William Lockeretz

The Lessons of the Dust Bowl

Several decades before the current concern with environmental problems, dust storms ravaged the Great Plains, and the threat of more dust storms still hangs over us

The dust storms of the 1930s were the worst man-made environmental problem the United States has ever seen, whether measured in physical terms or by their human and economic impact. Indeed, at a time when we are so concerned about air pollution measured in parts per billion, it is hard to picture dust so thick that pedestrians could literally bump into each other in the middle of the day. The term *air pollution* scarcely begins to describe a cloud several miles high carrying hundreds of millions of tons of dust as far as several thousand miles.

Yet airborne dust was only one part—certainly the most spectacular part—of an even greater problem. For the blowing dust once was topsoil, and topsoil was the most valuable and productive resource of the area known as the Dust Bowl, which included considerable portions of Texas, New Mexico, Colorado, Oklahoma, and Kansas (see Fig. 1). Blowing soil came to symbolize dramatically the breakdown of an agricultural system that was the basis of the region's economy and social order. When the dust had settled, the region not only had to recover from staggering economic losses and human suffering but also faced the more far-reaching challenge of restructuring its fundamental economic activity to ensure that the problem would never recur. Unfortunately, new dust storms in the past few years—although not nearly as severe as those of the 1930s—suggest that even today this goal has not been fully achieved.

William Lockeretz is a research associate at the Center for the Biology of Natural Systems at Washington University, where he has worked since 1971 on a range of environmental and resource topics. He received his B.S. from City College of New York and his M.A. and Ph.D. from Harvard. For the past four years he has led a research project on resource conservation in agricultural production. Address: Center for the Biology of Natural Systems, Washington University, St. Louis, MO 63130.

Those who experienced the dust storms generally said that they were almost beyond description. Soil conservationist Russell Lord (1938) called them "as nearly a literal hell on earth as can be imagined." During a bad dust storm, any semblance of normal activity was out of the question. Homes, barns, tractors, and fields were buried under drifts up to 25 feet high (Fig. 2). The sky could turn completely black in a matter of minutes, and at times dust obscured the sun for several days (Fig. 3). Some people actually thought they were seeing the end of the world.

Even wet towels stuffed in the cracks of windows could not keep the dust out, and from across the room an electric light might look no brighter than the tip of a cigarette. Everything in the house—even food in the refrigerator—was covered with dust. To be able to breathe, people covered their faces with wet cloths, but continuously breathing the damp air only aggravated the effects of the dust. Each storm was followed by many cases of serious lung damage, and some proved fatal.

Dust storms were extremely frequent on the Great Plains during the mid-thirties, although they were not always intense and long-lasting. There were an average of nine storms per month during the first four months of each year (the main dust storm season) from 1933 to 1936 at Amarillo, Texas, and in one month there were dust storms on 23 days (Choun 1936). These storms lasted an average of about ten hours, and during about one-fifth of them visibility reached zero.

The record at Amarillo was not particularly unusual. At various times serious wind erosion, and sometimes full-blown "black blizzards," hit virtually every part of the Plains, not just the Dust Bowl. For example, the great dust storm of May 1934, which deposited large amounts of dust on the East Coast and the North Atlantic (Hand 1934; Mattice 1935), originated in the Dakotas and Nebraska. The most severe storms occurred from 1933 to 1938 on the Southern Plains, and from 1933 to 1936 in the north.

The economic and social consequences of the dust storms were aggravated by two other problems—drought and depression—that made recovery much more difficult. The severe and protracted drought that began in 1931 and precipitated the dust storms damaged crops even on fields that escaped blowing, not just on those that contributed to the storms. Moreover, because of the Depression, farmers got very low prices for whatever crops they were able to produce. It is hard to separate the interacting effects of the dust storms, drought, and depression, but we can say that the storms made an already distressing situation much worse.

Farmers bankrupted by dust storms joined the ranks of tenants and farm laborers who were displaced by machines ("tractored out") and who could find no other jobs in the depressed region (Stein 1973). The re-

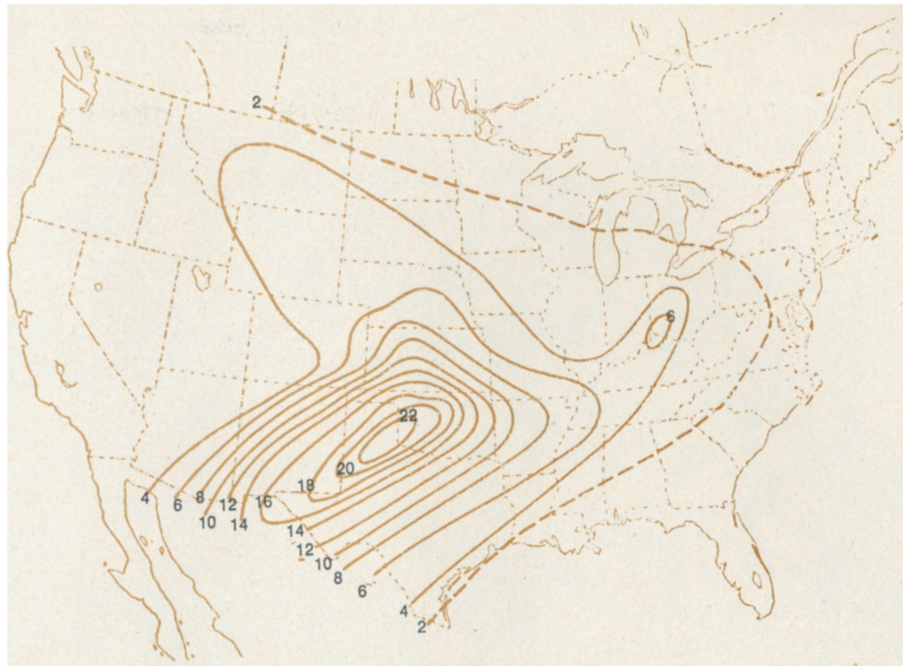


Figure 1. The contours indicate the number of days with dust storms or dusty conditions during March 1936. During the 1930s the main dust storm area shifted from month to month. The worst area on the Southern Plains during 1933–38 corresponds roughly to the 16-day contour on this map shifted about 200 miles to the northwest. (From Martin 1936.)

sulting movement of hundreds of thousands of Dust Bowl refugees to the West Coast—so vividly portrayed in *The Grapes of Wrath*—was without precedent in the country's history. Those who were able to remain faced equally discouraging prospects. In 1937 the Soil Conservation Service estimated that 43 percent of a 16-million-acre area in the heart of the Dust Bowl had been seriously damaged by wind erosion (Joel 1937), a major resource loss for a region almost entirely dependent on agriculture. In some Southern Plains counties, more than half of all farm families were on relief in 1935 (Kifer and Stewart 1938). The federally created Great Plains Committee, in a superb report called *The Future of the Great Plains* (1937), painted a disturbing picture of widespread rural poverty, a staggering burden of mortgages and debts, and increasingly frequent farm foreclosures.

Soil erosion

Soil is both an indispensable and a nonrenewable resource. Excluding fishing and some very intensive techniques with limited applications (like hydroponics), there is no way to obtain food without soil. Nor can we manufacture soil, and the natural processes that form it work very slowly. It takes many centuries to rebuild as much topsoil as a dust storm can remove in a matter of days or hours.

Soil erosion has been a problem in the United States since colonial times. In the older agricultural areas of the humid eastern part of the country, the major form of erosion is by water. In contrast, wind erosion is worst in semiarid, drought-prone areas with a flat, treeless topography that offers no obstacles to the wind, and large portions of the Great Plains region are therefore highly susceptible (Kimberlin et al. 1977). Severe dust storms have been known since ancient times in North Africa, the Near East, and Central China (Idso 1976). On the Great Plains, in addition to the "dirty thirties," there have been several other periods of fairly serious dust storms in the century since settlement began. But no other dust storms in the country's history reached the continental proportions attained during the 1930s.

Wind erosion is initiated by the force of the wind against individual particles at the soil surface. Very small particles get carried in suspension, while large ones simply roll or slide along the surface. But in a process called saltation, particles between .1 and .5 mm are lifted up to about a meter and are accelerated by the greater wind speed at that height before hitting the ground again. Be-

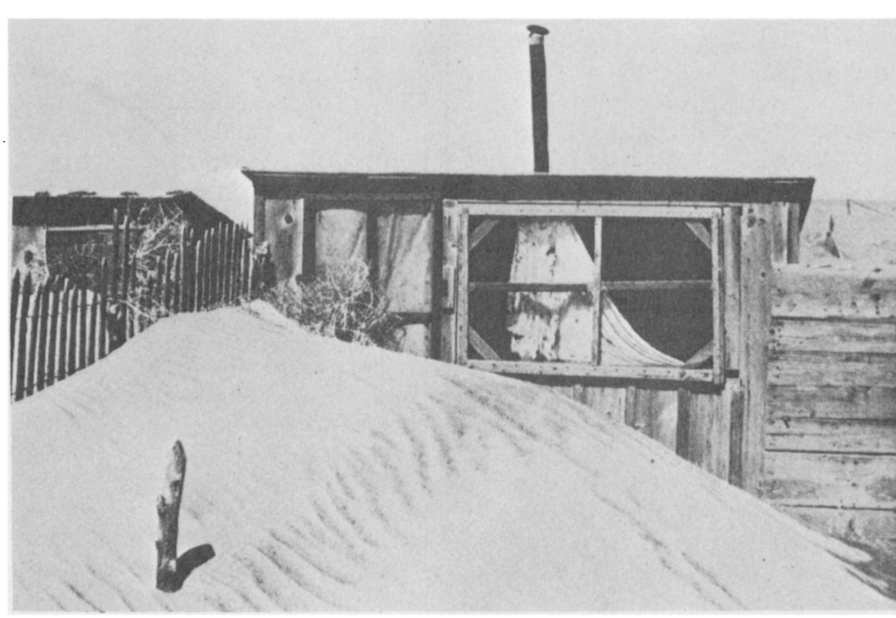


Figure 2. After a particularly bad dust storm, sand drifts could reach 25 feet in height and bury tractors, barns, and homes beneath them. (Photo courtesy of Resettlement Administration.)

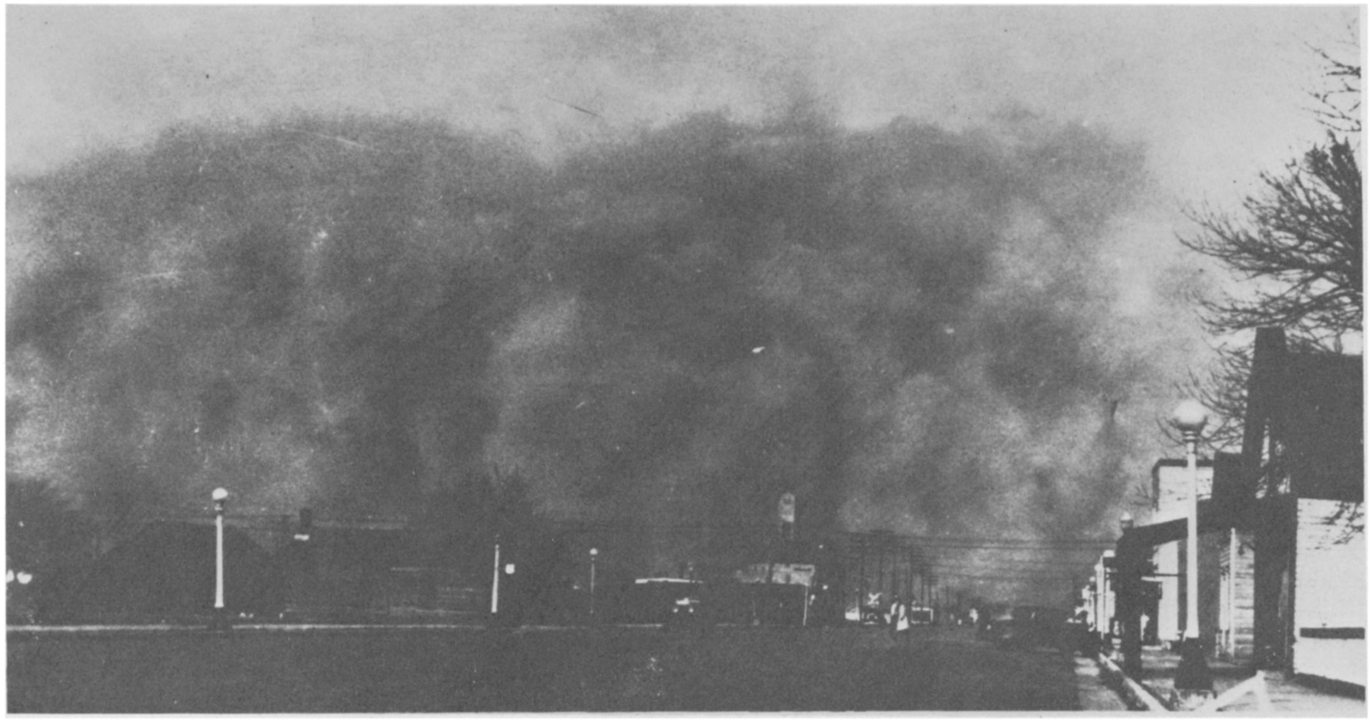


Figure 3. "Black blizzards" were common in Kansas and the rest of the Dust Bowl during the 1930s. Several minutes after the start of a storm the sky would turn completely black, and the sun would be hidden from view for days at a time. (This photo and the one on the facing page are by courtesy of the Soil Conservation Service.)

cause their impact in turn loosens and dislodges more particles and damages or destroys plants, wind erosion is a cumulative process. Thus one effective erosion-control technique is to break the avalanching effect with strips of erosion-resistant plants perpendicular to the prevailing wind direction (Fig. 4).

The most effective method of prevention is an adequate cover, either of growing plants or residues from the previous crops (Woodruff et al. 1972). A good cover reduces wind speed at the surface and shields the soil from the wind's abrasive action. It also traps dust blown in from exposed soil and absorbs the impact of saltating particles. Also, plant roots help to bind the soil.

Erosion can be reduced by creating barriers that cut down the wind speed. Using rows of trees near buildings as windbreaks or shelterbelts is common even in humid areas. Unfortunately, trees do poorly in many parts of the Southern Plains. Tall annual crops such as sorghum offer some protection, but the rows must be fairly closely spaced. Mixing crops on a single field, which is also done in strip cropping, presents problems for the farmer who wants to raise the single most profitable crop on as much land as possible. Single-crop farming was an important factor in creating the Dust Bowl, as will be seen.

Erosion is also minimized by maintaining a rough, cloddy surface to reduce surface wind speed. Large clods cannot be moved by the wind and also help protect more erodible soil components. The formation of stable clods is aided by returning organic matter to the soil. When some early Plains farmers burned grain straw to facilitate tillage, they accelerated the loss of humus and made the soil more erodible (McDonald 1938).

Because crops differ considerably in their tolerance of drought and their susceptibility to erosion, erosion control requires choosing an appropriate mix of crops, depending on the weather, soil moisture, and soil erodibility. The major Plains crops include grasses, close-planted small grains, and row crops. Perennial grasses offer year-round protection, even in a drought, if they are not overgrazed. However, grass provides no income for farmers who do not have cattle.

Winter wheat is the dominant small grain on the Southern Plains. Planted in late summer or early fall, it provides good cover in the fall, winter, and the following spring (when the erosion hazard is greatest), if a good stand is established and maintained, which may not be possible during a drought. By the 1930s it was already well known that when the soil moisture is below a certain critical level at planting time, crop failure will probably result (Rule 1939). However, economic factors sometimes encouraged or compelled Plains farmers to plant wheat anyway.

The sorghums, which are fairly drought-tolerant relatives of corn, are an important group of row crops in the Southern Plains. Sorghums were originally raised as livestock forages, although since the 1950s they have also been raised for grain. They leave a considerable amount of residue, which can be left to protect the field until after the main blowing season the following spring.

These crops differ in the relative timing of expenses and income. Wheat and grain sorghums provide a cash income in less than a year, but forage crops provide no return until

Figure 4. Wind erosion is common in semiarid, drought-prone areas with a flat, treeless topography. To prevent the wind from loosening and dislodging soil particles, a combination of windbreaks—created with trees or tall crops—and strip-cropping of erosion-resistant plants like grass perpendicular to the prevailing wind direction is used. Besides reducing surface wind speed, the grass catches blowing soil.

the cattle are marketed. The need for immediate cash made many Plains farmers specialize in wheat shortly before the dust storms of the 1930s.

Soils differ significantly in their susceptibility to erosion. Some Plains soils cannot be cultivated safely and are best kept permanently in grass. Of course, while rainfall is above average, even these soils can profitably grow crops. Some farmers overlooked their limitations and chose a cropping system for maximum return under the best weather conditions, rather than for protection during unfavorable ones. This practice has caused many problems in a region where growing conditions are so variable and unpredictable (Sears 1935).

Rainfall and yield

The successes and failures of Plains agriculture have been determined by variations in rainfall more than by any other physical factor. Seasonal temperatures generally are favorable for grain production. Many Plains soils are among the most fertile in the country, with newly turned sod giving high yields even without fertilization. The extensive tracts of level land so characteristic of the Plains are well suited to large-scale mechanization, with the result that when tractors and combine harvesters were introduced after World War I, wheat production costs in the Plains became the lowest in the country (Stephens 1937). But the average annual precipitation, between about 12 and 25 inches, depending upon the location, is roughly equal to or somewhat below the minimum needed for grain production. Therefore even relatively minor fluctuations in rainfall cause disproportionately large fluctuations in yield.

Yet great variations in precipitation, not just minor fluctuations, are the rule on the Plains. The concept of "average" is really only a mathematical construction, not a very useful predictor of actual precipitation in a particular year. For example, from 1875 to 1936 (roughly from the beginning of crop production to the drought that followed the most important period of conversion from native sod to cultivated crops) the average annual precipitation at Dodge City, Kansas, was 20 inches, just about enough to produce crops (Stephens 1937). But in one out of five years it was above 25 inches, while in one out of six years it was less than 15 inches. This range represents the difference between bumper crops and virtual crop failure. Periods of several consecutive years of subnormal precipitation are even more damaging, since they exhaust farmers' financial reserves and since the cumulative depletion of soil moisture and loss of cover increases soil erosion. The same precipitation data for Dodge City show five different times in 61 years in which annual precipitation stayed below the 20-inch average for at least three successive years.

Yet even these figures do not tell the whole story. Rainfall is helpful during the fall and spring growth periods of winter wheat, but heavy rains when the crop is nearing maturity in summer can seriously damage the crop. Year-to-year variations in the seasonal distribution of precipitation on the Plains compound the effects of variations in total annual precipitation (Thorntwaite 1936).

It is not surprising, therefore, that crop yields on the Plains have fluctuated sharply. For example, in Sheridan County in northwest Kansas, the fraction of wheat land that was actually harvested varied between 11

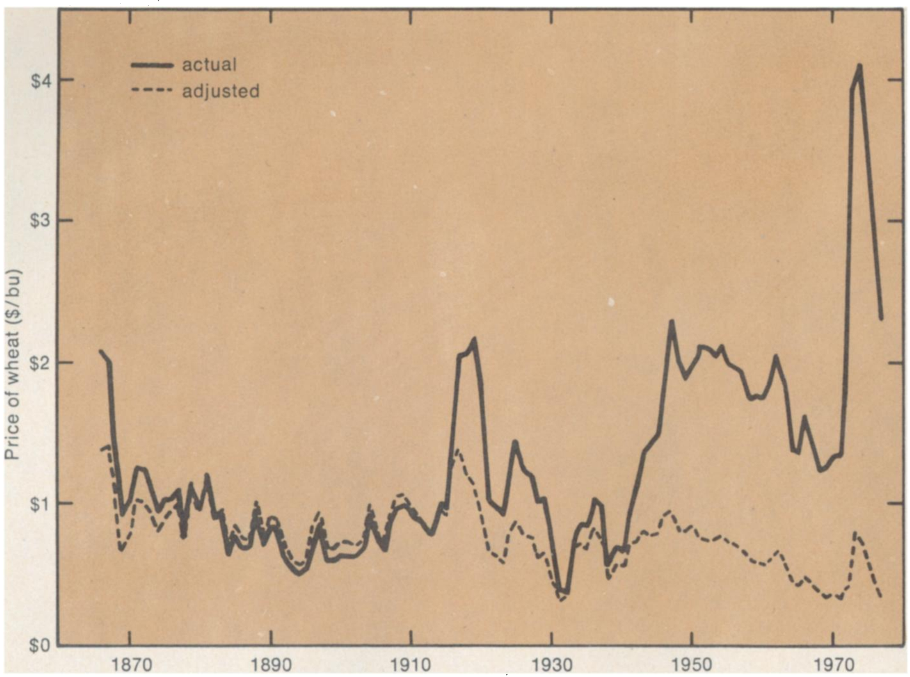


Figure 5. The national seasonal average price of wheat has varied sharply since the Civil War. The first three peaks correspond to major wars, while the most recent peak is related to grain sales to the USSR and to other aspects of the world grain situation. The deep valleys reflect the agricultural depression of the early 1920s and the Great Depression beginning in 1929. The adjusted price, which is in terms of the purchasing power of the farmer's dollar in 1910–14, shows a gradual decline along with these short-term changes.

percent and 99 percent from 1912 to 1934, and the yield per planted acre ranged from .3 to 21.3 bushels (Thorntwaite 1936). The economic effects of such yield variations were further aggravated by changing crop prices. The income of Plains farmers specializing in wheat depends directly on the price of that one crop. Such farmers do not have even the limited flexibility available to farmers of more diversified crops, who at least can adjust to changes in the relative prices of various crops and livestock, although not to changes in the overall price level.

Since the Civil War, the national annual average price of wheat has varied between $.38 and $4.09 per bushel (USDA 1967, 1977). These extremes mainly reflect cyclic changes, with only a very slight upward trend. Short-run changes have often been very sharp. The price of wheat has at least doubled within two years on three different occasions, and three times it has fallen by at least half (see Fig. 5). The price received by a farmer at a particular time and particular location has varied even more sharply than these national annual average figures indicate.

Since the price of wheat is determined not only by the quantity produced but also by nonagricultural factors such as wars, overseas demand, and general economic conditions, variations in the quantity produced have not always been offset by opposing changes in price. When severe drought occurred during a major national depression, as in the 1930s, the results were disastrous.

Plains agriculture: Feast or famine

Throughout its history of about a century, Plains agriculture has followed a boom-or-bust pattern. Before the arrival of the first settlers—the cattlemen—the undisturbed ecosystem changed in response to variations in weather, but the far-reaching alterations that accompanied each wave of settlement greatly magnified the impact of subsequent weather cycles.

In the area that was to become the Dust Bowl, the native vegetation was mainly sod-forming short grasses such as buffalo grass and blue grama. Although much sparser looking than the tall-grass prairies farther east, the short-grass plains supported an enormous number of grazing animals, including vast herds of bison. In the semiarid climate, the short grasses cured naturally, thereby providing high-quality forage throughout the winter (McArdle and Costello 1936).

This phenomenon was exploited by cattlemen, the first arrivals, who introduced the longhorn breed from Mexico via Texas after the Civil War. Cattle ranged over vast unfenced areas, receiving virtually no attention except during roundups and trail drives. The cattle industry expanded feverishly in the early 1880s (Brisbin 1881), and aggressive promoters attracted speculative capital from as far away as Europe. But while it was highly romanticized in song and story, the open range actually represented only a transient phase. Overgrazing, the invention of barbed wire, dubious financial practices, the sudden collapse of the market, and devastating blizzards in 1886 and 1887 combined to end the open-range cattle industry (Webb 1931; Stewart 1936). From the mid-1880s on, cattlemen lost more and more of their range to newly arrived farmers, despite frequent fights to keep it, while fencing in the remaining land and managing it more closely. In its spectacular growth and equally spectacular collapse the industry foreshadowed the drastic cycles that were to become the pattern for Plains agriculture.

The conversion of the Plains from grassland to cultivated crops was accomplished by waves of optimistic farmers arriving during periods of favorable rainfall. But each such period was followed by serious drought, leading to dust storms, bankruptcies, foreclosures, and outmigrations. The economic, social, and technological factors that interacted with the physical environment to make the effects of the droughts so serious—and nothing less than catastrophic in the 1930s—became apparent almost from the earliest days of Plains agriculture.

Cultivation pushed into the Plains in the late 1870s on land distributed in 160-acre homestead units. Grazing cattle on only 160 acres was out of the question: only cultivation could possibly sustain a family. As long as rainfall was above average, there was a fair chance of success. But, with inadequate rainfall, crops failed, and, unprotected by crops, the soil could not withstand the region's high winds (McDonald 1938; Bennett 1939). Soon after they arrived many farmers were forced to leave the Plains during the first of what would be several periods of serious dust storms.

But the return of above-normal rainfall erased the memory of previous failures, and around 1900 another group was ready to try again. This time, the frontiersman's characteristic willingness to take risks was reinforced by the aggressive boosterism of various interest groups, especially the railroads. Having been granted alternate square miles of land in a checkerboard pattern out to 20 miles on each side of the line as payment for building railroads through the Plains, they were eager to bring in settlers to whom they could sell tracts of land and who would also generate increased traffic. Techniques like offering free one-way tickets to prospective settlers, reinforced by the promotional activities of state governments, newspapers, and speculators, proved quite effective.

The influx of farmers in the early twentieth century was further stimulated by the "dry farming" movement, which promoted special systems for areas with inadequate rainfall. The best-known proponent of dry farming, Hardy W. Campbell, advocated a firmly packed subsoil but a loose and finely divided topsoil, or "dust mulch," which he erroneously thought was necessary to minimize the loss of water from lower layers of soil. Campbell also recommended summer fallowing, which means raising a crop on alternate years only and cultivating the unplanted land several times during the summer to control weeds and to keep the surface in a condition to absorb the maximum amount of rain. The goal was to store up as much water as possible so that the next crop would have adequate moisture. Summer fallowing is still practiced by some Plains wheat growers, although most of Campbell's other techniques, especially the dust mulch, have long since been discarded. Modern summer fallowing, however, controls weeds either with herbicides or subsurface tillage, which, unlike the older cultivation methods, does not increase the soil's susceptibility to erosion.

Campbell's claim that these methods would ensure the Plains farmer protection against drought was widely publicized, often with a missionary zeal. Groups who wanted to have the Plains settled seized upon his work as an apparently scientific response to anyone who was concerned about the failures of previous Plains farmers (Hargreaves 1948).

At about the same time, the USDA set up several dry-land experiment stations in the Plains. The leader of this work, E. C. Chilcott, sharply criticized the exaggerated portrayals of any one dry-farming method as the panacea for Plains agriculture (Chilcott 1912). Unlike Campbell, USDA researchers recognized that a loose, finely divided topsoil was very susceptible to wind erosion, and they showed that the soil still could conserve moisture when left instead in a rough, cloddy condition. This principle was embodied in new soil-conserving tillage implements, especially starting in the 1930s (Chilcott 1937).

Along with the scientific and quasi-scientific precepts of the dry-farming movement, some utter nonsense also found acceptance. The saying "Rainfall follows the plow" reflected the theory that bringing more land under cultivation would make the Plains climate more favorable. An even more curious notion was that the telegraph lines and railroads then being built in the region would have the same effect. A particularly colorful rainmaking scheme was based on the belief that rainfall follows major military battles. C.W. Post, the breakfast cereal magnate, tried to make rain through a series of "battles," planned with military precision, in which he detonated large quantities of explosives (Johnson 1947).

The optimism of the early 1900s, founded on a mixture of science, pseudoscience, and hucksterism, was destroyed by the drought that hit the Southern Plains in 1910. This time the dust storms were quite severe, sometimes lasting several days and reducing visibility to near zero (Johnson 1947). In duration and intensity they anticipated some of the worst storms of the 1930s, although they never attained the same regional scale. Still, they were more than enough to cause widespread farm failures.

But once again the dust storms and drought did not convince everyone that it was dangerous to convert large amounts of grassland to cultivated crops without giving adequate attention to erosion. With the predictable eventual arrival of adequate rainfall, this time starting in 1914, came the almost equally predictable arrival of another wave of farmers determined to make plowed-under sod produce grain, regardless of whether the soil and climate were suitable for it.

By then, it was well known that cropping systems other than wheat monoculture offered better protection against drought and erosion. Nevertheless, the wheat boom that began around World War I was bigger by far than anything that had come before. The usual spirit of optimism and adventure was now strengthened by two very powerful forces: high prices and new technology. In 1919, wheat soared to a record average price of $2.16 a bushel, more than twice the 1910–14 average of $.87. This price would not be seen again for almost three decades and has never been equaled in terms of the purchasing power of the farmer's dollar (see Fig. 5). Such prices, if accompanied by good weather, held the promise of unbelievable profits, enough to pay off an entire farm in one year (Thorntwaite 1936).

Moreover, such profits could now be achieved on a vast scale. Tractors introduced around World War I could pull up to twelve disc plows at a time. The newly introduced combine harvester cut labor costs, reduced field losses, and allowed one man to handle a much larger acreage.

Some of the increase in wheat production occurred on large, highly mechanized farms developed with outside capital. The most spectacular example—the Thomas Campbell farm in Montana—capitalized at $2 million, produced 50,000 acres of wheat with 33 tractors, 50 gang plows, and 100 grain wagons (*Fortune* 1935). But many other farms were family-size operations run either by survivors of previous droughts or by new arrivals on still-available public land. Short-term economic considerations may have motivated some of these farmers, too, but others were interested in farming in a sustainable way so that they could pass a productive farm on to their descendants.

Unfortunately, economic necessity prevented many of them from carrying out this wish, since the favorable prices of World War I did not last very long. A serious agricultural depression began in 1921, dropping the average wheat price to $.97 by 1922. Traditional mixed farming could not hope to compete with large-scale wheat production that used the new mechanized methods and had the lowest costs in the country (Stephens 1937).

When favorable prices returned later in the decade (a high of $1.44 in 1925), weather, technology, and economic conditions coincided perfectly, and the wheat boom accelerated even more. The labor required to produce wheat on the Plains could be kept so low with the new machinery, and the necessary operations could be performed so quickly, that a person no longer even had to live on his farm. The so-called "suitcase farmer," based as much as several hundred miles away, could come to his farm for a few weeks each summer and live in temporary quarters (Hewes 1977). In those few weeks, he could harvest his previous winter wheat crop (assuming he had succeeded in raising one), till the ground, and seed the next crop. Many professional people and other city dwellers found in suitcase farming a nice opportunity of escaping from their normal routine each year as well as a way of putting their surplus capital to work in the hope of realizing handsome returns.

Economic factors dealt the first blow to the 1920s wheat boom. The Great Depression made wheat prices fall disastrously, down 62 percent in two years to an average of $.39 during 1931. Although yields remained fairly good at first, many Plains farmers were forced into heavy debt or had to become tenants. Paradoxically, the low wheat price actually encouraged wheat production, since farmers had to raise cash crops to have any hope of covering their operating costs, rent, interest on their newly acquired machinery, and mortgage payments on land bought at the inflated prices prevalent during more favorable years. Wheat acreage continued to rise, with the result that when the next drought came it was devastating.

Economic forces and unheeded warnings

In a very narrow sense, the drought that started in 1931 caused the Dust Bowl disaster. But the drought would not have had such destructive consequences had Plains farmers not converted large areas of grassland to crops, especially wheat, without regard for the suitability of the soil and climate for such farming. I have already discussed some of the factors that caused this indiscriminate expansion of wheat farming. High wheat prices encouraged some farmers to take risks in the hope of reaping tremendous rewards, while intervening low prices forced even the more cautious farmers to work the land still more intensively just to survive economically, a dilemma poignantly described by Carlson (1935). The unsuitably small holdings that inevitably would be abandoned and made available to speculators at distressed prices, together with the land grants that the railroads wanted to sell quickly, stimulated speculation in Plains land. Real estate dealers and promoters seized the opportunity to capture windfall profits from the agricultural boom and rising land prices that accompanied each return of favorable weather. Rapid advances in agricultural technology allowed farmers to produce wheat on a large scale, at low costs, and with unprecedented "efficiency," if the term is not taken to include what would eventually happen to the soil. Finally, an indefatigable optimism helped people interpret each return of good rainfall as a sign that the Plains climate had improved permanently.

One factor that can be ruled out as a cause of the Dust Bowl phenomenon is inadequate knowledge. Almost from the time settlers began arriving on the Plains, some people foresaw the problems that were inevitable unless agriculture was carried out in a way compatible with the region's very stringent climatic conditions. In a famous report entitled *Lands of the Arid Region of the United States* (1878), J.W. Powell, of the U.S. Geological Survey, warned that the 160-acre limit on farm size under the Homestead Act, which was originally established for the humid East, was completely inappropriate for the Plains. Powell's unheeded recommendation was for the limit to be increased to four sections (2,560 acres), so that an adequate income could be obtained from cattle grazing.

The chief hydrographer of the U.S. Geological Survey, F. Newell (1897), cautioned against interpreting a few years of above-average rainfall as indicating a permanent improvement in the Plains climate. He noted that the high fertility of the Plains soils made them very attractive as long as rainfall was favorable. But then the inevitable happens: "The following spring opens with the soil so dry that it is blown about over the windy plains. Another and perhaps another season of drought occurs, the settlers depart ... and this beautiful land, once so fruitful, is now dry and brown." But the rain eventually returns, and with it, Newell predicted with remarkable prescience, "recurs the flood of immigration, to be continued until the next long drought. This alternation of feast and famine ... bids fair to be repeated upon our Great Plains."

The causes and prevention of wind erosion were already understood before the World War I wheat boom. In 1912, E.E. Free had criticized the "dust mulch" theory of Campbell's dry farming system and instead had recommended a cloddy or granular surface. He had also suggested that new cultivation be done in stages, with strips of native vegetation left to protect newly seeded strips until they are established. However, this suggestion was not heeded by the farmers, who rushed to raise as much wheat as possible after the war.

Modern parallels

Because interest in the environment has increased so sharply in recent years, there is a tendency to forget that environmental problems have existed for a long time. It is interesting that contemporary observers who analyzed the dust storms in the 1930s in many ways anticipated current debates over today's environmental problems.

In its 1937 landmark report the Great Plains Committee clearly recognized that a complex set of causes lay be-

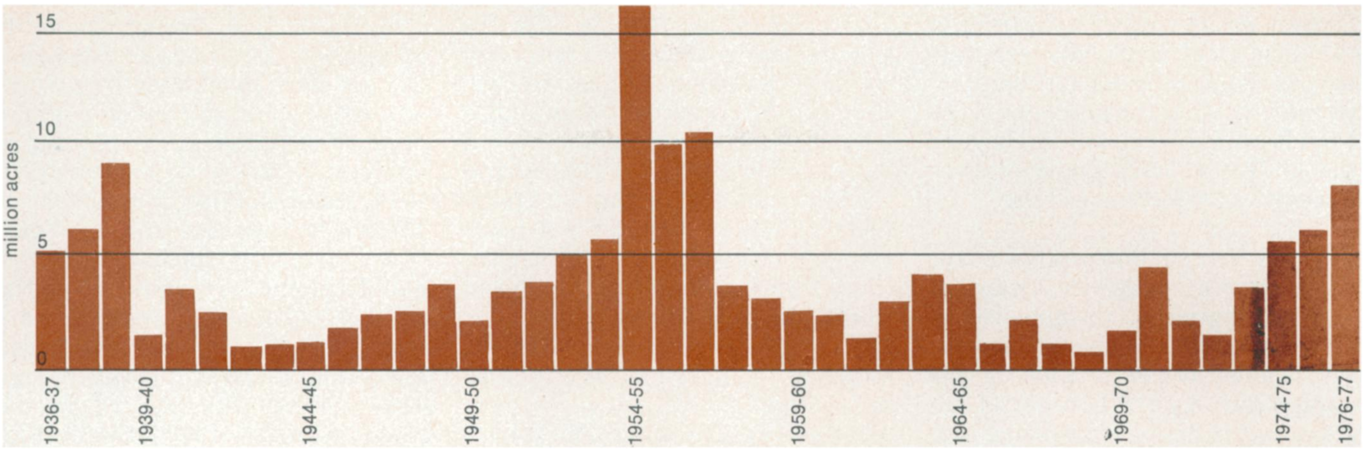


Figure 6. Although the dust storms of the 1950s were not as spectacular as those of the 1930s, more land was actually damaged annually by wind erosion in the Great Plains. Soil loss in the mid-1970s was on a scale comparable to that of the 1930s. (From *Soil Conservation* 1977.)

neath the Plains environmental problems and strove to understand how the climate, biota, and soils of the undisturbed Plains ecosystem interacted with the technological, economic, and social conditions that accompanied the settling of the Plains. The report could stand as a prototype of an environmental impact assessment, although this term would not come into common use for over three decades.

Together with several other deep-rooted attitudes that were identified as underlying causes of the dust storms, the Committee criticized the view that "an owner may do with his property as he likes." They commented that "all too frequently what appears to be of immediate good to the individual in the long run is not good for the people of the region," and noted that there is no "social accounting" adequate to deal with this problem. If we replace their clear language with the corresponding jargon of modern economics—"negative externalities"—we see that they identified what today is widely regarded as a key factor in many of our environmental problems.

H.H. Bennett (1939), the first head of the Soil Conservation Service, saw soil erosion problems as arising from "a false philosophy of plenty, a myth of inexhaustibility" in connection with apparently unlimited land and soil resources. The Great Plains Committee likewise challenged the belief that "resources are inexhaustible and can absorb an indefinite population, and that settlement and development will continue into the distant future." The parallels to modern discussions of how we permitted ourselves to get into our current energy situation are obvious.

Bennett and the Great Plains Committee represented what might be considered a middle ground in analyzing the causes of the Dust Bowl. They recognized that some serious mistakes had been made and that major changes were needed to rehabilitate Great Plains agriculture, but they also were confident that rehabilitation was possible. Others expressed more extreme views on both sides.

To some people, the dust storms were primarily a natural phenomenon, with man an innocent and helpless victim—a view that was often promoted by the narrowest kinds of local booster and special interest groups. Kansas historian J.C. Malin (1947) criticized the "erroneous idea" that the plow caused the dust storms, noting the reports of dust storms by early explorers. He attributed this "error" to "the excesses of political agitation, the sensationalism of various types of social agitators, and the lack of historical perspective of the 1930s." Some participants in the more recent debates over environmental problems have similarly used the strategy of either denying that there is a problem or pointing to the problems encountered in the natural ecosystem. This approach is sometimes coupled with attacks directed not at the problem but rather at those who say there is a problem.

Those who were at the other extreme also have their modern counterparts. One opinion held that any cultivation on a large scale was incompatible with the Plains environment and that the only solution was a massive reconversion to permanent vegetation (Thorntwaite 1936). Although the problem of wind erosion is still very much with us, and although after four decades there still is disagreement over just how much interference with the grass cover can be tolerated (Worster 1977), this view now seems too pessimistic. The most conservation-minded of today's Plains farmers have demonstrated that in much of the region crop production need not result in excessive erosion. The perceived need to abandon cultivation is somewhat analogous to the belief sometimes expressed today that the basic cause of our environmental problems is technology per se, not just misused or poorly planned technology.

The aftermath

Four decades of historical perspective have reinforced the middle-ground view, as represented by *The Future of the Great Plains,* for example. This position was that sustainable agriculture on the Plains required fundamental readjustments involving not just physical production practices but also the economic factors—land tenure, credit, and crop prices—that determined what production methods farmers would adopt. In the spirit of the New Deal, these changes were seen as requiring massive federal intervention, since the problems of the Dust Bowl were regional and beyond the ability of individuals or even states to solve for themselves.

This view was put into practice by the Soil Conservation Service, created in 1935 by a law passed unanimously by both houses of Congress shortly after Plains dust began settling in the Capitol during H.H. Bennett's Congressional testimony. Realizing that doing research on erosion control was not enough, the SCS actively encouraged and assisted farmers to adopt proved and available erosion-control methods. Through demonstration centers, conservation districts, and financial aid, Plains farmers were helped with shelterbelts, strip cropping, re-establishment of grass on damaged cropland, and new tillage methods (Rule 1939).

The new tillage methods made it possible for farmers to leave most of the residue of the previous crop on the surface as a "stubble mulch" while killing weeds and loosening the soil below to prepare the next seedbed. But while stubble mulching greatly reduced erosion, it was, unfortunately, not an adequate solution in many areas. Thus the Great Plains Committee recommended that some 15 million acres of Plains cropland be returned permanently to grass, a recommendation that obviously conflicted with the trend toward more cash grain production.

When favorable prices and good rainfall returned in the 1940s, once again some farmers ignored the lessons of previous droughts. As had happened twenty-five years earlier, the end of the drought came near the start of a world war, which increased demand and raised crop prices. By 1947, the price of wheat surpassed the 1919 record, and a new wheat boom was under way, accompanied in some circles by the usual bravado (*Fortune* 1948). In some areas nonresident owners who wanted to extend wheat production to unsuitable land organized to remove or weaken the successful land-use restrictions that resident farmers had imposed on themselves through Soil Conservation Districts (Finnell 1946; Johnson 1947).

Those who warned that the favorable weather was going to lead to a repetition of past disasters (e.g. Henson 1940 and Johnson 1947) were largely ignored, but their predictions proved correct. When drought returned in the 1950s, the dust storms were fairly severe, although they did not reach the scale of twenty years earlier because farmers were using improved tillage methods and at least in part had adopted other conservation measures. Still, from 1954 to 1956 some 10 to 16 million acres were damaged by erosion each year, a higher rate than in the 1930s (Fig. 6), and Great Plains cropland became a major source of air pollution (Hagen and Woodruff 1973). The USDA estimated that between 15 and 30 million acres under crops were unsuited for crop production and recommended that they be returned to grass (Muehlbeier 1958).

For almost two decades following the mid-fifties drought, erosion remained relatively low. Rainfall generally was fairly good. The government limited acreages of wheat and many other crops to help raise prices. New herbicides helped reduce erosion by permitting farmers to control weeds on summer fallow without cultivating the soil. The Great Plains Conservation Program that began in 1957 strengthened the efforts begun two decades earlier, although in 1972 it was estimated that about two-thirds of all land susceptible to wind erosion was still inadequately protected (Woodruff et al. 1972). With the introduction of center pivot systems, rotating sprinkler systems that irrigate 132-acre circles with almost no labor, irrigated hybrid sorghums on the Southern Plains and irrigated corn on the Northern Plains replaced much dry-land wheat and pasture. Unfortunately, irrigation sometimes introduced new erosion problems. Many shelterbelts have been removed to permit installation of center pivots (Sorenson and Marotz 1977), and the systems have permitted cropping of drought-susceptible sandy soils that erode readily if not enough crop residues are left.

Despite the steps taken toward erosion control, in 1976 and 1977 there were more dust storms, and erosion damage on the Plains reached levels comparable to the 1930s (see Fig. 6). Once again dust storms came when drought followed a rapid expansion of crop production during favorable conditions. This time the expansion had not been stimulated by a world war, although the slogan "all-out food production" (Hueg 1975), adopted in response to the "world food crisis" in 1974, was somewhat reminiscent of "Wheat will win the war" of World War I days. But the slogan was undoubtedly not as significant as the price of wheat, which rose to an average of $4.09 in 1974. With acreage restrictions removed, 23 percent more winter wheat was planted in the Plains in the fall of 1974 than in 1972. But coincidentally with the return of drought, prices fell as rapidly as they had risen, bringing the latest wheat boom to a sudden halt. "All-out food production" had a remarkably short life. In 1977, some wheat land was once more taken out of production as part of the price-support program. Once again, conservation could be profitable, at least for a while.

It is hard to say how severe the next dust storms will be. That there will be another drought we can predict quite confidently, since drought is a physical phenomenon entirely outside our control. But how much damage it will do is very much within our control and therefore much harder to predict.

References

Bennett, H. H. 1939. *Soil Conservation.* McGraw-Hill.

Brisbin, J. S. 1881. *The Beef Bonanza.* Reprinted 1959. Univ. of Okla. Press.

Carlson, A. D. 1935. Dust blowing. *Harper's* 171:149–58.

Chilcott, E. C. 1912. Some misconceptions concerning dry farming. In *Yearbook of the Dept. of Agriculture 1911,* pp. 247–56. USDA.

———. 1937. Preventing soil blowing on the southern Great Plains. USDA Farmers' Bull. 1771.

Choun, H. F. 1936. Dust storms in the southwestern plains area. *Monthly Weather Rev.* 64:195–99.

Finnell, H. F. 1946. Pity the poor land. *Soil Conservation* 12:27–33.

Fortune. 1935. Grasslands 2: The broken sod. April, pp. 65–66, 185–90.

Fortune. 1948. The land of the big rich. April, pp. 98–103, 183–88.

Free, E. 1912. The Movement of Soil Material by the Wind. USDA Bur. of Soils Bull. 68.

Great Plains Committee. 1937. *The Future of the Great Plains.* 75th Cong., 1st Sess., H. R. Doc. 144.

Hagen, L. J., and N. P. Woodruff. 1973. Air pollution from dust storms in the Great Plains. *Atmos. Env.* 7:323–32.

Hand, I. F. 1934. The character and magnitude of the dust cloud which passed over Washington, DC, May 11, 1934. *Monthly Weather Rev.* 62:157–58.

Hargreaves, M. W. M. 1948. Dry farming alias scientific farming. *Agr. Hist.* 22:39–56.

Henson, E. 1940. Borrowed time in the Dust Bowl. *Land Policy Rev.* 3:3–7.

Hewes, L. 1977. Early suitcase farming in the central Great Plains. *Agr. Hist.* 51:23–37.

Hueg, W. F., Jr. 1975. Agronomic research and production strategy for all-out food production. In *All-Out Food Production: Strategy and Resource Implications,* spec. publ. 23, Am. Soc. Agron.

Idso, S. B. 1976. Dust storms. *Sci. Am.* 235: 108–14.

Joel, A. H. 1937. Soil conservation reconnaissance survey of the southern Great Plains wind-erosion area. USDA Tech. Bull. 556.

Johnson, V. 1947. *Heaven's Tableland: The Dust Bowl Story.* Reprinted 1974. Da Capo Press.

Kifer, R. S., and H. L. Stewart. 1938. *Farming Hazards in the Drought Area.* Research Monograph 16, Works Progress Admin. Reprinted 1971. Da Capo Press.

Kimberlin, L. W., A. L. Hidlebaugh, and A. R. Grunewald. 1977. The potential wind erosion problem in the United States. *Trans. Am. Soc. Agr. Eng.* 29:873–79.

Lord, R. 1938. To hold this soil. USDA misc. publ. 321.

McArdle, R. E., and D. F. Costello. 1936. The virgin range. In *The Western Range,* pp. 72–80. U.S. Forest Serv. 74th Cong., 2nd Sess., Sen. Doc. 199.

McDonald, A. 1938. Erosion and its control in Oklahoma territory. USDA misc. publ. 301.

Malin, J. C. 1947. *The Grassland of North America: Prolegomena to Its History.* Lawrence, KS: privately printed.

Martin, R. J. 1936. Dust storms of February and March 1936 in the United States. *Monthly Weather Rev.* 64:87–88.

Mattice, W. A. 1935. Dust storms, November 1933 to May 1934. *Monthly Weather Rev.* 63:53–55.

Muehlbeier, J. 1958. Land-use problems in the Great Plains. In *Yearbook of Agriculture 1958,* pp. 161–66. USDA.

Newell, F. 1897. Irrigation on the Great Plains. In *Yearbook of the Dept. of Agriculture 1896,* pp. 167–96. USDA.

Powell, J. W. 1878. *Report on the Lands of the Arid Region of the United States.* 45th Cong., 2nd Sess., Exec. Doc. 73.

Rule, G. K. 1939. Crops against the wind on the southern Great Plains. USDA Farmers' Bull. 1833.

Sears, P. B. 1935. *Deserts on the March.* Univ. of Okla. Press.

Soil Conservation. 1977. Severe wind erosion hits Plains. 42:22.

Sorenson, C. J., and G. A. Marotz. 1977. Changes in shelterbelt mileage statistics over four decades in Kansas. *J. Soil and Water Cons.* 32:276–81.

Stein, W. J. 1973. *California and the Dust Bowl Migration.* Greenwood Press.

Stephens, P. H. 1937. Why the Dust Bowl? *J. Farm. Econ.* 19:750–57.

Stewart, G. 1936. History of range use. In *The Western Range,* pp. 119–33. U.S. Forest Serv. 74th Cong., 2nd Sess., Sen. Doc. 199.

Thorntwaite, C. W. 1936. The Great Plains. In *Migration and Economic Opportunity,* ed. C. Goodrich, pp. 202–50. Univ. of Penn. Press.

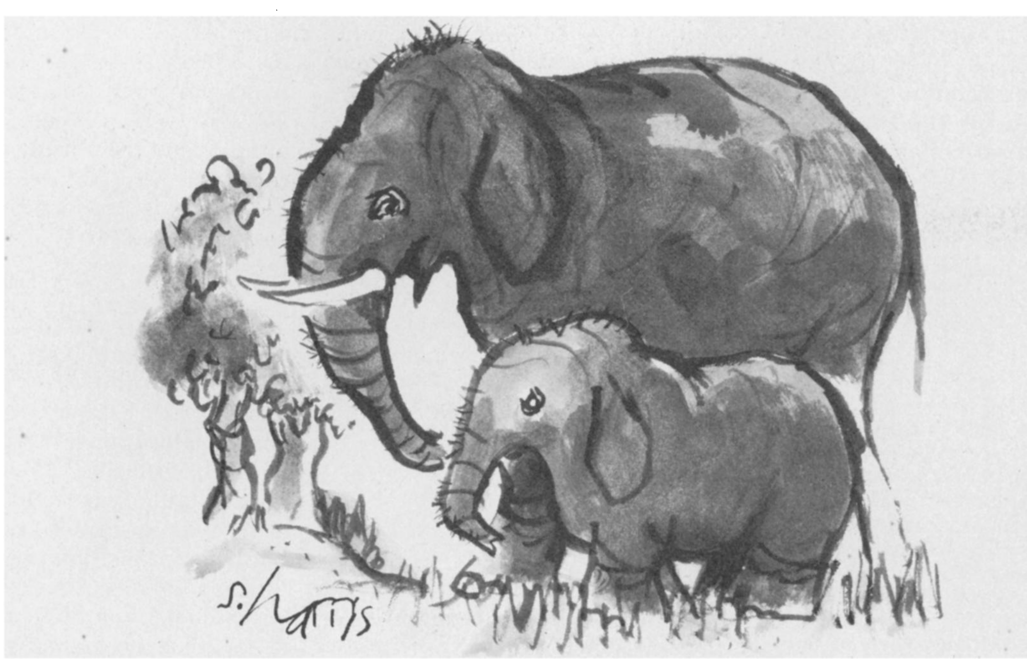
USDA. 1967. *Agricultural Statistics.*

USDA. 1977. *Agricultural Statistics.*

Webb, W. P. 1931. *The Great Plains.* Ginn.

Woodruff, N. P., L. Lyles, F. H. Siddoway, and D. W. Fryrear. 1972. How to control wind erosion. USDA Agr.Inf. Bull. 354.

Worster, D. 1977. Grass to dust: Ecology and the Great Plains in the 1930s. *Environ. Rev.* 4:2–12.



"When you're young, it comes naturally, but when you get a little older, you have to rely on mnemonics."