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

Gary D. Libecap
University of Arizona
National Bureau of Economic Research

and

Zeynep K. Hansen
University of Arizona

DRAFT

January 29, 2002

This is a working draft. We are collecting more data and modeling the relationships. Helpful comments on earlier versions were provided at Keio University, Tokyo; the Western Economics Association Meetings, San Francisco; the National Bureau of Economic Research, DAE, Summer Institute, July 2001; by Alban Thomas and other participants at the Fourth Toulouse Conference on Environment and Resource Economics, May 2001; and by Dean Lueck, Lee Alston, Steve Salant, and Ron Johnson. Research funding was provided by NSF Grant 9907139 and the International Center for Economic Research (ICER), Turin, Italy.

"In the morning the dust hung like fog, and the sun was as red as ripe new blood.
All day the dust sifted down from the sky, and the next day it sifted down.
An even blanket covered the earth. It settled on the corn, piled up on the tops of the fence posts, piled up on the wires; it settled on roofs, blanketed the weeds and trees."
John Steinbeck, The Grapes of Wrath (1939, 6)

"One man cannot stop the dust from blowing but one man can start it." Farm Security Administration, September 12, 1937[1]

I. Introduction.

The Dust Bowl of the 1930s was one of the most severe environmental crises in North America in the 20th Century.[2] 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. Similar droughts also occurred in the 1950s and 1970s in the Great Plains, but there is a consensus view among soil conservation officials that there was no comparable level of wind erosion.[3] Excessive cultivation of land in the 1930s, exposing unprotected dry soil to the wind, is the standard explanation for the Dust Bowl.[4] 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.

The leading historian of the Dust Bowl, Donald Worster (1979, 4), broadly blames a culture driven blindly for profits as the proximate cause of excessive cultivation of the Great Plains in the 1930s:

"It came about because the culture was operating in precisely the way it was supposed to. Americans blazed their way across a richly endowed continent with a ruthless, devastating efficiency unmatched by any people anywhere…The Dust Bowl…was the inevitable outcome of a culture that deliberately, self-consciously, set itself that task of dominating and exploiting the land for all it was worth."

We agree that extensive cultivation of the Great Plains was the culprit, but culture was not the cause. The problem lay in the property rights structure that arose from the federal Homestead Act. The key distinguishing factor between the 1930s and the later periods that led to more cultivation was the much greater prevalence of small farms in the 1930s. In 1930, nearly 2/3s of the farms on the Great Plains were less than 500 acres. By 1978, only 40 percent of the farms were that small. Small farmers cultivated more of their land, and cultivated it more intensely than did larger farmers.[5] They had less land in pasture, and kept more of their land in crops in order to earn sufficient income to maintain farm families. Moreover, we argue that small farms were less likely to use the costly wind erosion control techniques developed in the 1920s or earlier.[6] There were external benefits from such practices, but small farms had insufficient acreage to internalize them. Further, the prevalence of small farms created a coordination problem for the joint adoption of erosion control. Erosion control efforts were effective only if used by all or most farmers in a region. But small farmers resisted them, and the large numbers of farmers involved raised the costs of collective action.

In the early 1930s, field workers for the Soil Erosion Service (later the Soil Conservation Service, SCS) complained of farmer rejection of their recommendations for erosion control investments. Beginning in 1937, the federal government promoted local soil conservation statutes and districts within each state to subsidize and often force adoption of erosion controls. These included use of strip cropping, certain types of fallow, terracing, and the planting of trees for windbreaks or shelterbelts. Soil Conservation Districts were established throughout the Great Plains so that by December 1956, there were 827 Soil Conservation Districts in the Great Plains states.[7] The Soil Conservation Districts generally encompassed entire counties or more, and hence, were much larger than individual farms and better able to internalize the externalities associated with soil erosion control and to coordinate anti-erosion efforts among the farmers in their districts.[8] 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 prevalence of very small farms in the Great Plains was a direct result of the property rights distribution authorized by the Homestead Act. Under the Homestead Acts, hundreds of thousands of small, 160-320-acre farms were established in the Great Plains between 1880 and 1920. U.S. land policy developed during a time of a lack of knowledge regarding the climate of the Great Plains and appropriate farming methods. Small farms were viable, at least in the short term so long as rainfall was high, but when drought occurred small farms particularly were at risk, and this was the situation that they faced in the 1930s.

The Dust Bowl, then, was not a natural disaster, but rather a man-made one. It was the outcome of an inappropriate (*ex post*) property rights arrangement that had serious environmental consequences.[9] The institutional factors that contributed to the severity of the 1930s Dust Bowl have not been sufficiently considered in the historical literature. Moreover, neither the agricultural nor environmental economics literatures have examined the underlying causes of this catastrophic wind erosion or the institutional response to it. Our analysis represents a new assessment of the causes of the Dust Bowl that emphasizes the problem of very small farms on the Great Plains.

II. The Dust Bowl.

The Dust Bowl was certainly one of the major environmental crises of the twentieth century in North America.[10] Worster (1979, 24) described it in the following way:

"…the dust storms that swept across the southern plains in the 1930s created the most severe environmental catastrophe in the entire history of the white man on this continent. In no other instance was there greater or more sustained damage to the American land, and there have been few times when so much tragedy was visited on its inhabitants. Not even the Depression was more devastating, economically. And in ecological terms we have nothing in the nation's past nothing even in the polluted present, that compares. Suffice it to conclude here that in the decade of the 1930s the dust storms of the plains were an unqualified disaster."

Intense wind erosion began in 1931 and lasted through 1940. 1935 was one of the peak years with soil from 50 million acres blowing.[11] The storms were huge, some 600 by 400 miles, lasting 10 hours or more. One dust storm in May 1934 started in Montana and spread south. It covered an area 1,500 by 900 miles, lasted 36 hours, and carried some 350 million tons of soil toward the East Coast. During the storm of February 7, 1937, soil was carried from the Great Plains across the continent, depositing 34.2 tons of soil per square mile at Ames, Iowa, 14.9 tons at Marquette Michigan, and 10 tons in New Hampshire.[12] In his 1947 book on the Dust Bowl, Vance Johnson (1947, 194-5) estimated that in 1935 alone 850 million tons of topsoil had blown away from 4,340,000 acres in the southern plains. There were three sources of damage from wind erosion—lost fertile top soil, destroyed crops from the deposit of eroded material, and the effects of airborne material.

By 1935, 65 percent of the total area of the Great Plains had been damaged by wind erosion, with 15 percent severely affected. The area most affected and dubbed "the Dust Bowl" was in the southern plains, a 97 million-acre section of southeast Colorado, northeast New Mexico, southwestern Kansas, and the Panhandles of Oklahoma and Texas (Hurt, 1981, 2). By 1936, erosion was greatest in Oklahoma, impacting over 70 percent of the land, with 18 percent of Texas, 25 percent of Colorado, 16 percent of New Mexico, 30 percent of Kansas, and 17 percent of North Dakota damaged.[13] Later, we examine why wind erosion was most severe in particular parts of the Great Plains.

By 1938, the Soil Conservation Service estimated 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. Because light, rich topsoil was most likely to be carried away, leaving sandy infertile soil behind, wind erosion depleted soil quality and productivity. Damaged areas required the addition of fertilizers and organic material to reconstruct soil productivity. Samples of soil carried 500 miles from Texas to Iowa had 10 times as much organic matter, 9 times as much nitrogen, 19 times as much phosphoric acid, and 45 percent more potash as compared to the soil that remained.[14] Table 1 summarizes surveys of the extent of soil damage in the Great Plains by 1939 as determined by the Soil Conservation Service. As indicated, land with severe erosion as a share of total surveyed land was largest in the Dust Bowl region.

Table 1

Other costs of severe wind erosion included damage to livestock, household goods, merchandise, and health problems associated with inhalation of dust particles. Claims of greater incidence of pneumonia, asthma, influenza, and eye infections were reported from Dust Bowl counties in Colorado, Kansas, New Mexico, Oklahoma, and Texas. The SCS commented on health and livestock problems in western Baca County in the center of the Dust Bowl: “Much of the noticeable increase in sickness in the affected area seems to be directly traced to dust-laden air. This is not surprising when one considers the frequency and intensity of dust storms in many localities. Numerous livestock have died as a result of strangling, eating excessive amounts of grit, and from starvation, all associated directly or indirectly with wind erosion and drought."[15] Similarly the 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). Although there is not enough detail in these reports to compile an accurate assessment of the costs of 1930s wind erosion, the data are indicative of the broad economic effects involved.[16]

The social costs of wind erosion also were large. By 1940, over 70 percent of all farms in North Dakota were tax delinquent.[17] Farms throughout the Great Plains were abandoned and families, like the Joads described by John Steinbeck, migrated to more hospitable climates. Perhaps 20,000 families left the northern plains alone. By June 1935, over 44,000 families in eight drought states received WPA rural rehabilitation grants, and additional relief payments were provided by the Resettlement Administration, the Federal Emergency Relief Administration, and other organizations.[18] In a third of all counties in the Great Plains federal aid provided at least $476 per family between 1933 and 1936.[19] In the conclusion, we return to policy conflicts between the use of relief payments to sustain small farms and adoption of effective efforts to combat erosion.

III. Wind Erosion and Farm Size Externalities.

Wind erosion is a natural characteristic of the Great Plains given the strong prevailing winds and semi-arid climate of the region. It is most common in the late winter and spring when wind speed is highest (typically from the northwest in the northern plains and southwest in the southern plains).[20] Erosion vulnerability can be described by a wind erosion equation: $E = f(I, C, K, L, V)$ where E is annual soil loss in tons per acre, I is an erodibility index determined by the portion of soil particles greater than .84 mm. in diameter and surface soil moisture, C is a climatic factor indicated by wind velocity and surface soil moisture, K is soil surface roughness, L is the size of an exposed surface, and V is vegetative cover.[21] In the 1930s, virtually all of these factors set the stage for unprecedented erosion. Much of the soil was sandy, dry, and pulverized from intense cultivation. Because of extensive cultivation and drought the land was devoid of vegetative cover. Grasslands had been plowed and crops had withered. Figure 1 plots annual rainfall in three Great Plains states of Kansas, Montana, and Colorado from 1895 to 1985. Severe drought (precipitation one standard deviation below the mean) characterized the 1930s in all three states. Wind, drought, and exposed dry soil brought erosion.

Figure 1

To understand the potential externalities associated with combating wind erosion, it is important to review the dynamics involved. As the wind moves across a surface that is smooth, bare, and dry with loose, finely granulated soil, the particles start to move. The minimum wind speed required to start the flow depends on the size and weight of the soil particles and the friction provided by neighboring granules. Moisture makes the soil sticky and holds the particles in place. But if the soil is dry and sandy, a wind speed of about13 miles per hour at a height of one foot above the surface is sufficient to move particles along. They are carried in three types of movement: suspension, saltation, and surface creep. Dust particles less than .1 mm. in diameter are the first to go. They are lifted into the air where they are carried in suspension. These small particles usually are the finest-textured topsoil, rich in organic material and nutrients. In suspension they are whipped into the atmosphere 7,000 feet or higher and can be carried hundreds of miles.

Drought and repeated cultivation can break down flocculation, the clinging together of soil particles, making the particles finer and more vulnerable to blowing.[22] The soil that is left is coarser, heavier, and usually much less fertile. These coarser materials, ranging .1 to .5 mm. are pushed by the wind, bouncing or jumping in a process called saltation. The particles travel 10 to 15 times the height of their bounce and return, striking the soil, breaking soil clods and releasing more particles. The largest soil particles from .5 to 1.0 mm. roll or creep along the surface, and abrasion from these particles breaks down clods, destroys stable soil crusts, and wears down vegetation residue, exposing more soil. As the number of particles moved by the wind increases, erosion moves downwind in a process called *soil avalanching*. Erosion starts at the windward edge of an eroding field and the rate increases leeward until it reaches the maximum a given wind speed can carry.

The control of wind erosion involves covering the exposed soil, slowing the surface speed of the wind, and increasing the clumpiness of soil to make the particles more difficult to move. Vegetative cover from native grasses as pasture is the best source of control, but other cover crops and stubble mulching which retains plant (wheat) stalks after harvest also are effective. Providing obstructions that divert the wind upward can reduce surface wind velocity, and there are a variety of options. Windbreaks or shelterbelts, often trees planted at the head of field, work where trees can be grown (not everywhere on the Great Plains). Strip cropping with alternating bands of wheat and fallow (with stubble), used in the northern plains, or with bands of wheat and drought resistant crops like sorghum, used in the southern plains, were a more common method of breaking the wind flow. Obstructions had to be placed perpendicular to the wind and repeated at regular intervals. Otherwise, wind velocity regenerated downwind from the control points. Plowing to bury fine particles and to bring up larger and heavier earthen clods also reduced soil erosion (useful where the soil had more clay or was more moist).

In all cases, effective erosion control required that action be taken on large tracks of land. Cooperation among farmers in a region was essential: "A wind erosion area should be large enough so that it will not be covered from dust blowing from unprotected land."[23] The Soil Conservation Service (1937, 6-8) emphasized that the effects of erosion were not confined to the land that was "misused and abused but reach out to injure other lands and the works of men far removed." Further, there was not much "an individual farmer can do to prevent a dust storm without the cooperation of his neighbors. Single-handed combat with erosion is costly and can never be anything but piecemeal." If a farmer adopted erosion control practices, but adjacent farms were completely cultivated, then the investment would have little payoff. Sand from the surrounding areas would drift across property boundaries, obliterating crops and covering strip cropped and fallowed fields: "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."[24] Similarly, Charles Kellogg of the Soil Conservation Service (1935, 5) discussed the need for strip cropping to control wind erosion, but cautioned: "Such a practice, to be most effective, must be adopted on a community basis. Isolated farmers following this practice are not greatly benefited if the adjoining land is allowed to blow badly."

The movement of blowing soil across property boundaries created an externality from cultivated farms, reducing the returns from individual erosion control. Accordingly, areas characterized by cultivated homesteads contributed to more intense soil blowing, overwhelming farms that might have had more ground cover. If, however, the adjacent farms had grass cover through pasture or stubble cover from strip cropping and fallow, wind erosion would be slowed, with the benefits spread across all farms in the area.[25] As we will show, neither pasture nor fallow, however, was prominent on small homestead farms. Further, because obstructions had to be placed in numerous locations along the ground to block the re-acceleration of the wind, farmers had to act cooperatively in strip cropping or in constructing other wind breaks if their farms were very small. The requirement for cooperation was demonstrated dramatically by the national shelter belt project to plant bands of trees 132 feet wide a mile apart in a continuous north-south axis across the Great Plains from Devil's Lake, North Dakota to Sweetwater, Texas.[26] This need for cooperation among farmers introduced a collective action problem that was intensified by the large numbers of small homesteaders in the region.

Figure 2

Homestead settlement of the Great Plains (Figure 2) established the conditions for increased wind erosion. The native grasses were plowed as the land was placed into crops, and intensive cultivation reduced the size of soil particles. The soil in many areas was sandy and prone to blow, and the region was flat with little to obstruct wind. In the 1930s, severe drought and high temperatures also lowered soil moisture. The soil became dust and was picked up by the wind. Figure 3 illustrates the variation in wind erosion across the Great Plains in the 1930s. We use such maps to estimate why wind erosion was especially severe in regions like the Dust Bowl.

Figure 3

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 between 40 and 160 acres, and upon 5-years continuous residence and improvement (*cultivation*), receive title. Small farm allocations worked well in northern agriculture, east of the 100th meridian, where there were no important economies of scale in grain production, sufficient rainfall (above 30 inches a year), high soil quality, and familiar conditions, allowing farmers to use knowledge gained in the East or Europe. As migrants moved across the frontier, they transplanted farming practices, crops, and farm sizes used in their places of origin. Under these circumstances, property rights were assigned quickly and agriculture developed rapidly.

By 1880, however, the frontier reached the Great Plains and conditions were quite different from the Midwest. In his Report on the Arid Lands of North America made to Congress in 1878, John Wesley Powell warned that past methods of agricultural settlement could no longer be relied on and called for a minimum of 2,560-acre homesteads for "pastoral regions." There was no body of scientific knowledge that supported Powell's claim, and no action was taken. Land policy remained as before with only minimal adjustments in the Homestead Act, chief of which was the 1909 Enlarged Homestead Act that granted title to 320 acres of land after 5-year's residence *and continuous cultivation*.[27] This beneficial use requirement subsequently would contribute to wind erosion during drought. Under these land laws, between1880 and 1925 1,078,123 original homestead entries were filed to 202,298,425 acres in western Kansas, Nebraska, and the Dakotas and eastern Colorado and Montana, 45 percent of all homestead filings and 48 percent of all government land claimed during the period.[28]

Table 2

Table 2 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. 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. In 1930 at the start of the drought, 2/3s of the farms in the Great Plains were less than 500 acres in size and the mean farm size was 636 acres.

Figure 4

Figure 4 further illustrates the fragmentation of land ownership that characterized the Great Plains. It shows ownership patterns in Musselshell County, Montana in 1934. The 1,196,640 acres in the county were divided into 3,423 different tracts with an average size of 349.6 acres.[29] By the early 1930s, most agricultural studies indicated that Great Plains' farms had to be 700 acres or more to adopt fallow and other soil and moisture conserving practices for long-term viability.[30] As we argue, not only were small farms less likely to adopt wind erosion controls, but their proliferation created coordination problems in adopting wind erosion control techniques.

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

Erosion control was costly. Besides investment in specialized equipment there were the opportunity costs of lost immediate production if farmland were devoted to erosion-resistant crops or left in fallow as part of strip cropping.[31] Removing farmland from production and allowing it to rest for a year as fallow improved productivity by increasing soil moisture and nutrients. This was particularly important during periods of drought.[32] If farms were very large with repeated wind obstructions across fields, surface wind velocity could be effectively reduced. Further on large farms the benefits of wind erosion control accrued to the farmer. The farm contained more of the topsoil saved from lower wind speeds. But if farms were small, farmers captured fewer of the benefits, since much of the saved soil was on adjacent farms. Further, when farms were small, the effectiveness of wind erosion control in an area depended on cooperative actions by all farmers. No single farm was large enough to impact wind velocity. But cooperation was costly and would be limited due to the large number of farmers involved and the lack of incentive of small farmers to adopt erosion control practices.[33]

These issues suggest the following framework for incorporating farm size into the decision to fallow. In deciding whether or not to implement erosion control, such as fallow, farmers compare expected costs and returns. Assume that a farmer captures two distinct benefits from fallowing: increased soil moisture (nutrition) and reduced topsoil (wind) erosion. Define benefits per acre as:

$$B = n \quad \text{if } \ell < \overline{\ell}$$
$$B = n + (\ell - \overline{\ell})e \quad \text{if } \ell \geq \overline{\ell}$$

where n = per-acre nutritional benefits
e = per-acre benefits from reduced wind erosion
$n>0$ and $e>0$

Nutritional benefits of fallowing are captured by farms of all size, but the reduced erosion benefits depend on farm size. They accrue only when a farm is sufficiently large (when $\ell \geq \overline{\ell}$). The cost of fallowing is forgone production in the short run. We assume that land in a given region is homogeneous and costs of fallowing per acre are constant, i.e. $C = \overline{c}$. When $\overline{c} \leq n$, the benefits from fallowing exceed the costs, and all farms, regardless of size, will choose to fallow. If $\bar{c} > n$, farms with land size $\ell < \bar{\ell}$ will choose not to fallow. For farmers with larger farms ($\ell \geq \bar{\ell}$), the benefits will exceed costs when:

$$n + (\ell - \bar{\ell})e \geq \bar{c}$$
$$\ell \geq \frac{\bar{c} - n}{e} + \bar{\ell}$$

Thus, only farms larger than $\ell^* = \frac{\bar{c} - n}{e} + \bar{\ell}$ will have positive per-acre benefits from fallowing, and thus, choose to fallow. Farms with smaller size than this critical size will not fallow. Since benefits per acre are an increasing function of size (in this simple case, linear) larger farms beyond this threshold will have greater benefits from fallowing.

Now assume that the benefits from fallowing depend on other farmers' fallow/cultivation decision within the same region. If we define an index function, F, which takes on the value of one when a farmer chooses to fallow and zero otherwise, we can define $0 \leq \Sigma \leq 1$ as the proportion of farmers in a region that chooses to fallow, where $\Sigma = \frac{\sum_{i=1}^{N} F_i}{N}$. This variable introduces a coordination issue in a farmer's decision to fallow.

Define benefits of fallowing per acre as:

$$B = n \quad \text{if} \quad \ell < \bar{\ell}$$
$$B = n + (\ell - \bar{\ell})\Sigma e \quad \text{if} \quad \ell \geq \bar{\ell}$$

If all farmers in the region choose to fallow (i.e. $\Sigma = 1$), then we have the previous case. If some of the farmers do not fallow due to size constraints, then $\Sigma < 1$ and per-acre-fallowing benefits are reduced. This situation, in turn, increases the critical minimum size at which a farmer will fallow:

$$n + (\ell - \bar{\ell})\Sigma e \geq \bar{c}$$
$$\ell \geq \frac{\bar{c} - n}{\Sigma e} + \bar{\ell}$$

When $\Sigma < 1$, $\tilde{\ell} = \dfrac{\bar{c} - n}{\Sigma e} + \bar{\ell} > \ell^*$. Accordingly, the failure of other farms in a region to adopt wind erosion control practices (fallow) will reduce the benefits to all farms, even for those larger than the critical size because $\Sigma e < e$.

This framework suggests the following testable hypotheses:

a. Small farms were less likely to adopt conservation practices, like fallow.

b. Where small farms were prevalent, all farms (large and small) placed less land in fallow.

c. Regions characterized by large numbers of small farms had more land in cultivation and hence, more intense wind erosion.

d. Reductions in the costs of erosion control and/or increases in nutrient returns from fallow increased adoption of erosion control.

e. Voluntary collective action to control wind erosion was not effective because of the problem of coordinating large numbers of small farms with little individual incentive to invest in erosion control. Institutions for more formal, coercive collective action were necessary.

f. These institutions were implemented in regions with the most severe erosion.

g. Large farms internalized more of the benefits of erosion control and were the major advocates of collective action and small farmers were the "non cooperators."

We examine these predictions with data presented in the following three sections.

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

We first present qualitative evidence from the National Archives, the National Agricultural Library and the secondary literature. In terms of the prediction that small farms were less apt to invest in erosion control, USDA and Soil Conservation Service officials in the 1930s and subsequent 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.[34] For example, Bennett and Fowler (1936, 6-7) 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." The U.S. Great Plains Committee (1936, 3, 40-6, 75), appointed by President Roosevelt to address poverty and environmental damage concluded that "although we now know that in most parts of the Great Plains a farm of this size [homestead] is far too small to support a family. They were required to put this land under plow, regardless of whether or not it was suited to cultivation." Small marginal homesteads had to be completely cultivated to earn sufficient income to support a family. They were continuously cropped and cultivated, raised few livestock and had little pasture and associated protective grass cover. With declining agricultural prices in 1933 and dry conditions, small farmers especially had to plant as much as possible on their plots to try to offset falling yields and returns. Cooper, et al, (1938, 146-8) claimed that farms "are so small that the establishment of a system of farming that will conserve soil and produce a desirable family income is practically impossible." Coordinated adoption of erosion control practices was made more difficult by the sheer numbers of small units involved, as noted by Roland Renne (1935, 426-9): "Dealing with thousands of different owners slows up the adoption of a planned land use program…"

Diversification into livestock also was recommended because maintaining pasture retained grass cover, but given low grazing capacities livestock made sense only for large units (Starch, 1939, 119). Similarly, Soil Conservation Service climatologist Warren Thornthwaite (1936, 242) concluded that the small size of many farms precluded cattle raising and forced the cultivation of land which should have remained in grass, "…. in addition, the type of tillage which, because of its low cost, gives the farmer his only advantage is the primary cause of wind erosion so destructive in nature that it eventually renders the land unfit for cultivation."

Table 3

We now turn to more quantitative evidence on the relationship between small farms and erosion control practices. The data in Table 3 show the relationship between farm size and extent of cultivation. Part A of the table reports micro, farm-level data from a 1936 survey sponsored by the Resettlement Administration. 263 farms were surveyed in nine townships in southwestern North Dakota. Among the data collected were amount of land tilled (cultivated) and amount untilled (pasture, fallow) by farm size categories. As contemporary observers argued, small farmers tended to cultivate most of their farms. The ratio of tilled to untilled land per farm is larger than 1 for small farm size categories and less than one for larger farms. The correlation between farm size and the ratio of tilled to untilled land is -.69.[35] The ratio of cultivated (tilled) acreage to farm size rises as farm size decreases. Part B shows similar data for 170 farms in three western counties in South Dakota assembled from 1937 Agricultural Conservation Program records. In both cases, it is evident that small farmers had a greater share of their farms in cultivation than did larger farms, and this cultivated land was vulnerable to wind erosion.

Table 4

We further examine the relationship between farm size, cultivation, and use of fallow using census data. Table 4 reports regression results for fallow acres per farm and farm size using 1930 and 1954 census observations for 46 counties in western Kansas, a region in the heart of Great Plains wind erosion. The relationship that we estimate is

$$f_i = a + b_1 s_i + b_2 s_i^2 + b_3 p_i + e,$$

where f_i is average fallow acres (fallow acreage per land in farms) in each county, s_i is average farm size (land in farms divided by number of farms), s_i^2 is farm size squared, and p_i is average pasture (pasture per land in farms). Fallow is a census measure that includes various wind erosion control practices, such as strip cropping. Fallow acres per farm should rise with farm size at an increasing rate—unless there are many small farms and associated externalities that would weaken incentives to invest in wind erosion control as suggested in the theoretical framework. In 1930 average farm size was small (Table 2) and small homesteads were scattered throughout the Great Plains. By 1954, not only was average farm size nearly twice as large, but as we describe below, Soil Conservation Districts facilitated cooperative action in combating erosion, reducing externalities. Accordingly, the estimated relationships should be larger and more positive in the latter period. Pasture is an alternative to fallow on large farms, since larger farms could diversify more into livestock as size increased rather than into crops and fallow, and hence the variable should have a negative effect on fallow in both periods.

As indicated in the table, in 1930 the farm size variable is positive and significant and pasture is negative. The farm size squared variable is not significant. In 1954, however, the estimated relationships are much stronger, and the effect of farm size on fallow is more pronounced, with the coefficient on the size variable larger and more significant than in 1930. Further, the farm size squared variable is positive and now significant. The pasture variable remains negative. In both 1930 and 1954 where pasture was a large share of farm acreage, fallow was used less often. In both census periods, farm size had positive effect on use of fallow. But when there were many small farms and associated externalities from failure to invest in wind erosion control, as was the case in the 1930s, then the relationship between farm size and fallow was relatively weak. By 1954, conditions had changed so that investment in fallow was strongly linked to farm size.

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

As indicated in Figure 3, the intensity of wind erosion varied across the Great Plains. The literature on wind erosion and our analytical framework suggests that this variation would be a function of drought conditions, wind velocity, soil types, extent of pasture, cultivation, and farm size. In this section, we examine the extent to which differences in farm size and cultivation, controlling for other factors, can explain observed differences in the intensity of wind erosion.

Although we have not located numerical measures of variation in wind erosion across the Great Plains, numerous maps identify regions with "severe," "moderate," and "light" erosion. It is possible to use these maps to identify the counties where erosion took place and then to use census data and other sources to isolate the factors that might have contributed to that erosion.[36] Focusing initially on the traditional Dust Bowl counties, our framework suggests that these counties should have smaller farms, more farmland in cultivation, and less land in pasture than elsewhere in the Great Plains. Because we must use county level census data, the counties included in a region are important.

In Table 5 we show census measures of cropland and pasture as percents of county farm land and average farm size (land in farms divided by the number of farms in the county). In the table, the Great Plains is defined to include the western counties of North and South Dakota, Nebraska, and Kansas; the eastern counties of Montana and Colorado, excluding the 33 Dust Bowl counties, which are identified by maps of wind erosion intensity. One measure of the Dust Bowl includes counties near the convergence of Oklahoma, Texas, Kansas, Colorado, and New Mexico. Another measure drops the Texas and New Mexico counties, which often had large ranching properties. As indicated in the table, Dust Bowl counties, however measured, on average had more land in cultivation and less land in pasture than elsewhere in the Great Plains. Farm size in the Dust Bowl is smaller than elsewhere in most of the region, although not in many of the Texas and New Mexico counties.

This crude test lends support for the notion that cultivation and farm size were critical factors in determining where wind erosion would be most severe, holding all else constant. Although much of the focus of wind erosion in the 1930s is on the Dust Bowl, 33 counties in southwestern Kansas, southeastern Colorado, northwestern New Mexico, and the Panhandles of Texas and Oklahoma, this was not the only region with severe soil blowing.

We are collecting data to estimate the following relationship:

$EI_i = f(s_i,v_i,r_i,t_i,c_i,p_i,w_i)$ for the counties of the Great Plains,

where EI_i is the erosion index measure for county i, ranging from 1 to 3 for light, moderate, and severe erosion, s_i is average farm size in the county, v_i is the coefficient of variation of farm size (to capture the effect of externalities from small farms), r_i is rainfall deviation from normal, t_i is soil type, c_i is cultivation percent of farm land, p_i is pasture percent of farm land, and w_i is average wind velocity. Controlling for the other variables, such an analysis should allow for an examination of the effect of farm size and cultivation on wind erosion. This analysis will be a direct statistical test of the hypothesis that the small farms resulting from the Homestead Act importantly contributed to the environmental damage associated with the Dust Bowl.

VIII. Private Contracting or Government Intervention to Address the Coordination Problem: The Formation of Soil Conservation Districts.

As drought and wind erosion continued through the 1930s, the need for collective action became clear. There was the externality problem, but voluntary collective action was difficult to quickly assemble and maintain given the large number of farmers necessary for coordinated action, their heterogeneity (many small, some large), and the initial costs of erosion control. In his report to the Chief of the Soil Conservation Service, H.H. Bennett, J.T. Reece, 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.[37]

There were some private efforts for coordination, but they seem to have been very limited.[38] For example, in February1936, farmers in part of the Oklahoma Panhandle in the center of the Dust Bowl organized a voluntary Pony Creek Soil Conservation Association.[39] In 1934, the Soil Erosion Service in the Interior Department, later the Soil Conservation Service in the Department of Agriculture (1935), organized 79 demonstration plots to show farmers the benefits of listing fields and adoption of other practices to slow the flow of wind across the surface.[40]

Figure 5 shows the location of SCS demonstration plots and other erosion control exhibits. Fallow, strip cropping, contour plowing, stubble mulching and specialized plowing that maintained stubble cover, reduced tillage, planting shelterbelts, greater pasture, and use of drought resistant grains were urged. Nevertheless, there was resistance among farmers to adoption of these techniques. They were costly both in the time and specialized equipment required (duck foot plows, bar blade and rod weeders, shearing blades, improved tractors and combines). Moreover, they required that land be taken out of production; and to be effective in controlling wind erosion, they had to be used widely by most or all farmers in region.[41] Plans required that a third or more of a farm be placed in fallow as part of strip cropping, but officials of the USDA Bureau of Agricultural Economics in 1933 acknowledged that it was doubtful that additional yields would compensate for the lost production.[42] With limited acreage and high fixed investments, small farms were less apt to use these techniques or have the appropriate equipment.[43]

Farmers complained of the high up-front costs of erosion control techniques when the benefits were in the future, captured by other farmers, and dependent upon cooperative actions among all farmers in the region. As noted by Douglas Hurt (1981, 72): “Limited use of these implements [duck foot cultivator and rotary rod weeder used with fallow to roughen the soil] could not markedly improve the wind erosion conditions in the Dust Bowl; they had to be used widely and properly. For example, if one farmer listed his fields while his neighbors did not, the listed fields would have little or no effect on soil blowing." In a April 26, 1937 letter to President Roosevelt, a Texas farmer, William Loveless explained, "Without federal control the whole dust bowl area will become uninhabitable, and if it does, a strip of land will gradually be cut by the dust and sand from the present dust bowl country to the Gulf of Mexico…As you are aware, it is impossible for part of the land concerned to take care of itself under any program that *all the land concerned does not follow*."[44] The USDA Report of the Committee of Cooperation of Private Landowner summarized part of the problem in 1935:

"In general, the immediate financial returns from putting erosion controlling practices into effect are negative. Frequently some land has to be taken out of cultivation and put to less profitable use. Rearrangement of fields may require new fencing. Changes of cropping systems usually necessitate the purchase of seed of crops not grown in the old system. Were erosion controlling practices always profitable to the landowner, there would be little need for the Government to set up a Soil Conservation Service."[45]

Figure 5

Administrators and field personnel of the Soil Conservation Service (SCS) commented on a lack of voluntary farmer participation in the erosion control programs outlined in the demonstration projects. For example, in 1935, SCS Director Hugh Bennett reprimanded F.L. Duley, Regional SCS Director in Mankato, Kansas, stating, " Frankly, it is somewhat disappointing to note that such a small portion of your project is being retired from cultivation and that you are not using any strip-cropping measures whatsoever…we have been considering that strip-cropping would make up one of our principal means of erosion control."[46] Because of non-cooperators, the costs involved, and the urgency of the erosion problem, more formal, government intervention was necessary. [47]

As hypothesized, small farmers appear to have been the primary resisters or non-cooperators in 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[48]	145 acres	118 acres

The government response was the organization of Soil Conservation Districts to coordinate erosion control efforts and to subsidize investments. The importance of government intervention to offset private incentives in erosion control was recognized by the Soil Conservation Service: "In general, the immediate financial returns from putting erosion controlling practices into effect are negative…were erosion controlling practices always immediately profitable to the landowner, there would be little need for the Government to set up a Soil Conservation Service."[49]

Since the federal government did not have authority to regulate private land use via local government units, state legislation was required. A model statute was drafted by USDA Assistant Secretary M.L. Wilson and Assistant Solicitor Philip M. Glick and submitted by President Roosevelt to the state governors for legislative adoption in February 1937. The districts were to have police power to adopt programs and regulations on private lands, such as requiring strip cropping and contour terracing, and to mandate compliance with land use regulations voted by a majority of the farmers in a district:

"for the discontinuance of land use practices contributing to erosion and the adoption and carrying out of soil conservation practices and to provide for the enforcement of such programs and regulations…The failure by any land occupier to conserve the soil and control the erosion upon his lands causes a washing and blowing of soil, of water, from his lands on to other lands, makes the conservation of soil and the control of erosion of the other lands difficult or impossible."[50]

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. By 1940, there were 314 Soil Conservation Districts throughout the U.S., and by 1950, 2,285.[51] Table 6 outlines the rapid expansion of Soil Conservation Districts in seven Great Plains states between 1938 and 1950.

Table 6

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 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.[52] Further, farmers who did not comply were ineligible for the SCS assistance. Moreover, AAA erosion control payments could be withheld as an additional form of coercion.

Beginning in 1938, the Agricultural Adjustment Administration required that "every cooperator handle his land by using practices which are effective in preventing wind erosion." 30 percent of AAA payments to a farm were to be earned by carrying out soil conservation practices. AAA payments to the farmer 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," he 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.[53] In some cases, districts were granted eminent domain powers by state statutes to force adoption of erosion control practices and compliance with SCS contracts. In other cases, 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."[54]

We hypothesized that larger farmers would be the major proponents of Soil Conservation Districts. Their individual erosion control investments would be most at risk due to the failure of their smaller neighbors to voluntarily adopt such practices. 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 as shown in Table 7. As indicated, the petitioning farmers had larger farms on average than mean farm size in the county.

Table 7

We also hypothesized that reduction in the costs of erosion control and increases in the nutrient or productive benefits would increase adoption by all farmers. Low-cost loans and other subsidies to farmers for erosion control plus advice from SCS personnel on farming practices both reduced control costs and improved the nutrient value of such investments. These actions appear to have raised support among farmers for Soil Conservation Districts. Examination of Soil Conservation District files in Montana reveal that although larger farmers tended to be the principal proponents of the districts, in general there seems to have been wide-spread support among large and small farmers.[55]

Tables 8-9

The districts typically encompassed counties and often were enlarged, reflecting the need for land areas larger than individual (small) farms for effective soil erosion control. Table 8 shows the size of districts in Kansas, which ranged from about 250,000 acres to nearly 600,000 acres in 1941--all larger than any farm. Moreover, districts often were expanded to add additional farms and acreage as shown in Table 9.

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 1939 Extension Service Review noted:

"Individual farmers have been practicing measures of erosion control for years, but they have learned that it is a difficult if not a losing single-handed fight…As the forces of wind and water are not halted by the section line or fence row, erosion becomes a community problem, and community problems require community action."[56]

Further the Soil Conservation Service was concerned about the effects of inaction in adjacent areas on the success of newly organized soil conservation districts: "…a farm or area which adopts the most approved practices for controlling wind erosion can be largely nullified by neglect on the part of neighboring farmers or neighboring areas, what should be attitude of an agency toward assisting certain districts within the dust bowl if the work can be nullified by failure of neighboring counties or districts to enter the program?"[57]

The theoretical framework outlined in Section V suggests that the states with the greatest wind erosion problems would be the first to adopt legislation to promote cooperation among farmers and to address the externalities associated with erosion control. Indeed, Kansas, Oklahoma, and Texas, at the center of the Dust Bowl, enacted wind erosion legislation earlier than other Great Plains states, in 1935.[58] 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. The assessment was a binding first lien against the property. Conservation Districts were organized to achieve private and *public* interest objectives. Private interest activities included voluntary actions to contour pastures and restoring damaged grass stands, while public interest activities included the compulsory re-vegetation of severely eroded land.[59] 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. A 1937 version of the Kansas law "declared it to be the duty of the owner of real property to prevent dust blowing therefrom by planting trees, annual or biennial crops, or by cultivation." The Secretary of State and county commissioners were to conduct annual surveys of erosion. Control methods could be ordered on offending property if "this inspection reveals that the soil is being blown in such quantities as to be injurious either to (1) the land from which it originates, or (2) near-by land, or (3) the public health…" Costs would be assessed against the offending property. A 'soil drifting fund' was set up via property taxes in the county to cover other erosion control expenses.[60] In Oklahoma, the state law allowed county commissioners to enter upon land owned by persons who failed to cooperate in controlling wind erosion.[61] Finally, in later legislation in Colorado, a state with Dust Bowl counties, Soil Conservation Districts were authorized to levy specially assessments against the lands in the district to fund erosion control.[62] As the theory also suggests, 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. Subsequent districts created in 1938 were located in eastern and central regions.[63]

VIII. 1950s and 1970s Drought: No Similar Level of Wind Erosion.

As Figure 1 reveals, the 1950s and 1970s had severe droughts, comparable in some areas to that of the 1930s, yet there is no similar record of accompanying wind erosion. Dust storms occurred, but not to the degree experienced in the 1930s. Data suggest that wind erosion controls were widely used in the latter two periods because farm sizes were much larger than in the 1930s and because soil conservation districts both coordinated and subsidized the use of those techniques.

Through gradual consolidation of farms, by the 1950s and certainly by the 1970s, most of the small homesteads had disappeared from the Great Plains. The legacy of the Homestead Act largely had been corrected. As shown in Table 2 by 1954, average farm size was more than double that of 1925 and by 1974 average farm size had grown by an additional 40 percent. Use of fallow and other conservation practices also increased, indicating why the droughts of the 1950s and 70s did not involve the same level of wind erosion that occurred in the 1930s.

IX. Farm Size Change: Adjustment from the Initial Property Rights Allocation.

Table 10

Table 10 describes the farm-size changes that occurred on the Great Plains by the 1950s and 1970s that encouraged use of wind erosion control practices. It provides census data for two Great Plains states, Colorado and Montana for 1920 and 1982. In 1920, mean farm size in the two states was 408 and 608 acres, respectively. Most of the farms were less than 500 acres, and there was considerable heterogeneity in farm sizes as indicated by the coefficient of variation, which was 2.7 for Colorado and 2.3 for Montana. By 1982, however, mean farm size was much larger at 1,237 and 2,568 acres, respectively, and the variance in farm size had declined. The coefficient of variation was 1.67 for Colorado and .92 for Montana. Farm sizes had coalesced around the mean.

Figure 6

The pattern of farm size adjustment or "catch-up" from inappropriately small farms resulting from the Homestead Act is shown further in Figure 6. The figure presents mean farm size from1920 through 1987, constructed from census data for the Great Plains. The Great Plains states include eastern Montana, eastern Colorado, the western Dakotas, western Kansas, and western Nebraska. We also have included farm sizes for Midwestern states, where the Homestead Act size constraints were not binding, and for New South Wales, Australia.[64] The Midwestern states include Wisconsin, Minnesota, Iowa, eastern North and South Dakota, eastern Nebraska, and eastern Kansas.[65] We include farm size data for New South Wales as a base line for a comparable wheat-producing region that did not face the same farm size constraints encountered in the Great Plains. New South Wales accounts for approximately one-third of Australian wheat production and has a climate similar to that found in the Great Plains. The figure also shows the linear regression of farm size on time.

As illustrated, in the Midwest, farm sizes only gradually changed. Between 1920 and 1987 mean farm size approximately doubled from 175 acres to 371 acres, with the slope of the estimated adjustment equal to 3.3.[66] The experience of the Great Plains was quite different. Mean farm size in 1920 was 557 acres, and it tripled to 1,648 acres by 1987, with the slope of the estimated adjustment equal to 19.9. For New South Wales, farm size is 2,010 acres in 1920 and rises to 2,862 acres by 1978, the last year for which we have data. The slope of the adjustment is 5.9, which would be lower except for the spike in farm sizes in 1978. Even so, the adjustment path is more similar to that found in the Midwest than in the Great Plains.

The 160-acre limit of the Homestead Act was not a binding constraint in the Midwest. As late as 1920, a 160-acre farm was close to optimal in the region. From that time forward, only moderate farm-size adjustments took place in response to changes in the relative factor prices. Similarly, in New South Wales wheat farms started out large in 1920 and only gradually grew.[67] The homestead limit, however, was binding on the Great Plains. Although farm size grew, it took approximately 50 years before farm size changes in the Great Plains were similar to those in New South Wales and in the Midwest. After 1959 much the catch-up from small homesteads had taken place. The mean percent farm size change between census years from 1920 through 1959 in the Great Plains was 11.6 percent, but between 1964 and 1987 it dropped to 4.1 percent comparable to the mean percent change in the Midwest of 5.6 percent between 1920 and 1987.[68]

X. Conclusion.

One of the most important lessons of Ronald Coase's 1960 article, "The Problem of Social Cost," was that the initial assignment of property rights did not matter for efficiency so long as the transactions costs of reallocation were zero. Various examples, such as the problem of damages inflicted by a cattle-raiser on a farmer's fields, were used to show that if property rights could be costlessly traded, then assignment of liability would have no long-run effect on the allocation and use of resources. Coase recognized, however, that if transactions costs were high, then the liability rule or property rights assignment did matter for the overall value of production: "In these conditions the initial delimitation of legal rights does have an effect on the efficiency with which the economic system operates. One arrangement of property rights may bring about a greater value of production than any other."[69] Coase emphasized the transactions costs associated with searching and negotiating exchanges of rights, but did not dwell upon the transitional period of shifting from one rights arrangement to another and the economic costs that might occur during that time.

In this paper, we have examined a well-known environmental disaster, the Dust Bowl of the 1930s, and argue that it was the result of an inappropriate assignment of property rights to land in the Great Plains. The Homestead Act's allocation of 160 to 320-acre plots resulted in farms that were not only too small to be economically viable over the long-term, but the cultivation practices that took place on them directly contributed to the Dust Bowl. Although there were no particular barriers to the transfer of title to consolidate farms, the process of consolidating farms took 50 years or more.

The initial reaction of the Roosevelt Administration was to acquire many small farms through the Resettlement Administration to facilitate consolidation or to allow the land to be returned to grass land. The dilemma raised by policies that would improve the welfare of small farmers, but make it more difficult to address land use problems through acquisition was recognized at the time. At soil management conference in Pueblo, Colorado, December 12 and 13, 1935, C.H. Wilson of the Resettlement Administration argued “that he was not willing that anything should be done in this area that would improve the condition of the farmers or make the land more desirable for crop production, as that would make it more difficult for the Government to purchase this land and increase the purchase price.” He wanted to take the land out of production.[70] But plans for large-scale government land purchase and removal of the rural population generated opposition from Great Plains politicians and federal agency officials, including eventually Secretary of Agriculture Henry A.Wallace, Assistant Secretary M.L. Wilson, and others. By 1937, Wallace claimed that a major movement of families out of the region “was never contemplated.”[71] These plans were replaced with the system of subsidies and relief to keep farmers on the farm.[72] Although larger farmers received more money per farm from AAA benefit payments, small farms received more money per farm in the form of rehabilitation loans, grants, work relief, and feed and seed loans, with the range of total assistance from all sources between 1933-37 $1,356-$1,660 in the northern Great Plains.[73] As a result of these subsidies, small farms persisted as a legacy of the Homestead Act, slowing the process of consolidation and likely exacerbating the externality and coordination problems in implementing wind erosion control measures. Many small farmers had few alternatives other than to remain on their farms and subsidies helped them to do so. Accordingly, with this support, small farmers continued to farm until retirement, selling at that time.

For example, after 1936, the Farm Security Administration, which replaced the Resettlement Administration, assisted at least one farm family out of six in the Great Plains states.[74] Between 1933 and 1937 per capita relief and benefit payments in the Dust Bowl approached $1,000 in two southwestern Kansas counties and exceeded $500 in 12 other counties in the southern plains. The AAA had a direct objective in limiting farmer migration: "They had nowhere else to go and the Government helped them where they were." The land in crops actually increased in the Dust Bowl counties of the Great Plains between 1930 and 1935.[75] Although, the goal of maintaining small farms may have met other social and political objectives, our framework suggests that it made the problem of combating wind erosion more difficult. A 1940 USDA Office of Land Use Coordination report implies this problem in discussing the role of subsidies in encouraging farmers to stay and expand cultivation: "Farmers had not starved, but progress toward the permanent rehabilitation of the area had been slow."[76]

Small farmers cultivated more of their land in wheat than did large farmers because they were cash constrained and because their land was too limited to diversify into livestock, which required larger tracks for pasture. Small farmers also were less likely to invest in wind erosion control practices, such as fallow and related strip cropping because of the opportunity costs of lost production and because many of the benefits would be captured by adjacent farmers. Their failure to adopt wind erosion control, however, meant that erosion spread to their neighbors. Effective measures to slow surface wind velocity required repeated placement of obstructions on the land. If farms on the Great Plains had been very large, these activities could have taken place within the boundaries of a single unit. Since Great Plains' farms, instead, were small, these activities required coordinated investments. But coordinated action among reluctant small farmers was limited, resulting in little erosion control investment as the both the narrative information and the census fallow data suggest.

The introduction of Soil Conservation Districts after 1937 in the midst of the devastation of the Dust Bowl with coercive authority to force and subsidize cooperation helped to spread erosion control. The districts were much larger than individual farms and thereby could appropriately space wind obstructions. Soil conservation districts implemented control practices throughout the Great Plains, so that by the 1950s drought, the region was less vulnerable to damaging erosion. Also, by the 1950s, farm consolidation had occurred, raising average farm size and reducing the variance around the mean size. There were fewer very small farms on the Great Plains, reducing the externalities associated with erosion control. Larger farms were much more apt to invest in fallow and practices, and the conservation districts that spread throughout the Great Plains promoted coordination among farmers.

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, during the transition period, the Great Plains were subject to severe environmental damage with long-term economic consequences.[77]

Bibliography

Allen, Douglas W., 1991, "Homesteading and Property Rights; or 'How the West was Really Won'," Journal of Law and Economics, 34 (1), April, 1-23.

Allen, Douglas W. and Dean Lueck, 1998, "The Nature of the Farm," Journal of Law and Economics, 41, (2, pt.1) October: 343-86.

Alston, Lee J., 1983, "Farm Foreclosures in the United States During the Interwar Period," Journal of Economic History, 43(4): 885-903.

Bennett, Hugh H. and Frederick H. Fowler, 1936, Report of the Great Plains Drought Area Committee, Washington D.C.: Government Printing Office.

Bennett, Hugh H., 1939, Soil Conservation, New York: McGraw-Hill.

Bennett, John, B., F.R. Kenney, and W.R. Chapline, 1938, " The Problem: Subhumid Areas," Soils and Men, Yearbook of Agriculture,1938, USDA, Washington D.C.: Government Printing Office, 68-110.

Bonnifield, Paul, 1979, The Dust Bowl, Men, Dirt, and Depression, Albuquerque: University of New Mexico Press.

Clawson, Marion, M.H. Saunderson, and Neil W. Johnson, 1940, "Farm Adjustments in Montana, Study of Area IV: Its Past, Present, and Future," Montana Agricultural Experiment Station Bulletin No. 377, Bozeman, January.

Coase, Ronald, 1960, "The Problem of Social Cost," Journal of Law and Economics, III: 1-44.

Cooper, M.R., W.J. Roth, J.G. Maddox, R. Schickele, and H.A. Turner, 1938, " The Causes: Defects in Farming Systems and Farm Tenancy, Soil and Men, Yearbook of Agriculture,1938, USDA, Washington D.C.: Government Printing Office, 137-222.

Coxhead, Ian, 2001, "Consequences of a Food Security Strategy for Economic Welfare, Income Distribution and Land Degradation: The Philippine Case," World Development, **

Clements, Frederic E., 1938, "Climatic Cycles and Human Population in the Great Plains," Scientific Monthly, September, 193-210.

Demsetz, Harold, 1967, "Toward a Theory of Property Rights," American Economic Review, 57 (2): 347-59.

Eckert, Phil S. and Orlo H. Maughan, 1939, "Farm Mortgage Loan Experience in Central Montana," Montana Agricultural Experiment Station Bulletin No. 372, Bozeman, June.

Fite, Gilbert C., 1966, The Farmers' Frontier, 1865 to 1900, New York: Holt, Reinhart, and Winston.

Gutmann, Myron P. and Geoff Cunfer, 1999, "A New Look at the Causes of the Dust Bowl," The Charles L. Wood Agricultural History Lecture Series 99(1): 1-25.

Hargreaves, Mary W.M., 1976, "Land-Use Planning in Response to Drought: The Experience of the Thirties," Agricultural History, 50(4): 561-82.

Hewes, Leslie, 1979, "Agricultural Risk in the Great Plains," in Brian W. Blouet and Frederick C. Luebke, eds, The Great Plains: Environment and Culture, Lincoln: University of Nebraska Press, 157-85.

Hibbard, Benjamin H. 1924, reissue, 1965, History of Public Land Policies, New York: Macmillan.

Huffman, Roy E. and James L. Paschal, 1942, "Integrating the Use of Irrigated and Grazing Land in the Northern Great Plains," The Journal of Land and Public Utility Economics, 18, 17-27.

Hurt, R. Douglas, 1981, The Dust Bowl: An Agricultural and Social History, Chicago: Nelson-Hall.

________________, 1985, "The National Grasslands: Origin and Development in the Dust Bowl." Agricultural History, 59: 246-59.

Johnson, Sherman, E., 1937, "Land Use Readjustments in the Northern Great Plains," Journal of Land and Public Utility Economics, 8: 153-62.

Johnson, Vance, 1947, Heaven's Tableland: The Dust Bowl Story, New York: Farrar, Straus, and Co.

Kellogg, Charles E., 1935, "Soil Blowing and Dust Storms," USDA Miscellaneous Publication No. 221, Washington D.C.: Government Printing Office.

Kifer, R.S. and H.L. Stewart, 1938, Farming Hazards in the Drought Area, WPA Research Monograph XVI, Washington D.C.: Government Printing Office.

Kimmel, Roy I, 1940, " Unit Reorganization Program for the Southern Great Plains," Journal of Farm Economics, 22: 264-69.

Kislev, Yoav and Willis Peterson, 1982, "Prices, Technology, and Farm Size," Journal of

Political Economy, 90 (3): 578-595.

Knoeber, Charles, 1997, “Explaining State Bans on Corporate Farming,” Economic Inquiry, 35 (January): 151-66.

Kraenzel, Carl F., 1942, “New Frontiers of the Great Plains,” Journal of Farm Economics, 24: 571-88.

________________, 1955, The Great Plains in Transition, Norman: University of Oklahoma Press.

Libecap, Gary D., 1981, Locking Up the Range: Federal Land Use Controls and Grazing. Cambridge: Ballinger.

Libecap, Gary D. and Zeynep K. Hansen, 2001,“’Rain Follows the Plow’ and Dryfarming Doctrine: The Climate Information Problem and Homestead Failure in the Upper Great Plains, 1890-1925,” forthcoming, Journal of Economic History.

Noll, Roger G. and James E. Krier, 1990, “Some Implications of Cognitive Psychology for Risk Regulation,” Journal of Legal Studies, 19, June, 747-79.

Powell, John Wesley, 1878, Report on the Lands of the Arid Region of the United States, 45 Congress, 2nd Session, Executive Document, No. 73., Washington D.C.: Government Printing Office.

Peffer, E. Louise, 1951, The Closing of the Public Domain: Disposal and Reservation Policies, Stanford: Stanford University Press.

Renne, Roland, 1936a, “Western Land Policies and Recent Ownership Trends,” Journal of Land and Public Utility Economics, 7: 33-43.

________________, 1936b, “Montana Land Ownership: An Analysis of the Ownership Pattern and Its Significance in Land Use Planning,” Montana Experiment Station Bulleting No. 322, June, Bozeman.

Rucker, Randal R. and Lee J. Alston, 1987, “Farm Failures and Government Intervention: A Case Study of the 1930’s,” American Economic Review, 77 (4): 724-30.

Saunderson, M.H., R.B. Haight, E.M. Peterson, and Rex. E. Willard, 1937, “Ann Approach to Area Land Use Planning,” Land Use Planning Publication, No. 16, USDA, Resettlement Administration, Washington D.C.

Smith, Henry Nash, 1970, Virgin Land: The American West as Symbol and Myth, Cambridge: Harvard University Press, 1950, reissued.

Starch, E.A., 1936, "Readjusting Montana's Agriculture, VII, Montana's Dry-Land Agriculture," Montana Experiment Station Bulletin No. 318, April, Bozeman.

________________,1939, "Type of Farming Modifications Needed in the Great Plains," Journal of Farm Economics, 21, 114-120.

Stegner, Wallace, 1954, Beyond the 100th Meridian: John Wesley Powell and the Second Opening of the West, Boston: Houghton Mifflin.

Stephens, P.H., 1937, "Why the Dust Bowl?" Journal of Farm Economics, 19 (3), August, 750-57.

Steinbeck, John, 1939, The Grapes of Wrath, New York: Viking.

Thorfinnson, T., F. Cronin, and R. B. Hile, 1939, Size of Farm in Relation to Family Requirements in the Northern Plains, USDA, Bureau of Agricultural Economics, Washington D.C.: Government Printing Office.

Thornthwaite, C. Warren, 1936, "The Great Plains," in Goodrich, Carter, et. al, eds, Migration and Economic Opportunity: Report of the Study of Population Distribution, Philadelphia: University of Pennsylvania Press, 202-50.

United States Great Plains Committee, 1936, The Future of the Great Plains, Washington D.C.: Government Printing Office.

U.S. Department of Agriculture, Yearbook of Agriculture, various years.

U.S. Soil Conservation Service, USDA, 1937, Soil Conservation Districts for Erosion Control, Miscellaneous Publication No. 293, Washington D.C.

Vamplew, Wray, ed., 1987, Australians: Historical Statistics, Broadway, NSW: Fairfax, Syme & Weldon Associates.

Webb, Walter Prescott, 1931, The Great Plains, Boston: Ginn and Company.

Woodruff, N.P, Leon Lyles, F.H. Siddoway, and D.W. Fryrear, 1972, "How to Control Wind Erosion," Agriculture Information Bulletin No. 354, Agricultural Research Service, USDA, Washington D.C.

Worster, Donald, 1979, Dust Bowl: The Southern Plains in the 1930s, New York: Oxford University Press.

________________, 2001, A River Running West: The Life of John Wesley Powell, New York: Oxford University Press.

[1] Farm Security Administration, "The Great Plains Yesterday, Today and Tomorrow," Merrill G. Burlingame Special Collections, 00002, Box 32, Montana State University Bozeman.

[2] The historical literature on the Dust Bowl is large. Standard references include Worster (1979), Bonnifield (1979), and Hurt (1981). More recent work is by Gutmann and Confer (1999). The USDA and agricultural economics literature provide more quantitative data. For an assessment of the impact of the Dust Bowl, see Worster (1979, 5, 12, 13, 29, 22-24) and Bennett (1939, 55-87). Bennett was head of the Soil Conservation Service.

[3] **we may have something--Unfortunately, so far as we are aware, there are no quantitative comparisons of wind erosion across the three periods. Nevertheless, no one has claimed that the 1950s or 1970s erosion was on the scale of that which occurred in the 1930s. See assessment by Hurt (1981, 145-54). Helms (1990b) suggests that wind erosion in the 1950s was less severe arguing that by that time there had been the accumulation of conservation practices on the Great Plains. The memo from D.A. Williams, Administrator of the Soil Conservation Service to State Conservationists, SCS, April 28, 1954, p. 5 compares the situation in 1954 with that in the 1930s and states that conditions are better in the 1950s, with less erosion due to conservation practices. National Agricultural Library, USDA History Collection, Special Collections.

[4] See Johnson (1947, 135-54), Worster (1979). A famous video documentary was prepared in 1936 by the Resettlement Administration under Rexford Tugwell, titled, "The Plow that Broke the Plains." See also, Kellogg (1935) and Lord (1938). Bennett (1939, 729, 738-42) outlines the land use problems of the Great Plains made severe by the region's climate and extensive cultivation. He also outlines protective practices.

[5] The 1937 Yearbook of Agriculture, pages 33-37 commented on the severe drought that prevailed in 1936 and for the previous 3 years. Gutmann and Cunfer (1999) argue that high temperatures in the 1930s played a critical role. They agree that cultivation practices compounded conditions. They do not find a clear relationship between wheat acreage and the incidence of wind erosion. But they do not examine cultivation practices on small farms.

[6] As early as the mid 1920s, USDA publications and those of the state agricultural extension services in the Great Plains outlined a variety of practices, crops, and equipment that could promote productivity and reduce wind erosion during drought. For example, see Seamans (1921) and Wilson (1923). See also, Hurt (1981, 67-8).

[7] Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, and Texas. U.S. Soil Conservation Service data, National Archives, Record Group 114, MLR 1172, Box 1.

[8] The Soil Erosion Service in the Interior Department was created in 1933 and transferred to the Department of Agriculture as the Soil Conservation Service in 1935. Soil Conservation Districts were created throughout the U.S. to address water erosion problems as well.

[9] Coxhead (2001) examines a similar case where government policy has inadvertent negative environmental consequences. He argues that corn price support programs in the Philippines encourage expansion of cultivation in frontier, upland agronomic zones and correspondingly to land degradation through greater erosion. He concludes that environmental consequences should be considered in evaluating agricultural policies aimed at self-sufficiency and price stability. Alban Thomas brought this study to our attention.

[10] There is a large historical literature on the Dust Bowl. Important references include Worster (1979), Bonnifield (1979), Hurt (1981), and Gutmann and Confer (1999). The USDA and agricultural economics literature provide more quantitative data. For an assessment of its impact, see Worster (1979, 5, 12, 13, 29, 22-24) and Bennett (1939, 55-87). Bennett was head of the Soil Conservation Service.

[11] Hurt (1981, 3-4). See also USDA, Office of Land Use Coordination, Editorial Reference Series, No. 7, "The Dust Bowl: Agricultural Problems and Solutions," p. 1, gives peak years of 1935 and 36 and outlines the areas involved. USDA History Collection, Special Collections, National Agricultural Library.

[12] Bennett (1939, 119-21), Hurt (1981, 35).

[13] Thornthwaite (1936, 238-40). In 1936 Bennett and Fowler (1936, 8) claimed that because of the dust storms of 1934 and 35, 80 percent of the Great Plains were in some state of erosion, with "as much as 15 percent may already have been seriously and permanently injured."

[14] Bennett (1939, 118), 1938 Yearbook of Agriculture, "Soils and Men," page 71.

[15] "The District Program of the Western Baca County Soil Erosion District," National Archives, Record Group 114, MLR 1176(A1), Box 93. The date is probably 1938.

[16] National Archives, Record Group 114, MLR 1, Box 72. Worster (1979, 21-23) states that respiratory illness was significantly higher in the 45 western Kansas counties in the Dust Bowl than in the rest of the state.

[17] National Resources Planning Board (1940, 1).

[18] National Resources Planning Board (1940, 3), U.S. Resettlement Administration (1936) and Link (1937, 8-11). Migration patterns in the Great Plains during the 1930s are discussed in Taeuber and Taylor (1937, 45-7, 52-3).

[19] Cronin and Beers (1937, 27).

[20] Stephens (1937), Starch (1939), U.S. Great Plains Committee, (1936, 27-32) reported that the climate of the region was uncertain with light rainfall and the windiest conditions in the US. Clements (1938, 199) argued that cultivation was the key causal factor in the Dust Bowl. Gutmann and Cunfer (1999) point out that drought conditions associated with the Dust Bowl have long characterized the Great Plains. Whether or not wind erosion as severe as that of the 1930s occurred earlier is unknown. If our hypothesis is correct, it is unlikely. In their study, Gutmann and Cunfer statistically examine the determinants of dust storms between 1961 and 1988 for 39 weather stations in the Great Plains where relatively complete data exist. Because data are not available for the Dust Bowl years, they use the estimated coefficients to predict the incidence of dust storms for Great Plains counties between 1930 and 1990. Their results under predict the number of dust storms for 1934-35, the test period. They argue that unusually high temperatures during that time were major contributing factors.

[21] This discussion of erosion and its control is drawn from Woodruff, Lyles, Siddoway, and Fryrear (1972). See also Johnson (1947, 193) and Worster (1979, 14, 15).

[22] Hurt (1981, 18).

[23] Kansas surveys and discussion, 1933, National Archives, Record Group 114, MLR Entry 1, Box 228.

[24] 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?? Entry 1, 200 Projects, Box 4.

[25] The importance of strip cropping to reduce wind erosion is described in Kell and Brown (1938, 30-32). Some of the uncertainties regarding the effects of investing in erosion control are described in Held and Clawson (1965, 25-7). Chepil (1959) describes the optimal size of strips and Craig (1959) summarizes erosion control practices.

[26] Hurt (1891, 121-37).

[27] 35 Stat. 693.

[28] Annual Reports of the Commissioner of the General Land Office for the Fiscal Years, 1880-1925. The calculations are for state totals.

[29] From Renne (1935, 425). Renne claimed that Musselshell County was representative of ownership patterns in the western Great Plains.

[30] For example, see Renne (1935, 427), Cochrane (1938), and Halcrow (1938).

[31] Costs included the cost of specialized equipment for contour terracing, strip cropping, and listing, as well as the lost output in property adjacent to windbreaks. Windbreak trees absorbed nutrients and moisture, hurting adjacent crops (Greb and Block, 1961, 223-6).

[32] See Mathews and Clark (1932).

[33] Hannah (1950), Hines (1952) in the Journal of Soil and Water Conservation discuss the externality problem.

[34] Worster (1979, 85). In examining the causes of the Dust Bowl, Bennett, Kenney, and Chapline (1938, 68-76) criticized past homestead policies and pointed to "repeated attempts at too intensive use of the soil have resulted in serious problems of depletion, in destruction of physical resources…."Kimmel (1940, 264) linked the Dust Bowl to the dense settlement of the plains by homesteaders who put the land into cultivation, displacing grass land. Bennett and Fowler (1936, 4-10) emphasized the use of farming practices that were brought from the East, but inappropriate for a semi-arid region. They particularly pointed to excessive plowing. They also pointed to overgrazing as contributing to the removal of land cover. How important this was in a region dominantly in grain is unclear. Ranchers did have very uncertain property rights to range land because they could not obtain title to the land that they used under the land laws. For discussion of this issue, see Libecap (1981). USDA and Extension Service personnel blamed U.S. land policy for placing hundreds of thousands of small farms on site, and policies to encourage larger farms were urged. Huffman and Paschal (1942) argue "A misguided land settlement policy of the federal government resulted in the settlement of a large part of the Northern Great Plains in relatively small tracts." The USDA Yearbook of Agriculture (1940, 409) concluded: "The ill-advised application of homestead policies to this territory [Great Plains] divided the land into small units of 320 or640 acres, where operating units of several sections [1,280-1,920 acres] were requisite." See Kraenzel, (1942, 583-6), "On the whole, farms are too small in the Great Plains region. This is the result of homesteading practices." He called for diversification. Stephens (1937, 751), and Bennett and Fowler (1936, 4).

[35] Since farm size is reported in size groups, the mid point of each of the size categories was used. For the largest farm size, 3000 acres was used.

[36] Initially, we have categorized counties as to intensity of drought using the maps provided in USDA, SCS, Great Plains Area Generalized Map Showing Dominant Conditions of Erosion, 1934, National Archives, Record Group 114, Soil Conservation Service, Box 57 (MLR?), Kifer and Stewart, 1938, p. 9, U.S. Great Plains Commission, 1936, p. 29. We will refine these measures.

[37] 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 Entry 1176 (A1), Box 28.

[38] Our reading of the secondary literature, as well as research of primary sources reveals little mention of private coordination efforts to combat wind erosion.

---

[39] First Annual Report, Pony Creek Project, Guyman, Oklahoma, June 30, 1936, National Archives, Record Group 114, MLR Entry 1176 (A1), Box 45.

[40] Simms (1970) provides a history of the SCS. Chilcott (1937) outlines techniques to prevent soil blowing. Bennett (1939, 742, 747) describes the efforts of the SCS on the Great Plains in the 1930s.

[41] For discussion of demonstration farms and the lack of enthusiasm among farmers, see Helms (1990, pp. 13-15). Bennett (1939, 361, 737) describes the use of strip cropping and points out that many farmers did not adopt such techniques.

[42] 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 Entry 1, Box 74.

[43] Hurt (1981, 70-3), 1938 Yearbook of Agriculture, "Soils and Men," pages 686-688. Summer fallow was the greatest source of moisture conservation. Hewes (1979, 167) discusses the costs of summer fallow, but does not make specific reference to whether small farms used it or not. Kraenzel (1955, 311) also discusses the problems of small farmers with a maximum of 320 acres. He noted that summer fallow could not make progress until farms were large enough. See also, Clawson, Saunderson and Johnson (1940, 36-41). Renne, (1936a, 33) argued that ranches in the Great Plains had to be 6 to 8,000 acres to sustain a minimum sized herd of 200 animals and a farm 800 acres to allow for a minimum of 400 acres in crop and 400 acres in fallow each year.

[44] Record Group 16, Office of the Secretary of Agriculture, Box 2639, emphasis added.

[45] Record Group 114, Soil Conservation Service, Box 4, National Archives.

[46] Record Group 114, Soil Conservation Service, Box 6, letter Bennett to Duley, August 20, 1935.

[47] Bennett (1939, 315-22) was the first head of the SCS and he describes his call for a national program and the adoption of state soil conservation district statutes. Held and Clawson (1965, 49) discuss the problem of non-cooperating farmers and the corresponding effort in some states to include regulatory power in their statute.

[48] Green Creek Project, TEX-8, Dublin Texas, 1937, National Archives, Record Group 114, MLR Entry 1001, Box 65, and Dalhart, Texas Project, TEX-3, 1939, National Archives, Record Group 114, MLR Entry 1154, Box 1.

[49]The "Report of the Committee on Cooperation of Private Landowners," N.d. National Archives, Record Group 114, Soil Conservation Service Central Files, Box 4. **do not have the MLR.

[50] Helms (1990, 30-1).

[51] Annual Report of the Chief of the Soil Conservation Service, Washington D.C., 1953; Simms (1970, 77, 81).

[52] Helms (1990, 47). 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 the land use regulation (Helms, 49, Held and Clawson, 1965, 49). Montana gave more authority to conservation district supervisors than did the model law, see Feldmeir (1949). Hurt (1981, 74-7) describes adoption of soil conservation district statutes in the southern Great Plains. Kansas' initial statute had taxing authority to assess property for the costs of combating wind erosion. A non-complying farmer challenged this authority successfully in the state supreme court.

[53] "AAA's Part in Limiting Farm Family Migration," USDA History Collection, Special Collections, National Agricultural Library.

[54] "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. The federal government also sought to remove "submarginal" land from production by purchasing it under Title III of the Bankhead-Jones Act. 6 million acres in the southern Great Plains out of 32 million in cultivation were thought too poor to remain in cultivation. "Activities of Federal and State Agencies in Solving Agricultural Problems of the Southwest," address by Roy I. Kimmel, Coordinator Southern Great Plains, February 10, 1939, Manhattan Kansas, History Collection, Special Collections, National Agricultural Library.

[55] Farm Service Agency Files, Helena Montana. Agency files include petitions for organizing districts, votes, and general reports on SCD activities. There is little indication of active opposition and lists of advocates and voting results, where acreage is provided reveals broad support.

[56] Both quotes from Partain (1939, 357-8).

[57] Letter from J. Phil Campbell, Head Cooperative Relations in Extension to I.K. Landon, Kansas State Coordinator, Soil Conservation Service, October 8, 1937, National Archives, Record Group 114, SCS Files MLR 1176(A1), Box 28.

[58] Great Plains Committee (1936, 105-7).

[59] Letter to H.H. Bennett, Chief SCS, 9/4/35, National Archives, Record Group 114, MLR Entry 1, Box 13.

[60] Hockley and Walker (1939). Wehrwein (1936, 312-3). Kansas had even earlier legislation. The laws were considered drastic, and the Kansas law initially was not enforced. The Kansas law was declared unconstitutional in 1936 by the Kansas Supreme Court because it gave too much taxing power to county commissioners. A new law was passed in 1937 with taxing power held by the Secretary of State to create a soil drifting fund (Teagarden, 1937).

[61] "Aid Available to Farmers in Controlling Wind Erosion," 5-27-38, p. 7, National Archives, Record Group 16, Records of the Office of the Secretary of Agriculture, General Correspondence, Box 2873, **no MLR.

[62] Soil Conservation Service (1937, 14).

[63] 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 from Ira K. Landon, State Coordinator to D.S. Meyer, USDA, SCS, September 7, 1937, National Archives, Record Group 114, MLR 1176(A1), Box 28.

[64] Farm size data for New South Wales are from Vamplew (1987, 72-3). Both the U.S. and Australian data sets include crop and pasture land.

[65] For the transitional states that were bisected by the 100th meridian we used county data following the Great Plains division described in Hargreaves (1957) for Montana and the Dakotas and Fite (1966) for Kansas. We connected these divisions through Nebraska. We also used just the eastern, non-mountain counties of Colorado.

[66] Kislev and Peterson (1982) analyzed the growth in farm size for the United States as a whole from 1930-1970, where per farm size grew at an annual rate of 2.2 percent. They attribute this growth to changes in

the relative price of farm labor to machinery, which grew at almost the same rate. Further, they argued that technical improvements were similar across machine types.

[67] For discussion of Australian land policy, see **

[68] These are the mean percent changes in farm size calculated from census period to census period using the data from Table 1.

[69] Coase (1960, 16). See also Demsetz (1967, 349) for elaboration.

[70] "Report of Dust Control Conference," Pueblo, Colorado, December 12-13, 1935, Agricultural History Collection, Special Collections, USDA National Agricultural Library.

[71] See radio talk by Secretary Wallace, January 12, 1937, "The Rural Resettlement Administration of the Department of Agriculture," Merrill G. Burlingame Special Collections, 2001, Box 6, Montana State University, Bozeman.

[72] See letter from Wallace to President Roosevelt, September 20, 1939 voicing concern about accumulation of large land holdings in western Kansas. Another letter from Elinor Roosevelt to Mrs. Jack Havercamp of Grinnell, Kansas, n.d., discussed the role of the Farm Security Administration in enabling small farmers to keep farming, National Archives, Record Group 16, Records of the Office of the Secretary of Agriculture, General Correspondence, Box 3018, no MLR**; See also letter from M.L. Wilson to Curtis L. Mosher, October 7, 1935, National Archives, Record Group 16, Records of the Office of the Secretary of Agriculture, General Correspondence, Box 2195, no MLR**; "Officials in this county [Baca, Colorado] are reluctant toward encouraging the removal of farmers to other areas, because of increased financial burdens resulting from removed farmers," "Summary of Project Report on Springfield District, Baca County, Colorado, May 10, 1935, National Archives, Record Group 114, Soil Conservation Service Central Files, Box 6, **no MLR. Letter from For a chronology of agricultural programs in the Great Plains, see "Chronology of the Land Utilization Program," USDA History Collection, Special Collections, National Agricultural Library. For discussion of efforts to maintain the family farm while expanding its size and making it more efficient, see pamphlet, "Whither, the Family Type Farm," USDA History Collection, Special Collections, National Agricultural Library. E.A. Starch's "Coordinated Re-development Activities within the Great Plains," n.d. notes the hostile reaction of those in parts of the Great Plains whose land was deemed 'submarginal' and not fit for cultivation, implying that migration was the only solution. USDA History Collection, Special Collections, National Agricultural Library.

[73] In a sample of 74 small and 53 large farms in South Dakota, 1933-37, the average assistance payment from all sources—AAA, emergency grants, rehabilitation loans--per large farm was $1,660 and per small farm was $1,356 (Thorfinnson, Cronin, and Hile, 1939, 9).

[74] "Activities of Federal and State Agencies in Solving Agricultural Problems of the Southwest," address by Roy I. Kimmel, Coordinator Southern Great Plains, February 10, 1939, Manhattan Kansas, History Collection, Special Collections, National Agricultural Library.

[75] USDA, Office of Land Use Coordination, Editorial Reference Series, No. 7, 1940, "The Dust Bowl: Agricultural Problems and Solutions," p. 16, USDA History Collection, Special Collections, National Agricultural Library. See also, "AAA's Part in Limiting Farm Family Migration," USDA History Collection, Special Collections, National Agricultural Library. Benefit earnings were provided to 80 percent of Nebraska's farmers for example. Other payments included those through commodity loans, and subsidized crop insurance. Letter , 2/25/35 from M.H. Farris to James Farley pointing out that there were no jobs in the cities for displaced farmers, so there was a need to keep them on the farm. Huey Long had made the plight of small farmers, especially tenant farmers, a political issue and there was concern about its impact on Roosevelt's re-election. National Archives, Record Group 16, Records of the Office of the Secretary of Agriculture, General Correspondence, Box 2253, no MLR**.

[76] 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.

[77] Coxhead (2001) examines a similar case where government policy has inadvertent negative environmental consequences. He argues that corn price support programs in the Philippines encourage expansion of cultivation in frontier, upland agronomic zones and correspondingly to land degradation through greater erosion. He concludes that environmental consequences should be considered in evaluating agricultural policies aimed at self-sufficiency and price stability. Alban Thomas brought this study to our attention.