Materials Handling for Dairy Farms
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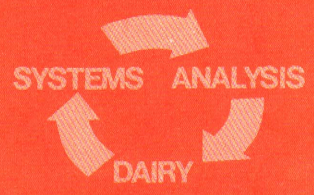
MATERIALS HANDLING for Dairy Farms



By Robert L. Maddex
Extension Agricultural Engineer

FARM OPERATORS have many options in the selection of machinery and equipment to handle materials. Too often a component is purchased before the entire system for handling a material or materials is worked out. The component may or may not work into the system that evolves. Better and more efficient systems result when material handling systems are worked out in detail using some of the tools and techniques that provide for orderly planning and decision making. This is particularly true for dairy farm operators who handle more different material than any other type of livestock operation and often several groups of dairy cattle.

Five key factors that influence material handling systems are: volume, materials handled, animal requirements, legal or site restraints and purpose.

Preferences of the farm operator in terms of the total livestock facility are also important. There is no one best system or group of components. However there are some system planning guidelines and techniques that result in more efficient facilities.

Materials Handling

Materials handling is the organized movement of a material from source to utilization. For hay or corn handling starts in the field and goes to the animal. For water handling starts at the well and goes to the animal.

A material handling system includes the machinery, equipment, structures, labor and management required to move a material from source to utilizations.

For hay or corn silage, the materials handling system includes the machinery, equipment, structures, labor and management practices needed to move the material from harvest to feeding.

System Functions

The functions of a system are carried out by components and provide for the "organized movement" and orderly flow of the material from the source to utilization. The functions for feed materials are:

—harvesting,
—transporting,
—storing,
—processing,
—transporting to feeding, and
—distributing for feeding.

Other functions that will vary with materials and methods used by the operator include:

—handling into storage,
—handling out of storage,
—grinding,
—measuring weight or volume, and
—mixing.

Many handling systems will not require all functions. The order of functions may change for different materials.

Purpose

Clearly identifying the purpose of purposes of a materials handling system or a component is essential to zeroing in on the target to be achieved. The purpose or purposes will vary for individual dairy operatons, some of the more likely are:

—To increase milking herd.
—To reduce labor requirements.
—To mechanize all feed handling.
—To separate cows in milk from other animals.
—To reduce or eliminate hired labor.
—To eliminate drudgery.
—To group animals for feeding.

To achieve any one of these purposes or others is very likely to involve more than just the purchase of machinery, equipment or structures. Changes in feed rations, handling of cattle, cropping programs may be required. For most dairy farmers this means some trade-offs, such as:

—labor vs. investment,
—form of feed vs. mechanization,
—rations vs. type of facility,
—more cows vs. insufficient income,
—animal groups vs. feeding methods,
—labor peaks vs. cropping programs, and
—operators preference vs. labor requirements.

Trade-offs require decisions. Intelligent decisions require planning. Planning requires effort.

Evaluating a Plan

Evaluation should accompany planning. It is well to apply a few yardsticks to evaluate any materials handling system planned. The best way to do this is a list of checkpoints for a particular installation. Some important checkpoints are:

1. *Will the system get the job done?*
2. *Will the system provide the quantity and quality of feed desired?*
3. *Will the system provide a return on the investment?*
4. *Can the system be expanded?*

System Planning

Steps in Planning

A good approach to planning a materials handling system is by steps. The order of these steps as shown in Chart No. 1 helps identify the decisions that dairy farmers need to make as they plan material handling systems. The steps are related, and each has an impact upon the other. It is likely that some changes and trade-offs will be made before the plan is completed. Sincere effort put into securing and using good information in each step of the planning will help reduce unforeseen problems later on. Look for the limitations of each step in planning as well as the good points.

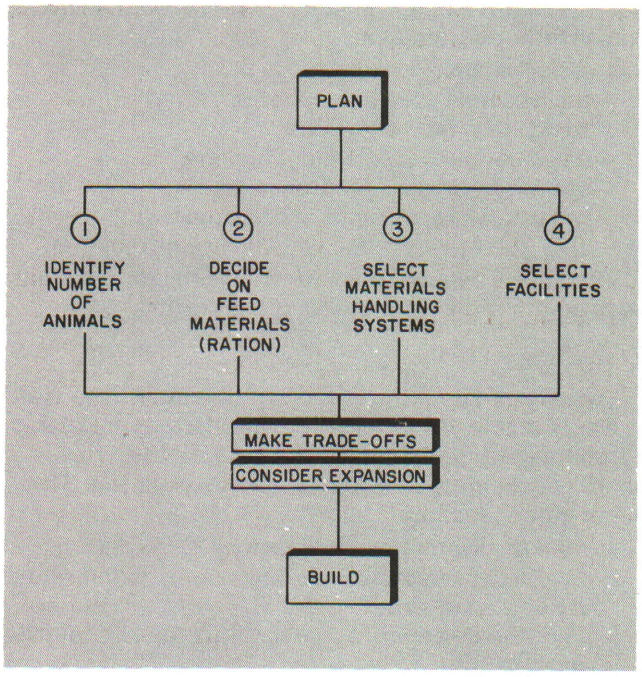
A plan must have a base. The total number of animals plus a breakdown by groups is the starting point as Step 1.

Feeds (Step 2) on dairy farms often come up in short supply. Once the number of animals are identified, a good approximation of the total feed requirements can be made. Sizing of storages and the selection of equipment for handling feed are more realistic when accurate projections of feeds needed are made. The type of feed should also be considered. Most dairy nutritionists recommend some dry hay in the rations. Where and how it is fed becomes a problem. Thus, some trade-offs in handling systems and facilities may be required.

The selection of a materials handling system should be made on the basis of the type and quantity of materials to be handled, not on the basis of what will fit into existing structures. Thus the material handling system should be planned before structures are chosen (Step 3).

The final step (Step 4) in planning the materials handling system is fitting the handling system and structures together. Once structures are erected, the dairy operator is committed to certain practices in handling both materials and animals. It is highly important to recognize potential conflicts that can arise between handling of animals, handling of materials and the layout of structures. The dairy operator has more flexibility in trade-offs before construction starts.

CHART NO. 1



Planning Tools and Techniques

Orderly planning helps identify and record the benchmarks on which planning is based. Assists to orderly planning are the **Dairy System Planning Guide,** tally sheets, flow diagrams, simple sketching, reference material and worksheets. When completed, the **Dairy System Planning Guide** becomes a good chart of material and systems needs for a dairy operation. Tally sheets provide a listing of decisions made to handle materials and animals. Flow diagrams provide a visual chart of material movement and a way to size components for each function. Simple sketching helps relate system components to each other including structures and is probably the quickest way to check out flow paths for materials, animals and people. All of these tools provide excellent communications with commercial representatives, equipment suppliers, contractors, and finance people.

Step 1. Identifying Animal Numbers

The numbers of animals of different ages vary considerably in dairy herds. One basis for estimating numbers is given on the planning guide. A farther breakdown of the young stock groups might be helpful in identifying housing and feed requirements for larger herds. The percentage of animals in each group is based on a combination of DHIA and farm account records. Individual farms may prefer to use their own figures for estimating animal numbers.

Step 2. Deciding on Feed Materials

The choice of feed materials has a real impact on the material handling system and the facilities. Since most dairy nutritionists recommend some dry hay in the ration for all cows, there is almost immediate conflict between what feed materials are best for the dairy cow and which lend themselves to mechanized handling and feeding. Dry hay is difficult to handle. One solution is to feed haylage (low-moisture hay silage) to the milking cows and dry hay to the dry cows in another location.

Providing a balanced ration to dairy cows is important to milk production and herd health. While every dairyman should determine the best ration for

Dairy System Planning Guide

(EXAMPLE)

A. Milk Production—Goal per year

Per cow 14,000
Per man 650,000

B. Dairy Animals

1. Cows milking 100
2. Dry cows (20% of 1) 20
3. Youngstock
   - 10 to 24 months—(60% of 1) 60
   - 6 weeks to 10 months—(30% of 1) 30
4. Calves—under 6 weeks (15% of 1) 15

TOTAL 225

C. Feed Requirements

	Number	Dry hay equiv.	Feeds selected: Hay	Haylage	CS	Grain
Milking cows	100	650 T		175 T	1,350 T	9,000 Bu (250 T)
Dry cows	20	130 T	40 T		270 T	
Youngstock—10-24 months.	60	240 T	120 T		360 T	
Youngstock—6 weeks to 10 months. . . .	30	45 T	45 T			1,565 Bu. (43.8 T)
Totals (feed selected)		1,065 T	205 T	175 T	1,980 T	10,565 Bu.

T = Ton

D. Crop Land Needed

Hay	*Haylage*	*CS*	*Grain*
68 A	29 A	132 A	132 A

E. Feeding Space (feet)

Animals	Number	Hay *(1 ft/head)*	Silage *(2 ft/head)*
Milking cows	100	80	100 (feed both sides of bunk)
Dry cows and Youngstock . . . . . 10-24 months	80	80	80 (feed both sides of bunk)
Youngstock . . . . . 6 weeks to 10 months	30	30	30 (1ft/head)

F. Waterers—1 drinking unit per 50 animals

Milking cows (100 head)—1 double waterer or 2 single units.

Dry cows and youngstock, 10-24 months, (80 head)—1 double unit or 2 single units.

Youngstock, 6 weeks to 10 months, 30 head—1 single unit.

Feed Requirement Worksheet

(EXAMPLE)

A. Feed Requirements (for estimating handling system components)

1. Hay or hay equivalent per animal (2.7 to 3.0 lbs./cwt.)

Animal	T/yr.	lb./day
Mature cow	6½	35
Youngstock		
10 to 24 months	4	20
6 weeks to 10 months	½	8

2. Grain

Per milking cow—2½ T/year
Youngstock—6 weeks to 10 months—450 lb./bu.

3. Hay equivalent

1 unit hay = 1.75 units hay silage = 3 units of corn silage

B. Possible rations to provide hay equivalent

	Annually	Daily
Per cow		
(1)	2 T hay + 8 T haylage	11 lb. hay + 44 lbs. haylage
(2)	2 T hay + 13½ T corn silage	11 lb. hay + 75 lbs. corn silage
(3)	3.5 T haylage + 13½ T corn silage	20 lb. haylage + 75 lbs. corn silage
Per young stock 10 to 24 months		
(4)	1 T hay + 5.25 T corn silage	6 lbs.hay + 28 lbs. haylage
(5)	1 T hay + 9 T corn silage	6 lbs.hay + 49 lbs. corn silage
(6)	2 T hay + 6 T corn silage	12 lbs. hay + 33 lbs. corn silage

C. Grain—fed according to production. If high-moisture grain is used, grain volume would have to be increased to allow for additional moisture by these factors:

—20% moisture—1.06
—25% moisture—1.125
—30% moisture—1.20

D. Rations selected (from B above)

Milking cows . . . . . #3
Dry cows . . . . . #2
Youngstock, 10-24 months . . . . . #6

his herd based on feed supply, feed quality, animals size and milk production levels, a feed estimate of 6½ T of hay or hay equivalent and 2½ T of grain per mature cow provides a reasonable basis for system planning. The worksheet on feed requirements can be used to detrmine feed requirements. These requirements can be transferred to the planning guide.

Step 3. Selecting Material Handling Systems

There are several tools that will help in the identification and selection of materials handling systems. The more completely these tools are used, the better the end results and the decisions made in developing the dairy facilities.

The "tally sheet" provides a listing of the decisions made in regard to the methods of handling materials and the components to be used on the farmstead. The "example" tally sheet is based on the information developed in Steps 1 and 2. Shown in parenthesis are the decisions some dairymen have made in expanding dairy facilities. Systems for handling both animals and materials are identified for all animal groups. Further examination of each decision can identify the inputs needed to complete the animal and materials handling system.

The "flow diagram" is a tool that can detail both field and farmstead components needed to move a material from the source to utilization. See Figure 1.

Materials Handling Tally Sheet

(EXAMPLE)

Materials Handling System
(Tower Silo—Mechanical Feeders)

Material	Amount	Components
Milking cows	*100 head*	*(New unit—2 groups)*
Haylage	175 T	20 x 40 silo and unloader
Corn silage	1,350 T	Two 24 x 64 silos and 2 unloaders
High-moisture ground, shelled, corn—(30% moisture)		
10,565 bu x 1.2 (conversion factor) = 12,678 bu		20 x 65 silo and unloader
		100 feet of mechanical feeder
		100 feet of feed bunk
		Connecting conveyors
		Mixer and scales
Dry cows and youngstock 10 to 24 months (existing barn, silo and feeder)		
Hay	160 T	30 x 60 x 15 storage hay feeders
Corn silage	630 T	Two 20 x 20 silos, mechanical feeder
Youngstock, 6 weeks to 10 months (remodel existing pole barn)		
Hay	45 T	Fed in pens

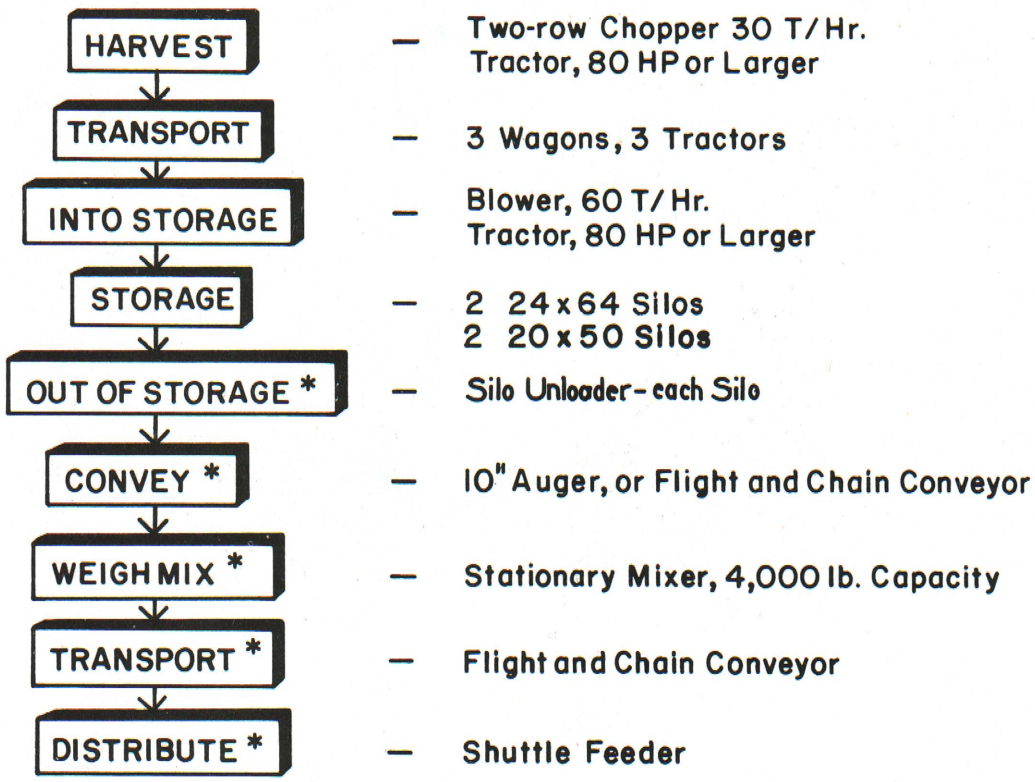
Volume as previously indicated becomes a key factor in charting the flow of materials. In the example, 1,980 tons of corn silage are required. If a three-week period, 21 days, is an acceptable period for harvesting silage, then within this period the number of working days and hours need to be established. In most years the selection of 14 working days of 6 hours per day could be expected. This gives a total of 84 hours. An average harvesting rate of approximately 24 tons per hour would be required to harvest the 1,980 tons in 84 hours. The chopper capacity would have to be more than 24 tons an hour since some down time should be anticipated even on the best days. The example flow diagram for corn silage shows the approximate flow rates. Equipment could be selected from manufacturer's information. Figure 2 shows the farmstead flow diagram and components for a complete ration using the feed materials calculated. Flow rates would depend on the equipment selected.

A third tool is simple sketching as shown in Figure 3. All components are indicated. Actual conveyor length could be determined after the plan for the housing units has been selected. Figure 3 is a sketch of the components for a complete ration shown in the flow diagram of Figure 2 for the milking herd.

Step 4. Selecting Facilities

The purpose of a structure is to (1) provide adequate environment for the animals, (2) organize the work of handling materials and animals, and (3) give a return on the investment. Since a 3-sided building will provide adequate protection for all but some very young animals, the main purpose of the structure becomes one of providing for the handling of materials and animals.

FLOW DIAGRAM
(1,980 Tons of Corn Silage)



*HORSEPOWER REQUIREMENTS CAN BE ADDED FROM MANUFACTURER'S LITERATURE.

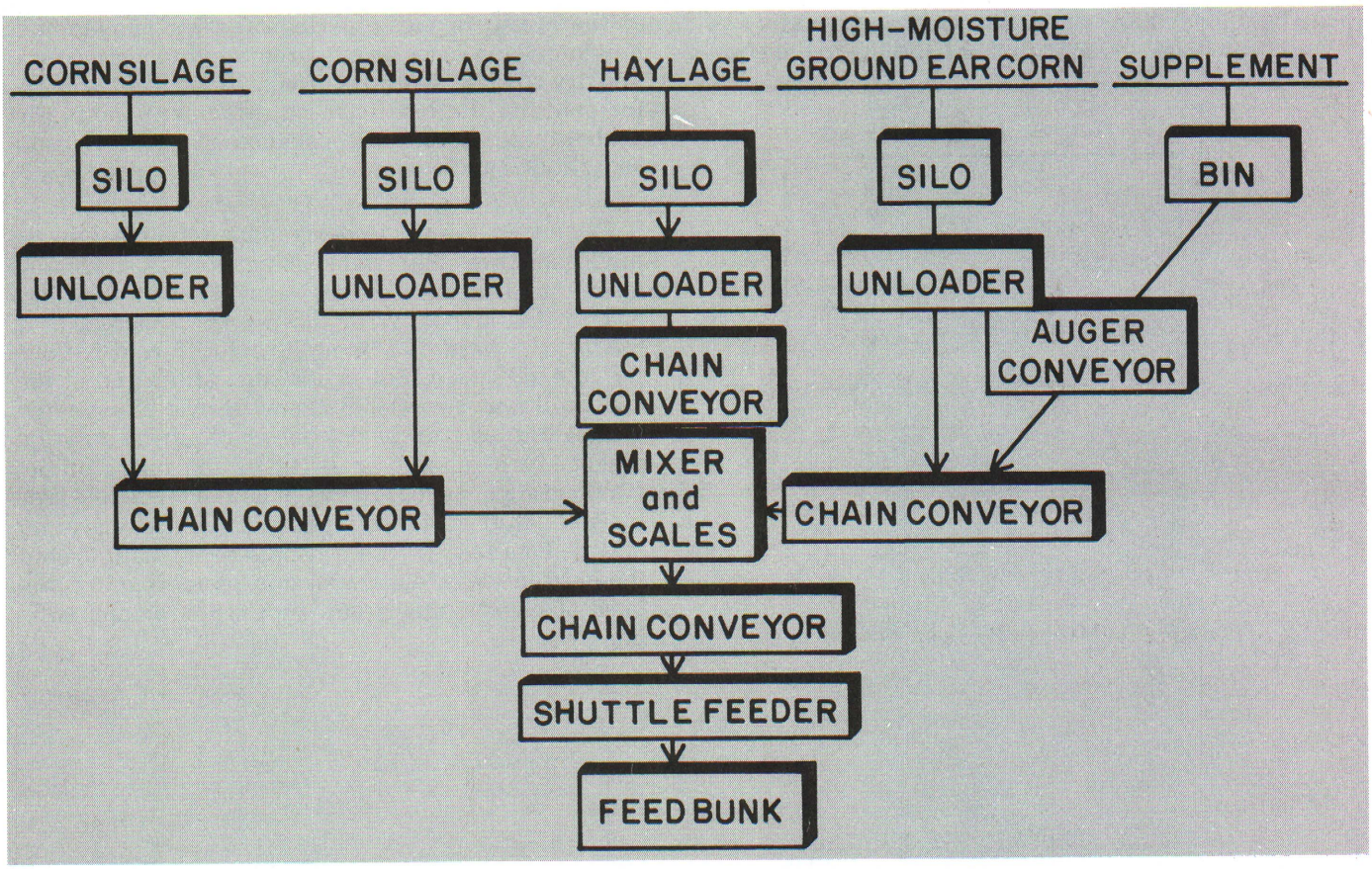
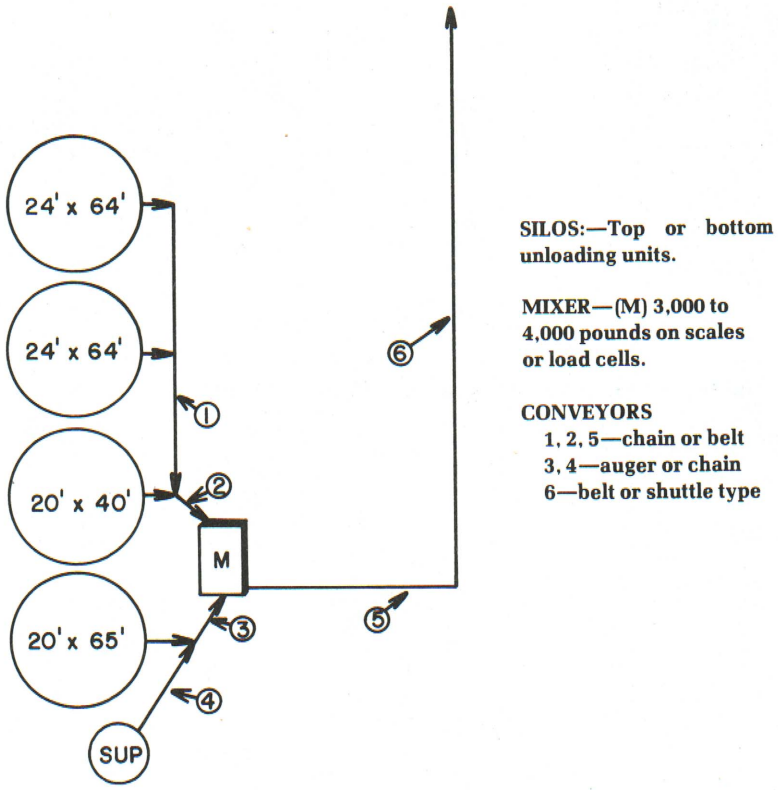


Figure 2—Farmstead Flow Diagram—Complete Feed.



SILOS:—Top or bottom unloading units.

MIXER—(M) 3,000 to 4,000 pounds on scales or load cells.

CONVEYORS
1, 2, 5—chain or belt
3, 4—auger or chain
6—belt or shuttle type

Figure 3—Simple sketch showing silos, mixer and conveyors.

The following layouts illustrate the relation of materials handling, and animal handling to the housing unit.

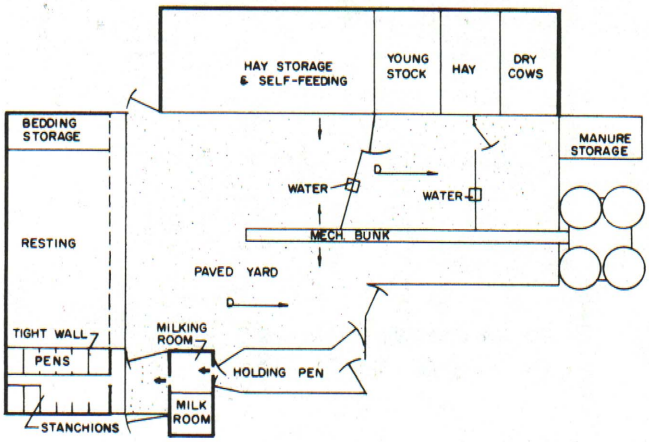
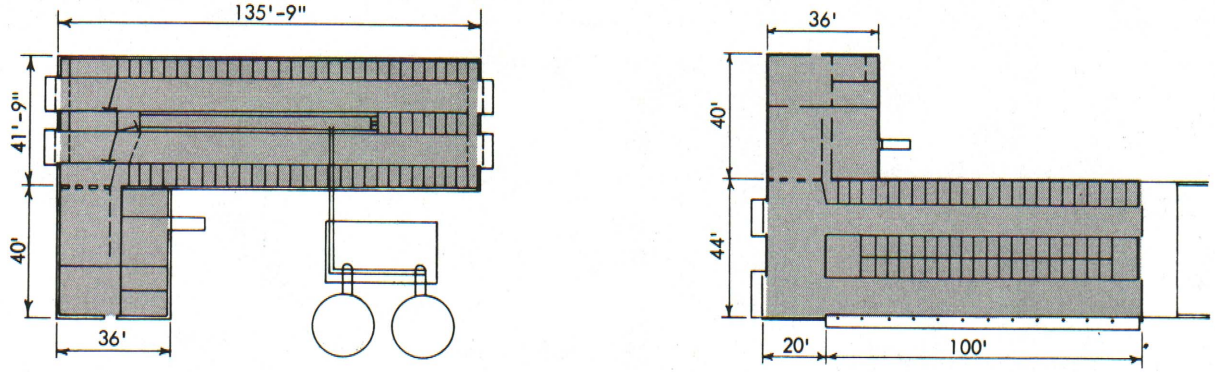


Figure 4—Cold free stall—open lot feeding.

The layout in Fig. 4 permits feeding silages and hay to milking cows as one group and to youngstock and dry cows as separate groups. It does not provide for splitting the milking herd. Manure handling is probably more difficult because of the rain and snow added in the open lot.

Layout A (Fig. 5) is designed for the feeding of high moisture materials using tower silos and mechanical feeders. There is no place to feed dry hay in this layout. With the proper selection of a feeder, the herd can be split and different rations fed to each group. The cross alley at the end of the free-stall unit permits good cow traffic of separate groups into and out of the parlor requiring only the placement of chains or gates by the operator between groups. Layout B (Fig. 5) uses a fence line type bunk which permits the feeding of silages or dry hay usually by a feed wagon. It would be difficult to split the herd in two groups with this layout due to problems of maintaining group separation during milking.



A B

Figure 5—Cold covered layouts for 60-65 cow herds.

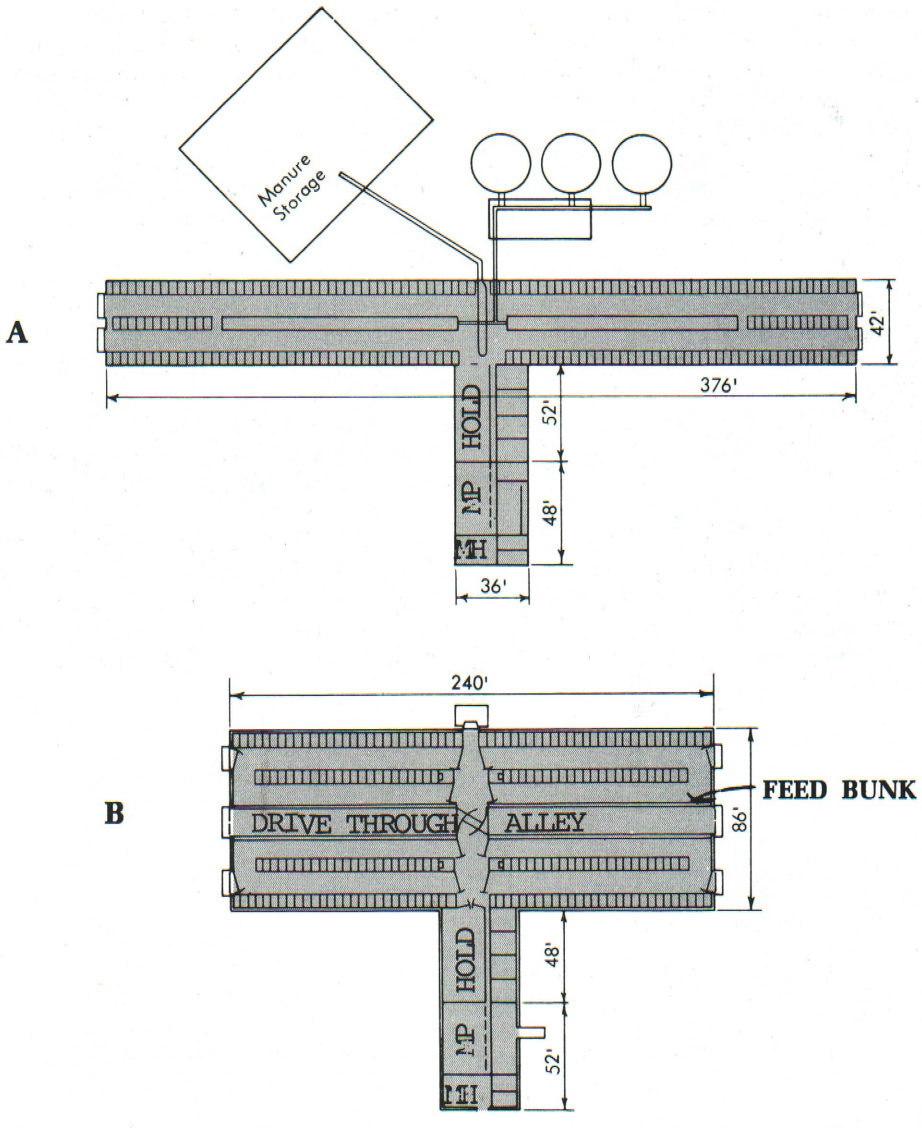


Figure 6—Cold covered layouts for 200-cow herds.

Fig. 6A is designed for feeding high moisture materials only. Fig. 6B is designed for feeding with a wagon or mixer trailer and permits the feeding of high moisture materials or dry hay. Animals can be separated into 2 or 4 groups in each barn with good cow traffic patterns.

Both layouts in Fig. 7 are designed for high-moisture feeds and split herds. The groups are separated by the feed manager and by gates or chains at the end of the alleys. The cross alley (Fig. 7A) between the free stalls and holding area permits easy handling of the two groups with minimum operator time. At milking time, Gate 1 is opened and Group 1 moved to holding area. Gate 2 separating Group 2 is left closed. As cows from Group 1 leave the milking parlor, the only place they have to go is back to the Group 1 area. When Group 1 is milked, Gate 1 is closed, confining Group 1 to their area. Gate 2 is opened, and Group 2 moved to the holding area. As Group 2 is milked, they return to Area 2. When milking is finished, both are closed, confining the cows in their separate groups. This layout also permits the use of a crowd gate to bring cows into the milking parlor.

In layout B (Fig. 7) the cow traffic requires a lot more operator time. The chain from the end of the feed bunk to the milk parlor serves as part of the holding area and must be kept in place during milking to keep the milked cows separated from the unmilked cows in either group. At milking time,

Group 1 cows are moved into the holding area, and the chain replaced across the Group 1 area. In order to have a place for the milked cows from Group 1 cows in Group 2 must be moved in the Group 1 area. When Group 1 is milked, Group 2 is moved into the holding area, and then Group 1 is moved from the Group 2 area to the Group 1 area through the small gate between the center stalls and the end of the barn opposite the milking area. Group 2 cows return from the milk parlor to Group 2 area. The use of the cross alley as shown in layout B or an alley between the stalls and feeder for the holding area always complicates the cow traffic problems. Such a holding area also eliminates the possibility of using a crowd gate. Reducing building costs by eliminating the cross alley is not a good way to save money.

Expansion of Material Handling Systems

The expansion yardstick should be applied to all material handling systems as well as to the housing facility. While it's impossible and really impractical to plan for unlimited expansion, a good guideline is to be able to double the size of the animal numbers without major loss of efficiency in handling materials or animals or major remodeling of planned facility.

The cold covered layout for 60-65 cows (Fig. 5A) could be doubled as shown in Figure 8. The major hurdle to overcome would be cow traffic if the herd was split. This could be overcome by providing a cross alley in the expansion unit plus some additional gates to create a holding area as shown. If the use of the cross alley for a holding area had been avoided in the original unit, the cow traffic problem would have been simplified. New feed storage and handling systems would be added for the expanded cow area. The layout in Fig. 5B could be expanded in some way with feed supplied by additional bunk. Additional feed storage could be added to the existing feed storage area.

Layout 6B could be expanded by extending the cow alley and adding a second unit as shown in Figure 9. Layout 6A is difficult to expand, since the silos and manure storage block the addition of a second housing as in Figure 9A.

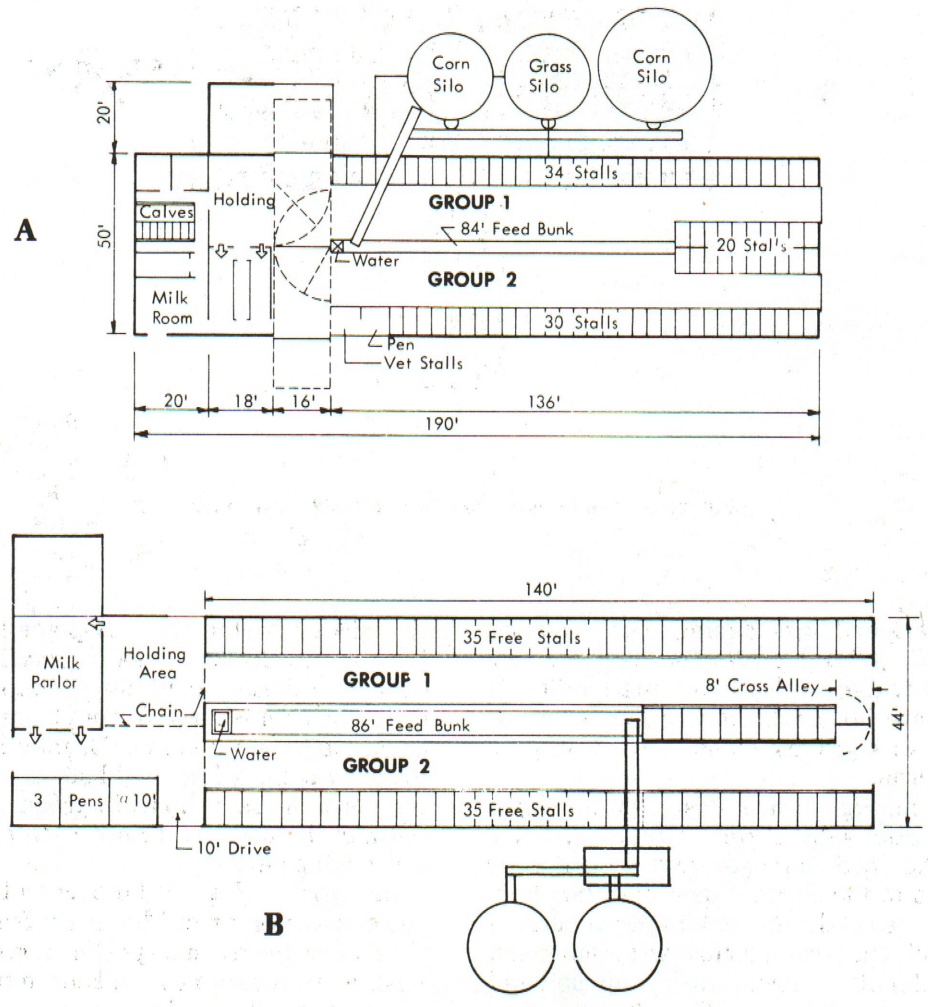


Figure 7—Cow traffic for split herds.

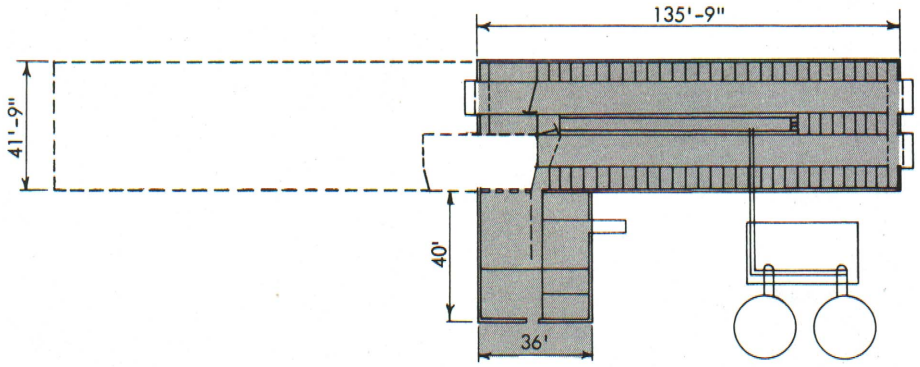


Figure 8—Expansion of cold covered layout. (See Fig. 5A.)

Manure Handling Systems

The selection of a manure handling system must be a companion decision with the selection of feed handling systems, cow traffic patterns and the housing unit layout. A manure handling system usually involves the functions shown in the flow diagram in Fig. 10.

The selection of a manure handling system needs more detailed consideration and reference information than included here. A few guidelines that are important in relation to feed and animal handling and layout are these:

Alley lengths—approximately 150 feet; longer alley results in manure accumulations that spill over scrapers or into free stalls. Also the stretching of chain for automatic scrapers increases maintenance.

Straight curbs—improve scraper performance and reduce hand labor. The double stalls at the end of the feed bunk in Fig. 6A create corners requiring hand labor. Corners prevent a good installation of an automatic scraper and make it more difficult to scrape with a blade. Good concrete work is required for good equipment performance. Provide 2 to 2.25 cu./ft./day/cow for manure and wastewater storage.

References

MWPS #7—Dairy Housing and Equipment Handbook
MWPS #18—Livestock Facilities Waste Handbook

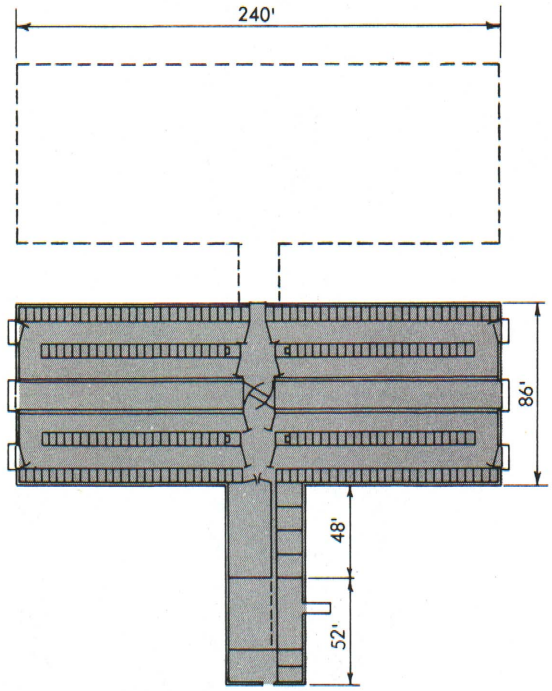


Figure 9—Expansion of cold covered layout. (See Fig. 6A.)

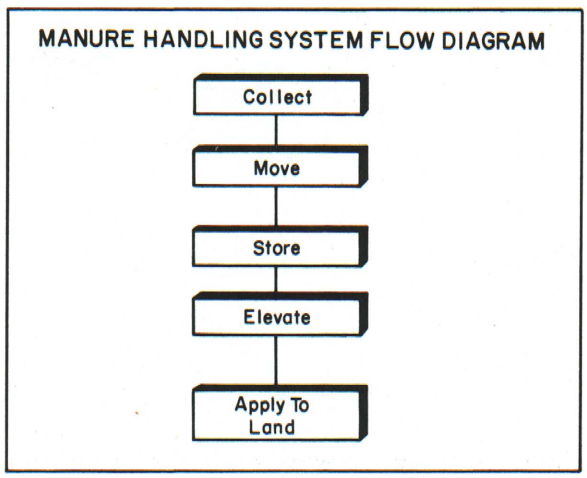


Figure 10

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