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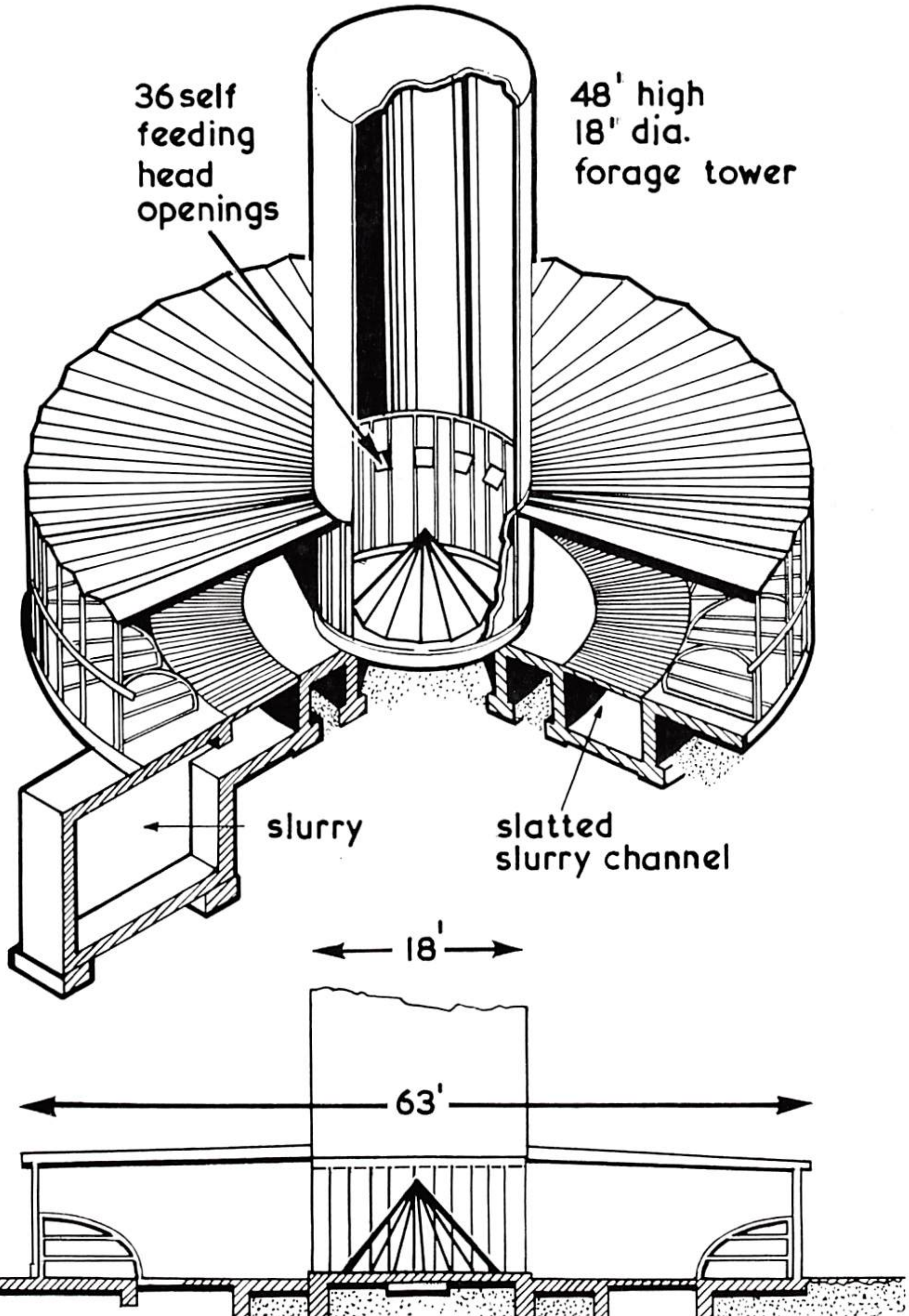

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Front Cover A rotary silage feeding system Fig 11 page 15.

GUEST EDITORIAL

Milk Production and the Engineer

by A. S. Foot BSc MSc*

FOR those who are old enough to remember, sometimes with a certain amount of nostalgia, the days of the small hand-milked herd and the horse plough, the last 50 years represent great changes, not only in field machinery, but also in equipment more directly associated with milk production. It is true that bucket-type milking machines were not uncommon in the 1920s and 1930s, but up to the last war many dairymen would argue in favour of hand milking, and subsequently mechanisation was encouraged more by rapid increases in labour costs than by a natural interest in machinery itself. Perhaps the biggest change has been in the attitude of farmers and stockmen to machinery. In the 1930s it was often regarded as a necessary evil, while in the 1970s interest often goes beyond the question of economics and is concerned also with convenience and comfort. Moreover there is a tendency to regard the milking parlour as something of a status symbol and "keeping up with the Joneses" may even take precedence over careful budgeting.

There are a number of reasons why mechanisation of milk production is particularly fraught with difficulties. The cow herself is phlegmatic and generally not difficult to handle, but new developments have often involved her basic physiology and anatomy and sometimes her comfort and health. This is perhaps easier to envisage in the case of a change such as that from natural to artificial insemination, but it is not always so obvious in changes in milking and feeding.

In the case of milking, some of the more important biological restraints have been established. Thus, as long ago as 1916 Professor W. L. Gaines in his classic experiments in Illinois demonstrated that ejection, or "let down" of milk from the upper udder was to some extent under the control of the animal and, in the terminology of the reflex physiologist, subject to both unconditioned and conditioned stimuli. There can be no doubt that the milking of the cow is affected by factors in her immediate environment.

Since the war, workers at Shinfield have demonstrated the importance of the size and type of the teat orifice in the cow, not only so far as it affects the rate of milking, but also in relation to the rate of infection by mastitis-producing pathogens. It is also known that the microflora on the teats may affect the rate and severity of new mastitis infection because transmission from cow to cow often takes place at milking time. Milk is a very good medium for the proliferation of a wide range of bacteria, a few of which are dangerous, and many of which, given a suitable temperature, quickly cause deterioration in milk. These and many other facts about the cow are sometimes not so well known to the engineer as to the biologist.

The nutrition of the ruminant is a field in which scientific facts are being accumulated at a very rapid rate. From the point of view of the engineer it is perhaps worth noting that many of these new facts concern not only the nutrient content of feeds, but also the physical form, the quantities and timetable of presentation to the animal. Such factors as periodicity of feeding, diet particle size, and artificial or natural protection of protein and fat against the microflora of the rumen may affect the supply of energy protein and minerals, and hence the yield and composition of milk. Thus the engineer is increasingly concerned, not only with feed production and processing, but also with its presentation to the cow.

Since the ruminant has important extra stages in its digestive system it offers much greater scope to the nutritionalist to manipulate its diet. As knowledge of the function of the rumen accumulates, processing of both concentrates and roughage may be defined in scientific terms so that the engineer should have specific objectives.

As herds increase in size the concept of cow accommodation as purpose built mainly for milking is giving place to that of integrated units in which feed is stored, processed, presented to the cow, and the milk and slurry processed and despatched. In these circumstances the attention given to the individual cow in the past must inevitably be devoted to systems in which high yield may be sustained by efficient feeding and management on a herd basis and with minimum time devoted to individuals by the milker.

The pressure that is placed on the cow to produce

** Deputy Director, National Institute for Research in Dairying.*

more and more milk has resulted sometimes in "metabolic" disabilities due to deficiencies of energy, protein or minerals, or to malfunction of the rumen. Apart from acetonaemia, hypocalcaemia, hypomagnesaemia and bloat, complicated fertility problems may arise. Examination of body fluids, particularly blood, is being used to diagnose some of these conditions as well as the common infectious diseases. The engineer would be unwise to assume that all cows will be in normal health all the time, and the move to loose housing in large or small groups will not eliminate the need to handle, and perhaps weigh, the individual cow from time to time.

The engineer may be tempted to argue that cattle breeding should aim to produce a cow that will thrive in situations where extensive mechanisation and automation is introduced. He might reasonably argue that if cows can be bred with udders which are suitable for machine milking, the geneticist and breeder might also breed to withstand stress, or to accept novel feeding regimes. There are, however, two basic difficulties. First, the generation interval in cows of 4 or 5 years means that inherent changes in anatomy and physiology must be very slow and, second, there are other factors such as milk yield which are of immediate economic importance and will normally take preference in a breeding programme.

A good engineer and a good biologist are not often found in one and the same person, and when the phenomenon occurs he is not so often interested in milk production. One of the reasons is lack of training in the past in bio-engineering for milk production. The gap can be partially filled by collaboration between specialists from different disciplines, but the need for dialogue between them is self-evident, and the meeting of the Institute of Agricultural Engineers reported here is a good example which should be repeated many times in the future.

ENGINEERING FOR MILK PRODUCTION

MANURE DISPOSAL FROM THE DAIRY HERD

by G. F. Shattock NDAgrE MIAgrE*

Characteristics of Manure

TRADITIONAL systems of manure disposal involving absorbtion of the liquid fraction by adding straw or other materials, or draining off the liquid and running it to waste on the land or into a ditch, are likely to become either less practicable for reasons of cost or illegal as recent legislation is enforced. The use of direct discharge systems, or of unlined lagoons on land of a permeable nature, may result in pollution of underground water resources.

Silage effluent can also present problems if allowed to run off into a watercourse, as it is very toxic to fish and to aquatic vegetation. Seepage and grass scorch should not occur if applications are kept below 750 gal/acre when the effluent is disposed of on to the grassland—as, for example, the fields from which the silage was produced.

Dairy cows produce 9-10 gal/day of manure, consisting of two parts of faeces to one part of urine by weight, having a dry matter content of approximately 12 per cent in the undiluted state. In practice, the characteristics of the manure are subject to considerable variation as a result of the quantity of washing-down water and rainwater allowed to blend with it. Sources of waste water are indicated in Table 1:—

**Summarised paper. Agricultural Development and Advisory Service, Reading*

Table 1

Waste Water from Various Activities

Source	Description: Housing system	Description: Washing method	Quantity: for 1 cow/day (gal)	Quantity: for 50 cows/week (gal)
Washing water cows from dairy	Cowshed	Bucket	3 to 4	1000 to 1400
	Cowshed	Power hose**	12	4200
	Yard	Bucket	4 to 5	1400 to 1750
	Yard	Power hose**	12 to 15	4200 to 5250
	Parlour	Bucket	—	350
	Parlour	Power hose**	—	1400
One inch of rainfall			(gal/1000 ft²) 500	(gal/acre) 22700

***Assuming the use of the power hose for total cleaning, not just for a wash down after removal of solid dung by other means.*

Excessive use of hoses for washing-down can double the cost of manure disposal. Up to a certain scale of operation, the provision of roofing for open concrete areas can sometimes be justified by the savings in disposal costs made through minimising dilution of the manure by rainwater.

In choosing a system of manure handling, control of the consistency of the manure is important. The addition of water, rather than excluding it, improves the characteristics of the slurry if it is to be handled hydraulically, at the expense of increasing the volume to be dealt with. Contaminants such as feed residues, hay, straw and waste silage are most undesirable; precision chopping of grass for silage and improvements to feed bunkers and hay racks to prevent wastage may avoid the need for more expensive special equipment at subseqeunt stages. The effects of the type of housing and bedding material used are important in this context. Simpler housing arrangements are acceptable where liquid rather than solid handling systems are adopted, so that once the threshold scale of operation is reached economic considerations may make the use of liquid handling systems inescapable.

Manure Removal and Storage

Methods of removing manure from the livestock areas include tractor-mounted scrapers, chain and flight scrapers in cowsheds and flood-washing, using about 1,000 gal of water for a 60-cow unit, and requiring a fall of 1 in 40 on the dung channel.

Storage methods include the use of earth-walled compounds for solids and semi-solid material. The maximum height of the compound walls should not exceed 5 ft and the slope on the floor should be kept below 1 in 24 if handling is to be by means of tractor-mounted loaders.

If semi-solid slurry is to be stored, separate provision must be made for drawings from yards and parlour, if possible incorporating sedimentation ditches and ponds capable of holding at least 40 days' production of liquid effluent.

More liquid slurries can be stored in above-ground prefabricated storage tanks up to 50 ft in diameter and 12 ft 6 in high. A most important aspect of management and an essential feature of above ground storage in tanks is the pre-treatment or homogenisation of the manure, by vigorous agitation, before it is put into storage. Provision should be made for recirculation, to assist in preventing the formation of a crust.

Below-ground concrete storage tanks should not normally be of greater depth than 8 ft, and must be reinforced and proofed against ground pressure and the entry of ground water, respectively.

Longer-term pond storage is still in the experimental stage. Provision must be made for removing the sludge that settles out in due course.

Manure Treatment Systems

The maximum practicable rate of application of manure to land is 5,000 gal/acre of undiluted manure, in normal circumstances—equivalent to the winter period production of two cows. In the rare cases where dairy farms are more heavily stocked than this, and with large pig and poultry enterprises associated with small areas of land, treatment before disposal may be essential.

Treatment plants may employ the **activated sludge** principle, in which the effluent is continuously aerated and mixed to allow aerobic bacteria to digest the waste material. In the alternative **biological filtration** system the effluent is fed over a film of bacteria built up on a coarse filter medium.

The problems that have arisen with treatment plants of these two kinds when used for farm waste arise from its high content of biologically degradable material and the often considerable fibre content, associated with a very low level of dilution as compared with human sewage.

Several types of treatment plant are under trial at the present time and the best hope for the future is that treatment on the farm will be able to produce effluents that can either be applied to the land without smell or any danger of polluting water supplies, or be dealt with at reasonable cost by local authority sewage work. Such effluents will be associated with a much reduced weight of dry matter concentrated into a sludge which may possibly be used as a compost material.

Editorial Note

Members are requested to note that the subject of the Institution's Annual Conference in May 1973 is Farm Waste Treatment and Disposal, when many of the points referred to in the summary of Mr Shattock's paper will be dealt with in detail, incorporating new material from research work now in progress.

FEEDING DAIRY COWS —MECHANISATION ASPECTS*

by J. I. Payne NDAgrE FIAgrE†

THE importance of mechanisation to the agricultural industry has been well demonstrated over the last 20 years. F. G. Sturrock has put its contribution towards increased productivity as being " equal to all the other advances put together "; but surprisingly the engineer has only recently been encouraged to make a contribution to the field of feed blending and distribution. No doubt in 20 years' time we will wonder how any stock farmer managed without the highly sophisticated feed blending and distribution systems that will be available then.

The economic climate to which farming is exposed puts the farmer in the paradoxical position of having to expand enterprises in order to remain viable, while at the same time he is faced with a declining labour force. The regular male labour force has declined from 575,000 workers in 1950 to approximately 218,000 in 1970. Fig. 1 illustrates the position 1963/1970.

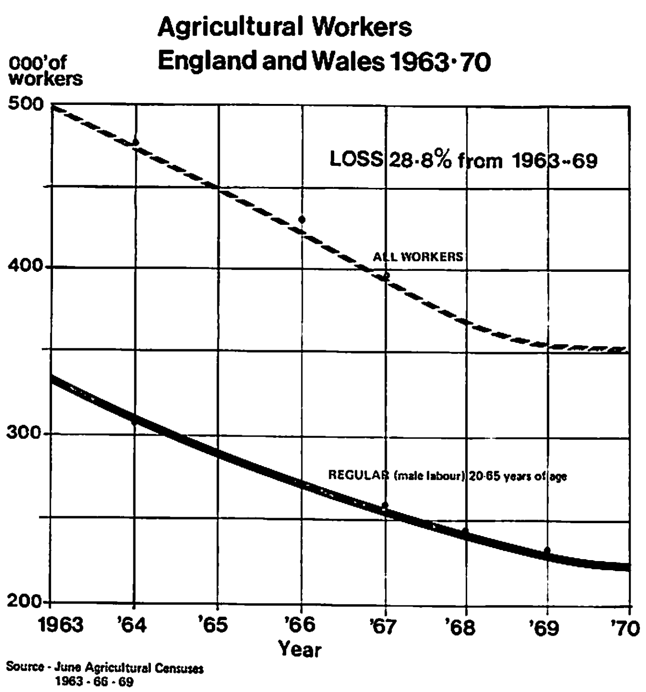


Fig. 1

The labour requirement for the dairy herd is a variable quantity depending upon:—

- herd size
- location of milking
- position of housing

Fig. 2 gives the data for system where *(A)* the stock is housed and milked in a cowshed and *(B)* where they are housed in cubicles and milked in a parlour. The average curve is also given for *(A)* and *(B)* but the average curve takes into account the data not on the graph for hand milking systems in a bail.

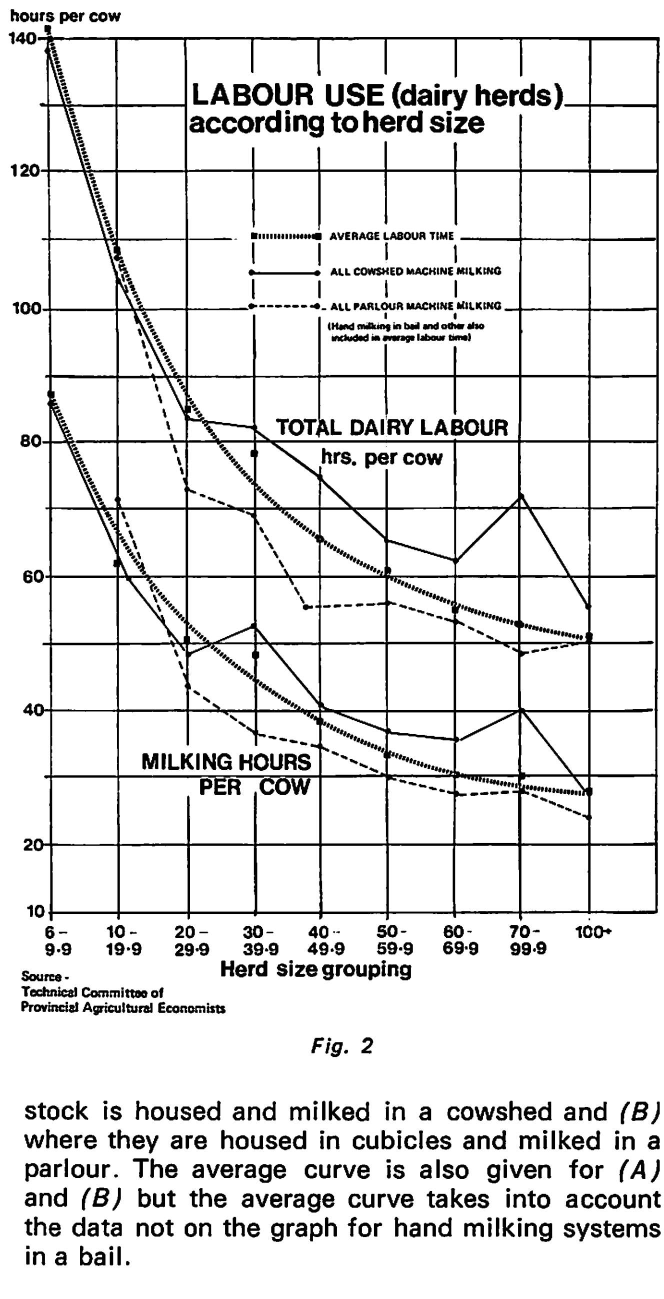


Fig. 2

Dairy Herd Size

The growth in the average herd size in England and Wales has been steady for many years, but has increased more rapidly recently. In 1954 the average herd size was 14 cows, this rose to 30 cows

The Institution apologises for any inconvenience caused by the late arrival of this and the Autumn and Winter issues. The Summer issue will be published on 15 July.

Presented at the Autumn Meeting of the Institution of Agricultural Engineers at the University of Reading, Whiteknights Park, Reading, 30 September 1971.

† *National livestock mechanisation specialist, ADAS.*

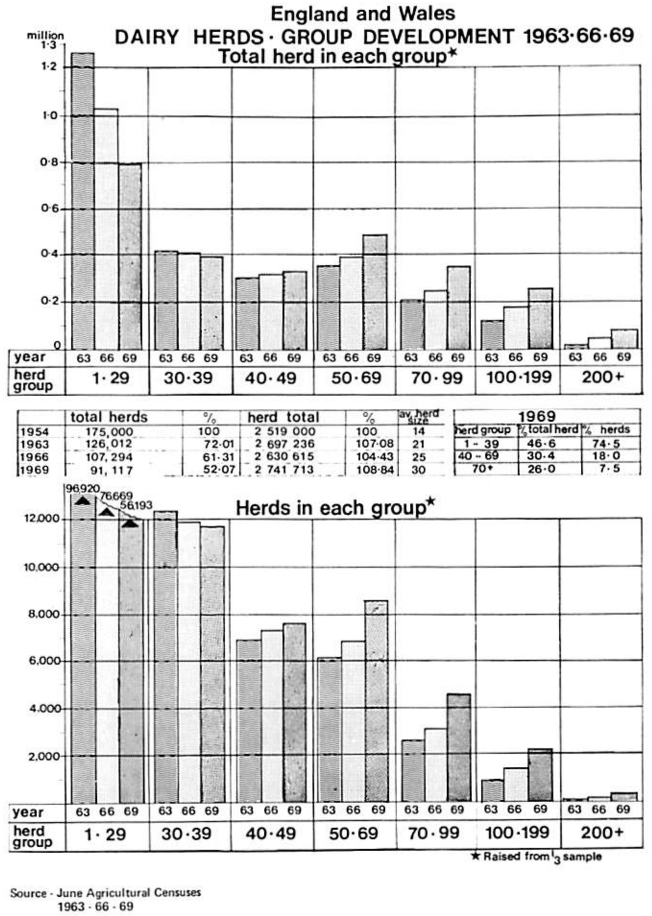


Fig. 3

in 1969. Fig. 3 shows the trend during the six years from 1963 to 1969, and Table 1 gives a summary of the position in 1969:—

Table 1

Dairy herds in England and Wales 1969

Herd groups	Number of herds	Percentage herds	Percentage of total herds
1-29	56,193	61·7	29·1
30-69	27,996	30·7	44·9
70+	6,928	7·6	26·0

The majority of cows are still being milked in cowsheds. Table 2 indicates that 75 per cent of herds are, while 19 per cent are milked in parlours. It must be remembered however that the average herd size in cowsheds is probably only in the order of 20-25 cows whereas this will rise to about 65 cows for the herds milked in milking parlours:—

Table 2

1968/69 Dairy herds (England & Wales)

Milking location		Place of housing	
Location	*per cent*	*Place*	*per cent*
Cowshed	58·60	Cowshed	62·20
Milking shed	16·50	Yard	20·90
Herringbone parlour	5·13	Cubicles	6·80
Tandem parlour	1·70	Kennels	0·15
Abreast parlour	11·50	Out-of-doors all year	4·45
Chute parlour	0·54	Mixed	5·50
Mobile bail	1·63		
Fixed bail	2·50		
Mixed	1·90		

NOTE: A milking shed is a cowshed in which cows are milked in batches.

These basic data emphasise the importance and need to adopt systems of management, housing and handling that enable stock enterprises to be continued or expanded with an existing or reduced labour force and without loss of stockmanship, while at the same time only involving a capital outlay that can be adequately justified for, as stated by Stansfield[1], "There is no correlation between the money spent on facilities and the profitability of a dairy enterprise, the most important factors which determine profits include: stocking rate, margin of sales over feed costs, herd health, calving interval and seasonality of production. Such factors are affected by buildings and equipment but in an indirect way, by allowing stockmen and herd managers to be more effective."

The maximum capital investment that can be justified according to the percentage return the farmer expects, and the performance of his herd in terms of gross margins i.e. sales less variable costs (primary feed) are indicated on the graph by Stansfield[1] Fig. 3A who points out that if a 20 per cent return is required from a herd with a gross margin of £100 then only £90 per cow place can be justified, but if a 7 per cent return is adequate then £250 per cow place may be justified. The role of mechanisation in livestock enterprises of the future is obvious, and as stated by Culpin[2] " there is now less

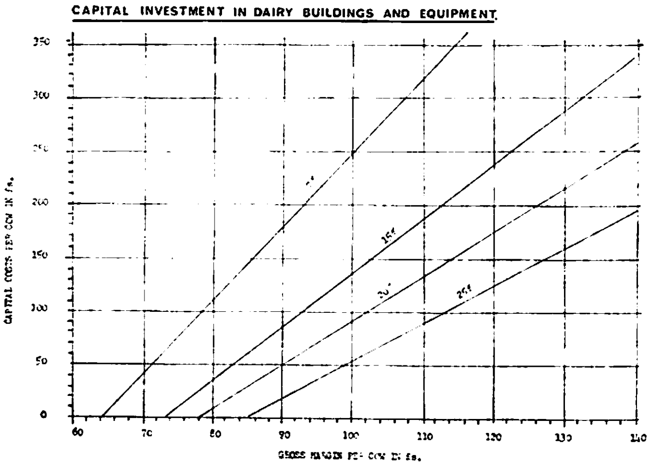


Fig. 3A

muddled thinking than in the past about this role." The discussion now is not " whether " to apply mechanised systems but, " how ". The farmer's logical line of approach towards chores undertaken by the stockman should obviously be to consider whether tasks can be:—

1. eliminated
2. simplified
3. mechanised
4. automated

Feeding Systems

The aims and objectives of any proposed mechanised feed distribution and dispensing systems must be considered very carefully before the final choice of system and equipment is made. Payne[3] suggests that some of the aims and objectives should be:—

Aim		Objectives
1. Reduce physical effort.	(a)	Take drudgery out of a task that may be done better by other means.
	(a)	Possibly allow greater flexibility in choice of labour e.g. female labour.
2. Save stockman or stockwoman time.	(a)	Give him or her more time to attend to and observe the stock.
	(b)	Give him or her time to look after more stock.
	(c)	Give him or her time to check and record performance and other management data.
3. Deliver required amount and blend of feed to a suitable feeding place.	(a)	Optimise use of available feed.
	(b)	Feed according to stage of lactation to obtain full yield or growth potential.
	(c)	Reduce adverse effects caused by the bossy animal(s) on the more timid or weaker ones.
4. Dispense feed quickly (unless ad-lib feeding).	(a)	Reduce stress on stock.
5. Provide for quick accurate adjustment of quantity of feed delivered.	(a)	Enable stockman or stockwoman to make quick accurate adjustments so that feed rate may be changed according to daily requirements e.g. accommodating change in stock numbers.
	(b)	Make economic savings in feed bill.
6. Automatic systems should include a by-pass method.	(a)	Enable selected stock units or feed areas to be passed as for example empty pens.
7. Automatic systems should " fail safe ".	(a)	Ensure that conveyor systems do not carry feed to dispensers unless dispenser outlet doors are closed.
8. Automatic systems should have a method over-riding control system.	(a)	Enable stockman or stockwoman to feed stock by manual control should equipment fail.
	(b)	Enable extra feed to be delivered if required by manually over-riding automatic control.
9. Dust free.	(a)	Reduce dusty atmosphere problem and adverse effect on stock and stockman.
10. Effective emergency or maintenance back-up facilities.	(a)	Reduce stress factor and risk of drop in production in event of a mechanical breakdown causing delayed feeding.

The economic viability of the mechanised feeding system will obviously depend upon the number of the aims and objectives the equipment fulfils. The mechanical reliability of mechanised feeding systems is of prime importance and greater effort must be made to improve reliability and service back-up facilities for, as stated by Stanfield[1] " Mechanical breakdowns not only increase costs of production but also lower output by upsetting the routine of cows and staff, cause considerable stress and may even precipitate metabolic disease."

The feeding of diary cows falls into two main categories:—

1. Forage as
   - (a) hay
   - (b) silage
   - (c) dried grass
2. Concentrates as
   - (a) a commercially produced feed
   - (b) a farm blended feed

Hay

Haymaking is still the most widely practised forage conservation system in this country with over 7 million tons per year being harvested. Considerable progress has been made in the field to improve cutting methods, accelerate wilting rate and gather the crop, although a great deal more work is required to improve gathering and stacking methods. It must be remembered that speed is very often the essence of good hay, a day late may mean a crop lost.

Barn hay drying is one way to reduce hazards in the field and undoubtedly barn hay driers have proved their ability to produce a super quality hay provided they are correctly designed and well managed. Work at experimental husbandry farms has indicated that an average of 20 per cent more dry matter can be harvested by barn hay drying methods compared to field made hay. This, in practice means between 5 and 7 cwt more per acre of the more nutritive fractions of the hay—the leaf.

I raised the point about barn hay drying because it is a conservation system that blends in with the requirements of a small farm also any surplus hay is of course a saleable commodity we must remember that as I mentioned previously 74 per cent of the dairy herds in England and Wales contained less than 70 cows and we will have farmers with small herds with us for many years to come. It is also interesting to note that the majority of barn hay driers at the moment are dealing with less than 100 tons. This would be adequate for a 60 cow herd being fed 20 lb of barn dried hay per day for a 180-day winter. The cost of such a drier would obviously depend on such factors as available power supply, buildings, and type of drier to be installed and, of course, materials to be used in the construction. However if a new steel framed building to cover 1800 ft^2 was installed and arranged as two drying areas with cladding and ventilation floor as indicated in diagram Fig. 4 the drier would have a

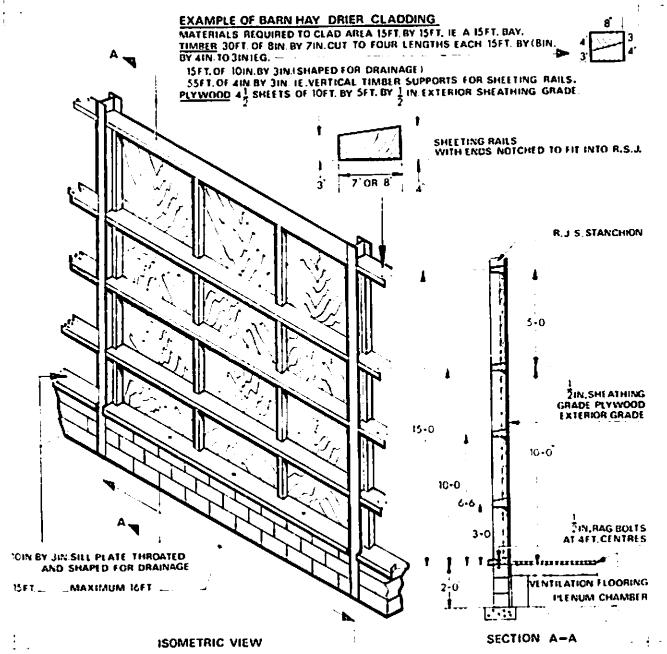


Fig. 4

single fan with a diversion chamber to either drying area and the fan would deliver 37,000 f^3/min at 3 in swg. The capital cost of such a plant would be approximately £27 per ton capacity before deduction of any grant or allowances.

Barn hay has in the main been dried in bales of the standard 30-36 in long by 18 in by 14 in size which when dried weigh approximately 40 lb and provide a means by which the stockman can roughly assess the quantity being fed per cow. The disadvantage with this system is the physical effort of handling the bales and a number of different systems are being tried to overcome this problem.

The research workers at the University of Minnesota have been carrying out research work into the drying of alfalfa hay in small bales. Strait[4] reports that much of this work was done with 12 in cube bales. These were made by using a standard 18 in by 14 in baler which was modified to produce the 12 in cube and fitted with an engine driven belt type bale thrower which throws the bales into a standard forage wagon which had been designed originally for both front and rear unloading, but the front unloading equipment was removed. The drying compartment was made 16 ft long, 8 ft wide and 10 ft deep and was equipped for mechanical unloading of the dried bales by means of a chain and flight conveyor system, the drier holds approximately 4 tons of dried hay. A farm size unit, the research workers estimate, would hold approximately 12 tons. The fan fitted to the research plant delivers 9500 f^3/min against 1·6 in swg and heat was supplied to the drying air by means of an indirect oil fired heater. The drying air temperature being raised to between 125-145°F with recirculation and this could be increased to 155-160°F by recirculation. The burner is stated to use 6 gallons of fuel oil per hour and the drying time is between 16 and 19 hours. This work is obviously very interesting and could lead if ultimately adopted to systems of mechanised dispensing, a 12 in cube bale of super quality hay would appear to be a very suitable package and of a reasonable size to allow a rationing system to be adopted.

The interest in the United Kingdom has recently centred on hay towers or hay hills, these are designed to dry wilted grass in a loose form that has been chopped into lengths of approximately 4-5 in. A typical example of one such tower is illustrated Fig. 5 and 6, and comprises a roof cowling of 33 ft in diameter which is supported on a centre rotating mast and the roof may be raised up or lowered down the mast according to requirements, the roof cowling has a multi section skirt hanging down from it which acts as a stack former for the chopped grass. The mode of operation is to cut the grass, wilt it and then chop it with either a loader wagon or a forage harvester into the appropriate length and then to transport the material to the hay tower where it is unloaded into a blower which delivers the grass up through the roof cowling to a spreading device consisting of three radial arms which have spring tines mounted on them and the combined rotating action of the radial arms (driven by the rotating mast) and the tines spread the grass uniformly between the skirt of the roof cowling and an inner bung which forms a 7 ft diameter flue, the flue acts as a ventilation chamber for the radial drying system at harvest time and as an unloading shaft during the feeding period. The roof, spreader and bung may be raised as required to accommodate the loading rate.

The feeding cycle involves fitting angled finger

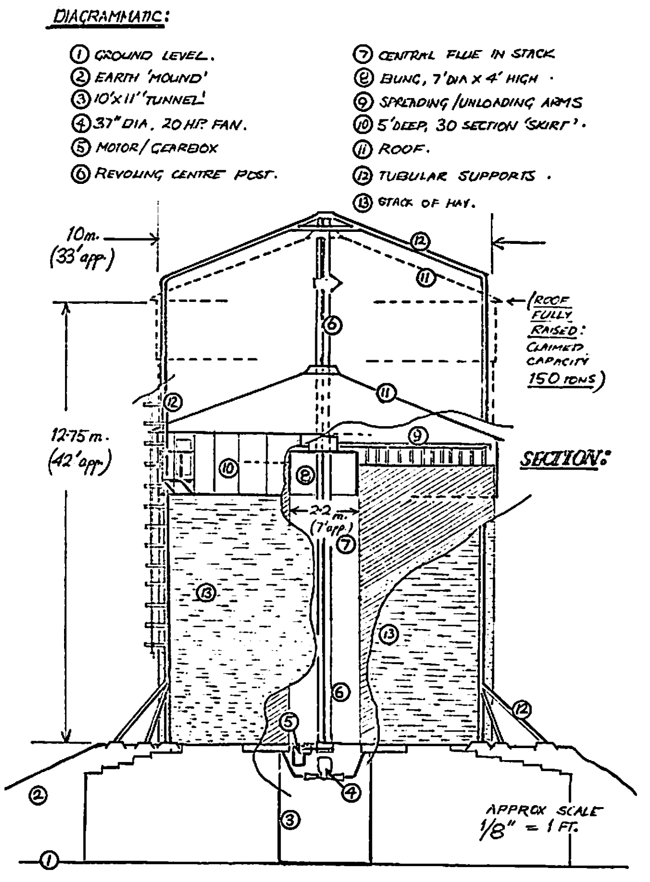


Fig. 5 Hay hill side elevation. (See also Appendix page 16)

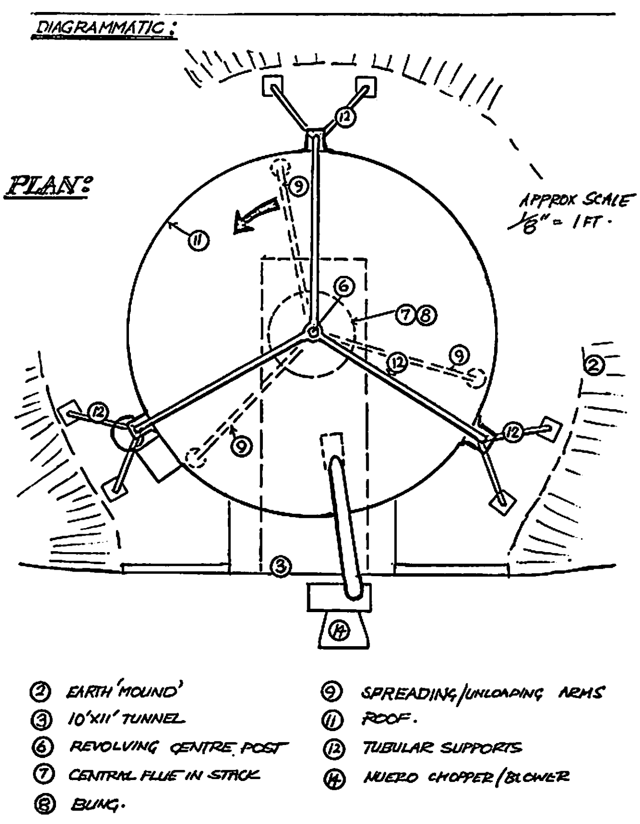


Fig. 6 Hay hill plan.

wheels in place of the tines on the spreader bars putting the spreading mechanism into reverse and it then scrapes off the dried hay and drops it down the centre shaft at which point it either drops into a forage box underneath the tower if the tower has been elevated, or into a conveyor system and is then transported to the stock. One such tower installed on a farm in Berkshire is stated to hold 150 tons of dried hay and the capital cost involved was just over £6,000, approximately £44 per ton capacity before any grant or allowances have been deducted. The tower is erected on a small mound and a tunnel has been excavated from underneath it so that a forage wagon may be reversed into this tunnel to receive the dried grass at feeding time and deliver it to the stock areas. The capital cost of this equipment is high but it is possible that this may be reduced as developments take place and the farmer who installed the particular unit in Berkshire feels that this system can undoubtedly be a one-man operated system capable of harvesting between 7 and 10 acres of hay per day.

Silage

Silage feeding systems are being looked at from many aspects at the moment. The need to make maximum use of available feeds has encouraged farmers to adopt mechanised feeding systems in various forms. The system must of course be influenced by the method of storage and the method of storage in turn is influenced by a number of factors prevailing on the individual farm, but as a general statement it can be said that there is relatively little difference between the cost of storage in a tower silage system as against a clamp feeding system providing the clamp is covered by a roof, in fact in some circumstances if for example a self-feeding system is being practised with silage at a maximum depth of 6 ft then a tower can be approximately 30 per cent cheaper than a covered clamp silo, but if mechanised extraction systems are adopted from the clamp with silage stacked to perhaps 14 or 15 ft deep, then the cost difference will be small and may in fact be in favour of the covered clamp when related to some types of towers.

The majority of self-feed silos have in the past been of the clamp silo types. But, we are of course, in the rotary age, with rotary mowers, rotary tedders, rotary parlours, etc. It is therefore only logical that we should have some other rotary developments.

At Rutgers University, New Jersey, *USA*, a rotary silage feeding system consists basically of an 18 ft diameter tower 40 ft high, in the centre of a circular housing system of approximately 63 ft diameter, to hold between 34 and 40 cows. The house consists of cubicles, a slatted floor over a dunging channel and a feed pad surrounding the base of the silage tower. The cows self-feed on the silage dropping down from the tower. This is obviously an extremely interesting development and one which we will be watching closely. (See Fig. 11 page 15)

→ *page 10*

Clamp or Bunker Silage

Various types of mechanisation are being adopted to extract silage from clamp and bunker silos. In each case the most successful examples depend upon management skill and preplanning to ensure adequate removal rates and minimum exposed surface areas on the silage face to reduce secondary fermentation problems and subsequent spoilage. Fore and rear mounted loaders fitted with buck rakes can handle metered chop silage and load a trailer or deliver it directly to the stock without much difficulty providing very short tines are used on the buck rake, but when a flail harvester has been used to harvest the crop the material is more difficult to handle and air can be induced into the remaining silage leading to secondary fermentation problems, unless the silage is cut in a vertical face. Under ideal conditions trailers have been loaded with silage at rates in excess of 1/3 ton/min using fore loaders.

Slew Loader and Forage Boxes

Slew loaders are being used on a number of farms to load forage boxes and easy feed trailers. It is important with this system to be very careful at the planning stage to ensure the cross sectional area of the bunker is a practical minimum to avoid the risk of inducing air into the silage. It may in fact be worthwhile to use a system of cutting the silage face down at the appropriate width if secondary fermentation is a problem.

Slew loader performance is rather similar to fore or rear mounted loaders when loading trailers but of course wear and tear on the tractor is considerably reduced. The choice of slew loader will obviously depend upon the requirement of the individual farmer: some farmers may in fact have enough work for the loader to remain permanently attached to the tractor and in that case they will not be particularly interested or concerned at the speed at which the loader can be attached to or removed from the tractor, but other farmers will have need of a tractor during the daytime and will require a machine to be very quickly attached and removed. In each case it is however desirable to ensure that the slew loader has special pads to provide stability during the loading process, taking the weight off the tractor. Loading rates of ½ ton/min have been recorded. When handling metered chop silage this decreased to less than 1/3 ton/min loading silage from a flail harvester.

Purpose Made Clamp Silo Unloaders

Work is proceeding at research stations to mechanise the extraction of silage from horizontal silos. The design objectives include producing a machine that:—

(1) Will handle silages with a wide range of physical characteristics from finely chopped material to possibly unchopped material.

(2) That has a high rate of work and a relatively low power requirement.

The machine being developed at the *NIAE* is based upon a cutting mechanism with twin contra-rotating double axis augers and a conveying mechanism to cut the silage out of the clamp silo and deliver it to another conveyor or into a trailer. Work rates of approximately 10 ton/hour have been recorded with the test rig and work is continuing in order to try and make the equipment a more practical proposition and able to cater for farm conditions. The future of such equipment will obviously depend on its mechanical efficiency and its economic comparison as a complete system when compared with tower silage in which a similar degree of mechanisation is practised.

An American-designed tractor mounted clamp silo unloader is being used on at least one farm in the *UK* and with it is claimed considerable success. The machine has a boom arm with a chain driven extraction wheel mounted on it that bites into the silage face and drops the cut silage into the mouth of an elevator which in turn delivers the material into a forage box or other feed distribution trailer. The unit is stated to be capable of dealing with silo clamps up to 15 ft high, output has been quoted as 4½ tons in 10 minutes. The machine costs approximately £1,700, fitted to the farmer's own factor.

Tower Silo Unloaders

The early tower silo unloaders gave very disappointing performances when handling grass silage and much of the enthusiasm for towers was damped down because of this, however, output and reliability have improved and automatic load control systems are being developed to ensure that output from unloaders is maintained.

The main development work in the *UK* recently on unloaders has been with top and bottom unloaders of the chain and cutter type and there are now at least five different manufacturers producing their own version of this type of unloader. The top unloader costs between £850-£1,000 while bottom unloaders cost between £1,600 and £2,250.

Factors influencing the performance of unloaders are:—

(1) Chop length should be as short as possible preferably ¾ in or less; longer material than this affects the flow characteristics adversely of the forage and increases the load on the unloader reducing output and possibly causing mechanical breakdown.

(2) The material being ensilaged should be spread as uniformly as possible within the tower, failure to do this will lead to uneven density over the working surface and can lead to a number of problems. The digging and cutting mechanisms are meeting an uneven load and the output is consequently inconsistent.

(3) The material ensilaged should be wilted to the correct level prior to ensiling preferably within the band 35-45 per cent dry matter. Under wilting reduces the output of bottom and top unloaders and may cause blockages. Over wilting usually causes most trouble with top unloaders of the auger and fan type. Intake into the fan can be uneven and more problems occur as a result of gum

deposits building up in the fan housing and the delivery pipe.

The Choice of Feeder, Fixed or Mobile, Permanently Installed Conveyor Dispenser Feeders

Advantages

Labour requirement is minimised and automatic control is possible.

Feeding time is not related to availability of a tractor driver.

The space requirement is relatively low and cows can feed from either side of a feed manger.

Blending of ingredients is relatively easy.

Fairly precise rationing is possible.

Disadvantages

The capital cost is related to and therefore rises with cow numbers.

The feed dispenser must be adjacent to or very near to the silo if high capital costs are to be avoided.

Maintenance of the equipment must be done in-situ and is therefore not as convenient as a mobile unit.

There are two basic types of conveyor dispenser feeder available to the farmer at the moment and they are:—

conveyor distribution type(s)

conveyor progressive type(s)

The distribution type of feeders are designed to make some feed available along the full length of the manger immediately or very soon after the feeding cycle starts. This reduces the tendency for animals to crowd to one end of the feed manger and the inevitable bullying and means that the cattle can be at the feed manger during the feed distribution cycle.

The progressive manger feeders are designed to fill the manger progressively from the intake end and the cattle should be kept out of the feed manger during filling to avoid as mentioned the bullying and consequently stress that would inevitably occur. The rate at which the feed is put into the manger is more important with this type of equipment than the distribution type where there is no delay in the cattle having access to the feed in the feed manger.

J. A. Pascal[5] gave details of the performances and characteristics of various type of conveyor dispenser feeders and Table 3 is derived from this data.

Payne[3] has given the approximate cost-length relationship of various types of feeder available in the *UK* as shown in Fig. 7. He points out that the choice should not only be made on a price relationship but it should be based upon the equipment's ability to meet the feeding and reliability requirements of the enterprise being serviced.

The work of developing an automated feed blending system at Bridget's Experimental Husbandry Farm is reaching an interesting stage at the moment. The *NIAE* have constructed a programming panel which will allow the management at Bridget's a selection of five different programmes to be used for blending silage and other ingredients. The overall

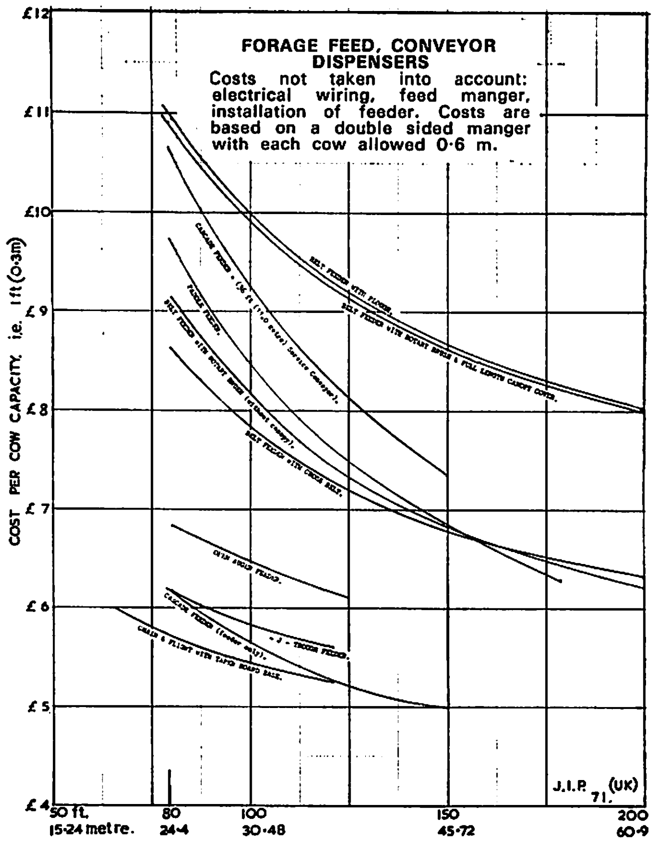


Fig. 7

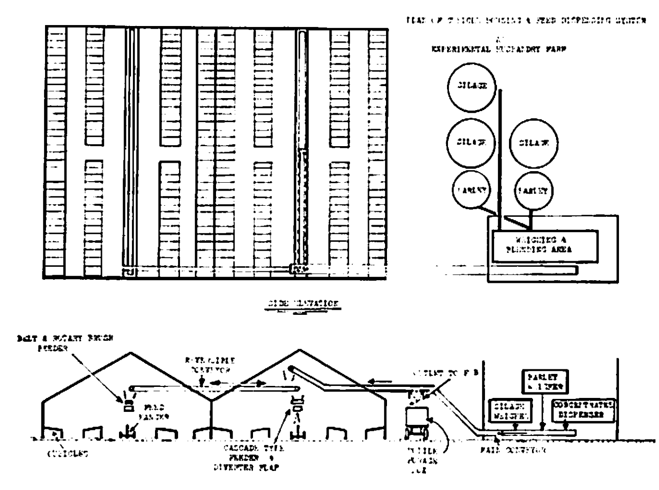


Fig. 8 (above) Fig. 9 (below)

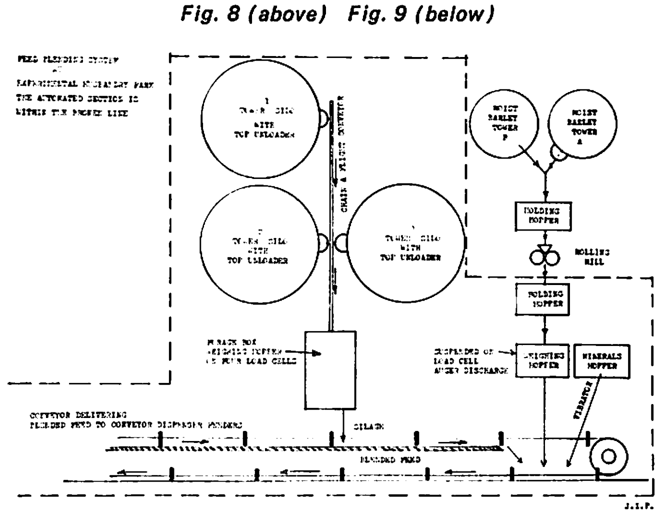


Table 3 Performance of Conveyor Dispenser Feeders

Derived from data by Pascal
*columns modified

Type	Material handled	Distribution of feed: *Along trough	Distribution of feed: Evenness	Distribution of feed: *Variation from side to side	Distribution of feed: *Quantity control	Distribution of feed: Particle separation with concentrates	*Maximum length of trough ft	*Power requirement 20 ft feed trough
Open bottom auger	Roughages up to 10 cm long	Progressive	Fair	Not possible	Difficult	Can be high	125	1-1½
Enclosed auger with slots	Roughages up to 5 cm long Also concentrates	Continuous distributive	Fairly good with uniform food	To either side by diverting boards	By time of running	Some	140	1-1½
Auger in *J* or *C* trough	Roughages up to 8 cm long Also concentrates	Continuous distributive	Fairly good with uniform food	To either side by diverter board	By time of running	Some	120	½-1
Revolving tube	Roughages up to 5 cm long Also concentrates	Continuous distributive	Good	Not possible	By number of discharges	Negligible	150	½-1
Three way discharge auger	Roughages up to 5 cm long Also concentrates	Continuous distributive	Good	To each side and along length	By number of discharges	Negligible	125	¾-1¼
Chain and flight with tapered board	Roughages up to 10 cm long Also concentrates	Continuous distributive	Good	Not possible	By time of running	None	120	¼-⅓
Paddle feeder	Roughages up to 10 cm long	Progressive	Fair, more than one complete circuit to be made by the feed	Not possible	By time of running	Some	180	1-1¼
Shuttling chain and slat	Roughages up to 10 cm long Also concentrates	Continuous distributive from the centre of the trough towards ends	Fairly good Even loading is essential	To either side by diverting flaps	By time of running	None	150 Specials to 300	¼-⅓
Belt feeder	Roughages up to 10 cm long Also concentrates	Continuous distributive	Good	To either side by plough angle, cross belt direction or brush rotation	By belt speed and/or scraper speed and/or thickness of feed on belt	None	200 Specials Longer	¼-½
Jog trough	Most feeds but best with light materials of long staple	Progressive	Good provided input conveyor has high capacity	Not possible	Difficult	Some	102 Series possible i.e. 102x	½-¾

dairy unit schme consists of three 60 ft by 20 ft diameter concrete stave silage towers with top unloaders, two moist barley towers one with a top unloader and another with a bottom auger unloading system. The plant is arranged to weigh the quantity of silage to be fed to the stock, to weigh the rolled moist barley and to blend the silage rolled barley and concentrates at a predetermined level according to the programme selected and as an insurance the *NIAE* are developing flow sensing devices to stop the equipment in the event of failure of any section of it, Figs 8 and 9 (page 12) illustrate the scheme.

Self-Feed Hopper Mangers

Self-feed hopper mangers are a fairly recent development in which conveyors carry the silage from the silo and it is ploughed off into the mangers which are circular and placed at suitable intervals. A degree of rationing is possible to the group on a volume basis. (See Fig. 12 page 15).

Forage Box Feeding Systems

Forage boxes are available in three forms:—

1. Tractor drawn as either 2-wheel or 4-wheel units close coupled, or 4-wheeled with Ackerman steering, the first two types being the most manoeuvrable.
2. General purpose units in which a forage box kit may be mounted on a lorry chassis, making it suitable for silage making or feeding.
3. Specialised units usually with a forage box kit fitted on an electrically or small engine powered chassis. These are only suitable for silage feeding duties.

The advantages of forage box feeding systems are:—

1. No further capital required for mechanised feeding system.
2. The silo need not be adjacent to the stock unit.
3. A fair degree of rationing can be achieved.
4. Distribution in the feed manger can be good (without the limitations of the operator).
5. The system is very flexible and a number of seperate feeding areas can be serviced.
6. Depending upon attachments fitted a degree of blending of other ingredients such as barley or concentrates may be achieved while distributing silage into feed manger.
7. Machine may be taken to workshop for repairs and maintenance.
8. Load-cell weighing systems can be built into some specialised versions to enable accurate rationing to be practised.

The disadvantages of forage box feeding systems in the present stage of development are:—

1. A tractor and driver must be available every time, or of course a driver and purpose built forage box must be available.
   However, forage box feeding systems provide the driver with a good viewing position for stock observation and the ability to make quick adjustment in quantity or blend of feed for variations in stock type or numbers but we must remember if these advantages are to be fully exploited the driver carrying out the duty of feeding must be the stockman.
2. Extra costs may be involved in providing roadways between the silo and the stock units.
3. There must be adequate turning room for the forage box unit to drive into and out of stock units without having to make complicated manoeuvres, although self-propelled units require much less space than the larger 4-wheel trailer type.

To plan with less than 30 ft between entrance to feed passage and a building opposite would be unwise (see Fig. 10).

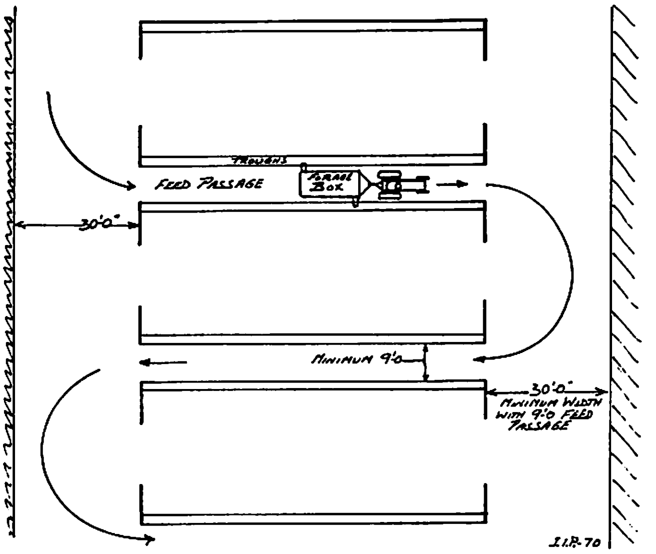


Fig. 10

The forage box feeding system for dairy stock, beef cattle and possibly sheep has many built-in advantages and the next logical step is the self-steering or automatic unit with guide wires tracing the stock unit feeding circuit and a programmed feeding sequence. Work is progressing at the University of Illinois and at other research stations on this type of equipment. It may also be practical to design such equipment to undertake other duties automatically such as scraping out manure from the stock areas although care would be necessary to ensure that disease infected manure was not directly transmitted to forage and other feeds from the vehicle tyres, particularly in the case of multi-stock units.

Other Trailers

Flail type manure spreaders are being used with considerable success to dispense silage to stock on a number of farms. The rear delivery type of spreader may have a vee blade fitted to it to act as a diverter so that the silage being flung from the flail beaters is spread to either side of a feed passage.

Easy feed trailers are also being used with a degree of success on a number of farms. They are basically low platformed trailers with a skeleton framework hopper to hold the silage and they have the advantage of:—

(1) being a transport vehicle as well as a feeder hopper

(2) provide a means of volume assessment so that a degree of rationing may be practised.

(3) allowing some flexibility in the relationship between building layout and silo

(4) the trailers may be designed for multi-purpose tasks e.g. as a silage feed hopper in the winter and a bale transport trailer during the summer.

Dried Grass

The value of dried grass is well known and requires no explanation from me. No doubt as the grass crop becomes more widely recognised as a high value crop there will be more dried grass used in dairy rations. The form in which it is to be used will depend on various factors. The general range of processes are: —

(1) unmilled

(2) chopped

(3) milled

(4) pellets

(5) cobs

(6) wafers

J. Connell[6] suggests that " at present the more attractive systems based on dried grass feeding for the dairy cow will include barley, minerals and barley straw or silage. The results from trials at Shinfield have indicated consistently that cows fed dried grass in the wafer and cube form, with hay and barley straw, will produce 5 to 6 gallons at the peak yield stage of lactation. For cows capable of higher yields it will be necessary to include barley to increase the energy concentration of the diet. By adding barley it is also possible to avoid any wastage of protein which may be high in the dried grass especially the autumn batches produced from highly fertilised swards. One very encouraging aspect of dried grass feeding is the high voluntary intake of dry matter achieved by the cows fed wafers or cubes. At the peak yield stage of lactation, mature Friesian cows will consume 40 lb dried grass daily. The actual quantity to be fed will be determined by the quality of the grass and the other feeds to be offered. From observations at Shinfield it would appear that from May till July with successful grassland management digestibility should be close to 70 per cent with crude protein about 18 per cent of the dry matter. From July till the end of the season digestibility will be seldom above 65 per cent but should not fall below 60 per cent with crude protein content over 20 per cent in the dry matter. As about 50 per cent of the total production target will be in store by early July this gives an indication of how storage may be planned. The first store should accommodate the best material, the second for production after mid-July and perhaps a third store to accept the dried grass not considered good enough for either of the main stores. The claim sometimes made that the long fibre available from the wafer is essential in cow feeding is erroneous. In most cases the necessary long fibre can be more cheaply supplied as hay, silage or barley straw to maintain normal milk quality."

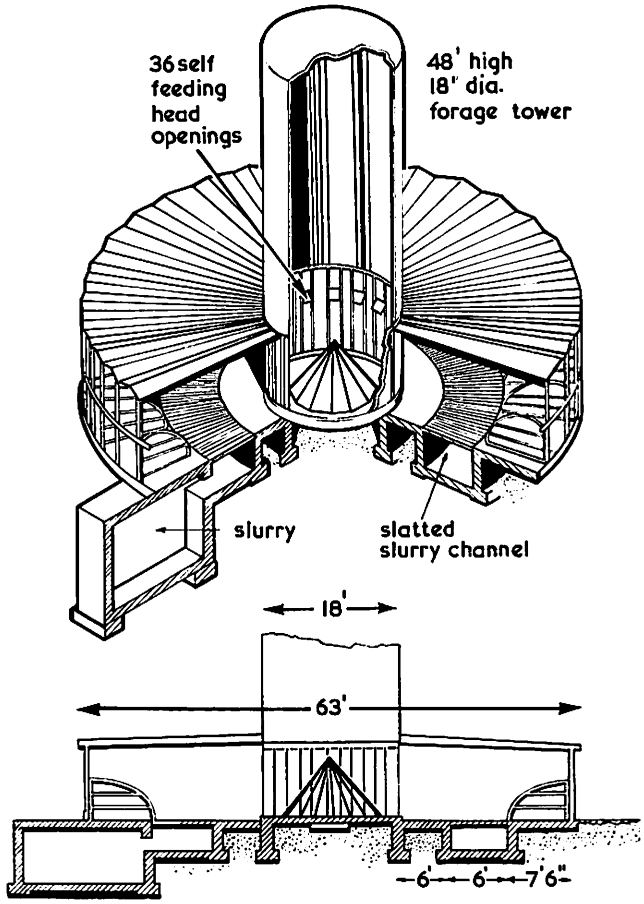
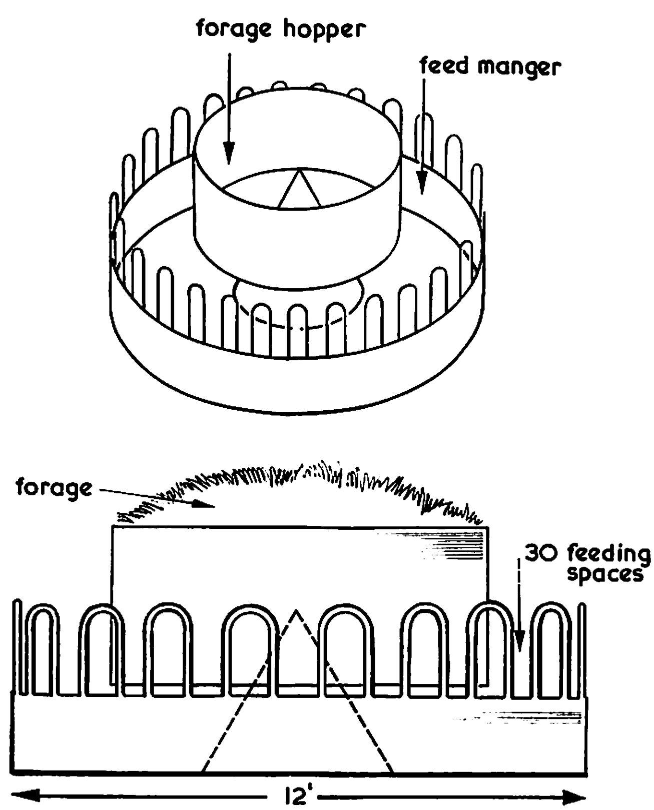


Fig. 11 (above) Fig. 12 (below)



Dried grass can undoubtedly be a satisfactory feed but in dairy cow keeping the final result is expressed as profit rather than milk. Therefore the cost of the drying installation which is high at present can only be justified after careful deliberation for each interested farmer or group of farmers. Dried grass or lucerne products must arrive cheaply enough at the cow's mouth, relative to alternative supplies available and likely to be available.

The systems of feeding dried grass at the moment are very much in the early stages of development and range between self feeding system with time control over the period the stock are at feeding face to systems of dispensing by means of either a mobile feed dispensing forage box or a fixed conveyor dispenser and no doubt there will be a number of developments in future to find the ideal system.

Appendix to Fig. 5

Specifications of Hay Hills and Hay Towers

Basic (manufacturers' figures)

Hay hills

Diameters 23 to 33 ft (7 to 10 metres)
Height to eaves 40 ft (12 metres)
Overall heights 49 to 53 ft (15 to 16 metres)
Cubic capacity
(23 ft dia) = 16,100 ft^3 (460 m^3)
(33 ft dia) = 35,000 ft^3 (1000 m^3)
Tonnage
(23 ft dia) = 54-64 ton at 250-300 ft^3/ton
(33 ft dia) = 130-150 ton at 230-280 ft^3/ton
Chopped hay may require up to 400 ft^3/ton
Unloading rate
(23 ft dia) 22-66 lb/min adjustable
(33 ft dia) 33-88 lb/min adjustable
Fan capacity
(23 ft dia) 27,000 ft^3/min at 2-3 in swg
(33 ft dia) 35,800 ft^3/min at 2-3 in swg

Hay Towers

Diameters 23 to 33 ft (7 to 10 metres)
Height to eaves 35 to 42 ft (10·7 to 12·75 metres)
Overall heights 42 to 49 ft (13·00 to 15·00 metres)
Cubic capacity
23 ft D x 35 ft H = 13,600 ft^3
33 ft D x 42 ft H = 35,000 ft^3
Tonnage
54 to 62 ton
140 to 160 ton
Unloading and fan capacity as for hay hills

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1. J. M. Stansfield, *CIGR/FEZ* Congress 22 July 1971.
2. C. Culpin, Journal of the *RSAE* Vol. 130, 1969.
3. J. I. Payne, *CIGR* Congress Paris 20-23 July 1971.
4. Prof. J. Strait, *ASAE* Winter meeting, Chicago, 8-11 December 1970.
5. J. A. Pascal, *CIGR* Congress Paris 20-23 July 1971.
6. J. Connell, note for Royal International Dairy Show 1970.

Fig.	Data	Data Source
1.	Labour graph 63/70	*MAFF* agricultural census (Survey Branch)
2.	Labour use (dairy herd)	Technical Committee of Provisional Agric. Economics
3.	Dairy herd group development	*MAFF* agricultural census, (Survey Branch)
3a.	Investment and return graph	P. M. Stansfield *CIGR/FEZ* Congress 1971.
4.	Barn hay cladding	J. I. Payne private communication.
5.	Hay hill	Nicholson private communication.
6.	Hay hill	Nicholson private communication.
7.	Dispenser feeders cost-length relationships	J. I. Payne, *CIGR* Congress 1971.
8.	Bridget's *EHF* mechanised feeding system	J. I. Payne, *CIGR* Congress 1971.
9.	Bridget's *EHF* mechanised feeding system	J. I. Payne, *CIGR* Congress 1971.

PIPELINE MILKING MACHINES AND MILKING SYSTEMS*

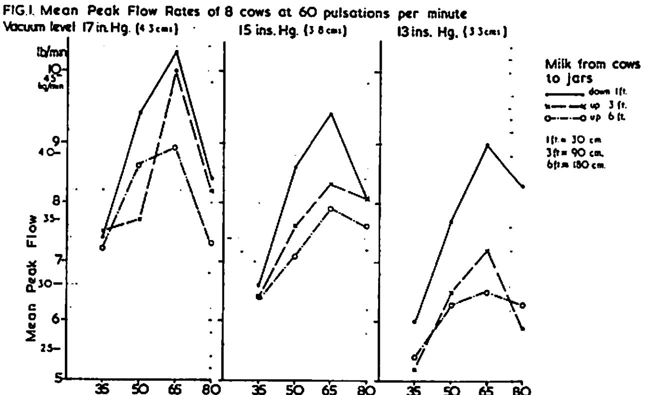
by P. A. Clough[†]

THE double action milking machine used in virtually all the installations in the *UK* has remained basically unchanged during the 68 years since it was invented by Gillies. Research and development has been directed towards improvement of the rate and completeness of milking without causing pain or injury to the individual cow. In recent years interest has centred on pipeline milking machines in two-level milking parlours equipped with five or more milking units. The herringbone milking parlour, which became the most popular design of milking parlour during the past decade, is now being challenged by rotary parlours, which are expected to lead dairy farmers into an age of so-called automation.

During machine milking the milk flow from each quarter of the udder of a cow rises rapidly to a peak flow rate which is maintained until virtually all the milk has been removed. The relative importance of adjustments to the milking machine intended to reduce milking time per cow can be assessed by measuring the effect on peak flow rate. The most important factors affecting peak milk flow rate with a particular design of teat cup cluster are vacuum level, pulsation rate and ratio, and the difference in height between the teats and the receiving jar during milking. These factors have a combined effect on the pressure changes at the apex of the teat in the teat cup liner, and the proportion of each pulsation cycle (of one second duration) when the liner is open, allowing milk to flow.

The results of our work at *NIRD*, when peak flow rates are measured with 36 different combinations of three vacuum levels, four pulsation ratios and three heights of the receiving jar, are summarised in Fig. 1. At all vacuum levels and heights of the receiving jar peak flow rate was highest with the 65 per cent pulsation ratio—the percentage of the full pulsation cycle when the liners were more than half open—and declined steeply with increasing or decreasing ratio. Peak flow rate increased with higher vacuum levels and the difference was most marked when milk was elevated 6 ft (180 cm) from the udder to the receiving jar.

FIG.1. Mean Peak Flow Rates of 8 cows at 60 pulsations per minute

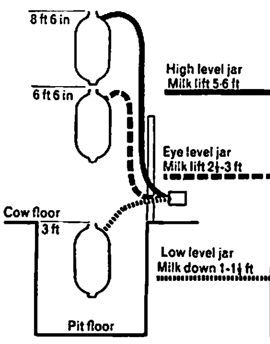


In a further experiment we measured the influence of combinations of three vacuum levels and three heights of jar with a common pulsation rate and ratio of 60 cycles per minute and 65 per cent milking ratio on peak flow rate, milking time and strippings yield.

The pattern of peak flow rates was similar to the previous experiment. The mean milking times for a mean milk yield of 23·3 lb (10·6 kg) per cow per milking are shown in Table 1 (page 18).

These data indicate that under farm conditions there would be an advantage in operating milking machines at 17 in Hg (43 cm) when milk has to be elevated 5 ft from cow to receiving jar. When it is convenient to site the receiving jars below the level of the udders of the cows there would be no benefit from operating the milking machine at a vacuum level above 15 in Hg (38 cm).

When the milking machine was operated at 15 in Hg (38 cm) the changes in milking time associated with the height of the receiving jar were relatively small and would not justify the installation of low level jars in herringbone milking parlours (see Fig. 2).



	Accurate reading of yield	Sampling or rejecting of milk	Main milk tube length	Vacuum at teat
High level jar Milk lift 5-6 ft	Difficult	Easy but inconvenient	Longest at 8 ft, no obstacle to milker	Depressed 3·5 in Hg during milk flow
Eye level jar Milk lift 2½-3 ft	Easy	Easy and most convenient	Moderate at 6 ft, no obstacle to milker	Down 2·5 in Hg during milk flow
Low level jar Milk down 1-1½ ft	Most difficult	Most difficult	Shortest at 3 ft, obstructs milker	Down ½ in Hg during milk flow

Note. Overall vacuum fluctuations similar at all jar levels

Fig. 2

The amount of milk removed as strippings by manual assistance once the machine milk flow stopper was highest at the 17 in Hg vacuum level and lowest when the vacuum level was 15 in Hg, representing between 3·5 per cent and 1·2 per cent of the mean machine milk yields.

In other work at *NIRD* we have shown that teat cup liner design and the weight of the cluster assembly influence the proportion of the milk available after let-down has occurred which is not

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Table 1

Mean machine milking times of 12 cows

	Vacuum level	(33 cm) 13 in Hg	(38 cm) 15 in Hg	(43 cm) 17 in Hg
Milk moved	up 5 ft (165 cm)	5.88 min	5.65 min	4.90 min
from cow	up 2 ft (60 cm)	5.80 min	5.55 min	4.85 min
to jar	down 1 ft (30 cm)	5.54 min	5.15 min	4.95 min

removed by the milking machine without some manual assistance.

Small volumes of milk may be retained in the quarters of an udder after every milking without depression of lactation yield and it is uneconomic to practise machine stripping in milking parlours.

The design features of teat cup liners which promote fast and complete milking have not been clearly defined, but the soft flexible mouthpiece and relatively small diameter of the simple extruder liner under tension has long been associated with efficient milking. The problems of maintaining mouthpiece rings in the correct position and the need to use back cords to prevent cups falling off the teats during milking have led to a preference for the use of moulded teat cup liners in milking parlours. During the past ten years there has been a changeover to the use of long lasting synthetic rubber in the manufacture of teat cup liners and this has been accompanied by improvements in the design of moulded teat cup liners. There are now many moulded teat cup liners which, when used at cluster assembly weights recommended by the manufacturer, will quickly remove 95-99 per cent of the milk available after let-down has occurred and rarely fall off the teats during milking.

Evidence from Eire, New Zealand and Holland has suggested that the incidence of mastitis infections is related to the vacuum fluctuations which occur from time to time in the main vacuum system of a milking machine and the cyclic fluctuations which occur in the pulsating teat cup liners during milking. Work is in progress at *NIRD* which should determine what factors affect the vacuum fluctuations which may be associated with the incidence of mastitis. Once this information is available it should be relatively easy to modify the milking machine components to avoid vacuum fluctuations. For example, an increase in the internal dimensions of the short milk tubes, claw piece and long tube would reduce the overall fluctuations and the depression of mean milking vacuum below the teat during milk flow.

Pipeline milking machines equipped with rigidly mounted, calibrated, one-piece glass jars, which are necessary to allow the milk yield of each cow to be measured and inspected before rejection or transfer to a refrigerated bulk tank, have been cleaned and disinfected either by the circulation of combined detergent and chemical disinfectant solution through the milking equipment for 5-10 minutes, or by a controlled flow of boiling water through the plant to waste for 5-6 minutes. Evidence from *NIRD* and *ADAS* experiments has demonstrated the importance of heat disinfection in both systems of cleaning. The overall costs of the two systems of cleaning are similar, but heat disinfection is properly controlled with the acidified boiling water system. Problems which arose with electric storage water heaters used for boiling water have been solved by improvements in design, material and electrical control devices. A simple and effective oil-fired boiler which will heat water to boiling point for less then half the cost involved in heating water by means of electricity is now available from Perkins Boilers Limited.

Milking Parlours

Two level milking parlours, in which the cows stand 0·75 to 1·00 m above the level of the work area of the milker, differ in the number of stalls per milking unit, the arrangement of the stalls, and whether the stalls and milking units are stationary or in motion during milking.

The majority of fixed herringbone parlours in Great Britain are two stalls per unit layouts with a single row of receiver jars along the centre of the pit at eye-level to the milker, or above the head of the milker; but since 1968 one stall per unit herringbones have been available with a row of receiver jars along each side of the parlour under the cow standings.

Milking parlours in which the cows and the milking equipment are carried on a rotating platform are all of the one stall per unit type and have been known since 1930 when the first Rotolactor was constructed in the *USA*. This arrangement is essentially an abreast parlour on a circular platform on which the cows stand side by side facing the centre of the circle. The milkers work at a lower level around the perimeter of the circle of cows. Access to the stalls is by a bridge from the collection passage and exit via a spiral ramp in the centre of the circle and a tunnel under the stalls. This is a very expensive milking installation which can only be justified where 30-40 cows are on the platform and the herd size exceeds 700 cows. Although rotolactors have been constructed in Eastern and Western Europe during the past decade there is no evidence to show that any rotolactor has been used in a profitable enterprise where milk is produced and sold wholesale.

A simple and cheaper form of rotary abreast parlour known as the Turnstyle has been developed in New Zealand and is likely to be marketed in the *UK*. Cows back off the platform when leaving this parlour, so it is possible to have a turntable of 20 ft (6·2 m) diameter to accommodate 14 cows in a building of 27 ft (8·2 m) diameter. Unfortunately a single milker on the perimeter at the cow entry point cannot observe all the milking units.

The rotary tandem parlour was developed in Italy and has tandem stalls around the perimeter of a rotating platform. The milker in the centre can observe all the milking units and deal with emergencies quickly, but in this layout each stall is 2·5 m long and a building of some 11·0 m diameter would be required for a 14-stall parlour. Rotary tandem parlours with up to ten stalls may have the entry and exit doors side by side and be rotated through a small arc each time cows are changed. These are known as carousel parlours to distinguish them from the larger continuously rotating tandem parlours. The majority of carousel parlours, marketed by Fullwood & Bland Limited, have eight stalls and eight milking units in a building of 7·5 m diameter.

The Alfa-Laval Unilactor is a form of tandem milking parlour in which the stalls are on wheels attached to a track around a rectangular pit. This parlour has been designed for one-man operation with automatic udder washing and teat cup cluster removal to allow one milker with 14-17 stalls and units to milk 100 to 120 cows/hour. This is a very expensive layout in which the milker works at one end of the pit and may be up to 12 m away from the stalls at the other end of the pit.

Rotary herringbone milking parlours have been in use in eastern Europe for some ten years. They are known as rotary herringbone parlours because the cows, on a raised platform round the perimeter of the circle, overlap each other as in a fixed herringbone parlour. This arrangement allows almost twice the number of cows and units to be accommodated in a given circle than in a rotary tandem parlour.

An inexpensive rotary herringbone parlour was constructed by a dairy farmer in Australia in 1968 to contain 13 cows and milking units in a circle 7·3 m diameter. Some difficulty was experienced in preventing more than one animal leaving the platform. A commercial version of this parlour equipped with head yokes to control the cows is now available from Alfa-Laval Ltd. This rotary herringbone parlour has 14 stalls and milking units and needs a building of 8·20 m diameter. An alternative design developed by Gascoigne Gush and Dent Ltd with 12 stalls and milking units will fit into a building 7·5 m in diameter.

At *NIRD* we have established the dimensional requirements for an 18-cow rotary herringbone and designed a platform and prototype stalls which have been installed in a sectional wooden building of 9·0 m diameter. Fullwood & Bland Limited have cooperated with us and undertaken to construct and install all the equipment for this milking parlour.

Milking Parlour Performance

The dairy farmer should have a milking parlour that will enable his herd to be milked as quickly as possible without incurring unreasonable capital and running costs. Before a rational selection of type and size can be made it is essential to understand the factors which affect the number of cows milked per man hour and then make an economic and management appraisal of the possible alternative parlours.

In a well organised parlour the milker performs the same series of manual operations for each cow milked. The number and duration of the operations in the work routine determine the time devoted to each cow, and hence the maximum number of cows which may be milked per man hour.

To realise the potential performance of the milker it would be necessary to provide a sufficient number of milking units to guarantee that the milker would never wait for cows to complete milking. To avoid excessive overmilking the removal of teat cup clusters would have to be mechanised and automatically controlled to occur at the completion of milking.

The majority of the dairy herds in the *UK* are too small to justify the capital and running costs involved for the marginal reduction in herd milking time which would be achieved. The effect of type and size of milking parlour on the number of cows milked per man hour can be demonstrated using data on work routines practised in existing milking parlours.

The herringbone layout has become established as the cheapest, most compact and most versatile of the fixed two-level milking parlours. It has been found both convenient and quicker to carry out the routine operations on all the cows in a batch and the work routine operations and times shown in Fig. 3 are based on data collected in a 10-stall 5-unit herringbone milking parlour at the *NIRD.* The manual operations listed in routine *A* cover all the requirements of machine milking, management and hygiene and can be completed in the times shown without any difficulty. Ergonomic assessment in this milking parlour when 50 cows were milked per hour did not reveal any sign of physical or mental stress on the milker. The work routine of 1·2 minutes per cow and 50 cows milked per man hour should be regarded as the lowest acceptable performance in herds of 60 or more cows.

Fig 3 COWS PER MAN HOUR COMPARISON
Work routines in herringbone and rotary parlours

	A min/cow	B min/cow	C min/cow	D min/cow	E min/cow	F min/cow
Disinfect teats	0·10	0·07	0·07	0·05	0·05	
Change and feed cows	0·25	0·20	0·18	0·15	0·15	
Foremilk	0·10	0·08				
Wash and dry udder	0·25	0·25	0·25	0·20		
*Change unit	0·30	0·25	0·25	0·25	0·25	0·20
Record yield	0·15	0·10				
Miscellaneous	0·05	0·05	0·05	0·05	0·05	0·05
Total min/cow	1·20	1·00	0·80	0·70	0·50	0·25
Max. No. cows/man h	50	60	75	85	120	240

*In one stall per unit parlour this is in two elements: take off/put on cluster.

Small adjustments to the equipment and technique of working reduced the duration of some elements and the work routine time to 1·0 minute as in routine *B* of Fig. 3.

The times of 0·8 minute and 0·7 minute per cow for routines *C* and *D* in Fig. 3 were realised by the omission of elements not absolutely essential to milking. The shortest manual work routine in a fixed herringbone milking parlour would include supervision of the movement of cows in and out of the parlour and movement of milking clusters from cow to cow resulting in the work routine *E* requiring 0·5 minute per cow to allow 120 cows to be milked per man hour.

Only one manual operation, that of putting teat cups on the teats of cows, is included in routine *F* of Fig. 3 and the time of 0·25 minute per cow would lead to the ultimate maximum performance of 240 cows per man hour.

Elements in Work Routines in Herringbone and Rotary Milking Parlours

The most vital element is that of transferring the teat cup clusters from cow to cow. The movement is across the parlour in herringbone parlours with two stalls per unit. In all milking parlours with one stall per unit teat cup clusters are removed to a parking bracket and later attached to the next cow in the same stall. The mechanisation of teat cup cluster removal operation would be essential in parlours with continuously rotating platforms.

In a rotary tandem milking parlour with six or eight stalls and milking units the platform is rotated through an arc of 60° or 45° respectively to allow for one cow to leave and one cow to enter the parlour. The work done and the distance travelled by the milker to remove the teat cups from one cow and attend to the next cow is similar to that in herringbone parlours.

The movement of cows in and out of a milking parlour is usually controlled by the milker who may also identify each animal and operate a dispenser to discharge a rationed quantity of concentrate food into each manger. The changeover of batches of cows in herringbone milking parlours is facilitated if the entry doors are open at all times, entry and exit are in line, and the internal gates remotely controlled by the milker. Less time need be devoted to identification where a colour code is attached to the cows and feed dispensers as for routine *B* of Fig. 3, or where the milker identified the number or alphabetic code branded on the cow and inserts a feed programme card or dials the code into a feed control unit as in routines *C*, *D*, and *E*.

Cows may enter and leave a milking parlour without supervision if milking units are removed automatically as the milking of a herd of cows proceeds. Each cow may wear an electronic device which identifies the animal to the decoding and feed control equipment in the parlour and may be fed automatically as in routine *F* of Fig. 3.

Cows need not be identified before if each milking unit jar is suspended from a weighing device to control food allocation according to the weight of the milk in the jar throughout milking.

Milk is less likely to become contaminated when the teats of a cow are washed and dried immediately before milking. Good housing and grazing management help to avoid unnecessary soiling of udders and teats. It would be unwise to omit washing from the work routine of the milker, but it is possible to complete cleaning in less than 0·25 minute per cow when running warm water containing a chemical disinfectant, and paper towels are available at every milking point.

Complete mechanisation of udder washing is possible in Mediterranean sub-tropical climates by means of irrigation sprinklers on the floor of the collection area. High ambient temperatures ensure that the udders are dry by the time the cows enter the milking parlour. In cool temporate climates mechanical udder washing has not proved satisfactory to date.

The immersion of the teats of each cow in a solution of disinfectant immediately after milking is the most effective means of prevention of new infections by mastitis-causing bacteria and should be included in all work routines. In rotary milking parlours in which the platform rotates continuously it would be necessary to mechanise the disinfection process by spraying disinfectant solution on the teats of each cow.

The foremilk is removed from each teat before milking because it is most likely to be contaminated, in addition it is a means of detecting clinical mastitis. This is a short duration operation and is often omitted by farmers. A more reliable indication of clinical mastitis would result from the use of a clawpiece having a transparent cover and an internal metal mesh filter through which all the milk from a cow would pass. Clots indicating clinical mastitis would be retained on the segment of the filter opposite the inlet tube from a particular teat cup and would be visible to the milker at the end of milking of a cow.

The day to day milk yield of a cow may be affected by changes in feeding, by illness or oestrus. Measurement of milk yield at every milking does provide a very sensitive check on the health of each animal but a written record is necessary for reference and this involves the milker in identifying each animal at the end of milking. Specially designed moveable equipment is necessary in a herringbone parlour but is only satisfactory where one milker is employed.

The measurement of milk yield for one day at intervals of one or two weeks would appear to be adequate for the control of most concentrate feeding regimes and may be recorded via a tape recorder as in routines *C*, *D* and *E* of Fig. 3. This is a simple operation in the parlour and a written record can be made at a less critical time of day.

In one-man rotary milking parlours with 12 or more stalls in which the platform would be rotated continuously and the teat cups removed automatically, the milker would not be in a position to observe milk yield. The milk of each cow could be discharged and weighed automatically and assigned to the cow identified on entering the parlour by a milker or automatic equipment. In situations where work routines *E* and *F* could be applied the milker would be increasingly dependent on mechanical equipment to reduce manual work and indicate anomalous milk yield and symptoms of disease.

The basic differences between one stall per unit and two stalls per unit fixed herringbone milking parlours are illustrated by the multiple activity charts in Fig. 4. Carousel rotary tandem parlour work pattern is illustrated in Fig. 5.

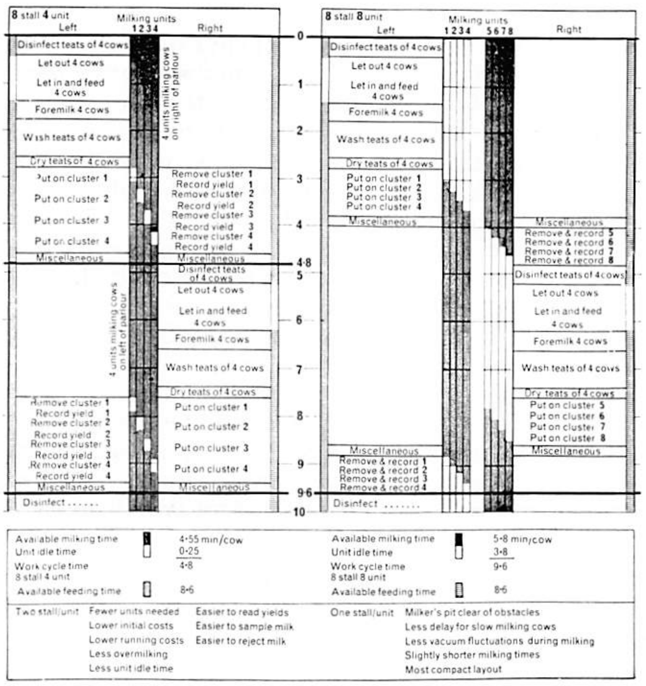
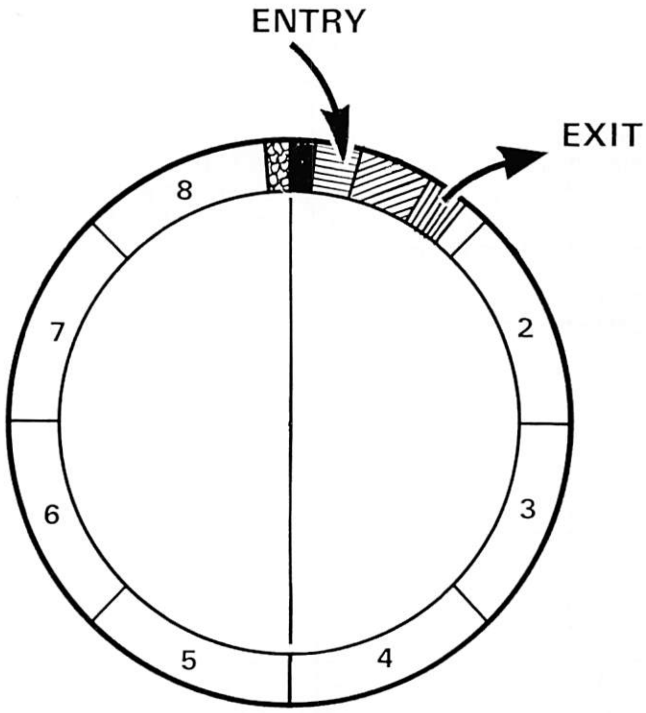


Fig. 4

The mean milking time available for each cow in each parlour for a given work routine time is shown in Table 2. In herringbone milking parlours the available milking time is longer when the parlour has one stall per milking unit and is similar to that in a two-stall per unit parlour having an additional two stall and one unit. An eight stall eight unit rotary tandem is equivalent to 12 stall 12 unit and 14 stall seven unit herringbone parlours in respect of available milking time.

The time available for concentrate feeding is dependent upon, and increases with, the number of stalls in herringbone and rotary tandem parlours

Fig. 5. Work routine in rotary tandem carousel milking parlours.



Key to shading	MAN MIN-COW
REMOVE CLUSTER	0·05
DISINFECT TEATS	0·07
CHANGE COWS AND FEED	0·18
WASH AND DRY TEATS	0·25
PUT ON TEAT CUPS	0·20

Rotation time = No. of stalls x work routine time/cow

Available milking time = No. of stalls − 1 x work routine time/cow
= Rotation time − 1 work routine time/cow

Available feeding time = Rotation time—time to change cow and feed

for a specified work routine time. In milking parlours in which the available milking times are similar the time available for feeding decreases from two stall per unit to one stall per unit herringbone

Table 2 **Effect of Routine Time on Mean Milking and Feeding Time per Cow**

Work routine min/cow	Max No. cows man/hr	Mean times min/cow	Herringbone 8 / 4	8 / 8	10 / 5	10 / 10	12 / 6	12 / 12	14 / 7	16 / 8	Carousel 6 / 6	8 / 8
1.20	50	Milking	4.6	5.6	5.8	7.1	6.9	8.6	8.1	9.3	6.0	8.4
		Feeding	8.6		10.8		12.9		15.1	17.2	7.0	9.3
1.00	60	Milking	3.8	4.8	4.8	6.0	5.8	7.2	6.8	7.8	5.0	7.0
		Feeding	7.2		9.0		10.8		12.6	14.4	5.8	7.8
0.80	75	Milking	3.0	4.0	3.8	4.8	4.6	5.7	5.4	6.2	4.0	5.6
		Feeding	5.7		7.1		8.5		10.0	11.5	4.6	6.2
0.70	85	Milking	2.6	3.4	3.3	4.3	4.0	5.2	4.7	5.4	3.5	4.9
		Feeding	5.0		6.3		7.5		8.8	10.0	4.0	5.4

layouts and is further reduced in rotary tandem parlours.

The rate at which dry concentrates are consumed by a cow is unlikely to exceed 0·45 kg/min and the time available for feeding may be a critical factor. This sets an upper limit to the amount of concentrates which may be offered in a particular type and size of parlour. We have found it possible to raise the rate of consumption to between 1 and 2 kg/min by preparing a slurry containing 2 kg of meal in 5 kg of water which cows are able to drink.

Table 3
Milking Performances Details for 80-Cow Herd Milked in 10-Stall, 5-Unit Herringbone Parlour

Mean milk yield lb/cow	No. cows milked per man hour	No. cows milked per unit per hour	Mean unit time per cow min/cow
29.3	40	8	7.5
27.1	46	9	6.5
25.0	50	10	6.0
22.9	54	11	5.6
20.5	59	12	5.1
15.0	65	13	4.6
13.1	75	15	4.0

Table 3 has been prepared from actual milking performance in the ten stall five unit herringbone parlour at the *NIRD*. The mean unit times per cow, calculated from records of the herd milk yield and total herd milking time include a unit idle time of 0·2 minute per cow, and were used to compile Table 2 and Fig. 5 which shows the highest mean milk yield at a milking at which the maximum milking performance (calculated by dividing work routine time/cow into 60 minutes) should be realised in herds of more than 60 cows.

Most commercial herds of Friesian cows in Great Britain have a herd peak milk yield of between 35 lb (16·0 kg) and 50 lb (22·5 kg) per cow per day. Mean morning milk yield does not usually exceed 25 lb (11·3 kg) per cow except where milking intervals are very dissimilar. The minimum size of herringbone and rotary tandem parlours needed to guarantee maximum milking performance at a mean milk yield of 25 lb (11·3 kg) per cow at morning milk yield are shown in Table 4. There would be no advantage from a larger installation but there would be additional overmilking of most cows in a herd.

The comparative costs of equipment for milking parlours in which available milking time would be similar are shown in Table 5 with the relative costs of buildings for herringbone and rotary tandem parlours. In normal circumstances dairy farmers with herds of up to 80 cows would choose a fixed herringbone milking parlour which would enable 50-60 cows to be milked per hour by one milker. The two stalls per unit layout with eye-level jars would be less expensive in capital and running costs, but the equivalent size of one stall per unit parlour with jars below the cows would have the advantage of a clear working area for the milker.

The eight stall eight unit carousel rotary tandem parlour operated by one man would be a reasonable alternative for herds of 100-200 cows because the additional capital cost per cow compared with an equivalent fixed herringbone layout would be relatively small. Work in a rotary carousel parlour is somewhat less complicated than in a two stall per unit herringbone and fewer units are needed than in a one stall per unit herringbone parlour for a similar milking performance. Mechanisation of teat cup cluster removal to avoid overmilking and measurement of milk yield would also be easier and less costly in a carousel parlour.

Table 4
Mean Milk Yield in lb per Cow up to which Maximum Performance is Possible

Work routine min/cow	Maximum performance cows milked per man hr	Herringbone 8 / 4	8 / 8	10 / 5	10 / 10	12 / 6	12 / 12	14 / 7	16 / 8	Carousel 6 / 6	8 / 8
											Cows / Units
1.2	50	20	25		30		35		40	25	35
1.0	60	15	20		25		30		35	20	30
0.8	75	12	15		20		25		30	15	25
0.7	85	8	12		15		20		25	12	20

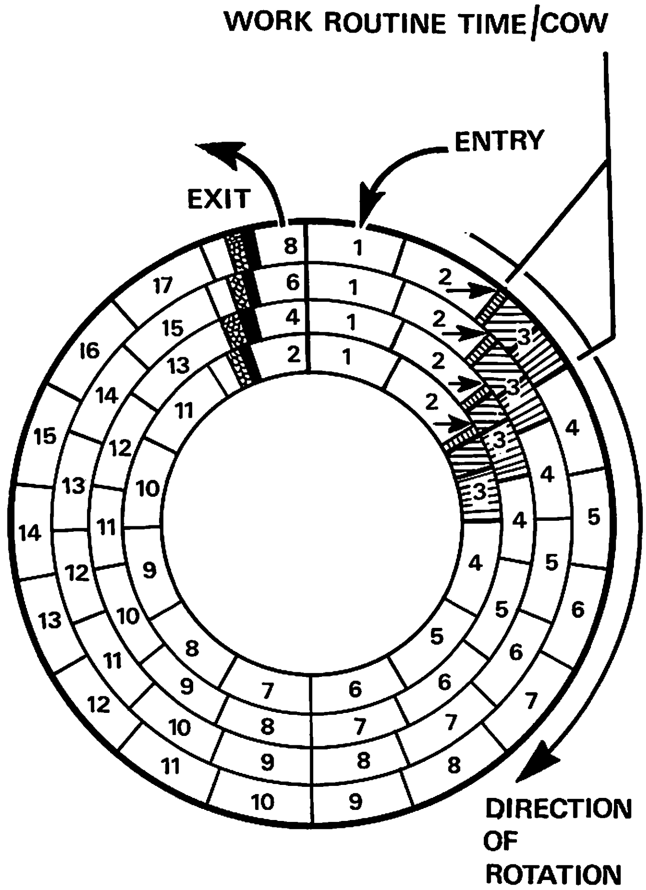
Mean Feeding Time Available Minutes per Cow

Work routine min/cow	Maximum performance cows milked per man hr	Herringbone 8 / 4	8 / 8	10 / 5	10 / 10	12 / 6	12 / 12	14 / 7	16 / 8	Carousel 6 / 6	8 / 8
											Cows / Units
1.2	50	8.6		10.8		12.9		15.1	17.2	7.0	9.3
1.0	60	7.2		9.0		10.8		12.6	14.4	5.8	7.8
0.8	75	5.7		7.1		8.5		10.0	11.5	4.6	6.2
0.7	85	5.0		6.3		7.5		8.8	10.0	4.0	5.4

Table 5
Cost of Milking Parlours

	Herringbone 8/8	10/5	10/10	12/6	12/12	14/7	16/8	Rotary tandem 6/6	8/8
Cost of milk and feeding equipment	1900	1600	2175	1790	2485	1970	2165	2800	3500
Cost of building	1000	1150	1150	1300	1300	1450	1600	1200	1800
Total (£)	2900	2750	3325	3090	3785	3420	2765	4000	5300

Fig. 6 Work routine in rotary parlours with platform continuously rotating



Assume (a) One milker
(b) Cow exit time 0·30 min
(c) Clusters removed automatically
(d) Teats disinfected automatically

Key to shading		MAN MIN-COW
	REMOVE CLUSTER	0·0
	DISINFECT TEATS	0·0
	IDENTIFY TO FEED	0·05
	WASH AND DRY TEATS	0·20
	PUT ON TEAT CUPS	0·20
	Nº OF STALL	

Rotation time = No. of stalls x work routine time per cow

No. cows milked/hour = 60 min divided by work routine time/cow

Available milking time = No. of stalls x work routine time per cow—(3 x work routine time/cow + 0·30 min)
= (no. stalls −3) x work routine time/cow −0·30 min

Available feeding time = Rotation time—(2 x work routine time/cow + 0·40 min)

Table 6

The Relation Between Work Routine Rotation Time and Maximum Milking and Feeding Time

Work routine	Maximum		Rotary Tandem and Herringbone Parlours with continuously rotating platform				
Time min/cow	No. cows milked min/cow	Time available min/cow	12	14	16	18	Stalls
			12	14	16	18	Units
		Rotation	8.0	9.3	10.7	12.0	
0.67	90	Milking	5.7	7.0	8.4	9.7	
		Feeding	6.1	7.4	8.8	10.1	
		Rotation	7.2	8.4	9.6	10.8	
0.60	100	Milking	5.1	6.3	7.5	8.7	
		Feeding	5.5	6.7	7.9	9.1	
		Rotation	6.0	7.0	8.0	9.0	
0.50	120	Milking	4.2	5.2	6.2	7.2	
		Feeding	4.6	5.6	6.7	7.6	
		Rotation	4.8	5.6	6.4	7.2	
0.40	150	Milking	3.7	4.5	5.3	6.1	
		Feeding	4.1	4.9	5.7	6.5	

Note: In rotary turnstyle milking parlours the available milking and feeding times will be as above plus 1 work routine time.

The long term aim in dairy farming must be to make further improvement in the number of cows managed per man while reducing the number of hours worked each day and the number of days per week. This can best be realised by having one person milking in a milking parlour with sufficient milking units to enable herd milking to be completed in approximately one hour at each end of a shorter working day. These larger milking parlours would of necessity be equipped with automatic devices to remove teat cup clusters and disinfect teats to reduce manual work and improve milking performance while maintaining a high standard of management. It would be relatively complicated and costly to mechanise operations in large fixed herringbone installations and increasing the size of the carousel rotary tandem parlour to ten or more milking units would be costly in terms of equipment and additional building, and the milker would still be involved in changing cows.

When 90 or more cows are to be milked per man hour considerations should be given to rotary herringbone and turnstyle milking parlours in which the platform is rotated continuously. At present these parlours are available with 12, 14 or 16 stalls and

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FUTURE DEVELOPMENTS, AUTOMATION AND AUTOMATIC CONTROLS*

E. J. Cant†

Summary

THIS paper sets out to discuss what areas of the work routine associated with feeding and milking dairy herds would repay increased mechanisation, and what types of milking parlour are best suited to the introduction of automation techniques.

The latter section deals with equipment installed at the National Institute for Research in Dairying and developed with the objective of examining the possibilities of controlling and optimising the level of concentrate fed to each cow on an individual basis throughout lactation.

Economic Aspects of Automation

Before deciding what operations associated with milking a herd should be mechanised or automated it is reasonable to consider first what areas of herd management would repay economically the introduction of some degree of automation.

Fig. 1 shows the broad breakdown in the day-to-day costs of producing milk from cows, and it is in the areas of improved feeding, better utilisation of labour and improved herd management, that we must look for savings to be produced by automation. The first of these items to deal with is feeding, since the type of solution chosen, which could be simply improved accuracy of present feeding systems, or at the other extreme a controlled system for each cow, will have secondary effects on the utilisation of labour in the form of adjustments to the cowman's work routine.

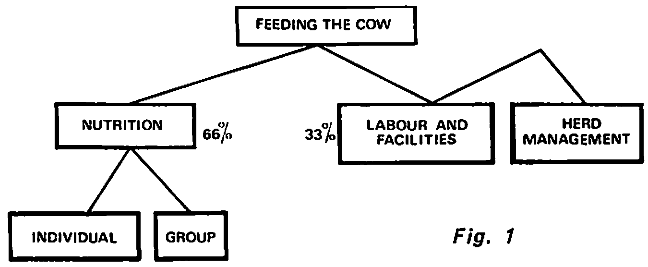

Fig. 1

The techniques in current use for determining quantity of concentrate feed given to animals vary from the extreme of ad-lib feeding to giving a feed quantity in some way related to the animal's yield.

The most widely known system of proportional feeding is probably Woodman's, in which animals are fed at a fixed rate of about 4 lb of concentrate, for every gallon of milk they produce. The calculation is normally updated at one or two week intervals, and is based on either the average day's yield during that period or a single day's yield taken at random during the period. An alternative system to this which has yielded results at least as good as Woodman's but with less information required during lactation, is that implemented by Silcock & Lever Limited.[1]

The essential items here are that each animal is fed to the peak of lactation at an average feed rate depending on whether it is classified as a high, medium or low yielder. The farmer then gives information on the yield of each animal somewhere between the sixth and eighth week of lactation when the yield would be about maximum. From this peak yield figure, the rate of decline of yield is estimated and the farmer receives information at intervals on the weekly concentrate feed each animal should be given. The decreases in feed are usually on ten steps of 2 lb per time. Of the herds participating in this system, 73·2 per cent showed an increased margin of profit of milk sold over concentrates given per cow with an average increase for all herds of £2 per animal.

Work so far has not produced any feeding systems which show a substantial improvement over these two relatively simple ones mentioned, and so savings in the simple margin of milk produced over feed given would seem at present to be available only where the ration is at present poorly estimated,

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† *National Institute for Research & Dairying.*

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milking units and the approximate cost of £500 per stall and unit involves an outlay of £6,000-£8,000 plus the necessary building. I believe the further attention to design and construction and the installation costs would enable manufacturers to aim at a price of £300 to £350 per stall and milking unit. Recognition of the vital importance of herd milking time in determining the number of workers employed and the duration of the working day should influence owners of herds of 100-300 cows to increase the proportion of the total capital invested in building and equipment allocated to the milking parlour and milking equipment. The pattern of work and the maximum available milking and feeding time per cow in relation to the number of stalls and units and the rotation time are illustrated in Fig. 6 and Table 6 on page 23.

although this would seem to be the majority of farms.

Techniques of Feeding

The techniques of feeding animals can be broadly divided into feeding the animals as individuals or dividing the herd into groups and feeding each group an amount of concentrates, dependent on the average yield performance of the group (Fig. 1).

First of all to look at the advantages of group feeding; here the identification is simple, consisting only of identifying each group, and the cowman needs only a knowledge of the group's feed requirements. The number of calculations of feed are dependent only on the number of groups in the herd and knowledge of an animal's individual yield is of very low priority and would probably be required at the most once per week.

The most obvious drawback to group feeding of animals is that, because of the spread in calving dates, to implement any form of rationing other than imprecise systems would lead to large numbers of groups, and animals constantly changing between them, thus substantially eliminating any advantage. This implies that we must be prepared to cater for animals on an individual basis and hence be able to identify them or else to feed them a proportionate amount of concentrate related to quantity of milk they give during milking.

This latter technique has been developed by one manufacturer so that for every fixed quantity of milk given, a feeder provides the cow with a related amount of concentrate. The arguments levelled against this type of device are that for a high-yielding animal the time required for her to receive food and eat it would slow down the throughput of the parlour, and additionally if the animal's yield drops substantially on any one day due perhaps to illness, she is penalised in her feed and this may produce further declines in yield.

The first objection of the extension of feeding time, could possibly be overcome by providing the animal with a liquid feed, which it has been found she can eat at about three times the rate for dry feed, but the second difficulty cannot be solved without prior knowledge of roughly what the animal should have and this again leads to the necessity of identifying the animal.

If then we are to feed the animal on an individual basis, requiring that she should be identified, we must decide on the basis of the design of feeding system we shall use what other information is necessary.

Work at the Institute on feeding systems has demonstrated that the knowledge of the animal's peak yield is sufficient to enable the animal to be fed to achieve 80 per cent of the total possible yield during lactation, but it is felt that a knowledge of yield should enable the feeding system to be improved by a further ten per cent.

So the position would seem to be that whereas at present there is little justification to record daily yields for each animal, from an experimental viewpoint it would prove valuable. It is impossible to estimate accurately what savings could be gained by improved yield due to better feeding, but probably a pessimistic estimate for a 100 cow herd would be, say, £500 using Silcock's average figures for improved margin plus an allowance for labour saved and better herd management.

Choice of Milking Parlour

To consider now savings in work routine time by mechanisation of jobs, it is necessary to decide first of all which type of milking parlour we should consider: on present performance the choice is substantially between the herringbone or rotary. The most attractive advantage of a rotary over a herringbone parlour is that each operation on the animal need only occur at one particular position, and the routine of operating the parlour is controlled by the equipment and not by the cowman.

These advantages are obvious if we consider the operations which could conceivably be mechanised: these are, in order: recognising the cow; allocating feed; udder washing; possibly milking end point detection; cluster removal; and yield measurement. Dealing with these in turn, the first job of recognising the animal occurs in a herringbone parlour at the most pressurised part of the work routine. At this time the previous cows are being let out and teat-dipped, and the new batch are entering, and front and back gates must be operated at the appropriate times.

In a rotary parlour only one animal enters at a time and is dealt with by the cowman before the next cow enters. It can be seen that in a herringbone, to add the task of identifying animals manually from numbers on collars or flanks would impair the parlour performance still further, and the only alternative to this is automatic identification. The only equipment commercially available at present is expensive, of the order of £3,500 for a 100-cow herd. In the rotary it is more feasible to accept that the cowman has time to enter identities manually on switches or pushbuttons.

The second job of allocating feed is dependent for both parlours on electrical equipment once the identity is known, but whereas a herringbone might require ten feeders, the rotary will need only one. This ten-to-one ratio also applies to udder washing and possibly to cluster removal although it might be reasonable to assume that it would be worth installing two or three such devices in a rotary to prevent severe overmilking. Yield measure need only be done at one position, unlike say a 5-unit herringbone which would require a measuring device at each unit.

There are, then, several good economic reasons for considering rotary rather than herringbone parlours, particularly a rotary herringbone with its smaller diameter than a rotary tandem and hence its lower initial cost.

Data Acquisition

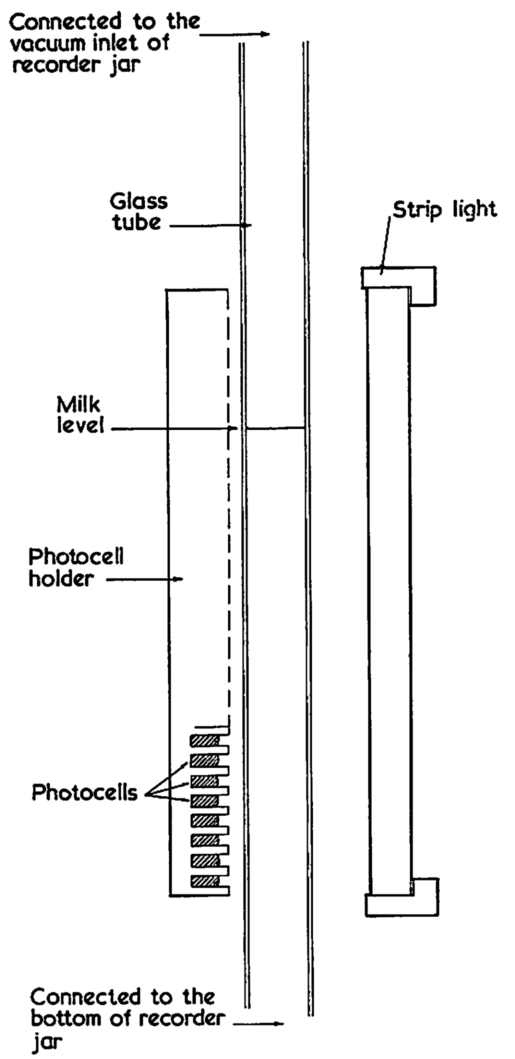
Looking now at the third item, management, in which we might be able to obtain benefits by automation, the farmer would need to have access to a computer in which longer term information such as trends in milk production, summaries of the performances of cows with completed lactations, cows which have been calved for 6-8 weeks and are due for service, number of cows in milk and dry, etc., could be stored and analysed.

At the outset of the work in connection with the herringbone parlour we were fortunate enough to have the co-operation of the National Institute of Agricultural Engineering and during the project a computer was made available to us by the *NRDC*. This to some extent affected details in the direction we took with the work subsequently. It was decided to build equipment to measure the animal's yield and then, with the addition of identifying equipment, either manual or automatic, present this information to the computer which would calculate each animal's ration and control the feeding arrangements, in accordance with some particular feeding plan.

Yield was measured volumetrically using a number of photo-conductive cells to scan a side tube attached at top and bottom to the receiver jar (Fig. 2). Each receiver jar has a measuring device, and as the cowman operates the valve to transfer milk, the volume of milk is recorded and the information stored, by the equipment, so that when all jars have

Fig. 2

MILK MEASURING EQUIPMENT
THE DIAGRAMMATIC LAYOUT



YIELD RECORDS MORNING MILKING

8 January 1971

Weighed quantity of milk in jar lb	Instrument reading
UNIT 1	
22·5	23
14·1	14
27·6	28
33·0	33
7·3	7
UNIT 2	
15·0	15
25·1	25
13·7	14
8·0	8
18·9	19
UNIT 3	
12·5	12
13·8	14
21·5	22
26·1	26
49·6	50
UNIT 4	
14·8	15
24·0	24
33·6	34
28·3	22
14·2	14
UNIT 5	
14·4	15
10.0	10
25·9	26
28.3	28
40·4	40

Fig. 3

been emptied the yields are transmitted in binary code to the computer in stall order, regardless of the operating sequence of the valves.

To identify the animals, there is a manual panel with two decade switches on which the animal's number is set and these are entered to the computer by pushbutton. In addition, automatic identification equipment manufactured by Teledictor for Fullwood & Bland has been installed in the milking parlour at the Institute (Fig. 4).

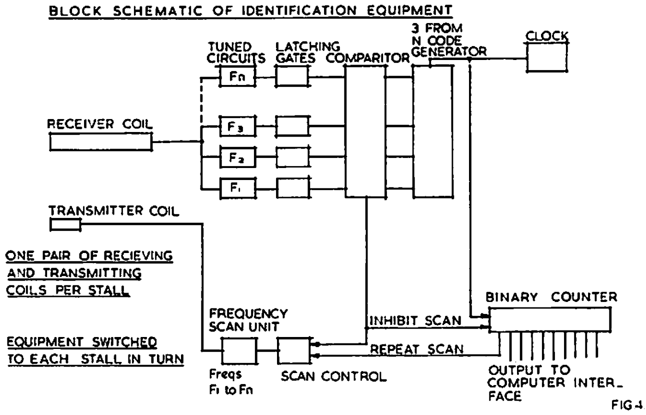


FIG 4

The identifying device on the animal consists of three tuned circuits attached to the cow's collar. These circuits are each tuned to one of a number of frequencies being transmitted across the manger in the parlour; the receiving and transmitting coils are aligned such that a minimum signal is normally received. When the animal's collar is inserted between transmitting and receiving coils a signal is received which consists of the three frequencies, to which the coils in the identifying device are turned out of the total number being transmitted. Hence for a ten-frequency system the total number of different combinations of three different frequencies available would be:

$$\frac{10 \times 9 \times 8}{3 \times 2 \times 1} = 120$$

The received signal is decoded and presented both as a display number and as a binary number to the computer. The computer programme controls the acceptance of information from the parlour and then performs a calculation for each animal to update its feed. This calculation is dependent on the average weekly yield for the preceding three weeks and at what position on the lactation curve the animal is at. The operation of the complete system is best described with the aid of the block diagram Fig. 5 and the timing diagram Fig. 6.

Before milking the computer rests in a quiescent condition awaiting an initiating signal from the

BLOCK SCHEMATIC OF PARLOUR CONTROL EQUIPMENT

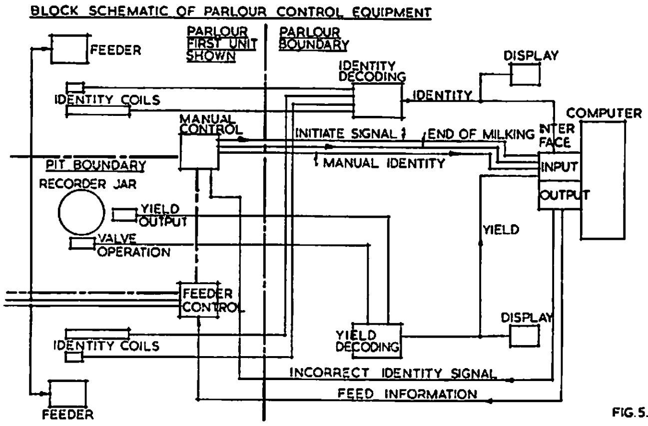


FIG. 5.

cowman's control panel, together with the information that the gates at each end of the parlour are closed. On receipt of these signals the computer begins interrogating the output lines from the identifying equipment, looking for the first animal's identity. When this is received and all identity lines have returned to logic 0 it stores this number and looks for the second identity.

This procedure continues until all five identities have been received. The computer then correlates these identities with the feed quantity it has previously calculated and, after selecting which side of the parlour is to be fed, operates all five feeders simultaneously via the equipment in the manual feeder control box.

The feeders used deliver a fixed quantity of feed for each electrical impulse received, and so the computer output is simply a number of pulses suitably amplified by the interface equipment.

For the first parlour filling cows are let into both sides simultaneously, and so the computer now switches to the other side of the parlour and repeats the procedure of identifying and feeding. When this has been completed the computer now awaits the arrival of yield information (Fig. 3) (page 26).

Data Recording

The yield recording equipment is continually scanning each measurement unit and storing this information in stall order in a shift register. The

RELATIVE TIMING OF RECEIPT OF INFORMATION BY THE COMPUTER FROM HERRINGBONE PARLOUR

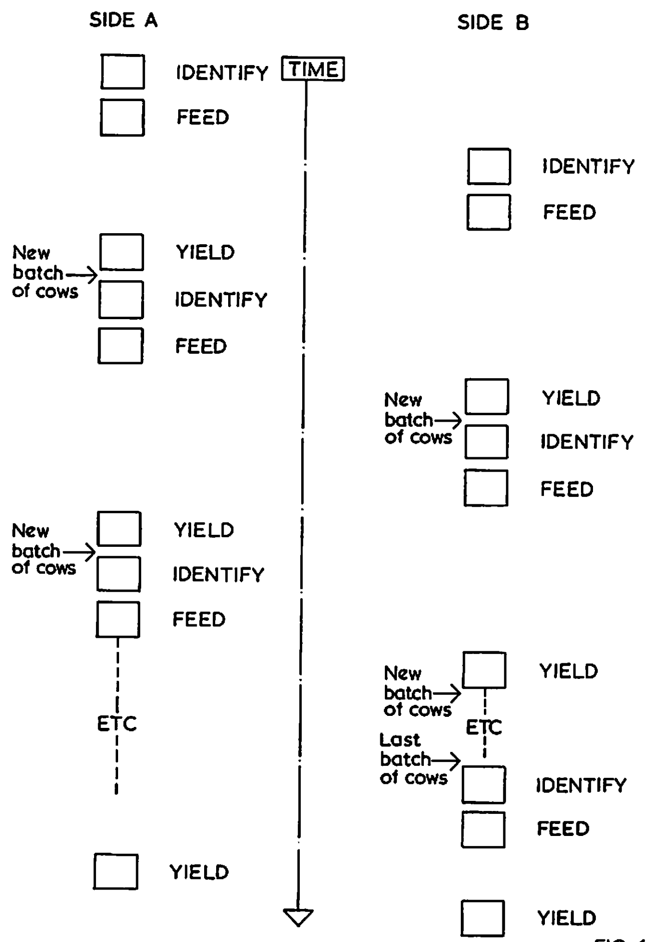


FIG. 6.

scan rate is set at one unit/second and each unit must register the same yield twice in succession before it can update the store: this gives a measure of error protection from transient noise. At the bottom of each receiver jar and close to the valve is mounted a proximity detector, so that when the cowman begins to operate the valve to empty the jar a signal is received by the yield recording equipment which locks the latest reading for that jar in the store.

When all five valves have been operated, the yield information is clocked from the store and is received by the computer in stall order, regardless of the operating sequence of the valves (Fig. 7). This equipment is then reset by the back gate switches. The computer correlates the yield information with the first set of five identities it recorded and stores these ready for use in updating the feed requirements.

The five animals whose yield has been recorded are now let out of the parlour and a new group enters; the computer looks for these identities and feeds them and then transfers its attention to the other side of the parlour and awaits the yield information from these animals. This sequence to identify side *A*, feed side *A*, record yield side *B* and then identify side *B*, feed side *B*, yield side *A*, is repeated until the herd has been milked, at which point the cowman operates a switch to indicate that milking has finished. Provision is made for manual entry of identity from the parlour, and if, due to any fault such as a cow's transducer missing, an identity is not received. Then after a short interval the computer signals to the parlour which cow has not been identified by stall number. The cowman can then enter the correct number manually, after which the computer returns to its normal programme.

System of Feed Calculation

The feeds for each animal are recalculated by the machine after each seven days' milking. The calculation of animals' feed performed by the computer is based on the following system. Animals are initially fed up to the peak of lactation at a rate of 5 lb of concentrate per gallon of the previous week's average yield. The peak is detected by the computer and at this point an artificial lactation decline curve is computed for each animal at a rate of $2\frac{1}{2}$ per cent compound decrease per week, and limits to this curve of 1 per cent are calculated.

A comparison is made of the week's yield with that predicted by this model, and if the actual yield is outside the 1 per cent limit a correction is made in the feed in an attempt to persuade the cow to return to the predicted level of yield. When the week's yield has fallen by 20 lb from the last change of feed the feed is reduced to maintain the animal on the theoretical curve. To build in safeguards against severe changes in animal yield from those predicted, maximum and minimum quantities of concentrate per gallon yield are set, together with provision for computing a new decline curve should the animal go drastically above or below her predicted yield and show no signs of returning during a period of three weeks.

Future Work

This equipment will be operated throughout the current lactation to assess its performance and reliability, after which it is intended to experiment with various feeding systems, to obtain more information on techniques of rationing animals.

BLOCK SCHEMATIC OF YIELD DECODING EQUIPMENT

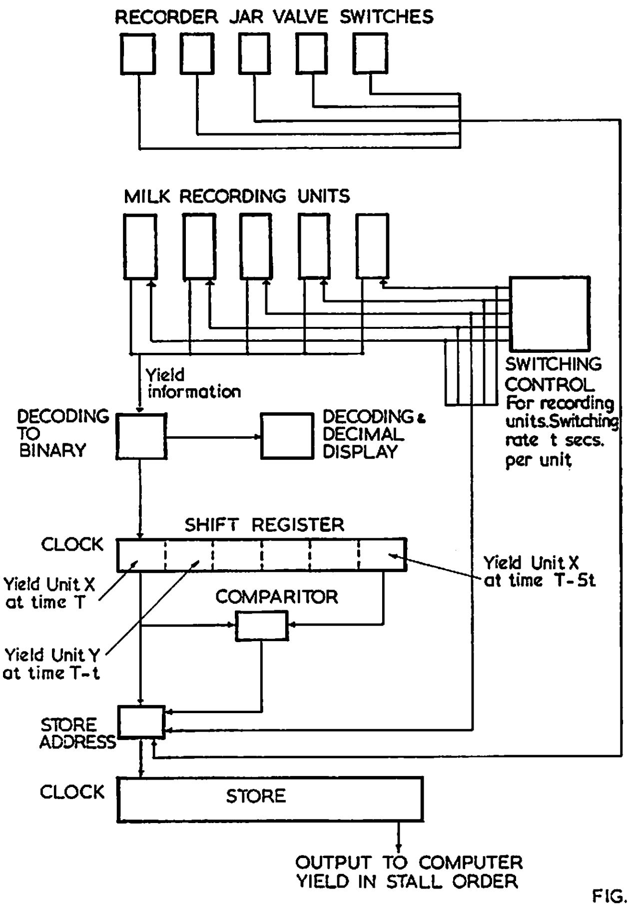


FIG. 7.

Operating experience so far has shown certain difficulties with the animal identification equipment. These problems have been mainly concerned with maintaining coil alignment in the parlour.

Reference

1. Silcox & Lever Feeds Limited, Dairy Colloquium. 10 November 1970.

ENGINEERING FOR MILK PRODUCTION

Edited Summaries of Discussions

Following Paper by G. F. Shattock

R. Q. Hepherd (National Institute of Agricultural Engineering) said that storage of slurry gave rise to problems, particularly when the storage period was prolonged to, say, two to six months. Mr Shattock had given an excellent description of the methods currently in use to overcome these problems. But Mr Hepherd wanted to question the necessity for storage of slurry in its natural state, although there were obvious reasons why this was done at present.

His suggestion was that slurry should be treated in such a way as to permit daily application at very low rates, approaching the rate of natural rainfall or lower, throughout the year, thus enabling the land to absorb the slurry without run-off. This could be done by changing the physical characteristics of slurry. A possibility currently under investigation at the *NIAE* was separation of the solid from the liquid fractions before spreading or storage. The resulting liquid was thin and easily pumped. Equipment for a separation of this kind was now becoming available, and Mr Hepherd would be glad to hear views on the practicability of this approach.

He also asked if it were not the case that lined, rubber or plastics lagoons were almost impossible to empty by mechanical means without damage being caused.

R. G. Gent (Bristol) asked about the dilution that was recommended in applying silage liquor to the land, and what effect an application of 750 gal/acre would have.

Mr Shattock replied that the reference in his paper was to the application of neat silage liquor. Higher rates of application could be used if it were diluted, but 750 gal/acre should not be exceeded. This figure represented only 1/30th in and was hardly noticeable on the surface. Mr Shattock thought it might be advantageous to apply the liquor to the land from which the silage was taken to restore any mineral or other material it might contain.

So far as Mr Hepherd's question on the need to store slurry was concerned, in his paper he had said that he doubted if any kind of treatment for cow slurry was normally necessary, because the stocking rates for dairy herds were usually low enough for sufficient land to be available to receive the slurry. With pig and poultry units, however, this was often not so, and treatment of the excreta was necessary. In his experience these effluents were easier to treat than cow excreta. Storage as a thick liquid until it could be applied to the land at a favourable time of year was quite practicable, in his view. Selection of the best time for application was important, and there was some evidence favouring March.

Referring to lined lagoons, Mr Shattock said he thought they were only suitable for treated liquids. He did not know of a mechanical method of emptying such lagoons.

C. V. Brutey (National Farmers' Union) suggested that developments were needed in mechanising the removal of solid material from buildings and yards. Once the solid manure was outside the building there was a range of equipment available for stacking it, and spreading it on the land, where it had a beneficial effect in terms of both physical properties and manuring. He suggested that too much attention had been given to slurry systems and not enough to the question of moving solids to points from which subsequent handling could easily be arranged.

J. R. Swift (Challow, Berks) asked if Mr Shattock could comment on the possibilities offered by mixing quicklime with poultry manure.

Mr Shattock regretted he had no information on this technique. Replying to Mr Brutey, he said that he was very much in favour of handling manure as a solid, if it could be kept solid. But where cows were self-fed on silage, roofs leaked, drinkers leaked, milking parlours were washed down, and so on, the manure very soon acquired a thin porridge-like consistency. Any farmer who had sufficient straw could use this to soak up the excess liquid, but unless some material of this type was available, handling some liquid at least was inevitable. He knew of no disadvantages in handling manure as a solid, except on all-grass farms, where it was difficult to get the solid manure to rot down.

Following Paper by C. Dobson*

Dennis Warren (farmer, Oxfordshire) opening the discussion, said that Mr Dobson's title *The Effect of Machines on Dairy Building Layout* gave him an urge to present another paper on *The Effect of Machines on Dairy Unit Managers* in which he would advocate avoiding the use of machines as much as possible. He believed it was very easy for highly-mechanised farmers or managers to spend far too much time keeping the machines going and not enough on the cows and on milk production itself. A major difficulty could arise from piece-meal buying of machinery. In fact, it was desirable to buy all the items of equipment required for a particular operation as a complete system.

Turning to specific points, Mr Warren said there was a need for equipment designed to handle long-cut grass, including forage boxes. Self-fed silage systems, he thought, would continue in existence for a long time to come.

Mr Warren was impressed with Mr Dobson's suggestions on the provision of kerbs to prevent damage to buildings, and on the use of gulleys to avoid having to turn corners with a manure scraper blade, an implement which he thought should be used in straight lines.

In his view, large amounts of slurry could only be handled by pumping systems, and he would like to ask if there was not a need to develop pumps which would handle slurry in a thicker form. Another important point was to design the collection yard so that it was easy to scrape or flush down. In the latter case the provision of multiple connection points for high-pressure hoses, located in the fence line rather than on the walls of buildings, could be very helpful.

Finally, Mr Warren emphasised that there was no point in spending a great deal of money on further mechanisation to enable milking staff to carry out the job more quickly, unless there was also a profitable opportunity to make use of the time saved.

F. E. Goldsmith (Alfa-Laval Limited) said that designers had given a great deal of attention to requirements for cleaning milking equipment, but not sufficient, in his view, to the design and layout of the equipment in relation to its primary use for milking. Mr Dobson, commenting on Mr Warren's remarks, said floor levels and floor and wall finishes were important, as muck was a very adhesive material. At Bridgett's Experimental Husbandry Farm it had been found, for example, that power hoses were initially more effective on painted unrendered surfaces than on painted rendered surfaces.

He went on to say that it was most important to liaise with the milking machine manufacturer to obtain the optimum layout in a milking parlour. But thought must also be given to the removal of muck. Very often much time and money were spent on the first, and too little on the second. He agreed with Mr Warren on the importance of wall finishes, although it might seem to be merely a detail to cost-conscious farmers; in his experience it was the little details that tended to cause most trouble.

In the trial of wall finishes at Bridgett's, cleaning the unrendered surfaces by hand took much longer than cleaning the rendered surfaces; in all cases the surfaces were painted. But as soon as the pressure hose system was installed the position changed and the hoses removed muck from the unrendered surfaces more quickly. The lasting qualities of the various paint treatments differed considerably, and some were still almost as good as when they were first applied four or five years earlier.

Replying to a question from Mr Clough as to what was meant by a high-pressure hose system, Mr Dobson said that at Bridgett's *EHC* the pump for the slurry irrigation system was connected to a 2 in flexible hose, terminating in a 1 in galvanised pipe. Mr Shattock added that at Bridgett's the pressure at the nozzle was only 5 lb/in^2, at 60 gal/min. Mr Clough emphasised that high volume, and not high pressure, was what was required.

Mr Dobson agreed with this comment and added that an area of concrete approximately to 1/5 acre could be hosed down in 15-20 minutes.

U. G. Curson (Norwich) suggested that a uniform gradient from the milking parlour through to the collecting yard was undesirable, because that led to considerable dilution of the slurry. Was it not better to intercept the washing water used in the milking parlour to avoid this? If the interception point was carefully chosen, the water would not be very dirty.

Mr Dobson said that the possibilities varied from farm to farm, but it was normally quite easy to arrange for interception. However, the washing water could not be regarded as clean.

R. Q. Hepherd said that the questions concerned with pumps suitable for thicker slurry and with disposal of waste water were linked together. The slurry from the floor of a covered cubicle house was almost impossible to pump through an organic irrigation system without being diluted, and extra water (including parlour washings, etc.) was required to make it pumpable. The main advantage of the separation process he had referred to earlier was that it made the liquid fraction of the slurry easy to pump. This was surely a better approach than trying to design pumps to handle a particularly difficult liquid.

Mr Shattock said that he agreed with Mr Hepherd that if the coarse solids could be removed from slurry, this left a material that could be handled by many different types of relatively cheap pumps. If one insisted on trying to pump slurry of 12 per cent or more dry matter content, in a condition he would describe as thick porridge, the cost of the pump and the associated problems would far outweigh any advantages from minimising the water content.

W. Barnard (Alfa-Laval Limited) asked what had determined the area of concrete between the cubicle buildings in a plan shown by Mr Dobson, which seemed excessive and merely to extend the area on which slurry was spread and the time required to deal with it. Some planners put large areas of concrete on both ends of the building.

Mr Dobson replied that the dimensions were directed by the turning circle of vehicles, such as forage boxes, entering the feeding area. A minimum allowance for turning tractors and trailers would be 25 ft (7·6 m), and future developments in the design of this kind of equipment might demand more. Assuming forage wagon feeding was under consideration, a concrete turning area at both ends of the building was necessary, but it was not necessary for both ends to be covered in slurry. Depending on the falls, layout, etc., it should be possible to limit the area of slurry.

J. R. Swift (Challow, Berks) said that the discussion had concentrated mainly on the back end of the cow, but in his

**Mr Dobson's paper appeared in I AGR E, Vol. 26, No. 4, Winter.*

experience far too little attention was given to the storage of concentrate feed and the mechanical feeding of cows in the milking parlour. Daily he received drawings in which no space was provided for bulk storage, or the layout necessitated a costly and tortuous conveying system to the feeders. He suggested that more attention should be given to this aspect.

Mr Dobson said that very often a bulk bin could be inset into the area of the building, and Mr Clough said that building the parlour block parallel to the cubicle unit had two advantages—it reduced the area of concrete subject to fouling and it solved the problem of locating bulk storage hoppers without placing them where they would be in the way of mobile equipment moving food or scraping slurry. It was also possible to achieve a directional pattern in which food was taken into the building from one end, effluent was removed at the other, and cows could circulate at either side of the parlour.

Mr Dobson agreed that the parallel layout suggested by Mr Clough was suitable up to herd sizes of 120-150 cows. Beyond that it would be better to have the two units separated. It was a question of scale. Mr Clough replied that he would recommend the parallel layout for herds of up to 300 cows or more.

F. Roberts (Big Dutchman Limited) said that building layouts frequently did not allow sufficient headroom. The plan was acceptable, but the elevation inadequate, and this resulted in having to use more expensive conveying equipment than would otherwise be necessary. He hoped this point would be noted.

Referring to the question asked earlier by Mr Swift, Mr Roberts said that a system of adding quicklime to manure had been introduced by his company. This involved using two timed augers and a mixer to add one part of quicklime to ten to 15 parts of manure. This controlled smell and reduced the volume considerably from the original volume. This was achieved in a storage period of up to 24 hours, the mixer discharging on to a concrete apron, and manure could be kept for long periods in this state.

R. Hayward (farmer, Oxfordshire) said that he wished to make a plea for slurry tankers, forage boxes and other machines that did not block up, and were reliable, and did not incorporate large areas of sheet metal which made it difficult to carry out proper maintenance.

Tony Quick (*ADAS*, Wolverhampton) asked that in view of the illustrations already shown of the dairy unit at the Nettlebed Estate (designed by Dennis Warren) and the mechanised dairy unit at High Copse Farm, *NIRD* (designed by Peter Clough)—and bearing in mind the title of his talk, whether Mr Dobson had any comparative costs/cow or diary buildings layouts designed to accommodate wheeled transport for feeding, cleaning out, etc., (including equipment costs and additional concrete required for turning circles, etc.) as against those for fully mechanised layouts requiring no wheeled transport.

Mr Shattock pointed out that the solid manure mechanical equipment had the advantage over liquid handling equipment in that it was less disastrous in the event of breakdown. So far as reliability was concerned, machines could be made more reliable if farmers were prepared to pay higher prices for them. However, he agreed with the point of Mr Quick's question, which was that tremendous areas of concrete were put down, and that the cost of keeping them clean was very high.

Mr Clough said that cubicle layouts were becoming increasingly popular, and prefabricated, standardised layouts were most desirable. Up to the present time it had been very difficult to find a company to supply complete installations—parlour, cubicle house, feeding equipment, manure handling system, etc. What was wanted was a range of standard outfits for different sizes of enterprise, which a farmer could order as a package deal from a single supplier, whose job it would be to ensure that he supplied an integrated, compatible system.

Mr Dobson said that such development would take place gradually. A draft British standard on preferred dimensions for farm buildings was in preparation. The extent to which farmers and manufacturers would voluntarily limit their requirements and designs to the preferred dimensions would, in the end, determine whether or not standardised plans and layouts were produced.

Mr Clough said that some so-called package-deal buildings and equipments were already on offer, but in his view these tended to fall short of the fully-integrated systems he envisaged. There was still not enough contact and co-operation between the manufacturers of the various different components of such systems.

Mr Dobson said he accepted the desirability of the package-deal system. In practice, site work presented very real difficulties, and a firm based at one end of the country had great difficulty in co-ordinating the site work by a local contractor perhaps 200 miles away. Half or more of the total cost might be in the site work.

J. M. Stansfield (deputy director, University of Reading Farms) said that farmers themselves were often to blame, in that they were inclined to insist on modifications to the standard layout, to incorporate special features. It was up to the advisors to emphasise that such departures from the standard plan involved a risk of prejudicing the performance of the unit. In the end, it was the cowman who had to try to make a dairy enterprise work, and Mr Stansfield felt strongly that he should be brought into the discussion of a design at an early stage.

Following Papers by P. Clough and J. I. Payne

F. E. Goldsmith (Alfa-Laval Limited) said that he felt sure everyone would agree with Mr Clough's conclusions on the height of recorder jars. Some so-called low-level parlours only warranted this description because there was no place to put the jars other than low down, in the muck. Modified designs could no doubt be achieved which met all the required features without this disadvantage.

It was difficult to decide quite what the farmer's criteria were in selecting a milking parlour design, and particularly in assessing the advantages of a rotary parlour. Other factors had to be taken into account than milking more cows or producing more gallons per man hour, one of which was operator fatigue—the cowman had been described as the most important animal on the farm

For the rotary parlour concept to be successful, it must provide a complete system, carried to its logical conclusion by including automatic teat-cup removal. One difficulty which was still outstanding was the variation in milking time between cows, although it might be possible to control milking time mechanically so that the units remained on every cow for the same length of time.

M. J. B. Turner (National Institute of Agricultural Engineering) said that he had been very interested in the conveyor feeding systems described by Mr Payne, but as had already been mentioned by Mr Roberts, he felt that there could be a conflict between the physical requirements of conveyor systems and the building designs described by Mr Dobson. How could this be resolved, and would Mr Payne like to comment on the figures for labour requirement quoted by Mr Dobson for conveyor/feeder systems? Mr Turner also asked if it was thought that zero-grazing would be adopted more widely in the *UK* and whether this might lead to feeding of green crops directly or from some kind of storage. These questions had important implications for the type of machinery required.

Mr Payne said that he felt a misleading impression had been given about conveyor dispenser feeders. He believed the conveyor dispenser feeder could be expected to work with only about 20-30 per cent of the labour content of other mechanised feeding systems, although he agreed that such a saving did not necessarily justify the additional capital cost. It should be remembered that there was little difference in the costs of storage as between a deep clamp system and a concrete tower system, excluding the cost of the unloading equipment. It was important to decide what is required in terms of feed blending facilities and then one had to be careful to compare all the relevant points in drawing one's conclusions on the merits of widely different methods of feeding silage.

The problem with zero-grazing was the additional management skill and time required to ensure that the crop could be provided consistently over a given period of time. Work was proceeding at the Grassland Research Institute, Hurley, on preservation of grass with formaldehyde and formic acid. This or similar developments might lead to the possibility of adopting a treatment for all the grass harvested. This would allow very high rates of harvesting to be achieved, enabling the whole grass crop to be harvested at the optimum stage of growth and ensiled direct or if the grass was to be dried then the peak flush of grass might be put into a buffer store. He would be very interested to observe further progress along this line.

Mr Clough said that the unilactor system was the nearest approach to a complete rotary milking system, but in his view the price was too high. The challenge to designers of rotary parlours was to produce an acceptable system at a cost of not more than £300-£400 per cow place, as any higher figure would not compete with the herringbone parlour.

There was no doubt that very good throughputs could be achieved with fixed herringbone parlours, and on Dennis Warren's farm one man was milking 250 cows twice daily without undue strain.

Mr Clough thought that automatic cluster removal should be developed both for rotary parlours and for carousel types; there were several relatively simple ways in which it might be done.

On the question of the choice between layouts in fixed herringbone parlours, Mr Clough thought there might be a case for placing the jars at ground level in the centre of the pit, with the pipes ɪunning below a sub-floor. Automatic cluster removal, swinging the clusters to the centre of the pit, would then be a possibility, whereas with other layouts it would be very inconvenient.

It was difficult to obtain a high enough throughput with a fixed herringbone arrangement, except with a very large installation, involving movement of the operator over long distances. If it was really necessary to milk 90 - 120 cows/man hour a rotary layout offered the best possibilities, but he would recommend a rotary herringbone or turnstile arrangement for compactness. In any case, he felt that commercial adoption of these systems would probably not gain momentum for several years.

Following Paper by E. J. Cant

N. Fairey (farmer, Hants.) said that farmers must be grateful to agricultural engineers 'for their past efforts. The question of reliability had already been mentioned, and he hoped future design would concentrate on this aspect. The milking machine was a marvellous example of a reliable piece of equipment, working for 365 days a year with very little servicing and giving very little trouble.

Some of the systems described at the conference were complicated and a bit frightening to farmers. The cost of milk production was now very high, with farm costs of £200/cow, the price of the cow itself at one cow per acre £150, and a further cost of about £200 for the milking parlour and equipment. He doubted if many farmers were making a net profit of more than £40-£50/cow, which was a return of only 7½ per cent on the capital investment of £550 represented by the figures he had quoted. He did not think milk production could stand much more in the way of further costs for the types of equipment described in some of the day's papers, especially as milk production was still rising and the effects of entry into the Common Market could not yet be predicted.

Referring to specific points arising from the conference, Mr Fairey said he was delighted that the right priorities had been selected and that Mr Shattock had dealt first of all with getting the muck away from the cows. He thought simple systems of handling were usually the best, and regretted that pond or lagoon storage had been so briefly dismissed, "as likely to sludge up after perhaps 5 years". These storage systems appealed to farmers and he hoped further investigations into their use would be carried out.

However, treatment plants were likely to become essential in some cases, and in some areas pressure from local authorities would drive farmers into installing them. He asked if perhaps farmers and engineers should even now approach local authorities for grants to be made for experimental work in this connection, and possibly for installations. The residues from livestock were still of value on the land, and the costs of inorganic fertilisers were increasing.

Mr Dobson's paper was interesting and practical in its approach to levels and falls and some of the small details which were important in a dairy enterprise. The order of priorities had been clearly established also, which was easy enough to do in planning a new installation, but this was not so easy when expanding existing set-ups. Many dairy farmers were in fact expanding their enterprises, and a vital feature in any new installation was to allow for expansion. Mr Fairey reminded Mr Dobson that farmers were not yet familiar with metric units, and suggested that dimensions should be given in feet and inches as well.

Turning to Mr Payne's paper, Mr Fairey said that the cost of mechanical feeding equipment was alarmingly high, and he again stressed the need for reliability. Some feeding systems were not yet sufficiently reliable, possibly because they were designed down to a price rather than up to a standard. In this connection, he thought that farmers were no longer always buying the cheapest possible equipment, but were prepared to pay a little more for machines of proved reliability.

Barn drying of hay was likely to be increasingly adopted in the future, and Mr Fairey suggested that where on-floor grain drying installations were available they could possibly be used to dry hay as well. He was not convinced that the costs of tower silo systems and clamp systems were similar, as Mr Payne had suggested, and in any case the problem with tower silage was wilting the material to 40 per cent dry matter so that the unloading equipment would work. He had difficulty in making silage of 30 per cent dry matter in covered clamps, and he doubted if 40 per cent dry matter was feasible, for climatic reasons. On the other hand, he believed self-fed silage, supplemented with brewer's grains and other feeds, could give yields of over 1,200 gallons/cow, and that it was a system that would still be adopted for some time to come. Dried grass, however, would certainly be more in demand if entry into the Common Market caused feed prices to rise.

He was interested that Mr Clough had condemned milking parlour layout with low-level jars, which confirmed his own opinions and experience. However, he did not agree with Mr Clough that achievement of the maximum number of cows milked per man hour was the only important objective in milk production. High yield/cow and good stockmanship went together, and a good stockman had an indefinable ability to get milk out of cows. This was derived partly from close contact with the cows, and would be lost with a factory approach to milking. What mattered was economic milk production, not simply speed.

Mr Cant's paper was fascinating and even though some of the terminology was unfamiliar, automation in the milking parlour must be considered seriously, provided the cost was acceptable. Mr Fairey questioned the need for concentrate feeding in the parlour. However, if it was arranged to take place elsewhere a yoke system with individual rationing could be allied to a simple visual identification system, and the cowman would not be pushed for time in operating the system.

Mr Fairey also referred to the problems of breakdown of elaborate systems, such as those based on computers. Would it be possible to get technicians to come out at 05 30 on a Sunday morning? Would it be necessary to employ *BSc's* rather than ordinary cowmen in the dairy in future?

Finally, Mr Fairey said that he felt sure that agricultural engineers were fully aware of the problems facing the farming industry, and that farmers were grateful for their efforts. Again, he stressed the need to make haste slowly and to select engineering techniques which were reliable in practical circumstances without being unduly expensive.

S. W. R. Cox (head of Control and Instrumentation Division *NIAE*) said that, apart from the possibilities offered by computers in controlling operations in the way Mr Cant had described, there were a number of ways in which they could be used to aid management of the farm.

H. P. Puckett (United States Department of Agriculture and University of Illinois) said that he had found the theme of the conference of great interest, since he had been engaged in parallel work on automation of milk production. In his view, the dairy farmer deserved the same standard of living as anyone else, which meant that he should work fewer hours to produce more milk than at present. This could only be achieved by automation, utilising sensing systems to draw attention to the abnormalities which should claim the cowman's attention, rather than routine matters.

Mr Payne, replying to Mr Fairey, said that his figures on the comparable costs of tower and bunker silos were based on densities of silage of 430 lb dry matter/yd^3 in tower and 225 lb/yd^3 in bunkers. The capital cost of silos then worked out at £60·50/cow for a covered clamp, £51·30 for a vitreous-enamelled steel tower and £41·30 for a concrete tower, excluding unloading equipment.

Mr Clough said that the yokes referred to by Mr Fairey might appear to offer a simple basis for individual feeding, but in his experience cowmen did not like using them because of the additional time and effort involved in disturbing measured quantities of food to each cow.

John G. Shipman (Field Development Adviser—*AHFITB*) said that he felt more emphasis should be placed on the automation of stockmanship.

He went on to suggest that the cowman and relief man would be able to deal more effectively with larger numbers of cows if the priorities of accurate feeding, and identification of oestrus, early stages of mastitis and predisposing causes of illness and disease, could be aided by automatically monitoring such things as the milk yield, composition and other physical characteristics of the cow.

John Matthews (Tractor and Machine Division, *NIAE*) said that he wished to draw attention to health aspects of work in connection with milk production. In particular, the ergonomics section at the *NIAE* had been investigating the incidence of mental stress among cowmen working in herringbone parlours, especially in relation to the discrepancies noted between potential and actual rates of cow throughput.

They had found no evidence of undue stress, and had concluded that it would be difficult to find a more contented and highly-motivated body of workers than milkers. However, alongside this observation they had come to the conclusion that milking staff were finding ways within the milking routine to lose a little time and avoid overload, which achieved the observed state of contentment and accounted for the loss of performance.

it was interesting that when cowmen had been asked to indicate what they felt were sources of stress, it was in the keeping of records that the greatest stress appeared to lie. This suggested that efforts should be concentrated on monitoring milk yield, breeding and health records rather than on automation of physical tasks such as cluster removal.

Mr Clough, concluding the discussion, said that while a cowman had to be in attendance he could easily look out for mastitis and oestrus, and he saw no point in arranging automatic means of putting on the clusters. Milk and feed records could be made simply on magnetic tape, and transcribed later. Engineers should concentrate on improving the mechanical aspects of the equipment before tackling the animal health monitoring suggested by Mr Matthews.

Douglas Bomford Trust

IT is regretted that the announcement about the Douglas Bomford Trust in the last issue of *I Agr E* was in some respects premature.

The establishment of the Trust was formally announced on 9 May 1972, and it became fully operational on 10 May.

Display advertisements are now being accepted for the Summer issue, published 15 July. The copy date for these and all Editorial contributions is 1 June. Branch secretaries please note the latter.

INSTITUTION NEWS & NOTES

ERB—The Register is Open

ABOUT 800 members of the Institution are now eligible for registration by the Engineers' Registration Board (*ERB*), if they so wish, and those concerned will receive letters about it in a few weeks time. These notes are intended to follow on from the article in the Newsdesk section of the *Journal*, Vol. 26, No. 1 p. 6, and to remind all members of what is involved.

ERB has been set up by the 15 institutions comprising the Council of Engineering Institutions (*CEI*) and a large number of other engineering institutions, including the Institution of Agricultural Engineers. Its function is to register the names of properly-qualified engineers in three Registers. These are:

1. Chartered Engineers, entitled to the designation *C Eng*.
2. Technician Engineers, entitled to the designation *T Eng (CEI)*.
3. Engineering Technicians, entitled to the designation *Tech (CEI)*.

Eligibility

At the present time only suitably-qualified members of the 15 *CEI* institutions are entitled to be registered as Chartered Engineers (*C Eng*). Membership of *I Agr E* does NOT constitute an eligible qualification although every effort is being made to find a route by which those members and fellows qualified at the level of a degree in agricultural engineering may be so registered.

The registers now open to the 800 members mentioned are the *T Eng (CEI)* section and the *Tech (CEI)* section. The requirements for *T Eng (CEI)* will normally be satisfied by members of *I Agr E* in the member grade, although certain experienced graduates and highly-qualified technicians associates will also be eligible. All technician associates will normally meet the requirements for *Tech (CEI)*. Institution members in the fellow grade will also normally be eligible for *T Eng (CEI)* registration—but see "Who should register?" below. Because the requirements for registration depend in part on training and experience there will be a number of members who are offered registration initially in a lower register than the one to which they will aspire eventually.

Cost and Benefit

The arrangements made by *ERB* provide for an annual fee to be paid by individual institutions for participation in each register, plus an annual fee for each registered member. The Institution of Agricultural Engineers will meet these costs through an annual registration fee of £1 payable by each eligible member who wishes to be registered. Eligible members who nevertheless do NOT wish to be registered as *T Eng (CEI)* or *Tech (CEI)* are under no obligation to pay this annual fee which is, of course, additional to their subscription as members of *I Agr E*.

The benefit to be dervied from registration is the security and satisfaction to be obtained from national recognition as an accredited technician engineer or engineering technician, with the right to use the abbreviated designation after one's name.

Who Should Register?

It is hoped that a substantial proportion of eligible members will consider that the benefits of registration are worth the relatively small annual charge. As their careers develop, some of those in Register 3 will become eligible for transfer to Register 2. In due course, when a means is available for opening Register 1 to members of non-*CEI* institutions who are qualified at degree level, transfer from Register 2 should be possible. In regretting that the *C Eng* register is not immediately available to us, we have to remember that we are in the same position as a substantial number of other engineering institutions outside the *CEI* ring fence and that the pressure to find a means of admitting suitably-qualified members of these institutions is very considerable. The building of such a bridge into this jealouslyguarded compound is bound to be a difficult and protracted process, but remains the ultimate logical step in the integration of the engineering profession as a whole.

Consequently, Institution members who already meet the criteria for designation as Chartered Engineers, but cannot yet be registered because they are not members of a *CEI* institution, may feel that they would not wish to accept registration in the *T Eng* register, even though fully entitled to it.

Members who do not yet meet the *C Eng* criteria, or who do not expect to have the opportunity to do so, but are eligible for other registers have everything to gain by claiming their right of admission to the *T Eng* or *Tech (CEI)* sections. Admission can be requested at any time, but will be dealt with most expeditiously for those now eligible, and with the minimum amount of form-filling, if advantage is taken of the opportunity to register with the large initial batch of registrations under *I Agr E* sponsorship.

AROUND THE BRANCHES

East Anglian

THE annual dinner dance of the East Anglian Branch of The Institution of Agricultural Engineers held at Park Hotel, Diss, Norfolk, on 16 February 1972, attracted about 90 members and their friends.

Guests of the Branch included *IAgrE* President Claude Culpin and Mrs Culpin; Norfolk *AMTDA* Branch chairman Colin Bramwell and Mrs Bramwell; Suffolk *AMTDA* Branch chairman R. Allen; *IAgrE* Secretary Harold Weavers and Mrs Weavers. Also attending were representatives of machinery manufacturers and dealers, farm machinery lecturers, *ADAS* advisory officers and *MAFF* safety inspectors.

East Anglian *IAgrE* Branch chairman Urban Curson welcomed guests in a short speech, to which the President responded.

Dancing by candle-light due to a power cut was to the Barry Tatum Trio.

Writers' Guide for Farm Machinery Instruction Books

ON 16 March the East Anglian Branch launched its writers' guide for farm machinery instruction books, having spent two years in its preparation, during which time support from farm machinery manufacturers in the *UK* and from abroad was overwhelming.

Over a hundred copies of the new writers' guide were sold before publication date.

The recommendations which can be summed up in eight words—keep it brief, simple and easy to read, are summarised below.

Operator instruction books should be printed A4 or A5 on a paper which does not suffer from farm conditions. Line length should be short for easy reading, pages should be clearly numbered and headings printed in bold type. The covers should protect the text. The binding should allow the book to be flat when opened. Books should be sealed in a plastic bag.

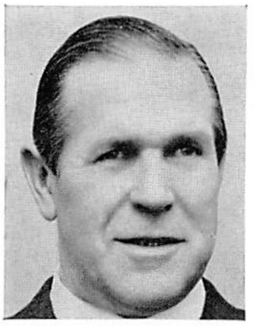
The layout should preferably be in the following order and include the following items: title, publication number, illustration for identification, list of contents, safety precautions, explanation of left and right hand and space for recording identification numbers. Installation of new equipment, preparation for operation, operation, maintenance and storage procedure. Accessories, spare parts list, specification and data, charts, space for notes.

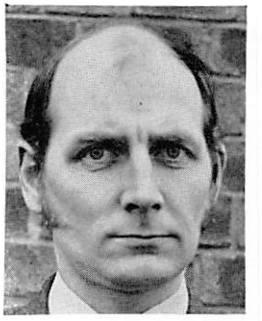
The writer should appreciate who his reader is and where he is going to use the book. Text should be brief and precise. Words should be short and simple. Abbreviations should be avoided. All dimensions should be given in metric *ISO* units with the imperial equivalent in parenthesis. The use of capitals should be kept to a minimum. The draft should be checked by a non-engineer.

Good, clear illustrations should be used and where possible, to reduce the text, should be adjacent to relating text.

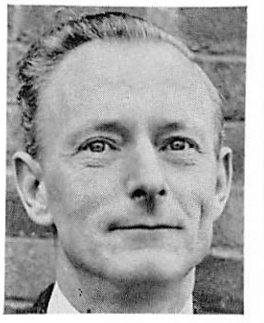
Copies are available at £1·75 from John Mott, Education Office, County Hall, Norwich NOR 49A.

PERSONAL





Above: J. D. Elstone



Above right: A. N. Curry

Right: W. Swift

THE new manager of product engineering and service at Howard Harvestore Ltd, Saxham, Bury St Edmunds, Suffolk, is **A. N. Curry** (27) who was previously service manager. He now assumes responsibility for product performance which will also include site planning, drawing office and spare parts control.

W. Swift (43) who has been working for the Rotary Hoes Group for 14 years, the last seven with Howard Harvestore, is the new field service manager responsible for all field work in the *UK* and service training of overseas distributors.

MATTHEWS & YATES LIMITED, Cyclone Works, Swinton, Manchester, manufacturers of on-floor crop drying systems, have recruited **T. D. Dewes FIAgrE** to their technical sales department. As agricultural advisory officer he will provide customers with technical advice on all the company's agricultural products.

Mr Dewes has for many years been machinery advisory officer with the Ministry of Agriculture, and has extensive experience in all forms of on-floor and in-bin crop drying.

THE assistant managing director of David Brown Tractors Ltd, Meltham, **J. Douglas Elstone OBE FIAgrE**, has recently retired thus realising a lifetime's ambition to retire at the age of 60 so that he might devote more time to his many leisure pursuits.

Mr Elstone joined David Brown Tractors as director of marketing in 1959, in which capacity he travelled extensively in many parts of the world. He held the position ten years before being appointed assistant managing director. He was awarded the *OBE* in 1967, is a Fellow of the Institution of Agricultural Engineers, a Liveryman of the Worshipful Company of Farmers, and a Freeman of the City of London.

He has had long association with the farming industry, and been a member of several *SMMT* and *BSI* committees, and for several years was a member of the Council of the Association of Agriculture. He has been a member of the Council of the Agricultural Engineers Association since 1960 and was president in 1963/64.

He was a member of the British delegation to the Joint Assembly of the European Committee of Associations of Manufacturers of Agricultural Machinery (*CEMA*) from 1962 to 1970 and leader from 1963 onwards. In 1963/64 he was chairman of the Royal Smithfield Show Joint Committee, chairman of the National Power Farming Conference in 1967, and elected a member of the British National Export Council for Europe in 1970.

THE INSTITUTION OF AG

AUTUMN NATION

Combined with a *CIGR*

SUGAR BEET AND POTATO

to be held at the NATIONAL COLLEGE OF A
on 2, 3 and 4 O

Convenor: Professor P

2 October

ASPECTS OF THE MECHANISATION OF THE SUGAR BEET CROP

Chairman: C. Culpin (Past President *IAgrE*) and
British National Representative on *CIGR*.

A Survey of European Production of Sugar Beet

by J. Jorritsma, Instituut voor Rationale Suiker Productie,
Bergen op Zoom, Netherlands.

Developments in the Mechanisation of Soil Preparation and Establishment of the Sugar Beet Crop

by M. Martens, l'Institute Belge pour l'amelioration de la
Betterave, Tienen, Belgium, and
D. R. Brisbourne, Agricultural Development, British Sugar Corporation, *UK*.

Discussion

Trends in Sugar Beet Harvester Design and Systems of Handling

by W. Brinkman, Institut fur Landtechnik der Universitat Bonn, W. Germany.

Performance Assessment of Beet Harvesting Machinery

by G. Maughan, British Sugar Corporation, *UK*.

Discussion

ꞮICULTURAL ENGINEERS

ꞮL MEETING 1972

ꞮSection III Meeting

PRODUCTION IN EUROPE

ICULTURAL ENGINEERING, Silsoe, Bedford,
tober 1972.

Ꞓ. J. Payne *(NCAE)*

3 October	**VISITS ARRANGED BY THE BRITISH SUGAR CORPORATION** **or** **ASPECTS OF THE MECHANISATION ON THE POTATO CROP** Chairman: P. C. J. Payne
	A Survey of European Production of Potatoes by J. M. Glotzbach, Commodity Board for Potatoes, The Netherlands.
	Aspects of Soil Preparation and Planting for the Potato Crop by D. E. van der Zaag, European Association for Potato Research, and F .E. Shotton, Terrington Experimental Husbandry Farm, Norfolk, *UK.* **Discussion**
	Recent Developments in Potato Harvesting Machinery by D. McRae, National Institute of Agricultural Engineering, Scottish Station, Penicuik, *UK.*
	Performance Assessment of Machinery for the Potato Crop by I. Rutherford, *ADAS* Liaison Unit, *NIAE*, Silsoe, *UK.* **Discussion**
4 October	**Visit to the Potato Marketing Board Harvester Demonstration, Driffield, Yorkshire.**
Note	Simultaneous translation facilities in French, German and English will be available for all the paper presentations.
Conference Dinner Speakers:	J. A. C. Gibb, President Institution of Agricultural Engineers and F. Coolman, President Section III *CIGR.*

PUBLICATIONS RECEIVED

Combines Operation and Adjustment

THE Canadian Department of Agriculture's publication 1464 1972 *Combines Operation and Adjustment* by O. H. Friesen, an agricultural engineer in the Manitoba Department of Agriculture, deals with the principles of combine operation, pick-up and feeding adjustments, threshing adjustments, problems and possible causes and harvesting of special crops. It runs to 30 pages and is obtainable from the Information Division of the Canada Department of Agriculture, Ottawa K1A OC7.

Scientific Reports of the Agricultural College of Norway

THE most recent reports from the Agricultural College of Norway are numbers 22-30 volume 50 dated 1971. Number 22 by S. Frogner and K. Aastveit is entitled *Induced Mutations in Hexaploid Wheat;* number 23 by K. Ronningen, A. Bekken and T. Gjedrem is entitled *Results from a Sheep Crossbreeding Experiment;* number 24 by Henrik Solbu and Jostein Wiggen is entitled *Mating of Heifers at a Young Age;* number 25 by Finn Mage is entitled *Bud Dormancy in Cultivars of Fruit Trees and Bushes;* number 26 by Olav M. Benestad is entitled *Frozen Earth Indication;* number 27 by Ola Syrstad is entitled *Selection for Protein Content in Milk;* number 28 by Olavi Junttila is entitled *Seed Quality and Germination of Seed Lots of some Ornamental Shrubs Collected at Different Localities in Norway;* number 29 by Johannes Opstvedt and Thor Homb is entitled *Studies on the Nutrition of Skim Milk-Barley-Feed Calves—1. Effects of Mineral Supplementations;* and number 30 by Egil Berge is entitled *Frost Loads on Forage Silos in Norway.*

Scientific reports from the Agricultural College of Norway are obtainable from The Library, Agricultural College of Norway, N-1432 As-NLH, Norway, at an annual subscription of kr 15.00.

Annual Report of Swedish Institute of Agricultural Engineering

BULLETIN No. 342 1971 of the Swedish Institute of Agricultural Engineering entitled *Annual Report of the Swedish Institute of Agricultural Engineering 1970/71,* is in two parts, the first part of 69 pages is entirely in Swedish while the second part is an English translation comprising some 43 pages, which also includes a list of available publications from the Swedish Institute of Agricultural Engineering.

As the Swedish edition contains illustrations, both parts are necessary to English readers.

Copies are obtainable from the Swedish Institute of Agricultural Engineering, Ultuna 750 07 Uppsala 7, Sweden.

Agricultural Engineering

THE February 1972 issue of *Agricultural Engineering,* the journal of the American Society of Agricultural Engineers, contains articles on *The Human Use of Technology* by Dr Melvin Kranzberg; *The Employment Status of Agricultural Engineers* by John D. Alden; and more details of the *ASAE* 10 year safety plan.

The journal is published by the American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, Mich. 49085, *USA.*

Top Link

THE members' magazine of the Norfolk Farm Machinery Club, *Top Link,* volume 25 number 3 March 1972, which is edited by John Mott, carries a report of the technical day held recently at the Norfolk School of Agriculture, and a short illustrated feature on power take-off guards.

Copies from the Norfolk Farm Machinery Club, County Education Office, County Hall, Norwich NOR 49A.

Journal of the Farmers' Club

THE February 1972 issue of the *Journal of the Farmers' Club* includes a profile of W. J. Cumber *CBE* by R. Trow-Smith. Mr Cumber is the senior member of the Farmers' Club and is now over 93 years of age and has been in farming all his life.

Copies from The Farmers' Club, 3 Whitehall Court, London SW1A 2EL.

Potato Quarterly

THE Potato Marketing Board in February issued their first *Potato Quarterly.* It is introduced by J. E. Rennie, the board chairman, and continues with news of interest to members. Viewpoint is written by Alex F. Yeaman who deals with the future of potatoes, and from abroad is a feature dealing with American growers' problems. The technical report deals with the production of healthier potatoes and then there is a short feature on the various varieties.

Copies from the Potato Marketing Board, 50 Hans Crescent, London SW1X 0NB.

CME

THE April issue of *CME (The Chartered Mechanical Engineer)* has three articles which have some interest to the agricultural engineer. *Down With Maintenance? Ten Simple Thoughts on the Complex Subject of Terotechnology,* deals with the installation, commissioning, maintenance, replacement and removal of plant, machinery and equipment, and runs into four pages. *Stirling Engines—the Second Coming?* by G. Walker *PhD BSc CEng,* deals in four pages with the Stirling engine as a future prime mover, cooling engine, heat pump and pressure generator. It is well illustrated with line drawings and photographs. The third feature *Pollution in Perspective* by E. G. Semler *BSc CEng (Fellow)* deals with all forms of pollution from poisoning of the air and soils to noise.

The journal is published by the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London SW1H 9JJ.

The Transport Engineer

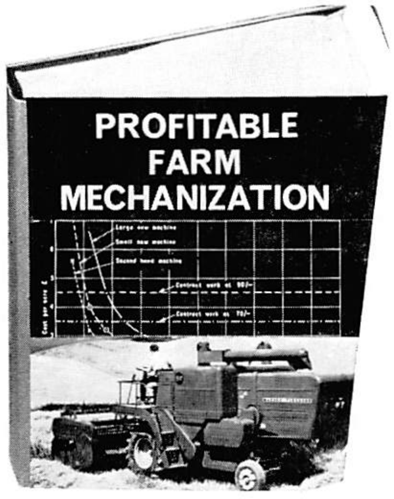
THE April 1972 issue of *The Transport Engineer,* the journal of the Institute of Road Transport Engineers, contains an article by J. D. Savage *CEng MIMechE AMIRTE* entitled *The Contribution of Future Vehicle Power Units to the Reduction of Air Pollution.* This runs into four pages and is fully illustrated. A second feature by W. M. Scott *CEng MIMechE* is entitled *Diesel Engine Development to Avoid Air Pollution,* and this is well illustrated and covers three pages.

The journal is published by the Institute of Road Transport Engineers, 1 Cromwell Place, Kensington, London SW7 2JF.

FORTHCOMING EVENTS

May/June	
31/1	National Grassland Demonstration, National Agricultural Centre, Stoneleigh, Warwickshire.
June	
7	Grass Silage Demonstration, Norfolk School of Agriculture.
8-13	*ELMIA* 72 International Trade Fair for Agriculture and Horticulture, Jonkoping, Sweden.
20/23	Royal Highland Show, Edinburgh.
28/29	National Institute for Research in Dairying Open Days, Shinfield, Reading.
July	
3/6	Royal Show, National Agricultural Centre, Stoneleigh, Warwickshire.
10/21	Short course in Aerial Photographic Interpretation for Land Resource Appraisal, National College of Agricultural Engineering, Silsoe, Bedford.

Profitable Farm Mechanization (340 pages, 89 illustrations) shows how the profit on most farming operations can be improved by the *right* choice of the *right* machinery. It provides valuable costing tables, goes into repair costs, useful life of equipment, the question of sharing little used equipment and the advantages of machinery syndicates.



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THE INSTITUTION OF AGRICULTURAL ENGINEERS
EDITORIAL UNIT, PENN PLACE,
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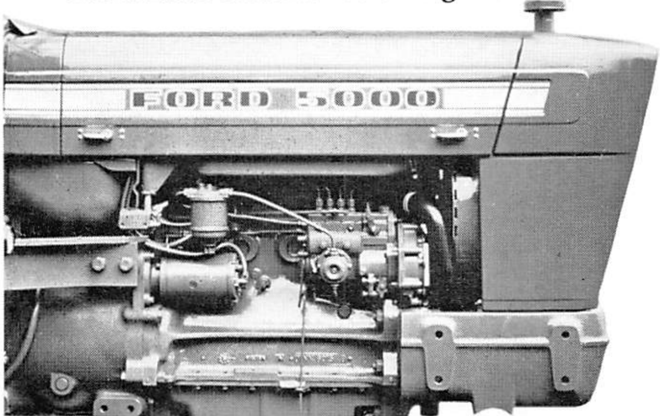

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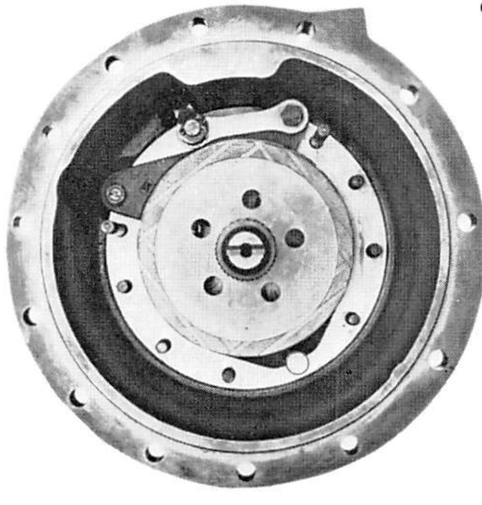

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