BARN AGAIN!

A NATIONAL PROGRAM TO PRESERVE HISTORIC FARM BUILDINGS

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BARN FOUNDATIONS

King barn after restoration

Starting with a good foundation

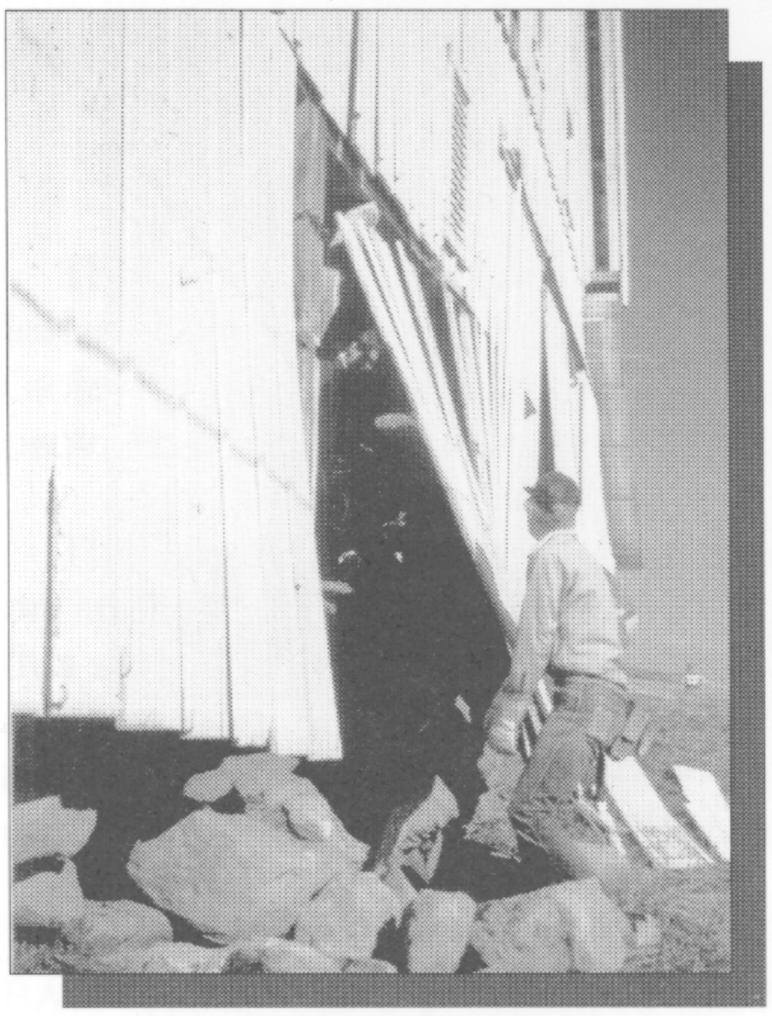
In 1987, Ted and Janis King decided to restore their 100-year-old barn, turning it into a storage facility for their Knoxville, Illinois farm. The Kings desperately needed additional space for round bale storage. Their historic barn seemed like a perfect solution to their storage problems. It was also a focal point for local history and Janis King felt very strongly that they should do everything possible to save it. The problem was a crumbling foundation. As the foundation collapsed, one side of the barn began to buckle and lean. Many people thought that fixing the foundation was impractical because the damage looked so severe. Janis King consulted an engineer who told her, "I could give you a thousand reasons to burn the thing down."

Skepticism is common when it comes to restoring old barns. Sometimes the problems appear so severe it seems the only solution is to tear down the old barn and replace it with a pole barn. But Janis King was unwilling to give up. She thought that the barn could be saved and turned into the vital working center of their farm. She was right!

With the help of a barn restoration contractor and local stone masons, the barn was jacked up and the sandstone foundation was rebuilt. The once dilapidated King barn became a 6,576-square-foot storage facility, with a new, large sliding door and a raised haymow to allow easy access with heavy equipment. The restored barn was more than twice the size of a new 40-foot by 60 -foot pole barn. The essential structural work cost $8,725. The Kings invested an additional $15,000 in a new roof, exterior repairs and painting, and still figured they saved $25,000 over the cost of a new storage facility.

Many farmers can recover the cost of their barn

rehabilitation through savings in crop storage in only one season. After the foundation is fixed and the barn begins to pay for itself, other cosmetic



King barn before restoration

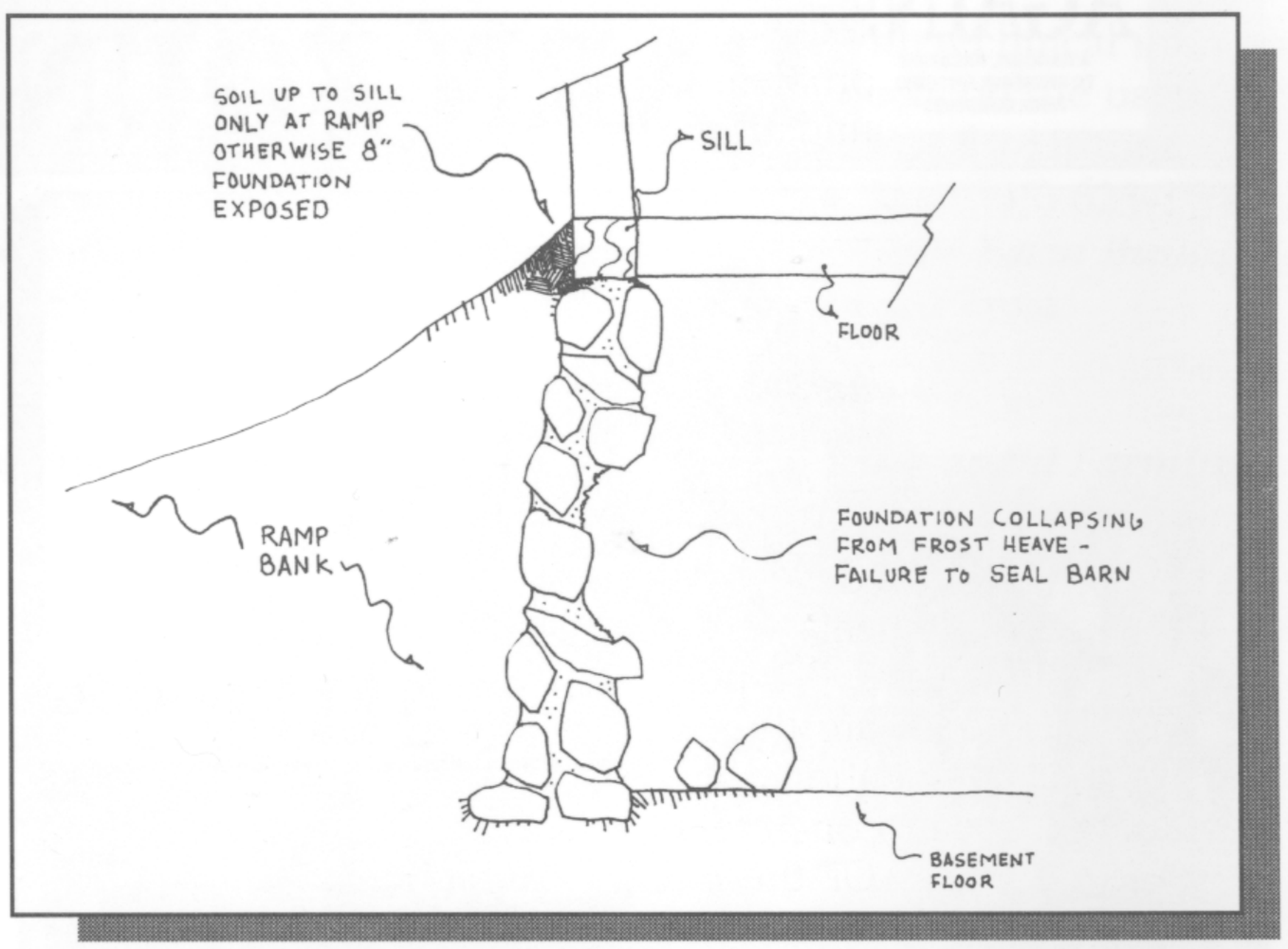
repairs can be made. The King project is a good example of how farmers can use practical preservation techniques to save thousands of dollars while preserving a piece of family and local history.

Even serious foundation problems can be solved at a reasonable cost.

One of the most daunting tasks faced in restoring an old barn is repairing the foundation. Many farmers take one look at a crumbling foundation or the precariously leaning basement wall of a barn and say, "it's impossible." While a crumbling foundation may scare you away from using your old barn, chances are very good it can be repaired. Even serious foundation problems can often be solved at a reasonable cost. With a solid foundation and a good roof, most barns will last indefinitely.

Foundation problems

The two most common kinds of barn foundations are retaining wall foundations found in multi-story bank and ramp barns, and simple perimeter foundations found in one-story barns. In both types of barns, deterioration of the foundation can lead to leaning or collapsing walls, rotted sill beams and general structural failure.



Cross-section of ramp barn foundation

Bank and ramp barns

There are a number of problems unique to the foundations of bank or ramp barns. Most of these barns have at least two stories, a ground-level first floor and a basement. The foundations in these barns usually take the form of retaining walls, forming both the foundation for the structure above and the walls of the basement below. As time goes by these foundations may suffer from a number of problems. Basement walls buckle in, crack, and collapse, especially around ramps. This causes barn walls to sag and buckle leading to structural failure and, if not corrected, the eventual collapse of the barn.

Why does this happen? Many people think that water and drainage are the main culprits. While water is certainly responsible for much foundation damage, in bank barns the primary cause of foundation decay is freezing and thawing in and around foundation walls. Moisture in the walls and surrounding soil expands and contracts as it freezes, thaws, and re-freezes, causing "frost heave."

While the removal of livestock causes a drop in the inside temperature of barns,

this is not the most common cause of frost heave in barn foundations. The real damage occurs when a barn is not maintained and kept sealed from the elements - often because the barn is no longer used for livestock. When broken windows are not repaired, or barn doors are left open during the winter, cold penetrates into the barn, allowing moisture in basement walls and floors to freeze. Constant exposure to winter wind and cold coupled with drainage and grading problems is a recipe for foundation failure.

Frost heave is a common cause of foundation damage.

Problems caused by exposure to the elements vary according to the type of foundation. There are three basic types of foundations in bank barns: stone, concrete, and concrete block. Of these three types, stone foundations are the most susceptible to the effects of repeated freezing and thawing. In stone foundations, the pressure from freezing and thawing loosens mortar, undermining the stability of the wall. Stones fall out of place and eventually the wall caves in. A similar pattern may be found in concrete block walls. Blocks are pushed out of place and mortar crumbles as walls buckle inward.

The strongest type of foundation is the formed concrete wall. Because it has fewer joints, there is less room for moisture to infiltrate. Some older concrete walls were not reinforced with steel, making them much weaker than modern concrete foundations. When exposed to adverse conditions, concrete retaining walls tend to develop cracks in one or two spots. If the problem is not corrected they too will buckle and fall inward. All of these problems are accentuated in the ramp area where the intense pressure of continuous load bearing coupled with freezing speeds up the process.

Single-story barns

Single-story barns present a different set of problems. One of the most common problems in single-story barns is that the barn structure often rests directly on the ground. Many owners of single-story barns complain that their old barn has "sunk." They can remember when the foundation was visible but now it is below the surface of the ground. When this happens, inadequate clearance for lower structural supports allows soil, manure, and composted hay to come in direct contact with the wood.

A vanishing foundation does not necessarily mean that a barn is sinking. More likely, over a period of fifty to one hundred years, manure, rotting hay, and other materials composted and built up inside the barn, and soil built up around the outside of the barn, "raising" the level of the ground until it covered the foundation. Sometimes the raised soil completely covers the sill beams and lower siding. When the level of the ground rises, water collects around walls and seeps into structural supports, undermining the stability of the barn. One of the most common problems in old barns is rotten sill beams. Once the sill beams go the rest of the barn is likely to follow! Proper grading inside and around your barn can save thousands of dollars in future repairs.

Stone masons at work on King barn foundation, after frame was jacked up and stabilized.

Foundation Solutions

Stone Repair

- ✓ Step 1: Carefully remove all loose mortar and clean surrounding area.
- ✓ Step 2: Examine, remove and clean any loose stones.
- ✓ Step 3: Tuckpoint all joints with a soft mortar mix high in lime. Equal parts by weight of hydrated mason lime to Portland cement (2 to by vol.) with appropriate mortar color added to match existing mortar.

Stone Foundations

Stone foundations present some unique restoration problems. Prior to the 1940s, building barns with stone foundations was common practice. Most communities had skilled stone masons working in their area. Today a skilled stone mason is a rare commodity! In many areas of the country you may have difficulty finding someone with the knowledge and skill to repair old stonework.

One way to get around this problem is to do the work yourself. If your foundation damage is localized, tuck-pointing (replacing missing mortar) or rebuilding a small section of your stone foundation can easily be accomplished. If the damage is more widespread, the barn frame will need to be jacked up and stabilized before the foundation can be rebuilt or replaced.

Always remember, working on foundations and barn frames can be dangerous, especially if you aren't sure of what you are doing, or don't have the proper tools to carry out the job!

The key to successful tuckpointing or rebuilding stone walls is the mixing of the mortar. Portland cement is too hard to use as mortar for most stone foundations. If the mortar is harder than the stone, the weight of the barn will cause movement between the two and the new mortar will quickly crack and fall out in large chunks, leaving you back where you started. Use a soft mortar high in lime instead.

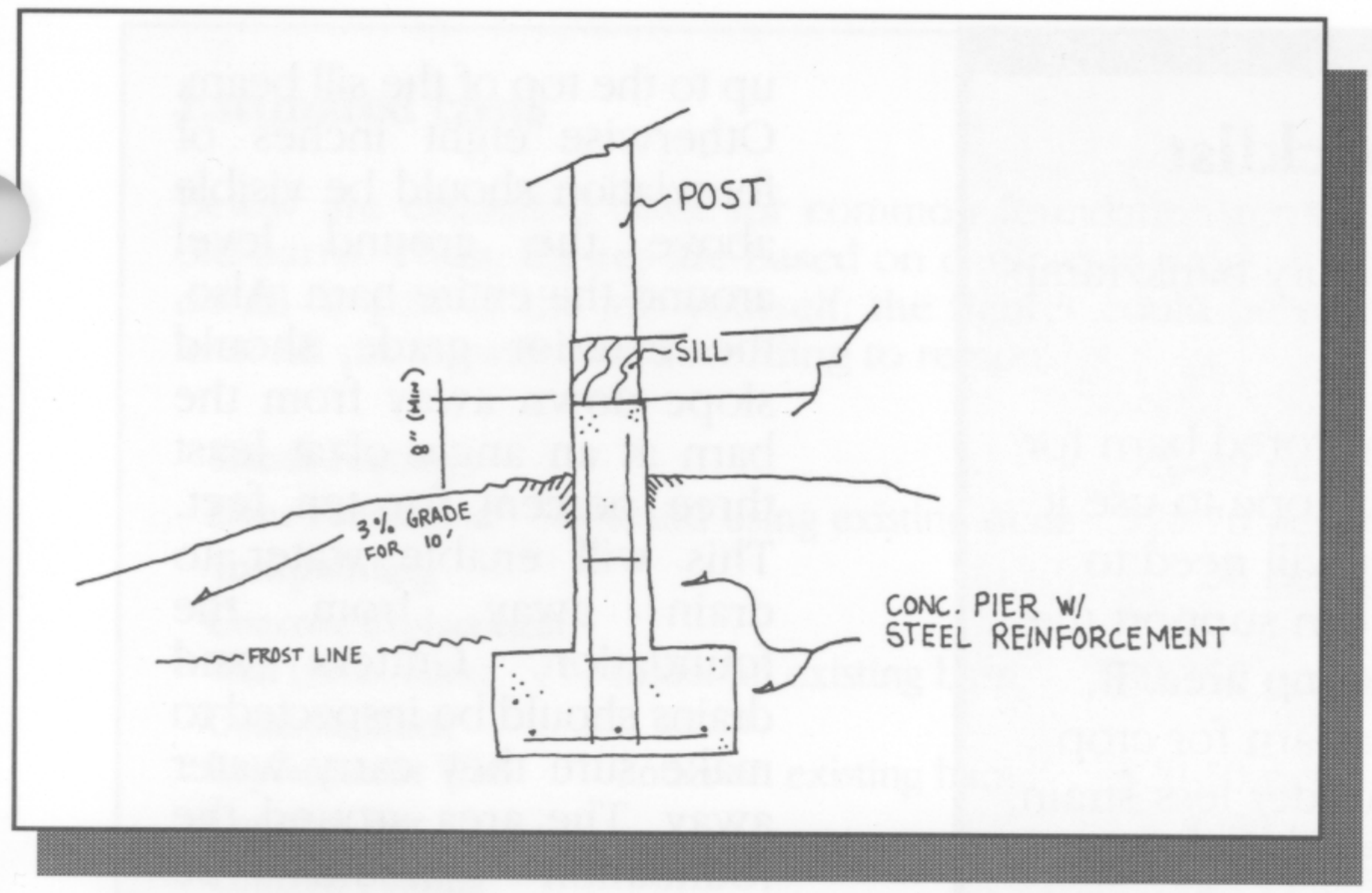
Ramps in bank barns that will be used to house heavy equipment can be buttressed by building shear walls in high stress areas of the foundation. A shear wall is a support wall built perpendicular to the leaning retaining wall. Usually you will need one at each end of the leaning section. These walls generally consist of a two- to three-foot concrete foundation with a framed wall on top. If your ramp will receive constant use, such as combine storage, then a steel - reinforced concrete replacement wall should be considered for the ramp area only. The cost of a formed concrete wall varies greatly depending on the site and the thickness of the wall. Under a ramp, the wall should be at least 10 inches thick.

Soft mortar is the key.

Janis King had studied stone repair and knew that she needed to replicate the barn's original lime-based mortar for a successful foundation repair job. "Our foundation was falling apart because of misguided attempts in the 1940s to repair it with Portland cement," she says. But she had a difficult time convincing local masons, who were used to working with hard-fired brick instead of sandstone, that the lime-based mortar would work. King interviewed several masons before finding one that was willing to do it her way. To insure that the repairs are done correctly and will last through the years, King recommends that barn owners get the technical information they need about barn rehabilitation techniques before interviewing contractors.

Repairing cracks in concrete

- ✓ Step 1: Remove loose material from crack and carefully clean surrounding area.
- ✓ Step 2: Seal the surface of the cracks with silicon to form a barrier for epoxy.
- ✓ Step 3: Inject resin into the crack.
- ✓ Step 4: When resin is dry, remove silicon and tuckpoint surface of crack.



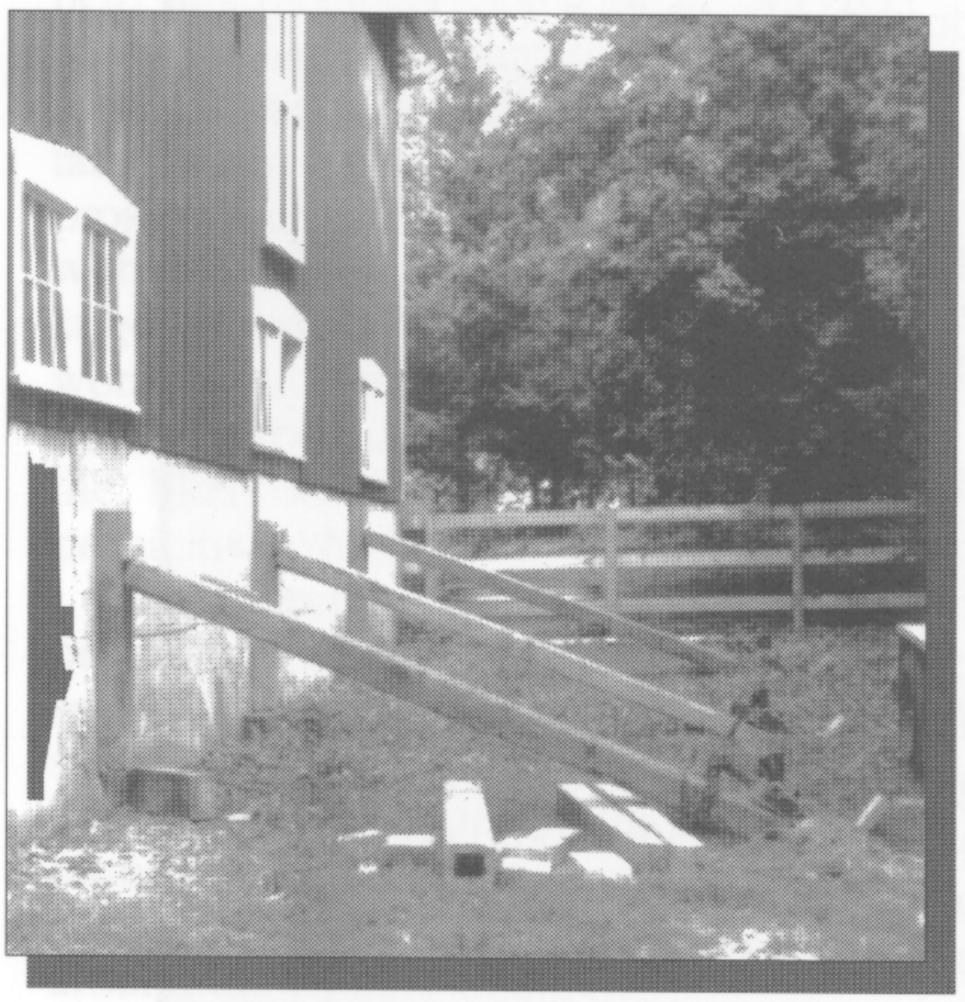
Cross-section of a small barn pier

Small stone foundations in single-story barns may also need to be replaced with a new concrete foundation or concrete piers depending on the proposed use of the structure.

Concrete foundations

The most common problems in concrete foundations are cracks. Cracks in concrete can be sealed by injecting epoxy resin into the problem area and then tuckpointing the surface. As with the stone, the area around the crack needs to be thoroughly cleaned before any repair work begins.

Because of the high tensile strength of concrete walls they can often be jacked back into place even if they are seriously off center. The techniques for accomplishing this vary according to the construction of the barn and the lay of the land around the foundation. Generally a series of wood frames are attached to the walls at the center and sides of the problem area. Then large beams, extending laterally, are slowly jacked, pushing the wall back into place. The key to this operation is making sure that the pressure from the jacks is dispersed to a wide area. Too much pressure on one spot could cause the wall to fail. Using several jacks at the same time insures that the wall moves as a unit. Once the wall is back in an upright position you can repair cracks and tuckpoint imperfections.



Jacks used to push a concrete wall back into place.

Concrete block

Buckled concrete block foundations may be pushed back into place, but they are not as resilient or movable as poured concrete foundation. Small areas can easily be rebuilt and tuckpointed, but the structure may have to be jacked up as with a stone foundation. Again, you may have to consult a barn restoration specialist about the jacking process as local contractors may be unwilling to attempt to jack a large barn.

Grading

In some cases the foundation may not need to be replaced at all. The foundation should be excavated around the outside and inside to expose the stone or concrete. At the top of an earth ramp, where the ramp meets the barn, the soil can come

If there is rot in the sill beam the jacking process is complicated and should not be attempted without professional help.

Foundation repair checklist

- ❑ Barn Type: Is your barn a multi-story bank/ramp or single-story barn?

- ❑ Usage: What will you use your restored barn for? If you own a ramp barn and you hope to use it for storing heavy equipment you will need to make sure that your foundation can support the added weight and strain on the ramp area. If, however, you intend to use your barn for crop storage, the foundation will be under less strain, because the weight will be more evenly distributed and there will be less movement. The same holds true for single-story barns. The proposed use for the barn will effect the work needed and the cost of your project.

- ❑ Foundation Type: Is your foundation stone? Is there some type of footing? Is your foundation concrete, or concrete block? Can you determine the depth of your foundation? Does it extend below the frost line?

- ❑ Foundation Damage: Check very carefully for cracks, settling, shifting, and loose or missing mortar.

- ❑ Drainage: Walk around your barn and notice the grade ten feet out from the barn walls. Is it at least three percent? Is there eight inches of exposed foundation above the ground level? Have hog wallows or paths undermined the foundation from the outside? Is there any place around your barn where water could collect? Are there trees nearby that could have roots that effect your foundation? These common problems cause some of the most serious damage to barn foundations and must be considered before renovation begins.

- ❑ Exposure: Is your barn airtight and insulated? Do you leave its doors open regularly? Are there broken windows or missing siding that could allow the cold in?

up to the top of the sill beam. Otherwise eight inches of foundation should be visible above the ground level around the entire barn. Also, the exterior grade should slope down away from the barn at an angle of at least three percent for ten feet. This will enable water to drain away from the foundation. Gutters and drains should be inspected to make sure they carry water away. The area around the foundation should be regularly cleaned to prevent future build-up of organic material around the structure.

Planning your project

Before calling a contractor or materials supplier make a quick check of your barn, using the foundation repair check list. You may need to dig out and expose a section of the foundation to check its condition. Then make a sketch of the areas that need repair. Be sure to include any work needed to comply with building code and insurance requirements. If you take the time to carefully map out your specific problems you will be an informed consumer, and will be more likely to get a realistic estimate from a contractor.

Estimated costs

Below are estimated costs for common foundation repair in old barns. These figures are based on contracted work. If you do all or part of the job yourself, the figures could be much less. All prices will vary according to region.

Trench Footing		$20-60 per ft.
Stone Foundation	Rebuild using existing stone	$20-70 per ft.
Tuckpointing		$6 per ft.
Concrete Replacement Wall (10 in. thick)	under an existing barn	$20-150 per ft.
Concrete Block Replacement Wall	under an existing barn	$20-50 per ft.
Concrete Pier		$350 each
Concrete Footing		$175 each

What will it cost?

The cost of rehabilitating and modifying an old barn for a new use will almost always be less than the cost of tearing it down and building a new structure. This is especially true if your barn has a basement. The added space of a basement can equal the total square footage of a new building!

Sometimes all you need is a good shovel to start building sweat equity in your old barn!

One of the best ways to save money is, of course, to do the work yourself. If all your barn needs is grading to expose the foundation, improve drainage, and change the grade, you can do the job yourself. Most farmers will have the necessary equipment to excavate. Sometimes all you need is a good shovel to start building sweat equity in your old barn!

If the damage is serious and the barn needs to be jacked up before the foundation can be replaced you will probably need the help of a qualified contractor. Many farmers find that their local contractor is reluctant to take on a barn foundation project. They are not familiar with the methods of jacking large wood structures and worry about the weight of the building. You may find that all the bids on the work are prohibitively high.

The best solution to this problem is to hire a barn specialist to jack up and stabilize the building, then have a local contractor do the foundation work. There are several contractors that travel around the country doing this type of work. Check the sources listed below for names of barn rehabilitation specialists. These contractors understand the process and are usually very willing to work with local craftsmen and farmers. This team approach can save money and ensure that everyone involved is comfortable with the working conditions.

For More Information

Organizations and Agencies:

State Historic Preservation Office (SHPO): Advice on maintaining the historic character of your barn, and information on the National Register of Historic Places and rehabilitation tax credits. Some SHPOs also maintain a list of rehabilitation contractors, craftsmen and architects. (Contact state government directory for your state.)

Cooperative Extension Service: Information about farm building needs and assistance with specific building projects and plans. (Contact land grant university in your state.)

BARN AGAIN! Program: General advice and assistance with barn rehabilitation projects. (Contact: 303 623-1504)

Publications:

BARN AGAIN! - A Guide to Rehabilitation of Older Farm Buildings, National Trust for Historic Preservation and Meredith Corporation, 1988, 18pp.

That Darn Barn, Kane County, IL, 1992, 24pp.

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The Barn Aid Series is designed to provide farmers and other barn owners with technical information on specific problems related to the restoration and reuse of older barns. Comments on the usefulness of this series are welcomed and should be addressed to BARN AGAIN!, National Trust for Historic Preservation, 910 16th St., Suite 1100, Denver, Colorado 80202. (303) 623-1504, Fax (303) 623-1508. Also available from the National Trust, ***BARN AGAIN!: A Guide to Rehabilitation of Older Farm Buildings.*** To receive a copy of this publication send $5.00 check or money order to the National Trust.

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