ANIMAL RESEARCH INSTITUTE FACILITIES FOR DAIRY CATTLE BREEDING RESEARCH*

by

J. E. Turnbull
Member C.S.A.E.
Engineering Research Service
Canada Department of Agriculture, Ottawa

C. G. Hickman
Animal Research Institute
Canada Department of Agriculture, Ottawa

A. J. Lee
Animal Research Institute
Canada Department of Agriculture, Ottawa

INTRODUCTION

This describes the structures, equipment and feed handling features of a unit of research buildings constructed as part of the Animal Research Institute Greenbelt Development, on the outskirts of Ottawa. This unit consists of five cattle buildings and a feed center designed for the dairy cattle breeding program of the Animal Research Institute.

Planning of these facilities was an outgrowth of genetics research conducted over the past 15 years and is based on well established experimental designs. These designs specify animal numbers, and the distribution of animals by age and lactation parity. Animal Research Institute investigations into housing and management practice were conducted over a 10-year period, followed by final studies by the Engineering Research Service. American and European features were combined in the final plans.

Animal Research Institute scientists set the general conditions for animal environment and management for the various cattle age-groups. From this, the Director of the Animal Research Institute chaired a preliminary design committee consisting of research scientists, an agricultural engineer from Engineering Research Service, the Greenbelt planning officer from the Architectural and Engineering Section, and farm operations staff.

This design committee prepared for each building a written brief for the guidance of the Department of Public Works and the Consultants, together with a tentative floor plan and sections. Preliminary drawings were prepared with about the same degree of detail as in the figures of this paper.

The briefs and drawings were then transmitted through the Department of Agriculture to the Department of Public Works, and then to a private consulting group for preparation of complete contract documents.

Department of Agriculture staff continued to supply design information and animal equipment details, as each building proceeded through the various design stages to a set of drawings and specifications suitable for contract. At this writing, three of the five animal buildings are complete and occupied, and the remaining two are to be constructed in 1968.

GUIDELINES USED FOR DESIGNING BUILDINGS

This set of dairy buildings was planned according to guidelines established by agreement between Agriculture and Public Works Departments.

Design to 'Farm Building Standards' (1)

This Supplement, together with appropriate sections of the National Building Code 1965, provided useful guidelines for structural safety, fire protection, animal space requirements, ventilation and heating requirements, electrical services, etc. It was found that many other accepted engineering standards developed for residential, industrial and commercial buildings had little application to buildings for animal research.

For economy, and to reasonably duplicate contemporary methods of farm building construction in Canada, the structures are single-storey, insulated wood frame, clear-span construction, with exhaust fan ventilation. Walls and ceilings are epoxy-painted plywood interior, and factory-painted sheet metal exterior. Wall frames are stud wall or post frame, depending on the requirements.

Total Confinement Housing

Total confinement of dairy cattle throughout the year in insulated buildings is unusual in Canada, but this is a requirement for precise research. Total confinement can provide extensive environmental control including lighting and provides uniform controlled feed supply regardless of season. It also simplifies collection of blood samples, live weights, body measurements and other data.

Separate Building Units

Separate building units were planned to house groups of cattle at various ages or production stages. This practice is desirable for large herds and has simplified planning of each building unit. It also provides fire separation, fresh air supply, disease control, and corresponds with the developing specialization of rearing replacement heifers for sale to commercial milk producers.

Ventilation

Exhaust fan groups located in one or both walls of each animal area are controlled by grouped thermostats near the room centre. Thermostats are adjusted in temperature steps to provide three to four ventilation rates, from winter minimum to summer maximum.

Light-proof adjustable fresh air inlets distribute unmodified outside air at the long walls near the ceilings in rooms up to 44 feet wide, and at the ceiling centre line in rooms 50 to 68 feet wide.

Heat lamps and/or fan-forced suspended heaters provide supplemental electric heat in young stock areas where winter heat balance is likely to be more critical. Adult animal areas depend on animal heat alone.

Manure Systems

Manure systems as far as possible are based on hydraulic removal, using animal area floors of expanded steel mesh (calves) and reinforced

*Contribution No. 151 from Engineering Research Service, and No. 313 from Animal Research Institute, Research Branch, Canada Department of Agriculture, Ottawa, Ontario.

concrete slats (young stock and cows). This method minimizes bedding costs since only the tie stalls and free stalls require any bedding. Thus almost half of the herd requires no bedding, and an additional quarter of the herd in free stalls requires only very small amounts. Liquid manure storage capacity was based on six months accumulation to eliminate the need for winter spreading.

Minimizing labor was another important aspect in the choice of hydraulic manure removal; manure removal is done by a specialized crew, and the herdsmen in each building are freed for other animal management duties and for research operations.

The manure removal system, in all animal buildings except the bull barn and tie-stall milking barn, is the "sluice-gate plus recirculation system for long channels" as described previously (4).

DESIGN OF THE DAIRY BREEDING RESEARCH UNIT

Table I indicates the number and capacities of individual buildings in the unit; figure 1 indicates the arrangement of buildings on site, and typical transfers of animals from building to building.

Feed Storage and Distribution

Original plans for the unit included hay and silage storage attached to each animal building. This would have required that each building have its own storage unloading and feed mixing facilities. Further disadvantages of this arrangement included smaller, less economic storage units, and problems of maintaining feed supply for 12 months per year feeding (e.g. a minimum of two silos for each type of silage). Also the subsoil at some of the building sites was found to be doubtful foundation material.

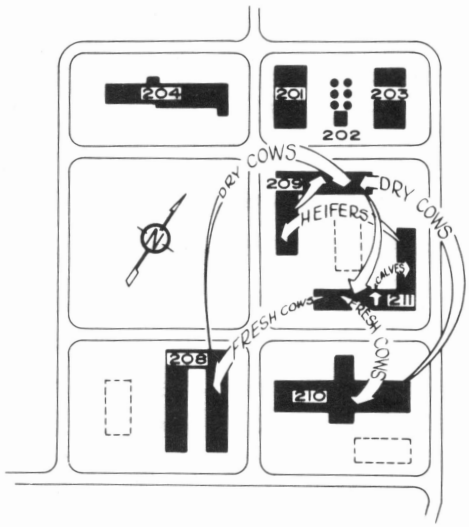

Figure 1. Site plan of Dairy Breeding Research Unit, Animal Research Institute Greenbelt Development.

A much more workable and efficient arrangement was devised, based on a centralized feed facility for long-term roughage storage (chopped hay barns and silos) and short-term concentrate storage (bulk bins). See Table I, buildings 201, 202, 203. Total roughage storage capacity is 2,500 tons dry matter as silage (grass or corn) plus 850 tons dry matter as chopped hay, based on silage at 1½ lb D.M. per day per 100 lb animal body weight, plus hay at ½ lb D.M.

With the centralized feed storage and multiple silos, only two silos are 'open' at any one time. This guarantees maximum usage rate, to minimize spoilage. Each silo can be emptied completely before refilling, and there are no problems of redistributing feed between barns when storage supplies run out at the end of the feeding seasons.

Components of the complete ration are assembled for each main feed group by a truck-mounted three-screw horizontal mixer (figure 2). The 280 cubic foot mixer box is mounted to the truck frame by four load transducers electronically linked to a scale indicator in the truck cab. This permits the truck driver to stop the mixer-truck under feed-receiving points (silo chutes, chopped hay elevators, and bulk bin augers) to assemble and weigh the main feed components.

Mixing is accomplished in transit from storage to the livestock barn, and the mixed ration is re-weighed out to each animal group. Mixed feed is delivered into an outside hopper feeding a double-chain conveyor leading into each animal area (figure 3). This provides a homogeneous feed, facilitating individual feed consumption studies.

TABLE I. DAIRY BREEDING RESEARCH UNIT - A. R. I. GREENBELT DEVELOPMENT

A.R.I. Building Number	Type of Housing	Housing Capacity	Animal Stage
201 and 203	Hay Storages	2, 72' x 136' x 20' chopped hay	
202	Silos	6, 30' diam. x 80' silos 6, 12-ton bulk bins	
211	Maternity Pens	24 cows	Cows and heifer calves, 2 weeks before calving to 3 days after
	Calf Stalls	128 calves	Birth to 12-16 weeks old
	Heifer Stalls (or pens)	144 heifers (tied) or 175 heifers (loose) at 15 ft^2/heifer	12-16 weeks old to 8-10 months old (or bulls 4 to 8 months old, for individual feeding)
209	Growing Pens	240 heifers at 22.7 ft^2/each	8-10 months old, to 2 months before calving
	Free Stalls	120 dry cows and pregnant heifers	2 months to 2 weeks before calving
210	Tie-Stalls	240 milk cows	First-and-second lactations, 3 days after calving until dry
208	Free Stalls	240 milk cows	Third-and-later lactations, 3 days after calving until dry
204	Loose Housing	30 bulls at 83 ft^2/each	Young bulls 8-12 months old
	Tie-Stalls	36 bulls	Bulls in waiting
	Pens	6 bulls	Active bulls Sick, injured or difficult bulls.

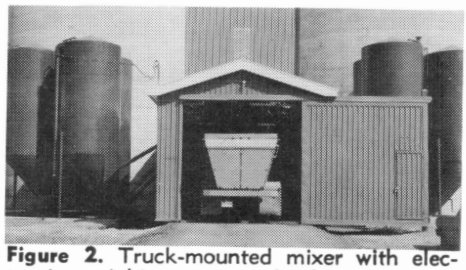

Figure 2. Truck-mounted mixer with electronic weighing system loads components of the ration.

Figure 3. Mixer-truck delivers mixed ration to cattle barn.