DAIRY-FARM BUILDINGS IN TROPICAL CLIMATES

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Choosing a Site for New Construction

The selection of a site for cattle yards, loafing shed, milking stable, and milk-room should be made with care. If possible, the site should be more or less centrally located in relation to accessibility to the various pastures. A high spot should be chosen that will allow good drainage from the yards and waste water disposal, and get the benefit of cooling breezes, if any. Some shade trees in or around the yards give the milking animals an opportunity to cool off before the afternoon milking, after their trek from pasture.

Orientation of the Buildings

In new construction it is cheaper to build if the milk-room, milking stable, and loafing shed are included under a single roof in a straight line. The building should run from west to east, with the milk-room at the west end, thus providing shade for the milking operation during the afternoon milking.

Orientation and Plan of the Cattle Yards

The yards should extend outwards from the end of the milking stable, and should not surround either the milk-room or the milking stable, to reduce the possible entry of dust and odours. This arrangement also makes the milk-room more accessible to the farm road for loading and hauling the milk and for stocking the feed-room with concentrates without the need for passing through the yards. There should be two yards, each sufficiently large to prevent crowding or fighting while the whole herd is in either. One yard is used for the animals to wait their turn to be milked, and the second for those already milked. If the animals can go

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directly to pasture after they are milked, this second yard need not be so large.

All lower limbs of trees and any brush in or surrounding the yards should be cleared away to give freer circulation of air.

Barbed wire should never be used for yard fences. To enclose a large number of horned animals in a comparatively small enclosure encourages milling about and fighting, and serious injuries can be caused by their being crowded against a barbed wire fence. Poles or heavy and durable sawn wood are best for yard fences. Solid walls of stone, brick, or adobe can be used, but this type will shut off the breeze to some extent and interfere with drainage.

A water trough should be provided in the yards, large enough for several animals to drink at the same time. It can be placed in the fence line between the two yards so that animals can drink from either side. A rail about one metre high should surround it to prevent animals from stepping or being pushed into the trough and fouling the water. Artificial shade should be provided above the trough to keep the water as cool as possible, and to help prevent the growth of algae.

If the feeding plan consists of soiling crops or " zero pasture ", then part of the yard fence should be " feed trough fences ". The troughs are filled with forage from the outside, and the animals eat from inside the yard. This fence-type feed trough should also have a rail about one metre high placed above the inside of the trough (height to depend upon the height of the withers of the animals) to prevent the animals from entering the bunk or being pushed over into the trough. This " trough fence " should run east and west to get full advantage of the artificial shade that it must have. Palm fronds tied down to a framework overhead will suffice for shade. It need not be waterproof. Animals eat more in tropical climates if they can eat in the shade.

More eating space per animal will be required if the animals are horned. Polled or dehorned animals need two linear feet of trough space per animal.[1]

Where mud is a problem in rainy weather, the entire yard should be paved with either concrete, brick or stone. Concrete is more expensive but of course more durable, requires less maintenance, and is easier to keep clean. Stone, if available, is cheaper but difficult to clean. A paved yard, although a considerable investment, will soon pay for itself by reducing the work of cleaning the yard and milking stable, facilitating the production of a higher quality milk; it also produces less dust in dry seasons, and reduces the fly problem.

[1] Dehorning mature animals with large horns presents a screw-worm problem in the tropics. At least three months are required for the sinus to close completely. A simpler, though slower, method would be to dehorn all infant female calves with a caustic paste or stick—or, better, a solution of antimony trichloride 28 %, salicylic acid, 7 %, and flexible collodian, 65 %. Best results are obtained by application to the horn button at between 3 and 10 days of age. In a few years all the animals would be hornless as the older animals leave the herd. Unquestionably restlessness and fighting of horned animals cost the dairyman a considerable amount in loss of production, mastitis and injuries.

The Dairy Building

The three separate units of the dairy building are included under one roof, the width of which is nine metres exclusive of the overhanging eaves. The total length depends upon herd size. Each unit will be discussed here separately.

The loafing shed

This part, although not as essential as the milking stable or milk-room, has an advantage when rains occur just before or during milking time. The loafing shed should be large enough to shelter one half of the milking herd at one time. It is impossible to produce milk of high quality when an animal comes from the rain into the milking stable dripping dirty water from her flanks into an open milking pail. In some areas of the tropics, rain showers usually occur at more or less regular times. If the milking hours can be arranged to avoid the fall of these showers just before and during milking hours, then a loafing shed would not be essential. [1] The loafing shed may have an earth floor, but should be sufficiently above the outside ground level to prevent flooding after heavy rains. All it needs is a good roof of the cheapest material available supported on concrete or brick columns or poles of durable wood. The roof is an extension of the milking-stable roof. The length of the loafing shed will depend upon herd size, and can be determined thus: if the shed is nine metres wide, each linear metre will flank nine square metres, which is sufficient for two cows while waiting to be milked. If the number of cows requiring shelter at one time is divided by two, the figure resulting will be the length of shed required.

The milking stable

This part of the installation is very important. If constructed and used properly it can contribute greatly to the ease of handling and milking the animals, and to the hygienic quality of the milk.

Fig. 1 and 2 show the old and new methods of milking. The first illustrates the custom of milking in the corral, with the calf tied to the mother's front leg, and the cow's legs tied together with a dirty rope, while the milker squats on his haunches. It would have been impossible to feed concentrates to cows loose in the corral. Fig. 2 shows milkers at work in the milking stable, using stools and holding the milking pail between their knees. They were trained to change their procedure from a slow stripping action, with hands wet with milk, to a full hand-grip with dry hands. Once the new habits were fixed, the workers preferred these methods.

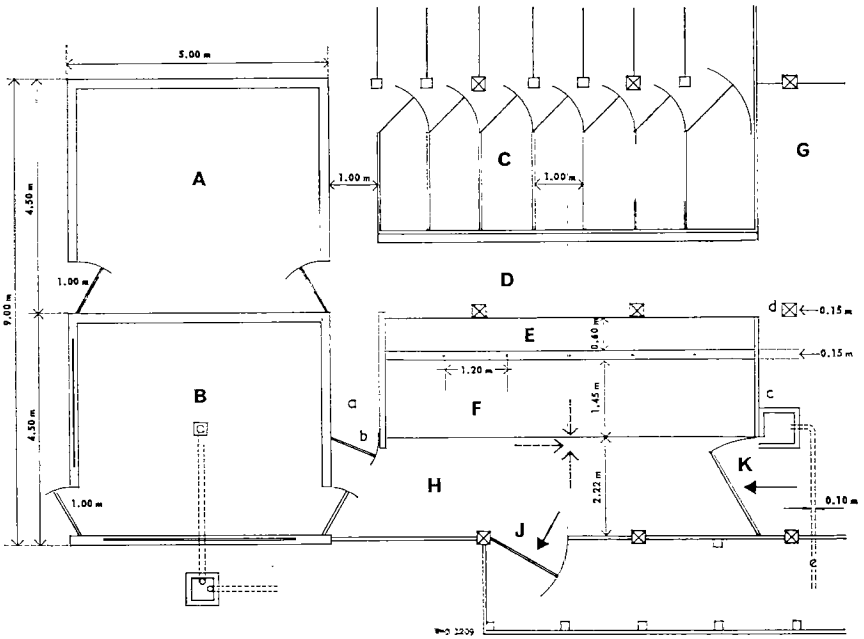
[1] In many areas of the tropics, rice hulls and cotton seed hulls are wasted. This material makes excellent bedding for the loafing shed. It gives comfort to the animals while resting and waiting their turn to be milked, and facilitates cleaning up after milking. This material also makes excellent bedding for small calves.

FIG. 1
OLD METHOD (NOT RECOMMENDED OF MILKING IN THE CORRAL

FIG. 2
NEW METHOD USING THE MILKING STABLE

There are two types of milking stable—one for milking a herd of 30-40 animals (see Fig. 3, 4), which consists of a single line of six stalls, where the animals face toward the centre of the stable. The other type of stable

FIG. 3
A SIMPLE AND EFFICIENT SMALL MILKING INSTALLATION
FOR A HERD OF UP TO 40 COWS



A = Feed-room
B = Milk-room (concrete floor, steel-trowel smooth finish)
C = Individual calf pens with gates to exercise lots
D = Elevated feeding alley (concrete, steel-trowel smooth finish)
E = Concrete manger
F = Six milking stalls, wood-float or rough finish
G = Loafing shed or corral
H = Concrete floor (wood-float or rough finish)
J = Cows leave here to pasture or to second corral
K = Cows enter here from corral or shed

a = Ramp up
b = Gate
c = Silt basin
d = columns
e = 4-in. (c. 10-cm) drain tile

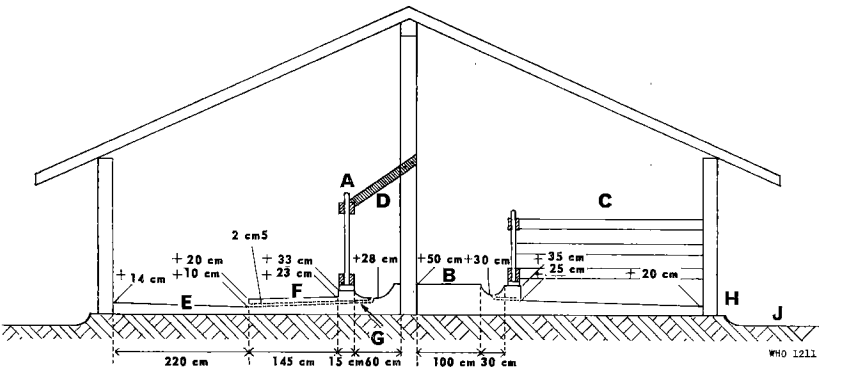
Note: The number of stalls can be increased or decreased according to herd size.

serves larger herds, with a double line of milking stalls, the animals facing outwards, and with a central alley for the milking operation (see Fig. 5, 6). In the opinion of the author, however, the " facing-in " type of stable is not to be recommended, since 98 % of the work takes place behind the cows, and this part should be as centrally located as possible. A central milking

FIG. 4

PROFILE OF FLOOR, MANGER AND FEED ALLEY IN MILKING STABLE

(Single line of cow stalls, showing profile of calf mangers with elevated feed alley)



A = Cow stanchions (wood)
B = Floor of feed alley (smooth concrete)
C = Calf stanchions (wood)
D = Brace
E = Alley for cows (rough finish)
F = Platform for cows (rough cement)
G = 1-in. (2.5-cm) pipe with ell and plug for drainage for washing mangers
H = 10 cm or more above ground level
J = Ground level

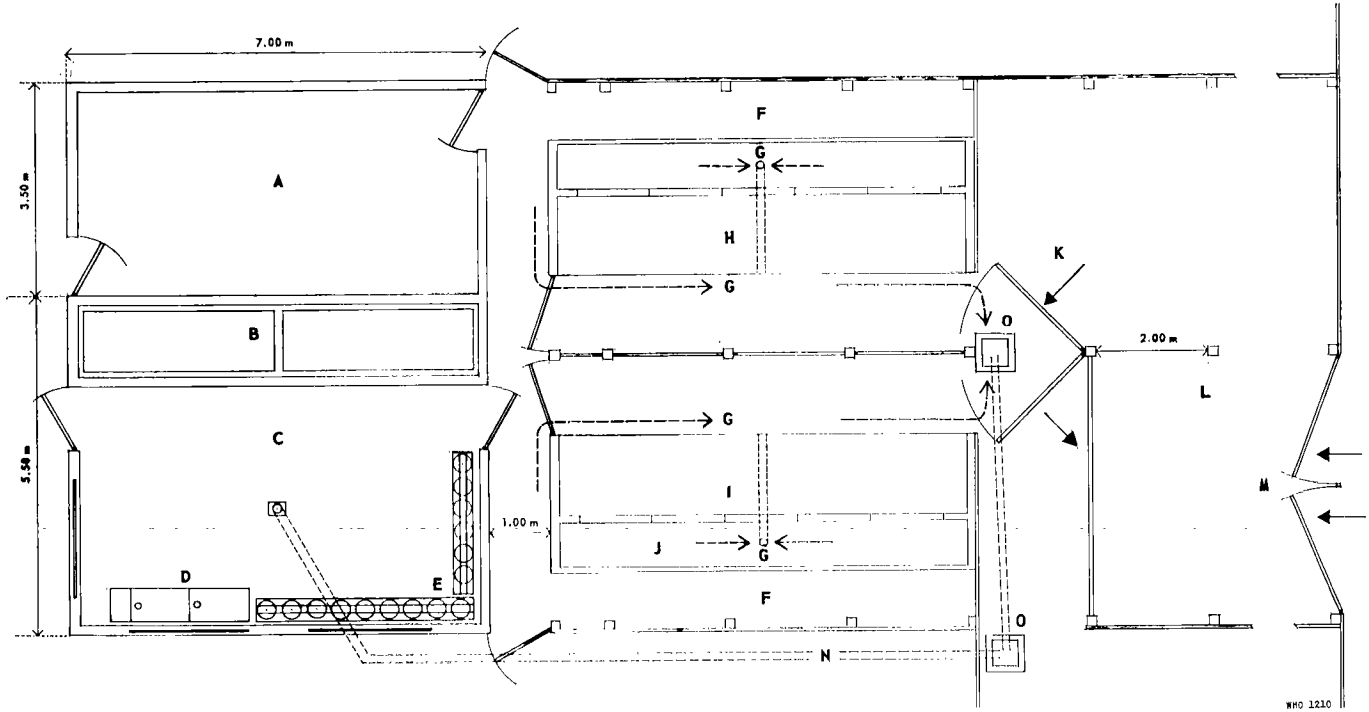
alley is closer to the milk-room and is easier to clean up after milking is done. The number of milking stalls in both stables is determined by the number of hand milkers used for milking. For an efficient hand-milking operation, two milking stalls should be provided for each hand wilker. With this arrangement, another attendant removes the cows already milked, and replaces them with unmilked animals while the milkers continue their work uninterrupted. It has been found best that the milker washes each animal's udder just before milking it; this assures that his own hands will be clean for each cow.

The single-line stable for smaller herds. As will be seen in Fig. 3, the animals enter at the end of the milking stable from the loafing shed or corral. They enter the stanchions, are milked, and leave by a side exit to a lane leading to the second corral or directly to pasture, thus avoiding confusion between unmilked and milked animals.

The single line of milking stalls in a stable 9 metres in width still leaves ample space for a row of individual calf stalls, for newly born calves which are hand-fed milk and concentrates (see Fig. 7, 8). This arrangement brings the calves close to the fresh warm-milk supply and to the feed room. The floor plan in Fig. 3 and the floor profile in Fig. 4 give details and dimensions; construction suggestions are given on page 137.

FIG. 5

MILKING STABLE FOR LARGER HERDS (DOUBLE-LINE STALLS)



A = Feed-room
B = Insulated tanks for 12 cans each (wood covers, mechanically chilled water)
C = Milk-room
D = Wash sink
E = Can and utensil racks
F = Feeding alley
G = Drainage
H = Stanchions 1.2 m centre to centre, six milking stalls each side
I = Platform (1.45 m for 900-lb. (400-kg) cow; length determined by size of cow)
J = Manger sloped towards drain
K = Concrete apron: cows enter milking stable
L = Loafing shed
M = Cows enter here from corral
N = 4-in. (10-cm) concrete tile
O = Silt basin

FIG. 6
END SECTION OF DOUBLE-LINE MILKING STABLE

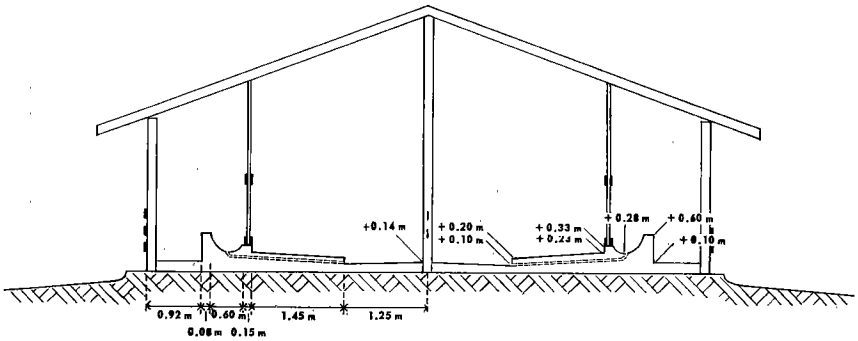
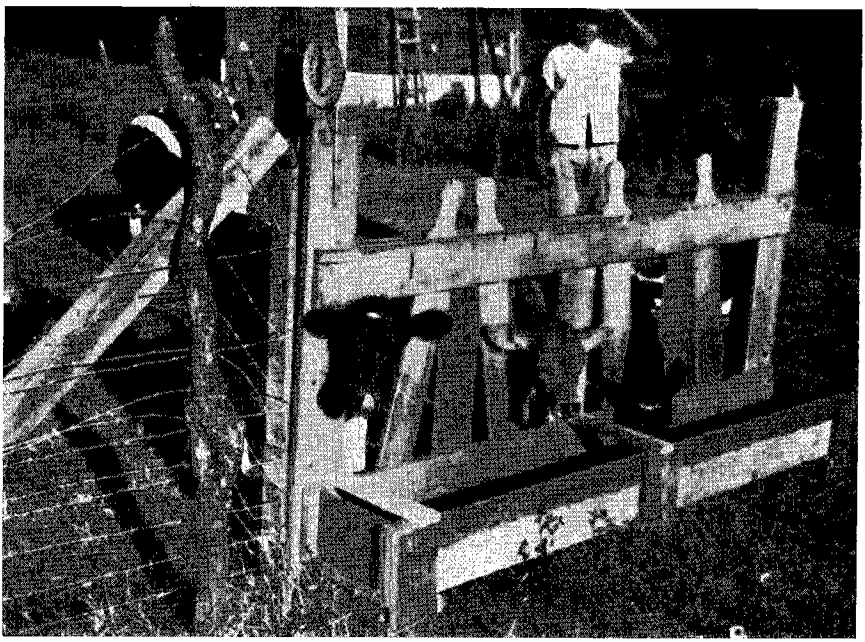


FIG. 7
INDIVIDUAL CALF STANCHIONS FOR FEEDING MILK AND MILK CONCENTRATES



The stable with a double line of milking stalls. The entire nine-metre width is taken up with the two lines of milking stalls, so provision for small calves must be made elsewhere in another building. In Fig. 5 it can be seen that there is a dividing fence in the centre of the central alley;

FIG. 8
FEEDING CALVES

FIG. 9
DIRECTION-CONTROLLING GATES TO MILKING STABLE

this is to guide the animals to the required destination—either into empty milking stalls, or to leave for pasture without molesting the milkers who are working on one side of the stable. It will also be seen that there are two long gates suspended from the same post two metres out from the milking-stable entrance, which control the direction the animals must take when entering or leaving the stable. Fig. 9 shows such an entry: the gate at the left is the entrance to the milking stable from the loafing shed; that at the right is for cows leaving the stable for pasture. Either gate can be swung over against the other, or can be hooked in the centre to the dividing fence in the stable (although the stable shown here had no such fence). Neither of the two types of stable is provided with stall divisions or partitions between the animals being milked. After the routine is established the animals learn to stand perpendicular to the line of stanchions, so that stall divisions would only be in the way of the milkers. In attempting to train animals to use the new stable, it is wise to start with a group of ten or twenty animals and then start with another group. It is necessary at first to lasso the heads or horns and drag the animals into the stanchions. A little concentrates rubbed on their wet noses will hasten a taste for this food; when the animals learn to like it, they will willingly or even eagerly enter the stanchions unassisted. All uneaten feed should be cleaned out after each milking and the mangers should be washed, to avoid attracting flies and ants. It is also wise to wet the floors of the milking stable just before bringing in the first animals, and to keep them wet through the entire milking operation. This prevents any manure dropped during the operation from sticking to a dry floor, and facilitates the cleaning operation afterwards.

It should be explained that the milking stable has no walls (see Fig. 10). If the yards should extend around the sides of the milking stable, it is necessary to attach a plank fence to the side columns so that animals in the yards cannot interfere when the animals being milked are eating their concentrates. Milking in the tropics is a hot job, so that it is best to have the stable as open as possible for free circulation of air.

The milk-room and feed-room unit

In the opinion of the writer this is the most important and essential part of the whole installation. If funds are not sufficient to construct the whole building, then it would be best to start with only the milk-room. This is absolutely necessary for the production of wholesome milk. Reasonably good milk can be produced, with extreme care, when milking is carried out in the yards provided there is a clean place to filter the milk and to clean and store the utensils. Good milk can be produced by milking in the yard, but it is more difficult, and the handling of the animals consumes much more time and work. Also it is virtually impossible to feed concentrates to loose cattle in the yard. As will be seen in Fig. 3 and Fig. 5

FIG. 10
GENERAL ASPECT OF MILKING SHED AND LOAFING SHED

the width of the milk-room is five and a half metres and that of the feed-room is three and a half metres. The length of the milk-room will depend upon the quantity of milk produced, the number of cans to be stored, and the size of the cooling tank or tanks, if used. It is suggested that in original planning and construction provision should be made for eventual milk cooling.

With larger herds, where 20 to 25 cans of milk each of 40-litre capacity are produced, the milk-room should be seven metres long. This will allow for space for two cooling tanks, with a capacity of 12 or more cans each, along the dividing wall between the milk-room and the feed-room. The feed-room is three and a half metres wide and seven metres long, and runs alongside of the milk-room. This gives sufficient space for a supply of concentrates, a place for storing shovels, brooms, and wheelbarrows, and also space for a small 4-5 kW diesel electric generator for supplying power for lighting and milk cooling if desired. Certainly in tropical climates cooling of milk on the farm is desirable. If milk payments are based upon milk quality, cooling of milk will pay. The writer has found that farm cooling of milk resulted in an increase of two hours or more in the reduction time of the milk when received at the plant.

The planning and construction of the milk-room should be undertaken with care. This is the heart of the farm dairy. The wall between the milk-room and the feed-room should be solid with no connecting passages

between the rooms. Similarly, the wall dividing the milk-room from the stable should also be solid, except for a screened door entering from the centre alley of the milking stable. At the far end of the milk-room there is another screened exit, for taking out the milk in cans. Both doors must open outwards, with self-closing springs attached. The two outside walls of the milk-room should be solid masonry up to 1.2 metres. Above that level the whole wall can be of screen, except for the necessary brick or concrete columns; this will give ample ventilation and light. This building should be constructed entirely of masonry. The inside walls of the milk-room should be plastered with concrete plaster and trowelled smooth with a steel trowel. The milk-room should have a smooth and tight ceiling to exclude insects and dust. Both walls and ceiling should be painted with a light-coloured washable paint. The lighter and brighter this room is, the cleaner it and the utensils will be maintained.

The floor of the milk-room should be of smooth concrete, slightly sloping towards a centre drain, which should be equipped with a trap to prevent odours and vermin from entering from the disposal system. The drainage system should be constructed of no less than 4-inch (10-cm) concrete or tile tubing. Waste water should be conducted underground with pipe or tile to at least 20 metres from the milk-room before it is discharged to the open. The discharge should not be near a water well, nor should it enter yards or pastures.

The details of the cooling tank or tanks can be seen in Fig. 11 and 12. This farm-constructed tank was found to be cheaper than imported insulated cabinets of steel. It is partially sunk into the floor to facilitate putting in or removing full cans of milk. It can be cooled with a 1-HP " drop-in " electric unit which usually has a built-in water-agitating device, or can be cooled with coils surrounding the inside of the tank. Faster and more efficient cooling will be accomplished if the water is ag ed while the unit is running. If servicing of the unit is necessary, it can be lifted out and a substitute unit used temporarily without any interruption in refrigeration. It is recommended that a non-absorbent kind of insulating material such as plastic foam be used. The floor of the cooling tank should slope slightly toward the drain, which should be trapped to prevent odours or vermin from entering the tank. The drain is made so that there is a sleeve or coupling of which the top end is just flush with the floor of the tank. The overflow pipe is screwed into the sleeve, and when it is necessary to change the water, the overflow pipe is unscrewed to allow the tank to drain. The length of the cooling tank is calculated at 1 foot (0.3 m) or slightly more for each can. A 10-foot (3-m) long (inside measurement) tank would hold ten to twelve 40-litre cans. This would require a 1-HP cooling unit.

The feed-room should also be constructed of masonry which need not necessarily be plastered and finished like the milk-room walls. However,

it should be constructed to exclude birds and rodents. The feed-room has a door at each end opening inwards; one entry for bringing in concentrates, the other for access to the stable for feeding concentrates.

If an electric generator is to be placed in the feed-room, sufficient ventilation should be provided. If a water-cooled diesel-electric plant is used, advantage can be taken of the hot cooling water by piping it to the milk-room for washing udders and utensils. The generator is usually started an hour or so before milking to cool down the water in the cooling tank or tanks, and is usually run for an hour or so after milking is completed to get the last milk cooled. Hot water would, therefore, be available for the whole milking operation.

Construction Details

Some general suggestions concerning construction are outlined below.

Clear span trusses are not necessary. The centre columns which support the roof are not in the way in either type of stable. The centre line of columns in the single-line stable are just in front of the manger and cause no obstruction. In the double-line stable, the centre columns hold the dividing fence. Of course eliminating the centre columns in the loafing barn would be desirable, but is not necessary.

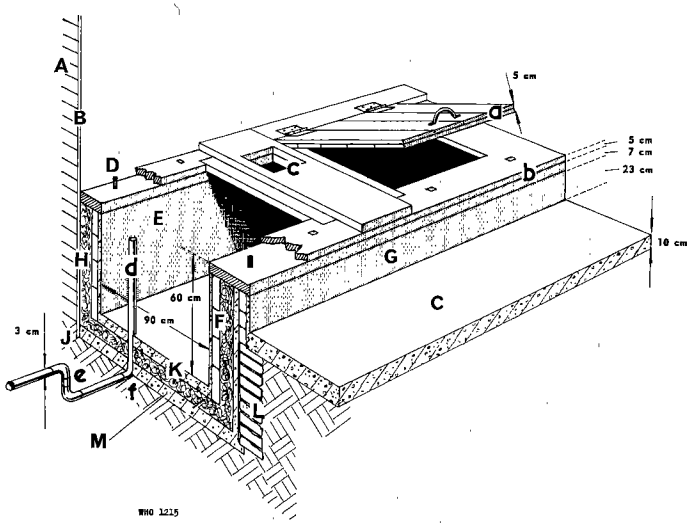
The spacing of the columns depends upon the roofing material used. Tile, which seems to be the most freely available in the tropics, is heavier and cheaper than sheet-metal roofing; but being heavier, requires heavier construction and more frequently spaced rafters and columns. Sheet-metal roofing, being lighter than tile, would require a less sturdy construction to support it. However, the writer believes that tile roofing is cooler even than aluminium roofing.

It will be noticed in Fig. 4 and 6 (see pages 130 and 132) that there is no gutter in the profile of the stables. Since animals are in the stable for so short a time, no gutter is required for accumulated manure as is the case with stables in the temperate zones, where the animals stay in the stable at night or even all the time in winter. A four-inch (10-cm) step is all that is necessary, with the stall platform and rear alley sloping toward this step. Cows do not like to back through a slippery gutter. Very little manure will be left in the milking stable after the animals get accustomed to the routine; they are not there long enough.

In both floor plans it will be seen that, at critical points, silt basins are located in the drainage systems. These are provided to catch silt and sand and to prevent them from clogging the underground tile farther out. The inlet and outlets of the basins should be higher than the bottom for accumulation of silt. They should be cleaned regularly.

Fig. 11 and 12 show details of the cooling tank. In the author's experience, construction workers in tropical countries are more accustomed

FIG. 11
DETAIL OF MILK-COOLING TANK



A = Brick wall between milk-room and feed-room
B = Concrete plaster and smooth finish over brick to base of tank
C = Milk-room floor (4-in. (10-cm) concrete, smooth)
D = 3-in. (7.5-cm) concrete with bolts (poured after insulation and bricks in place)
E = ½-in. (1.25-cm) plaster (smooth)
F = Bricks laid on edge against insulation
G = Concrete plaster (smooth)
H = 3-in. (7.5-cm) insulation
J = Concrete wall footing
K = Floor of tank: 3-in. (7.5-cm.) concrete (smooth)
L = Bricks laid flat
M = 3-in. (7.5-cm) concrete sub-floor (smooth finish)

a = Covers made of 1-in. (2.5-cm) lumber: two layers crosswise to prevent warping
b = Wood frame made of 2-in. (5-cm) lumber
c = Hole for drop-in cooling unit
d = Level of overflow to above neck of can (21 ½ in. for US 10-gallon can)
e = Trap
f = 1 ¼-in. (3-cm) galvanized pipe

to work with bricks than with concrete. By using bricks against the insulating material, and plastering smooth over the bricks for a final coat on the inside of the tank, the need for concrete forms and pouring of concrete will be eliminated. Care should be taken to keep all concrete or concrete plaster wet for at least seven days after application. Smooth-finish coats should be applied over the bricks or rough concrete as soon as possible while the mortar or concrete is still green and damp. This makes a chemical as well as a physical bond.

Considerable difficulty may also be experienced in finding construction workers on the farms who can read a plan. For the building of the stable floor, a model of its profile was cut to scale from a long 1-inch board (see

FIG. 12

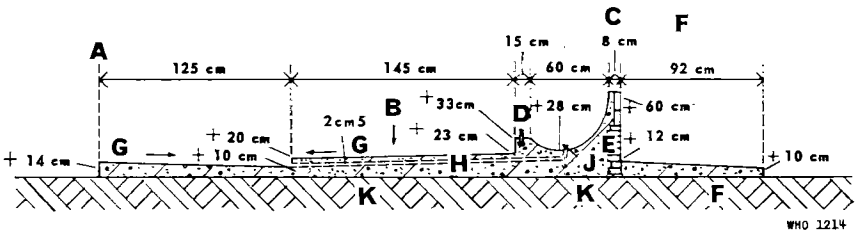
CONCRETE AND BRICK MILK-COOLING TANK AND UNIT

Covers open and cans of milk in cooling water; a 1-HP " drop-in " cooling unit in place. Cooling water is maintained at 3°-5°C. This unit has a water-agitating propellor which functions while the unit is running: the vigorous action of the circulating water can be seen directly below it.

Fig. 13). Two of these " forms " were cut on the job, and placed at opposite ends of the line of stalls. Strings were stretched between these two forms at each point where the elevation changed, so that the workers could follow the plan without difficulty; this eliminated errors and much supervision. For the double-line stable the form goes only to the mid-point

FIG. 13

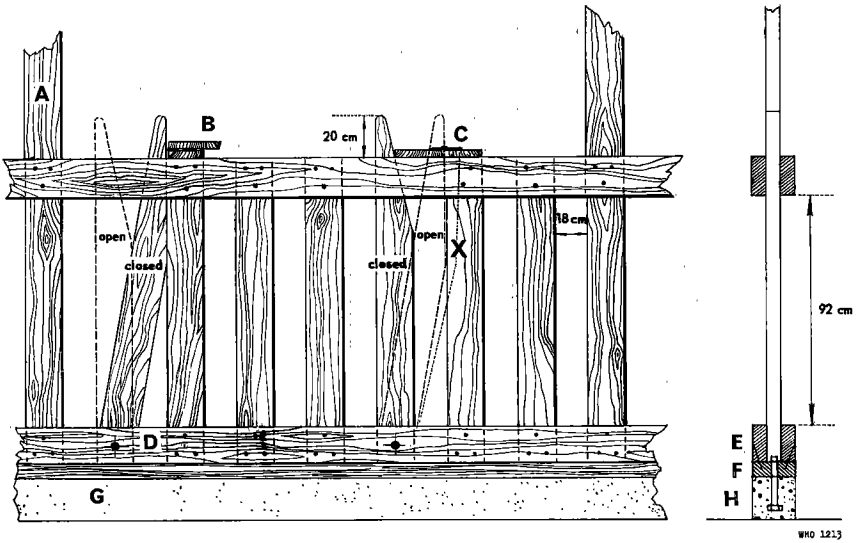
DETAIL OF CROSS-SECTION OF MANGER, COW PLATFORM, FEED ALLEY AND CENTRAL ALLEY



A = Mid-point of central alley
B = Central alley, stall platform (rough-float finish)
C = Manger and feed alley (smooth finish)
D = Bolts (spaced 1 m centre-to-centre)
E = Brick
F = Feed alley
G = Drainage
H = 1-in. (2.5-cm) pipe
J = 1-in. (2.5-cm) ell with plug
K = Fill

of the centre alley; after one line of stalls has been poured, the forms are placed on the other side from the centre outwards. The model form was cut in two places and hinged for folding for easy transport, for use in extension work.

FIG. 14
DETAIL OF WOOD STANCHIONS



A = Attached to roof
B = Two blocks (2 in. × 6 in. (5 cm × 15 cm)) with hinge
C = Hinge
D = Bolt
E = Nails
F = Plate bolted down to curb
G = Concrete curb (4 in. (10 cm)) with bolts 59 in. (1.5 m) apart
H = Concrete curb: cross-section
X = Cut here if a wider opening is desired

Note: All lumber is 2-in. × 6-in. (5-cm × 15-cm) material, except movable side of stanchion, which is $1^{7}/_{8}$ in. × 6 in. (4.75 cm × 15 cm).

Fig. 14-16 show the wood stanchions preferred by the author for use in the milking stable. They are constructed so that the cow cannot put its head through any opening but the right one. The opening for the cow's head should be not more than 7 inches (18 cm), to prevent a polled cow from withdrawing its head when the stanchion is closed. The openings between the fixed uprights should also be small enough to prevent the cow from putting its head into the wrong space. When the stanchion is open, even cows with long horns soon learn to tip their heads when putting their horns through. If a wider opening is desired, the fixed upright to the right of the movable upright can be tapered as shown in Fig. 14. The concrete curb has bolts set in the concrete for bolting down the wood plate

FIG. 15
A PORTABLE MODEL OF A STANCHION ASSEMBLY

FIG. 16
COWS IN STANCHIONS WITH FEED-MANGER IN FRONT

upon which the stanchion assembly is nailed. At every second stall, to the left of the stanchion opening, the fixed upright extends to the roof, to give stability to the row of stanchions. The sides of the stanchion openings should be slightly rounded off so that the edges will not cut the animals' necks while they are learning to use the stanchions. Fig. 15 shows a portable model of a stanchion assembly, which (with the model of the milking stable floor profile) was transported from farm to farm for carpenters to copy. (In this figure the stanchion is shown turned the wrong way—it should open to the right from the side as the milker milks the cow.) Fig. 16 shows the stanchion in use; cows with even larger horns than these can freely enter once they have learned how.