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American Agriculture in an Uncertain Global Economy

Willard W. Cochrane

During the 20th century, America had four basic policy goals for the food and agricultural sector: 1) producing an abundant supply of food, at reasonable prices, for the nation; 2) assuring a prosperous and productive economic climate for farmers; 3) maintaining the family farm as the basic unit of production in the food-supply chain; and 4) promoting a high quality of life for all individuals living in rural areas. How well did we do? The first goal was achieved relatively easily because the U.S. enjoys an abundance of resources and has led the world in developing scientific and technological innovations to increase agricultural production.

The second goal, however, met with much less success because the food-producing industry is inherently unstable. The main economic explanation for this instability is that the aggregate *demand* for food—in the short run at least—and the aggregate *supply* of basic food products are highly inelastic. Thus, any small shift either in the aggregate demand or supply of food products leads to a large price response, up or down—with a consequent change in farm incomes. A variety of factors, such as war, peace, long-term droughts, or major technological breakthroughs, continuously shift the aggregate demand or supply of food. As a result, the food-producing industry cannot, and will not, level off at some desirable economic level and stay there. Economic forces—especially inelastic aggregate demand and inelastic aggregate supply—won't let it.

Other major sources of the food system's instability during the past 70 years were the government's farm-support programs; notably, price support, deficiency payments, and acreage controls. These lacked the capacity and, in many cases, the appropriate design to cope with the great downward swings in farm prices—some of which were generated by a faltering aggregate demand and others by a surging aggregate supply. For example, it took the mammoth programs of World War II, and the once-in-a-lifetime increase in the demand for farm products that these programs created, to pull the farm sector out of the deep depression of the 1930s.

In the 1960s, however, farmers and their political leaders rejected the idea of turning the food-producing industry into a government-managed monopoly or public utility as a way of coping with the unruly shifts in aggregate demand and supply. Perhaps that was the proper

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The Economics of Windbreak Renovation

Mamane Annou and Glenn Pederson

Farmers and others who remember the Dust Bowl in the 1930s may still have a high regard for field windbreaks—rows of trees and shrubs planted to control wind damage. In the 1930s, new windbreaks were established throughout the northern Great Plains to reduce soil loss and improve soil productivity. Today, about 54,000 miles of these windbreaks remain in Minnesota, North Dakota, and South Dakota, but that number is steadily declining. Of this total, Minnesota accounts for only 5,000 miles, located primarily in the Red River Valley. All other states combined have 42,000 miles of windbreaks.

Windbreaks have multiple uses and provide multiple private and social benefits. They protect field crops during the growing season, enhance moisture by controlling snow distribution, and provide a habitat for wildlife. In addition, windbreaks provide attractive landscapes in rural areas.

Field windbreaks, however, are costly to establish, and equally costly to maintain and renovate. Windbreaks are becoming less effective at sheltering crops and controlling moisture because older windbreaks are losing trees that are not being replaced. For example, a survey conducted in 1979 found that 21 percent of windbreaks needed renovation and that, among windbreaks that were over 50 years old, one out of two were being removed and would not be replaced. Based on a similar survey done in 1992, we estimate that 70–90 percent of windbreaks in North and South Dakota need renovation.

For more than 60 years, government programs encouraged the planting of windbreaks by sharing the costs of acquiring and planting new trees. Currently, the Environmental Quality Incentive Program (EQIP) and the Stewardship Incentive Program (SIP) are the most comprehensive subsidy programs

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decision at the time for the nation. But, once again in 1999, falling global demand for U.S. agricultural products has pushed the food-producing industry into a depression.

Maintaining the Family Farm

Efforts to achieve the third farm policy goal have met with even less success. The total number of farms in the U.S. declined from 6.5 million in 1935 to 2 million in 1997. Most of this huge decline took place among family farms. Moreover, even the 2 million figure is an overstatement, because 1.3 million "farms" (or about 63 percent of the present day total) are limited-resource, residential, or retirement farms—leaving approximately 700,000 actively managed farms in the nation. Since 1935, therefore, the nation has lost 4.5 million farms, most of which were family farms. Today there are about 540,000 small- to medium-sized family farms and 160,000 large farms struggling to survive in the midst of a farm depression. How did this happen? There are a variety of causal explanations. Certainly, some farmers fell by the wayside because they were poor managers, but does that explain a net loss of 4.5 million farms? I think not.

Three factors explain these changes. First, the roller-coaster-like behavior that the farm sector experienced in the 20th century caught many farmers in exposed financial positions and, as a result, many were forced out of business when their product prices fell sharply. Families just getting started in farming and those engaged in expanding their operations were especially vulnerable.

Second, farm programs, which were put in place to help family farmers, in fact, contributed to the demise of many of them. These support programs provided income or price support depending on the number of units that a farmer produced, and the more a farmer produced, the more price or income support he or she received. As a result, the strong became stronger and the weak became weaker—until the weakest dropped out of farming.

And third, the rush to adopt modern technology forced many farmers out of business—particularly the smaller ones, or those on the financial edge. Much of the new mechanical technology was not size neutral, because large tractor hookups required large acreages over which to spread the huge costs of such hookups and thereby gain economic efficiencies from adopting them. The adoption of large, expensive machines pushed farmers in the direction of acquiring more land—but where could they get it? From their smaller neighbors, of course. And even size-neutral technologies like new and improved seeds put additional financial burdens on the farmer to purchase seeds—and the fertilizer and the herbicides to go along with the new seeds. As a result, the costs of planting a crop of corn skyrocketed from 1950 to 1999, which caused many farmers on the financial edge to sell out to their more successful and aggressive neighbors.

Where Agriculture Stands Today

Today, a small number of very large farmers produce about two-thirds of the nation's grain, livestock, fruit, and vegetables. The remaining third is produced by small- to medium-sized family farmers, who are struggling to survive. I say "struggling to survive" because smaller farmers do not have access to the favorable rates of short-term credit and long-term capital enjoyed by large, corporate farmers. In addition, small farmers are excluded from using the latest products of the biotechnology industry—such as genetically modified seed—unless they enter into production contracts with the agribusiness firms that supply these technologies. Such changes, and the farm depression of the 1990s, I believe, will continue to put family farmers out of business.

Rural Communities Decline as Family Farmers Go Under

It is questionable whether the quality of life in rural areas has improved over the past 100 years. Certainly the poorest of the poor still remain out there—in small rural towns, in backwater agricultural areas, and in immigrant labor camps. Federal governmental efforts to aid these people have been minimal, and even those efforts have been opposed by conservative farm organizations. But probably the most important negative factor has been the decline in the number of family farms, and decimation of the human population in the countryside. As farm families have disappeared, so has the support for small towns and the services they provided such as health, educational, shopping, and repair services. In many farming areas, neighborhood activities have simply disappeared with the people.

Current Trends in U.S. Agriculture

In commercial agriculture today, two developments are creating problems for family farmers—and the outcome of these developments will determine their fate.

The first problem is the continuing struggle, which is often minimized by economists, over who controls the use of productive resources on farms. Do family farmers or multinational corporations control these resources? The outcome of this struggle will determine whether there are any independent family farmers left in the year 2010.

The second problem is the continuing price-income crisis, which will determine whether family farmers remain in business or go under in the next few years. Both of these problems, although different in nature, will have a similar consequence for the family farmer.

Farms Are Growing Larger and More Industrialized

Since the 1970s, the productive resources of the food-producing industry have become concentrated in a relatively small number of large, corporate farms. These farms are characterized, as a general rule, by the following features:

- inputs are strictly controlled with the aid of computer technology;
- the farms are usually tied by contract, either to an input-providing agribusiness or processing firm, both of which make important business decisions for the farmer;
- the farms use factory-like conditions to boost production—particularly in the livestock industry.

All of these trends are taking place in a rapidly changing and often unpredictable global economy. In my view, farming is not farming anymore because food production is now an industrialized business in which important operating decisions are made by agribusiness executives and not by local farmers themselves.

I strongly believe that with the increased use of contracts, patents, and financial controls, the food-production sector is being converted into a poorly understood area of monopolistic-competition. Moreover, continued developments in this direction could have dire consequences for both farmers and consumers alike.

Fewer Buyers and Suppliers Are Creating an Oligopoly

Another trend in today's food-production industry is the reduced number and increased size of the corporations in each segment of the industry. As a result, the market power of the corporations that remain is increasing. In the past, most agricultural research was conducted by small groups scattered across the nation in universities, federal government, and midsized agricultural firms. Today, however, much agricultural research is done by large, multinational corporations, which allows them to create product monopolies. At the input supply level an oligopolistic structure is the norm. For most nonfarm produced inputs (for example, herbicides and farm machinery), a few large firms supply most of the products. In addition, at the handling and processing level, local farmers find few local buyers for their products. And at the retail level, the distribution and sale of food products is concentrated in a relatively few very large chains such as Kroger, Albertsons, Wal-Mart, Safeway, and Ahold, which are responsible for 40 percent of all retail food sales in the U.S.

Small Farmers Have Little Power in the Market

Only at the farmer-producer level do we find the classic atomistic market structure—that is, a situation where each seller is so small relative to the whole market, that he or she can have no appreciable effect on price. As a result the typical farmer-producer has no market power. At the input supply level, monopolists or oligopolists set the price on their product that best suits their long-run needs—and the farmer-producer can take it or leave it. Similarly, at the handler/processor level, monopolists or oligopolists set the price they will pay—and the farmer-producer, again, can take it or leave it.

Big Corporations Are Destroying the Small Farmer

Today, many suppliers of farm inputs enjoy near monopolies (and consequently, high prices) for their products, which is putting many small family farmers out of business. With the current move against monopolies in other industries (for example, the recent court proceedings against Microsoft), I suggest the Justice Department form a special unit in the monopolies division to investigate the monopolies that are being formed in the agricultural industry. Monopolies, however, are not the only problem; the very bigness of big business creates a problem in itself. *Bigness is the problem*—and the power that bigness brings with it.

Introduce a giant corporation providing a commonly used farm input into a local farming community, and it will have an advantage in every transaction, or activity, that it enters into—from fixing terms with a local farmer, to obtaining a tax-free site from the local government on which to locate its plant, to squeezing its local competitors. The power such a corporation wields will often disrupt and overwhelm the local business environment.

Global Demand for Food Is Highly Inelastic

Are other factors contributing to the decline of the family farmer? One factor that is undoubtedly causing the family farmer problems is the inelastic nature of the world's demand for food.

The global market for food products is a closed system with a given population distribution, a given income distribution, a given set of national laws and rules, and a given set of human tastes and preferences. Taking account of these givens, there exists at any point in time a *global demand* for food products. This concept may be difficult to measure, but it is real and is *highly inelastic.* Global demand for food is highly inelastic because the stomach of each individual in the world can only take in a finite amount of food.

The continuing increase in world production of food products in recent years, in combination with the erratic shifts in the severely inelastic global demand for those products, has led to disastrously low prices for those products—and business failure for many American farmers. It should be noted, however, that all food product prices will not rise or fall in lock step; the major products most directly affected by developments in the global economy will lead the way, and the pricing behavior of those products will spread to other products through the ubiquitous substitution process in the global market system.

As suggested above, both the global demand for food products and the aggregate supply of those products will continue to expand as populations and national economies grow. Supply and demand, however, are unlikely to grow at the same pace because the underlying factors that affect each are different. Population growth and income growth are the principal determinants of demand, while climate change, new research, new technologies, and spending on capital items (such as irrigation systems) are leading determinants of supply.

Thus, it seems likely that, on occasions, aggregate global supplies of food products will push ahead of aggregate demand, which will cause farm prices to fall sharply. On other occasions, aggregate demand will push ahead of aggregate supply, causing farm prices to shoot skyward. Whenever either happens (and I believe both will happen frequently), consumers can expect food prices to change—and change dramatically.

Food prices can change dramatically as a result of the interaction between a severely inelastic global demand for food products and an unpredictable aggregate supply of those products within the global economy. Consumers will continue to experience severe changes in food prices as long as humankind influences the nature and slope of the aggregate demand curve for food products. Thus, food producers, both large and small, would be wise to recognize that theirs is a high-risk industry. Domestic policies can mitigate the impacts of these price risks but they cannot eliminate them.

Family Farmers Must Organize to Survive

History tells us that boom times are the dangerous times for farmers. During

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such periods, producers tend to get carried away; they expand their operations with generous applications of credit and forget that boom times have always been followed by hard times—times when those who have over-extended their credit, unfortunately, go broke.

Agriculture is a high-risk, unpredictable, and unstable industry. What can family farmers do? Fold their tents and steal away into the night? There is, I believe, another option. They could form a national association—call it the National Trade Association of Family Farmers (NTAFF).

A powerful trade association of family farmers could achieve some important objectives. A newly formed NTAFF could

- bargain with Congress for new farm legislation that favors small farms and reduces the amount of support that goes currently to corporate farms,
- bargain with state governments to implement favorable tax provisions for family farmers,
- bargain with suppliers for the kinds of inputs that meet the requirements of small family farmers,
- negotiate contracts with suppliers that benefit family farmers such as giving them access to the same discounts enjoyed by corporate farmers, and
- bargain with handlers and processors to find new market outlets and buyers for the products of the family farm.

Trade associations have worked well for other sectors of the agricultural industry. Sugar beet growers, cotton producers, and wheat farmers have all formed trade associations that clearly benefited members. A strong trade association of family farmers would give them real market power and real political power. By organizing, family farmers could once again become a vital—and thriving—part of our nation's economy.

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available to farmers who elect to invest in their windbreaks. Under EQIP, a voluntary program that promotes the environmental benefits of conservation projects including windbreak renovation, successful applicants receive 75 percent of renovation costs, up to $10,000 per applicant per year. SIP, which encourages conservation practices that enhance wildlife habitat, increase recreation opportunities, or increase the supply of forest products, provides for a refund of 50–75 percent of the cost of windbreak renovation.

But, even with this level of assistance, does it make financial sense for a farmer to restore field windbreaks? Based on the costs of renovation and the cost-sharing incentives that are currently available, we evaluated representative windbreak renovation plans from the perspective of a farmer or other landowner. Conceptually, the decision to renovate a field windbreak is a capital investment decision (much like other farm improvements). Thus, we use a discounted net present value (NPV) approach to identify the factors that might inhibit farmers from renovating their windbreaks.

Deciding Whether and How to Renovate

In our stylized decision environment, we assume that the farmer's objective is to choose the renovation plan that maximizes the NPV of private net benefits. Similarly, society seeks to maximize the social net benefits of field windbreaks and encourages renovation by providing technical assistance and funding programs that extend cost-share payments to participating farmers. (We assume that the social benefits have already been determined to be sufficient to justify the cost-share subsidy in the first place.)

A farmer may decide to either renovate the windbreak or do nothing (that is, abandon it). The farmer's decision to renovate requires that he or she identifies the NPV of each renovation plan—subject to budget constraints. Because the alternative plans are mutually exclusive, the standard investment decision rule is to select the windbreak renovation plan that generates the highest positive NPV.

The cost of renovation depends on, to a significant degree, the initial physical characteristics of the existing windbreak, the desired level of protection, and the provisions of the cost-share program. We identified four categories of incremental cost associated with the decision to renovate:

- the cost of clearing away the old rows of trees,
- the cost of planting new trees,
- the cost of maintaining the new windbreak, and
- the opportunity cost of the land on which the windbreak is located.

Clearing consists of removing the decayed rows of trees, disposing of the debris, and leveling the site. Planting includes the selection of tree species and spacing specifications to achieve the desired density of vegetation in the windbreak. And once planted, trees may require periodic maintenance such as pruning. A good renovation plan may include costs associated with using plastic to conserve moisture and herbicide to control weeds in the rows. With the exception of herbicide treatments, farmers typically contract out the renovation work, and many farmers apply for cost-share payments.

If a loan is obtained to finance the renovation, the interest cost is part of the cost of renovation. Noncash expenses are also typically incurred. For example, farmers are prohibited from cropping the area devoted to the new windbreak. Thus, the value of foregone production is an opportunity cost (assuming that crop production is the next-best use of the land).

On the benefit side, farmers expect that, by protecting crops, windbreaks will lead to an increase in crop yields in adjoining fields. Faster tree growth provides earlier crop protection—and higher yields. The expected increase in crop yields and the area protected by the windbreak combine to generate a stream of private benefits (positive net cash flows) that enter into the decision to renovate.

While a renovation project involves immediate cash outlays, most of the benefits are realized only in the future. Thus, it is important that we discount all the costs and benefits to a reference point in time (such as today) in order to determine the NPV of each renovation

plan. Once all the alternative plans are expressed in these terms, the farmer can select and implement the renovation plan that achieves the highest positive value.

Generally, cost-share programs are intended to promote renovation plans that produce environmental benefits. By reducing out-of-pocket costs, cost-sharing programs improve the NPV of a windbreak and make its renovation more attractive to the farmer. It also induces the adoption of renovation plans that are assumed to be socially desirable. (Cost-share programs would be inefficient, of course, if the subsidy exceeds the social benefits of renovation. Alternatively, if the cost-share subsidy were too low to induce a farmer to engage in a renovation, the result would also be inefficient.)

Defining the Best Clearing/ Planting Plan for Windbreak Renovation

In order to evaluate alternative windbreak renovation plans, we simulated the costs and benefits associated with renovating an existing quarter-mile, three-row field windbreak—a typical northern Great Plains windbreak. Our simulated windbreak is 33 feet wide and occupies an acre of land. In this analysis, we assume that

- the old windbreak has declined to 75 percent of its mature height and will become totally ineffective in 10 years from today; and
- a totally new windbreak or row of trees within the windbreak, if planted today, will become fully effective in 10 years and will protect the field for another 40 years thereafter.

Although uncertainty is an important consideration in any investment decision, we conducted our analysis under conditions of certainty (except for the discount rate) to emphasize the trade-offs that are involved. In our model, four variables are of particular interest:

- the area of cropland protected,
- the cost of renovating the windbreak,
- the yield increase that results from crops being protected by the windbreak, and
- the discount rate.

Based on assumptions (not reported here) about windbreak structure and farm crop rotation, we calculated the cash flows associated with the various windbreak clearing and planting scenarios shown in table 1. Our model assumes crop yields increase in proportion to the amount of protection they receive from the windbreak. For example, the yield of winter wheat per acre is assumed to increase by 23 percent in response to windbreak protection. A 10-year average yield and a three-year average market price of winter wheat were used in the analysis. Crop market prices were assumed to remain constant at the current expected level over the planning horizon (that is, crop prices are assumed constant in real terms). The costs of renovation activities were set at the rates published by the Natural Resource Conservation Service. Cost-share rates were taken from the EQIP program in North Dakota. A real interest rate of 6.5 percent was used to reflect the farmer's real interest rate on a long-term loan. And a real discount rate of 6.87 percent was used to calculate the present value of the renovation cash flows. For simplicity, we ignored the effects of taxes and depreciation.

Evaluating Multiple Renovation Plans

Of the 16 possible renovation plans we examined, five are profitable (that is, have positive NPVs), and 11 plans are unprofitable, as shown in table 1, when we include existing subsidies. All plans are based on the existing three-row windbreak described above. The three profitable plans (those with the highest NPVs) are:

- Clear no rows and plant no rows.
- Clear two rows and plant one row.
- Clear one row and plant one row.

Table 1 shows that renovation plans that involve replanting multiple rows are not as efficient as plans that call for replanting just a single row. The "clear no rows and plant no rows" plan represents an abandonment strategy where the windbreak is left to deteriorate. The other two plans (both consisting of partial removal and replanting) are more profitable than abandoning the windbreak.

The best renovation plan when accounting for existing subsidies, then, is to clear two rows and plant one row. This plan is better than abandonment, which involves an opportunity cost of land without providing crop benefits because protection ceases with the useful life of the existing windbreak. Interestingly, the abandonment strategy is still financially more attractive than renovation plans that involve total clearing (with no replanting) or replanting a multiple-row windbreak. The reason for this is that abandonment delays the costs of renovation and only incurs a gradually increasing penalty (in terms of reduced crop protection) as the windbreak ages—even though clearing the windbreak without replanting would bring more land into production.

If the farmer replants more than a single row, additional costs are incurred. For example, the "clear two rows and plant two rows" plan would lead to a loss of $963 ($616 + $347). This reduction of profitability is one estimate of the additional subsidy that society would need to pay in order to induce this farmer to replant two rows of trees when removing old windbreaks.

Historically, the objective of cost-share programs was to encourage windbreak renovation by reducing the initial cost of investing in windbreaks. The relevant question is, are the cost-share payments under current programs sufficient to make up the cost of deviating from the farmer's desired renovation plan?

The relevant plan for this evaluation of existing cost-share programs is *not* the "clear two rows replant one row" plan chosen above. To examine the effectiveness of existing subsides, we need to compare them to the costs incurred by deviating from the best plan when there are *no* subsidies. Table 2 shows the NPV of returns without a subsidy. For the "clear two rows" option, the desired plan, that is, the plan with the highest NPV, is "replant zero rows." To induce the farmer to replant two rows (instead replanting zero rows—the preferred plan), the government would need to pay him or her $2,389 ($147 + $2,242).

These subsidies appear to be sizable when compared to the amount of money a farmer can receive from current cost-share programs. In table 3, we report the present value of existing cost-share payments associated with alternative renovation plans for our hypothetical

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Table 1. Only a few renovation plans are profitable, even after accounting for cost-share payments (dollars per acre net present value)

	Clear rows			
Plant rows	0	1	2	3
0	6	77	147	-3,445
1	-89	172	347	-2,442
2	-1,073	-812	-616	-3,405
3	-3,044	-2,784	-2,587	-5,377

Table 2. With no subsidies, replant zero rows is always the preferred option (dollars per acre net present value)

	Clear rows			
Plant rows	0	1	2	3
0	6	77	147	-3,445
1	-1,251	-1,201	-1,149	-3,990
2	-2,342	-2,292	-2,242	-5,084
3	-5,036	-4,985	-4,935	-7,777

Table 3. Existing cost-share payments (dollars per acre, present value)

	Clear rows			
Plant rows	0	1	2	3
0	0	0	0	0
1	1,163	1,373	1,496	1,548
2	1,270	1,480	1,626	1,679
3	1,991	2,202	2,348	2,400

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windbreak, and in figure 1 we diagram these compared to the cost of alternative renovation plans that involve replanting 0–3 rows of trees. For each planting option, the "cost" shown is the amount of money lost by following that plan compared to the desired "replant zero rows" plan.

Thus, we see, for example, that the current level of cost-share payments are just sufficient to induce replanting using one-row windbreaks because the amount of the cost-share payment just covers the cost of deviating from the preferred zero-replant plan. To the right of the one-row planting point in figure 1, however, existing cost-share payments fall short of covering the cost of deviating from the efficient plan. The vertical distance between the two lines is the "subsidy gap" (or surplus, for the one-row option).

Although these results are based on a model with several simplifying assumptions, the implications are clear. Under the current cost-share program, field windbreaks will continue to evolve toward single-row plantings—even if multiple-row renovation happens to be more socially desirable.

No Subsidy, No Renovation

We started our research by assuming that the profitability of windbreak renovation is a function of the windbreak's initial condition, renovation cost, crop yield response to protection, land saving, and cost-share payments. Our analysis shows that if replanting is at all profitable in such situations, a farmer is likely to choose a single-row windbreak renovation plan to replace an existing multiple-row windbreak. This result holds true even when a variety of alternative courses of action are considered. Our results show that when farmers decide to renovate a windbreak, two main factors influence their decision; the increased crop yields a windbreak provides, and the amount of productive land freed up by replanting fewer rows. What do these results tell us about cost-share programs?

Our analysis suggests that critical windbreak renovation is not profitable unless the farmer receives cost-share payments. However, the existing cost-share payments currently available to

farmers are sufficient only to induce renovations that use a single row of trees. (A farmer, of course, may elect to replace an existing windbreak with multiple rows, but that decision would likely be motivated by considering other benefits that are not reflected in our investment profitability analysis.) Economic logic also suggests that renovation is more costly if the farmer waits until the windbreak is at the end of its useful life (and there is no remaining protection value) because it takes time to establish a replacement windbreak. A dead windbreak is more likely to be abandoned or cleared, and not replaced.

In conclusion, the cost-share programs currently in place may be ineffective in sustaining the existing multiple-row field windbreaks that we find today across the northern Great Plains.

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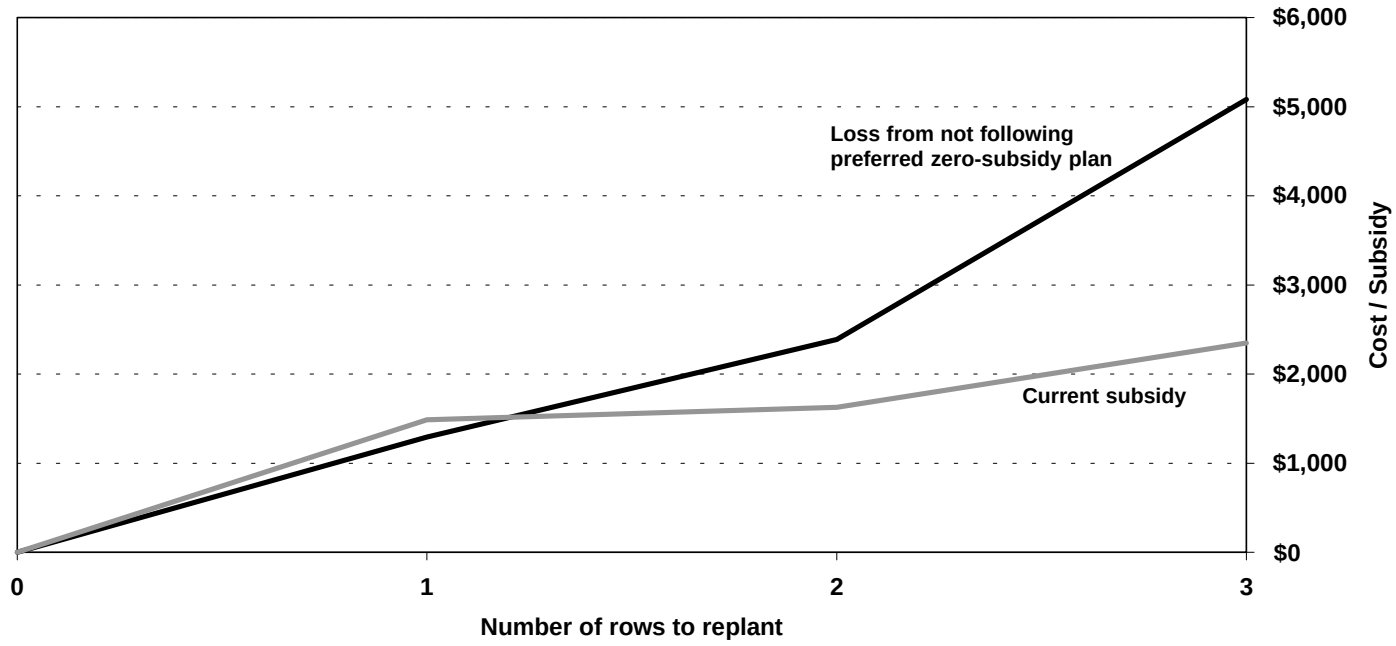
Figure 1. Current subsidies generally do not cover the cost of deviating from the preferred zero-subsidy renovation plan



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