In aggregate terms, one of every three crop acres produces for export. For wheat, soybeans, cotton and rice, the proportion is one acre out of every two, or higher. In terms of competition for land, we have reached a degree of agricultural export dependency for which parallels can only be found in the ante-bellum cotton South, or in our colonial era.

The concern raised by this degree of exposure to world markets is the second major root supporting current interests in the changing nature of competition for land. Export demand has brought reserves of cropland into production on a scale that has largely eliminated any cushion or margin of safety that might otherwise meliorate fears generated by conversion of cropland to urban and non-farm uses. Our export successes intensify urban conversion fears. They do more. They have also contributed heavily to increases in farmland prices to levels that threaten to prevent an orderly succession in ownership and control of land resources. The twin components of urban and export demand for land induce fears that are focused not only on the acres thus preempted, but also on the stability of the structure and organization of agriculture.

These elements in the pattern of competition for land are not new, but they have reached new levels of intensity. To them must be added elements that are new, and that derive generally from the interest in biological solutions to energy problems. The potentials for conversion of corn into alcohol, manure into methane, and biomass into energy have captured the imagination of both farm and non-farm people. To farmers, this offers the prospect of demand expansion on a scale that evokes images of a "green OPEC". To conservationists, it seems to offer a realistic substitution of renewable for exhaustible energy sources. Whatever the outcome of current efforts to give economic reality to the technology of crop and residue conversion, it is clear that any successes will involve large acreages of land. This adds an intriguing but largely incommensurable element to concerns over compeition for land.

A National Overview of Land Use Categories

In areal terms and approximate magnitudes, one-third of the 2,264,000,000 acres of land in the United States is forest land (32 percent), one-fourth is pasture and range (26 percent), one-fifth is cropland (21 percent), one-twelfth is devoted to "special uses" including urban, transport, recreation, wildlife, farmsteads, and various public installations (8 percent), and the remaining 13 percent is in marshes, swamps, rocky or desert areas, tundra, or other lands of low agricultural potential.[1/]

Although land is the most fixed of resources, and the land use categories are broad, it is surprisingly difficult to construct an accurate time-series of land-use statistics. Land use classifications are cultural as well as economic variables. New uses arise (wilderness, wildlife and recreation areas), old uses acquire new meaning (rivers or lakes become reservoirs or flowage areas), and the boundaries separating land uses become blurred.

For the limited purposes of this paper, initial attention will center on agricultural lands, and on lands in "special uses"--the urban complex that includes recreational, transportation, rural residential, and institutional uses. For ease of exposition, these can be classified as agricultural and urban use classes.

Estimates of the area in agricultural use are reasonably comparable for the period since 1910, especially for cropland. Estimates of pasture and range land exhibit greater variability, due primarily to confusion over

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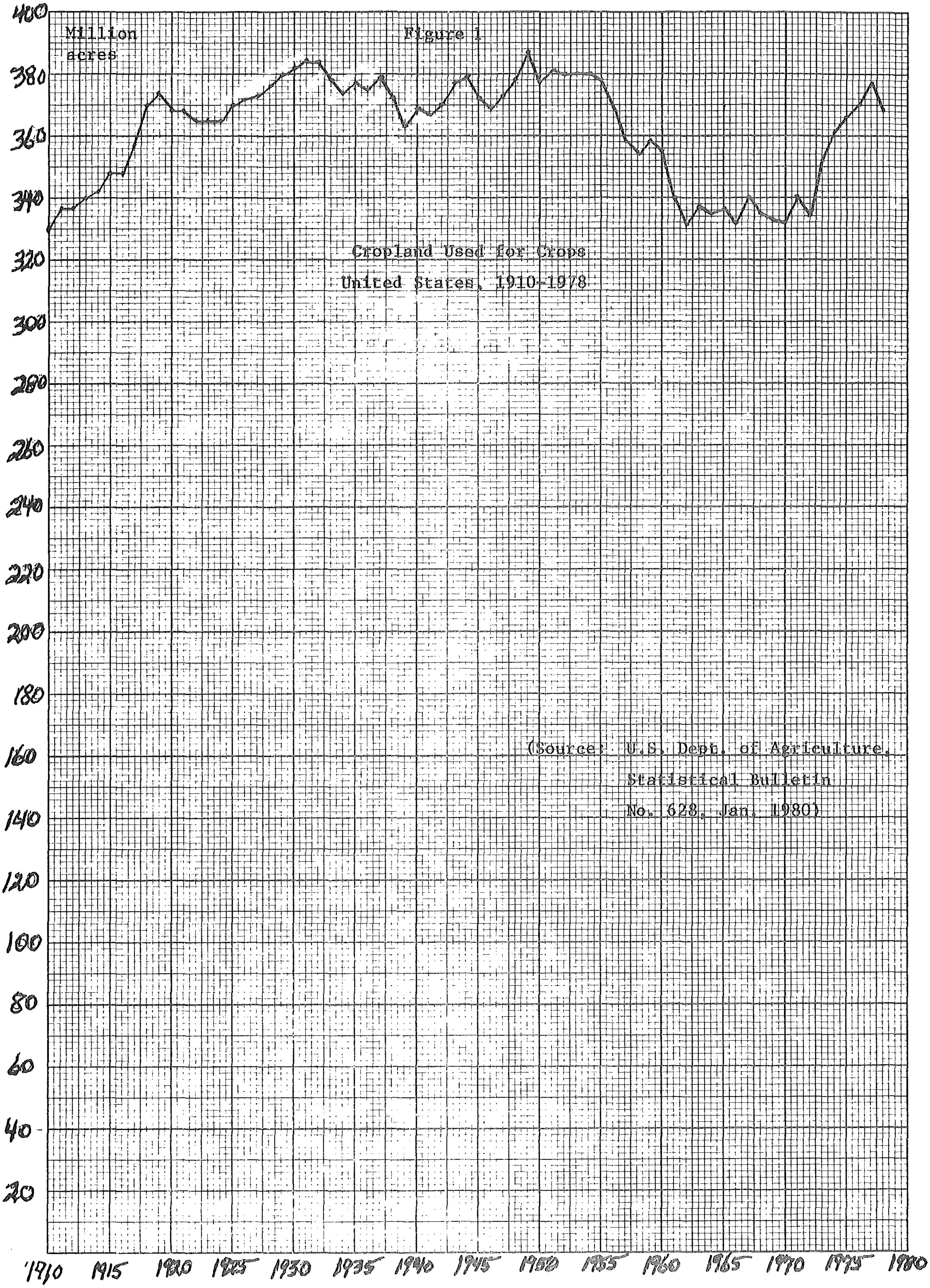
1/ These data and those that follow on land use by regions and states are drawn primarily from H. Thomas Frey, Major Uses of Land in the United States: 1974, U.S. Department of Agriculture, ESCS, Agricultural Economic Report No. 440, November 1979.

the classification of grazing lands in forest areas. Recognizing these limitations, it is instructive to note that the acreage of cropland used for crops in 1978 was identical (at 368 million acres) with the acreage in 1920-21. In the interim, the acreage used for crops had reached a high of 384 million acres in 1931-32, dropped to 363 million in 1939, climbed back to an all-time high of 387 million acres in 1949, and held steady at about 380 million acres to 1955, only to decline steadily to a low of 331 million acres in 1962 (almost identical with the 330 million acres of 1910). In Figure 1, this series is plotted since 1910. Measured in national aggregates, the acreage of cropland used for crops has been relatively stable for almost seventy years (USDA, Changes in Farm Production and Efficiency, 1978, Jan. 1980, p. 19).

This stability is misleading. National data mask regional shifts of critical magnitude. Two-dimensional data couched in areas leave unreported the enormous changes that have taken place in land use intensity. Consider first the regional shifts from 1939 to 1978.



Million acres
Figure 1
Cropland Used for Crops
United States, 1910-1978
(Source: U.S. Dept. of Agriculture,
Statistical Bulletin
No. 628, Jan. 1980)
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980

Cropland Shifts by Regions

Approximately one-third of the cropland has disappeared in two regions, the Northeast (down 32 percent), and the Southeast (down 35 percent). Losses since 1939 have been only slightly less severe in Appalachia (down 22 percent) and the Southern Plains (down 28 percent).

All other regions gained. The Lake States showed the least change (up 2 percent, 1939 to 1978), followed by the Mississippi Delta states (up 4 percent), the Northern Plains (up 12 percent), the Corn Belt (up 17 percent and all of it since 1970), the Pacific region (up 18 percent) and the Mountain states (up a whopping 40 percent). For the Pacific and Mountain regions, virtually all of the increases came in the decade 1939-1948. In those regions, there has been virtually no change since 1950.

The patterns of loss have been similarly varied. The Northeast lost 37 percent of its cropland in a steady decline from 1939 to 1969, followed by a modest recovery in the 1970's. The pattern was the same in Appalachia, where the loss to 1969 was also 37 percent, and the recovery in the 1970's a bit more vigorous. The most dramatic changes took place in the Delta States of Mississippi, Arkansas and Louisiana, which lost almost one-third of their cropland in the 20 years from 1939 to 1958. The region recovered more than all of the loss in the next 20 years, 1959-1978, ending the four decades 4 percent above the 1939 level.

The most acute decline has been in the Southeast. From 1939 to 1969 the region lost 49 percent of its cropland used for crops. The recovery in the 1970's has been significant, but the region still emerged in 1978 as having experienced the largest percentage decline in cropland used for crops of any region since 1939. This may come as a surprise to those accustomed to think of the Northeast as the region most afflicted by loss of cropland in recent decades. The data illustrate an important point: Urbanization is not the only reason for cropland declines.

A study by the U.S. Department of Agriculture used aerial photographic interpretation of land use changes in 53 rapidly urbanizing counties, 1961 to 1970. Over this time period, 35 percent of the land converted to urban use was cropland (Zeimetz, et al, USDA, 1976, p. 15). It should be noted that the study period fell within the years of greatest decline in the national total of cropland used for crops, which for the 48 states fell from 381 million acres in 1949 to 332 million acres in 1970. There are no recent and comprehensive data to measure the extent to which urban conversion of cropland has been affected by the increased demand for cropland following 1972. Our cropland conversion statistics are primarily "pre-OPEC" and "pre-Russian grain sale" data.

The Northeast contains 5 percent of the land area of the U.S., 3.6 percent of the cropland used for crops, and 20 percent of the national urban area (Frey, 1979, pp. 18, 26). For this reason, the competition between urban and agricultural land uses is centered in this region in its most concentrated form. For individual states, the loss has been acute. In the national context, the loss of 6 million acres in the Northeast, 1939 to 1978, is 1.6 percent of the 1978 area of cropland used for crops. In contast, the cropland expansion in 10 years in the Corn Belt, 1969 to 1978, was 12.5 million acres, or more than twice the loss over 40 years in the Northeast. This teaches an important lesson. The trends that we have noted can only be assessed in the context of the national market.

Cropland losses are not simply a consequence of urban-industrial competition with agricultural uses, in a narrow sense. Land use conversion is complex, and can be misleadingly interpreted if it is viewed as a process in which farms are transformed into housing estates or shopping centers. One of the clearest illustrations of this complexity involves forest land.

From 1952 to 1970 the area of commercial timberland (defined as capable of an annual growth of at least 20 cubic feet per acre) declined in all regions of the United States, except in the New England, Middle Atlantic, and South Atlantic states, plus Ohio and Kentucky in the Central region. The largest increases were in Pennsylvania (2,904,000 acres) and New York (2,537,000 acres), with increases of approximately one million acres or more in West Virginia, Georgia, Alabama, and Ohio (USDA, The Outlook for Timber in the United States, 1973, pp. 227-30).

Approximately three-fourths of the total area of commercial timberland in the United States is now in the eastern half of the country. In 1970, commercial timberlands covered "over 80 percent of the total land area in New England and more than half of the area along the Atlantic coast" (USDA, The Nation's Renewable Resources..., 1977, p. 15). It is not a spurious correlation to note that the two regions that experienced the largest percentage losses in cropland since 1939, the Northeast and the Southeast, are also the two regions with the highest proportion of their total land area in commercial timberland.

While we lack data on the long-run historical trend of land use shifts on specific tracts in these regions, it is clear that, in aggregate terms, cropland losses have been timberland gains. Cropland declines in New England began one hundred and fifty years ago--the Boston hinterland was at its agricultural land use peak in the 1820's. This process was repeated a century later in the Southeast. It is an irony of history that some of the same industries (e.g. textiles, furniture) that drew New England labor off the farms after the opening of the Erie Canal in 1825 were the ones that migrated to the Southeast and repeated the process after the development of the TVA in the 1930's. In both eras the major causal factors were cheap energy and local supplies of redundant agricultural labor.

The land use lessons from American history have been unambiguous. Industry has been the chief competitor for farm land, measured not in acres used, but in labor force withdrawn. The associated urbanization has generated demands for greenspace, for recreation, and for residential land uses that are inextricably combined with the largely unplanned expansion of private non-commercial forest land. Our most urban and industrial regions have become the most heavily forested. In the competition for cropland, the message to date is clear: Local trees have been preferred over local food.

In tracing long run regional trends in competition among major classes of land use, the greatest uncertainty relates to range and pasture lands. Because some cropland is frequently used in rotation pasture, and some forest land is regularly grazed, it is not even possible to derive accurate figures for the area of pasture and range land. No single agency of government is responsible, and no comprehensive national inventory of pasture and rangeland has ever been attempted.

Measured in acres, the magnitudes are substantial. "Cropland pasture" and "grassland pasture and range" in 1974 accounted for 681 million acres, or 30 percent of the total land area. If we add to this the 179 million acres of "forest land grazed", the total is 860 million acres or 38 percent of the land area. This is almost equal to the 900 million acres of "cropland used for crops" plus "forest land not grazed" (Frey, 1979, pp. 3-4).

While much range land is of low value in agricultural use, pasturing plays a critical role in the nation's meat supply. The dollar value of livestock gains from grazing was estimated in 1970 as almost equal to the total farm value of the 1970 wheat crop (USDA, The Nation's Renewable Resources--An Assessment, 1977, p. 42).

In regional terms, the most important shifts in pasture and rangeland use have occurred in the Southeast. Florida has emerged as a significant ranching state, and "southern" stocker and feeder cattle have become an important source of supply for the large commercial feedlots centered in Western Kansas and the Southern Great Plains. The reason for much of the large cropland loss in the Southeast, that was noted earlier, is to be found in the shift of former cropland into pasture and forest land uses.

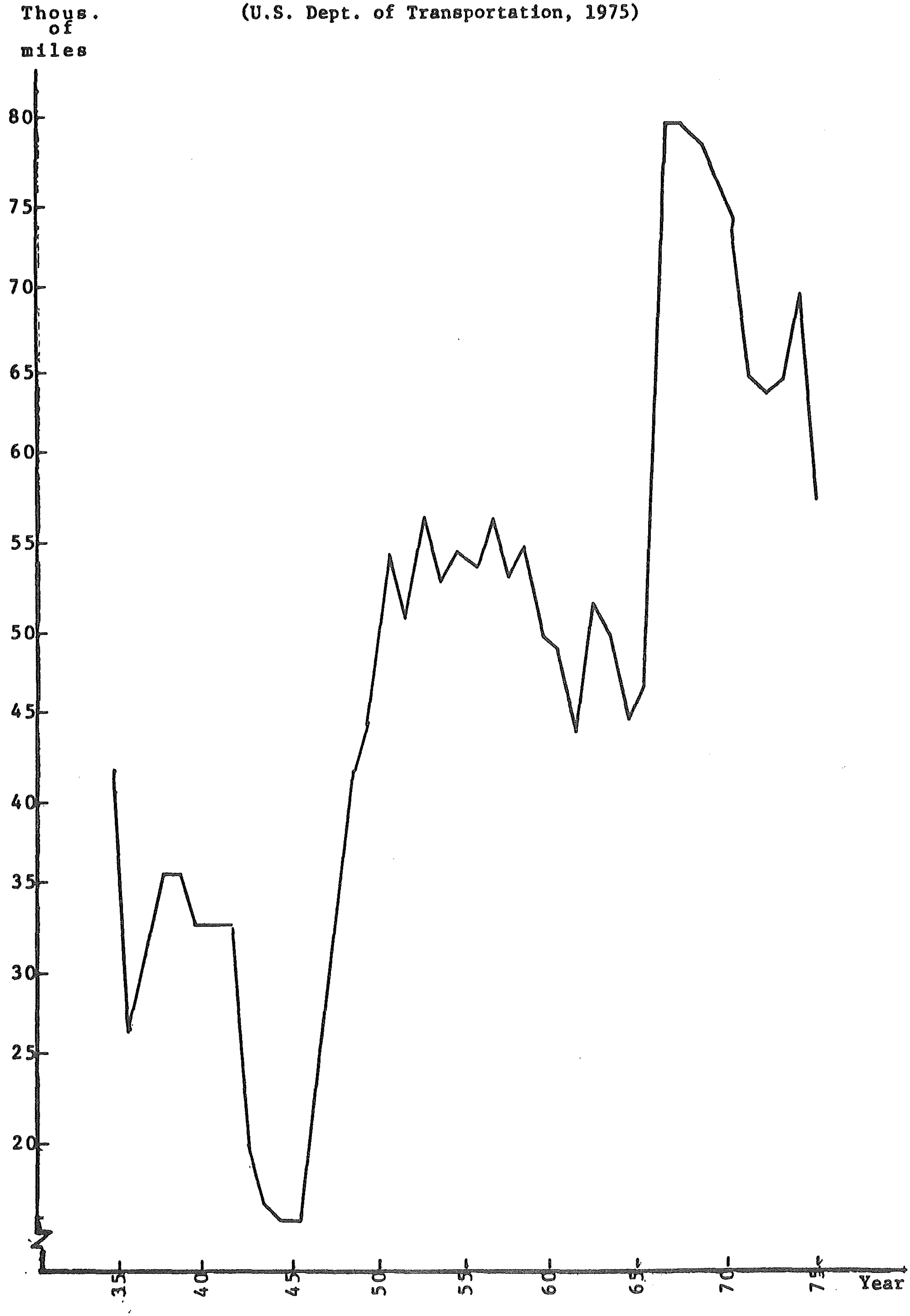
A Functional Survey of Competition for Land

Land for Highways. The period since the second World War witnessed the expansion of non-agricultural demands for land on a scale that may prove in the long view to have been episodic. In terms of both direct and cumulative effects, the dominant episode was triggered by the Federal Interstate and Defense Highway Act of 1956. This injected a nation-wide element of demand into the land market that was immediately important in terms of right-of-way acquisition, and of much greater importance in terms of the restructuring it generated in land uses and land values.

To build some 43,000 miles of Interstate highway, approximately 1.8 million acres were directly acquired as right-of-way, and uncounted millions of acres were given access-values that can be likened to a near-instantaneous conversion from agricultural-use value to urban-use value. A key feature of this new demand element was the speed with which it was introduced.

From 1956 to 1968 there was an increase of 36,000 miles in the nation's primary road system, most of it in Interstate highways. The effect on other primary and feeder-road construction was even more concentrated in time. State highway departments had been building an average of about 55,000 miles of road annually during 1950-55. This dropped to about 45,000 miles per year in 1960-64, while highway authorities were preoccupied with the initial construction of the Interstate system. It shot up to 80,000 miles per year in 1966 and 1967, remained above 75,000 miles per year through 1970, and held between 65,000 and 70,000 miles annually through 1974 (U.S. Dept. of Transportation, Highway Statistics, Summary to 1975, p. 204). Figure 2 illustrates the dramatic impact of this highway construction boom after 1965.

Figure 2
Total Mileage Built By State Highway Departments, 1934 - 1975
(U.S. Dept. of Transportation, 1975)



Between 1956 and 1975 a highway construction effort was undertaken that touched every corner of the country, created and destroyed values on an unprecedented scale, and achieved a transformation whose economic and social dimensions dwarf the railroad-building era in the 19th century. The construction period of the railway age was spread over three-quarters of a century. Construction in the Interstate highway age was compressed into twenty years. Nothing like it had ever happened, and it is not likely to be repeated.

The decline in new highway construction since 1975 has been almost as precipitous as was the increase after 1965. The drop-off in right-of-way acquisition has been so recent that it is not yet reflected in aggregate national statistics. The records reported by highway authorities, both state and federal, are focused on miles of new construction or on the number of tracts or parcels acquired, and not on the acreage of land involved. An indication of the decline in this activity is given in Table 1, showing the number of parcels acquired for the state highway system in Minnesota, 1957 through 1979. The decline in acres acquired after 1973 is much greater than is indicated by these data. Acquisitions since 1974 have been largely confined to small tracts to complete the system. New construction has been focused on the normal improvement of the regular trunk highways (Hansen, 1980).

There will be a continuing program of new construction to upgrade existing highways. It is quite unlikely that there will be any significant construction of newly located highways in the remaining decades of this century. State highway budgets and the Federal Highway Trust Fund are already overstrained by unexpectedly high maintenance costs. The life expectancy of major segments of the Interstate system is proving to be much shorter than originally planned. Given the continuing decline in the number of farms and farmsteads, we may well be on a plateau in the total miles in the nation's system of primary, secondary and local roads and highways. In any forecast of change, a decline is more probable than an increase.

Table 1

HIGHWAY RIGHT OF WAY ACQUIRED
Minnesota 1957-1979

Fiscal Year	No. of Parcels
1957	2,880
1958	3,375
1959	4,643
1960	2,689
1961	2,631
1962	2,587
1963	1,493
1964	2,219
1965	2,827
1966	2,516
1967	2,506
1968	2,185
1969	2,219
1970	1,852
1971	1,637
1972	1,567
1973	1,291
1974	960
1975	747
1976	814
1977	550
1978	785
1979	885

Source: A.H. Hansen, Minnesota Department of Transportation, St. Paul, Personal Communication, March 28, 1980.

The competition for land that was fostered by the boom in highway construction is still with us. It will be some years before the echo-effects have been assimilated in land use patterns. But it seems reasonable to conclude that the major effects are behind us. This is especially pertinent with reference to the loss of productive farm land, and to the supporting land use conversion data derived from the Conservation Needs Inventory of 1967 and the National Resource Inventories of 1977, conducted by the Soil Conservation Service of the U.S. Department of Agriculture. As shown in Figure 2 above, the period between these two inventories coincides almost exactly with the all-time peak in highway construction activity. Our most comprehensive statistics on farmland losses have been compiled for the period in which the suburbanizing effects of highway programs were at a maximum. This is an unsuitable base for long-range projections.

Highway programs must be given top ranking in any inventory of forces affecting the structure of competition for land in the past quarter century. This will almost surely not be the case in the next two decades.

Land for Reservoirs. In a somewhat longer time-frame, dating from the 1930's, a companion record is provided by the loss of agricultural land to dams and reservoirs. The Tennessee Valley Authority holds partial or full rights to over 1.5 million acres of land, of which an estimated 45 percent or 670,000 acres was prime farmland when acquired (Henderson and Headden, 1979, pp. 2-3). This was a significant loss of productive land. But the sense in which the land was "lost" must be qualified. The TVA stabilized the regimes of rivers in the Tennessee Valley, reducing flood damage on adjacent lands. Substitutes for land were created through the stimulus given to fertilizer production and use, utilizing basin-wide planning and cheap electric power.

The situation was reversed in the Missouri River basin. The six main-stem dams form an almost continuous lake from just west of Sioux City, Iowa to central Montana. Although the acreage of farm land lost to this chain of reservoirs was substantial, the losses measured in acres alone are seriously underestimated. In this semi-arid farming and ranching country, the traditional farm land use pattern involved an area of feed-producing land along or near the river, providing winter feed for livestock that grazed a much larger acreage stretching for many miles on both sides of the river. In a representative ranch, 640 acres of river-bottom land might supply the guarantee of winter feed that made possible the summer grazing of 25,000 acres of low-productivity grassland.

Flooding the lands used for winter feed to create reservoirs destroyed this land use pattern along major segments of the Missouri River. The acres of land under water or in flowage rights of way are an inadequate measure of the extent of this loss. The reduction in flood damage was important, but the benefits accrued largely to downstream lands in Nebraska, Iowa and Missouri. The costs in land lost to agriculture were paid in the Dakotas and Montana.

The dams on the Missouri River were designed for flood control, hydroelectric power production, and to provide a 9-foot navigation channel to Sioux City, Iowa. They were not designed to promote irrigation. In the competition for land, the main-stem dams on the Missouri River provide a text-book case of disassociation of costs and benefits, since flood control and navigation were of principal value to the down-stream states.

In the Columbia basin, involving the third great system of dams and reservoirs constructed since the 1930's, the loss of agricultural land was less pronounced. Much of the inundated land was of low agricultural potential and irrigation was designed into the system as a major claimant upon the newly available water.

Water has been the winner, in the competition between land and water in the TVA, the Missouri basin, and the Columbia basin. In appraising the effects of this competition upon land use shifts, the most important point is that our dam-building era, like our highway building era, is largely behind us. More dams and more highways will be built. But there is little likelihood that in the foreseeable future we will be able to compress into a similar time-frame any comparable programs of long-range capital formation affecting land use.

Urbanization. The third functional trend affecting competition for land in the past half-century is the headlong rush into the cities, and out of them. There is a close link here with the unplanned consequences of programs outlined earlier. The initial Interstate Highway Act of 1956 did not authorize the expenditure of Highway Trust Fund monies for construction within cities. This was quickly amended, and in practice the major expenditure of funds has been in metropolitan areas. What started out as a highway program to link cities together became in practice a gigantic program that sprawled cities ever farther into the countryside. A symbolic representation of the land use consequences is that of a boulder, not a pebble, dropped into a pond.

Information to illustrate this urban concentration of Interstate highway expenditures is extraordinarily difficult to assemble. Fragmentary data suggest that at least two-thirds of total expenditures on the Interstate system will prove to have been made within urban commuter-belts, and the proportion is quite likely higher. The spread city, the sprawled city, and the strip city have become distinguishing characteristics of the American urban mode.

It is this urbanization of the countryside that has evoked the greatest fears about loss of agricultural land. Unlike the direct loss of land involved in highway and dam building, the full effects of this new definition of an urban way of life are still ahead of us.

As a result of this new form of competition between agricultural and nonagricultural uses of rural lands, the distinction between urban and suburban land uses is losing analytical significance. So is the distinction between suburban and sprawled urban patterns of land use. A new form of land use is emerging, that might be called "rural urban", or "diffused urban", or perhaps "agri-urban".

The characteristics of agri-urban land use that are most distinctive are: 1) An intermixture of farm and rural-residential land uses, with no sharply defined boundaries for either uses. 2) A demand by dispersed rural residential land users for urban-type services that are not needed by farmers, and that often impose unnecessary costs on agricultural land users.

The financial base for the provision of services in rural areas has historically been the property tax. The distribution of the property tax burden has been most equitable when the predominant land use has been relatively homogenous in terms of type and size of land-using units. A mixture of urban and agricultural land uses leads to shifts in the demand for tax-supported services, and in the relative burden of costs.

When an intermixture of farm and nonfarm land uses prevails over any extended time period, it places strains on the property tax as a local fiscal support base. As a consequence, the property tax loses credibility, local officials turn to state or federal sources of funds, and the strength of local government is eroded by the loss of an independent financial base. The rural community loses identity.

The images that are called up by this description of agri-urbanization typically involve the Boston-to-Washington corridor, California, or perhaps northern Ohio and Indiana. In terms of the effect on agricultural land use, these are major areas of agri-urban concentration. In terms of the number of farm perople involved and of the impact on traditional land use patterns, the greatest change has been in the South.

In 1974, 41.4 percent of all farm operators in the South reported off-farm work of 100 days or more per year. In contrast, only 30.0 percent of farm operators in the North Central Region devoted this much time to off-farm work (Carlin and Ghelfi, 1979, p. 271).

Agri-urbanization is also blurring the distinction between "rural" and "agricultural". Many counties from New England through Appalachia and into northern Georgia are rural but not primarily agricultural. Many counties in the industrial Middle West and the Pacific coast region are important agriculturally but are essentially urban in character. As recently as 1940, "farm residents comprised more than half of all rural people. Today... farm people make up only 15 percent of the total rural population (Brown, 1979, p. 284).

The result is a form of competition for land that is no longer measured in terms of acres converted to non-farm uses. Actual conversion may involve a relatively small fraction of the total area. The relevant measure is the degree of compatibility between farm and non-farm uses. The effect of most consequence for agriculture is seen in the limitations placed upon the choice of size and intensity of farm enterprises. We have a rapidly expanding area in which the types of agricultural activity must conform to non-farm concepts of appropriate land use. Dust from field cultivation, noise from tractors working at night, odors from livestock, use of toxic chemicals and fertilizers--these are all aspects of modern agriculture that generate resentment or fear in non-farm rural residents. Above a relatively low density of rural residential land use, these fears become constraints on the farming mode. This restriction is of much greater potential importance than any loss of land in acre terms.

A geographic restructuring of the settlement pattern will be one of the most long-lasting consequences of this rural diffusion of urban competition for land. In keeping with our historical tradition, the determinant force will be the transport mode. From the Civil War to the Second World War, railroads dominated the locational structure of settlements in the United States. Success in the competition for land was determined by farm to market access for the products of land. A railroad map was also a map of the location of urban places. To be distant from a railroad was a major disadvantage, and the results were clearly apparent in patterns of land use intensity and in land values.

The highway era introduced major changes into this structure. Beginning slowly in the 1920's, and with a dampened momentum due to depression and war, the full force of this change was not released until after 1945. Interstitial areas within the railroad network were no longer keenly disadvantaged. The automobile and the motor truck created new transport options, with highways providing augmented capillaries for a transport system that had previously been dominated by arteries and veins.

This era lasted only about four decades, from roughly 1925 to 1965. The Interstate system of highways has reimposed a greatly reduced structure of arterial transport routes upon the settlement pattern, and urbanization is now clustering around these major routes. Although the noteworthy revival of population growth in non-metropolitan counties after 1970 has many causes, it is one measure of the decentralizing influence of these major highway corridors (Beale, 1976). We can anticipate the emergence of the Interstate city.

The urbanization pattern will also be profoundly altered by unique changes in housing demand that are a consequence of the post-war baby boom. From 1945 to the peak in 1957, there was a 56 percent increase in annual births. For eleven years, from 1954 through 1964, there were more than four million births each year. The decline, which began in 1962, was almost equally abrupt, to a low in 1973 that was only 15 percent above the level of 1945. The path traced by this remarkable upsurge is shown in Figure 3.

Figure 3 also shows the same curve moved forward 25 years. With a minor downward adjustment for mortality, we can note that in each year of the 1980's over four million young people will reach age 25. This is the "nesting age". Age at first marriage in 1979, for example, was estimated at 22.1 years for women and 24.4 years for men (U.S. Bureau of the Census, Current Population Reports, Series P-20, No. 349, 1980, p. 1). The demand for housing will experience the same distortions that characterized the demand for schools in the 1950's, and the demand for colleges and other post-highschool educational institutions in the 1960's. This will be followed by a sharp decline in the 1990's. Or will it?

What will be the land-use implications of this episodic increase in the demand for shelter? Demand projections based upon household formation will almost certainly be wrong. In 1960, "non-family" households (those occupied by a person living alone or by two or more persons including no one related to the person maintaining the household) were 15 percent of all

Figure 3

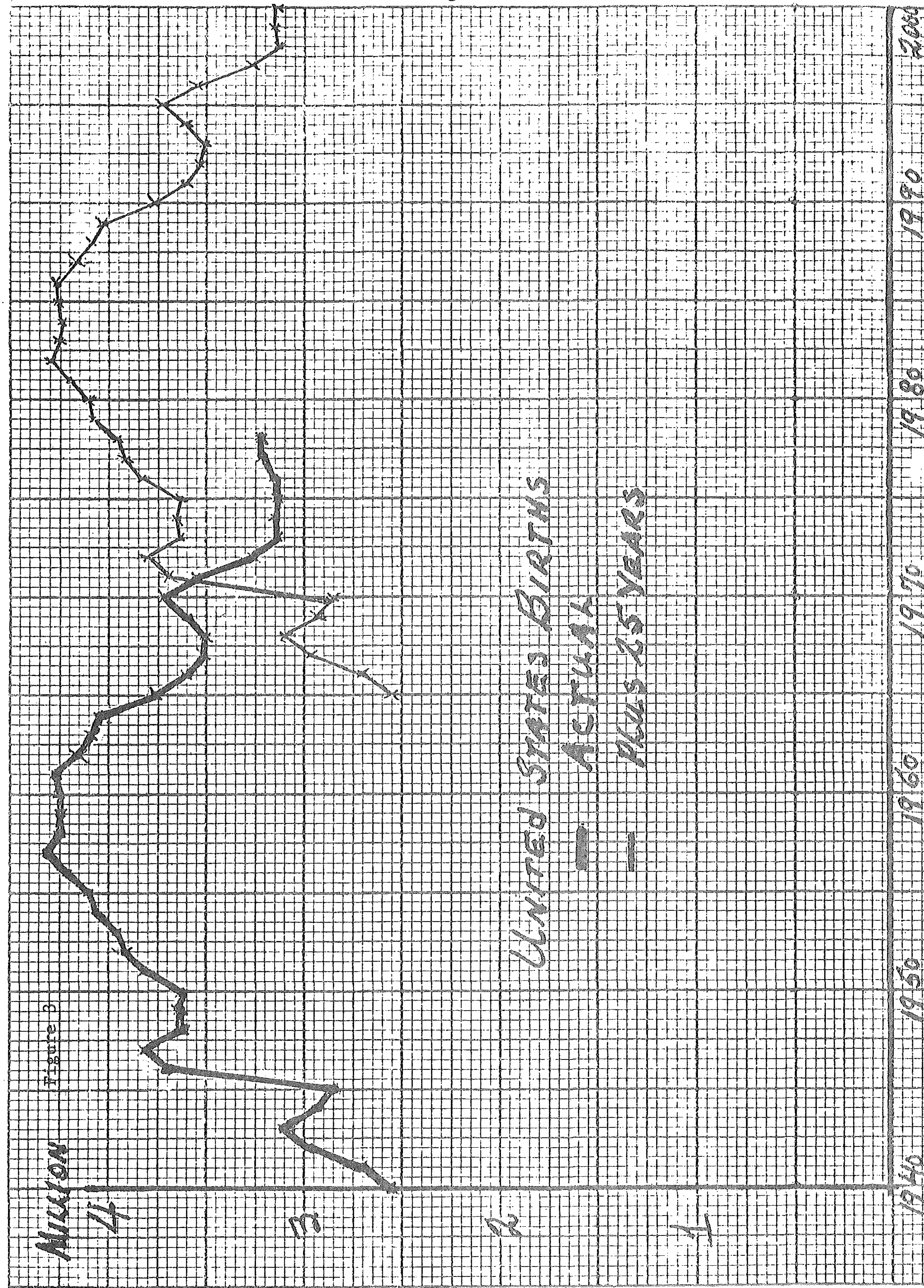


Figure 3
MILLION
4
3
2
1
1940
1950
1960
1970
1980
1990
2000
UNITED STATES BIRTHS
ACTUAL
PLUS 25 YEARS

households; by 1978 this percentage had risen to one-fourth. Single person households were 13 percent of the total in 1960 and 22 percent in 1978. Among persons living alone in 1978, 41 percent were over 65 years old, and 79 percent of these were female. The basis for forecasting housing demand has been radically changed (U.S. Bureau of the Census, Current Population Reports, Series P-20, No. 340, 1979, pp. 2-3).

One dimension of the changing structure of the demand for housing has been the sharp drop in the "home leaving age." This increased the demand for rental housing at a time when inflation-induced advantages of home ownership and the conversion of rental units to condominiums were at a maximum. This "first wave" effect of the baby boom on rental housing demand probably peaked in the latter years of the 1970's. Will it now be superseded by a peak in the 1980's in the demand for single-family detached houses?

If we draw upon experience from the 1950's and 1960's, we can project an unprecedented demand for building land. If we project current behavior patterns with respect to marriage and family, we can expect an attenuation of housing demand, and a much smaller per capita demand for associated land. This could be associated with a reduction in the frequency of home-leaving at early ages, and a continued demand for rental (and hence multiple-unit) housing beyond the nesting ages that dominated housing demand from about 1945 to 1975. This now seems to be the most reasonable projection.

There is some evidence that residential demand for agricultural land is moderating, but this is difficult to document. The major increases in the real costs of credit and of energy have occurred so recently that their effects are not yet revealed in comprehensive national statistics.

Data illustrating current trends in the progress of urban sprawl are available for the seven-county area of the Twin City Metropolitan region of Minneapolis and St. Paul. Total building permits peaked at 27,839 in 1972, and had fallen to 19,774 in 1978. Permits for new construction of single-family residences in rural areas were 32 percent of the total in 1973 and 19 percent in 1978. In the first six months of 1979 this percentage had fallen to 15 (Twin City Metropolitan Council, unpublished data, April 1980).

We may thus have some basis for an adjustment downward in the per capita demand for land for housing, by a factor of one-fourth, or even one-third. We are still left with the prospect that over 40 million young people will reach age 25 between 1980 and 1990. The resultant demand for residential land in the next ten years promises to be greater, in terms of area, than any expansion in demand for housing land we have ever experienced in a ten-year period. This demographic phenomenon will be the most destabilizing influence in shaping the competition for urban and rural residential land for the remainder of this century.

Land for Recreation. Although the diffusion of housing demand has been the principal source of professional concern over the loss of agricultural land, it has not generated the political emotions that have been aroused by recreational demand. Voter support for the Vermont Environment Control Act of 1970 (Act 250), one of the strictest controls on development in the United States, was mobilized primarily by fears of recreational and second-home development, and ski-resorts (New York Times, June 22, 1979, p. A-10). The sharpest land use controversies in Minnesota have focused on the Boundary Waters Canoe Area Wilderness, contributing to the defeat of a Governor and two Senators in the 1978 elections. In California, some of the most vehement opposition to land use control was aroused by establishment of the Whiskeytown-Shasta-Trinity National Recreation Area in 1965, and the scenario was repeated in Idaho with the establishment of the Sawtooth National Recreation Area in 1972. In none of these cases was there a prospective loss of any significant amount of agricultural land. The lesson seems clear: People will express concern over the loss of agricultural land, but they will arise and march when recreational land uses are involved.

The demographic variables outlined above in the discussion of urbanization promise to be of even greater importance in appraising competition for recreation land. Backpacking, canoeing, hiking and skiing have reached their present levels of popularity coincident with the young-adult phase of the baby-boom. These activities are by no means confined to the young, but the strength of the associated demand for land is almost surely correlated with age. We have no historical data to guide us in forecasting future demand. Is it highly elastic, with respect to income, or inelastic? Will people retain their consumption patterns for recreation as family and professional demands upon their time increase, or will recreational expenditures be the first to be cut back?

Initial evidence from recent months suggests that the travel-time and distance components in recreational demand for land will be the first focus of efforts to economize. People will seek the same or similar recreational experiences, but nearer home. If true, the result could be an increase in recreational demands involving farmland. Parks and recreational areas near population centers will impinge upon agricultural lands with greater force than had been the case when travel was relatively cheap and vacation targets were remote parks or wilderness areas. The most probable consequence of rising energy costs is an intensification of recreational competition for agricultural land.

Land for Energy. Roads, reservoirs, residences and recreation--these have been overt competitors for productive agricultural land in recent decades. We turn now to a new type of prospective competition that is receiving much current attention: Land-based production of energy, through the strip-mining of coal or the production of alcohols, methane, or related fuels from crops or crop residues.

Strip-mining of coal is the most spectacular, and has aroused the greatest environmental concern. Total U.S. coal production in 1979 was estimated at some 770 million tons, with over 64 percent coming from surface mines. Expansion plans now underway are projected to add 645 million tons of new capacity by 1987, most of it from surface mines, and over half of it in the Northern Great Plains (McMartin, 1980, pp. VIII-IX). Coal seams in the Northern Great Plains range up to 100 feet in thickness, while those in the eastern and middle western states are much thinner--often only two to four feet in thickness. The acreage of land disturbed is thus in inverse relation to the thickness of the seams. Projections of coal mining activity, 1975 to 1999, result in an estimated 568 thousand acres in average annual use for coal production, of which 358 thousand acres or 63 percent will be in eastern or middle western states.

The return of strip mined land to agricultural use will be expensive, but in most cases feasible, and the cost is now being incorporated into the price of coal. In approximate terms, the possibility of successful restoration is highest in areas where the disturbance of agricultural uses is of greatest significance. The estimated 568 thousand acres in average annual use, 1975 to 1999, includes an assumption that reclamation of stripmined land will require ten years in the Rocky Mountain Region, eight years in Montana and Wyoming, and five years in other stripmining areas, after the cessation of mining (McMartin, 1980, p. 98).

With these assumptions, and using the average value per acre of gross sales of farm products from surface mined lands in the various regions in 1974, coal mining from 1974 to 1999 would displace agricultural production worth $16,128,000 annually, at 1974 prices (McMartin, 1980, p. 96). This would have been 0.15 of one percent of the 1974 value of agricultural production from lands included within coal-producing regions. It is not possible to defend an argument that coal production poses a threat to food supplies.

Coal mining does threaten water supplies, primarily in the Northern Great Plains. To the extent that the coal is converted to electric power at the mines, there is also a problem with air pollution, and with thermal pollution of water. These problems may prove to be more serious than any impairment to food production capacity through loss of agricultural land.

A much greater potential for reduced food production capacity has been anticipated in the use of grains to produce motor fuel. The current popularity of gasohol in the Corn Belt is understandable, in a world of unstable grain prices and unpredictable foreign markets. This popularity can also be traced to the fact that is seems to promise the farmer a recovery of some degree of control over his costs of production, and a reduction of his dependence on suppliers of purchased inputs. It evokes memories of self-sufficiency.

In appraising the potential competition for land from "energy farms," or more generally from the conversion of biomass to liquid fuel, it is essential to keep in mind the true nature of the competition. "Crude oil contains 38 million Btu per ton. Dried plant matter contains 13 million Btu per ton. The energy content falls to about 4 million Btu per ton if biomass is not dried, about the same as oil shale and tar sands." (Zeimetz, 1979, p. 2). Under North American conditions, the competition that gasohol faces is not from other uses of land for crops or biomass, but from oil shale, tar sands, or the liquifaction of coal.

Viewed in this perspective, the key dimensions of the competition center on the relative costs of drying, transporting and storing alternative forms of biomass. Although large tonnages per acre of wet biomass can be produced in a variety of forms (sugarcane, sweet sorghum, corn, cattails), serious attention has focused on corn. A large fraction of the total energy content of the plant is in the grains, it is relatively dry when harvested, methods of production, harvesting, storage and transport are well-developed, and production is geographically concentrated in the Corn Belt. These are weighty advantages, and they have all but eliminated other crop competitors in the current search for a crop that can provide a liquid fuel to replace gasoline.

But corn still suffers severe disadvantages as a raw material for liquid fuel production in competition with oil shales, tar sands, or coal. These handicaps are of two kinds, temporal, and spatial.

The time disadvantage is most easily quantified. Corn is an annual crop, and is unsuited to multiple cropping. The entire raw material supply for 12 months of operation of an ethanol plant would be harvested in less than one month. The total annual cost of the crop, plus storage costs, would thus involve a capital carrying charge for the feed stock that would largely be absent if oil shales, tar sands or coal were used as raw material.

In U.S. experience over the years from 1960 to 1973, it cost about one-sixth of the cost of the grain to store a bushel for one year (Purdue Univ., Final Report to OTA, 1979, p. 252). If we take half of this amount to cover the storage cost of a supply of feedstock that declines to zero over 12 months, we have a storage cost of approximately 8 percent of the grain cost. If we assume an opportunity cost of capital of 15 percent, then roughly half of this amount would constitute an additional carrying charge over the 12 months. We can conclude that the cost of corn as a feedstock for an ethanol plant would involve additional carrying costs of at least 15 percent of the initial cost of the raw material supply. In many of the calculations of the cost of producing ethanol from grain these carrying costs have been ignored.

The spatial disadvantage is also pronounced. Corn is among the most efficient photosynthetic converters of solar energy, but it is still distributed quite widely over the landscape. This necessitates substantial transport costs. Using trucking charges prevailing in the Corn Belt in 1980 it is reasonable to conclude that a large-scale ethanol plant using corn as a feedstock would incur transport costs in the range of 12 to 15 percent of the cost of the corn.

To these estimates of additional costs, which approach 30 percent of the costs of corn production, we must add an insurance factor reflecting the uncertainties of weather and crop yields. Any large-scale ethanol plant would need assurance of a steady supply of feedstock. This would involve reserve storage capacity, and a supply territory larger than would be necessary if a constant supply stream could be assumed. Capital carrying charges, storage costs, and costs of transport are thus likely to be larger rather than smaller than these estimates indicate.

These considerations point up the disadvantages of corn in competition with oil shale, tar sands and coal. A multi-million dollar conversion plant could be located at these raw material sites with assurance that a steady supply of feedstock would be available over the depreciable life of the plant (now typically 30 years). The front-end load of capital carrying charges would be known with certainty, as would transport costs. While increases in gasoline costs may make it increasingly feasible to consider grain crops as a source of liquid fuel, they also advance the more likely prospect that attention will turn to oil shales, tar sands and coal.

There is an additional dimension in the debate over corn as an energy crop that deserves emphasis. Under existing technology, production of ethanol from grain results in a by-product of distiller's grains or "stillage" that has a potential feed value equivalent to roughly one-third of the feed value of the grain before distillation. Whether or not there is an energy gain in making ethanol from grain depends heavily on the effective use of these distiller's grains.This emerges clearly from the conclusions reached in a Purdue University study for the Office of Technology Assessment.

The Purdue study estimated average annual surplus production of grain in the U.S. over the four years 1976-1979 at 360 million bushels of corn and 260 million bushels of wheat for a total of 620 million bushels. The assumption was made that the feeding value of distiller's grains would have been the equivalent of one-third of the total grain processed into ethanol. If all of the distiller's grains were used as feed, this would have permitted the processing of 930 million bushels into ethanol without reducing domestic use or foreign exports. This would have produced about 2.5 billion gallons of ethanol annually, equivalent to approximately two percent of current gasoline consumption. Assuming a 10-percent ethanol-gasoline blend, this would have supplied 20 percent of the ethanol required nationally.

Using 1978 prices, it was assumed that this grain could have been procured for $2.30 per bushel for corn and $3.00 per bushel for wheat. In order to make the resulting ethanol competitive with gasoline in 1978, the corn would have had to be sold to distillers at $0.70 per bushel and the wheat at $0.75 (Purdue University, Final Report to OTA, 1979, pp. 249-252). Rising gasoline prices would of course narrow this spread, but it must also be assumed that costs of production and processing would also rise, though perhaps not as rapidly as gasoline prices.

This example illustrates the potential magnitude of ethanol production from grains without involving a diversion from domestic use or exports. It also emphasizes the highly important role played by the feeding value of the resultant distiller's grains. If these cannot be fully utilized, the net diversion of grain required to produce a given quantity of ethanol will be significantly increased. In the example above, if the distiller's grains were used at only 50 percent of their feed-value potential, the use of 930 million bushels of grain to produce ethanol would have involved the net withdrawal of 775 million bushels (instead of 620 million), or an increase of 25 percent in the net amount of grain required.

It is improbable that distiller's grains will be utilized as efficiently as would be necessary to justify large-scale production of ethanol from grain. The distiller's grain or stillage emerges from the ethanol plant in highly diluted form, averaging 1,000 pounds of solids in 10,000 pounds of stillage. If it is dried, the energy cost of drying precludes any net energy gain in the ethanol production process. In wet form, it has a storage life of no more than 24 hours in summer conditions. Because it is largely water, costs of transport limit its use to livestock feeders within about 20 miles of the plant. And fed in large amounts, it constitutes the force-feeding of water, resulting in urinary and nutritional problems in livestock. Its usefulness as a livestock feed is limited to a steady use in the ration, in small quantities (High Plains Journal, Dodge City, Kansas, Feb. 11, 1980, p. 6-B).

It seems improbable that ethanol from grains can compete with fuels from oil shales, tar sands, or other alternative sources in the forseeable future, unless it is very heavily subsidized. The most probable outcome is a limited use of gasohol on farms, where the subsidy can take the form of a labor input by the operator, valued at a very low opportunity cost wage, and then only in years of crop surpluses. Gasohol is unlikely to be a serious competitor for cropland.

The same conclusion seems warranted for energy produced from crop residues or farm wastes. Energy from biomass involves the transport or stockpiling of large quantities of low-value raw materials. Manure from large-scale continuous-flow confinement livestock feeding operations is the most promising input. Here too, successful production seems confined to individual farms, and to limited uses. The economics can be compared to a Boy Scout paper drive. If the labor and energy costs of assembling the raw material can be ignored, or charged to some other activity, it may be possible to achieve a net energy balance in the actual conversion process. It is unlikely in the extreme that energy production from biomass will introduce a new element into the competition for agricultural land.

A different situation may prevail with forest lands. Well-developed forests equal or exceed cropland in primary productivity and in annual energy fixation, and have the added advantage of a relatively high concentration of biomass per unit area (Leith, 1972, p. 6). They also provide an energy source that is comparatively efficient in direct combustion, thus eliminating the need for processing. A measure of the potential of the direct use of wood as fuel is provided by estimates that currently available aspen within 100 miles of Bemidji, Minnesota would be sufficient to provide an economic fuel supply for five 25 megawatt electric power plants operating at 80 percent load capacity over a 30-year life (Aube, 1980, p. 27).

The potential for alcohol from forest biomass is also high. If new technologies improve the economic prospects of liquid fuel production from biomass, they seem likely to increase the comparative advantage of trees over annual crops. There is little reason to disagree with Dovring's conclusion that "fuel feedstock from field crops is not likely ever to represent a major contribution to the fuel economy of the United States. Any permanent land surplus available to produce fuel should be planted to trees" (Dovring, 1979 p. 19).

The Changing Balance in Interregional Competition for Land

Irrigation. In terms of cropland acres involved and value of output, one of the most important shifts in land use in the past three decades has been the increase in irrigation. For the United States as a whole, the acreage of irrigated land was relatively constant from 1920 to 1944, at approximately 20 million acres. It jumped 9 million acres to 1954, another 7.5 million acres to 1964, and stood at 41,243,000 acres in 1974, almost exactly double the 1944 acreage. From 1964 to 1974, over 77 percent of the increase occurred in four states in the central and southern Great Plains: Nebraska, Kansas, Oklahoma and Texas. Between 1969 and 1974, the increase was confined largely to Kansas and Nebraska. There has been virtually no change in irrigated acreage in the Mountain and Pacific Coast states since 1964, although they still account for over half of the irrigated area of the United States (U.S. Census of Agriculture, 1974 and earlier years).

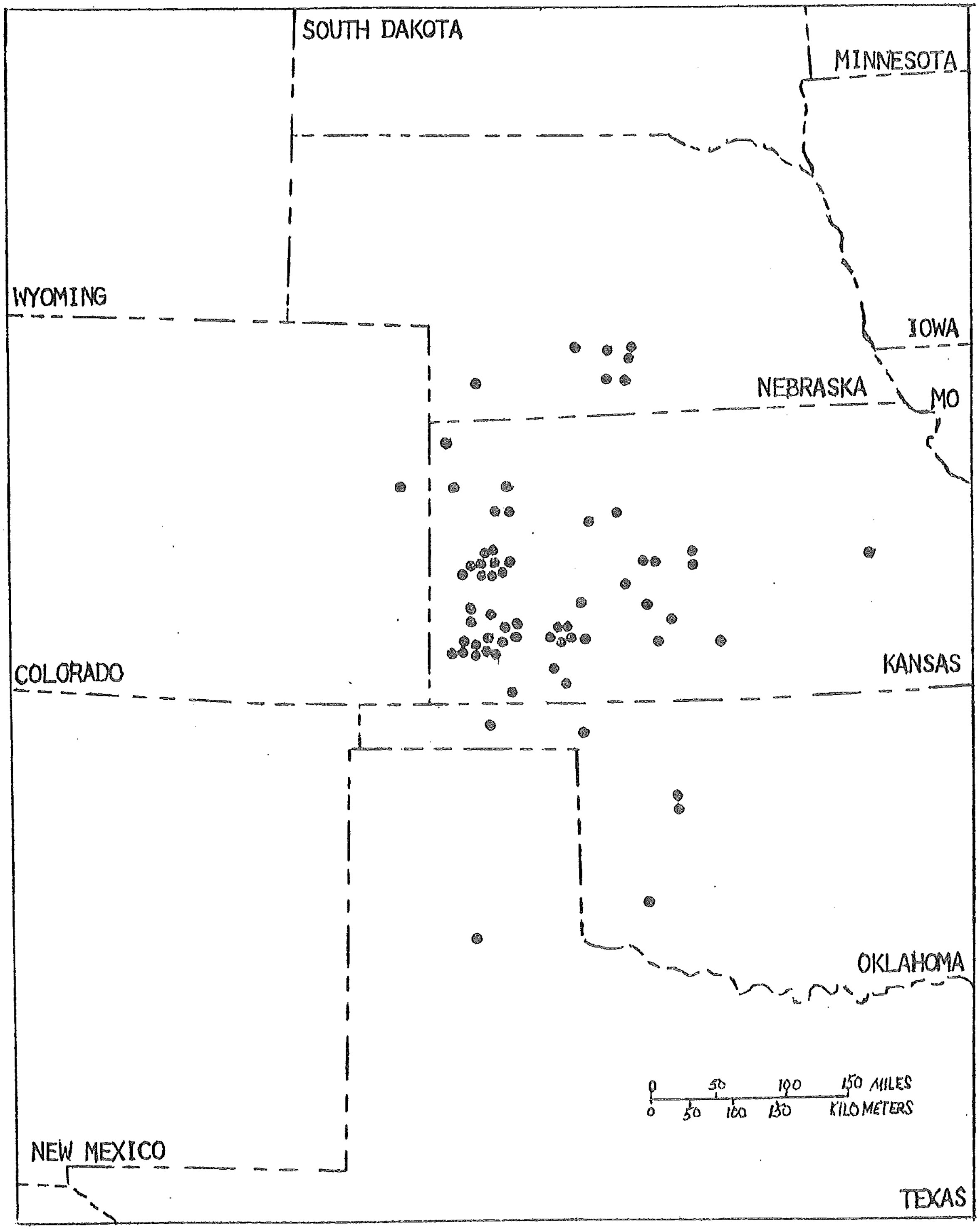
The output effect of this sharply regional shift in irrigation activity has been confined almost entirely to three crops--corn, sorghum and alfalfa. These are crops preeminently suited for the production of beef. This is reflected in a massive concentration of beef cattle feeding in large custom feedlots in Nebraska, western Kansas, eastern Colorado, and the panhandles of Texas and Oklahoma. The region in 1974 accounted for 44 percent of all fed cattle marketed in the United States while the Corn Belt accounted for only 20 percent (Martin, 1979, p. 100).

These large feedlots are highly concentrated, geographically. There are very few north of an east-west line through North Platte, Nebraska, or south of Amarillo, Texas. A circle centered on Garden City, Kansas, with a radius of 100 miles enclosed approximately two-thirds of the capacity of custom feedlots in the Southern Plains that were actively advertising for business in 1979 (High Plains Journal, Aug. 13, 1979, p. 20-B). The geographic concentration of these custom feedlots is indicated in Figure 4.

Many reasons account for this rise of the southern Great Plains and decline of the Corn Belt in cattle feeding. Cattle confined in large open lots are highly susceptible to the climate. Northern lots face severe winters, southern lots must reckon with heat stress in summer, and humid lots greatly increase the possibility of infectious disease. These considerations have been major location determinants. The shift of population to the Sunbelt has reoriented the market for fed beef and this too contributed to the shift. So has the conversion of cropland to pasture in the Southeast, and its emergence as the major beef cattle raising region of the nation. There were 9,923,000 beef cows in the Southeast in 1978, and 9,339,000 in the Southwest. These two regions accounted for half of all the beef cows in the United States (Martin 1979, pp. 89-99). Western Kansas feedlots represent a rough approximation of the solution of a gravity model of location for a beef-feeding industry that seeks to minimize the transport costs of its raw material inputs.

These are all important explanations for the restructuring of regional claims upon agricultural output that has resulted from shifts in cattle feeding. In value terms, this restructuring concerns the largest segment of American agriculture. Sales of cattle and calves in 1978 totaled 28 billion dollars, or one-fourth of the gross value of agricultural output (USDA, State Farm Income Statistics, Statistical Bulletin No. 627, Supple-

Figure 4: Location of Active Custom Feedlots in the Southern Great Plains in 1979.



Source: The High Plains Journal, Dodge City, Kansas, Aug. 13, 1979, p. 20-B.

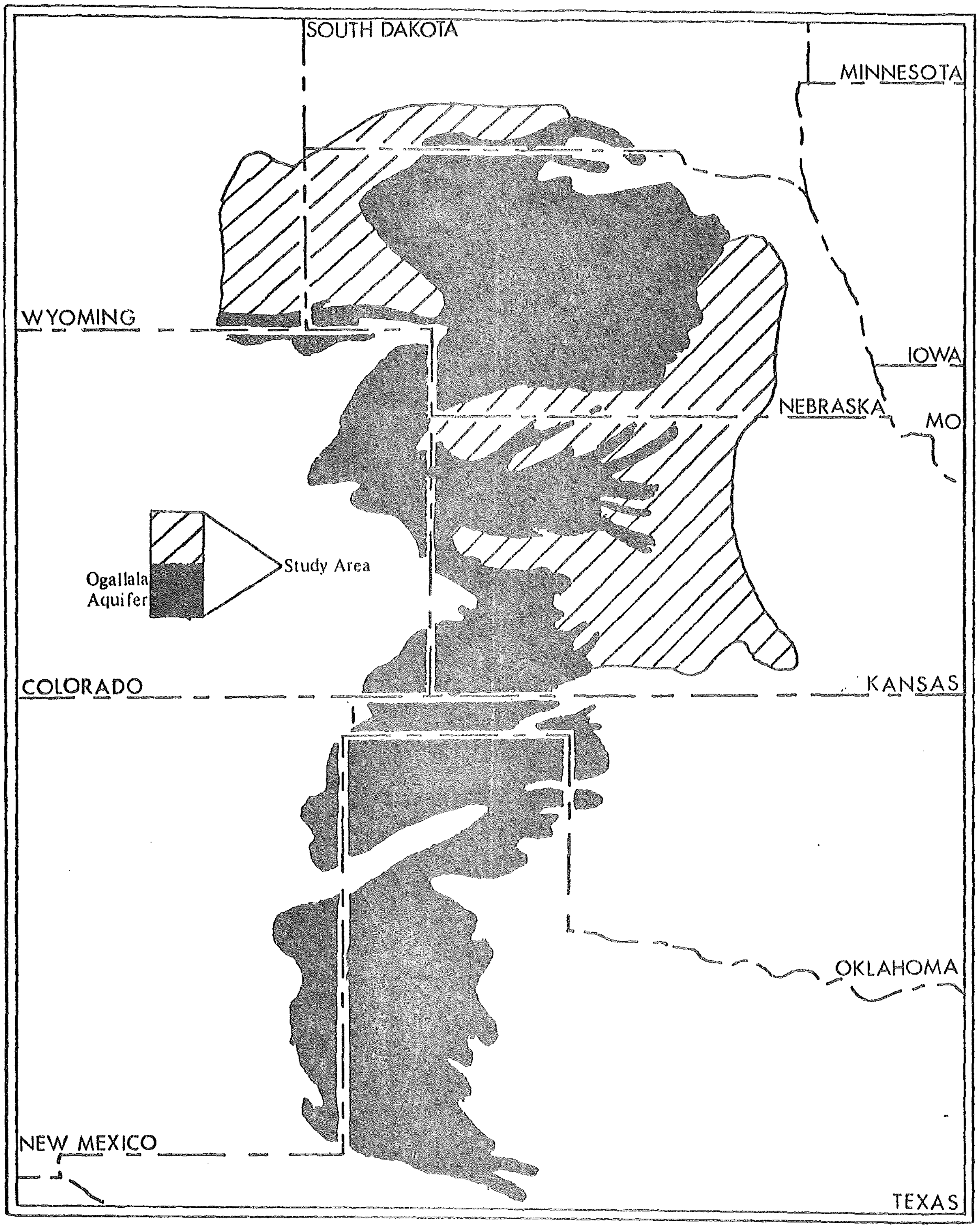
ment, Jan. 1980, p. 9). In acre terms, and with reference to the domestic market, beef feeding is the greatest claimant for the output from harvested cropland. These considerations merit a closer examination of the reasons for the shift.

The major explanation is provided by the development of irrigation in the Southern Plains. This provided a rapidly increasing supply of local feed over the past 25 years. But is has been accomplished at great cost in terms of resources, and the production base is unstable. Virtually all of the irrigation is from groundwater, and all of it in the area of greatest feedlot concentration is from the Ogallala aquifer. This vast underground lake stretches from the northern Nebraska border to the Texas panhandle, as shown in Figure 5. Its origin is uncertain but apparently geologic. Where there is recharge, it is very slow, and especially from Kansas south.

There has been no charge for this water, other than the cost of pumping. As was noted earlier, approximately two-thirds of the fuel used in pumping has been natural gas. The water, in effect, has been regarded as a free good, and almost all of the irrigation development has occurred during a period in which natural gas has been flagrantly underpriced. The water table has been steadily falling, in several Kansas counties at rates exceeding 5 feet per year (Kansas Water Resources Board, Newsletter, 1979). Natural gas prices have doubled, and more increases are in prospect. The future of irrigation in the region is entering a critical phase.

A recent U.S. Dept. of Agriculture study of 32 counties in the Texas High Plains used a simulation model to project irrigation prospects for the period 1976-2025. Applying a conservatively estimated rate of increase for natural gas prices, the study concluded that irrigation in the region would

Figure 5 THE OGALLALA AQUIFER



Source: Kansas Water Resources Board, Newsletter, Vol, 2, No. 2, November 1978.

terminate by approximately 1995. The major land use consequence would be a 70-percent decline in grain sorghum output and a return of wheat as the major dry-land crop (Young and Coomer, 1980, pp. 27-28).

A contemporary Kansas study attributed one-fourth of the state's gross farm income in 1977 to irrigation, almost all of which depends on the same Ogallala aquifer (Darling, Kansas Water Resources Board, Bulletin 24, 1979, p. 90). No estimates of the impact on land use of a decline in irrigation in Kansas are available to compare with those from the Texas study, but it must be assumed that the effects will be similar.

These studies raise serious questions about the feed-base for the present concentration of cattle feeding in the Southern Great Plains. If rising energy costs and falling water tables make irrigation in the region uneconomic, it will trigger the most significant regional shift in the present geographic pattern of land use that we have in prospect. This could alter the nature of competition for land in the Middle West and Great Plains during the declining phase of Great Plains irrigation as dramatically as it was altered in the expansion phase, and almost as quickly.

The most immediate impact will occur in the panhandle region of Texas, and in eastern New Mexico, where irrigation from groundwater has been increasingly under stress since the 1950's. A reappearance of dryland wheat and unirrigated varieties of sorghum would be associated with a declining feedgrain surplus. If this pattern of land use change works its way North, as the Ogallala aquifer is gradually exhausted, or pumping becomes uneconomic, it will erase the advantage of cheap and plentiful feed that has been the basis for the concentration of cattle feeding in the region.

The feed supply for cattle fed in the Southern Great Plains has come predominantly from water withdrawn from an aquifer that is unlikely to be recharged in our lifetime. The one-time withdrawal of this water has permitted the entire increase in feed output to be devoted to beef production, without burdening the feed supplies of the traditional Corn Belt. In approximate terms, the increase in fed beef output of the Southern Plains, and this means roughly half of the nation's total supply, has been achieved in the past two decades at no cost, in terms of regionally diverted feed grains. The economic rent generated by unpriced water from the Ogallala aquifer and by underpriced natural gas has been capitalized in part into local land values. But in a larger sense, it has been capitalized into a national level of beef consumption that cannot be sustained in the long run without a return to the feed grain supplies of the Corn Belt. We have a fed beef economy that has become dangerously dependent on an exhaustible resource base.

Grain Exports. The most acute competition for land in the United States today is between foreign and domestic consumers of meat. The grains of the Middle West and Great Plains have become the food reserve of the world. Wheat production roughly doubled in 25 years, from an average of 1,077 million bushels, 1951-55, to an average of 2,048 million bushels, 1975-79. Wheat exports in 1978-79 were 1,194 million bushels, and were forecast at 1,325 million bushels in 1979-80. Exports have taken more than all of the output increase in the past twenty years.

The record for corn is similar, but the quantities are much larger. On average, the United States produced 2,814 million bushels of corn for grain in 1951-55, and over 7,000 million bushels in both 1978 and 1979. Corn exports in fiscal 1978 were 1,933 million bushels, and 2,121 million bushels in fiscal 1979. In dollar terms, wheat exports in fiscal 1979 totaled 4,775 million dollars, corn exports 6,059 million dollars. Exports of feedstuffs, corn, sorghum and soybeans, in fiscal 1979 totaled 14,125 million dollars, or almost three times the value of wheat exports (USDA, Foreign Agriculture, March 1980, p. 21). Feedstuffs have become the dominant agricultural export.

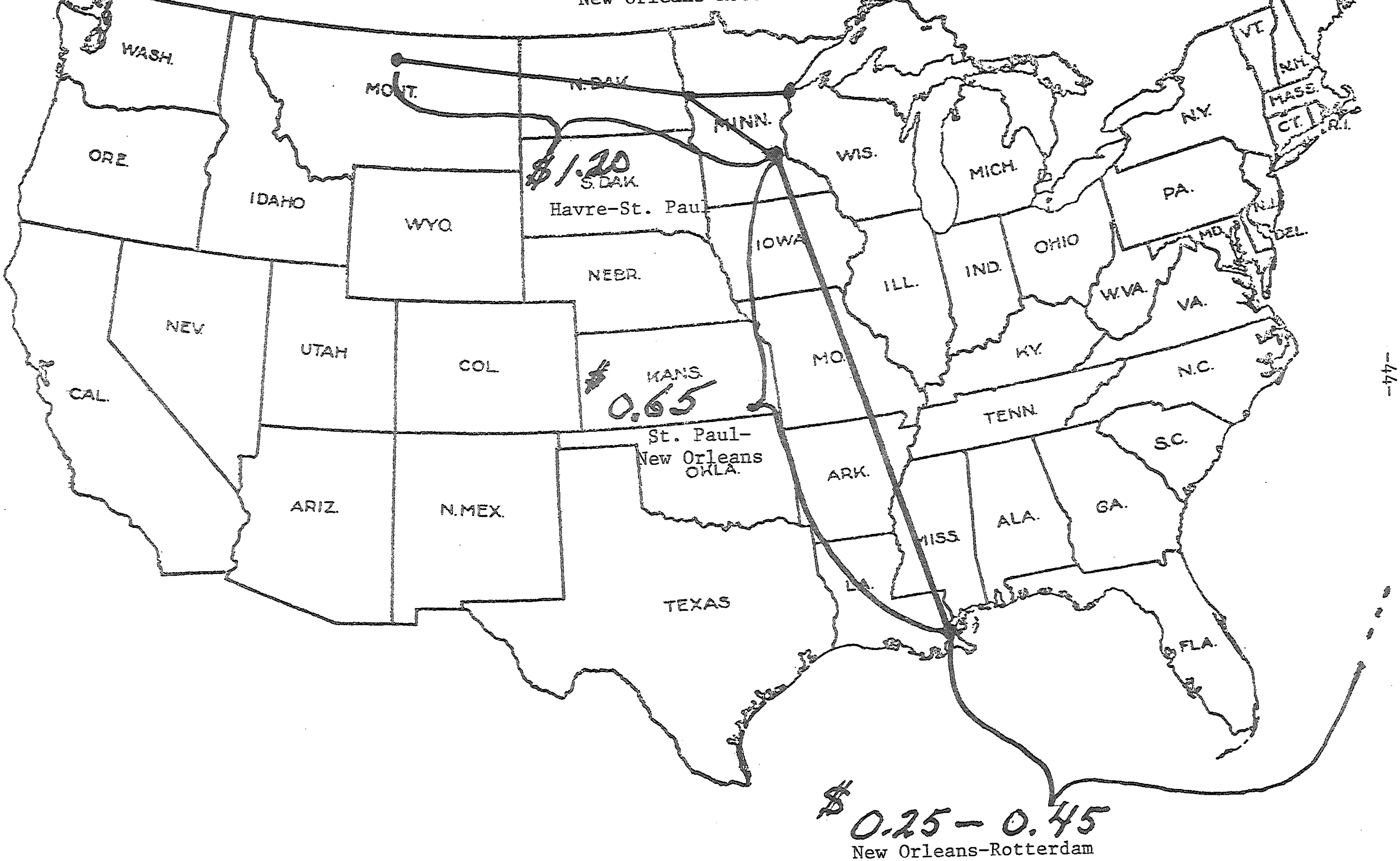
The growth of world demand for feed grains and oil seeds from the United States has generated a massive reorientation of the flow of crops to market. In the 19th century, the major export demand for agricultural products from North America was for high quality wheats. Bread was the goal. Since 1945, this trade has shifted to feeding stuffs, and meat has become the goal. This has led to a restructuring of competition for land that is yet to be reflected fully in the structure of American agriculture.

Coincident with this shift of foreign demand from bread to meat, there has been a historic shift in the pattern of transport costs. Over several decades and up to 1979, the real cost per ton-mile of water transport had fallen, and the real cost of land-transport had increased. An indication of the significance of this shift is provided by Figure 6. The "continental divide" in rail freight rates for grain in the United States runs through eastern Montana, approximately at the longitude of Forsyth. The cost of grain transport via railroad from there west to Pacific Coast ports is approximately equal to the cost of rail transport east to water transport at Duluth-Superior, or at Minneapolis-St. Paul.

In mid-1979 this cost averaged about $1.20 per bushel, for wheat. Transport costs by unit trains or river barges from Minneapolis-St. Paul to Gulf Coast ports were in the range of 0.65 cents per bushel. The cost of transport from Gulf ports to Rotterdam ranged from 0.25 to 0.45 cents per bushel. In transporting a bushel of wheat from central Montana to western

Figure 6

Transport Costs for One Bushel
of Wheat, Fall, 1979
Havre-St. Paul
St. Paul-New Orleans
New Orleans-Rotterdam



Europe in 1978-79, approximately 80 percent of the transport cost involved internal transport within the United States.

This transport cost structure has been altered since 1979 by sharply increasing ocean freight rates, reflecting the increasing cost of fuel oil. It is still true that, once a cargo of grain has been loaded onto an ocean-going vessel at a U.S. port, it can be shipped anywhere in the world for the approximate cost of transport from central Montana to Minneapolis-St. Paul. The market for North American grain has become a world market, and the revolution in transport costs has contributed heavily to this development.

In appraising the land-use consequences of this restructuring of transport costs, an additional institutional phenomenon is important. The most recent innovation in U.S. land-based transport is the "unit train". Shippers can lease entire trains of identical cars, designed to facilitate loading and unloading. The conventional leasing arrangement in 1979 to Gulf ports involved a contract for 45 round trips per year. Shippers who could achieve this minimum of 45 "turn-arounds" in 12 months could obtain substantially lower transport costs.

This introduced a time element as well as a distance element into the market structure for Midwest grains and oilseeds. Transport costs can be reduced if supplies can be located as close as possible to the Gulf, not only because of distance but in order to permit quick turnarounds, and thus enable shippers to make the 45 trips per year necessary to qualify for the lower unit-train leasing charges (DeWitt, 1980). This led grain shippers in 1979 to drain the lower Mississippi Valley first. Corn and soybeans (the principal exports) were procured first from Arkansas, Mississippi, Missouri, Southern Illinois, and Indiana. Procurement then shifted north, in a concentric circle pattern, to include Ohio, northern Illinois, Iowa, Nebraska and southern Minnesota. Where wheat was involved, Texas, Oklahoma, Illinois, Ohio, and Kansas grain moved to export markets first, followed by grain from Minnesota and the Dakotas, with Montana at the end of the line.

As a consequence, the northern and western Corn and Soybean Belts, and the northern Great Plains, have become the residual suppliers to the world market for grains and oilseeds. The grain and feedstuffs reserve of the world is stored in this region. Stocks of corn and soybeans in storage in Minnesota on January 1, 1979 and 1980, for example, were at record highs. As of January 1, 1980, 80 percent of the corn and 66 percent of the soybeans were stored on farms. (Minnesota Crop and Livestock Reporting Service, Minnesota Crops, Jan. 25, 1980). This has created a crisis in farm credit in the region, as producers strive to finance both their grain stocks and the costs of producing a new crop.

It has been conventional in recent years to point out that one-third of the crop acres in the United States produce for export. In estimating the participation of each state in the export market, the national percentage of each crop exported has been applied to that state's contribution to total production. This is dangerously misleading in estimating the effect of export demand on competition for land. Any variation in exports will have its greatest impact on producers at the end of the transport line. For example, a variation of 0.50 cents a bushel in the price of corn at Rotterdam in December 1979 would have been approximately 14 percent of the Rotterdam price, but 25 percent of the farm-gate price in southern Minnesota (USDA, Foreign Agricultural Circular, Grains, Dec. 13, 1979, p. 27). Export demand is always of greatest importance to the producers who are most distant from export markets.

These considerations point up the regional differences in the effects of the recent expansion of export markets for United States agricultural products. The competition for land in the United States has now entered an international phase. It has been noted that substitutes for land can be found in fertilizers, in superior seedstocks, and in tillage and management practices that obtain more output from the same area.

This observation can be reversed. For foreign buyers, imported grains and feedstuffs are, in effect, a substitute for their land, and for the higher levels of intensity that might otherwise be applied to their domestic agricultural resources. In expanding agricultural exports, the United States is "selling" its land, in the same sense that it may at the same time be creating substitutes for land through fertilizers and more intensive management practices. In terms of national policy, a key question can be raised: Is this "sale" of more intensive levels of land use through the export of the products of land a wise policy? The superficial answer is: Does it pay? Do we receive more net benefits through the foreign exchange earned in this way than would be obtained through the use of our land resources for other purposes? If the net effect of an expanded export market for agricultural products is to finance the continued wasteful use of imported petroleum fuels, the answer becomes ambiguous. To date, it is clear that the competition for agricultural land in the United States that results from expanded agricultural export markets has postponed a confrontation between the true costs and benefits of our current consumption of imported energy. Our agricultural exports, in effect, are financing an increasing portion of an agri-urban life style that depends heavily on the private motor car. Lovers of irony will note that agriculture is thus contributing to the continuation of suburbanizing pressures on rural land, which in turn have generated most of the current concern over loss of farmland to non-farm uses. Is this the best use of the fertility of the land?

The restructuring of internal locational advantage or disadvantage occasioned by transport cost differentials and the growth of export markets may have an unanticipated consequence for livestock feeding. As noted above, beef cattle feeding shifted from the Corn Belt to the Southern Great Plains as a result of rapid increases in the local supply of relatively cheap grains. Hybrid corn, hybrid sorghum, and irrigation facilitated a shift out of livestock in Midwest agriculture that has led one student of the problem to speak of the resulting "grain deserts" (Dovring, 1979, p. 15). The Delta states led in a shift of much of the nation's richest alluvial soils into corn and soybeans. This has led to a concentration of very large cash grain farms in the Mississippi Delta, as well as in the Great Plains.

When coupled with a freight rate pricing structure that has been altered by unit-train leasing practices, this southward shift of feedstuff production seems likely to focus foreign demand on the lower Mississippi Valley. Cattle feeders in the southern Great Plains will be bidding primarily against foreign buyers for their feedgrains. Relative feedgrain and soybean prices may reflect this shift by making it again attractive for farmers in the Upper Mississippi Valley to feed their grains to livestock, as was once the ruling case, rather than sell the grain for cash.

There is some evidence that this shift is beginning. The U.S. Department of Agriculture maintains a continuously updated data series on costs of production in Great Plains and in Corn Belt cattle feeding enterprises. Throughout 1972 and 1973, the price required to cover all costs of production of fed beef in southern Great Plains feedlots averaged 10 percent below the break-even price in Corn Belt feedlots. Throughout 1979, Great Plains feedlot costs were about 3 percent above Corn Belt costs, and this cost differential seems likely to increase (U.S. Dept. of Agriculture, Livestock and Meat Situation, LMS-195, February 1974, pp. 21-22, and LMS-232, February 1980, pp. 13-14). The export market has now become the most important force affecting interregional competition for agricultural land within the United States.

Some Future Prospects

In reviewing the past half-century of competition for land in the United States, it is clear that the dominant influence has been generated on the demand side. In spite of a doubling of agricultural output since the Second World War, and major changes in the composition of production inputs, the contribution of land as an input in the production process has remained surprisingly constant. In 1910, labor accounted for 53.4 percent of all agricultural inputs, land 20.2 percent, machinery 8.5 percent, agricultural chemicals 1.7 percent, and all other inputs 16.2 percent. In 1978, labor inputs were 16.0 percent of the total, land 21.6 percent, machinery 31.3 percent, agricultural chemicals 9.6 percent, and all other inputs 21.5 percent (U.S. Dept. of Agriculture, Measurement of Agricultural Productivity, 1980, p. 8). Changes on the demand side for land have thus come primarily from outside agriculture, or from abroad.

The brief survey attempted in this paper has highlighted some of the growth elements in this expansion of the demand for land. In speculating upon future trends, the data point to two major potential shifters in demand: urbanization, and foreign trade. The solution to the housing problem that will be acute in the 1980's will provide the most immediate evidence of the direction that will be taken by domestic non-farm demand for land. There is some evidence that residential demand for agricultural land is moderating. The major increases in the real costs of credit and of energy have occurred so recently that their effects are not yet revealed in comprehensive national statistics.

The short-term prospect is for a substantial reduction in the pressure of urban demand on rural lands. The longer term prospect will be a function of land use planning and guidance measures that are only now being introduced in many of the most critical areas of urban impact. A forecast of these trends is primarily an exercise of political and not economic judgment.

This leaves the foreign market for agricultural products as the major unknown. To the extent that agricultural land use becomes a tool of foreign policy, we can expect this to be the greatest influence upon competition for land in the United States in our time.

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