Small Farms, Externalities, and the Dust Bowl of the 1930s

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I. Introduction.

Wind erosion is a serious environmental and resource problem. Long term, it degrades soil productivity and contributes to existence of airborne particulates that harm health and air quality.[1] Cultivation practices are important contributors to erosion.[2] Since tillage exposes soil to wind, erosion control requires reduced cultivation as well as the use of vegetative strip crops and other wind breaks to slow surface wind velocity.[3] In contemporary research, farm size is shown to be an important determinant of adoption of soil conservation practices.[4] Larger farms are necessary to finance, effectively implement, and benefit from erosion control. By contrast small farmers are associated with more intensive cultivation, less frequent use of conservation practices, and greater soil erosion.[5] We extend these results in analyzing the effect of farm size on the origins of the Dust Bowl of the 1930s. We emphasize two points, an inappropriate assignment of property rights to land under the Homestead Act and the importance of externalities in addressing wind erosion. Our analysis provides a new and more complete explanation for the origins of the Dust Bowl of the 1930s.[6]

The Dust Bowl was one of the most severe environmental crises in North America in the 20th Century. Severe drought and damaging wind erosion hit in the Great Plains in 1930 and lasted through 1940. Sustained strong winds blew away an average of 480 tons per acre of topsoil. Although there were similarly severe droughts in the Great Plains earlier in the 19th century and later in the 1950s and 1970s, there were no comparable levels of wind erosion.[7] Excessive cultivation in the 1930s is the standard explanation for the Dust Bowl. The issue to be explained is why cultivation was more extensive and use of erosion control techniques more limited in the 1930s than later in the twentieth century.

We argue that the problem arose due to the proliferation of very small farms through the

Homestead Act. Small farmers cultivated more of their land than did larger farmers, and were less likely to use costly wind erosion control techniques and equipment.[8] Under the Homestead Acts, hundreds of thousands of 160 to 320-acre farms were established in the Great Plains between 1880 and 1920. By 1930, nearly 2/3s of the farms on the Great Plains were less than 500 acres. Although such farm sizes were viable in areas of higher and less variable rainfall, in the semi-arid Great Plains, by the 1930s agricultural extension agents were recommending farms of 700 to 1,200 acres.[9] Small farms were viable in the short term so long as rainfall was high, but when drought occurred, these farms particularly were at risk. This was the situation they faced in the 1930s.[10]

Farmers with larger holdings invested in erosion control because they internalized more of the down-wind benefits, whereas on smaller holdings, these benefits largely accrued to neighboring farmers. Small farmers also could free ride on the conservation efforts of others. The failure of some farmers to adopt wind erosion control reduced overall incentives to make such investments. Drifting soil from one farm smothered the lands and crops of adjacent farms, lowering productivity and reducing the returns from previous erosion control investments. In the face of these effects, individual efforts to combat erosion were effective only if used by all or most farmers in a region. But having many small farms in the Great Plains created coordination problems for the joint adoption of erosion control and raised the costs of private collective action to deal with the Dust Bowl.

In response beginning in 1937, the federal government promoted state soil conservation statutes and districts to subsidize and occasionally, force adoption of erosion controls. By the 1950s, Soil Conservation Districts were in place throughout the Great Plains. They generally encompassed entire counties and were better able to internalize the externalities associated with soil erosion control and to coordinate anti-erosion efforts among the farmers in their districts. Further, by the 1950s, gradual consolidation increased farm size. As a result, by the 1950s use of wind erosion control techniques was much more prevalent in the Great Plains than in the 1930s.

The Dust Bowl, then, was not a natural disaster, but rather at least in part, a human-induced one. Besides severe climatic conditions, it was the outcome of an inappropriate (*ex post*) property rights arrangement that had serious environmental consequences.

II. The Dust Bowl

We use the term, Dust Bowl, to describe wind erosion throughout the Great Plains, rather than focusing on a particular area of intense erosion. Although most dust storms were local or regional, some could be huge, 600 by 400 miles, lasting 10 hours or more. By 1938, the Soil Conservation Service reported that 80 percent of the land in the southern plains had been subject to wind erosion, with 40 percent to a serious degree. 10,000,000 acres had lost the upper five inches of topsoil, and 13,500,000 acres had lost 2 1/2 inches, with an average loss of 480 tons of topsoil per acre. Light, fertile topsoil tended to be carried hundreds of miles away. Other costs of wind erosion included destruction of nearby crops and farmland from the localized deposit of heavier eroded material (sand) that did not go to the upper atmosphere, damage to livestock, household goods, merchandise, and health problems associated with inhalation of dust particles. The 'sand pollution' damaged neighboring crops and drifted over adjacent fields. Chambers of Commerce of towns located in the region listed added costs from dust and blowing sand ranging from $50,000 from each storm (Liberal, Kansas) to $288,228 (Tucumcari, New Mexico).[11]

Figure 1 illustrates the range of wind erosion across the Great Plains in 1934, based on soil erosion surveys conducted by the Soil Conservation Service. As indicated, there was considerable variation, and we make use of this in our analysis of the effect of farm size on the Dust Bowl.

Figure 1

III. Control of Wind Erosion and Farm Size Externalities

The control of wind erosion involved covering the exposed soil, slowing the surface speed of the wind, and increasing the cloddishness of soil to make the particles more difficult to move. Pasture grasses, cover crops, and stubble mulching to retain wheat stalks after harvest provided soil protection. Obstructions, such trees or strip crops with alternating bands of wheat and fallow (with stubble) or tall, drought-resistant crops like sorghum, placed perpendicular to the wind, reduced surface wind velocity and carrying capacity. Repeated obstructions were required to prevent surface wind speeds from regenerating. Plowing to bury fine particles and to bring up larger and denser earthen clods also reduced erosion.

Investing in erosion control resulted in saved topsoil and reduced sand pollution, and the larger the farm, the more the farmer internalized those benefits. In the 1930s, however, there were few very large farms in the Great Plains that could capture most of the returns.[12] In contrast, farmers participating in erosion control practices incurred all the costs, which were primarily the opportunity costs of lost production as farmland was left in fallowed bands as strip cropping, as well as some specialized equipment costs.[13] Under these circumstances, there were reduced incentives to invest in erosion control. Moreover given small farms, effective efforts to combat erosion required cooperation among farmers in a region. If a farmer adopted erosion control practices, but adjacent farms were completely cultivated, then the investment would have little payoff: "If a whole community practices listing, all the fields will generally be well protected. Where only one field in a neighborhood is listed, however, the lister's furrows may become completely filled with soil from the neighboring fields."[14]

IV. Farm Size and Ownership Patterns in the Great Plains.

U.S. land policy had a bias toward small farms. Under the 1862 law, any family head could claim up to 160 acres, and upon 5-years continuous residence and improvement, receive title. Small farm allocations worked well in northern and eastern agriculture, where there were no important economies of scale in grain production, and sufficient rainfall. As migrants moved across the frontier, they transplanted farming practices, crops, and farm sizes used in their places of origin. As early as 1878, however, John Wesley Powell warned that the Homestead Act should be modified in the more arid West to allow for a minimum of 2,560-acre homesteads for "pastoral regions." There was no body of scientific knowledge that supported Powell's claim, and his recommendations would have dramatically reduced the number of claimants who could have established farms in the Great Plains. There was political opposition, and no action was taken.[15]

Table 1

Table 1 documents the pattern of settlement with data on mean farm size and the percent of farms below 500 acres, from 1880 through 1987 for the Great Plains from the U.S. Census. Homesteading led to an influx of new 160 to 320-acre farms through 1920, with farms under 500 acres accounting for over 70 percent of all farms by that year. The number of farms grew by more than four fold between 1880 and 1920.

V. A Model of Erosion Control Investment, Farm Size, Externalities, and Coordination Problems.

Consider the parameters facing farmers in deciding whether or not to invest in erosion control. Fallow is our investment measure. It is the only variable continuously reported in the census for soil conservation. It represents fallowed land in bands, as part of strip cropping, which was the primary means of slowing surface wind velocity in the 1930s, as recommended by the Soil Conservation Service.[16]

Farmer i earns profit: $\max \prod_i (f_i) = (a_i - f_i)\bar{p}\theta\left(\frac{\sum_{j=1}^{n} f_j}{A}\right)$, where: $j = \{1,2,...,n\}$ are the farms in a region; a_i = farm acres for farmer i ; $A = \left(\sum_{j=1}^{n} a_j\right)$ is the total regional farmland; f_i = acres placed in fallowed strips by farmer i ; $F = \left(\sum_{j=1}^{n} f_j\right)$ is the total regional strip-fallow acres; $\theta\left(\frac{F}{A}\right)$ is per acre productivity, which is a non-decreasing function of total strip fallow in the region); and $\bar{p}$ is profit per acre of production.

Farmer i maximizes profits by choosing how many acres to strip fallow, given other farmers' strip fallow choices in the region. Greater total strip fallow increases productivity on all cultivated lands because of reduced sand pollution. Given this framework, we can find, F^*, the socially-optimal level of total regional strip fallow acres. F^* is achieved privately when externalities are completely internalized, when there is only one farm in the region. This optimal level of strip fallow can be found by maximizing: $\prod(F) = (A - F)\bar{p}\theta\left(\frac{F}{A}\right)$, giving the marginal profit function: $\prod'(F) = -\bar{p}\theta\left(\frac{F}{A}\right) + \left(\frac{A-F}{A}\right)\bar{p}\theta'\left(\frac{F}{A}\right)$. F^* occurs when the marginal profit function is equal to zero.[17] The first term is the opportunity cost of strip fallowing, the per acre marginal cost of forgone production and profit. The second term shows the productive benefits from strip fallowing on the share of farmland cultivated.

When there is more than one farm in the region, we assume that each chooses a level of strip fallow by taking others' fallow decisions as given. This is similar to Cournot

competition in strip fallow choice. The marginal profit function for a farmer i is:
$\Pi^{i}_{f_i}(f_i) = -\bar{p}\theta\left(\frac{F}{A}\right) + \left(\frac{a_i - f_i}{A}\right)\bar{p}\theta'\left(\frac{F}{A}\right)$. Under this framework, the level of strip fallow chosen by a farmer is an increasing function of the farm's share of cultivated acres of total regional farmland. Larger farms will have more strip fallow than will smaller farms because they have more land in cultivation that can benefit from the per acre productivity gains associated with lower overall sand pollution. Even so, when there is more than one farm in the region and no collusion, the level of total strip fallow will be less than F^*.

To see this, consider $\Pi^{i}_{f_i}$ when all farmers in the region consider setting $f_j = s^* a_j$ where $s^* = \frac{f_j}{a_j} = \frac{F^*}{A}$ (individual farm strip-fallow shares equal the aggregate socially optimal strip-fallow share): $\Pi^{i}_{f_i} = -\bar{p}\theta\left(\frac{F^*}{A}\right) + \frac{a_i}{A}\left(\frac{A - F^*}{A}\right)\bar{p}\theta'\left(\frac{F^*}{A}\right)$.
So long as $a_i < A$, the marginal profit function is negative at F^*, and farmers will not adopt the optimal strip-fallow share. Moreover, marginal profits are more negative the smaller the farm, suggesting that smaller farms have even greater incentives to deviate from optimal strip-fallow shares. In the presence of many small farms in a region facing wind erosion, public policy to achieve F^* will require compensation to farmers to balance the marginal benefits and costs of that level of strip fallowing.

This framework suggests the following implications for our empirical analysis:

a. Small farms would be less likely to adopt fallow as strip cropping and related conservation practices or to purchase specialized equipment to control wind erosion.

b. Regions with more land in crops and cultivation, more small farms, and greater variation in farm size would have more intense wind erosion, all else equal.[18]

c. In the presence of many small farms and positive coordination costs, formal institutions to promote rapid collective action would be necessary.

d. Subsidies to small farms would encourage higher levels of strip fallowing and other forms of erosion control.

The model has assumed that all exogenous factors affecting per acre productivity, $\theta(\cdot)$, such as wind velocity, drought, and percent sand in soils, were the same across all regions of the Great Plains. We can allow for $\theta(\cdot)$ to differ across regions where $\theta_b(\cdot)$ and $\theta_g(\cdot)$ represent the per acre productivity in environmentally "bad" and "good" regions, respectively. If exogenous environmental factors affect per acre productivity, $\theta(\cdot)$, such that $\theta_b\left(\frac{F}{A}\right) < \theta_g\left(\frac{F}{A}\right)$ and $\theta_b'\left(\frac{F}{A}\right) > \theta_g'\left(\frac{F}{A}\right)$, the socially optimal level of strip fallow, F^*, would be higher in regions where negative environmental factors were more prevalent. These conditions imply that in such regions per acre productivity levels would be lower for any level of strip-fallow share choice and the gains from additional strip fallowing would be higher. Accordingly, those regions will have to place more acres to strip fallow in order to achieve the same level of θ^*, and hence:

e. Formal institutions to promote collective action would be implemented first in regions where drought, wind speed, percent of sand in soils and presence of small farms were most damaging.

f. Further, larger farmers in those regions would be the major advocates of collective action and until subsidies were made clear, smaller farmers would be the "non cooperators."

We use these implications in examining the empirical evidence in the following sections.

VI. Small Farms, Wind Erosion Control, and the Dust Bowl.

In terms of the prediction that small farmers invested less in erosion control, Soil Conservation Service officials and other investigators cited small farms on the Great Plains as a principal source of the region's problems. They lamented the failure to adopt Powell's recommended 2,560-acre plots.[19] Soil Conservation Service Director H.H. Bennett stated that federal homestead policy to keep land allotments small and to require that a portion be plowed "is now seen to have caused immeasurable harm."[20] Roland Renne of the Montana Experiment

Station (1935, 426-9) noted: "Dealing with thousands of different owners slows up the adoption of a planned land use program…"

Other evidence also shows that small farmers cultivated more of their lands, which made it vulnerable to wind erosion, and placed less into strip fallow. Farm-level data from a 1936 Resettlement Administration survey of 263 farms in nine townships in southwestern North Dakota show that the cultivated share of total farm land was inversely related to farm size:[21]

Farm Size (Acres)	2,051 and over	1,041 to 2,050	881 to 1,040	721 to 880	561 to 720	401 to 560	241 to 400	240 and Less
Ratio of Cultivated Acres to Farm Size	.29	.35	.50	.52	.54	.52	.53	1.00

Similar results are revealed in a 1937 survey of 170 farms in three western South Dakota counties:[22]

Farm Size (Acres)	5,281 and over	2,881 to 5,280	1,881 to 2,880	1,041 to 1,880	881 to 1040	721 to 880	561 to 720	401 to 560	241 to 400	240 and Less
Ratio of Cultivated Acres to Farm Size	.01	.07	.11	.25	.18	.26	.35	.32	.46	.43

In our quantitative evidence, we examine the relationship between farm size, cultivation, and use of strip fallow using census data. Table 2 reports separate regression results for fallow acres per farm, farm size, variation in farm size, and pasture for the census years 1930, 1945, and 1954 for 46 counties in western Kansas, a region in the heart of Great Plains wind erosion.[23]

The relationship that we estimate is

$$f_i = a + b_1 s_i + b_2 s_i^2 + b_3 d_i + b_4 p_i + e_i,$$

where f_i is average strip-fallow acres (fallow acreage divided by number of farms) in each county in each census year, s_t is average farm size (land in farms divided by number of farms), s_i^2 is farm size squared, d_i is the estimated standard deviation in farm size in each county, and p_i is pasture share (pasture acres as a share of total land in farms).[24]

Strip-fallow acres per farm are expected to rise with farm size at an increasing rate as externalities are mitigated. Greater deviation in farm size, however, should lower use of strip-fallow techniques since the existence of many small and larger farms in a county and associated increased externalities would weaken incentives to invest in wind erosion control. Pasture is an alternative to fallow on larger farms, since farmers with larger holdings could diversify more into livestock as size increases rather than into crops and strip fallow, and hence the variable should have a negative effect on strip fallow.

Table 2

As indicated in the table, in 1930 the farm size variable is positive and pasture is negative, as expected, but the estimated coefficient on neither variable is significant. When there were many small farms and associated externalities from failure to invest in wind erosion control, as was the case in the early 1930s, then the relationship between farm size and strip fallow was relatively weak. As noted earlier, the overall percent of fallow of total farmland in western Kansas and indeed the Great Plains in 1930 was very low, about 3 percent. By 1954, conditions had changed so that investment in strip fallow was more strongly linked to farm size. The coefficients on the size variables are more significant than in 1930. Further, the coefficient for the farm size-squared variable is positive and now significant. The impact of the pasture variable remains negative. In all the census years where pasture was a large share of farm acreage, strip fallow was used less often. In the 1945 and 1954 regressions, the standard deviation of farm size in a county exerts a negative and statistically significant effect on strip fallow. Where there was considerable range in farm sizes and associated effects of externalities from the failure of some farms to invest in erosion control, the use of strip fallow was reduced.[25]

We further examine the relationship between farm size, variation in farm size, and investment in wind erosion control for the period of 1930-1964. Using census data with consistent definitions over time, we estimate a panel regression model with time dummy variables to control for factors that vary over time, but do not differ across counties. These include wheat and cattle prices, federal farm programs, and other institutional and technological factors:

$$f_{it} = a_t + b_1 s_{it} + b_2 s_{it}^2 + b_3 d_{it} + b_4 p_{it} + e_{it},$$

The variables are defined as before, but we add time dummies with 1930 as the baseline. The results are reported in Table 3.[26]

Table 3

As indicated in the table, the coefficients on farm size and size-squared variables are positive and statistically significant.[27] The results indicate the strong impact of farm size on use of strip fallow. Further, the negative and significant coefficient on the farm size deviation variable points to the importance of the existence of smaller farms in a county for inhibiting investment by all farms in strip fallow. Additionally, when pasture was a large share of farm acreage, strip fallow was used less often. Large, positive coefficients on the time dummy variables indicate the growing use of strip fallow over the period.

Using the coefficients presented in Table 3 we demonstrate the potential increase in strip fallow, as farm size becomes larger. The average farm size during 1930-1964 in western Kansas counties was 827 acres and average fallow 236 acres. If farm size had been 1,000 acres, the expected strip fallow acres would have been 349 acres, an increase of more than 110 acres, and if average farm size were increased by one standard deviation to 1,199 acres, the expected mean strip-fallow acres would be over 500 acres, or almost half of total farm acres in strip fallow.

VII. The "Dust Bowl" and Cross-Sectional Analysis of the Intensity of Wind Erosion.

As indicated in Figure 1, the intensity of wind erosion varied across the counties of the Great Plains. The literature on erosion and our analytical framework suggest that this variation would be a function of differences in drought conditions, wind velocity, sand content of the soil, extent of cultivation, farm size, and the variation in farm sizes across the counties. In this section, we empirically examine these factors. In 1934, the Soil Conservation Service conducted reconnaissance erosion surveys throughout the United States. State and national maps were prepared in 1934 and 1935 detailing locations of wind and water erosion of different intensities, ranging from no erosion, slight, moderate, severe, and very severe erosion.[28] We use these maps to assign erosion index values to each county in the Great Plains.[29] Our definition of the Great Plains is based on the map of the region in Kifer and Stewart's (1937, 9) Works Progress Administration Report. Their designation of the Great Plains includes the 363 eastern counties of Montana, Colorado, and New Mexico, all of North Dakota, those west of the 97th meridian in South Dakota, most of those west of the 98th meridian in Nebraska, Kansas, and Oklahoma, and west Texas counties in the Panhandle to 32 degrees latitude.[30]

To analyze differences in erosion across the 363 Great Plains counties in 1934 we analyze the following relationship:

$$WE_i = f(s_i, v_i, r_i, t_i, c_i, w_i),$$

where WE_i is the wind erosion index measure for county i, ranging from 0 to 3 for no, light, moderate, and severe erosion; s_i is average farm size in the county; v_i is the standard deviation of farm size (to capture the effect of externalities from small farms); r_i is rainfall deviation during 1930-35 from normal, t_i is percent sand in county soil (sandy soils are highly erodible); c_i is percent of county farmland in cultivation; and w_i is average annual hourly wind velocity by county.[31] Controlling for these variables as well as state fixed effects, such an analysis allows for an examination of the impact of farm size and cultivation on wind erosion.[32]

Table 4

Table 4 summarizes the results of the statistical analysis.[33] The first column reports the results of a pooled OLS regression, the second column lists the coefficient estimates of the OLS model with state fixed effects, and column three reports ordered Probit results. The analyses indicate that the counties with larger average farm size were less likely to face severe wind erosion. Increases in the variation in farm sizes found in a county and higher cultivation shares increased the likelihood of more serious wind erosion. The coefficient estimates for all these variables are statistically significant, and their important impact on the severity of wind erosion supports our main hypothesis that small homestead farms directly contributed to the environmental damage associated with wind erosion on the Great Plains.

The coefficient estimates for the other variables that control for the differences in rainfall, soil quality, and wind velocity significantly affected the wind erosion magnitude in a county, as well. Higher annual wind speeds, greater sand content, lower-than-normal rainfall during 1930-35 increased the likelihood of wind erosion. Moreover, as indicated in the second column, state fixed effects that control for institutional and other state-specific factors significant affected the severity of wind erosion in a county and improve the overall performance of the model.

Table 5

Column three, which shows the results of the ordered Probit estimation, is included to account for the ordinal nature of the dependent variable. The exercise indicates that threshold parameters are correctly ordered and precisely estimated (μ_1 is assumed to be zero, and $0 = \mu_1 < \mu_2 < \mu_3$). Table 5 shows the cell frequencies as well as the predicted probabilities for different levels of erosion based on coefficient estimates of the ordered Probit model at various farm size values. In column two the predicted erosion probabilities are calculated at the mean values all of the variables (the mean value of the average farm size is 763 acres). The predicted probabilities of the model are very similar to the observed cell frequencies, indicating the model's ability to predict correctly. The last two columns are calculated at the mean values for the variables except that in column three farm size is 1,000 acres and in column four farm size is one standard deviation above the mean, or 1,568 acres. If farm size in the sample were 1,000 acres, the predicted probabilities of "no" or "light" wind erosion (i.e. Prob (WE = 0) and Prob (WE = 1)) increases and the probabilities of "moderate" and "severe" decreases. Similarly, if farm size were 1,568 acres, the predicted probability of "no" wind erosion increases from 0.1 to 0.23 and the predicted probability of "severe" wind erosion declines from 0.2 to 0.08. These calculations indicate the important effect of farm size on the magnitude of the wind erosion damage in a county.

VIII. The Policy Response to Fight Erosion: The Formation of Soil Conservation Districts.

As drought and wind erosion continued through the 1930s, the need for promoting immediate collective action became clearer. In a report to H.H. Bennett, J.T. Reece, Soil Conservation Supervisor in Littlefield, Texas, argued that "The premier problem in establishing a constructive erosion control program in this camp is securing adequate cooperation from the farmers and land owners, for without this, no conservation program is possible." He noted that most interested were large landowners.[34]

Beginning in 1934, the Soil Erosion Service in the Interior Department, later the Soil Conservation Service in the Department of Agriculture (1935), developed 79 demonstration areas to show farmers the benefits of using erosion control practices.[35] Nevertheless, there was resistance among at least some farmers to adoption of these techniques. Plans required that a third or more of a farm be placed in fallow as part of strip cropping, and therefore taken out of production.[36] Administrators and field personnel of the Soil Conservation Service commented on a lack of voluntary farmer participation in the erosion control programs outlined in the demonstration projects. Because of non-cooperators, the costs involved, and the urgency of the erosion problem, more formal, government intervention was necessary.[37]

Evidence suggests that the smallest farmers were the initial resisters to coordinated efforts to address wind erosion. We have obtained records from two erosion control projects in Texas in 1937 and 1939 where cooperators and non-cooperators are identified according to farm size. One site is Dalhart in the Texas Panhandle and the other is Dublin in somewhat less dry central Texas. Although the data set is small, in both cases cooperating farms were larger than non-cooperating farms:

	Size of Cooperating Farms	**Size of Non-Cooperating Farms**
Dalhart, Dallam County	629 acres	418 acres
Dublin, Erath County[38]	145 acres	118 acres

The government response was the organization of Soil Conservation Districts to coordinate erosion control efforts and to subsidize investments. Since the federal government did not have authority to regulate private land use via local government units, state legislation was required. 18 states enacted some variant of the law by June 1937 and all had by 1947. Once state legislation was enacted, farmers in a region could form a Soil Conservation District upon petition and favorable vote. In the Great Plains states of Colorado, Kansas, Montana, Nebraska, Oklahoma, and North and South Dakota there were 39 districts by 1938 covering 18,248,000 acres and 568 covering 318,316,000 acres by 1950.[39]

Within the districts, individual farmers entered into contracts with the SCS to cooperate in reducing soil erosion for five years. The SCS would provide equipment, seeds, fencing, and personnel for erosion control. Erosion control ordinances imposing land use regulations on all farmers could be adopted upon a favorable vote of a majority of the farmers in a district. Under the statute, the district supervisors could occupy parts of farms and begin erosion control with the costs plus 5 percent levied by court order against the farmer.[40] Further, farmers who did not comply were ineligible for SCS assistance. Moreover, beginning in 1938, the Agricultural Adjustment Administration (AAA) required that "every cooperator handle his land by using practices which are effective in preventing wind erosion." Subsidies were provided. 30 percent of AAA payments to a farm were to be earned by carrying out soil conservation practices. AAA payments to the farmer, however, were to be reduced by $1.00 per acre for each acre of land where approved practices were not implemented. Further, if it were deemed that the farmer's land had become "a wind erosion hazard to surrounding farmers in the community," they would not receive any funds under the 1939 Agricultural Conservation Program (ACP). These funds were significant to a farm family, amounting to $162 per applicant in 1939.[41] Soil Conservation Districts could acquire lands "for purposes of conservation" and receive 1939 Agricultural Conservation Program funds and loans from the Farm Security Administration (FSA). Finally, the FSA was authorized to make loans for erosion control investments to be repaid with ACP allocations. Other FSA loans were to assist farmers "obtain a proper-size operating unit."[42]

We hypothesized that larger farmers would be the major proponents of Soil Conservation Districts. They would internalize more of the gains of erosion control. We have evidence on this issue from the formation of three Soil Conservation Districts in Montana between 1941 and 1953: The Little Beaver SCD (formed January 27, 1942), the Cascade County SCD (approved June 17, 1946), and the Powder River County SCD (organized December 17, 1953). The petitioners for organization of these three districts are listed by farm size, and it is possible to compare the average farm size of the petitioners with the average farm size in the county:

Soil Conservation District	Average Size of Petitioners (Acres)	Average Farm Size in County (Acres)
Fallon County SCD	2,889	1,511 (1940)
Cascade County SCD	1,452	1,241 (1945)
Powder River SCD	3,533	3,381 (1950)

As indicated, the petitioning farmers had larger farms on average than mean farm size in the county.[43]

The districts typically encompassed counties and often were enlarged, reflecting the need for land areas larger than individual farms for effective soil erosion control. For example, districts in Kansas in 1941 ranged from about 250,000 acres to nearly 600,000--all larger than any farm.[44] The organization of Soil Conservation Districts clearly focused on externalities. The land-use ordinances applied only where neglect on one farm caused damage or hindered conservation treatment “on adjacent lands.”

The analytical framework suggests that the states with the greatest wind erosion problems would be the first to adopt legislation to promote cooperation among farmers. Indeed, Kansas, Oklahoma, and Texas, at the center of the Dust Bowl, enacted wind erosion legislation earlier than other Great Plains states, in 1935.[45] The Texas law created Wind Erosion Conservation Districts within each county with the power to enter private property to combat erosion and to charge the owner.[46] Under the Kansas law, the board of county commissioners of any Kansas county was authorized to order erosion control, and if the owner did not respond, to implement the controls and to levy a tax on the owner to recoup costs.[47] The first districts organized in Kansas in 1937 generally were in the western and southwestern parts of the state where the dust erosion was most severe.[48]In Oklahoma, the state law allowed county commissioners to enter upon land owned by persons who failed to cooperate in controlling wind erosion.[49] Finally, in

Colorado, with southeastern counties, such as Baca, in the Dust Bowl, 1937 legislation authorized Soil Conservation Districts to levy assessments against the lands in the district to fund erosion control. Districts also had the power to block new cultivation plans with “sod land ordinances.”[50]

IX. Conclusion.

In this paper, we re-examine a well-known environmental disaster, the Dust Bowl of the 1930s, and emphasize the important role that small farms and externalities played in contributing to severe wind erosion and in inhibiting corrective action. The results reported here are consistent with more contemporary analyses of the sources of wind erosion that emphasize the importance of farm size and land use practices as compared to natural geologic and climatic conditions. Small farmers cultivated more of their land and were less likely to invest in wind erosion control. Their failure to adopt wind erosion control, however, meant that sand pollution spread to their neighbors, reducing productivity and incentives to invest in strip fallow and other methods to fight erosion. With the hundreds of thousands of small farms that existed in the Great Plains in the 1930s, coordinating for collective action to combat erosion was difficult. The coordination problem to address externalities was not solved until the organization of Soil Conservation Districts after 1937.

If farms on the Great Plains had been much larger, erosion control could have taken place within the boundaries of single units, reducing external effects, coordination problems, and the need for Soil Conservation Districts.[51] The initial reaction of the Roosevelt Administration to wind erosion in the Great Plains was to acquire small farms through the Resettlement Administration to facilitate consolidation or to allow the land to be returned to grass land. But plans for large-scale government land purchase and removal of the rural population generated opposition from Great Plains politicians and federal agency officials. These plans were replaced with the system of subsidies to maintain the rural population and effectively slow the consolidation of homestead farms, thereby potentially exacerbating the problem of erosion control.[52] The land in crops actually *grew* in the Dust Bowl counties of the Great Plains between 1930 and 1935.

These effects increased the role of Soil Conservation Districts in addressing wind erosion on the Great Plains. Their actions, along with the gradual consolidation of farms, however, led to changes in cultivation practices to better protect the soil so that by the 1950s' and 1970s' droughts, the region was much less vulnerable to wind.

The Dust Bowl represents both the effects of an inappropriate assignment of property rights and the costs that can occur during the transition period to a new more efficient distribution of rights. Property rights adjustments often are not instantaneous, even in the absence of legal restrictions on property exchange. In the case at hand, the transition period may have been increased for political reasons, extending the environmental damage inflicted on the Great Plains.[53]

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Table 1
Average Farm Size in the Great Plains
1880-1987

Year	Mean Farm Size	Percent of Farms< 500 acres	Number of Farms	Year	Mean Farm Size	Percent of Farms< 500 acres	Number of Farms
1880	186	99	44,278	1950	1,055	53	160,824
1890	226	96	102,353	1954	1,145	50	151,654
1900	431	84	107,483	1959	1,303	45	134,073
1910	398	82	201,227	1964	1,477	42	120,859
1920	557	71	223,782	1969	1,500	42	116,844
1925	541	70	217,589	1974	1,596	41	109,299
1930	636	64	220,002	1978	1,630	40	105,814
1935	642	65	227,810	1982	1,665	41	101,262
1940	779	60	191,097	1987	1,648	43	103,705
1945	972	53	170,901				

Source: U.S. Agricultural Census. Great Plains states include eastern Montana and Colorado counties, western counties of the Dakotas, Nebraska and Kansas.

Table 2
Regression Analysis of the Relationship between Average Farm Size and Fallow Acres in Western Kansas Counties, 1930, 1945, 1954

Dependent Variable: Per Farm Fallow Acres						
Variables:	**Coefficient Estimates and std. errors in 1930**		**Coefficient Estimates and std. errors in 1945**		**Coefficient Estimates and std. errors in 1954**	
Constant	-52.66	49.55	97.47	68.58	258.38	103.91**
Average Farm Size	0.199	0.13	0.279	0.16***	0.546	0.22**
Average Farm Size Squared	-0.95 E-4	0.13 E-3	0.25 E-3	0.68 E-4*	0.30 E-3	0.11 E-3**
Standard Deviation of Farm Size	0.13	0.19	-0.83	0.24*	-0.91	0.45**
Share of Pastured Acres	-0.70	0.45	-1.12	0.61***	-7.64	1.34*
Adjusted R-squared	0.35		0.79		0.88	

46 observations per year; * Significant at 1 percent level; ** Significant at 5 percent level; ***Significant at 10 percent level

Table 3
Panel Regression Analysis of the Relationship Between Average Farm Size and Fallow Acres in Western Kansas Counties (1930-1964)

Dependent Variable: Per Farm Fallow Acres		
Variables:	**Coefficient Estimates**	**Std. Errors**
Constant	15.88	28.71
Average Farm Size	0.51	0.07*
Average Farm Size Squared	0.14 E-03	0.3 E-04*
Standard Deviation of Average Farm Size	-0.75	0.13*
Share of Pastured Acres	-3.02	0.33*
Time Dummies		
T1930	Left-out	
T1935	173.01	18.87*
T1940	191.99	19.08*
T1945	15.28	19.12
T1950	35.05	19.30***
T1954	198.58	19.50*
T1959	16.63	19.89
T1964	67.0	20.34 **
Adjusted R-squared	0.80	

368 observations;* Significant at 1 percent level; ** Significant at 5 percent level; ***Significant at 10 percent level

Table 4
Wind Erosion Analysis across Counties of the Great Plains

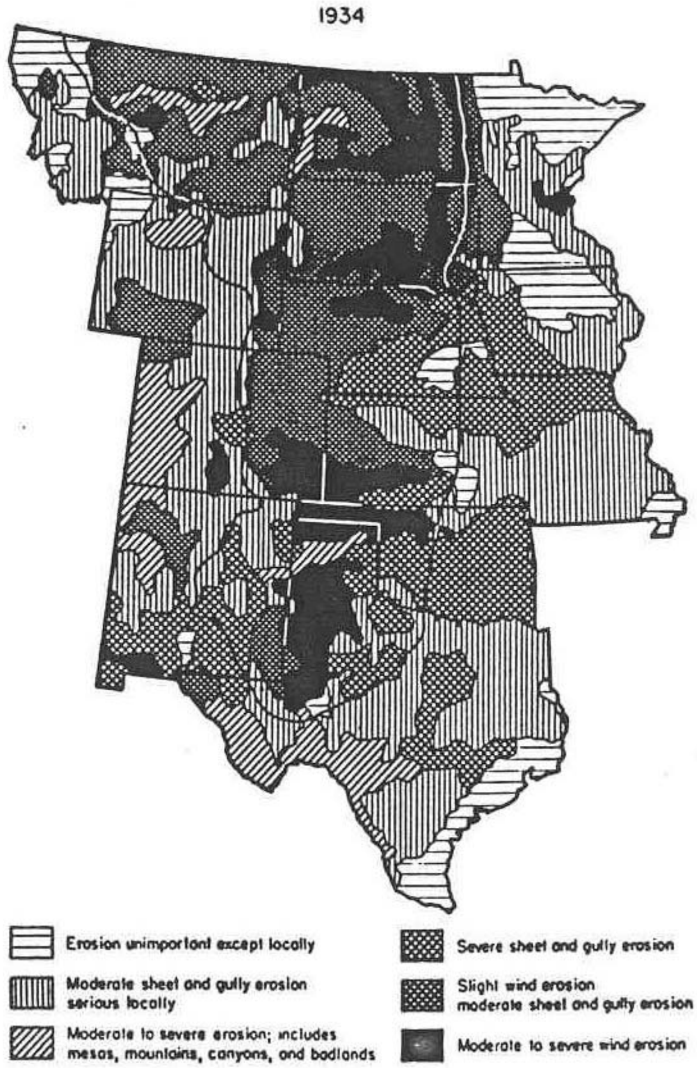
Variables:	Pooled OLS Results	OLS with State Fixed Effects	Ordered Probit Results
Constant	-1.19* (0.29)		-2.17* (0.39)
Average Farm Size	-0.47 E-3** (0.18 E-3)	-0.40 E-3** (0.16 E-3)	-0.66 E-3* (0.25 E-3)
Standard Deviation of Farm Size	0.85 E-3* (0.25 E-3)	0.71 E-3* (0.22 E-3)	0.001* (0.34 E-3)
Share of Cultivated Acres	0.025* (0.003)	0.019* (0.003)	0.030* (0.004)
Average Annual Wind Speed	0.10* (0.04)	0.23* (0.05)	0.12** (0.06)
Deviation in Rainfall	-0.02* (0.005)	-0.008*** (0.005)	-0.03* (0.006)
Sand Percentage in Soils	0.018* (0.003)	0.027* (0.003)	0.023* (0.004)
μ_2 **(Threshold Parameter)**			1.39* (0.10)
μ_3 **(Threshold Parameter)**			2.1* (0.12)
Number of Observations	363	363	363
Adjusted R-squared	0.24	0.48	
Log-likelihood			-427.0
χ^2 (critical value, 6 df = 16.81at 1%)			100.9*
Pseudo R-squared			.86

Standard Errors are in parentheses. Data are collected from various sources, as explained below.
*p<0.01; **p<0.05; ***p<0.1 Pseudo R-squared calculation based on Zavoina and McElvey (1975).

Table 5
Predicted Probabilities at Different Values of Average Farm Size

Cell Frequencies		**Predicted Probabilities**		**Predicted Probabilities**		**Predicted Probabilities**	
		Avg. Size = 762.7		Avg. Size = 1000		Avg. Size = 1568.1	
WE = 0	0.137	Prob (WE=0)	0.10	Prob (WE=0)	0.13	Prob (WE=0)	0.23
WE = 1	0.402	Prob (WE=1)	0.44	Prob (WE=1)	0.47	Prob (WE=1)	0.51
WE = 2	0.225	Prob (WE=2)	0.26	Prob (WE=2)	0.24	Prob (WE=2)	0.18
WE = 3	0.234	Prob (WE=3)	0.20	Prob (WE=3)	0.15	Prob (WE=3)	0.08

Figure 1
Wind Erosion in the Great Plains in the 1930s



Note: Irregular line bounds the Great Plains Region as delimited by the Great Plains Committee.

Source: Adapted from "General Distribution of Erosion," U.S. Department of Agriculture, Soil Conservation Service, August 1936.

[1] See Colacicco, et al (1989), Williams et al (1993), Ervin and Lee (1994), Pimmental et al (1995), and Smith et al (2000) for discussion of the long-term economic costs of soil erosion.

[2] Lee, Wigner, and Gregory (1993) find that drought conditions and wind speed as reflected in the Palmer Drought Severity Index are poor predictors of blowing dust amounts. Instead, agricultural management techniques account for much of the variability of blowing dust in the southern plains. Lee and Tchakerian (1995) also emphasize the importance of agricultural practices in determining the magnitude and frequency of wind erosion.

[3] Duly (1951), Fryrear (1963), Heady and Vocke (1978), Moldenhauer, Langdale, Frye, McCool, Papendick, Smika, and Fryrear (1983), and Fryrear and Skidmore (1985), and Bilbro, Fryrear, and Zobeck (1987, 114-20).

[4] See Frey (1952), Korsching, Stofferahn, Nowak and Wagener (1983), Lee and Stewart (1983), Rahm and Huffman (1984), and Norris and Batie (1987).

[5] Gross and Taves (1952), Marsh and Coleman (1955), Pampel and van Es (1977), Napier, Thraen, Gore, and Goe (1984), Nowak (1987), Camboni and Napier (1993), Napier and Sommers (1994), and Ashby (1985). Similarly, in the development literature there is a common finding of an inverse relationship between farm size and cultivation intensity (Berry and Cline, 1979, Feder, 1985, and Cornia, 1985).

[6] Economists have not examined the Dust Bowl in detail. Historians have written about it, stressing cultivation as the principal cause (Worster, 1979, Bonnifield, 1979, and Hurt, 1981). Why cultivation was more extensive in the 1930s than later during similar droughts has not been addressed. We examine the institutional determinants of cultivation. More recent analytical work is by Gutmann and Confer (1999). Contemporary discussions are in Johnson (1947, 135-54), Kellogg (1935), and Bennett (1939, 729, 738-42). A famous video documentary was prepared in 1936 by the Resettlement Administration under Rexford Tugwell, titled, "The Plow that Broke the Plains."

[7] The general conclusion is that erosion in the 1950s or 1970s erosion was not on the scale of the 1930s. See Borchert (1971, 5), Hurt (1981, 145-54), Rosenberg (1981, 121), and Changery (1983, 1). Data analyzed by Stout (2001) for Lubbock, Texas indicate a long-term decline in wind erosion from 1961 through 1982 and 1999.

[8] As early as the mid 1920s, the USDA and the state agricultural extension services in the Great Plains outlined a variety of practices, crops, and equipment that could reduce wind erosion during drought (Seamans, 1921, Wilson, 1923, and Hurt, 1981, 67-8). As we describe below, small farmers were less likely to invest in wind erosion control for a variety of reasons. We use a Cournot model to show how marginal profits of such investments varied by farm size. Small farmers also faced minimum income constraints, and the opportunity costs of placing land in strip fallow, planting drought-resistant crops, and purchasing specialized equipment could have prevented them from meeting their family income targets.

[9] Recommended sizes varied from 700 acres in Kansas to 1,200 or more in eastern Montana, Renne (1935, 427), Cochrane (1938), and Halcrow (1938). These sizes did not necessarily completely internalize erosion externalities, but were deemed sufficiently large to sustain a farm family during periods of variable rainfall.

[10] The settlement period for the Great Plains was late, from 1880-1910 in the south to 1900-1920 in the north. Although there were periodic droughts, including a major one in the northern plains between 1917-1921, there was nothing of the magnitude of the 1930s drought. Libecap and Hansen (2002) show that under conditions of virgin soil and sufficient rain, yields were high and homesteads offered a reasonable family income.

[11] National Archives, Record Group 114, MLR 1, Box 72.

[12] Hannah (1950), Hines (1952) points to the lack of incentive for individual farmers to idle lands and reduce soil erosion that had off-site effects.

[13] There was some specialized equipment (Barbarika, 1987). For incentive, cost/benefit issues, see Crowder and Young (1987, 177-87) and Stults and Strohbehn (1987).

[14] H.V. Geib, 1933, "Report of Wind Erosion Survey in the Region of the Oklahoma Panhandle and Adjacent Territory," National Archives, Record Group 114, MLR 1, Box 4.

[15] Hansen and Libecap (2002) examine the political economy of federal land law in semi-arid regions.

[16] The census variable also may include some summer-fallowed fields, which could contribute to wind erosion. Fallow in strip cropping appears to have been the primary practice. Soil conservation officials urged the use of fallow in strip crops. The statistical analysis reported below shows a negative relationship between fallow and the variance of farm sizes in a region across time periods. As we describe, this result is consistent with disincentives to use strip fallow as a wind erosion control. There is no obvious reason why summer fallow would be affected by the variance in farm sizes in a region. There was, however, very little fallow of any type in the Great Plains in 1930. For example, as indicated in census data for the 46 western Kansas counties, fallow was less than 5 percent of farm acreage in western Kansas in 1930, but over 38 percent in 1954.

[17] For an interior solution, F^* will depend on the functional form of $\theta\left(\frac{F}{A}\right)$, and it exists under certain conditions specified by the SOC.
[18] The effect of variation in farm size applies if overall differences are not too great (there are no cases of a few very large farms surrounded by many small ones). When no dominant farm internalizes most of the externalities, all farms place less land in fallow.
[19] For discussion of the small farm problem on the Great Plains, see Bennett and Fowler (1936, 4), Stephens (1937, 751), Bennett, Kenney, and Chapline (1938, 68-76), Kimmel (1940, 264), the USDA Yearbook of Agriculture (1940, 409), Huffman and Paschal (1942), and Kraenzel, (1942, 583-6).
[20] Bennett and Fowler (1936, 6-7)
[21] 1936 U.S. Resettlement Administration, Sample Surveys of Farms, USDA National Agricultural Library.
[22] Mead, Perkins, and Zieback Counties, South Dakota, "Farm Size as a Guide to Planning in the Tri-County Soil Conservation District," 1940 compiled from Agricultural Conservation Program Records, 1937, USDA National Agricultural Library.
[23] The census does not provide farm-specific data, but rather county-level data.

Descriptive Statistics for 46 Western Kansas Counties

	1930 Census Year		1945 Census Year		1954 Census Year	
Variables:	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Average Farm Size	590.77	195.72	857.72	406.35	917.72	363.18
Standard Deviation of Farm Size	286.20	84.92	410.72	209.99	433.52	190.78
Percent Share of Pastured Acres	40.23	13.66	37.94	21.79	34.83	12.99
Average Fallow Acres	36.73	35.36	172.40	186.42	388.93	288.66

[24] Since individual farm size data are not available in the census, we use the average farm size per county (county farm land/total number of county farms). The census provides total farm land and number of farms by county in the following categories: 0-49 acres, 50-99 acres, 100-179 acres, 180-259 acres, 260-499 acres, 500-999 acres and over 1,000 acres. In the category for farms over 1,000 acres, the mid-point is chosen as 3,000 acres. Although categories were slightly different across census years, we constructed categories that are comparable and use these data to calculate the standard deviation. The standard deviation of farm size is calculated based on the difference between average farm size and the mid-point of each category, weighted by the number of farms in each category. The formula for variance is provided below:

$$Variance = \sum_i (N_i / N_T)(M_i - \overline{F})^2$$

where N_i = # of farms in a category for a county; N_T= Total number of farms in a county; M_i=Mid-point of a size category; and $\overline{F}$ =Average farm size in a county. The census data for 1930, 1940 and 1950 from U.S. Historical Census Data Browser, http://fisher.lib.virginia.edu/census/ which presents ICPSR (Inter-university Consortium for Political and Social Research). The census data for 1935, 1945, 1954, 1959, and 1964 came from Great Plains Population and Environment Database, 2001, Inter-University Consortium for Political and Social Research (ICPSR)
[25] We estimated the same model using a different variable to capture the effect of variation of farm size--the percent of farmland in a county in farms less than 500 acres. The results of this alternative model are similar, but not as precisely estimated. There is a strong linear relationship between this variable and average farm size.
[26]

Descriptive Statistics for the Pooled Sample of 46 Western Kansas Counties over 1930-1964

Variables:	**Mean**	**Std. Dev.**
Average Farm Size	827.38	371.58
Standard Deviation of Farm Size	394.44	182.21
Percent Share of Pastured Acres	36.12	15.68
Average Fallow Acres	236.22	200.80

[27]

Correlation Matrix for Selected Variables from the Pooled Sample:

	Average Farm Size	Standard Deviation of Farm Size	Percent Share of Pastured Acres	Average Fallow Acres	Percent of Farm Land in Farms less than 500 Acres
Average Farm Size	1.00				
Standard Deviation of Farm Size	0.97	1.00			
Percent Share of Pastured Acres	0.06	0.15	1.00		
Average Fallow Acres	0.73	0.68	-0.28	1.00	
Percent of Farm Land in Farms less than 500 Acres	-0.81	-0.71	-0.08	-0.59	1.00

[28] State Erosion Reconnaissance Survey maps prepared in 1934 by the SCS for Montana, North and South Dakota, Nebraska, Kansas, Colorado, Oklahoma, Texas, and New Mexico are available at the National Archives, Record Group 114, Cartographic Collection. A 1935 U.S. Erosion Reconnaissance Survey map is available in Joel (1937).

[29] We consider only wind erosion as indicated on the maps and do not assign values for water erosion. The maps are color coded and shaded to identify locations of different erosion intensity. A county was assigned a value from 0 to 3 based on dominant erosion conditions indicated in the maps. Generally, a county's erosion index value was based on the condition that characterized 50 percent or more of the county. In cases where severe erosion conditions were widespread within the county, but the total appeared to cover less than 50 percent of the land area, the county was still assigned the severe index value, 3. The indication that severe erosion was widespread and not localized warranted the higher value.

[30] The results we describe shortly do not appear to be sensitive to our definition of the Great Plains. Dropping far eastern counties in North and South Dakota, for example, do not change our results.

[31] Rainfall deviation is average percent departure from normal by county, 1930-35, from Cronin and Beers (1937, Table 8, 41-54). Annual average hourly wind velocity in miles per hour 30 feet above the ground is from Chepil, Siddoway, and Armbrust (1962, 163). They provide a map of the United States with isobars of similar wind speeds. These are used to map onto county locations. For the Great Plains, the minimum wind speed was 9 miles per hour and the maximum was 14. Each county was assigned one of the following wind velocity values: 9 mph = 0, 10 mph =1, 11 mph = 2, 12 mph =3, 13 mph = 4, 14 mph =5. Soil erodibility in a county is indicated by percent sand, since sandy soils are highly erodible. % sand by county is from STATSGO data set graciously provided to us by Geoff Cunfer from the Great Plains Population and Environment Database, 2001, Inter-University Consortium for Political and Social Research (ICPSR), University of Michigan, www.icpsr. umich.edu/plains. We use 1930 Agricultural Census county-level measures of farmland, number of farms and cropland to calculate average farm size (land in farms divided by the number of farms in a county), variation in farm size and the cultivated share of farmland (land in crops divided by total farmland in a county). The calculation of average farm size by county and the standard deviation of farm size is described above. 1930 census data from ICPSR and from the U.S. Historical Census Data Browser, http: //fisher.lib.virginia.edu/census/. Using 1935 census data does not change the results.

[32]

Descriptive Statistics for the Sample of 363 Great Plains Counties		
Variables:	**Mean**	**Std. Dev.**
Average Farm Size	762.66	805.5
Standard Deviation of Farm Size	905.02	620.27
Share of Cultivated Acres	45.60	21.29
Average Annual Wind Speed	2.23	1.23
Deviation in Rainfall	-14.65	9.44
Sand Percentage in Soils	38.88	15.46
Wind Erosion Index	1.56	0.99
% of Farmland in Farms less than 500 acres	35.51	24.76

[33]

Correlation Matrix for Selected Variables							
	Average Farm Size	**Standard Deviation of Farm Size**	**% Share of Cultivated Acres**	**Average Wind Speed**	**Deviation in Rainfall**	**Sand % in Soils**	**WE Index**
Average Farm Size	1.00						

Standard Deviation of Farm Size	0.95	1.00					
Percent Share of Cultivated Acres	-0.55	-0.60	1.00				
Average Wind Speed	-0.08	-0.10	0.12	1.00			
Deviation in Rainfall	0.06	-0.71	-0.04	-0.59	1.00		
Sand Percentage in Soils	0.33	0.32	-0.41	-0.19	0.12	1.00	
Wind Erosion Index (WE)	-0.10	-0.09	0.33	0.13	-0.21	0.09	1.00

[34] Annual Report, July 1,1935-June 30, 1936, Erosion Control Work Camp, 15-T, Littlefield, Texas, J.T. Reece, Conservation Superintendent, National Archives, Record Group 114, MLR 1176 (A1), Box 28.
[35] Chilcott (1937), Bennett (1939, 742, 747), and Simms (1970).
[36] For discussion of demonstration farms and the lack of enthusiasm among farmers, see Bennett (1939, 361, 737) and Helms (1990, 13-15). Concerns about foregone production are noted in Memo to Eric England, Assistant Chief, Bureau of Agricultural Economics, from C.L. Holmes, Division of Farm Management and Costs, October 18, 1933, National Archives, Record Group 114, MLR 1, Box 74.
[37] Bennett (1939, 315-22). Held and Clawson (1965, 49) discuss the problem of non-cooperating farmers.
[38]Green Creek Project, TEX-8, Dublin Texas, 1937, National Archives, Record Group 114, MLR 1001, Box 65, and Dalhart, Tx Project, TEX-3, 1939, National Archives, Record Group 114, MLR 1154, Box 1.
[39] Soil Conservation District Records, National Archives, Record Group 114, MLR 1172, Box 1.
[40] Parks (1952, 14-5), Held and Clawson (1965, 47-9), Hurt (1981, 74-7) and Helms (1990, 47, 49). The states varied in the actual law that was enacted. Some had 90% voting requirements to implement a district; some did not include regulatory authority for the districts. 33 of the 48 kept coercive land use regulation, but most did not use it. The subsidies removed most opposition.
[41] "AAA's Part in Limiting Farm Family Migration," USDA History Collection, Special Collections, National Agricultural Library. Parks (1952, 56-9, 60) discusses subsidies, which were a major vehicle for compliance.
[42] "Aid Available to Farmers in Controlling Wind Erosion," pamphlet in History Collection, Special Collections, National Agricultural Library. Farmers could receive loans up to 60% of their expected ACP payments.
[43] Source: SCD petitioners, Farm Service Agency Files, Helena, Montana. Census data: Fallon County, 1940, http://fisher.lib.virginia.edu/census/, Cascade and Powder River Counties, 1945 and 1950, U.S. Census of Agriculture, 1950, Counties and State Economic Areas—Montana, Vol. 1, Pt. 27, 40-44.
[44] Soil Conservation District Records, National Archives, Record Group 114, MLR 1001, Box 12. See also, Morgan (1965, 45-51, 333-38, 358-70).
[45] U.S. Great Plains Committee (1936, 105-7), Wehrwein (1936), and Hockley and Walker (1938).
[46] Letter to H.H. Bennett, Chief SCS, 9/4/35, National Archives, Record Group 114, MLR 1, Box 13.
[47] Hockley and Walker (1939) and Wehrwein (1936, 312-3). Kansas had earlier legislation, but was declared unconstitutional in 1936 by the Kansas Supreme Court. A new law was passed in 1937
[48] By September 1937, 19 districts were being organized in Kansas with 11 (58 percent) in the west or southwest. 12 districts listed as likely to be organized in 1938, all in the east or central. Letter, Ira K. Landon, State Coordinator to D.S. Meyer, USDA, SCS, September 7, 1937, National Archives, Record Group 114, MLR 1176(A1), Box 28.
[49] "Aid Available to Farmers in Controlling Wind Erosion," May 27, 1938, p. 7, pamphlet in History Collection, Special Collections, National Agricultural Library.
[50] Soil Conservation Service (1937, 14), Colorado Soil Conservation Act, Colorado Laws 1937, c. 241.
[51] In examining economies of scale in field crops in the Great Plains, Miller, Rodewald, and McElroy (1981, 20-22) reported that costs declined gradually with increases in farm size to about 1,500 acres in both the northern and southern plains. After that costs were relatively flat, suggesting no serious diseconomies or compelling economies of scale. Although, the size of Soil Conservation Districts suggests much larger farms might have been optimal for erosion control, Allen and Lueck (1998, 2000), argue that transactions costs rise sharply for farms that require more than family labor.
[52] "Farmers had not starved, but progress toward the permanent rehabilitation of the area had been slow." USDA Office of Land Use Coordination, Editorial Reference Series, No. 7, 1940, "The Dust Bowl: Agricultural Problems and Solutions," p. 21, USDA History Collection, Special Collections, National Agricultural Library.

[53] Coase (1960, 16) and Demsetz (1967, 349) for discussion of inappropriate property rights. Coxhead (2000) discusses a contemporary case where government policies regarding property rights encourages soil degradation.