# Staff Papers Series

STAFF PAPER P85-6 FEBRUARY 1985

## Forces Changing American Agriculture and Resource Needs

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## I. Introduction

The decision framework within which individual land users determine the extent to which they will practice soil and water conservation is extremely complex. Economic considerations are often dominant, but by no means are they always determinant. Questions more appropriate to the study of philosophy and religion often arise, and these in turn are conditioned by the perceptions of the individual.

An opening theme of this paper is that these perceptions have been shaped during the past two decades by a sequence of irrational expectations. These expectations have focused on the role of the United States in meeting world food needs, and on the consequent prospects for expanded agricultural export markets. Four misperceptions can be identified:

1) An over-estimation of the rate of world population growth.
2) An over-estimation of caloric requirements for human work output in the less-developed countries.
3) An under-estimation of the rate of cropland response to non-land or industrial-type inputs, especially in the developed countries.
4) An under-estimation of the potentials of forage crops and of the possibilities of forage-feed grain substitution in animal agriculture.

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* Paper No. 1980, Miscellaneous Journal Series, Agricultural Experiment Station, University of Minnesota, presented at the National Extension Workshop on Soil and Water Conservation, Kansas City, Missouri, October 25, 1983; revised December 1984 to include data that were not available when the paper was first presented.

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Time constraints will not permit a detailed exploration of each of these issues. The most that can be attempted is to outline the argument and suggest areas in which further research seems most needed in order to appraise potential demands upon the soil and water resources of the United States.

## II. World Population Growth

It is an axiom in the collection of census-type data that a first census is of limited interpretive value. A second census permits some time perspective, and the estimation of trends. A third census can build upon the learning experience gained from earlier efforts, errors of omission or estimation can be identified, and the data base begins to encourage confidence in interpretation of trends.

The first United Nations conference to address problems of resource availability and population growth, in 1949, used forecasts of a world population of 2,798 million by 1970 (UN, 1949, Vol. 1). The world's actual population in 1970 reached 3,632 million, with almost all of the forecasting error accounted for by the less developed countries of Africa, Asia, and Latin America.

A drawdown in world carryover grain stocks began in the 1960's and accelerated dramatically in the early 1970's. World carryover stocks of wheat and coarse grains were 28.5 percent of annual utilization at the end of the 1961/62 crop year; by 1970/71 they had fallen to 15.9 percent, and reached a record low of 12.3 percent in 1975/76 (USDA, FAS, 1984, p. 27).

This alarming decline in grain stocks coincided with a peak of international concern about unconstrained world population growth. This concern drew upon projections derived from national censuses that in many of the developing or newly independent countries represented the first or at best the second attempt ever made at modern census-taking. Projected growth rates were shocking.

China, with over 22 percent of the world's population in 1984, provides the most dramatic example of the retreat from the population growth rate projections of the early 1970's. China has had three modern censuses, in 1953, 1964 and 1982. Between 1963 and 1973 her annual rate of natural increase was well above 2 percent, peaking at 3.6 percent in 1963 and 3.1 percent in 1968. These were the data available to those concerned about world food supplies in the early 1970's.

In contrast, data from China's third census in 1982 revealed a decade of almost continuous fall in the annual rate of natural increase, from 2.36 percent in 1972 to 1.67 percent in 1975 and 1.32 percent in 1982 (Banister, 1984, p. 254). This reduction of 44 percent in ten years in the population growth rate of the world's most populous country is not matched in other areas in which food supplies are currently inadequate, especially in Africa and in parts of Latin America. But it does illustrate the rapidity with which global estimates of population pressure on world food supplies can change.

World-wide rates of population growth are still of crisis proportions. Although falling, they are unlikely to decline to levels that will relieve pressure on world food supplies in the coming decade. But by themselves, these unsustainable rates of population growth do not guarantee an ever-expanding market for U.S. agricultural exports. Need has been confused with effective demand. Policies of cropland use in the United States that assume unlimited foreign markets have already been demonstrated to be wrong. But the expectation that these markets would materialize provides a part of the explanation of the pressures on cropland use that lie at the root of our current problems of soil and water conservation. Production plans have been based on a world market mirage.

## III. Caloric Requirements in Developing Countries

If we were asked to estimate the feed requirements for an animal population, for example, a dairy herd or cattle on feed, the first thing we would need to know is the size and weight of the animals. It can only be regarded as amazing that this basic question was not the point of departure in estimating future world food needs, and the potential gaps in supply.

The data that were used in the 1950's and 1960's were based primarily on dietary studies in Western Europe, and especially in the United States. It is noteworthy that resulting estimates of recommended daily allowances in terms of energy have steadily been revised downward. "The energy allowance for the United States 'reference man' -- in his twenties, weighing 70 kilograms, and not very active--now stands at 2,700 calories, 500 calories less than the 1953 recommendation" (Poleman, 1984, p. 5).

The successive World Food Surveys conducted by the UN Food and Agriculture Organization report a similar downward path in estimating daily energy allowances for less developed countries. The First Survey in 1946 placed the floor requirement at 2,600 calories per day. This was dropped to a range of 2230-2300 calories in the second survey in 1952 and to well under 2000 calories for Asian populations in the Fourth Survey in 1977 (UN, FAO, World Food Surveys, and Poleman, 1984, p. 6).

Overestimates of population growth rates and of food energy requirements were combined to yield the frightening estimates of world food shortfalls that dominated the discussion of world hunger problems in the 1970's. The prospects of meeting world food needs through international trade were confined almost entirely to trade in cereal grains. It was a simple step to conclude that demands upon cropland in the United States, the world's largest cereal grain exporter, could only increase. This misperception set the stage for the stress on continuous cropping and fencerow-to-fencerow farming that have generated the soil and water conservation problems of the 1980's.

## IV. Response Rates to Non-Land Inputs

Viewed from the perspective of the early 1970's, the biggest error in forecasting world food supplies available for export traces to the underestimation of the rate of response of agricultural output to non-land inputs in the developed, industrialized countries.

Between 1960-62 and 1980-82 the U.S. increased its production of wheat and coarse grains by 83 percent with an increase of only 12 percent in harvested area (USDA, FAS, 1984, p. 24). In the ten countries of the European Economic Community (EEC) production of wheat and coarse grains increased 56 percent from 1976 to 1984 with an actual slight reduction in the harvested area (USDA, FAS, 1984, p. 19).

The average yield of wheat in the UK in 1984 was 98 bushels per acre (The Economist, Sept. 8, 1984, p. 61). In France, the average wheat yield in 1984 was 83 bushels per acre. France has emerged as the second largest wheat exporter in the world, edging out Canada in 1984/85.

This phenomenal recent increase in production in the industrialized countries owes much to favorable weather. This should not obscure the fact that its basis rests on better seeds, more fertilizer, improved tillage, greater precision in disease and pest control--in short, on inputs that are not a function of the area of cultivated land.

Inventories of food producing capacity based on cultivated land area have been misleading for another reason, in that they underrated the possibilities of multiple cropping. Until well into the 1960's there was virtually no multiple cropping in the United States, apart from specialized vegetable crops. In 1981 it was estimated that ten percent of all soybeans in the U.S. were produced in multiple cropping sequences (principally with wheat), and in the Delta and Southeastern states the figure was twenty-five percent (Hazera and Fryar, 1981, p. 11).

The potential for this form of vertical instead of horizontal expansion of crop acreage is great in many of the developing countries. With shorter-maturing varieties, better water management, and timely ground preparation it is estimated that many tropical and subtropical areas now producing two crops a year could produce three. Rice in the Philippines is often cited as a specific example.

Estimates of the ability of the world to feed itself have been conditioned for too long by an areal concept of capacity. This two-dimensional view of agricultural potential has outlived its usefulness. It was still the basis for most of the concern about world food shortages that led to irrational expectations of unlimited export markets for the United States until well into the 1980's.

## V. Unrealized Potentials in Forages

If we rank the major sources of solar energy conversion through photosynthesis in terms of the gap between achieved levels and levels that could be achieved with existing technology, the gap is greatest in the grasses and forages. They have not attracted research investments on the scale devoted to grain crops. Apart from hay for horses, they seldom enter into even local trade in developed countries. Markets for forages are limited, pricing is primitive, and they are difficult to tax. As a result they are typically undervalued, even by those who produce them. They do not excite the interests of governments or traders, and low ratios of value to weight preclude transport outside of producing areas.

Forage crops have not figured prominently in estimates of food producing potentials in countries experiencing the transition from diets based on cereals and root crops to diets including larger proportions of animal proteins. It has been easier to satisfy rising demands for meat and milk by importing grain rather than by improving forage production. The outstanding example is the Soviet Union.

The USSR will import grains equivalent to 24 percent of world trade in wheat and coarse grains in 1984/85, a total of 50 million tons (USDA, FAS, 1984, p. 9). Much of this will be utilized in large cattle feedlots and dairy herds under intensive feeding regimes that preclude extensive use of forages. Although occupying a large share of the world's grasslands, the structure of farming in the USSR makes it difficult to use them efficiently. Socialist agriculture favors large-scale, industrial-type production units. The Soviet Union has belatedly recognized its underutilized forage crop potential, and some progress in forage production has been achieved since 1980.

For different reasons, a similar failure to exploit forage crops persists in India, with a cattle population much more than double that of the U.S. or of the USSR. The two nations of India and the USSR had a combined human population of 1,020 million in 1984, or 21.4 percent of the world's total. They hold 38 percent of the world's cattle. A neglect of forage crops in these two countries alone has a massive impact on global estimates of food producing potentials, and thus on estimates of future demands upon grain lands. The possibility of improved forage crop usage is an additional reason why estimates of future world demand for U.S. grain exports must be regarded with caution, and have almost surely been overstated.

## VI. Interregional Significance of Changes in Transport Costs

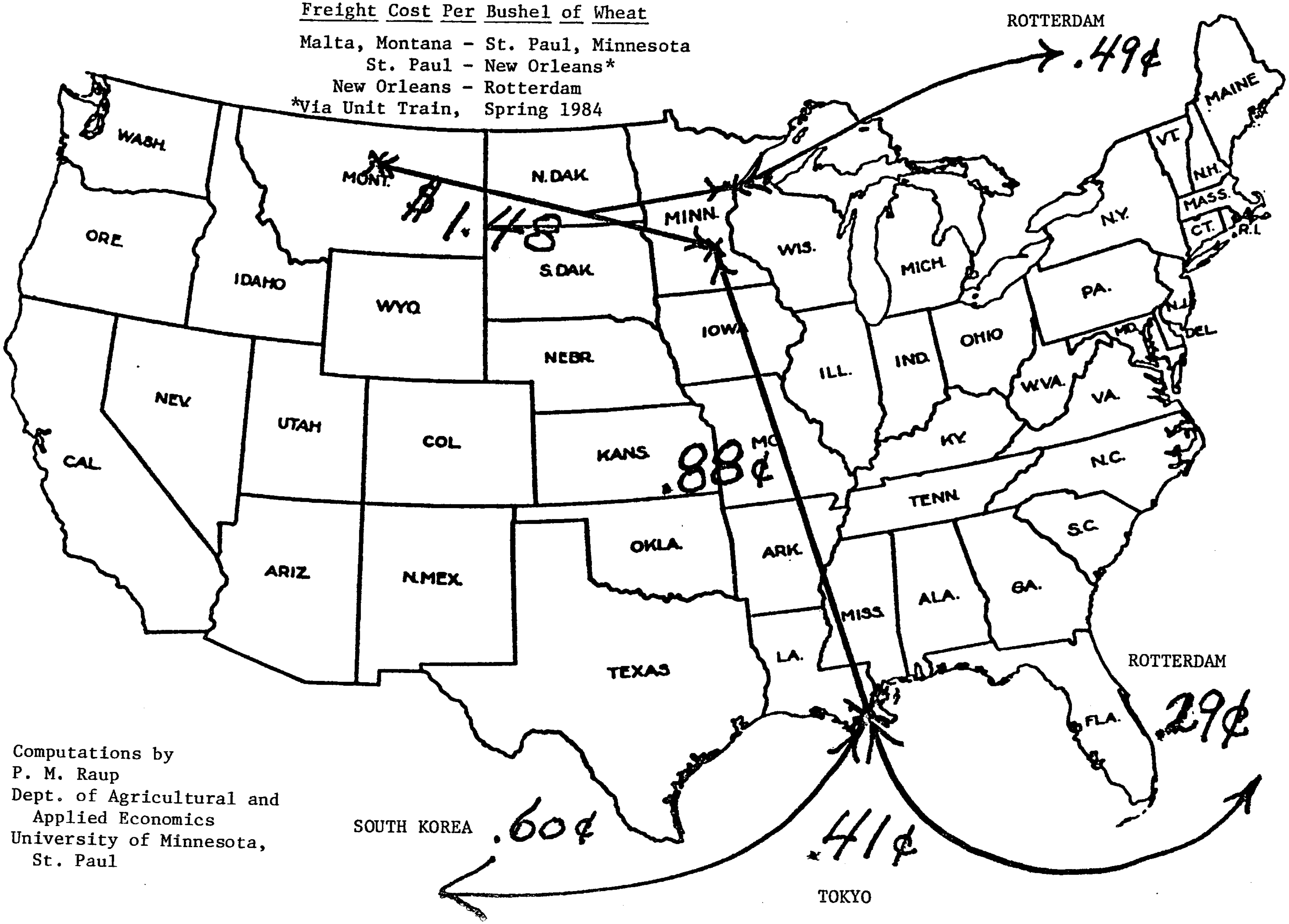
Grain producing regions in North America have experienced a fundamental restructuring of competitive advantage as a result of falling real costs of water-borne transport. At the peak of the initial grain export boom in 1973 the voyage charter rate for bulk grain from U.S. Gulf ports to Rotterdam averaged $0.35 cents per bushel (for wheat), in 1972 dollars. In 1982 the rate for the same voyage had fallen to $0.11 cents per bushel, again in constant 1972 dollars. A similar dramatic fall occurred in rates to the Far East. It cost $0.40 cents per bushel in 1972 dollars to ship wheat from Gulf ports to Japan in 1973; in 1982 the cost in constant dollars had fallen to $0.21 cents per bushel (computed from Harris, 1983).

Figure 1 shows comparable rates in current 1984 dollars. The freight rate for wheat from Gulf ports to Rotterdam in the Spring of 1984 was $0.29 cents per bushel; to Tokyo $0.41 cents per bushel, and to South Korea, $0.60 cents per bushel.

In contrast, internal freight rates increased in relative significance. To move a bushel of wheat from Minneapolis-St. Paul to Western European markets in 1984 cost $1.29, of which 75 percent or $0.88 cents was spent in moving it to Gulf ports. For wheat destined for Tokyo, 68 percent of

<u>Freight Cost Per Bushel of Wheat</u>

Malta, Montana - St. Paul, Minnesota
St. Paul - New Orleans*
New Orleans - Rotterdam
*Via Unit Train, Spring 1984

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the total freight charge from the Twin Cities was incurred within the United States. It cost more in 1984 to ship a bushel of wheat from Bismarck, North Dakota, to Minneapolis-St. Paul than to ship it from New Orleans to South Korea.

One consequence is that grain producing regions that are distant from ocean ports have suffered a loss of competitive advantage. A region that includes the Upper Midwest in the US and the Prairie Provinces in Canada has become much more sensitive to freight costs, and to price movements on world markets. This end-of-the line phenomenon was reflected in the grain export boom of the 1970s in the fact that farm land prices in Minnesota increased more than in any other state from 1973 to 1981. Similar explosive increases occurred in Saskatchewan and Alberta, in Canada. The decline in grain exports after 1981 had comparable reverse effects, in that farm land prices in grain growing counties of Minnesota fell 43 percent in real terms from 1981 to 1984. Declines of 50 percent or more have been reported from Saskatchewan and Alberta (Emerson and Raup, 1985).

The area in the U.S. most benefitted by this reorientation of grain markets has been the Mississippi Valley. The rise of multiple cropping of wheat and soybeans in the Delta States, cited above, is one of the most visible consequences. From a conservation point of view, the more significant development has been the accelerated intensity of land use in the Mississippi Delta. From 1949 to 1982 this region experienced the largest increase in the percentage of cropland used for crops in the U.S. Large increases after 1969 also occurred in the Corn Belt and in the Southeastern States (USDA, ERS, <u>Cropland Use and Supply</u>, 1984). These have been the regions most favored by shifts in freight rates and the rise of export markets.

Grain exports from the United States tripled in the twenty years from 1960-62 to 1980-82. Coupled with the revolutionary changes in grain transport costs, this has greatly altered the exposure of major grain growing regions to world market developments. This increased vulnerability has led farmers to seek shock-absorbing capacity wherever they can find it. One source has been in the postponement of capital maintenance costs. The decline in farm machinery purchases since 1980 has been dramatic and well-publicized. Less publicity is devoted to the neglect of land and water conservation practices on lands under intensive use, but this form of capital exhaustion has far more serious consequences.

## VII. Regional Shifts in Crop Production Intensity

Two major shifts in the intensity of cropland use have occurred since the 1950's. The first is the rise of soybeans as a major crop. In 1949 the U.S. harvested soybeans from 10,148,000 acres. In 1982 this has increased to 64,831,000 acres. For the same years, corn was harvested from 83,336,000 acres in 1949 and from 69,868,000 acres in 1982 (U.S. Census of Agriculture, 1949 and 1982). With exceptions, the increase in soybean acreage occurred in areas suited to corn. Corn and soybeans typically compete for the same land. How was it possible to increase soybean acreage by 54.7 million acres while reducing corn acreage by only 13.5 million acres? The answer is revealing, in terms of soil and water conservation goals. The acreage in corn moved west, spurred by irrigation from the Ogallala aquifer, and north, as a result of earlier maturing varieties. This freed some of the Corn Belt land needed for soybeans.

Most of the rest of the expanded soybean acreage involved a sharp decline in the acreage planted to oats, and a reduction in cropland pasture.

In the U.S. as a whole, oats were planted on 23.6 million acres in 1969; by 1982 this had dropped to 9.1 million acres (U.S. Census of Agriculture, 1969 and 1982). Cropland pasture dropped from 88.2 million acres in 1969 to 67.7 million acres in 1982, with 47 percent of the decline occurring in the Corn Belt states (these and subsequent land use data from USDA, ERS, Cropland Use and Supply, 1984).

It is this latter trend that is most significant for conservation farming. Meeting the demand for export crops has pushed the percentage of total cropland used for crops to the highest levels since World War II, in some of the most erodable areas, and with almost all of the increase occurring since 1969. In the Lake States, the Corn Belt and the Northern Plains, from 86 to 89 percent of total cropland was in crops in 1982. This is one measure of the stress on land use intensity, and of the roots of current concern over possible neglect of the nation's land base.

The second major shift in land use intensity occurred in the Great Plains, with the spectacular rise in irrigation from the Ogallala aquifer. This has accomplished a geographic reversal of concepts of crop risk in the central Great Plains. Historically, the low-risk counties were in the eastern parts of Nebraska and Kansas, the high-risk counties in the western sectors. At the beginning of the 1950's, the ten counties with highest corn production in Kansas were in the northeastern quadrant of the state, in the valleys of the Kansas and Missouri rivers. At the end of the 1970's eight of the ten Kansas counties leading in corn production were in the southwestern sector of the state, in former "dust bowl" territory. A similar reversal occurred in Nebraska, plus the addition of intensive irrigated corn production in Sand Hill counties outside the Ogallala basin. Regions that had been "cattle country" until after the Second World War became intensive crop producing areas, within a short two decades (Frederick, 1980, p. 163). Most of the acres converted to irrigation were devoted to corn, wheat, sorghum, and (in the Southern Plains) cotton.

This achievement of substantial protection from climate-based crop risk in some of the highest-risk areas of North America has been associated with a massive relocation of beef cattle feeding. Over two-fifths of the fed beef produced in the U.S. comes from feedlots situated almost exactly above the southern extensions of the Ogallala aquifer, in the Texas and Oklahoma panhandles, western Kansas, and eastern Colorado.

This ground water supply is under increasing stress, with falling water tables and rising pumping costs. It will not dry up, but it may well become an uneconomic source of water to produce the feed supplies required by the cattle feeding operations now dependent upon it. Reconversion to dry-land cropping will give rise to problems of conservation for which past experience yields few guides.

There is increasing pressure to specify required conservation practices as a condition for continued participation in governmental crop price support programs. If this policy is adopted, it will pose some of the most acute problems of implementation in irrigated areas of the Great Plains. With few exceptions, water has been treated as a free good, with no charge for withdrawal. Irrigation equipment has been heavily subsidized, through investment tax credits and accelerated depreciation allowances. If it proves necessary to maintain these subsidies to permit the continued depletion of an exhaustible resource in order to produce crops that are in surplus nationwide, some basic questions will need to be asked about the regional distribution of agricultural activity.

It is difficult to avoid the conclusion that present levels of fed beef consumption will be hard to maintain without a return to the feed grain supplies of the Corn Belt. Any failure of export markets for feed-grains to develop on the scale anticipated in the 1970's will tip costs and returns in favor of the Corn Belt. Large areas now achieve yields per acre under rainfed conditions that equal or exceed those achieved under irrigation in the Great Plains. Interregional shifts in the feed-livestock economy seem likely to continue.

## VIII. The Demographic Variable

The discussion to this point has concerned potentials for change in markets, crops, and land use. To this list of forces generating change in resource needs we need to add the internal demographic variables that will shape our perception of future problems of soil and water conservation.

The U.S. farm population was 30.5 million in 1930, and 30.5 million in 1940. It declined to 23.0 million in 1950, to 15.6 million in 1960, to 9.7 million in 1970, and to 6.9 million in 1981, using the old Census definition of a farm (changed in 1978). Using the new definition of a farm, the farm population was 5,787,000 in 1983.

Assuming that most of this migration out of agriculture involved individuals under 25 years of age, the reduction in the farm population of 23 million between 1940 and 1981 involved primarily individuals born after 1915. The oldest members of the generation that contributed to this heavy migration off of farms would thus be under 68 in 1983 and, with normal life expectancy, perhaps 80 percent or more of them are still living.

Although data are lacking, it seems probable that we have a population of people with farm backgrounds but who are no longer in farming that is at least double and perhaps more nearly triple the size of the farm population as currently defined (Raup, 1983).

If we use the post-1978 Census definition of a farm and of the farm population, it is roughly true to say that for every person now on a farm there are three persons in the non-farm population whose roots were in farming. This farm-rooted portion of the non-farm population is now at a peak, and will decline gradually to 2000 or 2010, and then precipitously. For the remainder of this century we can reckon with a population that includes a large number of non-farm people who have at least emotional or sentimental identification with agriculture.

The significance of this observation for resource conservation in agriculture is that many of them, and perhaps a majority, have more than sentimental ties. They are the heirs or prospective heirs of farm land owners. As a result of a massive off-farm migration concentrated in little more than 25 years, much of the beneficial ownership of farm land has moved out of agriculture.

These trends were accelerated by the land-boom of the 1970's. From 1972 through 1981 real capital gains in land values made farm land almost the only performing "growth stock" available to investors. This added a monumental financial incentive to sentimental reasons that off-farm migrants may have had for retaining any ownership interest in farm land.

The consequence is a structure of farm land ownership that is probably more fragmented today than at any time in our history. Professional farm managers recount instances in which they have assembled ownership tracts from a dozen to 50 or 60 landlords for rental to a single large tenant. Part-owner operators renting from half a dozen land owners are commonplace.

Much of the increase in rented land in the recent past has been explained by the desire of heirs of former farmland owners to retain their inheritance, in the hope of a capital gain. In a previous generation many of the heirs of deceased farmers eventually sold out, and their holdings were recombined into new farm units. The prospect of rapid capital gains in farmland in the 1970's narrowed the farmland market substantially, as more owners who in a earlier era would have sold out emerged as landlords, often of relatively small tracts of land. The result was a motive for landholding rooted in capital gain expectations rather than efficient farm management. When combined with the tendency for the size of ownership tracts to decline, this constitutes a major barrier to the efficient promotion of conservation farming. A much larger population of landowners must now be convinced of the desirability of conservation. Their motives for landholding do not make them receptive to arguments based on the possibility of sustained or increased profits from farm operation over a planning horizon stretching into several decades or beyond.

The implications for conservation policy are clear. A sustained effort is needed to promote conservation goals among the land owning population, which is not the same as the population of farm operators. The clientele for much of the information provided by land grant universities, experiment stations, extension services, and conservation agencies is increasingly non-farm in outlook. A different mix of effort will be required for successful conservation programs in the future.

The majority of people in this generation who identify with agriculture are not on farms. This is the overriding demographic and political fact that will have to be faced in the tailoring of successful land and water conservation programs for the remainder of this century.

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