INDIVIDUAL FARM ELEMENTS

This section of the historic context study considers a wide range of elements likely to be found on Minnesota farms. These elements are presented in alphabetical order, as listed below. “Barns” are listed by primary function (e.g., Beef Barns, Bull Barns, Dairy Barns, General Purpose or Combination Barns, Hay Barns, Hog Barns, Horse Barns, Milking Barns, Sheep Barns, Threshing Barns, and Tobacco Barns).

Acetylene or Carbide Gas Structures
Airplane Hangars
Animal Underpasses
Beef Barns
Boundary Markers
Brooder Houses
Bull Barns
Cattle Guards
Cesspools and Septic Tanks
Cisterns
Combination Buildings
Corncribs
Dairy Barns
Drainage Structures
Erosion Control Structures
Farm Shops
Farmhouses
Farms
Farmsteads
Farmyards
Fences
Field Rock Piles
Fields and Pastures
Garages
Gardens (Vegetable)
General Purpose or Combination Barns
Granaries, Elevators, Bins, Dryers
Greenhouses, Hotbeds, Coldframes
Hay Barns or Sheds
Hired Workers’ Housing
Hog Barns and Hog Cots
Horse Barns
Housebarns
Icehouses
Implement or Machine Sheds
Irrigation Structures
Landscaping and Ornamental Plantings
Manure Pits or Bunkers
Milk Houses
Milking Barns
Orchards
Other Animal Husbandry Elements
Other Crop Husbandry Elements
Other Domestic Elements
Other Service and Utility Elements
Potato Warehouses
Poultry Houses
Power Houses
Privies
Propane Gas Structures
Pumps and Pump Houses
Roads, Lanes, Tracks, Sidewalks
Roadside Markets
Root Cellars
Saunas
Scale Houses
Sheep Barns
Shelterbelts
Silos
Smokehouses
Springhouses and Springboxes
Stock Tanks
Stockyards
Sugarhouses
Summer Kitchens
Threshing Barns
Tobacco Barns
Utility Poles and Equipment
Water Power Structures
Water Tanks and Tank Houses
Wells
Wetlands
Windbreaks
Windmills
Woodlots
Woodsheds

Historical archaeological resources are addressed separately in Volume 4.

Landscape elements that were created, used, or manipulated by people are included on the list above. Examples include fields, pastures, gardens, ornamental plantings, woodlots, wetlands, and erosion control structures. For a discussion of farm landscape elements and their evaluation, see McClelland et al, *Guidelines for Evaluating and Documenting Rural Historic Landscapes [National Register Bulletin 30]* (1990).

To understand the development and operation of Minnesota farms, it may be useful to see that most of the farm elements on the list above fall into one of four broad categories based on use:

- crop husbandry elements
- animal husbandry elements
- domestic elements
- service and utility elements

Minnesota farms from the period covered by this context study – 1820-1960 – were generally comprised of elements from all four categories.

Information on the number and size of farms in Minnesota and how this changed through time can be found in the individual farm elements section entitled “Farms”.

Farm kids on a spring day. Location unknown, circa 1930. (MHS photo by Chester Sawyer Wilson)

▪ ACETYLENE OR CARBIDE GAS STRUCTURES

- Farm-generated gas for lighting, cooking, water heaters, and irons
- Found on an estimated 12,000 farms in the U.S. by 1912
- Generators were installed either indoors or, more commonly, in an underground pit

Acetylene was colorless gas used as a fuel in farm lighting plants by at least the 1910s. In the years before farms were electrified, some farmers installed acetylene plants (also called carbide plants) for lighting, while others generated electricity using water, wind, or gasoline engines. Because of the significant investment involved, many of the farms outfitted with acetylene were fairly prosperous.

Acetylene was made on the farm by combining water and calcium carbide, which was a granular material delivered in 100-pound, air-tight steel drums. The result of mixing water and calcium carbide was acetylene, a highly flammable gas (also known as carbide gas) with a pungent, penetrating odor. A by-product of acetylene gas production was slaked lime, which collected at the bottom of the generator tank. Farmers used the lime as a disinfectant, soil additive, whitewash, and wood post preservative (Musselman 1912: 132-133; Woolworth 1928: 218).

Acetylene was burned in specialized household lamps, cooking stoves, water heaters, and self-heating irons. Acetylene gas lamps produced a bright white light, gave off less heat than kerosene lamps, and didn't need fragile mantles. The acetylene was piped to the house and other buildings through ordinary gas pipes. In the house, the gas pipes were generally concealed in walls, floors, or ceilings, with periodic outlets (Woolworth 1928: 217-218; Mowry 1915: 4).

Acetylene generators were widely available and operated quite inexpensively. However, reports of acetylene gas plant explosions were fairly common and acetylene was considered somewhat risky for barns and outbuildings because of fire danger. In the 1920s, safety improvements in the technology made acetylene "worthy of serious consideration in connection with the lighting of practically all buildings and premises which are located out of range of low-priced and satisfactory service from central electric and city gas plants" (Woolworth 1928: 217-218; Mowry 1915: 4; Musselman 1912: 133-135).

There were many variations in acetylene generators and lighting plant designs, and they were generally more simple than farm-generated electricity plants. The generators were of two types: indoor and the outdoor pit. Indoor generators were typically installed in the farmhouse basement, although, for safety, some experts recommended that the generator be located in an isolated spot on the farmstead, or in a frost-proof building some distance from the house and other buildings. Because of space constraints, indoor generators ordinarily had a capacity of less than 100 pounds of carbide, and therefore, had to be cleaned and replenished every month or two. In addition, the disagreeable odors from basement generators tended to penetrate the house. For these reasons, outdoor pit generators were more popular (Woolworth 1928: 217-218; Mowry 1915: 1).

See also
Power Houses
Farmhouses
Appendix: Focus on Farm Electrification

Outdoor generators, the more popular type, were usually buried in concrete pits lined with galvanized metal, and placed 50' to 100' from the house. Outdoor installations had to be protected from freezing. Pit-type generators could be much larger than indoor generators – a capacity of 200 pounds of carbide was common. An average farm in 1928 used 200 to 500 pounds of carbide a year for lighting, so a 200-pound generator needed cleaning and replenishing only a few times a year (Musselman 1912: 134; Mowry 1915: 3-5; Woolworth 1928: 217).

Acetylene systems had to be handled carefully. Though intended to operate automatically, experts warned that "a perfectly-working acetylene gas system is a delicate piece of machinery" and susceptible to fire and explosion (Mowry 1915: 7). Still, carbide gas lighting systems were popular, and reports claimed that more than 200,000 farms in the U.S. had installed acetylene systems by 1912 (Musselman 1912: 133; Kline 2000: 98; Woolworth 1928: 218).

PREVALENCE

It is not known how many acetylene systems were in Minnesota, but they were not uncommon. It is assumed that most systems were eventually abandoned soon after farms were electrified in the mid-1930s through the mid-1950s. Extant acetylene structures are probably rare today. Evidence at ground level may include covers, rods, and pipes located in an area about 8' in diameter.

SOURCES

Kline, Ronald R. *Consumers in the Country: Technology and Social Change in Rural America*. Baltimore: Johns Hopkins University, 2000.

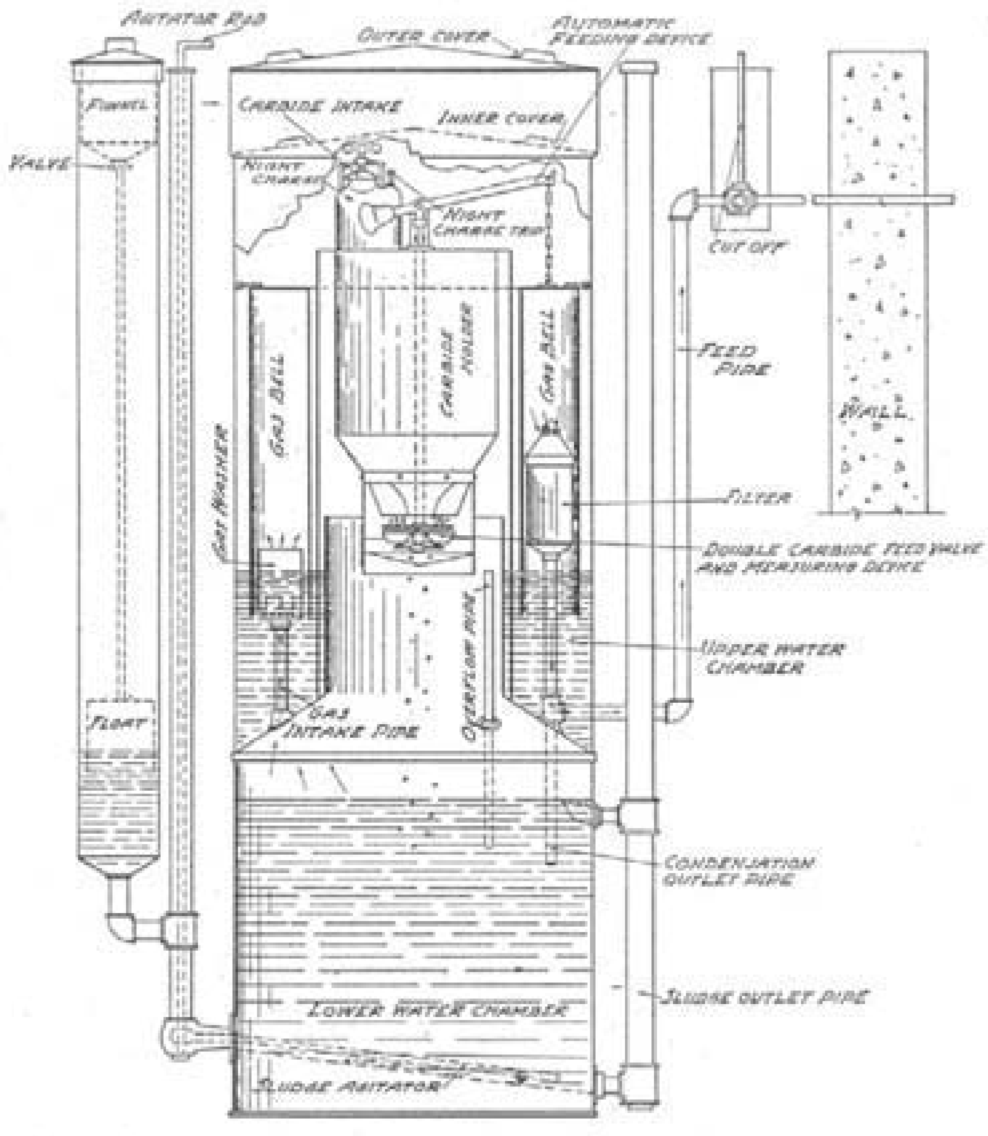
Mowry, J. L. "Lighting Farm Buildings." *Minnesota Agricultural Extension Service Bulletin* 58 (1915).

Mowry, J. L. "Lighting Farm Buildings." *Minnesota Farmers' Institute Annual* 27 (1914): 105-113.

Musselman, H. H. "Lighting Farm Buildings." *American Society of Agricultural Engineers: Transactions* 5 (1912): 130-137.

Wolfe, Audra J. "How Not to Electrocute the Farmer: Assessing Attitudes Towards Electrification on American Farms, 1920-1940." *Agricultural History* 74 (2000).

Woolworth, Clara. "Lighting Farm Buildings with Carbide Gas." *Agricultural Engineering* 9 (1928): 217-218.



This acetylene or carbide gas plant was designed to be buried in a pit about 12′ deep. The pit was usually located 50′ to 100′ from the farmhouse. Ground-level evidence of such a pit might include a circular pit cover, an agitator rod, and pipes, all located within an 8′-diameter circle. From Mowry's *Lighting Farm Buildings* (1915).

■ AIRPLANE HANGARS

- Barnstormers introduced many Minnesota farmers to the experience of flying
- Few farmers learned to fly or owned a plane before World War II
- Many farmers built their own farm landing strips and hangars
- Planes had some farm uses but were owned primarily for pleasure

This individual farm elements section discusses both airplane hangars and landing strips.

Farmers and flying are linked in the earliest history of Minnesota aviation. Many Minnesota farmers saw their first airplanes in the 1920s when “barnstormers” visited rural areas, flying into farm fields. These early pilots demonstrated aerobatic stunts and carried passengers for sightseeing rides. In their history of Minnesota aviation, Allard and Sandvick quoted an early barnstormer who recalled, “If you set down by a threshing crew, you didn’t have to put up a sign or anything, because in about ten minutes, you’d have the whole crew around the airplane, digging into their pockets for money. . . . The only person who didn’t care for that was usually the farmer whose land they were harvesting” (Allard and Sandvick 1993: 72).

According to Allard and Sandvick,”many of the earliest [Minnesota landing] fields were nothing more than farm strips that became the locally accepted places for aviators to gather, to purchase fuel from a local service station, or to tie down for the night.” A few early pilots “made a living, flying from farm to farm, selling machinery as well as airplanes, to the farmers” (Allard and Sandvick 1993: 147,149).

Some farmers were able to fly and own planes prior to World War II, but it wasn’t until after the war that it became very popular. Many farmers learned to fly through World War II readiness or military programs including the Civilian Pilot Training program, the War Training Service, or the U.S. Army Air Corps. The state’s agricultural schools, including the West Central School of Agriculture in Morris, offered ground school flight training during World War II that many farmers attended.

While some farmers owned their own planes, it was typical for two or more farmer-pilots to jointly own a plane that was stored on one person’s farm.

Farm landing strips were often 2,600’ to 3,300’ long and twice as wide as a plane. Farms frequently had two perpendicular landing strips so planes could land in all wind conditions. Most often the landing surface was planted with alfalfa that could be cut and baled for farm use. (One 89-year old former pilot, Charlie Schmidt, recalls having to dodge bales when landing.) Brome grass was considered the best landing surface, but it did not have alfalfa’s advantage as livestock feed. Some farmers seeded their strips with a special combination of Kentucky bluegrass and various legumes, and occasionally canary grass was used. Farmers also landed on rural roads surfaced with gravel or bituminous (Schmidt 2005).

See also
Roads, Lanes, Tracks, Sidewalks

Farm landing strips were very seldom paved and infrequently lighted. Many farmer-pilots did land on their fields at night, however, using ingenious methods to land safely such as stringing fences with reflector-surfaced license plates to mark the ends of the strip and positioning lighted flares along one side. Windsocks to indicate wind direction were frequently mounted on 4' x 4' poles, about 10' high, placed next to the strip (Schmidt 2005).

Most farmers built a hanger when they bought a plane so the aircraft wouldn't be damaged by weather. Hangars were also sometimes used to store farm equipment. Hangars were frequently T-shaped but also square or rectangular, particularly if they needed to house two airplanes (Schmidt 2005). In 1961, agricultural engineers Neubauer and Walker suggested an economical hangar that was T-shaped – roughly the shape of a plane – and just slightly larger than a plane (Neubauer and Walker 1961: 280).

Most early hangars were woodframe with gabled roofs and wood siding. Asphalt shingled roofs were common, but occasionally a farmer scavenged supplies for a metal roof. Hangar doors were usually sliding or rolling, although sometimes other methods of opening were used. One farmer is known to have used a plywood door that he would lower onto the ground and then taxi over. Returning from his flight he would taxi across the door into the hangar and then raise the door back up into place (Schmidt 2005).

Farm landing strips were not usually plowed to clear the snow, so in winter planes were often equipped with skis, custom-made by a local mechanic. If a farmer was headed for a warmer part of the country in winter, he would fly off of his farm on the skis and land at a snow-covered airport where he removed the skis. He could then taxi out to the public road where he could take off on the plane's tires (Schmidt 2005).

After World War II the number of farmer-pilots and their farm landing fields grew rapidly, in part because so many had either learned to fly or became interested in flying during the war. The U.S. government also sold large numbers of surplus planes after the war. In one west central Minnesota county, Stevens, there were landing strips on at least nine farms between 1946 and 1955. It was reported that the Schmidt Farm's landing strip near Morris had more aviation activity in the late 1950s than the local airport (Schmidt 2005; Schultz 1991: 13).

Used primarily for pleasure, planes were also useful to farmers for various farm chores. They were used to travel to distant communities to pick up parts or supplies, to locate stray cattle, and to check on irrigation systems, crops, and livestock.

Planes were also valuable for crop spraying. Crop-dusting began in the early 1920s, but became common after chemicals like DDT and 2,4-D were introduced in the 1940s. Early crop-dusters used jerry-rigged tanks and sprayers (e.g., a chemical-filled tank sitting on the seat next to the pilot), but eventually more sophisticated equipment was used. The use of planes to dust or spray chemicals kept crops from being crushed by tractor tires and protected fields from becoming rutted with deep tire grooves. Spray planes often landed on public roads to take on additional chemicals during the spraying process (Schmidt 2005).

The Minnesota Flying Farmers, a statewide group, was organized in 1946. Membership was especially high in the 1960s. The group provided opportunities for farmer-pilots to promote flying, to socialize, and to fly together to meetings and events.

Flying among farmers declined considerably after the 1970s. Many farm landing strips were eventually plowed and planted with crops, and hangars were converted to implement sheds and other uses (Schmidt 2005).

PREVALENCE

Farm aircraft hangars and landing strips were built throughout Minnesota, particularly after World War II. Some hangars survive, especially those that were converted to implement sheds and kept in good repair. Some landing strips also remain today.

SOURCES

Allard, Noel E., and Gerald N. Sandvick. *Minnesota Aviation History, 1857-1945*. Chaska, MN: Mahb Publishing, 1993.

Neubauer, Loren W., and Harry B. Walker. *Farm Building Design*. Englewood Cliffs, NJ: Prentice-Hall, 1961.

Schmidt, Charles [of Morris, MN, retired farmer-pilot, past president of Minnesota Flying Farmers; the only living charter member of that organization]. Interview with Arden Granger. 2005.

Schultz, Steven R. *Pilots, Planes, and Politics*. Undergraduate research paper. University of Minnesota, Morris, 1991.

A typical western Minnesota farm hangar, sided with metal. Its eastern side is entirely open. The landing strip, still in use, is aligned north and south and is located along the edge of the field shown in the foreground. Solvie Farm, Pope County, 2005. (Gemini Research photo)

▪ ANIMAL UNDERPASSES

- Structures that allowed cattle and other livestock to move beneath obstructions like roads and railbeds
- Especially prevalent between the late 19th century and the 1950s

Animal underpasses (also called cattle passes or pass-throughs) were structures built to allow livestock to pass beneath roads, railbeds, or similar obstructions. Those that crossed roads were often built to replace at-grade livestock crossings and were considered safer for both stock and vehicles. Underpasses were often built by or for farmers working in cooperation with a public road authority or railroad company.

Underpasses were especially used between the late 19th century and the 1950s, which was the period during which most Minnesota farms had livestock. Underpasses were important for allowing cattle, sheep, and other stock to reach permanent pastureland, and for providing access to fields so that animals could eat crop residue after the harvest. They were also built to allow livestock to move between the stockyard and a natural source of water, or between stockyards, pastures, or fields. Dairy cows, for example, might move twice a day between a milking barn on one side of a highway and a pasture on the other. Most underpasses in Minnesota were used for cattle, but sheep, hogs, and horses were also accommodated. Using an underpass for beef cattle might save a farmer from driving feeder cattle several extra miles to cross an impediment – a trip that could cause the fattening cattle to lose precious weight if made too frequently.

Underpasses were commonly made of stone, concrete block, or poured concrete. Some resembled the “box culverts” commonly used to carry water under roads. An underpass from the early 20th century might be 3′ to 4′ wide, 6′ tall, and as long as the width of the roadbed – perhaps 60′ to 100′. They sometimes had wing walls at the openings to support the adjacent slope. To help wary livestock enter the tunnel, it was recommended that it be straight so the animals could see down the entire length. The floor of the structure was sometimes scored, roughened, or filled with sand or gravel to keep it from being slippery. The fencing that formed part of an animal lane, or surrounded the adjacent stockyard, field, or pasture, was generally attached to (or erected close to) the ends of the underpass.

Underpasses built in the late 19th or early 20th century were sometimes rebuilt or replaced when a road or railbed was improved. Thus underpasses are often the same age as the associated road.

Modern monolithic livestock underpasses can be difficult to distinguish from concrete drainage culverts. Typical modern underpasses for cattle and horses are 4′ to 5′ wide and 5′ or 6′ tall and made of precast concrete or metal culvert material.

See also
Fences
Fields and Pastures
Diversification & Rise of Dairy, 1875-1900
Develop of Livestock, 1900-1940

Some farmers also built structures to allow livestock to pass over ditches, low spots, or streams. These structures (sometimes called pass-throughs) were often simple, above-ground bridges with fenced sides or railings (Howe 1940: 16).

PREVALENCE

Animal underpasses were built in all parts of Minnesota, but were likely more prevalent in areas where more livestock were raised. Underpasses are often rebuilt or removed when roads are reconstructed, making early examples more rare. Because they are integral with the road, however, the underpass usually remains in place if the road bed has not been rebuilt.

SOURCES

Howe, O. W. "Planning the Physical Layout of Farms." *University of Minnesota Agricultural Extension Division Special Bulletin* 350 (1940).

This poured concrete animal underpass in central Minnesota is approached by a scored concrete walkway. The walkway provides traction for animals and reduces erosion on the steep slope. Stearns County, 2004. (Gemini Research photo)

▪ BEEF BARNS

- Often called feeder barns
- Built from about 1890 through the post-World War II period
- Tall, fully-enclosed beef barns included storage for hay and feed inside; many had attached silos
- One-story semi-open and open barns had openings facing south and east to maximize sunlight but protect from winds
- Beef barns often had large openings to allow cattle to move in and out freely
- Most beef barns were framed with dimensional lumber, with pole barns becoming popular after World War II
- Metal siding became especially popular after World War II

During the early settlement period, most hogs and cattle on Minnesota farms were kept outdoors, or in very crude or temporary shelters.

In the 19th century some Minnesota farmers raised beef for home consumption (or occasionally slaughtered dairy cows), but relatively few raised beef cattle for sale. Free grasslands and wild hay fields – the low-cost resources on which early cattle farmers depended – were diminishing by the 1890s as the last undeveloped land was settled. Minnesota farms were not yet growing large quantities of concentrate feed crops such as corn. In addition, the state lacked good-quality beef breeds, as well as marketing and processing facilities (Shaw 1894).

By the 1890s, however, experts were recommending livestock farming as a way for farmers to diversify from wheat-dominated farming systems. After a period of remarkable growth, by 1915 Minnesota ranked fifth in the nation in the number of beef cattle. The increase was due in part to the diversification of Minnesota farms, to increased acreage planted to corn, to the introduction of the silo which allowed economical winter feeding, to the creation of markets, to improvements in breeding stock, and to the optimization of feed rations (Shaw 1894; Barns 1915: 22-23).

Another significant rise in Minnesota beef production followed World War II. This was fueled by increases in U.S. population, by increases in consumer demand for red meat, by new acreage planted to corn and other feed crops, by improvements in feed mixtures, and by improvements in breeding.

Like most animal enclosures, beef cattle barns (also called feeder barns), were best sited on well-drained land, down-wind from the farmhouse. Most farms that raised beef and other livestock had fenced fields and pastures to allow stock to eat crop residue and to graze on forage plants.

Adjacent to the cattle barn was a stockyard with a strong fence. The yard usually contained a feeding structure (see "Feeding" below), a large water tank that was usually equipped with a heater to prevent freezing, a structure or stock to hold animals during breeding or veterinary procedures,

See also

Dairy Barns
Stock Tanks
Bull Barns
Develop of Livestock, 1900-1940
Appendix: Focus on Minn Livestock

and possibly a loading chute. All of these structures were generally made of wood until after World War II when metal structures became popular. By 1954 the USDA was recommending paving a portion of the stockyard or feedlot with concrete, and surfacing the surrounding areas with gravel (Neubauer and Walker 1961: 66).

BARNS THAT HOUSED CATTLE AND STORED FEED AND BEDDING

Beef cattle were often raised in combination or general purpose barns that also housed dairy cattle and horses. (See "Dairy Barns" and "General Purpose or Combination Barns," two separate farm elements sections, for information on barn design, ventilation, mows, feeding and manure handling, etc.) However, several specialized structures for beef cattle were also developed.

The largest beef cattle barns housed the herd as well as feed and bedding for a season. These barns were built from the 1860s through the 1950s. After about 1910, many had attached silos. These barns needed to be warm, dry, well-ventilated, and provide light. Many had rooms in which feed could be ground and mixed. Most furnished "loose" housing, meaning the animals walked around freely. This exercise kept them healthy and some experts believed it stimulated their appetite. Stalls and pens were provided for bulls and calving. In some barns all beef cattle were housed in stalls. Early barns had windows to provide light; later styles usually had large door openings instead. Some barns included an interior stock tank for water (Midwest Farm 1933; Carter and Foster 1941: 223-225).

Some barns were large, complex, multi-compartmented buildings. For example, in 1894 the University of Minnesota's Thomas Shaw recommended a basement-barn in which the feed was stored on the first floor and cattle were housed in the basement. This barn, which Shaw considered relatively expensive, measured 60' x 110' and housed 30-40 animals. The first floor had a central alley, seven hay storage compartments, two grain storage bins, a room for chopping feed, and feed bins. The basement had two root cellars, a central feed room, three pens for bulls, eight calf pens, 25 box stalls, numerous windows, and an office (Shaw 1894: 116, 121-125; the barn described by Shaw had been built in 1886).

In barns without basements, hay and straw were generally stored in a loft and dropped from there to the floor below. Many had a central alley wide enough for a feed wagon and manure equipment. One typical example from 1951 had a 36' x 60' footprint (National Plan Service 1951). Another, in a plan offered by the University of Minnesota in 1953, measured 24' x 50' (*Farm Building Plans* 1953).

A form of beef or feeder barn common in the Midwest is called the "midwest three-portal barn" by historians Noble and Cleek (Noble and Cleek 1995: 74-75). (See illustration from Morris and Harvey (1950) at the end of this chapter. See also this context study's "Building and Planning Farm Structures: Barn Forms and Terminology.")

A variation, popular from the late 19th century through the 1950s, was a barn in which the entire central section from floor to eaves served as a tall, narrow hay mow, with animals housed in two parallel spaces along the barn side walls, or around three sides in a "U" shape. These were sometimes called "shed" barns. According to barn historian Lowell Soike, a barn of this style – but with an innovative pole support system that he considers a precursor to the common pole barn – was described in the May 31, 1889, issue of *Iowa Homestead*. The central hay section was framed either with massive, upright, square timber columns spiked to posts set in the ground, or with full-length telephone poles. The barn could hold 35 to 40 tons of hay (Soike 1995: 90-91).

Barns with tall, central hay storage often had gable or gambrel roofs, with roof pitches that could break into shed or hipped roofs over the lower housing areas. Farmers could load hay into the barn via a blower pipe at the peak of the roof. A barn with a central hay mow was usually wider than a barn with a second-story hay loft. A plan published by the National Plan Service in 1951, for example, had 54'-wide gable ends and 60'-long sidewalls, making the footprint of the barn almost square (National Plan Service 1951; Neubauer and Walker 1961: 69).

The housing areas could have large doors (usually left open), or openings with no doors, or could be entirely open-sided. All three variations allowed cattle to move freely in and out during good weather, but be sheltered from rain and extreme cold (Wooley 1946: 109-110; National Plan Service Circa 1950; Neubauer and Walker 1961: 68).

Another variation of the housing and storage barn provided storage for only a small supply of feed and bedding – perhaps two weeks' worth. In this case, the barn was accompanied by another storage building nearby (Wooley 1946: 111). In another variation, farmers built an addition onto an existing building to house their beef cattle, and sometimes feed and bedding.

PROVISIONS FOR MILKING

Between the late 19th century and the 1950s a significant number of Minnesota farmers milked their beef cows, raised "dual-purpose" breeds, or raised beef cattle along with dairy cows. These farmers needed the most substantial barns to support milking operations, and to protect specialized dairy breeds (which were more cold-sensitive than dual-purpose and beef breeds). These barns had stalls with ties or stanchions for milking, calving pens, and provisions for handling feed and milk. They were also subject to dairy sanitation laws.

In one example from 1934, a University expert recommended that a barn at least 32' x 70' could house 30 dual-purpose cows, plus their calves, plus a bull. The calves – an estimated 26 to 28 each season – would need to be fattened in an additional shed. That shed would need to measure 30' x 50' if the calves were fed indoors, or 20' x 50' if the feeding was done outside (Crickman et al 1934: 56-57).

SIMPLIFIED BUILDINGS

As more Minnesotans added beef cattle to their farms, and as herds grew larger, beef barns evolved from fully-enclosed buildings that were sometimes shared with other stock, to barns with one or two fully-open sides. These were often called beef "sheds."

Experts long recommended that beef cattle needed fresh air more than they needed warmth, and that good ventilation was important to preventing disease. As early as 1911 one expert was advising that "The experience of many feeders in the state [of Minnesota] shows clearly that, where the feed lot is fairly well-protected from cold winds, the open shed, facing south or east, is all that is necessary" as long as sufficient bedding was provided (Handschin 1911: 116; Sheffield 1910).

Ohio State University's Charles S. Plumb wrote in 1918, "Steers fed under sheds open to the south, with yards into which they can freely go, have given better results in growth and fattening than those kept in stalls in warm barns" (Plumb 1918: 318). Another expert, John Wooley, wrote in 1946 that exposure to the weather "sharpens" the appetite of the cattle (Wooley 1946: 108).

Because beef cattle required less shelter than other livestock, they were seen as adaptable to most any space as long as there were 30-40 sq. ft. per animal, not including storage and feeding areas (Handschin 1911: 115; Morris and Harvey 1950: 17; Neubauer and Walker 1961: 66).

At the same time that beef barns became more open, many were being built as one-story, rather than two-story structures. These buildings were simpler and less expensive to build, and were seen by some as more efficient to operate since the feed and bedding were stored on the same level as the animals. With the development of field pickup hay balers in the 1930s, more farmers stored their hay and straw in compressed bales that were sometimes too heavy for loft storage.

One-story, semi-open or open cattle barns became popular in the early 20th century. These barns had open "loafing" areas to which cattle had free access, as well as enclosed areas for calving and newborn animals. The barns were placed at the northwestern corner of the stockyard, with openings facing south, so the animals had protective cover but optimal sunshine. Feeding equipment could be placed either inside or outside of the building (Midwest Farm 1933; Carter and Foster 1941: 223-225). Farmers who used semi-open and open sheds that did not have storage areas needed to provide a structure for bedding and feed storage nearby.

A typical open rectangular beef barn – described in a 1950 source – could be 24' deep and any length (recommended to be in multiples of 12'). Each 12' of length could accommodate six cows, eight yearlings, or ten calves. A similar building in an "L" shape could have wings 48' long and 72' long, and be 24' deep (Morris and Harvey 1950: 15, 17). An inside height of 9' was recommended so that manure could accumulate during winter months since such barns were only cleaned once or twice per year. Feeding was done outside. Around 1960 Merickel Buildings of Wadena was offering plans and materials for open cattle barns measuring 20' x 30', 24' x 30', and 30' x 48' (*Merickel* ca. 1960).

Many farmers used their beef cattle barns for other purposes during much of the year since the cattle only required shelter during the winter.

CATTLE FEEDING ONLY

If the farm was simply going to feed or finish cattle – with no breeding, calving, or milking – the cattle shelter could be the simplest animal housing on the farm (Crickman et al 1934: 57-58; Wooley 1946: 108). Open sheds such as those described above were common.

FEEDING

The Minnesota Agricultural Experiment Station recommended in 1934, "Because the labor of feeding is considerably reduced by feeding out-of-doors and because fattening cattle will gain almost as rapidly and on very little more feed when fed out-of-doors . . . the majority of cattle fatteners prefer the outdoor feeding plan" (Crickman et al 1934: 56-58).

Feeding outside was also recommended to keep the food separate from rising piles of manure, especially in barns or sheds that were cleaned infrequently. Newborn calves and cows that were milked, however, were often fed inside.

Most feeding structures were made of wood, with metal structures introduced after World War II. Feeding structures included mangers (a term usually referring to an inside feed structure), racks (which held large loose material like hay and whole cornstalks), and bunks or troughs (which held liquids, grain, silage, and other particulate material). Some were called "self-feeders."

Outside racks and bunks were often on skids so they were portable. Racks and bunks were filled in several methods: by hand, from horse- or tractor-drawn wagons, with mechanical equipment (including augers) that extended from a barn, or with tractors equipped with front-end loaders.

Special feeding structures called "creep" feeders were built to allow nursing calves to access a feed source like grain, while preventing the adult cows from reaching it.

MANURE HANDLING

Cattle manure was deposited on fields and pastures in two ways: by the grazing animals as they walked, and by the farmer who spread manure-laden straw bedding on the land, either letting it incorporate passively or tilling it under. All but the earliest barns had openings large enough for manure-handling equipment to enter them.

Keeping manure within the barn and only removing it once or twice per year was advantageous: little of the precious manure was lost since it was mixed with absorbent bedding and kept out of the rain and, for farmers in northern climates who couldn't spread manure in the winter, the barn stored the manure until spring (Ashby 1916: 24). During the winter, the "manure pack" in the barn began to compost and heat up, providing a small amount of warmth for the animals (Lindor 2004).

In more recent decades, modern confinement buildings were sometimes built with slotted floors to allow manure to fall into a pit beneath the floor. The practice was discontinued by some farmers because it caused feet and leg problems for the cattle (Lindor 2004).

Modern feedlots use liquid manure pits, manure lagoons, and other methods to handle much larger quantities of manure than were historically produced on typical Minnesota farms. Manure lagoons first appeared in the 1970s (Hanke 2005).

MATERIALS

Buildings made of straw were used for winter beef housing in Minnesota from at least the 1870s through the 1950s.

Through the 1950s most beef barns were framed with dimensional lumber. Pole buildings framed with creosote-treated poles were introduced in the 1930s. By the 1930s metal-framed buildings were also being used by some farmers (Morris and Harvey 1950: 17; *Minnesota Farmscape* 1980: 9; *The Reynolds Pole Barn* 1953; Soike 1995).

Barns that housed beef cattle, feed, and bedding often had Gothic-arched, gambrel, or gabled roofs. Additions often had shed roofs. Semi-open and open buildings were usually gable-roofed, although a circa 1960 publication by Merickel Buildings of Wadena offered a "new appearing" modified quonset-like roof on a building whose walls and roof were corrugated metal (*Merickel* ca. 1960). Roofs were commonly covered with wood shingles, asphalt shingles, rolled asphalt roofing, or corrugated metal.

Floors were often wood or packed dirt or clay. Concrete was recommended for alleys for efficient cleaning, and sometimes for the entire floor. Floors were covered with bedding (e.g., straw, wood shavings, sawdust, or chopped corn stalks) to keep the cattle dry. More bedding was added as needed, and the manure and bedding removed when the barn was cleaned.

The earliest buildings were wood-sided. By the 1930s metal-sided buildings were introduced. A 1941 promotional publication by the Structural Clay Products Institute indicated at that time (perhaps optimistically) that tile was "rapidly gaining favor" for beef barns (Structural Clay 1941: 13).

After World War II metal-sided pole buildings became increasingly popular because of their durability, modular construction, and low maintenance (*The Reynolds Pole Barn* 1953). By the mid-1950s factory-built or "kit" beef barns such as those by Merickel Buildings of Wadena were also available (U.S. Steel 1957; *Merickel* ca. 1960).

PREVALENCE

It is expected that beef barns will be found throughout Minnesota. It is likely they are especially prevalent in corn- and soybean growing areas including southern and west central Minnesota. Because Minnesota's beef production rose significantly after World War II, it is likely that many post-1945 beef barns will be encountered. Pre-1900 beef-only barns are likely rare, and pre-1940 beef barns are likely uncommon. It is suspected that small structures like feed racks and feed bunks from pre-1945 operations may not have survived.

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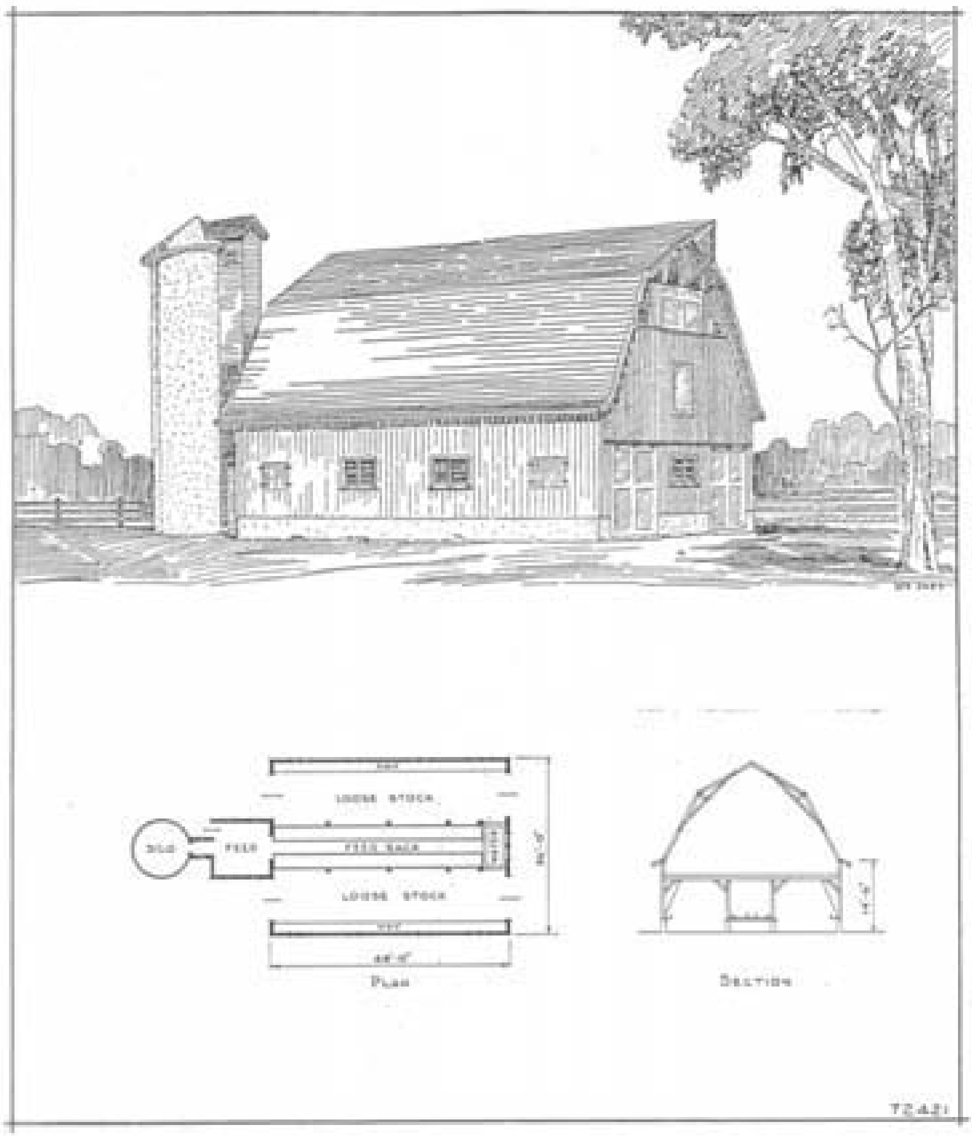
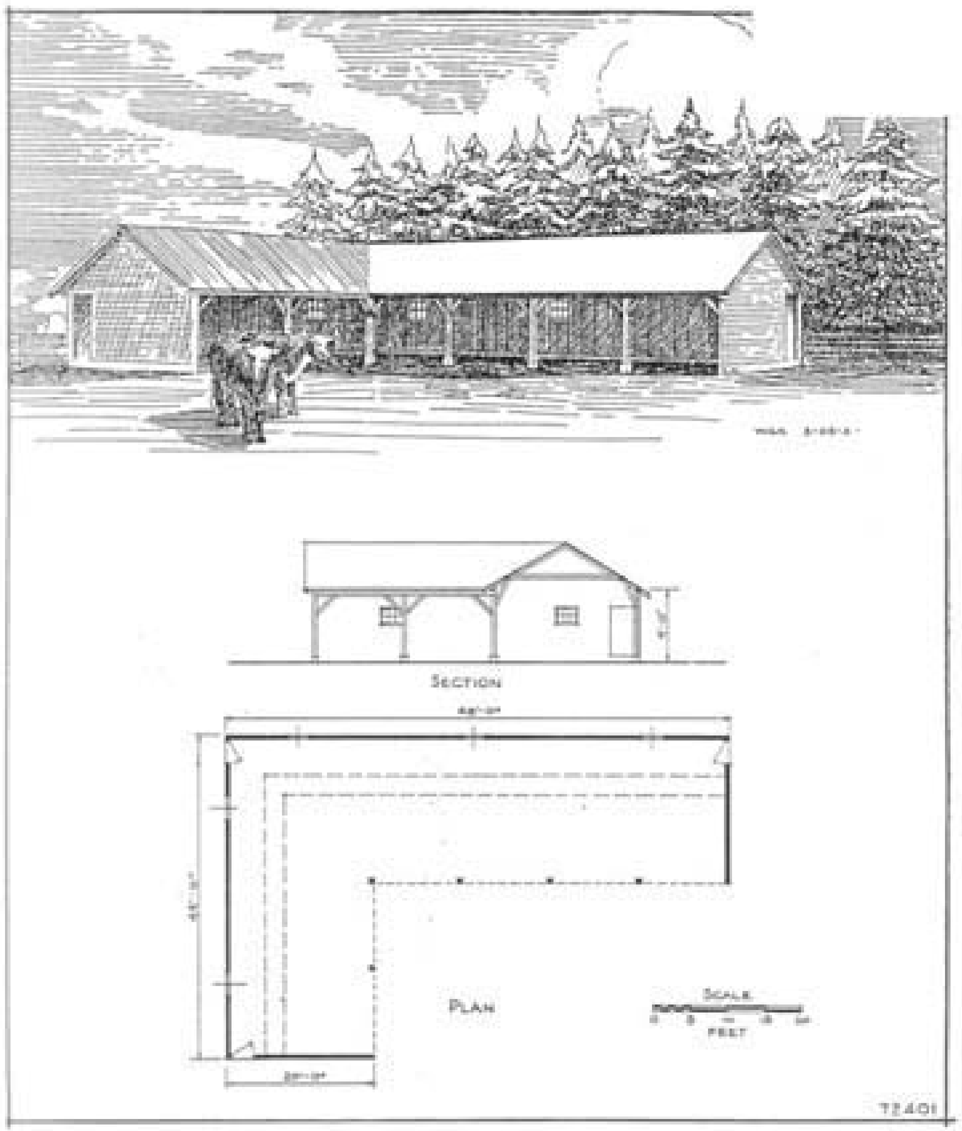
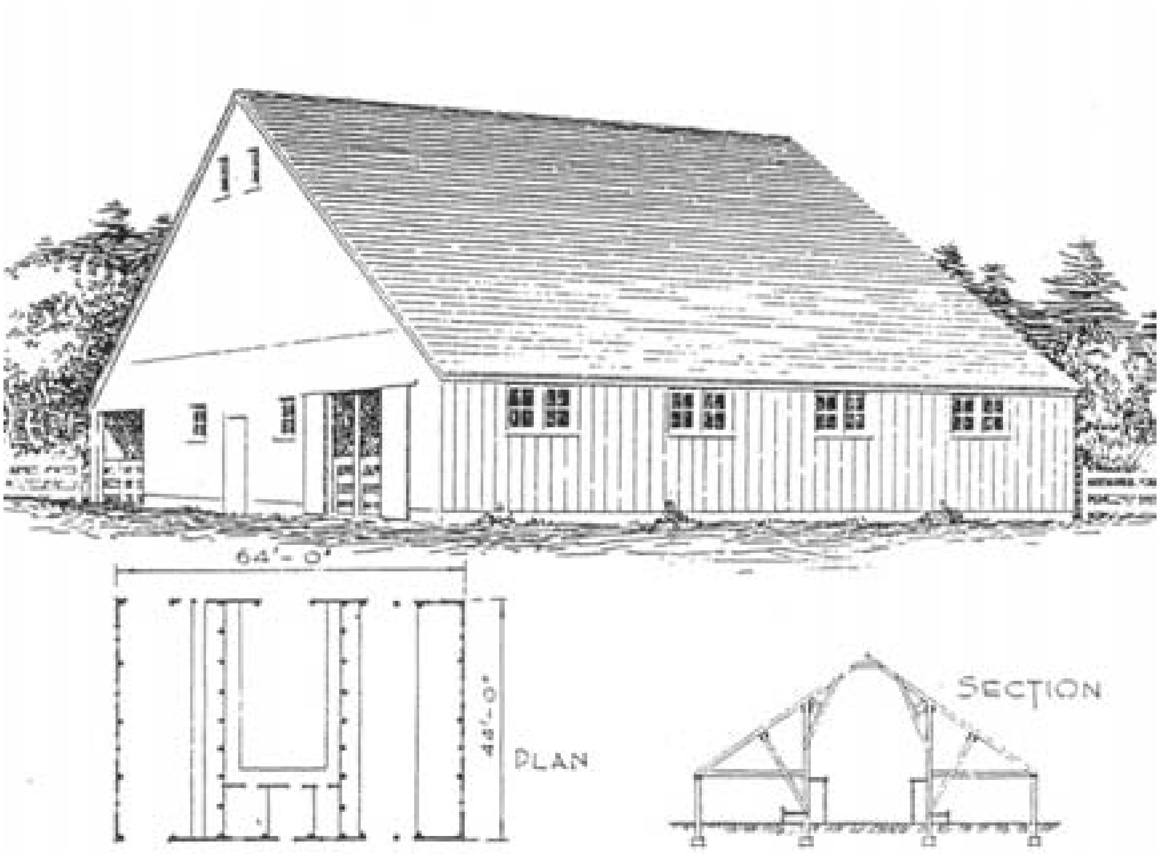


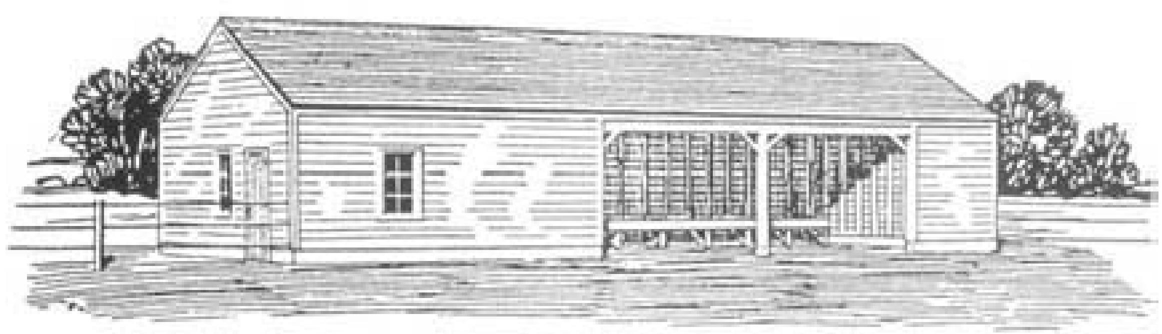
A "conventional two-story" cattle barn with a gambrel roof from a 1933 plan book for farmers. The barn had loose housing, hay and feed storage, mangers, a water tank, and an adjacent silo. From a Midwest Farm Building Plan Service catalog of plans, 1933.



Open sheds were often L-shaped. This barn had wings 44′ and 68′ long. From a Midwest Farm Building Plan Service catalog of plans, 1933.



A beef cattle or feeder barn with hay storage from floor to ridge pole in the center of the structure, and loose housing on either side. This plan was published in *Beef Production*, a 1950 Minnesota Extension bulletin by Morris and Harvey.



A 24′ x 56′ semi-open beef cattle barn designed by the National Plan Service. Plans were offered to farmers in a 1951 plan book (National Plan Service 1951).

An open cattle barn and feed bunk, probably in Minnesota. From the 1951 book *Modern Farm Management* by the University of Minnesota's Andrew Boss and George Pond.

■ BOUNDARY MARKERS

- The Public Land Survey divided the landscape into six-mile-square townships and one-mile-square sections
- The Public Land Survey was the basis of modern land descriptions, civil divisions, road systems, and farm ownership and size patterns
- Township, section, and quarter section boundaries are marked with corner monuments and witnesses
- Original corner monuments, set between 1847 and 1903, are now rare

The United States Public Land Survey began in Minnesota in 1847 and continued until 1903. Established in 1785, the survey divided Minnesota and other western territories into townships, sections, and quarter sections using a rectangular township and range surveying system. The rectangular survey provided short, precise, legal descriptions of public domain lands so the land could be sold and settled. The law required the land to be surveyed before private individuals could own it, although "squatting" on land during the early settlement period was common (Hart 1998: 149, 151; Jarchow 1949: 41).

The land was divided into townships six miles square, oriented in the cardinal compass directions. Each township was subdivided into 36 sections, with each section measuring one mile square or 640 acres. Townships were identified by latitude and range with respect to the principal meridian and baseline of the survey district; sections were numbered from 1 to 36.

The early survey influenced the location of roads, set many civil divisions, and laid the groundwork for land ownership. Today land survey lines still "determine the boundaries of most properties, and all but the most important highways follow property boundaries instead of cutting across them" (Hart 1998: 151).

Because of this historical land division, Hart wrote in 1998 that American farmers still "reckon their land in terms of sections of 640 acres, quarters of 160 acres, and 'forties,' or quarters of quarters." Even in 1998 "property boundary lines show astonishing tenacity and permanence," and in many regions the size of farms remained "closely related to the size of the parcels of land that the first settlers purchased" (Hart 1998: 151, 153, 157-158).

Land survey boundaries were identified on the ground with "monuments" and "witnesses" set at half-mile intervals along section lines. Monuments marked quarter section, section, and township corners. Monuments also marked "meander corners," which were places where the township, section, or quarter section boundaries intersected a stream or lake. In early surveys double sets of corner monuments were often set on all four boundaries of a township. Later, double monuments were used only when the northern boundary of a township was a standard parallel or served as a survey baseline (Moffitt and Bouchard 1992: 730-732).

See also

Early Settlement, 1820-1870
Appendix: Focus on Gov Land Programs
Farms

Minnesota's original corner monuments were set between 1847 and 1903. The first corner monuments were made of a wide variety of handy materials, many of them perishable. Materials included a wooden post, a charred stake or a quart of charcoal buried under a mound of earth, a big stone, or a rock mound. When a sound living tree stood at a corner point, it was often marked with grooves and notches indicating the number of miles to the township line in each direction (Moffitt and Bouchard 1992: 736, 743).

Whenever possible, early surveyors also marked the lines between corners with "blazes" or "hacks" on living trees that stood along the boundaries. Two hacks, resembling a sideways "W," were generally made to distinguish survey marks from accidental marks. The marks were cut at breast height on the sides of the tree facing the survey line (Moffitt and Bouchard 1992: 732).

Today corner monuments in Minnesota are made of concrete-filled pipes about 3' long and 1", 2", or 3" wide. Three-inch pipes mark township corners, 2" pipes mark section corners, and 1" pipes mark quarter section corners. The pipes are topped with brass or plastic caps inscribed with identification. Monuments mark all boundary corners including those adjacent to roads. When a corner point falls on solid rock that cannot be excavated, an "X" may be cut into the rock to mark the boundary, or a stone mound may be built to support a monument (Moffitt and Bouchard 1992: 736; Giese 2004).

To help people find corner monuments, they were "witnessed" by marking nearby trees, rocks, or other natural objects. In rocky areas early surveyors used stone mounds as witnesses. On the open grass prairie where there were few trees or rocks, corner points were witnessed by a pit in the ground near the monument. When these methods were not available, a monument could be witnessed by some other durable object placed at the base of the monument such as glassware, stoneware, metal, a stone with an "X," or a charred stake. Today these witnessing methods are falling out of use. Modern surveyors often witness the location of corner monuments with GPS coordinates (Moffitt and Bouchard 1992: 737; Giese 2004).

Most land survey lines have been "re-monumented" and early surveyors' monuments and witnesses are rare. Although the original monuments are still held as the true boundary corners, there was no systematic program to maintain them and many were lost to fires or farming practices. Likewise, "witnesses were wanting in permanence" and "early settlers made little effort to perpetuate either the corner monuments or the witnesses" (Moffitt and Bouchard 1992: 732, 734-735). According to one County Engineer, the most likely place to find an original monument would be on land that has never been tilled, such as a meander corner at a stream or lake (Giese 2004).

PREVALENCE

Boundary markers were used throughout Minnesota. It is expected that original boundary markers will be rare. Far more common will be replacement markers installed after 1945.

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This map, dating from 1891, is an early copy of the surveyor's data that translated the township and range system of land division into real space. The original surveyors placed boundary markers or monuments on the land to mark the section and quarter-section lines. Maps like this are still used at county recorders' offices to form the basis for land ownership documentation. (Courtesy Stevens County Recorder's Office)

▪ BROODER HOUSES

- Commonly built beginning in the 1930s
- Used to raise very young poultry that needed more care than older birds
- Chicks needed extra warmth for 6-8 weeks and were very susceptible to soil-borne diseases
- Brooder houses could either be stationary or portable
- Some farms divided the chicks into small groups in portable “colony” houses
- Electric brooder heaters, heat lamps, and incubators became common as farms electrified
- After 1915 farmers increasingly bought newborn chicks from local hatcheries

Brooder houses, which became prevalent in the 1930s, were special poultry houses in which baby chicks were raised. Between 1915 and 1950, Minnesota farmers increasingly purchased chicks from hatcheries, rather than incubating eggs on the farm, and usually received the newborn chicks when they were only a few days old. Because chicks were often born in the early spring, keeping them warm was difficult. They were also more vulnerable than older birds to the diseases that plagued poultry. (See also “Poultry Houses,” a separate farm element section.)

Prior to the 1930s, farms often arranged temporary quarters to serve as brooder houses. This might include closing off part of the general poultry house, using a makeshift structure, or using the attic, basement, or another room in the farmhouse (Smith et al 1936: 2).

Chick losses were high when farms used an improvised nursery because such spaces were often cold, overheated, unevenly heated, poorly ventilated, or crowded. They often provided no sunshine, which caused the chicks to be weak and frail. If part of the poultry house was used as the brooder house, the adult birds might be over-crowded, and there were problems controlling diseases and parasites to which chicks were especially susceptible. Using part of the general poultry house as a brooder house also limited the number of chicks the farm could raise (Smith et al 1936: 1-3).

For the reasons described above, poultry experts recommended that farmers build a specialized brooder house as part of their strategy to maximize poultry profits. Brooder houses could be used for storage or another purpose when not needed for chicks.

GENERAL CHARACTERISTICS

Brooder houses were similar to general poultry houses, which are described as a separate farm element section called “Poultry Houses.” The discussion herein is generally limited to those characteristics unique to brooder houses.

Brooder houses and general poultry houses were often indistinguishable from the outside, although brooder houses sometimes had a projecting stove pipe for the heater. Inside, brooder houses were less likely to have built-in equipment like roosts and nesting boxes.

See also
Poultry Houses
Appendix: Focus on Minn Livestock

Location and Portability. Brooder houses could either be stationary or portable. Like poultry houses, brooder houses were typically located in a sheltered area, facing south.

Stationary brooder houses were sometimes, but not always, larger than portable models. Some farmers felt stationary houses to be a better investment because they were more durable with proper foundations and heavier building materials. Because of the threat of soil-borne diseases, stationary houses often had elevated mesh runways which allowed chicks to exercise without coming into contact with the soil. These runs were sometimes called "sun porches" and sometimes had glazed ceilings to provide sunlight but retain heat.

Portable houses usually had temporary foundations, or were built on creosote-treated skids so they could be moved periodically to fresh ground. Portable houses often took more fuel to heat because their walls and ceilings were lighter for portability. Tenant farmers sometimes used portable brooder houses because they could take them along to new farms.

Portable Colony Houses. Some farmers used "colony" brooder houses, which were a set of small, usually identical, structures. Dividing the flock into small groups allowed the chicks to get better care and helped prevent the spread of disease. Colony houses were small and could be efficiently moved to fresh ground each season. New houses could be built as the farm gradually increased its flock. Colony houses had the disadvantage of requiring proportionally more building materials and maintenance than a single brooder house. Colony houses were especially popular in the 1930s.

Size. In general the size of a brooder house depended on the number of chicks being raised. Portable houses were sometimes smaller than stationary houses, and colony houses were sometimes as small as 4′ x 8′. Some experts recommended that no more than 50 chicks be raised together so that the correct temperature could be maintained. A 1936 source suggested that a 12′ x 14′ brooder house was sufficient to raise 200 chicks, providing approximately one square foot per chick (Smith et al 1936: 4-5). A University of Minnesota plan from 1953 recommended an 11′ x 14′ portable quonset-like brooder house on skids (*Farm Building Plans* 1953).

Materials. Stationary brooder houses were usually built of the same materials as general poultry houses, while portable houses tended to be more lightweight. By the late 1930s agricultural engineers were experimenting with strong, lightweight plywood for portable brooder houses (Giese and Dunkelberg 1939).

Brooder houses often had shed or saltbox roofs. By the 1930s and 1940s, however, some farmers and other experts were describing the advantages of rounded-arched roofs. According to one author from the University of Minnesota, "The most serious handicap to be overcome in portable houses is the difficulty of moving them if they are built warmly enough to conserve fuel. This disadvantage is largely overcome in the round-top houses because the shape reduces the weight and the space to be heated by about one-fifth" (Cooke 1943: 11).

In addition to being built by the farmer, ready-made colony houses could be purchased by about the 1930s. Around World War II, the Economy Portable Housing Company was selling factory-built hexagonal brooder houses made with wall panels and floors of tongue-and-groove fir. The houses had asphalt-covered polygonal roofs with central metal ventilators, four large windows (leaving two rear sides windowless), and "no cold corners" because of the six-sided design (Economy ca. 1940: 9-15).

Interior Arrangement. Stationary brooder houses were often divided into two pens to provide a warm area near the heater and a cooler exercise area. Having a cool area was important so the chicks would feather out faster. (If a chicken's feathers were missing, they were more vulnerable to the pecking of other chickens. In severe cases, this "cannibalism" led to chick losses.) Some two-pen brooder houses had a stove in each pen rather than separate warm and cool areas.

Colony houses typically consisted of a single interior space rather than divided pens.

Because chicks had a tendency to huddle in corners for warmth, partitions or bales of straw were often used to round out interior corners to prevent smothering.

Equipment. Whether stationary or portable, brooder houses did not typically have the permanent nesting boxes, roosts, or other built-in equipment found in a general poultry house. The brooder house's principal piece of equipment was an oil-, coal-, or electric-powered heater that was often placed near the center. It was recommended that the heater be placed within a structure called a "hover," which formed an elevated ceiling over the heater and chicks. The hover kept the chicks from crowding around the heater by heating the space more evenly. By the 1930s many types of electrically-heated incubators, brooder heaters, and heat lamps were commercially available. Large-scale brooder houses were sometimes heated by hot water systems. By 1960 radiant-slab brooders were in use (Plumb 1918: 378; Neubauer and Walker 1961: 95).

Once the heater and hover were removed at the end of six to eight weeks, portable roosts and sometimes portable partitions could be moved in. Some brooder roosts had two levels. When the young birds were able to get on the higher roosts, the lower roosts were removed.

PREVALENCE

Poultry was raised on at least 90 percent of Minnesota farms in the first half of the 20th century. While nearly all farms had a poultry house, they did not all have a separate brooder house. The prevalence of pre-1960 brooder houses is not well understood, and it is not known how many are still standing. It is likely that fewer portable brooder houses will have survived because they were built with lightweight materials. An entire intact colony would probably be uncommon.

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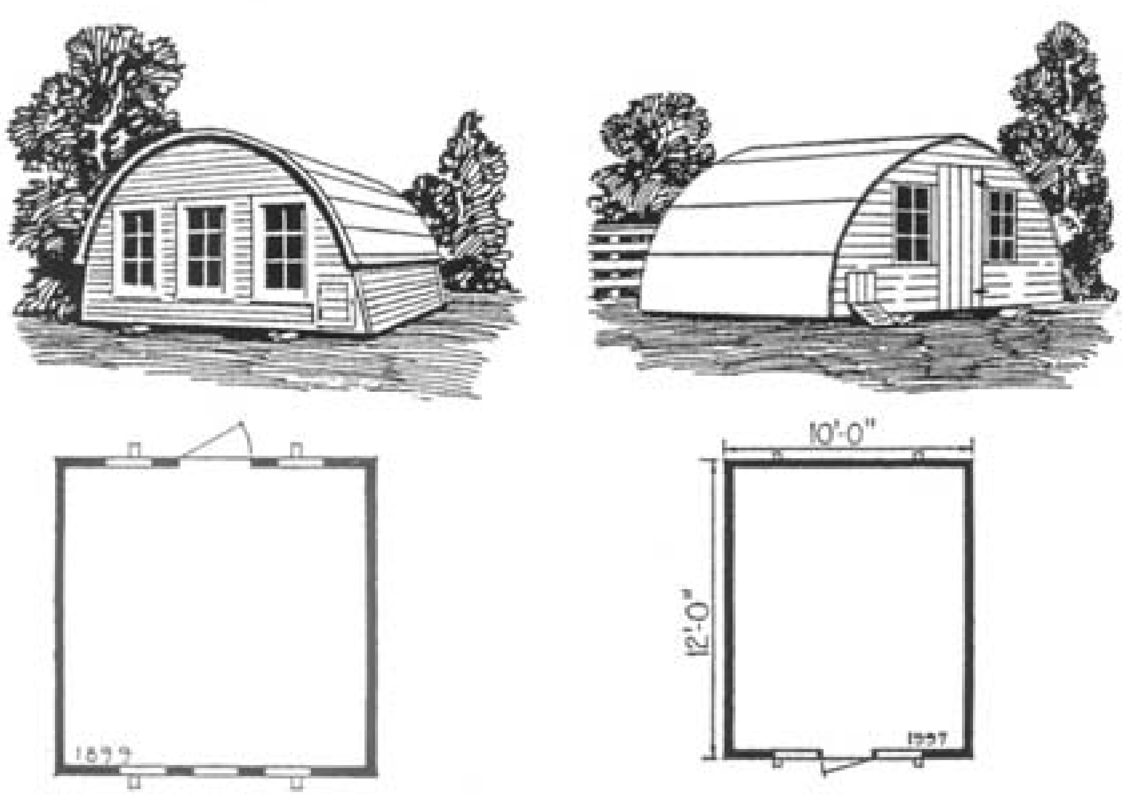
Colony brooder houses were used to raise chicks in small groups. Segregating the groups helped prevent the spread of parasites and disease, which were a serious problem. Because they required more materials and maintenance than a single structure, they were often used by farms raising large flocks and then only while the birds were young. The houses above appear to be sided with tar paper. Figreans Farm, St. Louis County, circa 1930. (MHS photo)

A colony brooder house with just-hatched chicks. Most brooder houses had little fixed equipment inside. An oil-, coal-, or electric-powered heater was needed for the first six to eight weeks to keep the chicks warm. Colony houses usually had temporary foundations, or were built on skids, so they could periodically be moved to fresh ground free of soil-harboring diseases. Location unknown, circa 1910. (MHS photo)



In 1951 the National Plan Service was offering plans for these two portable brooder houses with arched roofs. Footprints were 8′ x 12′, 10′ x 12′ and 12′ x 12′, with the 10′ x 12′ house capable of housing 250 chicks. The exterior walls were sheathed with wood siding and the roof may have been either rolled asphalt or galvanized metal. The University of Minnesota was offering a similar plan in 1953. Brooder houses were usually designed for storage or other purposes when not needed for chicks. From *Practical Structures for the Farm* (1951).

■ BULL BARNS

- Typically a small structure where a single bull was kept
- Early examples probably date from around 1900
- Usually surrounded by a stockyard with a strong fence
- Minnesota dairy farmers started using artificial insemination in the late 1940s

Dairy expert Clarence H. Eckles in a 1911 dairy management guide repeats an old saying, “the sire is half the herd” when introducing his discussion of the importance of bull selection and care to the success and productivity of a dairy herd (Eckles 1911/rpt. 1921: 154). Minnesota farmers kept bulls to breed both dairy and beef cows.

Some farms housed their bull in a barn with other animals. The practice was not recommended for sanitary reasons (particularly in dairy barns) or for the health of the bull who was too often “confined in a dark, dirty stall without exercise” (Eckles 1911/rpt. 1921: 170). Creating separate facilities for the bull was advised for worker safety, to make handling easier, and to insure that he received adequate exercise. More than one bull could be kept together as long as the space was large enough and the bulls were dehorned.

Some farmers used a shed or other available building to house their bull, while many built a dedicated structure. Early examples probably date from around 1900.

A woodframe, drop-sided 12′ x 16′ building was recommended by the Midwest Plan Service in 1937. It had a concrete foundation and a shed roof. The building had two small windows, a door for the worker, and a door for the bull. Inside was a manger and a stanchion to restrain the bull during barn cleaning, veterinary procedures, etc. A similar 14′ x 14′ structure was recommended by the University of Minnesota in a 1953 plan book (Midwest Farm 1937; *Farm Building Plans* 1953).

It was recommended that an outside pen or yard be adjacent to the housing. Experts recommended that the pen be long and narrow to encourage exercise as bulls tended to stand in the middle of a square yard and move very little. A 1937 Midwest Plan Service plan for a bull barn had a 56′ x 21′ pen (Midwest Farm 1937, also printed in Carter and Foster 1941: 222). The pen needed to be made of substantial material with closely-spaced fence posts to keep the bull from breaking out. Strong metal post-and-rail fencing secured in concrete-filled post holes was recommended by *Successful Farming* magazine in 1940 (Fox 1940: 49).

Eckles noted in 1911, “Plenty of exercise is one of the factors in preventing a bull from becoming vicious.” In addition to being strong and in good repair, the pen should be placed so that the bull can see the herd and the attendant since, according to Eckles, “Solitary confinement in an isolated box is not conducive toward the development of a quiet disposition in a bull” (Eckles 1911/rpt. 1921: 173).

See also
Beef Barns
Stockyards
Appendix: Focus on Biotech Agrichem

Successful Farming's advice in 1940 added that the bull pen should have a "well-drained location where bull can see the herd; shade; a stout keg or barrel for the bull to play with; [and] tanbark on the ground if possible" (Fox 1940: 49).

Safety for the hersdman when handling the bull was always a concern and experts warned that the "Doors between shelter and pen must be controllable from outside so the animal may be shut in or out of the stable without handling him" (Fox 1940: 49).

Farmers often included a breeding stall or chute at a corner of the pen. (Breeding the cows one-by-one facilitated the control and record-keeping important to herd management (Eckles 1950: 188).) The breeding stall also had to be carefully designed and strongly built to ensure worker safety. The cow entered and exited the stall via an exterior gate, while the bull entered the stall directly from the pen.

Artificial insemination reduced the need for farms to keep bulls. After several decades of experimentation in other countries, significant artificial insemination work began in the U.S. in the 1930s, particularly at Cornell University around 1936 and in Minnesota and Wisconsin in the late 1930s (Foote 2002: 3). Retired University of Minnesota animal scientist Harley Hanke believes that average Minnesota farmers began using artificial insemination for dairy cows around the late 1940s, and for beef cows about five years later (Hanke 2005).

Using artificial insemination for dairy herds was more common than for beef herds for several reasons. Dairy cows, who were accustomed to stanchions, were more tame than beef cows and easier to inseminate. Dairy farmers needed to breed several times a year, rather than once like many beef farmers, and dairy bulls tended to be more aggressive than beef bulls and therefore harder for the herdsman to safely handle. These factors favored artificial insemination on dairy farms (Hanke 2005).

Some Minnesota farmers rented a bull. This was more prevalent among beef producers and more prevalent among small farmers. Hanke estimated that about five to ten percent of Minnesota beef producers rented bulls in the 1950s and 1960s (Hanke 2005).

PREVALENCE

Keeping bulls was very common on Minnesota farms through 1960. After 1960, it was more common for beef producers than for dairy producers. Many Minnesota cattle farmers still keep bulls today.

Bull barns were likely vacated when farmers either began to use artificial insemination or phased out of cattle. Bull barns were then likely converted to other uses. Because they were strongly-built, many are likely to be standing.

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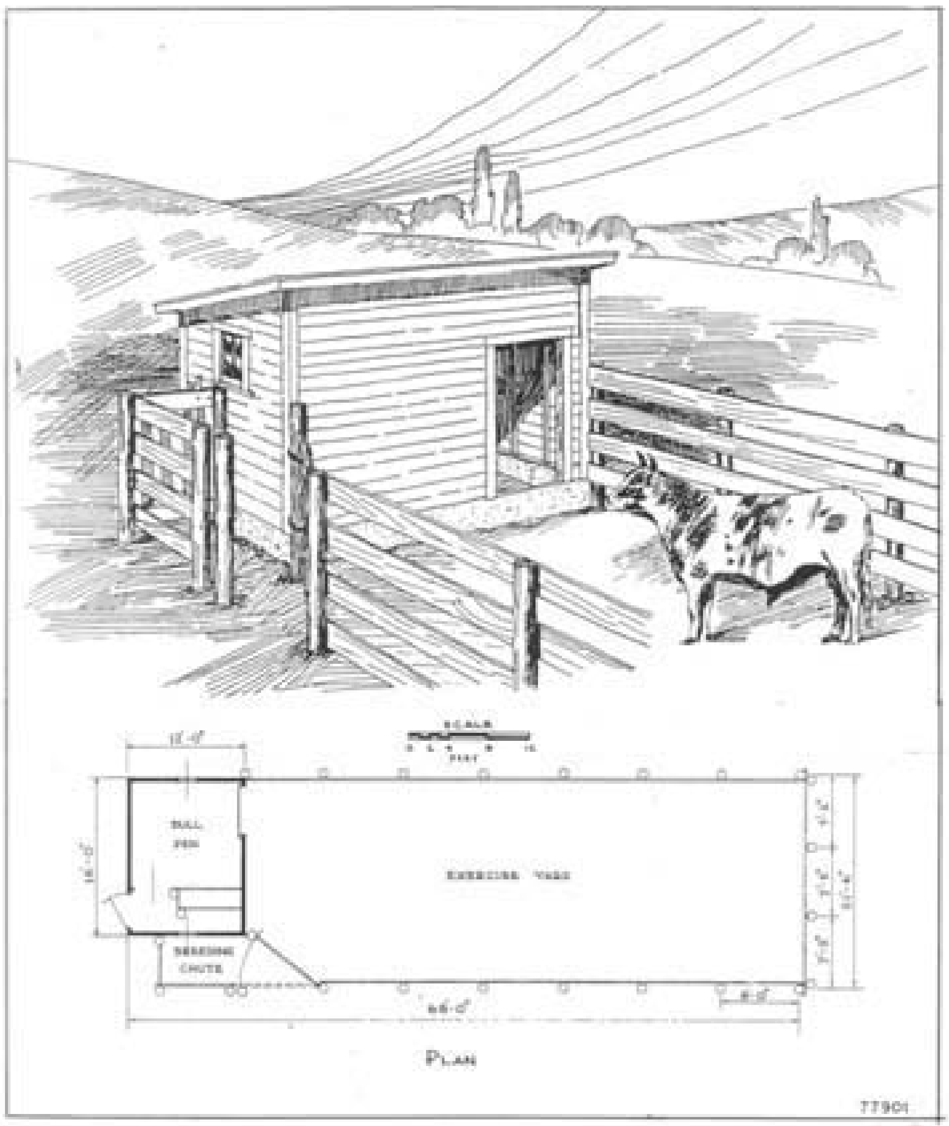

This 1937 design for a bull barn was typical. It had a 12′ x 16′ barn and a strong fence surrounding a yard. The gate to the yard was designed so that it could also serve the breeding chute at the corner of the building. From the Midwest Plan Service 1937 catalog of plans.

■ CATTLE GUARDS

- Structures that allowed vehicles to pass freely into pastures but prevented livestock from escaping
- Used beginning in the 1920s, but more guards were installed in the 1940s and 1950s

A cattle guard, or cattle grid, was an at-grade structure – usually built at the intersection of a farm lane and a fence line – that allowed vehicles to pass over it but discouraged livestock from escaping. Cattle guards often replaced gates that took time and trouble to open and close, especially when farm workers had to access a field or pasture frequently.

A cattle guard usually consisted of a set of parallel pipes or bars mounted over a shallow pit and set at right angles to the farm road or lane. The bars were mounted close enough together to support a vehicle, but too far apart to support the hooves of livestock.

Cattle guards were typically as wide as the roadbed (e.g., 12′) and measured 4′ to 8′ in the other direction. While a 4′ or 5′ distance might be sufficient to keep adult cows from wandering out of a field or pasture, energetic calves sometimes tried to jump the grid and therefore 8′ grids were sometimes used.

The pit could be built of materials such as earth, poured concrete, or concrete block. The pit was often at least 1′ deep and had to be cleared periodically of accumulated soil, debris, and weeds.

The bars or pipes were often about 4″ in diameter and were sometimes welded into a rectangular framework that was set over the pit. Some farmers preferred true-round pipes over flat-topped bars because the round pipes were more slippery to the animals' hooves. Some farmers made the bars from timbers (which were not long-lasting) or pieces of railroad track cut to length. In another variation, farmers filled the pit with short sections of concrete drain tile set on end. Modern cattle guards are generally built of precast concrete and/or steel.

PREVALENCE

Cattle guards were used throughout Minnesota, but especially in areas where livestock production was prevalent. The earliest probably date from the 1920s when cars and trucks became common on farms. Far more likely date from the 1940s-1950s when livestock feeding increased substantially.

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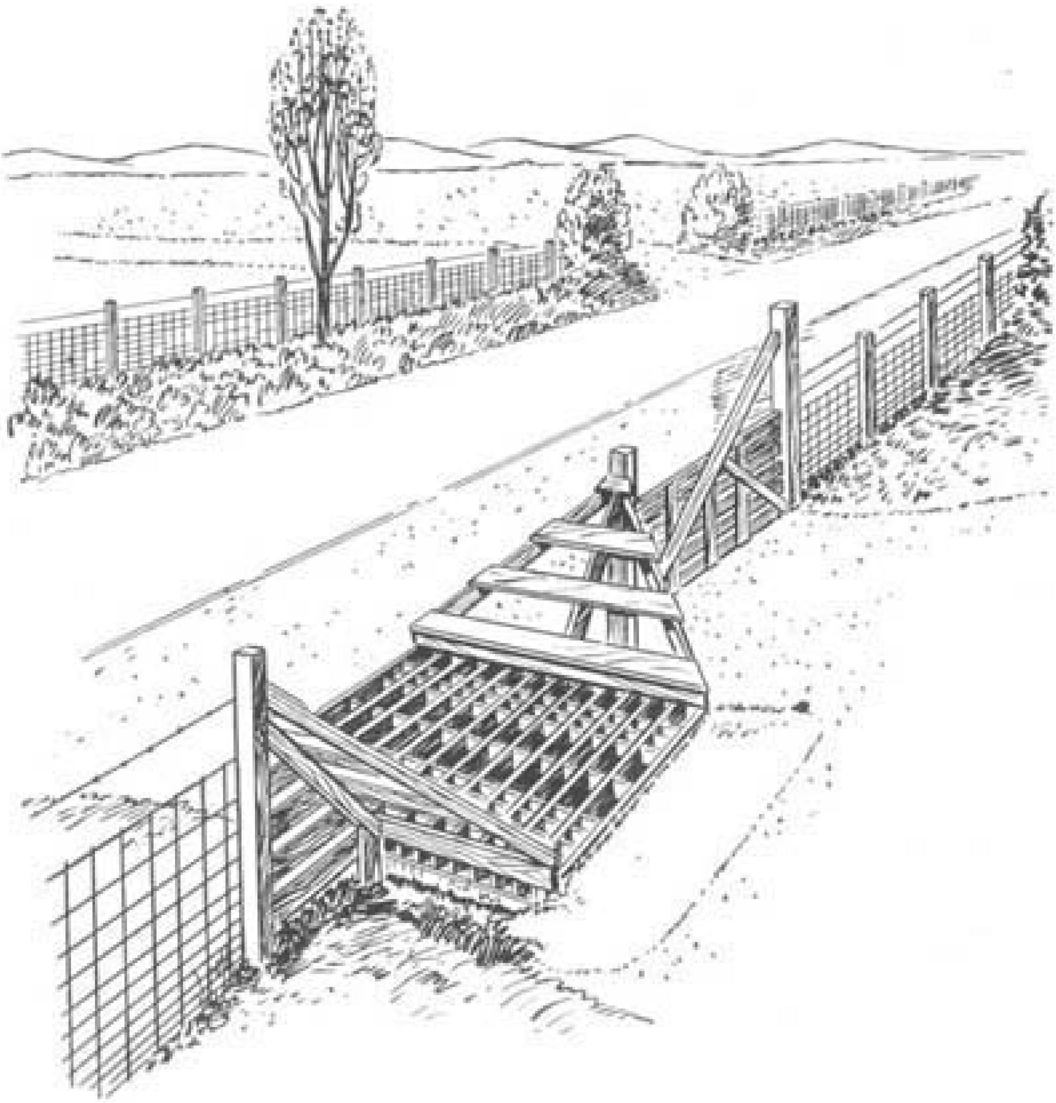
See also

Fences
Fields and Pastures
Roads, Lanes, Tracks, Sidewalks
Develop of Livestock, 1900-1940



A typical cattle guard of recommended design. Cattle guards could save valuable time otherwise spent opening and closing pasture gates. From Wooley's *Farm Buildings* (1946).

■ CESSPOOLS AND SEPTIC TANKS

- Cesspools were an earlier, simpler way to handle sewage
- Septic tanks in familiar form date from the 1880s
- Septic tanks were generally made of brick or clay tile plastered with cement; monolithic versions were made of poured concrete
- Usually sited near the house

Farm septic tanks were underground sewage disposal tanks in which household waste was decomposed by anaerobic bacteria. Forms of septic tanks were used in the U.S. by at least the mid-19th century, but in familiar form were introduced to the U.S. around 1883.

Before septic tanks were adopted, many farms drained household waste into a cesspool near the house. The cesspool was a covered hole or pit lined with lumber or brick. In porous soil, liquid waste quickly drained out through the walls of the pool, leaving the solid matter behind. In heavier soils the cesspool often overflowed and a new pool had to be dug. Cesspools seldom worked well and were a health hazard, "saturating the surrounding ground, for a long distance, with disease germs, which in time may be carried into the house water-supply" (Stewart 1914: 73).

Septic tanks offered a sanitary method of sewage disposal. They consisted of a single- or double-chambered underground tank with a tight cover. The tank was often made of poured concrete, but clay tile and brick plastered with cement were also used. Concrete septic tanks were usually rectangular but other shapes were also used. Typical in 1914 was a jug-shaped septic tank with an arched neck and a cast iron manhole cover. The tank was especially useful for small spaces and for masonry construction (Stewart 1914: 79; Structural Clay 1941).

Septic tank size depended on family size and the amount of wastewater that had to be treated in a 24-hour period. In 1914 a minimum size recommended by one author was 6′ long, 3′ wide, and 3′ deep. In 1953, plans distributed to farmers by the University of Minnesota had common tank sizes of 3′ to 5′ deep, 2 1/2′ to 4′ wide, and 5′ to 10′ long (Stewart 1914: 74-85; *Farm Building Plans* 1953; Structural Clay 1941).

The septic tank was covered by a permanent lid that could be removed to clean or repair the tank. Covers were usually made of reinforced concrete or cast iron. Wood was also used – one 1914 source discussed a double layer of 2″ pine planking laid crossways, but reminded farmers that it would last only a few years. Heavy concrete covers were often divided into small sections for easier removal. The tank lid was covered with at least 2′ of earth to shut out light and prevent freezing. Experts offered several cost-saving tips for septic tank construction, such as using old horseshoes for the lid handles and worn-out hay-rake teeth or scrap fencing to reinforce the concrete (Stewart 1914: 79, 82; *Farm Building Plans* 1953).

See also

Privies
Farmhouses

Sewage entered the septic tank through an inlet pipe. Flow through the tank was regulated by baffles that prevented movement on the surface of the effluent, where the bacterial action took place. After decomposition, which took about 24 hours, the liquid effluent flowed out through a 4" pipe into an underground dispersal system (Stewart 1914: 74-85).

Several methods were used to disperse the liquid. Often it was simply carried a short distance through drain tile to an open ditch or waterway. Sometimes the effluent was discharged into a covered dry well where it seeped away into the ground (Midwest Farm 1937; Stewart 1914: 75-76).

Septic tanks were usually located quite close to the foundation of the house so that the sewage could be discharged into the tank directly from the household's cast iron soil pipe.

PREVALENCE

Septic tanks were used on farms throughout Minnesota, with their use increasing after World War II when many farm outhouses were replaced. It is likely that many are extant, but they may be difficult to detect on the ground surface unless evidence of a depression or cover is visible.

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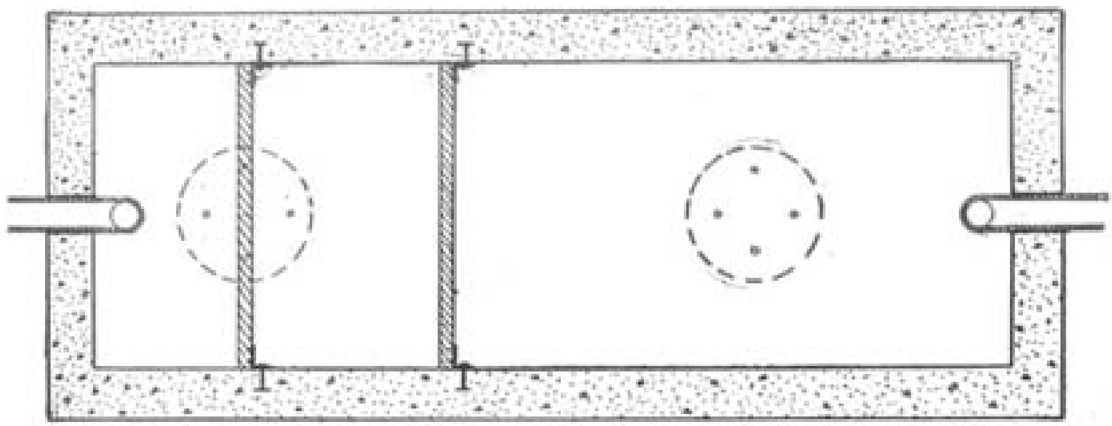

Fig. 35.—Top View of Septic Tank.

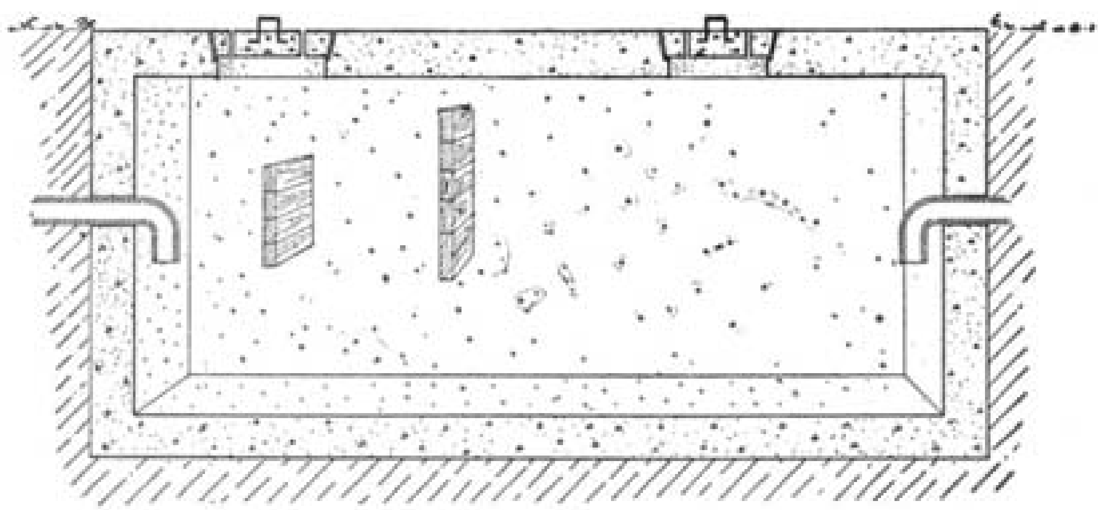

Fig. 36.—Lateral View of Septic Tank.

Top and lateral view of a septic tank from a 1920 farming manual whose audience included Minnesota farmers. From *Farm Economy* (Moore et al 1920).

▪ CISTERNS

- Devices used to store rainwater for household use
- Found on farms by at least the late 19th century
- Usually located underground near the house
- Least durable were jug-shaped cavities with cement-covered earthen walls
- More durable were cylindrical or rectangular cisterns with walls lined with stone, brick, or clay tile – all covered with cement – or with walls of poured concrete

Cisterns were circular or rectangular reservoirs for storing water collected from building roofs or pumped from wells (Brooks and Jacon 1994: 58). They were in use by at least the late 19th century, and usually located underground within or near the farmhouse.

Farmstead cisterns generally stored soft rainwater, which was much better for household chores than hard, mineral-laden well water. A 1920 *Farmers' Institutes Annual* extolled the advantages of rain water for washing, explaining that "less soap and no chemicals are needed for softening rain water, and dishes, clothes and bodies are more easily cleansed with soft than hard water; hence, these operations are more likely to be thoroughly done, especially by children, when plenty of soft water is easily available" (Shepperd 1920: 139). However, experts discouraged farm families from consuming cistern water, warning that it was unsafe for drinking (Stewart 1922: 7).

A successful cistern needed a year-round supply of "water as nearly pure and as nearly colorless as it is possible to have roof water" (Shepperd 1920: 145). Cisterns were usually filled by collecting rain in eave troughs or gutters. To keep the cistern clean farm specialists recommended discarding the water from the first portion of each rainfall until the roof was well rinsed. A 1920 publication showed farmers how to install a simple cut-off valve between the eave down spout and the cistern pipe. The valve was operated by means of a long cord so that the water could begin filling the cistern once the roof was washed. A metal screen prevented leaves, twigs, and other foreign material from entering the cistern (Shepperd 1920: 140, 145).

Water flowed into the cistern through an inlet pipe – typically 1" galvanized pipe – that entered the cistern below ground. Most cisterns also had an overflow pipe to carry away surplus rain water. A pump in the kitchen – often hand-operated – drew water out of the cistern through a suction pipe. A tightly-fitting, removable lid made of wood, concrete, or cast iron allowed access to the cistern for cleaning and repairs.

Cisterns were built in several shapes. Simple forms were made by digging a jug-shaped hole in the ground and plastering cement mortar directly onto the earth to form walls. The neck of the cistern could be either poured concrete or 20"-diameter concrete or clay sewer pipe. Jug-shaped cisterns were inexpensive to build, but they were practical only in areas where the soil consisted of very firm clay. They also had to be protected from freezing or the walls would crack (Shepperd 1920: 143).

See also

Farmhouses
Wells
Pumps and Pump Houses
Water Tanks and Tank Houses

Cylindrical and rectangular cisterns could be built in any soil and were much more durable than earthen cisterns. The walls were made of poured concrete or stone, brick, or clay masonry plastered with thick cement to make them waterproof. A rectangular cistern was a little cheaper to build than a cylindrical one, but it was also “less sanitary, because it has more sharp angles and dark corners to catch and hold dirt” (Shepperd 1920: 143; Structural Clay 1941). The walls of the cistern often angled inward at the top to form a bottle-shaped neck.

The size of a cistern depended on the needs of the farm family. For example, a circular cistern 8′ in diameter and 8′ deep had a capacity of about 100 barrels of water – roughly 4,300 gallons (Structural Clay 1941). In 1922 the Minnesota Extension Service estimated that a “normal family of eight persons – will use generally from 200 to 225 gallons of water per week” (Shepperd and Stewart 1922).

Some cisterns had filters inside. A commonly-used filter consisted of two parallel brick walls with sand between them. Water seeped through the layers of sand and brick, leaving impurities behind. A variation of the wall filter consisted of a beehive-shaped brick dome built on the floor of the cistern. Separate underground filter beds of sand and charcoal were also used (Shepperd 1920: 147; Midwest Farm 1937).

Cisterns were commonly located both inside the farmhouse and outdoors. Basement cisterns were preferred because they didn’t need special protection from frost and were less likely to be polluted by surface runoff (Stewart 1922: 7). Outdoor cisterns were generally placed near the house. If the farmstead had a hill, the cistern was sometimes cut into the hilltop to take advantage of the power of gravity in distributing water to the buildings below. An 1898 Minnesota publication shows a cistern located near the barn to supply water for the stock (Boss 1898: 159).

Cisterns were widely used for many decades. In 1930, only 12 percent of Minnesota farms had running water. Even as late as 1960, only eight out of ten Minnesota farmhouses had running water and indoor toilets (Jellison 1993: 55, 169).

PREVALENCE

Farm cisterns were commonly built throughout Minnesota, but early examples may be uncommon. Basement cisterns were often demolished when farmhouses were razed or replaced. It is possible that outdoor cisterns are more likely to have survived.

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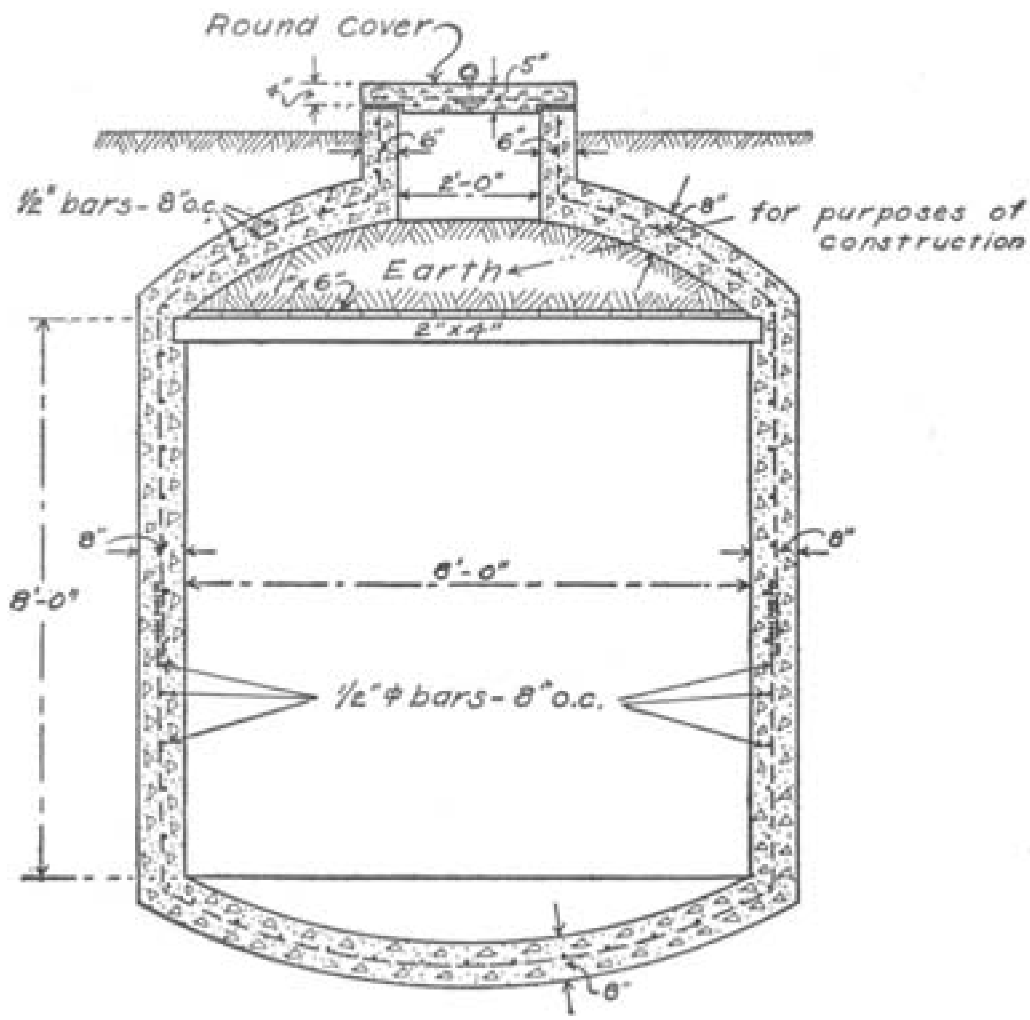

Cross-section of a poured concrete cistern from *Farm Economy*, a 1920 farming manual (Moore et al 1920).

Hand-operated pitcher pumps were commonly used in farm kitchens to pump water from a cistern. The water was used for bathing and washing clothes and dishes. Location unknown, circa 1910. (MHS photo)

■ COMBINATION BUILDINGS

- ▸ Common on Minnesota farms where it was often cost-effective to combine several structures under one roof
- ▸ Combination buildings often boosted efficiency, but could be a fire hazard

Combination buildings are structures built to serve several functions. They were sometimes built with a separate unit for each function. They often made use of a shared wall, but had no interior inter-connection.

Combination buildings were often built as a practical matter. They allowed farmers to save labor and materials by building one structure instead of two or three separate buildings, and let them build in phases, thereby spreading out capital costs. Combination buildings could also be efficient, reducing the distance farm workers had to walk to perform related functions. Combination buildings had many of the same advantages as building additions. Some farmers avoided combining buildings because of the risk of extra losses due to fire.

In Minnesota the use of combination buildings in the late 19th and early 20th centuries may have been more prevalent among particular immigrant groups such as Germans; this topic needs further research.

Combination buildings were constructed during all periods of Minnesota farming, from the early settlement era through the post-World War II period. Before and after World War II, in fact, there was a broad trend toward building multipurpose, rather than specialized structures, so that farmers could efficiently change operations to meet shifting markets and take advantage of evolving technology.

Many types of farm structures could be combined. Examples of common combinations included:

- implement shed, farm shop, and/or garage
- granary and corncrib
- granary and implement shed
- hay barn and livestock barn
- dairy barn and horse barn
- dairy barn and milk house
- icehouse and milk house

See the individual farm element section entitled "General Purpose or Combination Barns" for information on multi-use barns.

Housebarns, which were structures that combined the farm family and livestock under one roof, were rare in Minnesota but were built, particularly during the early settlement period (Jarchow 1949:

See also
Housebarns
Farm Shops
General Purpose or Combination Barns

83). They were generally conducted by specific ethnic groups such as Finns. At least one housebarn still stands in northern Minnesota's St. Louis County where it was built by Finnish farmers (Koop 1989).

PREVALENCE

Combination buildings were built throughout Minnesota during all farming periods. It is likely that many will still be standing, with early examples being more rare. Combination buildings with three or more separate units may be uncommon.

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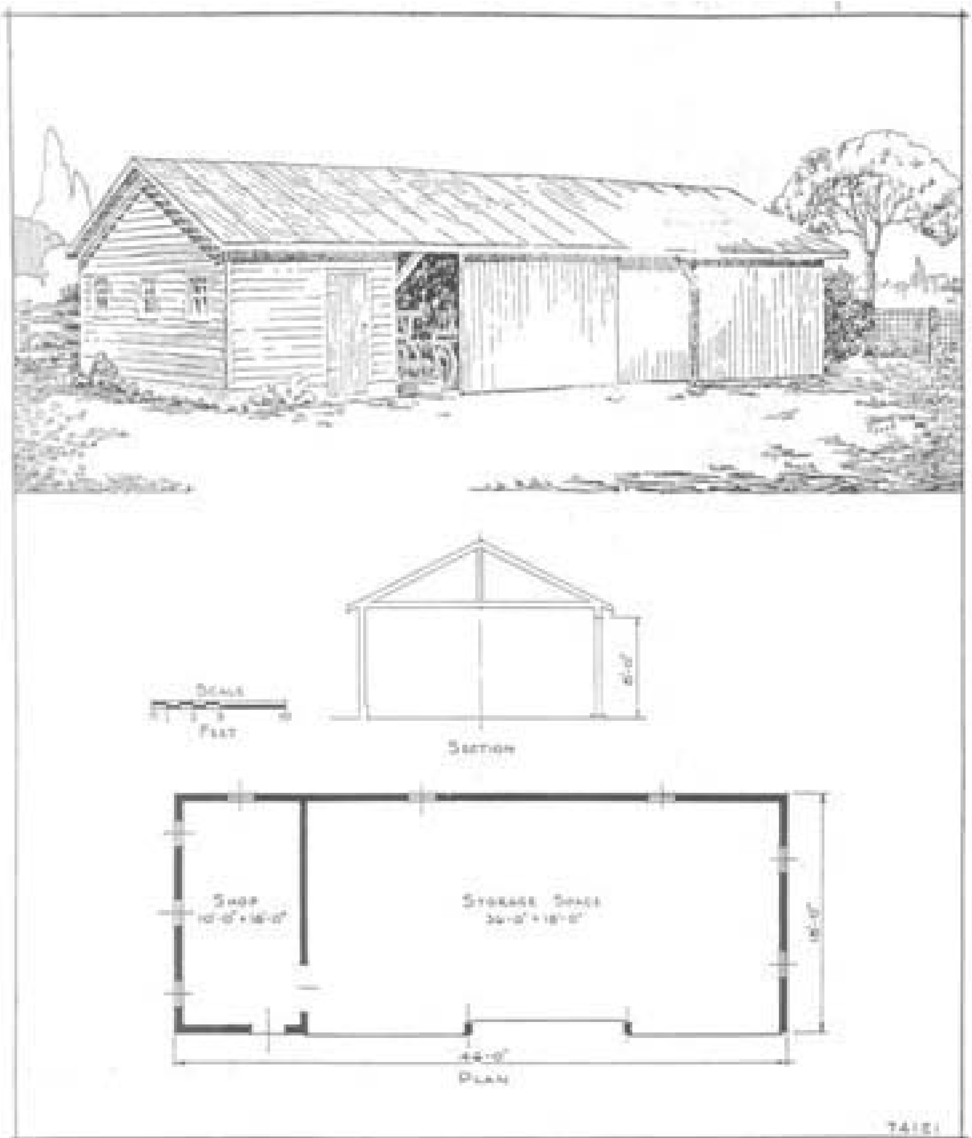
This farm near Pine River in north central Minnesota had a poultry house incorporated into a larger barn. This was an unusual combination – poultry houses were generally separate. Near Pine River, circa 1915. (MHS photo)



Farm shops and implement sheds were frequently combined under one roof. This 18′ x 46′ structure appeared in a Midwest Farm Building Plan Service catalog from 1933.

▪ CORNCRIBS

- Structures used to dry and store ear corn
- Sited for easy access to fields and livestock
- Associated with diversified farming and the rise of livestock farming
- Built in a variety of sizes and styles; carpenter-built or factory-made
- Sometimes combined with a grain bin
- Larger cribs and masonry cribs were more common in southern Minnesota
- Steel wire cribs became common in the 1940s
- Use began to decline in the mid-1950s with picker-shellers

Corncribs – or structures designed to store ear corn – were built in Minnesota beginning in the early settlement period. Corncribs were similar to granaries, except that the walls of corncribs were slatted or perforated to allow more air to circulate. (See "Granaries, Elevators, Bins, Dryers," a separate farm element section.) Corncribs were widely used throughout Minnesota, but especially in the southern half of the state where conditions were best for growing corn.

While corn was grown in Minnesota throughout the early settlement period, only the southern edge of the state had reasonable yields because most seed originated from Southern sources. In the mid-1890s, the Minnesota Agricultural Experiment Station developed 'Minnesota 13,' an open-pollinated variety more suited to cold regions. With 'Minnesota 13,' corn-growing crept northward. Cornfields, and the need for corncribs, increased in 1900-1920 as Minnesota farms continued to diversify. Corn production increased significantly after hybrids were introduced around 1930 and as the state's livestock industry grew. Double-hybrids, as the first hybrids were called, were used almost exclusively in Minnesota from the end of World War II until the early 1960s when single hybrids were introduced and yields increased again. Even with hybrid varieties, most corn-growing was concentrated south of a diagonal line drawn through Breckenridge, Little Falls, and Cambridge.

Before farm mechanization, Minnesota farmers used several methods to harvest and dry field corn. During the early settlement period, for example, corn stalks were cut, bundled into shocks, and left standing in the field to dry. They were sometimes left there all winter, with the farmer picking and husking the ears as needed for feed (Noble 1984: 105).

Some farmers harvested corn by walking the rows, picking the ears by hand, and throwing them into a wagon. By the late 1920s, harvesting equipment included tractor-drawn one-and two-row pickers. The corn was hauled to the barn where it was husked and then stored in a corncrib where it continued to slowly dry. Unlike wheat and hay which had to be harvested under time constraints to preserve quality, corn could be harvested very late. Many Minnesota farmers harvested through December (Lindor 2004).

See also

Granaries, Elevators, Bins, Dryers
Develop of Livestock, 1900-1940
Appendix: Focus on Minnesota Crops

Ear corn was removed from the corncrib in batches (e.g., 200 to 500 bushels) as needed for feed year-around. The batch was shelled and the shelled corn stored in a granary. Some farmers also ground ear corn and fed it to beef cattle, or ground ear corn and blew it into a silo. Beginning around the 1950s some livestock farmers also ensiled shelled corn for livestock feed (Lindor 2004).

GOVERNMENT STORAGE PROGRAMS

During the Depression there was an increase in corncribs built on Minnesota farms in response to USDA Commodity Credit Corporation loan programs authorized by the New Deal's Agricultural Adjustment Act of 1933. Beginning in 1934 farmers could borrow money on stored ear corn as part of a larger program to stabilize prices by reducing hog and corn production. According to Minnesota historian Jerome Tweton, "The corn had to be stored under seal; the farmer could pay off the loan and feed or sell the corn or let the Corporation take it over to satisfy the debt" (Tweton 1988: 117). Corn was also stored under another New Deal program, the "Ever-Normal Granary," also operated by the Commodity Credit Corporation. The Ever-Normal program, which began in 1938 and continued into the 1970s, sought to protect farmers' incomes, as well as consumer food prices, from market fluctuations. A secondary goal was to insure a reserve of grain against drought or other unforeseen events. Farmers were given loans on grain placed in storage with the idea that they could market the grain during years when supplies were down and prices high. The USDA also purchased corn directly from farmers to help control the market (Bridgman 1938; Tweton 1988: 121-123).

To participate in the government loan programs, farmers needed to store the corn in a substantial and permanent structure that would effectively protect the quality of the crop for a minimum of two years (Wooley 1946: 270). The Ever-Normal program "spawned a great wave of farm construction as farmers erected grain bins and other storage facilities on their farms" (Minnesota Institute 1939: 17).

POSTWAR PRODUCTION

After World War II there was another wave of corncrib construction as American farmers, still producing at high levels, faced bumper crops and too few storage facilities. The USDA collaborated with the Midwest Plan Service (based at Iowa State University in Ames) to quickly draw and issue plans for storage structures to handle the huge farm surpluses. In 1949 the Midwest Plan Service issued its response, a widely-distributed catalog called *Grain Storage Building Plans* that included a broad range of corncribs and granaries (Giese "Midwest" 1957; Midwest 1949).

OUTMODED

The use of corncribs began to decline in the 1950s as farmers began harvesting with combines that shelled as well as picked corn. The shelled corn was then stored in granaries rather than cribs. Writing in 1953 one agricultural engineer predicted, "The field shelling method of harvesting corn would make the present slatted corncrib as obsolete as the horse stable" (Kaiser 1953: 36).

In a farm memoir, retired southern Minnesota farmer Michael Cotter described the change:

> In the 1950s farmers started shelling the corn in the field with a new piece of equipment called a picker sheller. The ear corn that used to sit in cribs drying for six months, now

> as shelled corn, had to be dried immediately and grain dryers appeared. The grain dryers had to move a large volume of warm air through the wet shelled corn. The heat was provided by propane gas burners, and the fans were powered by either tractors or large electric motors. The fans would reduce corn moisture from 25 percent to 12 percent in a matter of a couple of hours. Corncribs and ear corn pickers gave way to combines that harvested every type of grain. And corn dryers enabled the corn to be stored in large round metal bins. . . . Six thousand bushels seemed like an enormous amount in 1949. By the 1960s we would have had 30,000 bushel stored in less space than the 6,000 (Cotter and Jackson 2001: 81).

Producers of hybrid seed corn were among the first to use artificial dryers for corn. The practice began in the late 1920s or early 1930s shortly after hybrids were first developed. In the 1950s mechanical driers became a necessity for farmers who shelled corn in the field, but were also used by farmers who continued to harvest ear corn. By 1960 mechanical drying was recommended for all ear corn harvested with more than a 20 percent moisture content. (Minnesota corn was often picked at 20 to 22 percent moisture.) With mechanical dryers, cribs for ear corn could be "any shape and size, and of various materials. . . . Sizes are unlimited except that tunnels, ducts, and perforated areas must be ample and close enough to provide air movement without high pressures" (Neubauer and Walker 1961: 229; Hukill 1957: 526).

Today some corncribs in Minnesota are still filled with ear corn each fall, but their use is increasingly rare. Most of these farmers are grinding the ear corn for cattle feed (Lindor 2004).

CORNCRIB DESIGN FEATURES

In 1921 agricultural engineers Kaiser and Foster described the evolution of corncrib design. They wrote:

> In the early days when grains [and ear corn] were shoveled by hand from wagons, the height of the bin or crib was naturally limited to the height a man could conveniently shovel. The old pioneer type of crib usually consisted of a simple shed roof structure standing by itself in some exposed position. When more storage room was required another crib was built alongside it with enough space between the two for a driveway and both were covered with the same roof. This driveway furnished the man who was unloading corn protection from the winds and storms which, in many cases, was badly needed as the farmer was often compelled to shovel off his load by lantern light after the evening chores were done and the evening meal was over. This sheltered driveway also provided a convenient place for housing vehicles and farm implements. With the advent of power-driven conveyors [in the 1920s] there occurred a radical change in the design of cribs and granaries. The height was no longer controlled by the height to which a man could shovel, therefore, cribs were built higher to obtain greater economy in construction. Bins for grain and cribs for corn were included under one roof so that one conveying system would serve to handle all of the farm grains, effecting further economy in construction (Kaiser and Foster 1921: 51).

Location. Corncribs needed a site that was well-drained, provided good air circulation, and was accessible for loading, unloading, and shelling. Cribs were often oriented north and south to catch maximum cross winds. They were frequently placed near fields for convenience at harvest. They were also sited near the hog house – which was often built on the southern edge of the farmstead – to ease the daily chore of feeding (Noble 1984: 106-107; Roe 1995: 172).

Size. Corncrib height was first determined by comfortable height for a worker standing in a wagon and filling the crib by hand. Later, mechanical elevators determined height. There was some debate among experts about whether tall cribs compressed the corn at the bottom of the crib to the point that air didn't sufficiently move through it (Noble 1984: 106; Barre and Sammet 1950: 337-338; Neubauer and Walker 1961: 227).

Cribs 5' to 8' wide were common. The width of a corncrib was limited by the ability of air to move through the corn, with narrower cribs allowing more air to reach the center. Local climate and winds helped determine the best width, and corncribs were narrower in Minnesota than they were in Kansas and Missouri. Agricultural engineers eventually determined that the optimal width in Minnesota was 6' to 7' for a rectangular crib, and a diameter of 9' to 11' for a round crib (Neubauer and Walker 1961: 227).

The length of a corncrib was determined by the amount of storage required. A typical length in 1930 was 16' or 18'.

Ventilation. To supply the ventilation needed to cure and hold the corn, a corncrib needed generous air gaps in the walls. The uppermost part of the walls was usually solid so that rain and snow wouldn't reach the top of the crop as it settled.

Many early cribs had gaps that were quite narrow. In 1921, one source recommended that gaps comprise a minimum of 20 percent of the crib's wall surface (Kaiser and Foster 1921: 53). Slatted wooden cribs met this goal. Cribs of "snow" fencing had gaps comprising about 50 percent of the wall surface, and wire mesh cribs had gaps comprising about 90 percent (Neubauer and Walker 1961: 228).

Wooden cribs were often fitted with interior ventilators – that is, slatted frameworks – that created open air space in the center of the crib. Vertical ventilators and shorter A-frame ventilators were common forms (Carter and Foster 1941: 271-272; National Plan 1951: 27).

Materials. Early corncribs were built of logs, poles, or planks, sometimes laid vertically but most often horizontally. Brinkman and Morgan documented cribs of both pole and log construction in their 1982 study of settlement-era farms in central Minnesota (Brinkman and Morgan 1982).

Because ear corn weighed less than loose grain, corncrib walls did not need to support as much weight as granary walls (Barre and Sammet 1950: 337-338). Tie rods or extra bracing were common, however, and the crib's exterior siding or slats were sometimes installed diagonally for extra strength.

Most cribs were built of dimensional lumber or crib fencing (also called "snow" fencing). Lower crib walls often incorporated metal screening or skirts of sheet metal to deter rodents. Steel wire cribs were popular beginning in the 1940s. At about the same time perforated steel cribs appeared. They were made of perforated steel and resembled a grain bin with a pattern of holes punched in the sides. Cribs of masonry and asbestos cement were also built, especially in southern Minnesota.

In 1961 the most prevalent type of crib being used on American farms was woodframe with slatted sides. Also common in 1961 were cribs of structural clay tile, concrete block, cement stave, perforated metal, and wire mesh (Neubauer and Walker 1961: 226).

Doors. Corncribs were usually filled through a hatch door in an upper wall or roof. After portable elevators came into use in the 1920s-1930s, most cribs were filled through the roof rather than through side wall openings. Cribs were emptied using one or more small doors or removable gates in the lower walls.

Foundation and Floors. Corncrib floors were set high with gaps beneath them for air circulation and "where dogs may hunt the pesky rats" (Fox 1940: 56). Cribs were often placed on large rocks or concrete blocks. Floors of wood, metal, and concrete were common. Alleys were often dirt or gravel.

Many corncribs had a "shelling" or "drag" trench beneath each crib floor that could double as a ventilation channel. When it was time to shell a batch of corn, boards or grates in the crib floor were removed and the ears dropped down into the trench. The ears were pulled from the trench for shelling, often with a drag conveyor (either portable or built-in) (Lindor 2004).

Roofs. Most rectangular corncribs had shed, gabled, or rounded-arched roofs. Most circular cribs had domed or conical roofs. Some experts preferred shed over gabled roofs because they believed gabled roofs allowed snow to accumulate on the corn beneath the peak (Barre and Sammet 1950: 336).

Conveyors. Portable conveyors or elevators for filling corncribs were being used on average-sized Minnesota farms beginning in the 1920s and were prevalent by World War II (Kaiser 1953: 36). (See the individual farm elements section entitled "Granaries, Elevators, Bins, Dryers" for information on built-in elevators.)

COMMON TYPES OF CORNCRIBS

Single Wooden Corncribs. Rectangular, single wooden cribs were among the earliest forms built in Minnesota. During the early settlement period they were often built of logs, with the wooden floor raised above the ground on large stones. Single wooden corncribs were economical because they allowed farmers to build only what they needed and expand later with a second or third crib.

The side walls of single cribs often tapered from top to bottom in a "keystone" or "coffin" shape (also called "slant-sided) that helped the gabled roof shelter more of the corn, provided good air movement, and facilitated gravity unloading (Noble and Cleek 1995: 156). The coffin shape made the crib somewhat unsteady, however. One source in 1950 also explained that the coffin shape "makes them more difficult to build, the crib has a greater [and therefore more expensive] roof area for the same storage capacity, and the side walls become weakened sooner because of the added weight and pressure on them" (Barre and Sammet 1950: 336).

Single cribs were frequently mounted on treated wooden skids so they could be moved where needed. In the mid-20th century a portable crib might be 8' wide, 10' long, and hold 200 to 500 bushels of ear corn (Carter and Foster 1941: 270).

A typical crib from 1953 was built with dimensional lumber and was 7′ x 32′ with a shed roof (*Farm Buildings* 1953). An interesting crib from 1949 was an 8′-wide structure built of snow fencing over a pole frame (Midwest Plan 1949: 8).

Temporary Corncribs. Temporary or low-cost corncribs were sometimes built of crib or snow fencing with little, if any, framework. Crib, snow, or "combination" fencing, as it was called, was made of wooden slats and woven wire. This fencing was commercially available by at least 1894 (Woodburn 1894: 347). Two rolls of the 4′-tall fencing could create a corncrib 8′ tall and 8′ to 10′ in diameter. A concrete platform and a portable roof were sometimes added (National Plan 1951: 27).

Double Corncribs. Double cribs were similar to the single cribs described above, except that two cribs were ganged under a single roof. One advantage of the double crib design was that one unit of the structure could be a corncrib and the other a grain bin.

Double cribs were usually separated by a central alley or drive. The alley could be about 4′ wide to allow air circulation, or up to 13′ wide to accommodate a wagon or harvester. In 1940, a *Successful Farming* publication noted that double-crib structures with driveways were "fairly expensive" considering their storage capacity (Fox 1940: 56). The passage was usually used to house tools or implements.

Geographer Allen G. Noble wrote, "The drive-in crib may have originated in the Middle Atlantic states. It occurs frequently in the Shenandoah Valley and occasionally throughout Appalachia, but it is in the Midwest (and especially the Corn Belt) that this crib is most commonly encountered" (Noble 1984: 107).

While usually straight-walled, some double cribs had coffin- or keystone-style outer walls that narrowed near the bottom.

A typical double crib from the 1930s and 1940s might be a gable-roofed structure measuring 20′ x 32′ if it had a 4′ alley, or 27′ x 32′ if it had an 11′ alley. Eight-foot-wide cribs could each store about 1,000 bushels of ear corn (Midwest Farm 1933; Barre and Fenton 1933: 12; Midwest Plan 1949: 9; *Farm Buildings* 1953).

Continuous Corncribs. Some corncribs were long, narrow structures dubbed continuous corncribs. They often had partition walls at regular intervals (e.g, every 16′) to form separate compartments.

Round Masonry Corncribs. Beginning in the 1910s, some cribs were built of concrete blocks, cement staves, or structural clay tile. Most were cylindrical. In 1921 Kaiser and Foster wrote, "The circular form is especially suited to masonry structures as this shape makes it easy to reinforce. There is also an economy of materials as a circular structure will enclose a greater volume for a given amount of wall space than any other form. Circular storages are used singly, in twos, or in groups or batteries" (Kaiser and Foster 1921: 52). Round masonry cribs often had domed metal roofs similar to silo roofs.

According to Noble, masonry cribs were built in Iowa and other parts of the Corn Belt from the 1920s-1950s (Noble 1984: 109).

Cement stave cribs were fairly new in 1919, according to one expert (Kaiser 1919: 26-27). The staves were 10" x 30" units that were designed to create gaps for air circulation. The staves incorporated small metal grates across the gaps to keep out rodents. Steel hoops encircled the corncribs for added strength.

Clay tiles for corncribs, and corncrib designs that best used clay tiles, were developed as the result of studies conducted at Iowa State University circa 1908-1920 (Bridgman 1938). One such design from 1941 was a 24'-diameter, round clay tile corncrib. At its center was an optional 10'-diameter grain bin or, if no grain storage was needed, a narrow air shaft. Depending on the design, the structure could store 2,000 to 20,000 bushels of ear corn (Structural 1941: 16).

Combination Corncrib-Granaries. Combination corncrib-granaries were very common in the Midwest. Simple forms resembled the double-crib structures described above with one unit being a corncrib and the other a grain bin (White Pine ca. 1925; *Farm Buildings* 1953).

A more elaborate and very popular design had two corncribs flanking the central drive, and grain bins overhead (Fox 1940: 55; National Plan ca. 1950: 47). Some examples had built-in elevating equipment. A typical structure might be 27' x 32', with an 11'-wide driveway and storage for 3,600 bushels of ear corn and 2,800 bushels of grain. Shelling and grinding equipment could also be installed overhead, with chutes sending the shelled or ground corn to one location and the empty cobs to another (Midwest Farm 1933; Kaiser and Foster 1921: 52; Structural 1941: 17; Barre and Sammet 1950: 338; *Farm Buildings* 1953).

Combination Corncrib-Granaries of Masonry. Combination corncrib-granaries built of masonry were developed in the 1910s and were very popular in Iowa. They usually had two or four rounded corncribs, a central drive, and overhead grain storage (in an overall oval footprint). One version was built with drying racks at the "attic" level where ear corn could be dried for a few days before being dropped into the cribs (Kaiser and Foster 1921: 52-56). A 1938 example measured 31' x 42' and stored 8,000 bushels of ear corn and 5,000 bushels of grain. In 1941 the Structural Clay Products Institute was promoting a 28' x 41' clay tile version (Structural 1940: 17; Bridgman 1938: 116, 119; Carter and Foster 1941: 273; Noble and Cleek 1995: 157).

Steel Corncribs with Wire Walls. Corncribs built of wire mesh stretched over a metal frame became available in the 1930s and were widely used in Minnesota through the 1960s. On some farms they were purchased to replace aging wooden cribs. In Midwestern states, the wire crib became "extremely popular after World War II because of its low cost, ease of filling, and low maintenance" (Roe 1995: 179). Most were prefabricated. Some were oval in cross section and elevated on steel frames (Fox 1940: 57). Round wire cribs usually had conical or domed metal roofs, while rectangular wire cribs often had rounded-arched roofs. Floors were commonly metal or poured concrete.

Steel Corncribs with Perforated Walls. Round steel corncribs with walls of punched or perforated steel were in use by 1940, but much less common than steel wire cribs. Internal ventilation channels were important since the walls didn't have much open surface area. In 1942 agricultural engineers were testing new "down-draft" metal cribs that had rotating wind fins that turned the tops of central flues to make best use of the wind (Malcom 1942; Barre and Sammet 1950: 326). One steel crib recommended in 1949 was 18' in diameter with a ventilated floor. It could hold 500 bushels of ear corn or 1,000 bushels of shelled corn or grain (Midwest Plan 1949: 14). Perforated steel cribs were not as successful as wire cribs because the perforations did not always provide adequate ventilation (Roe 1995: 180).

Prefabricated Wooden Corncribs. Some companies made prefabricated wooden corncribs. Around 1940, for example, the Economy Portable Housing Company was advertising an octagonal corncrib that was factory-made and shipped to the farm in sections, ready to assemble with three hours' work. The woodframe wall panels were built with diagonally-laid "West Coast fir." The floor and roof were also wood and came in sections (Economy ca. 1940).

Steel and Aluminum Sheds. After World War II and the introduction of the picker-sheller, large grain storage sheds became popular in the Midwest. One version issued by the Midwest Plan Service in 1949 had a quonset-style roof, sheathing of corrugated sheet steel installed over shiplap siding, and a poured concrete floor. The 16' x 32' structure could accommodate a "4,000-bushel ear corn dryer" which used a ventilating tunnel that ran lengthwise through the center of the building. Another model was 28' x 40' with a gabled roof and corrugated aluminum siding. It accommodated an ear corn dryer but instead of a ventilation tunnel it had an elevated drying floor that could be removed so the building could also be used as an implement shed (Midwest Plan 1949: 13-14). Prefabricated steel sheds were widely marketed for farmers who chose not to build one from scratch.

PREVALENCE

Corncribs were prevalent throughout Minnesota, but less common in northern counties. Larger cribs and masonry cribs were more often built in the corn-rich southern counties. The two most common forms of corncribs in Minnesota were built of wooden slats and steel wire. The use of cribs declined after average-sized farms began using picker-sheller harvesters in the mid-1950s and storing shelled corn in granaries. Corn dryers became common when this change was made. Corncribs are still encountered throughout the state with the earliest cribs being quite rare. Early examples of prefabricated or factory-made cribs are likely uncommon.

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A single-pen, coffin- or keystone-style corncrib with walls and roof sheathed with planks. Location unknown, 1903. (MHS photo by Frank T. Wilson)

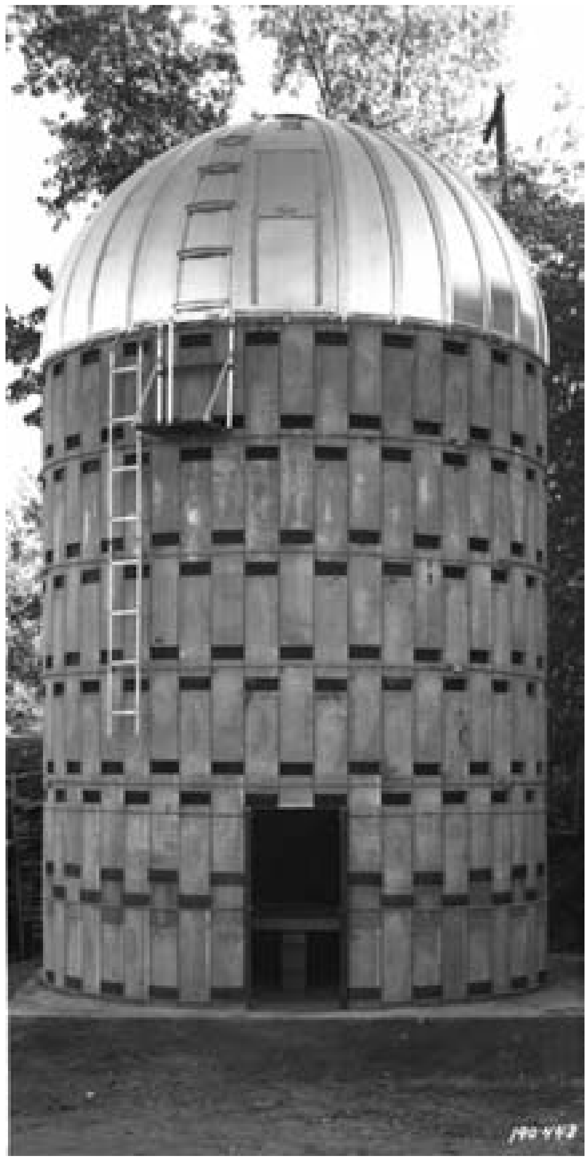
A single-pen corncrib of intricate pole construction. The man in the photo is shucking corn by hand. Location unknown, circa 1915. (MHS photo)

Farmers shelling corn using a sheller mounted on a flatbed. The shelled corn was placed in the wagon (right), and the ear corn into a simple corncrib (background) made of two rows of snow fencing. The two men on the left hold a banner that reads "Let the nation own the trusts," a socialist slogan. Location unknown, circa 1910. (MHS photo by Ole Mattiason Aarseth)

The optimal width for Minnesota corncribs was 6′ to 7′ but the length could vary. The height was determined first by comfortable hand-filling and then by the height of mechanical conveyors. This long, continuous crib probably had several interior partitions. Corncribs were often aligned north and south to catch cross-winds. Farm near LeCenter, 1998. (MHS photo by Chris Faust)

This style of combined corncrib-granary was very popular according to a 1940 publication from *Successful Farming* magazine (Fox 1940). There was a central drive between two cribs on the first level, and overhead grain bins on the second. Judging by the electric wires, there was probably an electric-powered elevator inside. This building was built with glue-laminated arches made by Rilco, a company founded in St. Paul in 1939. Location unknown, 1947. (MHS photo)

Prefabricated metal corncribs similar to this one were termed "experimental" in 1940 by *Successful Farming* magazine and the first models were just being marketed (Fox 1940). This version had perforated metal walls, which didn't ventilate as well as walls of wire mesh. Location unknown, photo 1938. (MHS photo by Norton and Peel)



Cement stave corncribs were first built in the 1910s. This brand new example was photographed in 1949. It had steel reinforcing hoops, a hatch in the roof for filling, and a lower door for unloading – all typical of the type. The staves incorporated small metal grates that kept rodents from passing through the air gaps. Location unknown, 1949. (MHS photo by Norton and Peel)

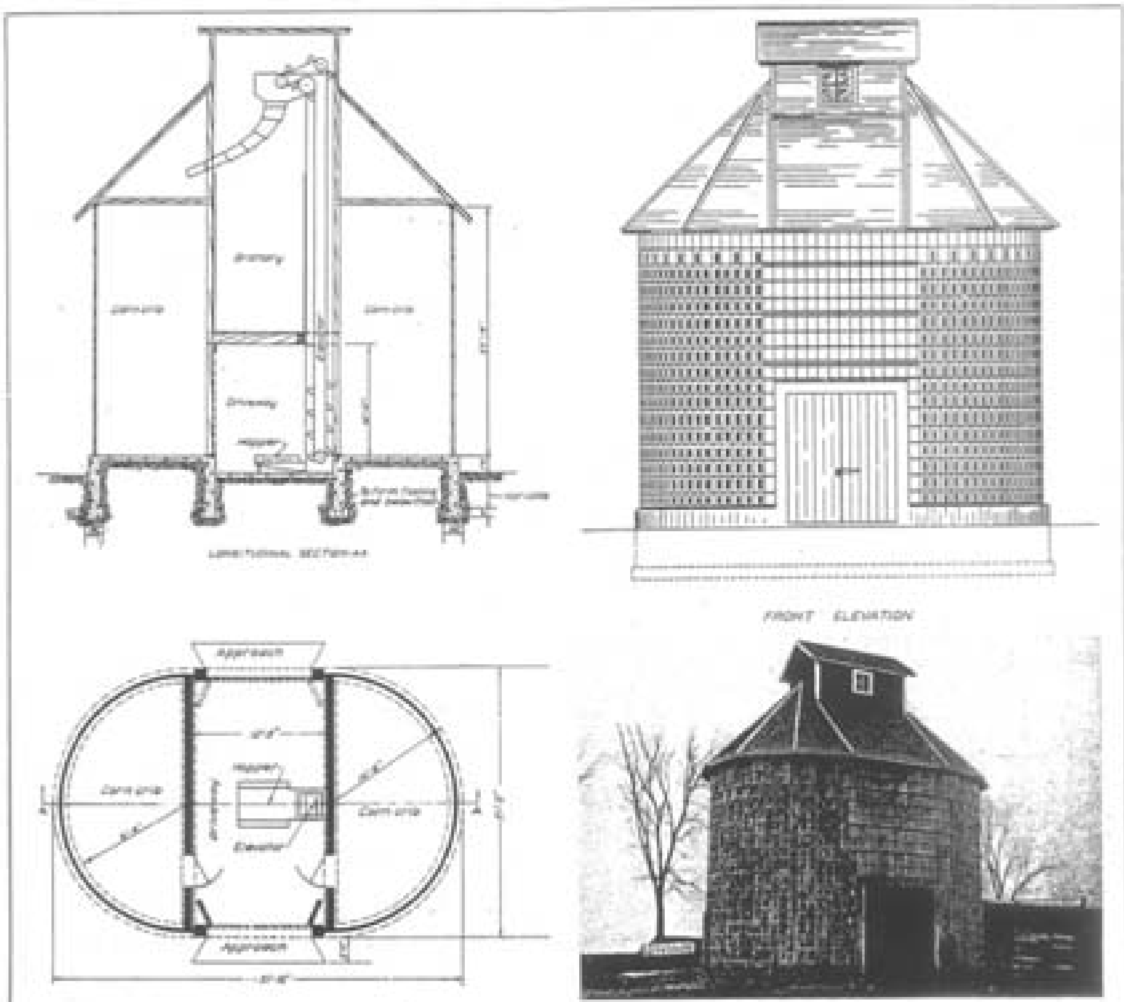
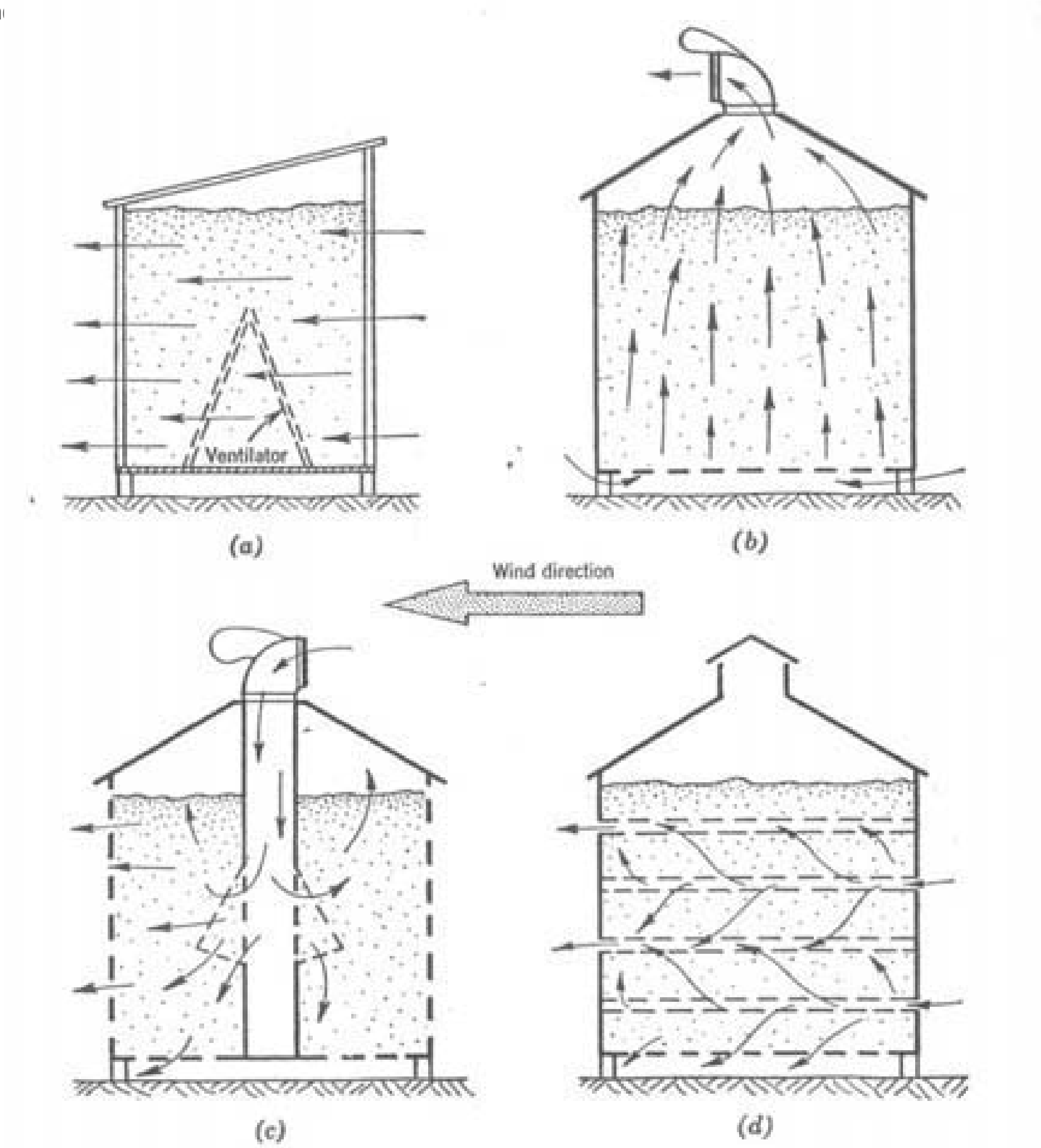


Fig. 5. A concrete stave farm elevator with semi-circular cribs and bins for small grain over driveway

Combination corncrib-granaries could also be built of masonry. This oval, cement stave model contained two semi-circular corncribs, upper-level grain storage, and a built-in elevator. This illustration appeared in a 1921 article in *Agricultural Engineering* that indicated this style was common in Iowa. They were also built in southern Minnesota. From Kaiser and Foster (1921).



Various types of bin ventilation are illustrated including (clockwise) an A-frame ventilator within a slatted wooden crib, a bin with tight sides and a perforated floor with air drawn upward, a bin with perforated sides and floor and a central flue with air flowing downward, and a bin with horizontal flues. From Barre and Sammet's *Farm Structures* (1950).

A steel wire corncrib now used for miscellaneous equipment storage. McLeod County, 2003. (Gemini Research photo)

Two versions of prefabricated steel wire corncribs. Both have poured concrete floors and standing-seam metal roofs. Some cribs filled with ear corn can still be encountered in Minnesota. Stearns County, 2004. (Gemini Research photo)

■ DAIRY BARNS

- A few dedicated dairy barns were built in Minnesota as early as the 1860s
- Most pre-1960 dairy barns were either stall barns or, less often, loose housing barns
- Two-story barns are characteristic of cold-climate dairying but were a fire hazard
- A few Minnesota dairy barns were one-story before World War II
- Most stall barns had two rows of stanchions; facing the cows in or out both had advantages
- Loose housing grew after a University of Wisconsin study began in 1941
- Round and polygonal barns were more popular in the Midwest than in other areas; an estimated 170-180 were built in Minnesota; about 70-75 were standing in 2001
- Field hay balers and choppers became affordable in the early 1940s, as did blowers and mechanical conveyors to move the hay up to the loft
- Feed and litter carriers were developed in the 1890s and paddle-type gutter cleaners date from about 1950
- Many farmers bought their first milking machines between 1915 and 1925, but they weren't widespread until after electrification

Dairying has historically been one of Minnesota's most important farm enterprises. The growth of dairying in the 1880s was closely linked to the diversification of Minnesota farms, and by 1940, some 90 percent of Minnesota farms had dairy cattle (Koller and Jesness 1940).

Women and older children worked in the dairy barn nearly as often as did male farmers. Marilyn Brinkman, in her study of Stearns County dairying, wrote that during both the early settlement period and at the turn of the 20th century, women often led the care of the dairy cows, including milking, churning butter, washing equipment, feeding and bedding the cows, and cleaning the barn. Brinkman found that, as dairy herds grew around the turn of the century, both women and men shared the dairying chores. She reported that on some farms, if the herd was six or seven cows, the women did the milking, but with a herd of 20 cows "everybody pitched in" (Brinkman 1988: 8-17). According to Mary Neth, a USDA survey in 1920 revealed that 45 percent of Midwestern farm women milked cows. In addition, 93 percent washed milk pails, 75 percent washed cream separators, and 66 percent made butter (Neth 1995: 19-20).

Dairy barns, or barns constructed for the housing of dairy cows, were one of the most common structures on Minnesota farms before 1960. In addition to barns, however, Minnesota dairy farms needed milk houses, milking barns, silos, manure pits, stockyards, bull barns, hay barns, etc., to produce and market dairy products. Many of these structures are described in individual farm elements sections in this context study, as are General Purpose or Combination Barns, which often combined dairy cows with other animals.

See also

General Purpose or Combination Barns
Barn Forms and Terminology
Milking Barns
Milk Houses
Silos
Diversification & Rise of Dairy, 1875-1900

Dairy barn design and construction were important for several reasons:

- dairy barns were prevalent – 90 percent of Minnesota farms had dairy cattle in 1939
- dairy barns were expensive – dairy farming required a greater investment in buildings than did cash grain farming
- milk cows were expensive and somewhat delicate; good dairy barns were necessary to protect this investment
- dairy barns were essential to storing enough feed to carry the herd through the long Minnesota winter
- milk was sold fresh and spoiled quickly; both public health and farm profits relied on proper barn conditions and the sanitary handling of cows, milking, and milk
- dairy structures were the most-regulated buildings on Minnesota farms and subject to stringent laws
- dairy barn design needed to support the efficient handling of 20 tons of milk, feed, bedding, and manure per cow per year
- barn design and dairy methods could make a significant difference in farm labor requirements; in 1960 labor differences among Minnesota dairy farmers ranged from 60 to 150 man-hours per cow per year depending on building, equipment, layout, and methods (Witzel 1960: 600)

TYPES OF DAIRY BARNS

Pre-1960 dairy barns were of two major types: the stall barn in which cows were confined in individual stalls (and a few horses shared the barn), and the pen barn that provided loose housing.

The pen barn had to be accompanied by a milking barn (also called a milking parlor) where the cows were secured while they were milked. Pen barns were much less common, perhaps because two buildings were needed. (See "Milking Barns," another individual farm elements section.)

Stall barns (also called tie-stall or stanchion barns) were more common, and their form changed very little between 1900 and the 1950s.

Although Minnesota statistics regarding the prevalence of stall versus pen barns have not yet been located, something may be learned from Wisconsin data: S. A. Witzel wrote in 1960 of a "recent" survey of dairy barns in Wisconsin that found only 600 loose housing systems on a total of about 101,000 farms with dairy cows (Witzel 1960: 601).

COMMON DAIRY BARN FORMS

Geographer Allen G. Noble in 1984 found that most dairy barns in Wisconsin and Michigan fell into five basic categories based on specific design characteristics. Vogeler in 1995 felt that the same five categories could also be applied to Minnesota (Vogeler 1995: 106-108; Noble 1984).

The five design groups described by Noble and Vogeler are listed below. Most were stall barns and included hay storage.

Three-bay or English Barn. Gabled roof, door on the sidewall, timber bents forming three equal-sized bays inside. Few windows. No basement. In its pure form apparently rare in Michigan, Wisconsin, and Minnesota, according to Noble and Vogeler. The Raised Three-Bay barn (see below) is more common, including in Minnesota.

Raised Three-Bay or Basement Barn. An English or Three-Bay barn raised on a basement. Animals housed in the basement with downslope access; feed and bedding stored on the floor above. A ramp is built to the main floor if no hillside available. Usually timber framed. Fairly common in central and southeastern Minnesota. Common in Michigan and Wisconsin, according to Vogeler.

German or Forebay Barn. Gable roofed forms generally built into a hillside with a first story forebay (usually the eave side) projecting over the basement level. Not found in Michigan but found in eastern, central, and northwestern Wisconsin, according to Vogeler. Very rare in Minnesota.

Wisconsin Barn. Narrow width to length ratio (e.g., 35' x 100'), often gambrel roof, large hay mow with gable end hay door, side walls with rows of closely-spaced windows, low main floor (stable) ceiling, two rows of stanchions. Common in Minnesota. Common in Michigan and Wisconsin, where one-half to three-quarters of barns in some counties are this type, according to Vogeler (Vogeler 1995: 106-108).

Round Roof Barn. Rounded arched (also called "rainbow" arched) or gothic arched roof with large hay mow. Most popular in the Midwest just after World War I. Fairly common in Minnesota. Apparently "scattered thinly" across Michigan and Wisconsin (Vogeler 1995: 106).

For more information on these and other barn forms, see this context's "Planning and Building Farm Structures: Barn Forms and Terminology."

LOCATION

Regardless of whether they were stall barns or pen barns, dairy barns needed to be placed on well-drained ground. A barn aligned north and south was preferred so that the sidewall windows would get maximum lighting (especially important before electricity) and so that roof shingles wouldn't curl during hot summers. The barn needed to be close enough to other structures for efficient operation, but far enough away to reduce the danger of spreading fire. To reduce odors at the farmhouse, barns were placed southeast of the house, or west or southwest of the house but at a greater distance away. Access to yards and pastures, to feed and bedding storage, to the milk house, and for the bulk milk truck were all important.

AGE

Before the 1880s, most dairy cows in Minnesota were housed in multipurpose structures. Very small herds were sometimes milked in the pasture where they were grazing.

Barns designed specifically for dairy cattle were built in Minnesota by the 1860s, but were not common until the 1880s. In explaining the evolution of dairy barns, Ingolf Vogeler wrote in 1995:

> As dairy farming spread into the northern Midwest during the late nineteenth century, most of the pioneer structures, which were often log, were replaced by new dairy barns, and older buildings were used for other activities, especially to house young stock, horses, and, later, tractors and mechanized equipment. Increasingly large dairy herds and more

> stringent sanitary requirements often meant that updating of older facilities was impractical. New barns were predominantly board-sided, plank-frame structures (Vogeler 1995: 102).

By the early 20th century, dimensional lumber, shipped by rail, became a common replacement for mortise-and-tenon timber frame construction, and new roof framing systems developed. According to Harper and Gordon, "By 1910 . . . a dramatic shift had taken place in the rural Midwest. The prototypical barn, although still two stories, was now a spacious, plank-frame structure built on a concrete or hollow tile foundation with an adjoining silo. Barn framing and interior plants had become more standardized. An optimum width of 36 feet provided the most economical use of lumber and allowed room in the basement for service alleys and a double-row arrangement of animal stalls" (Harper and Gordon 1995: 214-215).

Most of the barns described by Vogeler, Harper, and Gordon were stall barns. The earliest pen barns in the Midwest date from about 1890, but were rare until about 1950.

SIZE AND SHAPE

Stall barns in Minnesota tended to be long and narrow (e.g., no wider than 40′), like the "Wisconsin barn" identified by Noble. The narrow shape provided efficient use of space, good lighting, and heat conservation. On the other hand, barns were inefficient if they were too narrow and did not allow ample workspace for feeding and barn cleaning. Stall barns generally accommodated two rows of cows, a configuration that created the best balance between the amount of materials needed to build the barn and the distance the farmer needed to move during chores. Barns that were 36′ wide, for example, allowed light from the windows to reach all parts of the interior and were easier to keep warm. Many experts advised that barn width shouldn't exceed 32′ to 36′ in very cold climates. One wrote in 1923, for example, that a 36′ x 76′ barn "is larger than required on many farms and should be kept well filled with stock and warmly built or it will be cold under Minnesota conditions" (White 1923: 105).

The length of stall barns depended on the size of the herd and the length of hay carrier equipment mounted in the loft. As Minnesota farmers increased the number of cows they milked, they tended to either increase the length of the barn by adding onto an end, or add a perpendicular wing of the same width. The intersection of the wings then formed a stockyard sheltered from the wind.

Stall barn plans available to Minnesota farmers suggest typical dairy barn sizes. A Minnesota example described in 1907 was 36′ x 100′ and housed 30 milk cows, with feed alleys along the outer walls, five box stalls, a silo, and an attached milk house. The hay mow was accessed via a banked drive and had a feed room, feed bins, and was divided in half for straw and hay (Henry 1907). In 1937 the Midwest Plan Service was offering three plans for two-story dairy barns. The barns were 32′ x 80′, 34′ x 64′, and 36′ x 80′ and had stanchions for 20 to 28 cows (Midwest Farm 1937). In 1953 the University of Minnesota's plans for farmers included two-story dairy barns that were 32′, 34′, and 36′ wide (*Farm Building* 1953). In 1955 Rilco Laminated Products of St. Paul was offering two-story dairy barns that were 30′ to 40′ wide and 60′ to 80′ long, although the length was adjustable (Rilco 1955).

Pen barns tended to be wider than stall barns because they were not restricted by long, fixed rows of stalls. Pen barns often consisted of a large open space with perhaps a feed bunk, much more like a beef feeding barn or a sheep barn.

NUMBER OF STORIES

Two-Story Barns and Hay Mows. Both stall barns and pen barns could have either one or two stories. Two-story barns usually housed cows, feed, and bedding under one roof. It was usually cheaper to combine feed, bedding, and animals in one building than to build two separate structures. The hay and straw in the mow helped insulate the barn in harsh climates, and it was efficient for workers to drop hay and straw through chutes to the cows below. For these reasons, two-story dairy barns were much more common in Minnesota than those of one story.

The need to increase mow capacity to store more hay, thereby supporting a larger dairy herd, was one factor that led farmers to shift from gable-roofed timber frame barns to gambrel- and gothic-roofed styles. Framed with dimensional lumber, these self-supporting roof forms created larger interior spaces with fewer bents and crossbeams to obstruct the movement of equipment and workers inside. (Other factors influencing the shift away from timber framed barns included the increased availability of dimensional lumber and its lighter weight, and the fact that frames of dimensional lumber required less wood, less skilled carpentry, and less hand-work than timber frames.)

Farmers accessed the hay loft via wooden staircases or ladders inside the barn. In many cases, the ladders were nothing more than boards nailed to the sidewall studs.

On many farms, straw was stored in stacks outside because the barn only had sufficient capacity for the hay, which was more valuable and more fragile. Some hay mows were divided into two parts, one for hay and the other for straw. (These permanent partitions were more common in very early barns where the space was also shared with a threshing floor.) Mow floors, which also served as the ceiling above the cows, had to be built of tightly-fitting boards to prevent debris from sifting down and contaminating the milk.

The mow's hay chutes were usually located above the mangers, feed alley, or above the feed room. Chutes were sometimes simply holes cut in the mow floor, but were often vertical wooden boxes that extended some distance into the first floor to help control dust when the material was dropped. The chutes often had doors that could be closed to help the barn's ventilation system function properly.

The job of getting the hay out of the fields and into the mow was critical to the farm's survival over the winter, and was a back-breaking operation. (See Steven Hoffbeck's *The Haymakers* (2000) for excellent accounts.) One Minnesota farmer in 1914 advised his colleagues to take the hay into the north end of the barn which was shady and cooler on hot August days. If only one mow door was to be provided, he advised placing it on the north end for this reason (Henry 1914: 151).

Moving loose material into the hay mow was made somewhat easier by the invention of hay forks and the Louden hay carrier, patented in 1867 by William Louden of Fairfield, Iowa, which moved hay along a track mounted down the center of the mow ceiling. These devices gave farmers significant labor savings, although the hay still had to be hand-pitched from the center of the mow to evenly fill the space.

Ever-advancing hay-handling equipment led to the construction of barns with increasingly larger, stronger mows. The hay sling, which could hoist larger amounts of hay to the loft than the hay fork, also required stronger roof bracing, wider mow doors, and a stronger carrier track (Bassett 1914: 97; Wooley 1946: 265). Gambrel, gothic-, and rainbow-arched roofs increased capacity without increasing height, with the gambrel shape being the most popular (Vogeler 1995: 105). According to Iowa historian Lowell Soike:

> Louden's hay carrier encouraged farmers to think about building higher barns, longer barns, barns free of driveways for loading and unloading by hand, barns free of crossbeams, and barns with a hay door for outside access to the loft, especially at the gable end. The design of older eastern barns had been circumscribed by their own history, a past where heights and widths were suited to hand-pitching methods. This limited the size of storage bays and the practical height and length of working areas. Farmers had responded accordingly, building low and comparatively short barns, except on larger farms, where available hired hands made possible two- or three-story barns. Whether because of inconvenience or old farming habits, fewer people in the older farming areas would consequently upgrade their barns with hay carriers. As progressive farmers in the older eastern states struggled to accommodate the hay carrier to their low, big-beamed barns, the Midwesterners, most of whom had yet to build a barn, knew few such constraints (Soike 1995: 89-90).

Tractor-powered hay balers that could gather, bale, and tie hay were developed in the late 1930s and became affordable for some farmers in the early 1940s. Balers compressed hay and straw so that it took up considerably less volume than loose material. One result was that more material could be stored in the loft – but only if the mow floor could withstand the increased weight, or was reinforced to do so. For some farmers, the space-savings allowed them to store straw in the loft for the first time (previously all loft space had to be reserved for the more-valuable hay). The use of baled hay and straw led many Minnesota farms to evolve from two-story barns to one-story buildings where the extra weight wasn't a problem. Equipment that gathered hay into large round bales was developed in the 1940s.

Even with a baler, handling hay was a strenuous chore with bales weighing as much as 75 to 100 pounds. Mechanical elevators or conveyors were first used to move hay into barns in the 1920s. In southeastern Minnesota, virtually no farms used a portable elevator in 1920, 15 percent did in 1930, 33 percent in 1940, and 48 percent did in 1949 (McDaniel and Pond 1953: 5; Atkeson and Beresford 1935).

In the late 1930s and early 1940s, machines for chopping and blowing hay were developed. While chopped hay was often blown into silos, relatively few Minnesota farmers chopped hay for storage in a mow because chopped hay's advantages did not outweigh the extra labor involved (Lindor 2004). Advocates of chopping hay for mow storage argued that it was somewhat less fire-prone than loose or "long" hay. Like baled hay, chopped hay took up less room so barns with smaller mows could be built, or more hay could be stored in the same amount of space. Barns designed for loose hay sometimes needed modifications to accept baled or chopped hay including reinforcement to carry the greater weight, alteration of mow doors or other entry points, and alteration of the hay chutes (Wooley 1946: 265-266).

By the 1940s some farmers were installing mechanical systems in their mows to cool and dry long hay in the mow, rather than letting it dry in the field. The practice was fairly uncommon in Minnesota (Lindor 2004; Strait 1944). One method was to place loose hay in the mow in successive layers, drying each layer with fans and/or air that was drawn or forced through duct work. Some farmers in 1961 were using slatted floors in combination with fans and ducts. Others were using vertical flues to dry chopped hay that was blown into barns in piles up to 25' deep (Hukill 1957: 526; Neubauer and Walker 1961: 238-240; Lindor 2004).

The difficulty of getting hay and straw to the second story was sometimes solved by building a basement barn in which the ground level or a ramped driveway led directly into the storage area. While basement barns were built in many hilly areas, they had some disadvantages: they were often more expensive to construct, the lower level was often dark and damp, considerable storage space had to be sacrificed to the drive-in alley, and much of Minnesota's landscape was too flat to make the basement barn practical.

Despite their assets, hay mows were a great fire hazard and frequently ignited under hot, dry conditions. In a barn fire, the farmer could lose not only the whole barn but often the animals as well. Insurance – if the farmer had any – might replace the building but did not replace the loss of milking income while the barn was being reconstructed and the herd rebuilt. In the 1930s and 1940s farmers experimented with concrete mow floors to prevent the spread of fire, but they did not become widespread (Nelson 1947).

The second story on a Minnesota dairy barn, with its roof topped with caps and cupolas, dormers, and lightning rods, is part of what makes large dairy barns such a distinctive regional type. Ingolf Vogeler explained in 1995 that the large dairy barns of the upper Midwest are unique in the nation. He wrote: "Huge barns remain characteristic of the northern Midwest . . . . In the South, small outbuildings and simple shelters are adequate for domestic animals, and in the western plains, range cattle are protected near [hay] stacks or in open-ended sheds. Even in the heart of the corn-soybean belt, large barns are not the necessity they are in Minnesota, Wisconsin, Michigan, and the rest of the dairy belt" (Vogeler 1995: 100).

One-Story Barns. One-story dairy barns had been used in the Midwest and known to Minnesotans since at least the 1890s (Casselman 1895: 71). While they remained few in number before 1930, one-story barns were the subject of renewed interest in the 1930s and 1940s as farmers sought low-cost dairy housing during the Depression, and as they increased production during World War II. Loose housing and one-story designs drew increased attention after a Wisconsin research project began in 1941. (See "More Information on Pen Barns or Loose Housing" below.) After 1950 one-story dairy barns became more prevalent.

One-story barns had the advantage of separating the highly-flammable feed and bedding from the livestock. Wisconsin dairy expert S. A. Witzel noted that, by the 1930s, many farmers had spent decades slowly building up herds of prized dairy cows whose loss to fire would be devastating. Housing hay and livestock in separate structures could reduce the farm's insurance cost and, if the hay did burn, ensure that the farm still had a building from which to operate during recovery (Witzel 1939: 395). One-story barns were also less susceptible to wind damage than taller structures.

By the 1930s the growing costs of labor and lumber were making two-story barns increasingly expensive, and new methods and materials like pole frames and prefabricated construction – both conducive to one-story construction – were being developed.

One-story barns were also advantageous for farms using increasing amounts of machine-baled and -chopped hay, which took up less space than loose hay but were heavier. The extra weight strained both hay loft floors and workers' backs. With a one-story barn, hay and straw were often housed in an adjacent structure and moved into the barn by machine.

One-story buildings were also expandable with relative ease if the herd size grew.

Advances in the dairy industry and stringent dairy laws also favored one-story buildings. After World War II many dairy farmers were faced with the task of modernizing their operations if they wanted to participate in lucrative dairy markets. The dairy industry was increasingly regulated, labor costs had risen, operations were being mechanized, and larger herds were required to make a profit. Many farmers chose to replace older two-story barns with one-story buildings, often of pole-frame or prefabricated construction (Witzel 1939: 395). These one-story barns were built in both fixed stall and loose housing styles. By the 1950s, furnaces, offices, locker rooms, and toilets were also being incorporated. Some one-story barns were built as wings of older two-story barns, with the older structures still providing storage for feed and bedding (Eckles 1950: 512).

In a 1946 article entitled "Trends in Dairy Barn Design," the University of Minnesota described a one-story dairy barn with a moderately-pitched gabled roof that created a small storage loft. The building was sided with asbestos shingles. It had two rows of stalls with cows facing outward, and a central cleaning alley with an under-floor liquid manure collection system, among other modern features (Christopherson 1946).

Vogeler wrote in 1995, "Since the 1950s, low height, gable-roofed, pole structures have become the dominant types of [dairy] barns built" (Vogeler 1995: 105).

OTHER BARN COMPONENTS

Windows and Whitewash. In both stall and pen barns, windows provided ventilation and light, especially in the years before electrification. Good lighting reduced mold, helped farmers keep the barn clean, and made milking more sanitary. Some experts advocated four to six square feet of window area per cow. Others recommended a window for each cow. In summer, open barn windows were often covered with screens of muslin cloth or wire mesh to prevent flies from entering (White 1923: 102; White and Witzel 1934: 7).

Some dairy barns were whitewashed on the inside to brighten the interior, making them easier to keep clean (White and Witzel 1934). Some experts recommended painting the interior with aluminum paint for the same reason (Fox 1940).

Dairy cows generally needed more protection from the cold than did beef cattle or dual-purpose breeds. Hay and straw in the loft provided considerable insulation, but some dairy barns also had storm sash over the windows and insulation in the walls. An over-heated barn was not desirable, however, and by the mid-20th century studies were showing that cool temperatures were better for dairy herds (Witzel and Derber 1952; Stewart 1960). In 1961 Neubauer and Walker wrote, "Dairy animals can endure freezing temperatures without serious hardship for long periods, but barn temperatures should be maintained above 32 degrees F. at all times, in order to assure optimum milk production . . . At temperatures above 65 degrees F., there seems to be a gradual reduction in milk production, which becomes significant above 75 degrees, and critical at 85 degrees" (Neubauer and Walker 1961: 52).

Doors. Exterior barn doors were either hinged or hung on rollers. Roller doors had the advantage of taking up less space when open, of not blowing open or shut in the wind, and were less susceptible to being broken by livestock. Some large first-story doors had a smaller inset door so the big door didn't have to be used on a regular basis or opened during frigid weather.

Ventilation. Bovine tuberculosis was a disease that could spread from cows to humans and was a serious public health problem until 1950. To prevent the spread of tuberculosis and other diseases, it was important that dairy barns be properly ventilated. Before 1960 most dairy barns used a passive gravity ventilation system. The two most common methods, the King system and the Rutherford system, relied on the principle that warm air rises and cold air drops. The systems worked best when the barn doors were closed and there was a big difference between the inside and outside temperatures. Both systems were fairly straightforward to build in wooden barns and, with some extra work, could be installed in masonry barns.

The King system, developed around 1900 by Wisconsin professor F. H. King, became the most common. Outside air entered the barn via intake flues located at the base of the barn's sidewalls near the ground level. The air traveled upward through the walls to a point just below the hay mow floor where it escaped from the walls and dropped into the building. Outlet flues in the interior of the barn usually had openings near the floor. The warm foul air rose up the outlet flues and out of the building near the roof (Moore et al 1920).

The Rutherford system was used in colder regions of the U.S. and Canada but was less common overall. It used intake and outlet flues in opposite positions as the King system. The fresh air entered the barn through openings on outside walls near the top of the ground floor. The cold air dropped through the walls and entered the barn just above the floor. The outlet flue openings were usually located at the ceiling above the animals. The flues carried the warm air through the mow and out the roof.

In both systems, the outlet flues generally rose 2'-3' above the roof and ended with a cap or emptied into a cupola. Cupolas of wood were built as part of the barn's roof structure while metal cupolas were purchased from various manufacturers. Cowls that turned with the wind were sometimes placed on top of the flues. Some experts advised 8-10 gravity flues in a good-size barn, but recommendations varied.

Electric fans were first used for dairy barns in the late 1910s on a mostly experimental basis (Kelley 1921). They were discussed in technical literature in the 1930s and became widespread in the 1950s. While the cost of running fans could be high, some experts pointed out that the "long high flues and many intake openings of the gravity system are much more costly in material and labor" (Neubauer and Walker 1961: 48). It was recommended that one-story barns, in particular, use electric fans for ventilation, along with electrically-operated gutter cleaners and other equipment (Christopherson 1946: 15).

Stalls and Stanchions. In stall barns the milk cows were typically aligned in rows, with a two-row system most common because it used barn space and the farmers' labor most efficiently. It was more common for the cows to face outward toward the side walls of the barn. This gave farmers less distance to move the milking equipment and aligned the manure gutters along a central cleaning alley. Experts indicated, however, that it was equally useful to face the cows inward. With this arrangement, light from the windows illuminated the twice-daily milking process, and feeding was conveniently concentrated in the central alley. This style also allowed the barn's structural posts to serve as stanchion supports. The posts were in a more awkward location when the cows faced out (Eckles 1950: 521).

Individual stalls and/or stanchions were useful because they secured the cows for milking, confined the manure to specific locations and, experts believed, prevented the cows from stepping on one another. Stalls without stanchions were considered by many to be more comfortable for the cows, however, and dairy cows usually gave more milk when content and comfortable.

Often divided by partitions of wood or metal, stalls had to be wide enough to be comfortable but narrow enough so the cows couldn't turn around. Stalls that were too long could result in dirty cows because the manure didn't always land in one place. Stalls could have interior doors (sometimes split Dutch-door-style) or chains across the end. Once the size of stalls became standardized around the turn of the century, commercial stall partition assemblies were readily available (Bidwell 1890: 12; Macy 1925: 2; Giese 1943: 70). In 1946 the University of Minnesota discussed stall rows that angled slightly to provide some longer stalls for larger cows (Christopherson 1946: 15).

Stanchions, chains, straps, and halters were used to restrain the cows in a stall barn. The first stanchions were wooden and homemade. By 1902 there were numerous styles of commercial and homemade stanchions, each with advantages and disadvantages. Stanchions could be adjustable or fixed, made of wood and iron, and incorporate bars, ropes, and chains ("Cow Ties" 1902). Rigid stanchions, for example, kept the cows cleaner but were less comfortable than movable stanchions. Stanchions were eventually standardized in size. Some assemblies were mounted into the reinforced concrete barn floor at the time it was poured.

Providing adequate water was important to maintaining good milk production and by 1920 many stalls had individual water bowls and salt cups (Kelley and Edick 1923: 140). Water bowls were placed about 26"-30" from the floor, especially if automatic, so the cows wouldn't step on the levers and flood the barn. By the 1950s water cups (which came into use in the early 20th century) had electric heaters to maintain an optimal water temperature during cold months.

Calf and Bull Pens. Most dairy barns had separate pens where calves were born and nursed, or where a bull might be kept.

Feed Alleys and Mangers. In stall barns the dairy cows were usually fed in wooden, steel, or concrete mangers fixed at the head of the stalls. Mangers with rounded corners were easier to clean. While continuous mangers took less labor to clean than those with divisions, the cows tended to eat each other's food and diseases could spread. The mangers were aligned along a feed alley or feed passage that was either down the center of the barn or along the side walls, depending on which direction the cows faced. Feeding alleys needed to be at least 6' wide to accommodate a three- or four-wheeled cart or feed carrier. Well-designed feed alleys had a direct connection to the silo and to overhead hay chutes.

By the 1890s some farmers were equipping their stall barns with a mechanical feed carrier. Some models had feed containers suspended on an overhead track, somewhat similar to a manure carrier. (See "Beef Barns" for additional information on feeding.)

In 1946 the University of Minnesota described a trend toward placing food directly on the floor at the head of the stalls, instead of in an elevated manger. The article explained. "Dairymen using this arrangement have found it most satisfactory as it eliminates the lifting of hay from the floor to the manger. Any hay or grain pushed away from the curb by the cows can be quickly swept back [toward the cow] with a fiber push broom" (Christopherson 1946: 15).

Feed Rooms. Many dairy barns had feed rooms or "mix rooms" where feed was chopped, ground, mixed, and stored. The room could be located on the main level or – in a basement barn – in the hay mow. A feed room might contain a scale, mixing containers, fodder cutter, grinder, feed bins, and the outlet of a hay chute from the loft above. As dairy herds became larger and labor more expensive, farmers mechanized feed handling further and developed new ways to mix, store, and move cattle feed (Millier 1951).

Root Cellars. Many Midwestern farmers fed their dairy cattle root crops like turnips, mangels, and rutabagas, and stored the roots near the herd. Root cellars were often located under the central alley, under the silo, under the ramped driveway of a basement barn, or near the feed room. Root cellars appeared in some published barn plans as late as 1923 (Casselman 1895: 72; Louden 1923).

Floors. Early dairy barns had dirt floors, some with dirt manure gutters that were eventually lined with boards. Wooden barn floors were better, but were often slippery, dirty, and prone to decay. Poured concrete floors were considered a vast improvement. By the early 20th century concrete floors often incorporated alleys, mangers, stanchion bases, gutters, and proper drainage – all in a single monolithic pour. Concrete floors had to be scored or roughened when poured to help keep the animals from slipping. Sand could be scattered on floors to increase traction. Some concrete floors had an overlay of wood, especially under the animals, to relieve uncomfortable coldness that was thought to reduce milk production. Some barns had cork blocks, creosoted wood blocks, or short blocks of end-cut logs beneath the animals for warmth and comfort (White 1923: 99; Eckles 1950: 516-517).

In pen barns, the cows lounged on deep straw bedding that captured and absorbed the manure.

Gutters and Manure Handling. In New England in the early- to mid-19th century, some farmers allowed cow manure to drop into holes below the barn floor – a practice that Minnesota experts abhorred and was apparently rare in the state. Instead, most manure was removed from stall barns daily and hauled to a manure pile or pit ideally located about 50' away. Many felt the most practical way to clean a stall barn was to have a central alley, edged with gutters, with a door at each end, and of sufficient width (e.g., 8' or 9') so a manure spreader could be brought into the barn and directly filled. Stall barns were easier to keep clean with well-designed gutters, and various gutter shapes were developed. By the early 20th century, typical concrete gutters were about 10" wide and 16" deep.

Early manure handling equipment included the mechanical litter carrier, developed in the 1890s for stall barns. A typical carrier consisted of a metal tub suspended on a track that ran the length of the barn and out to the manure pile. These carriers were eventually electrified. Barn gutter cleaners with chains and paddles came into wide use in the 1950s. Gutters were sometimes altered to accommodate the equipment, or poured to its specifications. (See "Beef Barns" for additional information on manure handling.)

In a pen barn or loose housing system, manure was only removed from the barn once or twice a year. Instead, the farmer regularly added fresh bedding that absorbed the manure, capturing it for spreading on the fields. The straw-manure mix (or "manure pack") under the cows heated up as it decomposed, providing useful heat to the herd during cold winter months. Because the manure was stored within the barn, it remained sheltered from the weather and was not lost to rain or run-off.

Milking Machines. Milking the cows consumed more time than any other dairy farm chore. The first milking machines were developed in the mid-19th century but did not work well. In Scotland, William Murchland invented a vacuum milker in 1889, for which he was given a U.S. patent in 1892. Eventual improvements to the Murchland milker included a foot-operated pump. By the late 1890s several milking machines were commercially available and successfully operated. In 1916 dairy specialists Eckles and Warren characterized milking machines as not yet out of the experimental stage (Eckles and Warren 1916/rpt. 1921: 66). Many Minnesota farmers purchased their first milking machines between 1915 and 1925, but they weren't widespread until after farm electrification.

In 1931 agricultural engineers were suggesting that an electrical milking machine would pay for itself with a herd of eight or ten good quality cows, and would pay for itself with a herd of only five or six cows if the alternative was "[milking] irregularly or indifferently done by children or a hired man" (Prickett 1931: 151). Despite the fact that the equipment had to be washed after each use with both cold and scalding water, milking machines saved labor and were more sanitary than hand milking, although they could spread disease from cow to cow.

Two basic types of machines were used in 1931 and improved through the next decades. One was a portable model with a motor and vacuum pump mounted on a small milk tank that was moved throughout the barn. The container was usually emptied after each cow was milked. The second was a stationary system with pipe lines that pumped milk directly from the cows into milk cans or a refrigerated bulk tank. The latter system was expensive and difficult to keep clean, so many farmers continued to use portable milkers and milk cans into the 1960s (Prickett 1931: 151-152; Witzel 1960).

Milk Houses. All dairy barns had a dedicated space where the raw milk was handled. Often called the "milk room" or "milk house," this space could be incorporated into the barn's original design, be an addition, or be an entirely separate structure. Milk sanitation laws eventually required that the milk house be completely separated from the stable area – for example with a vestibule and self-closing door – although the milk house did not have to be a detached structure. For information on milk handling, see the separate individual farm elements section entitled "Milk Houses."

Electricity. Dairy farmers were among the first farmers to use electricity, and the farmhouse, farmyard, and dairy facilities were usually the first areas on a farm to get electric lights. Electric lighting was especially helpful because much of the work in dairy barns and milk houses took place before and after daylight hours.

In the dairy barn, electricity was "largely responsible for the rapid development of the milking machine" (Golding and Neff 1956: 305). In her study of Stearns County dairy farms, Marilyn Brinkman wrote that time spent on milking chores was cut 45 percent with electrification (Brinkman 1988: 20). In addition to lights and milking machines, electricity was widely used for cooling milk, heating water, and sterilizing dairy equipment. Electric fans, water cup heaters, manure conveyors, tail clippers, and other devices were also prevalent (Golding and Neff 1956: 305-306). A 1940 *Successful Farming* publication recommended that dairy barns have one outlet for every five cows. Barns also needed overhead lights with reflectors and separate electrical circuits for the cream separator and churn, refrigerator, cooler compressor, and other equipment (Fox 1940: 63-64).

Maternity Barns. Some dairy farms had a separate wing or building that served as a calf or maternity barn (National Plan 1951: 10). It is not known how prevalent they were in Minnesota.

MORE INFORMATION ON PEN BARNS OR LOOSE HOUSING

In a pen barn or loose housing system (also called a loafing barn), cows were milked in a separate milking barn or milking parlor. (See the separate individual farm elements section entitled "Milking Barns.") The need for two buildings, rather than one, was one reason that pen barns were less common among Minnesota farmers than were stall barns before 1960.

Pen barns could be either one or two stories tall. If no storage for feed and bedding was provided within the barn, another storage facility had to be located nearby. One-story pen barns were generally taller than one-story stall barns so that a winter's worth of manure-straw could accumulate on the floor and still leave sufficient headroom for manure-handling equipment (Christopher 1946: 5).

A few Midwestern farms were using pen barns or loose housing by the late-19th century. In 1905 a University of Illinois dairy specialist, Wilbur Fraser, published an analysis of the productivity of dairy cows kept in loose housing. He included in his report some farms in Illinois that had been using loose housing since 1891. The farms studied in 1905 had loose housing set up in buildings of various sizes. Fraser's findings were so favorable that the University of Illinois began using loose housing for part of its own herd in 1903 (Fraser 1905).

In a pen barn, cows spent most of their time in a loafing or resting area. At particular times of the day they were also given access to a feeding area where the feed bunk was located, to an exercise area, and to a holding area where they waited to enter the milking barn. Stanchions were only used in the milking barn.

Fraser's work anticipated a more generalized trend from stanchion to loose housing, the advent of the separate milking parlor, and the development of the one-story dairy barn, all of which came to eventually dominate the dairy industry, especially after the 1950s. Fraser and others found that unrestrained cows did not injure one another as had been previously believed. The cows were healthy, productive, and apparently more comfortable (and therefore gave equivalent or more milk) than restrained cows. Pen barns sometimes needed more floor space than conventional barns, but were easier and less expensive to build because they didn't need the complicated arrangement of stalls, mangers, gutters, and stanchions. Pen barns were not as advantageous for farmers who sold cows for breeding since the herd wasn't as well-displayed as they were in the fixed rows of a stall barn. Pen barns required less labor for barn-cleaning and feeding, and generally stayed cleaner than stall barns, although considerably more bedding was needed. In explaining some of the labor advantages of loose housing, Witzel wrote in 1960, "Cows confined to stalls cannot help themselves, select the feed they want, go out for sunshine, or obtain exercise without the dairyman being on hand to wait on them" (Witzel 1960: 600; Fraser 1905; Ashby 1916; Engene et al 1948; Neubauer and Walker 1961: 55; Christopherson 1946).

An experiment to test stall barns versus pen barns, as well as loose housing under both warm and cold barn temperatures, began in 1941 in a newly-built dairy research barn at the University of Wisconsin in Madison. (The Wisconsin Dairy Barn Research Project also tested steel's suitability as a building material for one-story dairy barns, granaries, and silos.) The experts found that cattle in pen barns usually had longer productive lives because of fewer injuries, less stiffness, and a better appetite. Cold housing with open doors was found to be just as suitable as warm housing (Witzel and Barrett 1944; Witzel and Heizer 1946; Engene et al 1948; Witzer and Derber 1952).

Pen barns were becoming somewhat common in 1936, although they were not widespread, according the University of Minnesota (White et al 1936: 3). In 1944, Wisconsin's S. A. Witzel included pen barns in a discussion of recent trends in agricultural engineering (Witzel 1944: 376). In a 1946 University of Minnesota publication discussing one-story dairy barns, both stall and loose housing were discussed (Christopherson 1946). In 1948, following World War II and the release of results from the Wisconsin study, the Minnesota Extension Service published a bulletin that indicated that "many" farmers in Minnesota were using loose housing (Engene et al 1948). The Minnesota Agricultural Experiment Station began a loose housing study in 1949. In 1952 it reported that the cows were producing as well or better in loose housing than in the University's stall barn (Peterson 1952).

In 1950 Minnesota's C. H. Eckles wrote that loose housing was "becoming increasingly popular" (Eckles 1950: 514). In 1960 Witzel wrote that as a general rule in Wisconsin, stall barns were being used for herds of less than 50 to 60 cows, while pen barns were being used for larger herds. Witzel indicated that in a "recent" survey of dairy barns in Wisconsin, only 600 loose housing systems were being used on about 101,000 dairy farms (Witzel 1960: 600-601).

Older stall barns could be remodeled into pen barns. In 1950 the University of Minnesota's C. H. Eckles wrote, "[Loose housing's] great advantage is to be found in remodeling old barns. They are generally of undesirable size or dimensions for standard barn equipment but may be gutted to form the open-shed part, and by the addition of a simple milking quarter, a modern and economical barn may be secured. In recent years much development has taken place in labor-saving design and convenience in milking parlors" (Eckles 1950: 514).

Because of their simple design, pen barns also favored prefabrication. By the late 1940s several companies were offering one-story pen barns that were all or partly prefabricated. They included Stan-Steel (Great Lakes Steel), which offered Quonset barns, and Reynolds Aluminum, which in 1953 was advertising a pole barn for dairy cattle with corrugated aluminum sides and roof. A 52' x 60' Reynolds barn could hold 30-40 cows in loose housing (Reynolds 1953).

CONFINEMENT HOUSING

In 1960 dairy expert S. A. Witzel reported that confinement housing, whereby dairy cows spent virtually no time in outdoor pastures, was a new concept in Midwestern dairying. Modern methods of intensive cropping and mechanical harvesting were producing higher yields per acre than pasturage, and farmers were finding their fields better-used for crops than for grazing. Herds were growing increasingly large and confinement systems were offering better control over all facets of production, better use of labor, and other lowered costs (Witzel 1960). Air conditioning for confinement barns, which held promise to alleviate the overheating inherent in confinement systems, was just beginning to be discussed in 1960 (Stewart 1960).

NONORTHOGONAL BARNS

Nonorthogonal barns, or those without right angles, were a special subtype of dairy barns and multipurpose barns. Most nonorthogonal dairy barns were stall barns.

In the Midwest the construction of nonorthogonal barns began as early as 1850, peaked around 1910, and ended during the 1930s (McMahan 1991: E2-E3).

Proponents of nonorthogonals explained that they provided more natural light to the interior, encompassed more interior space with fewer building materials, and increased the efficiency of farm labor through their unique spatial arrangement. They were, however, hard to expand. Many were built around a central silo, although this made the silo more difficult to fill.

Polygonal barns, most of which were built in 1850-1900, were the first popular form of nonorthogonal barns and were cheaper to build than true-round barns. Most polygonal barns had 6, 8, 9, 10, 12, 14, or 16 sides. Those with a greater number of sides were often built to more closely approach the true-round form and its presumed advantages (Meyer 2001). Some polygonal barns were built to escape patent restrictions that had been placed on some round barn designs.

One of the first octagonal barns that became widely known was built in 1874 in New York. It was owned by Elliot Stewart, a farmer and the editor of the *Livestock Journal*. Stewart replaced four rectangular barns (totaling 7,000 sq. ft.) with a 5,350 sq. ft. octagonal barn. Stewart claimed that octagonal barns were cheaper to build because fewer materials were needed, and that they were much more efficient for feeding animals because of their "shorter lines of travel." His articles on the octagonal barn were reprinted in several publications (McMahan 1991: E4-E5).

Most true-round barns were built during the years 1889-1936. Round barns were usually more expensive to construct than other nonorthogonal forms because they usually required curved lumber and special carpentry expertise. Despite this drawback, they became the most popular form of nonorthogonal after about 1900. Round barns were purported to resist strong winds better than other nonorthogonals and therefore to be more storm-proof. Minnesota dairy expert Clarence H. Eckles noted that round barns used between 34 and 58 percent fewer materials to build than comparable rectangular barns (Eckles 1950: 513).

Nonorthogonal barns were generally planned and built in several ways. Some were built by carpenters who traveled a wide area and specialized in nonorthogonals. Some were built by carpenters who worked only in a small, local area. Some were built with the help of companies that sold plans, materials, or entire kits, and sometimes offered to supply labor. Others were simply planned and built by farmers themselves (Sculle and Price 1995: 197). Traveling specialists included Jeremiah T. Shaffer who, along with his five brothers-in-law, owned Minnesota's Shaffer-Haas building company. This company is known to have built 25 round barns in Illinois, 14 in Wisconsin, and 3 near Albert Lea, Minnesota. Most date from circa 1901-1917. Another builder, Indiana-born Benton Steele, is known to have built 44 round barns in the Midwest (Sculle and Price 1995: 197-200).

Nonorthogonal kits could be ordered from companies such as the Radford Architectural Company of Chicago, Sears and Roebuck of Chicago, and the Gordon Van-Tine Company of Davenport, Iowa. One Minnesota example of kit construction was the A. C. Sherman Barn near Sleepy Eye, which was built from a kit in 1908-1909 (Sculle and Price 1995: 200-201).

Nonorthogonals were more prevalent in the Midwest's corn-growing and dairying regions than in any other parts of the country (Sculle and Price 1995: 188). Even in the Midwest, however, they were rare. Indiana and Wisconsin are believed to have had the most nonorthogonal barns, with about 220 built in each state (Meyer 2001). About 15 percent of Indiana's nonorthogonal barns were octagonal (McMahan 1991: F12). Iowa is believed to have ranked third in the number of nonorthogonal barns, and Minnesota fourth (Meyer 2001). Through many years of study, historian Roy W. Meyer had by 2001 identified, or found reference to, about 170-180 nonorthogonals known to have been built in Minnesota. Roughly 60 percent had been demolished by 2001, with only about 70-75 barns still standing in Minnesota at that time (Meyer 2001). Only about 44 nonorthogonal barns are believed to have been built in South Dakota. Most, or about 36 of the 44, were extant in 1995 (Ahrendt 1995). The world's largest round barn, built circa 1917 with a 150'-diameter, still stands in Marshfield, Wisconsin.

The collapse of the farm economy in the 1920s slowed the construction of nonorthogonal barns. At the same time, they had lost popularity among farm journalists (Sculle and Price 1995: 204-205). By the time the economy improved in the 1940s and farmers could again afford to build large barns, technology had changed drastically and nonorthogonals were considered obsolete. Large two-story barns, whether round, polygonal, or rectangular, were almost completely supplanted by modern one-story, steel-sided pole barns that, in the words of one historian, "were inexpensive, easy to build and completely devoid of character" (McMahan 1991: E11).

PREVALENCE

Dairy barns were widely built throughout Minnesota. Early barns built specifically for dairy operations are likely rare. Well-preserved examples of two-story, fixed-stall barns dating from the 1890s and later are likely to be fairly common. Basement barns are still found in hilly areas. Nonorthogonal barns are rare. Pre-1945 examples of pen barns or loose housing barns are probably rare.

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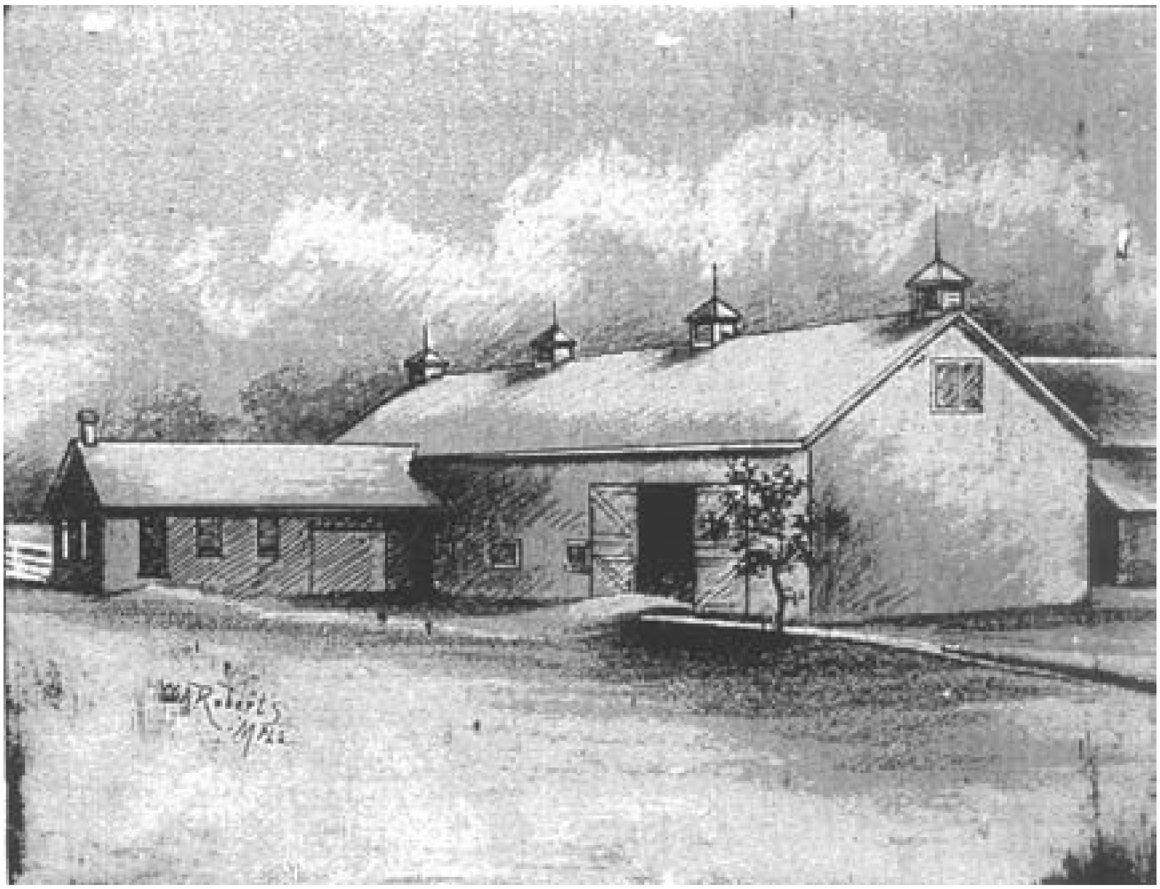
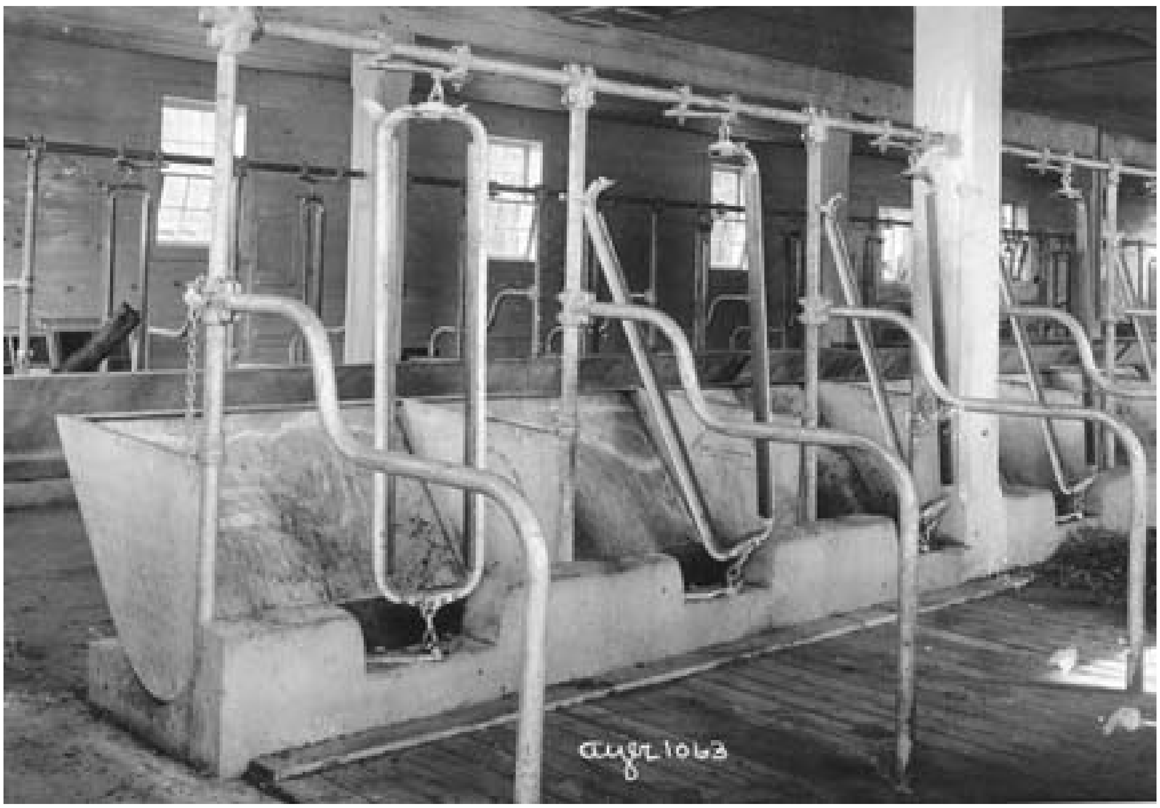


One-story dairy barns are not a modern invention. This illustration was published in an 1895 issue of the *Minnesota Farmers' Institutes Annual*. The 36' x 112' building had stalls in which 32 cows were chained, root cellars under the feed alley floor, five calving pens, and a milk house wing. From Casselman (1895).

A load of hay ready for the loft. One Minnesota farmer in 1914 advised that the hay door be placed on the northern end of the barn so that the hot dusty chore of loading the hay in August could be done in the shade (Henry 1914). While second story lofts saved labor at feeding time, the dry hay was highly flammable and barn fires were common. Location unknown, circa 1910. (MHS photo by Harry Darius Ayer)

Loading the mow using a hay sling. In the field, the empty bed of a wagon was loaded with three layers, each consisting of a canvas or rope sling and then about 4' of hay. Back at the barn, each sling and its load was lifted off the wagon and hoisted into the loft. The load was raised with pulleys, with horses (later tractors) towing the ropes away from the barn. Location unknown, circa 1910. (MHS photo by Harry Darius Ayer)



The interior of a "Wisconsin" style barn, common in Minnesota. It had two rows of stalls, pipe stanchions, steel mangers, and wooden floors beneath the cows. The cows faced inward, which allowed light from the windows to illuminate the milking process. Hackney Farm near St. Paul, circa 1910. (MHS photo by Harry Darius Ayer)

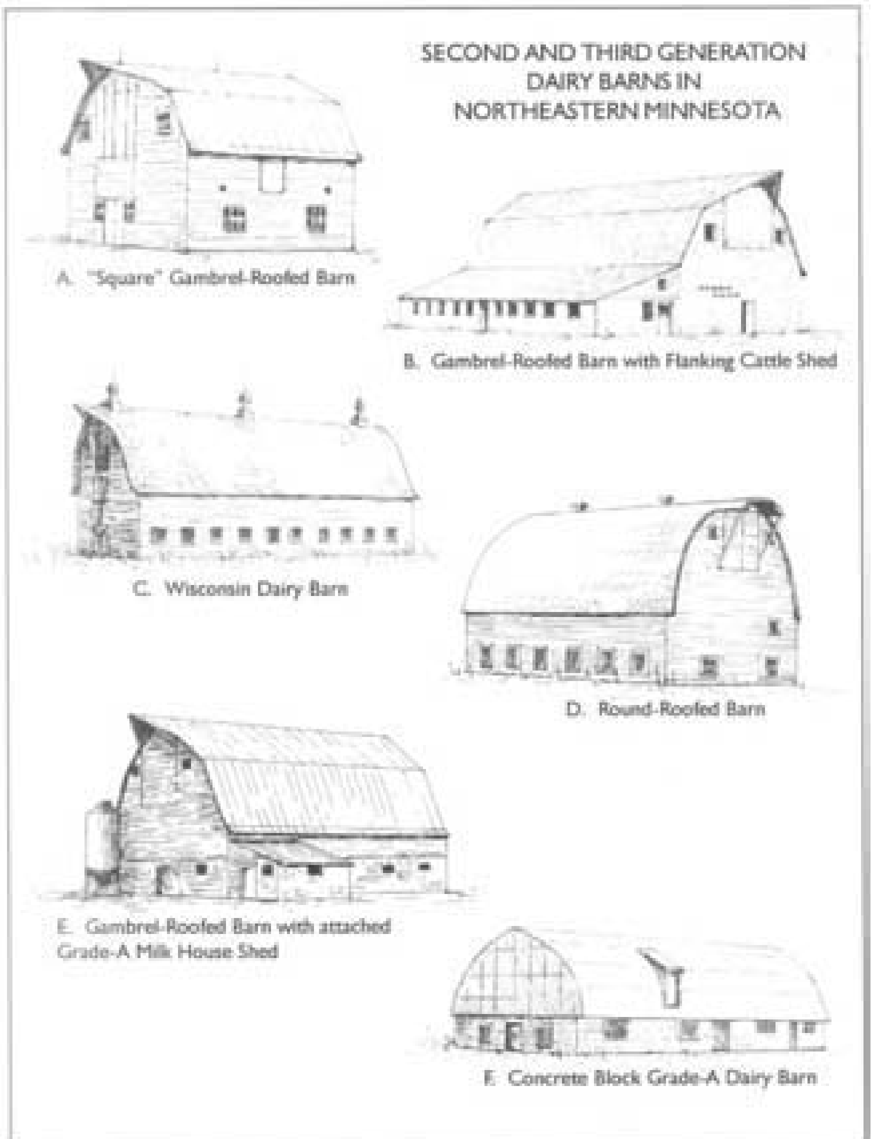
A barn sided with unpainted sawn lumber, probably in northern Minnesota. Location unknown, circa 1915. (MHS photo)

Most dairy barns had passive gravity ventilation systems with outlet flues topped with metal caps and/or wooden cupolas. The fresh air intakes were usually along the barn's sidewalls. This barn was covered with sheets of corrugated metal, a low-maintenance material that was in use by the early 20th century. Six milk cans stand near the door in this photo. Location unknown, circa 1910. (MHS photo by Harry Darius Ayer)

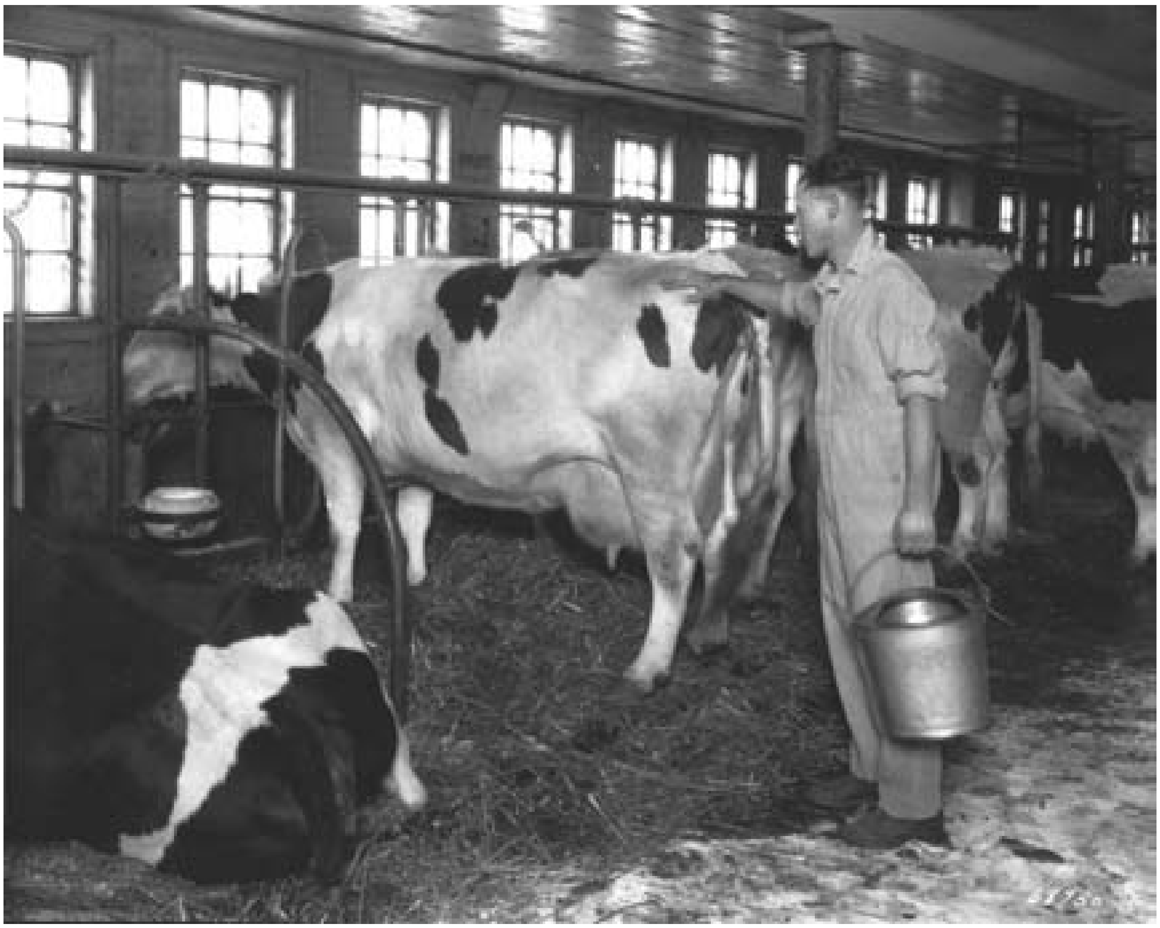
A dairy barn with stone basement and a concrete block milk house addition. The end walls feature decorative wood shingles, which is unusual. The painted lettering reads “Pleasant View Dairy Farm, Isidor A. Schwinghammer, prop., Albany, Minn., registered and high grade Holstein-Friesian cattle, Chester White swine, and Rhode Island Red poultry.” Photo taken circa 1915. (MHS photo by Henry A. Briol)

Purebred Holsteins and a wooden silo on a Stearns County dairy farm. Many Minnesota dairy farms in the early 20th century had 12 to 20 cows. The number was determined by factors such as the number of workers available to milk, the capacity of the silo, and the amount of hay that could be cut and stored. Falkner Farm, near Albany, 1917. (MHS photo by Henry A. Briol)

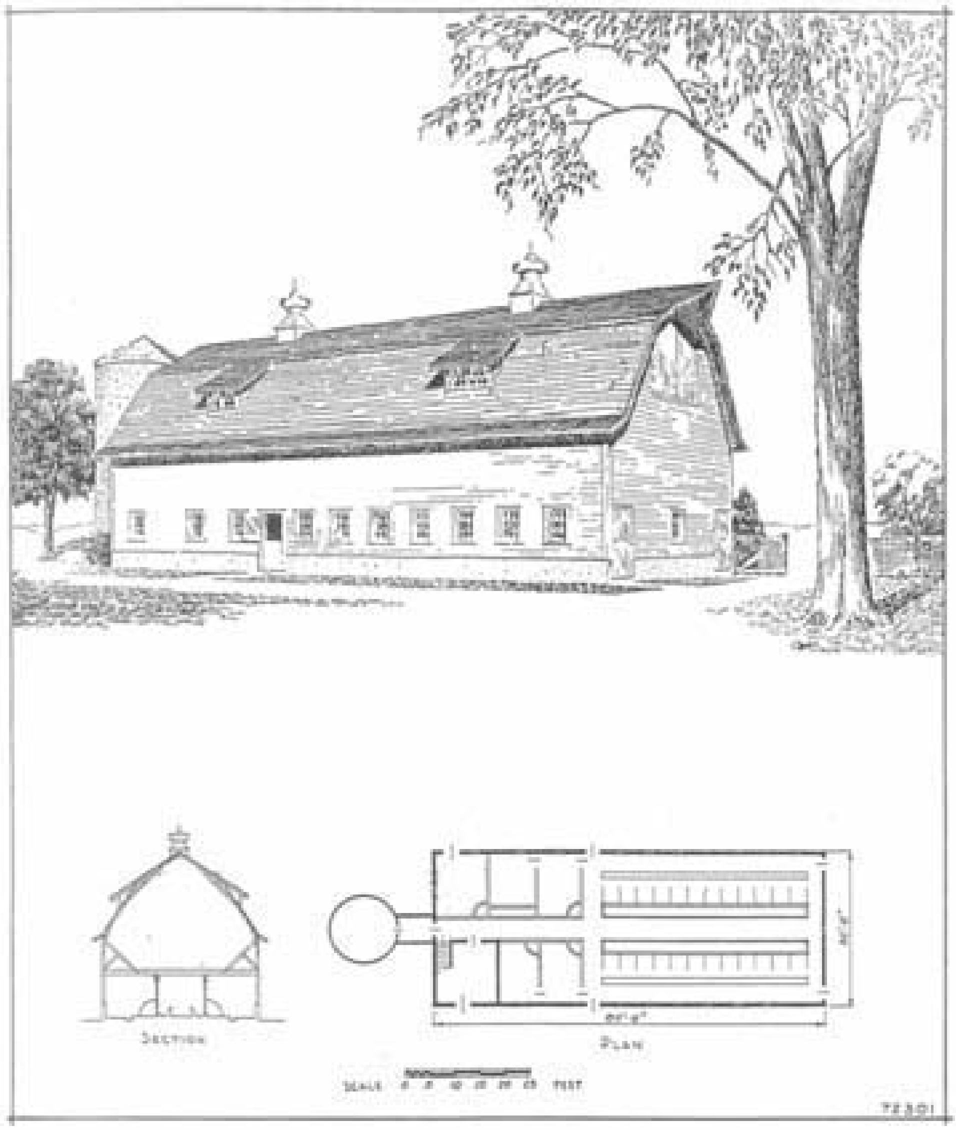
Basement barns often had lower-level animal stables and an upper storage area into which a feed wagon could be driven. This type of barn had a few drawbacks: it was usually more expensive to construct, it required hilly terrain or a large earthen ramp, the basement was often dark and damp, and the upper-level driveway stole storage space. Itasca County, circa 1920. (MHS photo)



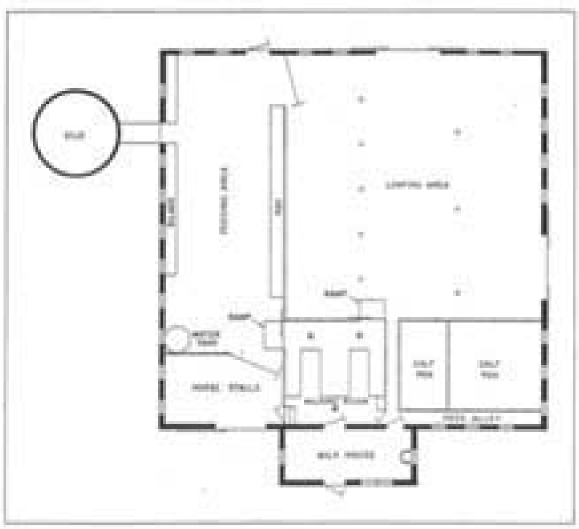
Types of dairy barns in northeastern Minnesota in 1999. Drawn by Debra Flanders based on photos by Arnold Alanen for Alanen's *A Field Guide to the Architecture and Landscapes of Northeastern Minnesota* (2000).



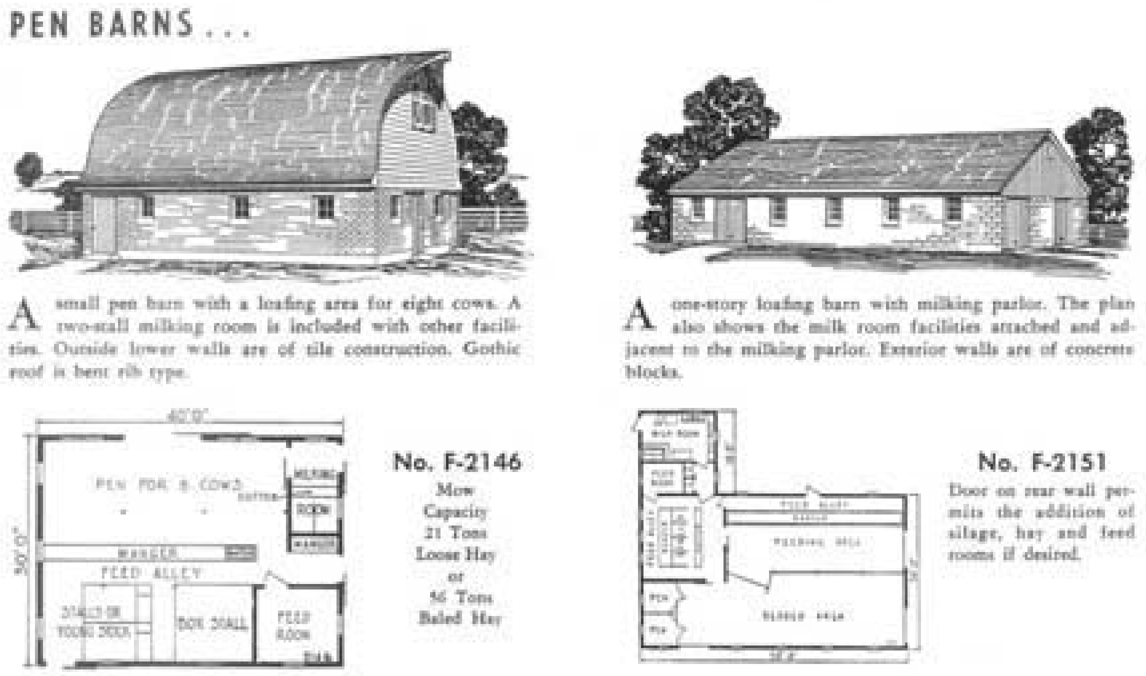
The interior of a well-lighted, Wisconsin-style stall barn. The pipe stanchions allowed the cattle to swivel their heads and lie down, and the cows could probably see out the many windows. The manger was concrete, and small salt cups were attached to the stanchions. The low ceiling helped conserve heat. Lake Elmo, 1927. (MHS photo by Hibbard Studio)



Two-story dairy barns were built in Minnesota from the late 19th century through the 1950s. In this 32′ x 80′ example, the cows faced inward. While either style worked, it was more common for cows to face outward, which gave farmers less distance to move the milking equipment. Facing the cows outward also made barn cleaning more efficient by placing the manure gutters along a central alley. From the Midwest Plan Service, 1933.



Both of these loose housing arrangements were created from older stall barns that were remodeled. The one with the square footprint was expanded toward the right. From a Minnesota Agricultural Extension Service bulletin published in 1948 and entitled "Loose Housing for Dairy Cattle."



PEN BARNS . . .

A small pen barn with a loafing area for eight cows. A two-stall milking room is included with other facilities. Outside lower walls are of tile construction. Gothic roof is bent rib type.

No. F-2146

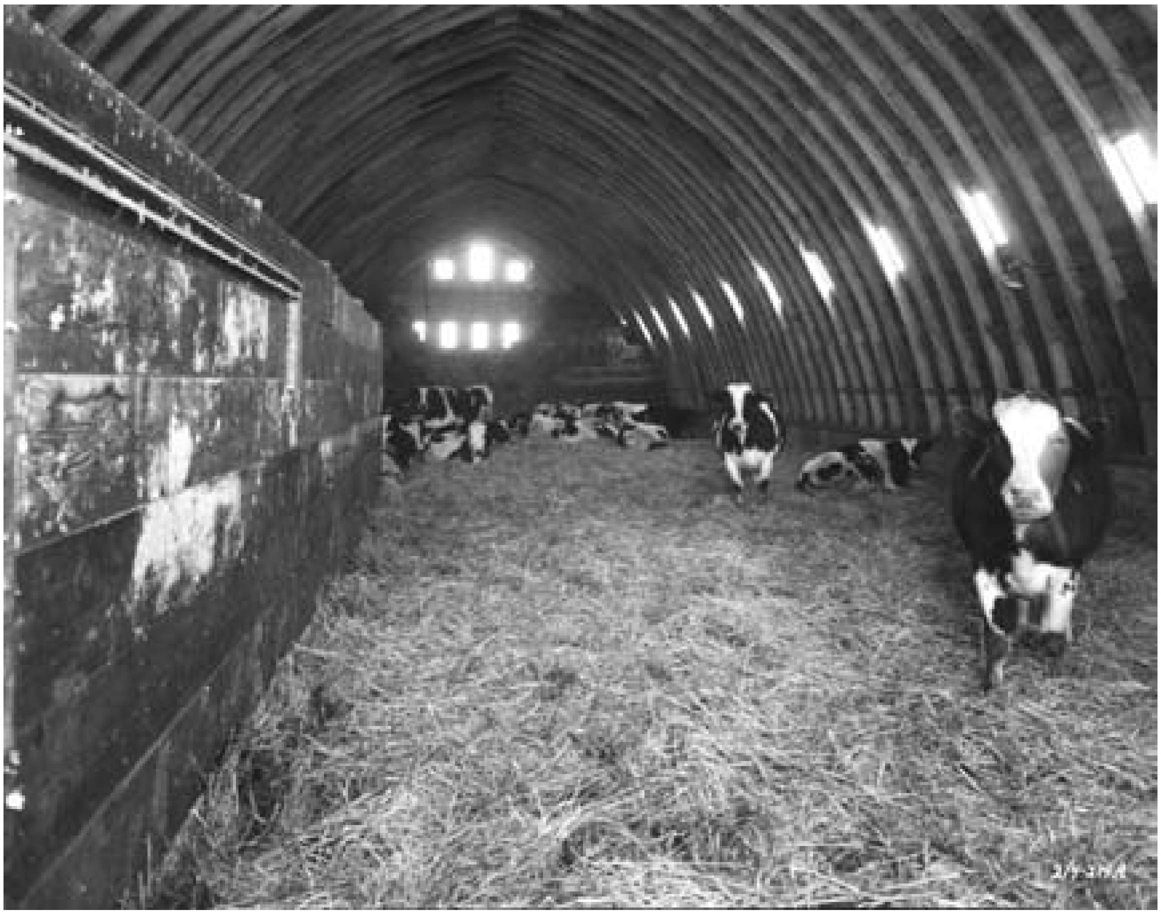
Mow Capacity 21 Tons Loose Hay or 56 Tons Baled Hay

A one-story loafing barn with milking parlor. The plan also shows the milk room facilities attached and adjacent to the milking parlor. Exterior walls are of concrete blocks.

No. F-2151

Door on rear wall permits the addition of silage, hay and feed rooms if desired.

Two styles of loafing or pen barns, both built of hollow clay tile. The barn on the left had upper-level storage, while the barn on the right had separate feed and bedding areas. From the 1951 publication *Practical Farm Buildings* by the National Plan Service.



A few Midwestern farmers used loose housing as early as the turn of the century. By the 1940s studies were finding that loose housing saved labor and that cows housed this way enjoyed better health, fewer injuries, and longer productive lives. The cows lounged or “loafed” on a deep bed of straw. Milking was done in a separate milking parlor or barn. Location unknown, 1953. (MHS photo by Norton and Peel)

Round and other nonorthogonal barns were usually stall-type dairy barns. They sometimes had a central internal silo. Mount Vernon Township, Winona County, circa 1973. (MHS photo)

Location unknown, circa 1910. (MHS photo by Harry Darius Ayer)

■ DRAINAGE STRUCTURES

- Drainage improved tillable acreage, crop yields, and farm profits, but altered the natural environment by removing wetlands
- Most of Minnesota's public drainage ditches were built between 1860 and 1920
- Drainage activity peaked in the 1910s
- Subsurface drains were the most effective method of farmland drainage
- Subsurface drain tiles were made of various materials: clay (first used in the U.S. in 1835), concrete (1862), plastic (1940), corrugated plastic (1964)

Minnesota has some of the richest cropland in the country. But much of the land – especially in the southern and western parts of the state, the Red River Valley, and the cutover peat regions – was excessively wet and poorly drained. Inadequately drained soils were slow to dry out and warm up in the spring, delaying field work and planting and resulting in a shorter growing season. Even a one-week delay in seeding could mean significant yield losses – in some cases as much as 50 percent. One source claimed that up to one-fourth of a farm's acreage could be too wet to till (Roe 1923: 70). Another source estimated that 45 percent of Minnesota's soils were originally wet (Herrick and Raup 1957: 1).

Beginning shortly after settlement, Minnesota farmers began to systematically drain the state's wet soils, "potholes," and sloughs. Drainage accelerated during the period 1900-1920 when farmers sought to expand acreage but the state's best cropland was already in production. Drainage considerably altered the state's ecology, as well as increasing its cropland (Cunfer and Guse 2001; Amato 2001; Timmerman 2001). Soil drainage also played a role in controlling erosion. (See also "Erosion Control Structures," a separate individual farm elements section.)

By the 1960s, drainage improvements had been made on about one-third of the state's cropland, and about one-half of the land in the Minnesota and Red River valleys. Widespread drainage increased the size of fields, and they became more regular in shape. Drainage increased productivity and profits, but also affected wildlife and flood-control efforts (Nass 1989: 130; Baerwald 1989: 30). Much of the historic system of ditches, subsurface tiles, culverts, headwalls, and other structures remains today.

OVERVIEW OF DRAINAGE

Unwanted water was removed from the upper 3' to 4' of agricultural lands by cutting channels into which water could seep, and linking the channels by gravity or a pump to an exit outlet. In some areas like pastures, the drainage channels were left open. But on cropland, where open channels would interfere with fieldwork, lengths of pipe – called tile – were laid at the bottom of the channels and then the trenches were filled in. Water percolated by gravity through the soil and into the drainage system.

See also

Erosion Control Structures
Fields and Pastures
Industrialization and Prosperity, 1900-1920
Developing the Cutover, 1900-1940

The location of the drainage structures, their depth, slope, and distance apart depended on topography, soil type, rainfall, watertable height, watershed area, and land use. Because of the number of variables, drainage systems were usually designed by engineers. As a general rule, more and shallower drainage channels were needed on heavy soils than on light or sandy soils. Ideally, channels were fairly straight and had a uniform slope. Branch, or lateral, channels flowed into a main channel which led to an outlet – usually a public ditch or surface waterway.

Public outlet channels were government enterprises. Sometimes satisfactory drainage outlets were secured by improving natural channels – for example, widening, deepening, or straightening a creek bed. But more often, new open ditches or large tile lines were built. These formed the backbone of Minnesota's public drainage system (Russell and Lewis 1956; Sutton 1957; Wilson 2000).

STATE AND FEDERAL GOVERNMENT

Construction of public drainage outlets was enabled and promoted in the 1850s-1950s by federal and state laws. Minnesota's first drainage law was passed in 1859 during the first year of statehood, "to regulate and encourage the drainage of lands." The law let farm neighbors form corporations to build drainage ditches, and spelled out requirements for pro rata assessments of costs and settlement of disputes. Subsequent laws in the 1870s gave township and county authorities a voice in drainage decisions and ditch governance (Wilson 2000: 4).

In 1893 the Red River Board of Audit was set up to oversee drainage in the Red River Valley, and in 1897 a State Drainage Commission was established. The State Commission, which had the authority to drain any land in the state, reflected the public consensus that "the wetland areas that have impeded the progress of development . . . should be transformed to productive lands as rapidly as possible" (Timmerman 2001: 126).

By 1907 the state had a large body of agricultural drainage law that allowed public ditches to be built by townships, counties, district courts, or the State Drainage Commission. Construction of new public ditches was usually initiated by a petition of landowners to one of the drainage authorities. If the governing body approved the petition, engineering surveys, designs, and cost and benefit estimates were made, and public hearings were held on construction, financing, and tax assessments for the project. Public drainage systems were financed through assessments to benefitting property owners ("Reclaiming" 1905: 74-76; Herrick and Raup 1957: 14; Russell and Lewis 1956: 572-4; Dickman 1977: 24-5; Wilson 2000: 4).

State organization of drainage ended in 1947 with a major revision of state drainage law, and authority to establish public ditches was thereafter limited to counties and judicial district courts.

In the 1950s Minnesota agricultural policies began to shift from drainage promotion to conservation. Water began to be seen not as a nuisance or an enemy but as a valuable resource. Policymakers and drainage engineers began to think about the effects of farmland drainage on rivers, lakes, wildlife, recreation, and flooding. Watershed districts were organized to oversee regional water management and conservation programs (Herrick and Raup 1957; Wilson 2000: 4-7).

In the early 1960s the role of wetlands in flood control and in environmental and water quality protection gained new recognition. New state laws in the early 1970s limited drainage activities and established stricter environmental requirements for new systems. In the 1980s the federal government began to restrict the draining of wetlands (Cunfer and Guse 2001: 144). These changes culminated in the 1991 Minnesota Wetland Protection Act – "one of the most sweeping wetlands protection laws in the country" – which aimed at no net loss of existing wetlands (Herrick and Raup 1957; Wilson 2000: 4-7).

The federal government also played an important role in drainage. The Army Corps of Engineers constructed drains, levees, dams, and flood control structures on Minnesota's navigable rivers and their tributaries. The USDA provided extensive technical assistance. The Soil Conservation Service advised individual farmers on their private farm drainage and conservation plans. The Agricultural Conservation Program paid farmers in some areas to install drainage and other water-control structures. During the 1930s, federal refinancing programs bailed out many bankrupt drainage districts, and Works Progress Administration and Civilian Conservation Corps relief workers built new ditches and cleaned and reconstructed existing drainage systems (Sutton 1957: 408).

DRAINAGE ACTIVITY IN MINNESOTA

Most of Minnesota's public drainage ditches were built between 1860 and 1920 during the so-called Era of Reclamation. The peak of ditch construction in Minnesota was during the prosperous decade of the 1910s. Drainage and road-building projects were often combined, and the soil removed in dredging was used to build adjacent roads. Minnesota's pattern was consistent with the rest of the Midwest, where drainage peaked in the 1910s and early 1920s (Cunfer and Guse 2001: 144-145).

There were few public drainage projects in Minnesota from 1920 to 1945 during the years of agricultural depression, drought, and war. Drainage activities picked up again after World War II when the farm economy improved, and when Minnesota experienced a series of wet summers (Nass 1989: 131; Wilson 2000: 7). In 1960 Minnesota ranked second among states in acreage drained (Cunfer and Guse 2001: 145).

Most public drainage ditches in Minnesota were built by counties or judicial districts. After the county ditches were built, many individual farmers installed private systems that emptied into the public outlets. By 1950 Minnesota had more than 16,000 miles of public surface ditches and 10,000 miles of public subsurface tile, draining more than 11 million acres of farmland. This did not include the much greater length of private ditches and tile built by landowners (Russell and Lewis 1956: 574-575; Sutton 1957: 406-407).

TYPES OF STRUCTURES

Experts advised farmers to invest in a complete drainage plan designed by a drainage engineer, even if they were only able to install the system a little at a time. The Minnesota Agricultural Experiment Station advised farmers in 1950, "A properly designed system normally requires the services of a trained drainage engineer. Very few farmers or tilers are competent to design a drainage system (Manson and Rost 1950: 13). The type of plan depended in part on expected land use: some crops such as potatoes, for example, needed more complete drainage than others like pasture grasses (Roe and Neal 1938: 3-4).

Farmers often installed drainage systems themselves. The University of Minnesota helped by publishing detailed construction guides. Through the 1930s farm ditches less than 4' deep, and early tile lines, were often dug by hand. Larger ditches were usually dug by a farmer with a team, plow, and slip or wheel scrapers, and finished by hand. By 1905 the first tile trenching machines were used to install shallow tile, and backhoes or dragline excavators were used to install deep tile (Roe 1924: 6; Roe and Neal 1938; Sutton 1957: 412; Wilson 2000: 7-12).

Shallow Farm Drains. The cheapest and simplest drainage system was the short surface drain that followed a natural swale or depression, or traveled the shortest line between sloughs. Farmers often worked out these field drains by themselves, marking the natural water flow after a heavy rain and later excavating a shallow channel. This type of ditch, which only needed to be deep enough to keep the water moving, was V-shaped but shallow so it could be farmed across. If the channel floor was too wet for crops, the farmer could sow grass and mow it periodically.

These simple surface drains could move abundant water a short distance to the nearest slough or outlet. They were especially important in the early years of Minnesota agriculture, before county ditches and tile drains were built. Even after tile drainage became common, many farmers maintained surface channels as auxiliary ditches to help remove surface floods quickly, especially in the spring (Stewart 1908: 100-105; Boss 1918: 177; Roe and Neal 1938: 11-12).

Open Farm Ditches. Farmers used open farm (or field) ditches, which were deeper than simple surface drains, as outlet channels or to control surface floods and avoid overloading tile drains. Soil type and slope dictated the depth and width of open farm ditches and the steepness of the ditch walls. Fibrous peat or hardpan clay ditch walls, for instance, would stand nearly vertical for years. Ordinary loam soils required side slopes of 1.5:1 or flatter. Ditch walls in sandy soil needed a ratio of 2:1 or 3:1 (Roe 1924: 11; Roe and Neal 1938: 10-11).

By the 1930s farm experts were discouraging the use of open farm ditches except where unavoidable. "Usually, open ditches as a permanent type of improvement have little place on the modern farm. Frequently, however, depth, grade and outlet conditions make necessary some open ditching in connection with tile" (Roe and Neal 1938: 10-11).

Intercepting Farm Ditches. This type of ditch was built at the foot of a hill to cut off the flow of water from a highland and prevent flooding of cultivated lowland. Intercepting ditches were wide and shallow and followed the contour of the hill. All the excavated material was thrown to the lower side of the ditch, thereby increasing the ditch capacity. The bank and sides were smoothed and sown with grass (Roe and Neal 1938: 11).

County and Judicial Ditches. One of the roles of public outlet ditches was to gather water from private systems. Public ditches varied in depth, width, and slope according to the topography, volume of water carried, watershed size, and other factors. Some of the first ditches in Freeborn County, for example, were 32′ wide at the top and 11.5′ deep. Early ditches in southern Minnesota had a slope of about 1′ per mile. In the Crookston area, early ditches ranged from 2′ to 16′ deep, and 6′ to 20′ wide, with a slope of 1′ to 10′ per mile. Ditches with greater slope had to be cleaned out less often than ditches with a flatter slope ("Reclaiming" 1905: 77-79).

County ditches were generally V-shaped, with the spoil, or excavated dirt, thrown on one or both sides. W-shaped ditches were also built, with the spoil placed in the middle between two separate trenches. They were typically designed to handle about 1.5″ to 3″ of runoff per 24 hours. But after 10 or 15 years, most ditches became clogged with sediment, grasses, young trees, and other debris, typically losing about one-third of their drainage capacity. Ditches were then cleaned out and repaired, with costs assessed to the benefitting property owners (Sutton 1957: 410-411). In the 1950s agricultural engineers began designing more environmentally-sensitive surface drainage systems, taking into account flood control and natural resource conservation (Sutton 1957: 410-411).

Culverts. When an open ditch had to cross a road or embankment, water was channeled through a culvert. Culverts were made from a variety of materials, including wood, corrugated metal, and concrete. Many had headwalls of stone rubble, brick, or poured concrete (Robertson and Stewart 1908: 24-30).

Controlled Drainage Structures. In some areas, check dams and other structures were installed in open ditches to control erosion and regulate water level and flow. Drain tile gates, for example, were used to control the water levels in outlet ditches (Sutton 1957: 413).

Subsurface or Tile Drainage. Subsurface drainage, also called tile drainage or under drainage, consisted of lengths of clay, concrete, or perforated plastic pipe buried at intervals in farm fields. Water percolated through the soil and into the tile, and then flowed by gravity through the underground network of lines and mains into a surface ditch or waterway. Tile drains were more expensive than open surface drains, but they were the most effective way to dispose of surplus and conserve productive cropland. Properly constructed tile drains were generally very durable, needed little or no attention after installation, and were considered a permanent improvement. Tiles were made by a number of local firms in cities like Hutchinson, Glencoe, Fertile, Lengby, and Mason City, Iowa (Stewart 1908: 100-101; Sutton 1957; Wilson 2000: 15; Robertson and Stewart 1908: 34).

Early subsurface drain tile was usually made of unglazed clay pipes laid end to end. Clay drain tiles came in many sizes and were round or horseshoe-shaped. First used in America in 1835, clay drain tiles were resistant to corrosion in both acid and alkaline conditions, although they were susceptible to damage from freezing and thawing. Clay tile lines were quite durable – often lasting 50 years – if installed with care and covered with at least 2′ of soil (Robb 1935; Structural Clay 1941: 11; Wilson 2000: 15).

In 1862 the first concrete drain pipe came into use. By 1919 concrete tiles were being used in many public drainage projects in Minnesota, especially in southern and southwestern counties. Many of these concrete tile drains failed in the alkali conditions of southern Minnesota. This prompted two decades of research by the University of Minnesota on improving the durability of concrete tile. Concrete tile was not recommended for high-acid peat soils or for strong alkali conditions (Roe and Neal 1938: 10; Wilson 2000: 15-18).

Bituminized fiber pipe was also used for drainage in some places. Corrugated metal pipe was used for special conditions such as quicksand or road crossings, and for drain outlets. Plastic tubes were first used in 1949. Corrugated plastic pipe, now the most widely used subsurface drainage material, was first used in 1964 (Sutton 1957: 412; Wilson 2000).

The size of tile drains depended mainly on soil, topography, and the attainable slope. Larger tile, perhaps 8″, was usually required when the grade was too flat, in an area with poor surface drainage, or when surface inlets were used. Because small tiles were hard to lay accurately and clogged easily, sizes under 5″ were not recommended. Tile larger than 24″ was not usually economical for farms. Main lines were usually larger than lateral or branch lines (Stewart 1908: 102-103; Roe 1924: 1; Roe and Neal 1938: 5-10; Russell and Lewis 1956: 573).

When the drain tiles exited into an open ditch, the end of the tile had to be supported and protected from breakage, frost, blockage, and washout. One early method was to build a wooden box around the tile end. Tile ends were often reinforced with iron culverts, iron rings, or cement tile. When needed, more elaborate headwalls were made of brick, stone, or concrete. The end of the tile was usually screened with poultry netting, iron grates, or removable metal or wood screens (Stewart 1908; Roe 1924; Roe and Neal 1938; Robertson and Stewart 1908; Russell and Lewis 1956).

Pumped Outlets. In some locations, such as swamps, or river and lake bottoms, topography did not allow for a gravity drainage outlet. In these areas, mechanical pumps were used if the farm had electricity. A "lift station" pumped the drainage water from a sump (which stored water from the tile line) into the receiving ditch or waterway. The electric pump was generally housed in a pump house or protective shelter (Sutton 1957: 412-413; Wilson 2000: 14-16; Sands n.d.).

Mole Drains. In stiff, heavy soils free from stones, mole drains were sometimes installed. Cheaper than tile drains, they were constructed using a special steel-bladed mole plow, which cut a 2" or 3" tunnel, or mole, about 2' below the surface, for water to drain into. Mole drains had to be much closer together than tile drains – usually about 10' or 12' apart – and were typically not more than 200 yards long. In stiff soils, mole drains could last a decade or more (Russell and Lewis 1956: 573).

Vertical Surface Drains. Vertical surface drains, sometimes made of a vertical length of tile, improved drainage in glacial pockets and other low, wet areas. These structures were placed in the lowest point of a depression and dropped surface water down into a tile drain or into a layer of gravel that had a natural outlet. The opening was capped with an iron grate that remained visible at the surface.

Another type of surface inlet sent water down funnel-shaped layers of sand, gravel, and tile bats to the subsurface drain. The inverted funnel shape was about 2' wide at the surface and about 6' wide where it met the buried tile line. This inlet didn't interfere with plowing in fields (Wilson 2000: 23).

Vertical Catch Basins. Vertical catch basins improved drainage around farm buildings and stockyards where the ground was usually packed down, making it hard for surface water to filter down to tile drains. Catch basins could be made with broken clay tiles, corrugated culvert pipe, sewer pipe, iron grates, and even wooden boxes (Robertson and Stewart 1908: 76-81; Roe and Neal 1938: 7-8).

PREVALENCE

Drainage structures – including open ditches, subsurface tile lines, and outlet structures – were built throughout Minnesota by both individual landowners and public entities. It is expected that many are extant, with intact pre-1920 examples being less common.

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Laying subsurface drain tile with a machine. Shallow tiles and ditches were generally dug by hand. About four miles west of Dawson, Lac qui Parle County, circa 1905. (MHS photo)

This drain tile required structural support at its outlet to the ditch. Location unknown, circa 1910. (MHS photo by Harry Darius Ayer)

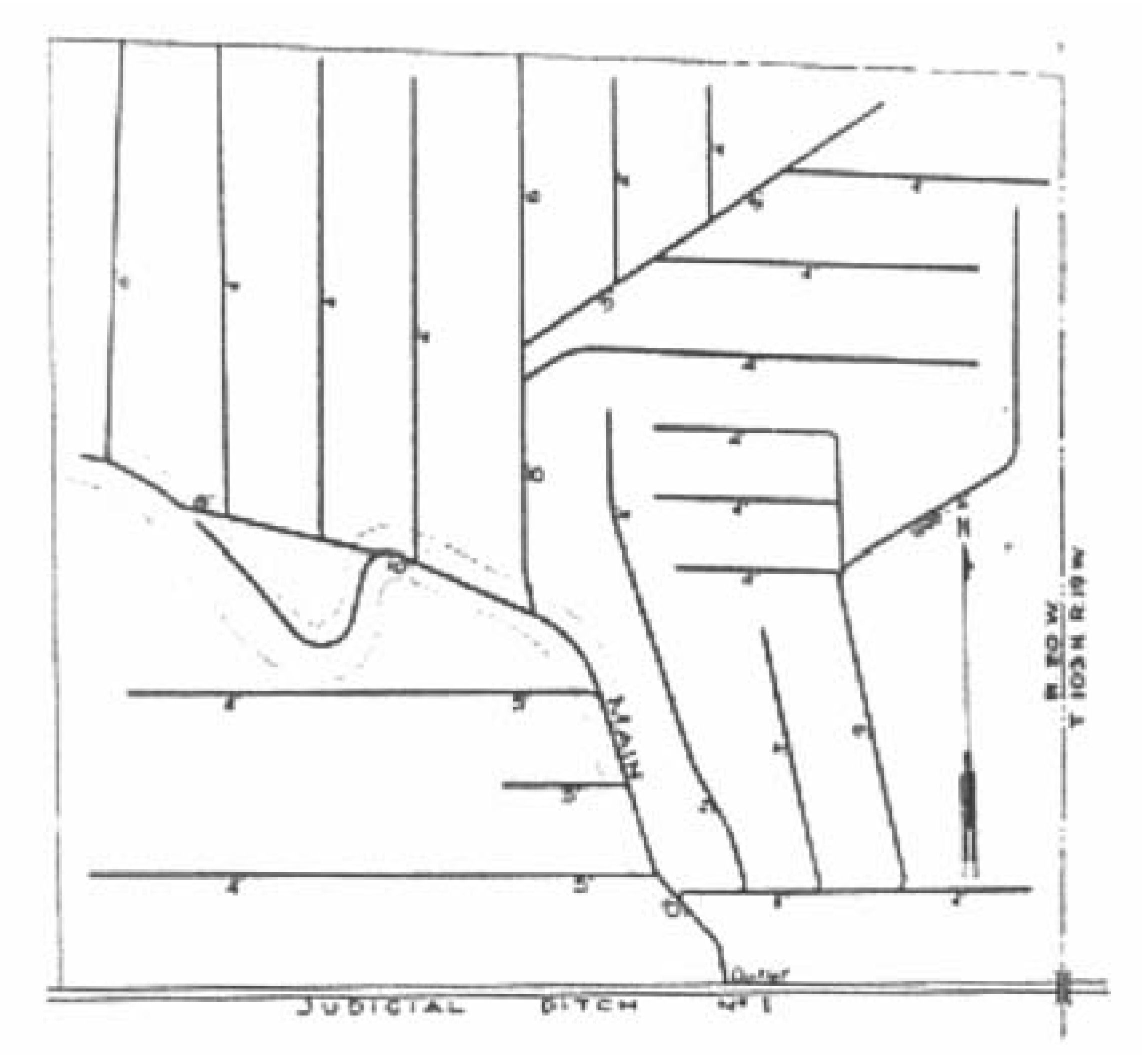

Diagram of a subsurface drainage system in Freeborn County. Tile drains were spaced closer together in heavy soils and farther apart in light soils. From a 1927 bulletin used by Bruce N. Wilson in his *History of Drainage Research at the University of Minnesota* (2000).

▪ EROSION CONTROL STRUCTURES

- Erosion control structures were often used in combination
- Elaborate stone or concrete water-control structures were built in areas with the steepest terrain
- Many structures date from New Deal conservation efforts

The roots of natural prairie grasses ran deep, holding the moisture and the soil. When farmers tilled the land, the soil was exposed to the erosive forces of water and wind.

Erosion from water was most serious in Minnesota's "driftless" area – the six southeastern counties where the terrain was steepest. In 1937 Roe and Neal cautioned that one-quarter-inch of soil could be washed away by water in a single year and, if unchecked, could result in the loss of nearly all original top soil over 40 years (Roe and Neal 1937: 2; Helms et al 1996: 378).

Early research on erosion control began nationwide soon after 1900. A leader in the field was Hugh H. Bennett of the United States Department of Agriculture (USDA). By the 1910s county agricultural agents were advising farmers to terrace vulnerable fields. The effort began in Southern states and spread next to the Midwest (Nichols and Smith 1957: 422).

While soil conservationists had been warning of the effects of erosion for years, it was not until the 1930s that a broad conservation effort began. The movement was a response to a combination of factors including recognition of widespread damage from years of poor farming practices, several years of drought and wind storms, and the availability of federal funds and federal relief labor. Bennett became director of a new federal Soil Erosion Service (SES) in 1933. In 1935 it became the Soil Conservation Service (SCS) within the USDA.

The SES and SCS collaborated with work programs like the Civilian Conservation Corps (CCC) and with state agencies and nonprofit groups to educate farmers and the public, secure funds, establish demonstration areas, and construct erosion control projects. In areas like southeastern Minnesota, professional engineers and federal relief workers built hundreds of erosion control structures on private and public land. The SCS also introduced strip-cropping and terracing to southeastern Minnesota in the 1930s (Helms et al 1996: 392).

In 1934-1935, Soil Conservation Associations were formed in Minnesota around 11 CCC camps and conservation projects. These led to a system of Soil and Water Conservation Districts (SWCDs), authorized by the Minnesota Legislature in 1937 following a federal enabling law. The state's first district, near Winona, was organized in 1938. (The most recent district, in Ramsey County, was organized in 1973. Minnesota now has 91 districts.) The SWCDs helped implement conservation efforts statewide and, at the local level, provided advocacy, technical expertise, plant materials, and equipment.

See also
Shelterbelts
Fields and Pastures
Drainage Structures
Depression & Interwar Period, 1920-1940

BASIC EROSION CONTROL METHODS

The most common methods to prevent and reduce wind and water erosion required no special structures. These practices included avoiding steep land when cultivating, planting a cover crop, planting a catch crop, deep tilling, improving soil tilth, strip cropping (i.e., alternating deeply-cultivated crops like corn with grains or grasses), and leaving field stubble or intermittent stubble rows. Running crop rows diagonally on slopes was not recommended. Methods to improve soil tilth included adding manure, crop rotation, turning under a green manure crop, and letting a field lie fallow for a year.

Research on so-called conservation tillage – a prominent modern erosion control practice – was well underway by 1957 (Nichols and Smith 1957: 425). Conservation tillage was made possible in part by the size and strength of modern machinery. Methods include “no-till,” ridge tilling, strip tilling, and mulch tilling. In recent decades, farmers have also been encouraged to retire steep land from production, just as they were in the 1930s.

WIND EROSION

Fields were vulnerable to wind erosion when the soil was left open, especially during winters when snow cover was light or intermittent. In fact wind erosion was most serious when strong winds blew across tilled fields in the fall and early spring. Wind erosion both carried away the topsoil and stripped moisture from the fields. The topography and soil texture helped determine the extent of the damage.

Wind erosion was controlled through the basic field methods described above, as well as by planting shelterbelts. (See also an individual farm elements section called “Shelterbelts.”)

WATER SHEET EROSION

Sheet erosion occurred when a thin layer of topsoil was removed by water running over an area of land. Sheet erosion could damage an entire field, and sometimes created gullies, a more serious form of erosion. Sheet erosion was encouraged by shallow tilling and failure to maintain a high organic content in the soil (Roe and Neal 1937: 5). Sheet erosion was mitigated through the field methods described above, as well as building terraces with water outlets.

WATER GULLIES

Gullies, which were often caused by unchecked sheet erosion, occurred when water cut a path into the land. Removing vegetation from slopes, cultivating steep slopes, over-grazing, and losing the organic content of the soil all promoted gullying (Roe and Neal 1937: 5). Arresting the gullying before it became deep was important. Shallow gullying could be alleviated by building diversion ditches to redirect the water; sodding waterways to hold down the soil; building low barriers of sod, wire, and straw to slow the water; and repairing gullied land.

Deeper or more acute gullies called for more drastic measures. According to Roe and Neal, the first step was to stop the head erosion, or advancement of the gully. They wrote in 1937, “It is usually necessary to construct [at the top of the gully] a plank or galvanized iron flume, a corrugated iron culvert, or a concrete or masonry dam provided with a vertical drop and some sort of apron with side or wing walls" (Roe and Neal 1937: 9). Once this had been accomplished, check dams and soil-saving dams were often constructed.

When the tractor-loader became a standard piece of farm equipment after World War II, many farmers were able to fill troublesome gullies and other small areas of erosion-prone terrain.

EXAMPLES OF EROSION CONTROL STRUCTURES

While the basic cropping and tillage methods described above could be implemented by all farmers, it was advised that farmers seek engineering expertise to design and build most of the structures listed below. Once built, all erosion control structures had to be inspected annually and maintained.

Barriers of Sod, Wire, or Straw. Low barriers of sod, wire, straw, and other materials were built within shallow gullies and in other areas to slow the flow of water. Trees such as willows could also be planted within gullies if soil moisture was sufficient (Roe and Neal 1937: 9).

Check Dams. Check dams were simple dam structures used to slow the flow of water in and near gullies. They were often made of loose rock, woven wire such as poultry netting, posts, creosote-treated timbers, brush, or – if warranted by the volume or speed of the water – mortared stone or concrete. Dams of concrete had a different design than those of stone because the concrete weighed less and was susceptible to slipping if not properly designed. Several check dams were often built along the length of a gully (Roe and Neal 1937: 10).

Culverts. Culverts were used to contain and direct the flow of water. They also carried water under roads, railroad trackbeds, and other structures. They were often built with corrugated iron pipes and stone rubble or concrete headwalls. Culverts generally had wing walls to help direct the water into the culvert if the flow was significant. Poured concrete box culverts were also common.

Diversion Ditches. Diversion ditches directed the flow of water and were constructed, for example, at the head of a gully to prevent gully erosion. Farmers could often drive over shallow ditches. Some ditches were lined with stone riprap in uncultivated areas. Fast-moving water generally required a flume, rather than a diversion ditch.

Drop Structures. Drop structures, like check dams, were used to stabilize steep waterways where damage from rushing water might be severe if left unchecked. Drop structures were often designed to create a straight vertical drop of 6′ to 8′ that would dissipate the energy of the flowing water. Drop structures were often built of poured concrete or mortared stone. Stone dams built near the heads of gullies with circular arc spillways were drop structures "used effectively by the ECW [a Civilian Conservation Corps precursor] engineering staff in southeastern Minnesota" (Roe and Neal 1935: 21).

Flumes. Flumes or chutes were channels designed to carry swiftly flowing water to help prevent gully erosion. They were usually built of timber, galvanized iron, concrete, or mortared stone. Some were very long and elaborate in design and were built in combination with other erosion control structures like culverts and drop structures.

Grass Waterways. Grass or sod waterways or swales, like diversion ditches, helped combat shallow gully erosion by directing the flow of water. Some grass waterways were created by filling gullies to the point that machinery could be driven over them. The waterways were generally lined with a buffer strip of untilled land or similar device to prevent soil from washing into the waterway and clogging it.

Riprap. Riprap consisted of stones or broken rocks placed along gullies, ditches, stream banks, and other waterways to stabilize the soil and prevent it from washing away. Riprap was also used on the slopes of earthen dams and other erosion control structures. Historically, stones of uniform size were hand-placed. Later, riprapping consisted of stones dumped with a tractor-loader and then evened out. This method required more rock, but less labor. Riprap was most often found where natural deposits of rock were readily available and therefore inexpensive.

Soil-saving Dams. Soil-saving dams, also known as sediment storage dams, were structures made of earth, stone, concrete, or other materials. They slowed the flow of water and allowed soil sediment to settle out rather than being washed away. A soil-saving dam might be built at the mouth or foot of a gully to keep the soil within it.

Terraces. Terraces or bench terraces were bench-like flattened areas that slowed the flow of water down the slope so the displaced soil could be redeposited. Terraces were generally used to combat sheet erosion. Roe and Neal wrote in 1935 that terraces were the most effective method of controlling water erosion in cultivated fields and that, if combined with contour plowing and strip cropping, the soil loss could be negligible and yields improved (Roe and Neal 1935: 3-4).

Terraces could be built with common field equipment. It was advised that they be built from the top of the hill down so that, if it should rain before the field was completely terraced, the finished terraces would offer some protection for the soil farther down the slope.

There were several types of terraces, and terraces for cropland and non-cultivated land could differ. The Mangum terrace, built with broad ridges of earth, was considered most effective for Minnesota in 1935.

Experts advised that cropland terraces should have grades no steeper than 1:250. The terrace interval was determined by the grade of the slope (with closer intervals on steeper grades) and by the speed at which local soils could absorb the water. Most terraces had water outlets that could be shallow sodded ditches, or steeper structures with check dams.

After World War II, terraces became broader as the size of farm equipment increased. One of the disadvantages of terraces – the fact that they could leave awkwardly-shaped areas or row patterns that were difficult to work – became even more troublesome as machines got larger. Engineers developed new configurations such as parallel terraces and push-up terraces to help mitigate this difficulty (Larson and Machmeier 1962; Larson and Swan 1965).

A 1965 University of Minnesota publication indicated that there were about 50,000 acres of crop land in Minnesota protected with terraces at that time. About 1.3 million acres were being protected with contour plowing and strip cropping (Larson and Swan 1965: 15).

PREVALENCE

Basic methods to control water and wind erosion were implemented throughout Minnesota by the 1930s. Engineered structures such as terraces and check dams were most often used on steep land, while less dramatic practices were used where erosion was not as severe. Many early 20th century field terraces have been altered to accommodate larger equipment and/or have been damaged by years of farming and erosion. Erosion control structures built of lightweight materials such as brush and wire are less likely to have survived than those of mortared stone and poured concrete. Extant examples of elaborate or well-developed systems of erosion control structures will likely be rare. Structures built by New Deal conservation efforts should also be evaluated under statewide federal relief historic contexts.

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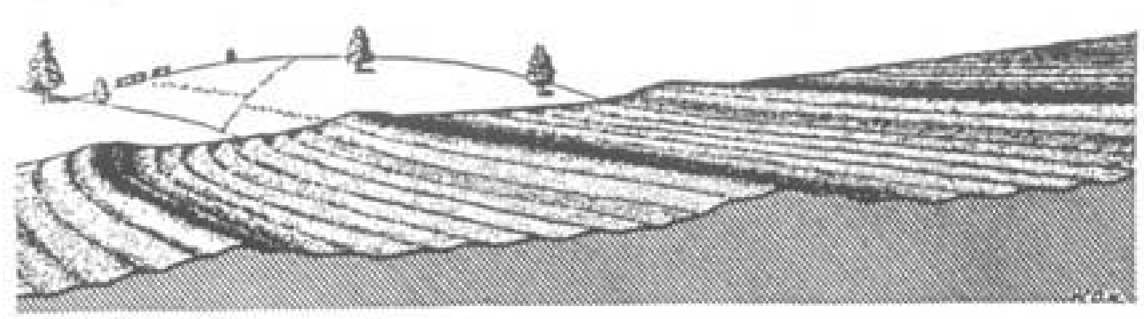
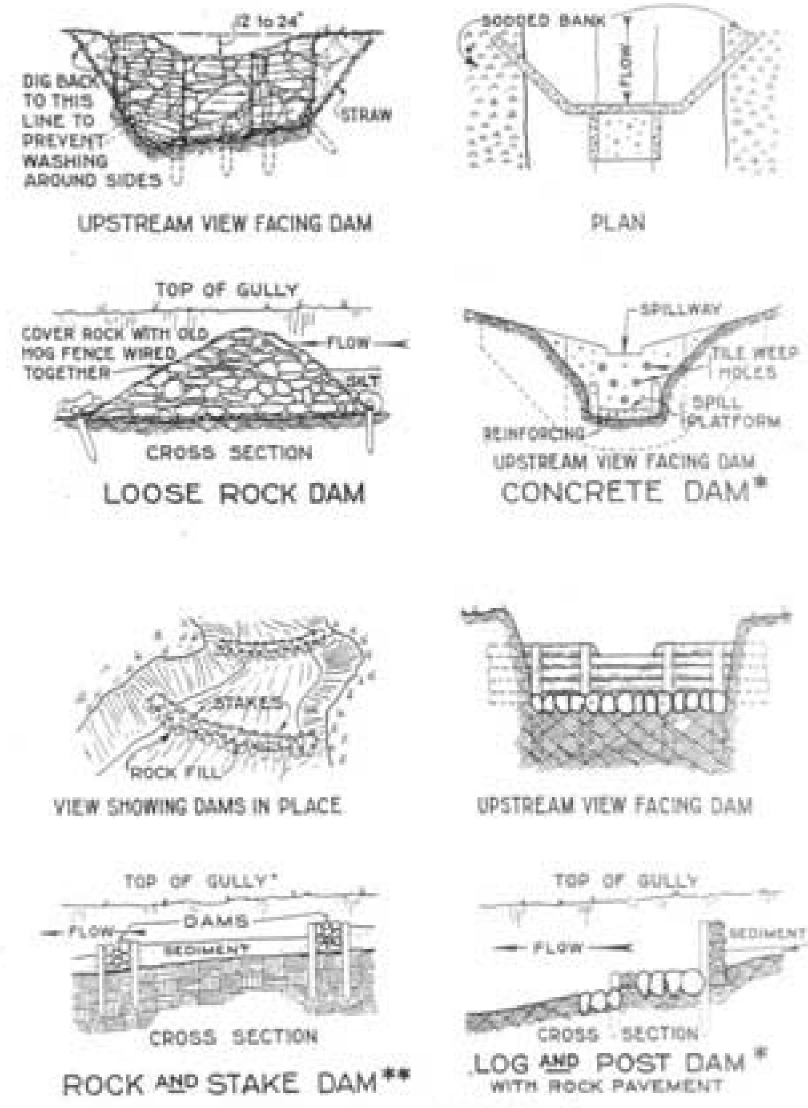


Mangum terraces, recommended for Minnesota, were made by excavating ridges of soil at intervals down the slope. This 1935 publication recommended that terraces have slopes of 1:250 or less. From Roe and Neal's "Soil Erosion Control by Engineering Methods" (1935).



A Minnesota Extension Service bulletin from 1937 illustrated effective check dams suitable for Minnesota farms. Check dams were placed along gullies to slow the flow of water. They were usually built of loose rock, woven wire, posts, creosote-treated timbers, brush, mortared stone, or concrete (Roe and Neal 1937).