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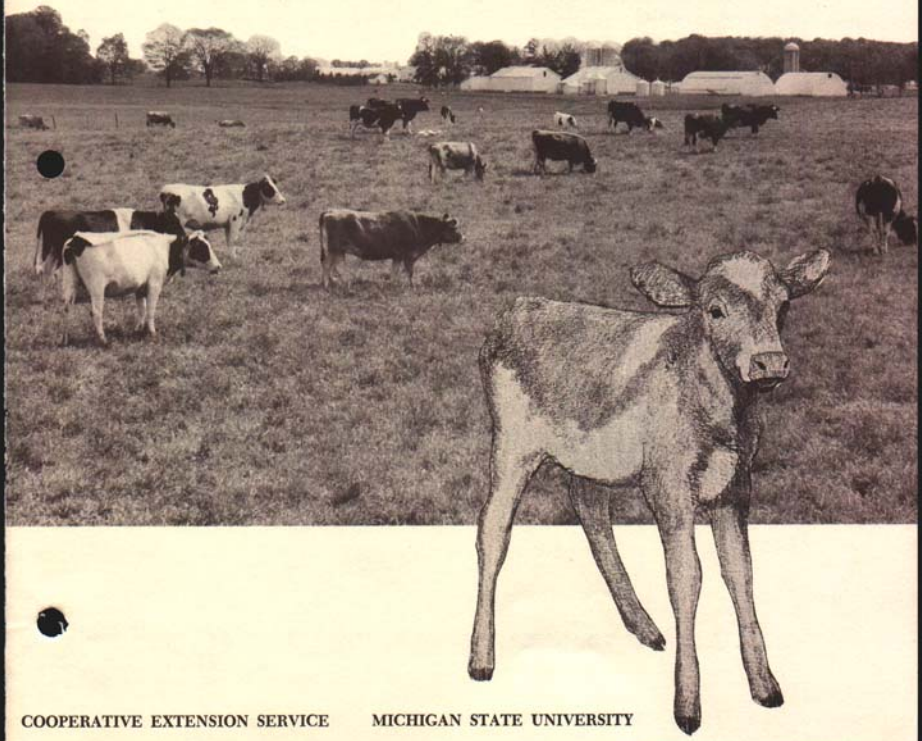
RAISING CALVES

to improve the dairy business



COOPERATIVE EXTENSION SERVICE MICHIGAN STATE UNIVERSITY

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RAISING CALVES

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Successful calf raising is an essential step toward maintaining and improving the dairy business. It results in:

(1) more calves to choose from for upgrading the dairy herd
(2) greater income from calf sales
(3) herd replacements when they are needed
(4) no cash layout for herd replacements
(5) no danger of buying disease troubles.

This bulletin consists of three major sections:

1. General herd management: pre-calving, calving, feeding and nutrition;

2. Health management and calf diseases: identification of several diseases with suggestions for prevention and control;

3. Calf and maternity housing: discussion of heat and moisture problems and importance of planning in maternity area, starting barn, growing pens and treatment stalls.

1. General Management Guidelines

THE HEALTH OF A DAIRY CALF begins before birth and demands the dairyman's alert attention through maturity and beyond. This section offers some general guidelines along this route to successful dairy production.

MANAGEMENT OF THE PREGNANT DRY COW

The health and nutritional status of the dam before calving influence the health and vigor of newborn calves and the ability of the cow to recover from the stress of calving. The following considerations deserve attention from the herdsman.

Udder Health — Check the health of the udder at the last milking prior to drying off to be sure it is free of mastitis. Cows often carry an udder infection during the dry period and develop clinical mastitis at or near calving. Such infections may jeopardize the health of the cow and the newborn calf. Treat the dry cows as recommended by your veterinarian.

Diet — Pregnant dry cows must receive a diet that provides adequate energy, protein, minerals, vitamins and water. The content of these nutrients will vary in forages depending on the species of forage, its maturity when harvested, the availability of nutrients in the soil and the amount of damage that occurs during harvesting and storage.

The successful feeder must know these nutrient requirements and the nutrient composition of various feedstuffs. In addition, he must recognize significant variations in the quality of feeds and make the necessary adjustments in the ration to balance the diet properly.

Basic principles for feeding the dry cows are given below. See Extension Bulletin E-667, "Diets for Pregnant Dry Cows" for further details.

Energy — Pregnant dry cows should be in reasonably good condition at calving time but must not be excessively fat. Energy requirements as total digestible nutrients (TDN) or Net Energy (NE) are propor-

tional to normal body weight (See Bul. E-667). In general, good quality hay crop forages fed free choice will provide adequate energy for dry cows. Corn silage may be very high in energy, depending on its grain content, and normally should be restricted to 4.5 to 5.0 lbs. per 100 lbs. of body weight when fed as the only forage. Feeding grain to dry cows is generally not necessary except as required to balance the diet of low quality forages, and exceptionally high producing cows that are thin when they begin the dry period. The observant feeder must adjust the ration as required.

Protein — The protein requirements of pregnant dry cows are proportional to body size. The requirement for 800-lb. cows is about 2.0 lbs. of total crude protein per day and increases to 2.7 for 1,600 lb. cows. Good quality legume, and legume-grass forages fed free choice or according to energy requirements will normally meet the protein requirements. However, when haylage has been overheated in storage and appears dark brown to black, the protein becomes largely undigestible and must be supplemented with good quality protein to prevent protein deficiency. Corn silage and low quality grass hay are normally low in protein content and generally require supplemental protein when fed as the only forage. Corn silage treated with 10 lbs. urea per ton as ensiled, or a similar quantity of nitrogen from anhydrous ammonia, as contained in ProSil, is a satisfactory feed for pregnant dry cows when adequately supplemented with minerals and vitamins.

Failure to provide adequate protein can result in serious muscle and liver degeneration in cows, and low resistence to disease in the offspring.

Minerals — Calcium, phosphorus, salt, iodine and other trace minerals must be provided in adequate quantities. Trace mineralized salt fed free choice or at the rate of 2 ounces per head daily will normally provide the salt and trace mineral requirements.

Feed a mineral supplement containing calcium and phosphorus in the appropriate proportions to complement the forages fed so that the total ration contains about 2.3 parts calcium to 1 part phosphorus by weight to help prevent milk fever. Alfalfa hay may be very high in calicum and require only phosphorus supplementation, whereas corn silage is low in calcium and requires supplemental calcium and phosphorus.

In some cases feeding 1 to 2 lbs. of wheat bran (Western grown) or linseed meal may be desirable to provide extra selenium in the diet. White muscle disease in calves and liver damage can result from selenium and vitamin E deficiencies.

Vitamins — Cattle normally receive adequate vitamin A (from carotene), D, and E from good quality forages. Poor quality forages, particularly those that are severly damaged by weather or overheating in storage, may be very low in these vitamins. In such cases the diet should be supplemented with 30,000 to 50,000 International Units (IU) of vitamin A, 5,000 to 10,000 of vitamin D and 50 to 100 IU of vitamin E per head daily. Cattle and calves deficient in vitamin A are susceptible to infections. Cattle deficient in vitamin D utilize the calcium and phosphorus in the diet poorly and may be more susceptible to milk fever, stiffness of joints, and broken bones as is the case when calves develop rickets.

PREPARATION FOR CALVING

When you judge the cow to be within 4 to 5 days of freshening, put her in a box stall or some other area away from other cows. During the summer months an outside paddock, preferably a pasture lot close-by, may be the best calving facility. The first indications of approaching calving are a pronounced swelling and enlarging of the vulva and a dropping away or sinking on both sides of the tail setting. When these signs are noted do not disturb the cow, but observe her from time to time. Keep the freshening stall free of drafts, clean, and well bedded with fresh, clean straw or other suitable bedding.

If disease has been a problem, thoroughly scrub and disinfect the stall. Use a hot, one percent lye solution. You can make it by dissolving a 13-ounce can

Maternity pen: — clean, well bedded, providing protection for the newborn calf from severe weather exposure.

of lye in a quart of cold water, then adding 10 gallons of hot water. Washing powder and a chlorine creosol or organic iodide disinfectant are also satisfactory. Dry out the pen and when possible allow 2 to 3 weeks of time lapse before putting new calves in the pen. This will help break the cycle of infecting organisms.

Mammary Edema — Some cows and particularly heifers will develop swollen udders due to mammary edema prior to calving. The tendency appears to be inherited and is most prevalent in the highest producers. Removal of the salt 30 days before calving and restricting water to two-thirds of the normal amount 15 days before calving has been shown to significantly reduce udder edema whereas reduction of either salt or water alone was not effective.

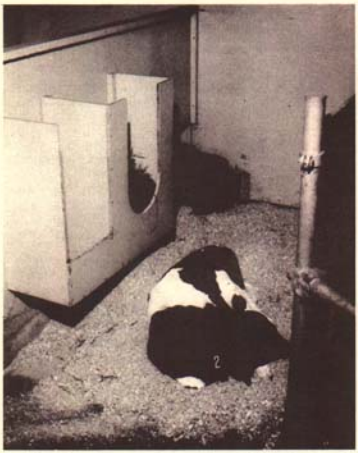
Also after calving, the administration of a diuretic (such as trichloromethiazide) and a corticosteroid (dexamethasone) by a veterinarian is effective in relieving edema, without depressing milk production.

Prepartum Milking — Milking prior to calving is generally not desirable since the colostrum is necessary for the calf, and milking will not significantly reduce udder edema. However, some older cows may develop extremely large udders, and relieving the pressure by milking may be desirable to improve the comfort of the cow and avoid breaking down the udder attachments. Freeze the colostrum milk by filling gallon plastic jugs ⅔ full and placing them in the deep freeze for later feeding to the calf.

CALVING TIME

Be on hand when the calf arrives in case you have to help deliver it. When labor appears to be unproductive call your veterinarian for assistance. After delivery, remove any mucous from the newborn calf's nose and mouth to prevent suffocation. If the calf does not begin breathing immediately, apply artificial respiration by alternately compressing and relaxing the chest walls. If necessary, hang the calf up by the hind feet for 5 minutes to help remove fluids and stimulate respiration.

In cold weather, dry the calf by rubbing with a clean burlap sack or other dry cloth. Squeeze the material out of the attached navel cord and immediately paint the cord end with 7% tincture of iodine solution to prevent infection. If the navel is hemorrhaging, it may be necessary to tie it off with a clean, disinfected (dip in alcohol) length of cotton or linen thread to prevent the calf from bleeding to death.



Provide clean, dry pens for newborn calves. Note solid wall between pens, feed box, and water bowl.

Remove all expelled membranes and soiled bedding from the stall immediately. Where disease is a problem, wash the cow's udder and teats with a chlorine solution before the calf begins to nurse. If the calf does not nurse within a couple of hours help it get started.

FEEDING THE NEWBORN CALF — FIRST MONTH

Immediately After Birth — Be sure the calf gets three to four feedings of colostrum during the first 24 hours of life. Encourage the calf to take some colostrum within one half hour of birth if possible. The antibodies in colostrum are not absorbed into the blood stream of the calf to any appreciable extent after 24-30 hours from birth. Colostrum is also high in vitamin A which is necessary to increase the calf's resistence to disease. In addition it contains about six times as much protein, three times as much mineral matter, and twice the dry matter concentration of normal milk. Small feeds of two to three pints per feeding are sufficient for the first 2 days. Cows that have been milked for several days before calving will not produce colostrum at calving. Their calves must be provided colostrum from another source.

Limit milk to about 0.8% of body weight per calf daily. For example, calves of various weights should be fed the amounts shown below.

50-lb. calf = 4.0 lb. per day or one quart per feeding twice daily.

80-lb. calf = 7.0 lb. per day or 3.5 pints per feeding twice daily.

100-lb. calf = 8.0 lb. per day or 2 quarts per feeding twice daily.

Eight pounds is the maximum amount of milk necessary to feed to any calf in an early weaning system for heifer replacements. The quantity of milk can be reduced to 4 lbs. per day after 21 days of age and discontinued completely by 30 days of age.

Excess colostrum may be fed to other calves. Most cows produce more colostrum than needed for their own calf. It can be frozen and saved in two-quart cartons for later feeding or fed to other calves when diluted in an equal amount of water. Colostrum can furnish most of the milk for herd replacements when calves are limit-fed and fresh colostrum is available regularly.

Milk Replacer may be substituted for whole milk as soon as the dam's milk is marketable. The milk replacer must be composed of high quality dry milk solids. Replacers containing ten percent or more animal fat are desirable. Replacers must also contain all necessary vitamins and minerals. Feed the milk replacer according to the manufacturer's directions. Dried skimmed milk and dried whole whey provide easily digestible high quality proteins and should constitute the protein in milk replacers.

A plastic nipple bottle in a fitted wire holder provides a convenient way to feed calves.

Sucrose (cane or beet sugar), vegetable protein, starch and cereal flour are unsatisfactory ingredients in milk replacers for newborn calves. The milk replacer solution passes directly into the abomasum (or true stomach) and such ingredients are poorly utilized until the enzyme system has developed sufficiently after about 2 weeks of age. Cheap replacers may contain larger amounts of these ingredients and result in unsatisfactory performance.

ONCE-A-DAY MILK FEEDING

Calves fed milk or milk replacer once per day *after the colostrum feeding period* (2-3 days) grow as rapidly and are as healthy as those fed twice daily when being raised for herd replacements. Feeding milk once daily reduces the labor time required for feeding milk about 40%. This advantage is desirable in some operations and is being practiced on some farms.

The same daily allowance of milk or milk replacer is given at one feeding rather than divided into two feedings.

Milk Replacer — Mix one part (by weight) of milk replacer with four parts of water. One cup of replacer weighs about 0.3 lb. Then 3⅓ cups of milk replacer mixed in two quarts (4.0 lbs.) of water provides the 20% milk solids formula suggested here. This solution is fed at the rate of 0.6% of initial body weight of the calf continuously until weaned.

Age of Calf	Approximate Amount to Feed Once-A-Day	
	Small Calves	Large Calves
First three days	——Colostrum——	
4th and 5th day	1.5 qts	2.0 qts
6th through 24th day	2.0 qts	3.0 qts
25th through 28th day	1.0 qt	1.5 qts

Milk replacers mixed at regular concentrations as recommended by the manufacturer have also been used successfully in once-a-day feeding. Keep fresh calf starter, hay and water before calves at all times. Be sure to check calves at least twice daily to see that starter, hay and water are fresh and clean and to help spot calves showing signs of illness.

CALF STARTER

Calves raised on a limited milk feeding system must be encouraged to eat a starting grain ration at an early age, usually 5 to 7 days. The starter ration must be palatable to small calves. A coarse textured mixture composed of cracked corn and rolled or crimped oats or pellets and 8 to 10% molasses is desirable and should contain 16 to 18% protein. Several high quality calf starter meals or pellets are available commercially from feed companies. The mixture shown below is satisfactory for calves fed limited milk.

Calf Starter Ration	Pounds per Cwt
Shelled corn: cracked or coarsely ground	38
Oats, whole, rolled or crimped	30
Soybean meal	20
Molasses	10
Dicalcium phosphate	1
Trace mineralized salt	1
Vitamin A (International Units)	200,000
Vitamin D (International Units)	100,000

Small calves can be encouraged to eat dry feed by placing a small amount in their mouth or allowing them to suck it from the fingers. The starting ration must be offered free choice so that calves are consuming 1 to 1½ lbs. of starter daily by time they are weaned from milk at 4 to 5 weeks of age. Starter consumption increases rapidly when milk feeding is discontinued.

Limiting the quantity of starter to 4 to 5 lbs. per head daily will encourage calves to eat more hay or other forage as they grow larger. Continue feeding the high protein calf starter until the calves are 7 to 8 weeks old.

Forage for Calves

Small calves do not need hay while they are fed milk and a high quality starting ration that is fortified with the necessary vitamins and minerals. Although they eat very little hay during the first three to four weeks they should be accustomed to eating hay by the end of the milk feeding period when they must depend on hay and starter for growth. Provide a small handful of your best, bright, leafy hay to calves at 2 to 3 weeks of age. Put the hay in a rack where the calves can eat it easily without soiling it. Replace it daily with fresh hay.

Grass or legume silage or haylage can be offered to calves at any age. The moisture content and quality of the silage will affect the amount they will eat and the growth rate when silage is the only forage offered. Unwilted or direct cut silage will produce little growth. Increase the grain allowance to maintain normal growth if direct cut silage must be fed to young calves. Also, remove any leftover silage from the manger at each feeding, especially in warm weather to prevent spoiling.

Getting a taste from the fingers. Encourage the calf to eat grain at an early age.

Wilted silage, about 30 to 35% dry matter, will produce moderate growth but will require some grain to produce good results even with yearling and older young cattle. Good quality haylage or low moisture silage (about 50% dry matter) will produce growth equal to that from hay of comparable quality. Poor quality forages must be supplemented with additional grain, protein, and vitamins A, D and E for satisfactory performance of cattle.

AFTER WEANING
(Second and third months of age to puberty)

Milk feeding can be eliminated when calves are 4 to 5 weeks of age provided they are consuming 1 to 1½ lbs. daily of a good quality starting ration. Starter consumption increases rapidly when milk is discontinued. Normally replacement heifers should receive up to 3 to 5 lb. daily of a starter ration until they are 7 to 8 weeks of age. Thereafter, a lower protein (12 to 14%) grain ration can gradually replace the calf

Table 1. Growth of yearling heifers fed various forages.

	Alfalfa Hay		Direct Cut Alfalfa Silage		Corn silage	Urea corn silage (0.5% urea)
	Early cut 5/25	Late Cut 6/15	Early cut 5/25	Late Cut 6/15		
Dry matter intake:						
% of body wt.	2.4	2.3	1.8	1.8	2.3	2.2
Daily gain, lb	1.8	1.3	1.5	1.3	1.9	2.0
Efficiency:						
(DM consumed/lb gain)	10.3	13.2	8.6	11.5	8.5	7.8

Data from experiments by J. W. Thomas, R. S. Emery, L. D. Brown and J. T. Huber, MSU Dairy Dept. Heifers ranged from 500 to 700 lb body weight during the experiment.

starter. By the time calves are 3 months of age they will grow normally when fed a ration of farm grains and hay or silage supplemented with protein, to provide a total ration containing 12 to 13% protein, plus salt, minerals and water. The amount of grain ration required will depend on the quality of forages fed and the desired growth rate but usually 2 to 4 lb. daily is sufficient.

The daily nutrient requirements for normal growth of dairy heifers are shown in Appendix Table 1. These are reasonable estimates of nutrient requirements for normal conditions. Actual requirements can be influenced by the health of the cattle, environmental conditions, and the balance of nutrients in the ration.

The growth rate of heifers can be controlled within limits by the quantity of nutrients fed. The pounds of total digestible nutrients (TDN) required daily to produce different rates of growth for heifers of given body size are shown in Appendix Table 4. These estimates also apply reasonably well to young dairy bulls up to about 8 months of age (puberty) and to dairy steers raised for beef.

PUBERTY (9 MONTHS) TO CALVING

By the time heifers are 9 to 11 months of age they will have reached sexual maturity and will consume enough forage to grow at a rate of 1.2 to 1.8 lbs. daily when fed only forages that are properly balanced with protein, minerals and water. Extra energy as grain will only be necessary to supplement low quality forages to achieve the desired growth.

Yearling heifers will grow (1.8 to 2.0 lbs. per day) rapidly when fed corn silage free choice. They will consume 2.0 to 2.25 lbs. of corn silage dry matter per 100 lb. of body weight or about 6 to 7 lbs. of silage per 100 lbs. of body weight (32% moisture silage) daily. Corn silage that is high in grain content may cause the heifers to become too fat if fed free choice. Therefore limiting the amount of silage fed in keeping with desired growth and body condition may be necessary. See Appendix Table 4 (Feed Requirements of Growing Dairy Heifers According to Size and Rate of Gain).

Corn silage and other low protein forages must be supplemented with additional protein. Addition of 8 to 10 lbs. urea per ton of silage at ensiling, or equivalent amount of protein from a liquid silage additive containing anhydrous ammonia or urea with molasses, water and minerals, results in satisfactory growth when fed to dairy heifers. High corn silage diets must also be balanced with calcium, phosphorus, and trace mineralized salt.

Heifers fed early harvested alfalfa hay or silage grow more rapidly and require 20 to 25% less feed to produce the same amount of gain than heifers fed alfalfa harvested 20 days later. The late cut alfalfa is typical of most Michigan forages.

Heifers fed early cut hay grew more rapidly than those fed early cut silage but required 16% more dry matter per pound of gain in experiments at MSU.

Heifers fed corn silage without protein supplement grew rapidly in this experiment since the protein content of the untreated silage was higher than normal. Addition of 0.5% urea (10 lbs. per ton) to silage at ensiling time increased the growth rate 5% and reduced the pounds of dry matter required per pound of gain by 8%. Addition of urea to lower protein silage gives even more dramatic effects.

PASTURE FOR YOUNG CATTLE

Yearling cattle grazing on good quality grass or legume pasture will grow normally when provided free choice salt, minerals and water. However, supplemental feeding of hay, silage or grain may be necessary to maintain normal growth if the quality or quantity of forage is inadequate. Heifers less than 1 year of age usually will require 2 to 4 lbs. of grain daily in addition to pasture forage for normal growth

depending on their size and the quality of forage available.

EFFECT OF NUTRITION ON HEIFER REPRODUCTION AND HEALTH

Heifers that have been deprived of adequate amounts of energy, protein, and minerals or vitamins will grow poorly and may be shy breeders.

Deficiencies of energy, protein, phosphorus, iodine, cobalt and vitamin A are probably the most common in growing heifers.

Energy deficiency from lack of good quality roughage, poor pasture, or failure to supplement poor quality feeds with grain causes a lack of estrus (symptoms of heat) in dairy cattle. Failure to find the cattle in heat causes delayed breeding and increased number of services per conception. Heifers, and cows, should be gaining weight at breeding time for best reproductive efficiency. Springing heifers and pregnant dry cows should be fed limited amounts of energy (See Nutrient Requirements, Appendix Table 3), to avoid excessive fatness at calving time. Fat cows, and those fed low protein rations tend to have ketosis at calving and may have poor resistence to infections of the uterus and udder.

Protein deficiency causes a lack of appetite and therefore slow growth rate in dairy cattle. Because of the low feed intake cattle may fail to show symptoms of heat. Adequate protein intake is necessary for proper development and function of the reproductive organs as well as for prenatal nutrient needs, and requirements of the developing fetus. Underdevelopment of the ovaries and uterus and delayed sexual maturity are common findings in heifers fed diets inadequate in protein.

Phosphorus deficiency results in a lack of appetite and may delay sexual maturity and depress signs of estrus. Phosphorus is used in the transfer of energy in body tissues. The ration should contain a minimum of 0.25% phosphorus. Many forages and native pastures are too low in phosphorus content unless supplemented. Provide dicalcium phosphate, steamed bonemeal, or a commercial mineral supplement free choice.

Iodine deficiency causes failure to show estrus, and may result in a lower conception rate, increase the incidence of retained placentas, and cause calves to be hairless, weak or dead at birth. Calves from iodine deficient cows may have enlarged thyroids or "goitre."

Manganese deficiency has been shown to cause irregularity or absence of the estrus cycle and a marked delay in the opening of the vaginal orifice. Resorption of fetuses; birth of dead, small or weak offspring; poor udder development and almost complete absence of milk secretion have been attributed to severe manganese deficiency.

Zinc deficiency causes a reduction in testicular size in bull calves, delayed sexual maturity and severe atrophy of the testes, and lowered fertility in cows. The effects on the reproductive processes of the female have not been well defined.

Vitamin A deficiency in the dam will cause abortions pre-term in the last half of pregnancy. Also, there is some evidence that grossly deficient vitamin A diets may lead to irregularities in estrus and lowered fertility through suppression of ovulation or failure of implantation of the fertilized egg in the uterus.

Since vitamin A affects the health of mucous membranes a deficiency results in tissues being more susceptible to infection. Cattle receive their vitamin A from the carotene in plants. However, forages that have been badly damaged by weather, or overheated in storage, may be poor sources of carotene and when when fed for 120 to 150 days vitamin A deficiency can result.

Cobalt deficiency results in lack of appetite and poor growth of young calves. Milk from cows whose diet is deficient in cobalt is low in vitamin B_{12}. Trace mineralized salt contains cobalt which is used by bac-

Yearling heifers fed only good quality hay and silage will grow well.

teria in the rumen of cattle to produce vitamin B_{12} and prevent cobalt deficiency.

Salt deficiency for an extended period of several months results in a lack of appetite, poor growth or milk production and depraved appetite of cattle. Cattle may consume urine, manure, dirt or other abnormal material when salt deficient. The deficiency is due to lack of sodium and is more common when cattle are fed only roughage. Feeding ½ to 1 ounce of sodium chloride (common salt) rapidly alleviates deficiency symptoms.

TIME TO BREED HEIFERS

Heifers fed sufficiently well to achieve normal growth will reach breeding size at 14 to 15 months of age as required to calve at 24 months. Normal weights for 15-month-old heifers are: Holsteins 750 to 800 lbs., Jersey 500 to 550 lbs., Guernsey 550 to 600 lbs. Brown Swiss are somewhat later maturing and normally not bred until 18 months old at 750 to 800 lbs.

Delaying the breeding for heifers to calve at 30 to 36 months of age results in slightly more milk for the first lactation, but less lifetime production and less profit. Heifers that begin their first lactation at 24 months will normally have paid their rearing cost in milk production before they reach 36 months of age.

ANTIBIOTICS

Antibiotics are contained in nearly all commercial milk replacers and most commercial calf starters. Feeding certain antibiotics (the tetracyclines are usually most effective) to calves reduces calf scours and increases the amount of feed consumed and thus increases the growth rate. The amount of disease infestation that exists in a given surrounding where calves are raised probably contributes to the degree of results that can be expected from feeding antibiotics to calves.

Antibiotics are usually included at a rate to provide 45 to 65 milligrams per calf daily for low level continuous feeding. There is no apparent advantage to feeding antibiotics to calves after they are 3 to 4 months of age. Antibiotics are used at 10 to 15 times the above levels when used for treatment of certain diseases. Where good, healthy calves are produced without antibiotics, there is little or no apparent advantage for including them in the ration.

VEALING CALVES

Surplus dairy calves, generally bull calves, may be marketed as veal. Veal calves are milk-fed to weights of 180 to 220 lbs. About 10 lbs. of whole milk are required to produce 1 lb. of gain. Calves will gain approximately 2 lbs. per day on a liberal milk feeding program with good management. Calves weighing over 80 lbs. at birth make more rapid gains and require less feed to reach market weight than smaller calves.

Milk replacers specially formulated for veal production are available on the market. Veal milk replacers usually contain 10 to 20% animal fat. They may be homogenized and contain an emulsifier to improve solubility and utilization. Rates of gain approaching 2 lbs. per day or better have been reported for calves fed certain milk replacers. Such rates of gain can be expected with uniformly good quality calves and superior management but may be difficult to achieve consistently with large numbers. Your personal experience will be the best measure. Feed conversion averages about 1.3 lbs. of milk replacer powder per lb. of gain. In practice the conversion will range from about 1.2 to 1.5 lbs. of replacer per lb. of gain depending largely on the rate of gain achieved.

Generally, only those calves reaching sufficiently high quality to demand prime or choice market price will be profitable as vealers. Otherwise calves will be more profitable when sold as deacons. Initial weight and value of the calf, amount and value of feed required to reach market weight, veterinary, mortality, housing, and labor expenses must be deducted from the market value of veal to determine the profit from the enterprise.

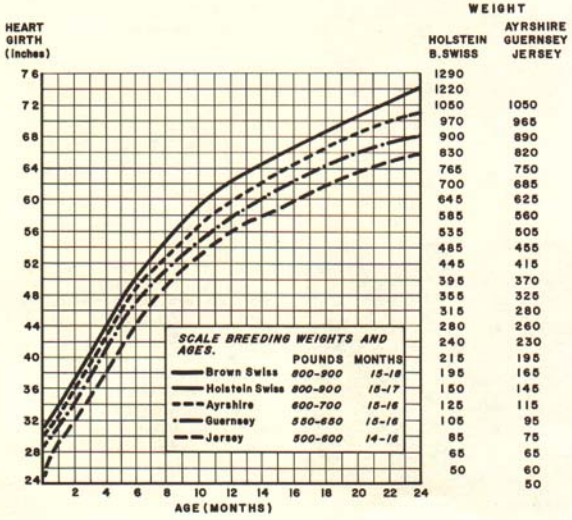
Approximate Feed Requirements for Dairy Heifers

Months of Age	HOLSTEIN Milk† lbs.	HOLSTEIN Grain lbs.	HOLSTEIN Hay lbs.	HOLSTEIN Water gal./day	JERSEY Milk lbs.	JERSEY Grain lbs.	JERSEY Hay lbs.	JERSEY Water gal./day
1 and 2	300	80	45	1.5	200	55	30	.8
3 and 4	0	190	200	2.9		168	110	1.9
5 and 6	0	180	425	4.4		155	315	3.0
7 and 8		125	600	5.7		125	415	4.2
9 and 10		*	880	7.0		*	585	5.1
11 and 12		*	1050	8.4		*	695	5.9
Total to 1 year	300	575	3200		200	500	2150	
13 and 14	0	*	1180	9.3		*	800	6.8
15 and 16			1280	10.1		*	870	7.3
17 and 18			1400	11.0		*	900	7.9
19 and 20			1500	11.9		*	920	8.5
21 and 22			1590	12.8		*	965	9.1
23 and 24		300	1350	13.2		300	995	9.6
Total 1 to 2 years		300	8300			300	5450	
Total: Birth to 2 years	300	875	11500		200	800	7600	

* Two to four pounds of grain daily will be necessary with low quality forage.

† 25 pounds of milk replacer can be substituted for most of the milk.

Normal Weight and Heart Girth of Dairy Heifers (Birth to 24 months)



2. Health Management and Calf Diseases

DISEASE CAUSES HEAVY LOSS of calves in many herds. Dairymen commonly take calf diseases for granted and many expect to lose calves as a normal part of the operation.

Excessive treatment of disease symptoms without locating and correcting the underlying causes is a false but common approach to disease control. A calf with pneumonia undoubtedly has infectious agents (germs) in its lungs which may respond to medication. But, more than likely the calf became susceptible to pneumonia because of exposure to drafts, dampness or cold temperatures. These were basic and predisposing causes of the condition. The "shot", or antibiotic in feed is an unsatisfactory substitute for a healthful environment and a disease prevention program.

The first requirement for a healthy calf is a healthy, well nourished and disease-free sire and dam. Nutritional deficiency in the dam may result in abortion. Or, if the calf is carried to term, it may appear quite normal, yet be weak and lack resistance to disease. Vitamin A, as an example, may be deficient, yet is very important in the health and livability of offspring.

An infectious disease in the sire or dam may cause abortions but not in all cases. Calves from dams that have systemic or uterine infection may actually be infected prior to, and at the time of, birth.

A well planned and executed herd health program with emphasis on the dam to assure reproductive health is vital to successful calf raising. Following birth, management, nutrition, and disease prevention must be interwoven to assure healthy, growthy herd replacements.

Apply tincture of iodine to the navel to prevent infections.

NAVEL ILL

The first exposure to disease after birth is usually via the navel. The navel is moist and contains several vessels — hollow tubes that lead inside the body. Disease-producing organisms that enter the navel may cause disease. These "germs" are usually pus producers. The calf's temperature will rise; she will act depressed, and may also show signs of scours and pneumonia. The navel remains enlarged and moist, discharging fluid and pus. The joints of the calf may become enlarged and painful. Abscesses quite often develop in the liver or urinary system.

Prevention depends upon sanitation. A first step in prevention is to have a clean, dry and well bedded maternity area. As soon after birth as possible apply tincture of iodine (7%) to the navel. Then place the calf in a clean, dry, well ventilated, and well bedded individual pen. When dehorning a calf under two weeks old, lay the calf on her side to check for and remove any extra teats and then examine the region around the navel for evidence of hernias and/or navel infection.

CALF SCOURS AND PNEUMONIA

This disease complex is probably the leading killer of calves under 2 to 3 weeks of age. It is usually caused by a combination of factors such as improper nutrition, excessive feeding, poor management and infection. Many types of bacteria are involved but most of them are toxin (poison) producers. Calves may start out with diarrhea or scours which then progresses into pneumonia — the combination causing death. The reverse order also occurs, or each condition can exist separately.

Enteritis or scours is recognized by a fetid smell, thin watery feces, lack of appetite, depression and loss of weight. Electrolytes, such as bicarbonates, sodium, potassium and chloride, may be lost from the body fluids of calves having severe diarrhea and should be replaced. Loss of these elements disturbs the body chemistry and is probably the major factor in the calf's death in addition to toxin production previously mentioned.

Avoid Overfeeding

Too heavy feeding may cause the calf to start scouring. Calf feeding is an art, especially with certain breeds. As a rule, it is better to keep calves a little hungry than to overfeed them. Colostrum milk is very important, especially during the first 12 to 24 hours, as a means of transferring antibodies (disease protection) from the dam to the newborn calf.

Dampness and filth also contribute to calf diseases. These conditions harbor disease-producing germs and reduce the calf's resistance to infection. The sanitation of feeding devices is likewise important. Calf pails should be kept thoroughly clean and disinfected. The interior of the nipples on nipple pails is a potential reservoir for infectious agents. These too should be kept clean.

How can you successfully prevent and treat a calf-scour problem? Success depends on accurate diagnosis of the infectious agents, the sensitivity of the organism to antibiotics, and attention to preventing or eliminating contributing factors. Antibiotics and sulfas in various types and forms may eliminate the infection. Blood transfusions, electrolyte solutions, and other treatment (such as heat) may be necessary to prevent death and aid in recovery.

Using Antibiotics

Antibiotics do not work uniformly. Products that work today on a given farm may be ineffective in the future. Effective treatment on one farm may fail on a neighboring herd. On certain farms calves die within the first 24 hours unless medication is used very soon after birth. In such herds the reproductive health of the dam should be investigated and extreme precautions taken in the cleaning and disinfecting of maternity pens and individual calf pens.

Pneumonia Symptoms

Pneumonia is a disease in which the lungs are inflamed. The onset may be rapid due to sudden changes in weather, draft, dampness and related environmental factors. It may occur along with scours or it may occur gradually over a period of time and result in chronic pneumonia with extensive lung damage, scar tissue formation, and related complications that could permanently weaken the animal's health. Symptoms of pneumonia are depression, high temperature, lack of appetite, rapid breathing, and coughing. Nasal discharge and watery eyes also may be apparent.

Using Sulfa

Sulfa drugs must be used properly to be effective against pneumonia. Excessive use may cause damage especially to the kidneys. Usually an initial full 24-hour dose will be given, followed by one-half dosage twice a day or at such interval as your veterinarian may prescribe. This time interval varies with different sulfa compounds. Treatment will usually be continued for three to five days. Calves with chronic attacks usually have considerable lung damage, respond poorly to treatment, have very poor growth rate, and should be seriously considered for culling.

DIPTHERIA OR NECROBACILLOSIS

Necrobacillosis is a term that covers several cattle diseases, (calf diphtheria, foot rot, necrotic stomatitis, and necrotic hepatitis). Several agents may be involved in this complex. Predisposing causes are injury, moisture and filth. The organism thought to be the cause of, or at least involved in, necrobacillosis is *Spherophorus necrophorus.*

Diphtheria infects young calves. Sores appear in the mouth, on the tongue, cheeks, gums and throat, and may affect more internal parts. When sores are severe, the calf has difficulty in nursing and eating. There is fever and loss of weight and appetite. A caseous (cheese-like) material covers the lesions. When this is removed, there is a raw appearance to the affected area. The mouth has a foul odor. The calf may salivate and make sucking noises when not eating. There usually is swelling in the cheeks along the back teeth. It can be seen on the outside. Death often results from lack of nutrition (because the mouth is too sore to eat), toxemia from the infection, or pneumonia.

To treat and prevent: (1) remove sick and affected calves from the herd; (2) clean and disinfect places where sick calves have been housed. Allow to stand empty for 2 or 3 weeks before new calves are brought in, if possible. Thoroughly clean, disinfect, and allow pails, feed boxes, etc. to dry; (3) Clean calf area daily until no new cases appear; (4) Examine remaining unaffected calves at feeding time to locate new cases early; (5) Treat the local lesions with an antiseptic. (Efficiency of antiseptics and drugs varies from area to area. Your local veterinarian can help you here.) Effective drugs have been sulfas, penicillin, and broad-spectrum antibiotics, depending on the area.

RINGWORM

Ringworm is a skin condition usually seen during the winter months, but it may occur at any time of the year. A variety of fungi causes this disease. These fungi infect the skin and hair follicles, causing a loss of hair and a gray scaly crust formation over the infected area. The condition quite commonly begins around the eyes and head region but may affect any

Ringworm can be controlled with good sanitary procedures and veterinary treatment.

of the body area covered with hair. This condition may infect man also. Precautions should be taken to prevent it from spreading to humans.

Adequate nutrition and a ration well fortified with vitamin A and vitamin D are essential in preventing ringworm. Vitamin A is important to maintain proper tissue health and resistance to infection. However, supplemental vitamin A is not effective as a curative treatment in established cases of ringworm when cattle are receiving normal diets. Cattle should be kept in clean, dry pens with as much sunlight as possible.

Ringworm Treatment

Treatment involves the removal of the scurf and medication to destroy the fungi. A wire brush or steel curry comb will remove the scurf. *Do not use this curry comb on normal animals as this is one means of spreading the infection.* Strong tincture of iodine (7%) is probably the most commonly used medication. Iodine-based ointments, sulfur ointments and a variety of proprietary compounds are also available. It must be stressed that removal of the scurf is important to the effectiveness of any of these agents. Several repeated treatments may be necessary to overcome the ringworm problem. Wear rubber gloves to avoid infecting yourself with ringworm.

PARASITES

Parasites may be external or internal. Sucking lice are the most common external parasites. They suck blood and therefore can cause severe anemia. The calves look rough, grow poorly, have very poor feed efficiency, and may finally get so weak that they cannot stand. The owner is often at a loss to explain the poor condition because he has not seen the lice. They are visible to the naked eye if you part the hair and look carefully, aided by good light. Severely anemic calves breathe rapidly and may appear to have pneumonia. Anemic calves also lack resistance to disease and thus readily succumb to infections.

Coccidiosis — Coccidia are small, single-celled objects that invade, multiply, and cause damage in the intestinal wall of calves. Infestation most commonly occurs in young stock under two years of age but may occur in older animals. It is usually seen under conditions of overcrowding, dampness and darkness. A deficiency of vitamin A or general malnutrition may be conducive to this disease.

Symptoms are unthriftiness, poor growth rate, and diarrhea. Bloody diarrhea may occur. The coccidia are passed in the feces. Fecal contamination of feed, mangers, and watering devices is the main means of spread. Therefore, prevention depends upon individual pens, sanitation practices and good management. The type and extent of treatment will depend on the severity of the condition.

Stomach worms are small threadlike worms that suck blood and thus produce anemia. Diarrhea, loss of weight, rough hair coat, and poor performance are noted. Phenothiazine or thiabendazole is effective as a control. Good sanitation and nutrition are exceedingly important.

Tapeworms may be introduced to your farm through purchased stock and then infect other animals. Phenothiazine will not control this parasite. Control products are quite toxic and should be administered only under veterinary supervision.

Lungworms may cause chronic coughing and pneumonia. They usually are acquired on wet, lowland pastures but are rarely a problem where calves are raised in clean, dry, well bedded, individual calf pens.

Diagnosis and differentiation of the various types of parasites require specialized training. Fresh fecal samples are examined under the microscope to determine the type of eggs being passed in the feces. Treatment can then be based upon these findings.

Use of Insecticides

Exercise good judgment in using insecticides for lice control on young calves. Calves under three to four months of age are very subject to lindane poisoning. Excessive organic phosphates cause salivation, diarrhea, muscular tremors, and death. Treatment with atropine, if early enough, may save some individuals. Many of the old home remedies contain naphthalene moth crystals. This may result in the condition known as X disease, or hyperkeratosis, for which we have no cure. Avoid the use of such products.

See your local veterinarian or get a list of currently approved products for fly and lice control from your County Extension office. Then be sure to read and follow directions carefully in applying the product. *Internal parasitism* may occur in several forms:

NONINFECTIOUS DISEASES

Certain disease conditions may occur even when recommended feeding or management practices are followed. As mentioned, toxicity may result from excessive lindane or organic phosphate and the use of nephthalene. Lead poisoning may occur as a result of using lumber previously painted with lead-based paints. Calf pens, feed racks and other equipment should never be painted with lead paints. Old paint pails should not be used for feeding or watering devices unless they have been thoroughly burned or otherwise cleaned out.

FILTH — MANURE BALLS

Manure may collect on the tail and feet of calves. If it dries or freezes on, it may cut off circulation as the calf grows and result in loss of the tail or other affected parts. Control of diarrhea, well-bedded pens and removal of manure from the hair will prevent this occurrence.

SUCKING

Sucking of the navel, ears, or udder of other calves often occurs, especially in group pens. Individual pens and the feeding of grain immediately following milk will help prevent sucking. Holding calves in stanchions for 15 to 30 minutes after milk feeding may also be successful. Sucking of ears in cold weather may lead to freezing and loss of the margins of the ears, creating an undesirable appearance.

Remove "extra" teats when calves are 4 to 6 weeks old. Use sharp scissors and swab with iodine.

EXTRA TEATS

Extra teats are unsightly and may be bothersome later. Remove them when calves are 2 to 6 weeks old. Stretch the teat and snip it off close to the udder with a clean, sharp pair of scissors or knife and treat with tincture of iodine.

HORNS

Dehorn calves when they are young. Electric dehorning is safe and easy. Commercial preparations and caustic potash are satisfactory if used properly.

BRUCELLOSIS VACCINATION

Michigan Law requires that cattle must be calfhood-vaccinated against Brucellosis with Strain 19 vaccine by an accredited veterinarian between 3 and 7 months of age to be sold for dairy or breeding purposes.

"REDNOSE" (IBR) AND "VIRUS DIARRHEA" (BVD)

IBR (Infectious Bovine Rhinotracheitis) and BVD (Bovine Virus Diarrhea) are two virus diseases which cause severe economic losses in cattle of all ages in this state. Vaccination prior to exposure is the only effective method for the prevention of losses.

The following program for preconditioning dairy replacement heifers is suggested:

Newborn Calf

1. Iodine navel
2. Vitamin ADE injection
3. Colostrum, within two hours after birth
4. Individual identification
5. Dehorn

Three to Four Months

1. Blackleg and Malignant Edema Immunization
2. Brucellosis vaccination
3. Remove extra teats
4. Fecal examination, worm control if indicated
5. External parasite control

Nine to Twelve Months

1. IBR, BVD, PI_3 vaccination
2. Fecal examination, worm control if indicated
3. External parasite control

HERD HEALTH RECORDS

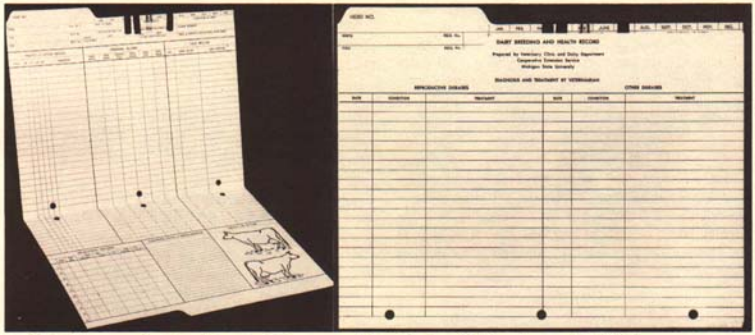
A concise and accurate record of each individual in the herd is essential for well-organized herd health and breeding programs. This record should begin

the moment the animal enters the herd either through birth or purchase.

Individual cow record folders have been prepared and are available through your County Extension agent, local veterinarian, or the Bulletin Office, c/o Department of Information Services, Michigan State University, P. O. Box 231, East Lansing, MI 48823.

Start a record-keeping system. Make out a folder for each calf when it is born. The record folder contains all information pertinent to the calf from birth until it leaves your herd. Such items as sire, dam, birth date, identification number, and all other history of occurrences such as calving record, disease, vaccination, and medical treatment are included.

The folder also serves as an organizer for registration and health papers. Identification of each animal is essential to a record program. Ear tag or tattoo calves at birth and enter the identification on the individual record form.



A calf health program begins with a record for every calf from the day of birth and proper identification.

Dehorn – electrically

Be sure the dehorner is hot and place it directly over the horn button.

Rotate the dehorner to form a ring around the base of the horn.

The "Cap" is easily flipped off when properly done

— and the horn is gone forever.

Dehorn–commercial preparations

Commercially prepared dehorning liquids or caustic potash can do a neat job of dehorning.

Vaccination

Vaccination with Strain 19 between 120 and 280 days of age is a must for dairy cattle. Strive for the younger age groups (4 to 6 months).

Ear tag or tattoo

Identify calves temporarily by number. Ear tag or tattoo for permanent identification. Record the identification with birth date, sex, sire, and dam in the herd record system. A tattoo is permanent identification.

3. Calf and Maternity Housing

A HOUSING SYSTEM for the calf and treatment areas should be well planned. These facilities should be so constructed, located and operated to complement the total dairy operation. Calf housing becomes more important as cow numbers per man increase because a dairyman has less time to be a "nurse maid" to each individual calf or cow.

A HEALTHFUL ENVIRONMENT

A healthful environment is essential in raising calves. Losses approaching twenty percent of the calf crop are common on Michigan dairy farms. Much of this high mortality can be blamed on the failure to provide adequate calf housing facilities as dairy herds have expanded. Exposure of newborn calves to sharp changes in temperature, cold drafts, wet and humid conditions are major contributing causes of calf losses in Michigan.

Calves must be protected from these poor environmental conditions and kept in reasonably warm, dry, well-ventilated quarters. To provide these conditions requires: (1) *A maternity area* to prevent sudden exposure of newborn calves during cold, wet weather. Expectant cows should be confined to well-bedded, sanitized freshening stalls or pens, 24 to 48 hours prior to freshening. Provide one pen for each 20 cows. (2) *A starting barn* to house calves from birth until about 8 weeks of age. This area can be either a cold barn or warm barn but must be properly constructed and ventilated to remove moisture, and prevent drafts. Calves can withstand freezing temperatures providing the ventilation is sufficient to remove excess moisture and prevent an "ice-box" condition from occurring.

Growing pens can double as maternity pens.

The warm barn provides additional comfort for the operator as well as newborn calves but requires adequate insulation, ventilation and supplemental heat. Barns that are tightly enclosed without these features will accumulate too much moisture and create a health hazard for calves. (3) *Growing pens* for calves leaving the starting barn (at 2 to 4 months of age) until they are yearlings. The area containing the growing pens should be ventilated enough to control moisture; properly planned, these pens can double as freshening stalls or pens. Provide one pen for each 20 cows; (4) *Treatment stalls* for veterinary treatment, breeding and routing handling. These can be conveniently located in the calf barn if not provided elsewhere. This hospital area needs access to an equipment storage area and hot water. Provide one stall for each 20 cows.

A new calf housing plan which includes all the above features as options is available from your County Cooperative Extension Service or the Agricultural Engineering Department, Michigan State University, East Lansing.

FEATURES OF COLD CALF BARNS

A pole-type barn that is open to the east or south such as a loose housing or free-stall barn can be a satisfactory calf barn. Frequently a section of the barn for older cattle can be arranged as a starting barn for calves. Calves may be tied in 2′ x 4′ individual stalls, or run loose in pens providing about 20-25 square feet per calf. Individual pens are preferred to minimize the spread of communicable diseases, and prevent calves from sucking each other. Cold pens should have at least three solid sides to prevent drafts through the pen. Pens located near the open side of a barn may need to be partially covered with plywood or other material to prevent snow and rain from blowing on the calves and it also helps to conserve heat on severe days. Heat lamps can be used to protect newborn calves from chilling in severe weather. The barn must be adequately ventilated to allow uniform movement of moisture-laden air from the building. The floor may

A cold building, free of drafts and dry, makes good housing for small herds.

consist of sand or other coarse material that will allow good drainage.

If individual tie stalls are to be used, a concrete floor or other hard surface is desirable for easy cleaning. The tie stalls require only about one-half as much space per calf as individual pens and are convenient to use. Feeding and watering must be done by hand in the cold barn since water pipes will freeze in cold weather.

WARM CALF HOUSING

A warm calf barn offers some advantages for the larger herd where the operator may need to spend more time in the calf-raising facility. Insulation and ventilation are necessary in a warm barn in order to maintain a healthy and comfortable environmental condition. Supplemental heat is needed during cold weather to furnish enough heat for removal of moisture.

A closed building must have good insulation. Provide a minimum insulation value (R value) of 12 in the sidewalls, and 14 in the ceiling. This requires a minimum of 3-inch "batt insulation" or its equivalent in the side walls and 6-inch "insulation in the ceiling." Protect the insulation with an adequate vapor barrier. After applying the insulation, cover the entire inside walls and ceiling with 4 mil polyethylene film. Then apply the inside sheathing which may be exterior plywood, sheet metal or pressure treated matched boards. Leave an air space between the insulation and exterior siding. The vapor barrier keeps the moisture produced inside the building from getting into the wall where it will condense and ruin the insulation and cause deterioration of the wall.

When remodeling, the insulation value of existing walls and ceilings can be determined from information available from building suppliers, heating, ventilating and power companies, or your County Extension Agent.

Ventilation by use of fans is necessary to remove the moisture-laden air from warm enclosed housing otherwise the moisture given off from the breath and urine of the calves tends to accumulate, causing high humidity. For winter operation, 1/10 cubic foot per minute (cfm) of air per pound of animal is recommended. Be sure to use one fan small enough, or a two-speed fan, or a fan with a motorized shutter, to produce a low volume equal to a low calculated rate during the coldest weather and when few calves may be in the building.

Fans should be operated with a time clock or with a timer-thermostat control to provide a low rate. With exhaust fans in one side, a slot inlet along the ceiling on the opposite side will provide good air distribution with a minimum of drafts.

Hinged doors or deflectors on the fresh air inlets should be provided so that cold air does not drop directly on the small calves.

For summer ventilation, windows providing cross ventilation are recommended. When this is not possible, a fan capacity of 2 cfm per lb of animal, or an air change every two minutes is recommended.

HEAT

When adequate ventilation to remove moisture is provided, the heat given off by the small calves is not enough to maintain the desired temperature during cold weather. The animals' heat must be supplemented with other types of heat. The amount of heat to add can be found with the following formula:

Multiply

pounds of calf x 4 _____
square feet of wall area x 5 _____
square feet of glass x 10 _____
Total BTU required

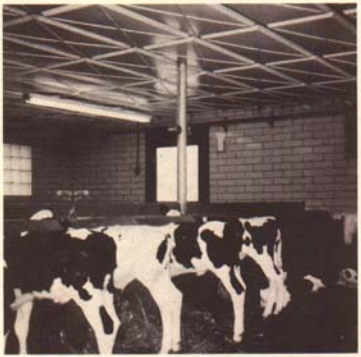
$$\frac{\text{Total BTU}}{3000} = \text{Kilowatt of electricity}$$

This amount of heat can be supplied by either gas, oil or electric heaters. Some type of convection heater, equipped with a fan for circulation, is recommended. Electric heaters are very convenient and easy to control. Radiant heaters are very directional. Animals in the direct ray from the heater become very warm, while animals outside the rays are cold. A fan on the heater acts to circulate the heat and maintain a more uniform room temperature without overheating certain areas. Each heater should be controlled by a thermostat.

SERVICE AREA

The service area is an important part of all calf housing and should contain facilities for: (1) Storage of feed for the calves; (2) Hot and cold water under pressure; (3) Good drain facilities for waste from the washing area and urine; (4) Wash vat for washing and sterilizing calf pails; (5) Storage rack for the clean utensils; (6) A cabinet for storing veterinary supplies.

Free stalls can be used for young cattle about 3 months old or older.



Tie stalls, 2½′ wide x 4′ long, are desirable in a warm calf-starting barn and reduce the space required per head. Walls and ceilings are insulated.

YOUNGSTOCK AREA

When calves are 6 to 8 weeks old they can be transferred into group pens. These pens need not be heated, but should be protected from cold wind, properly ventilated and dry. Allow 25 to 30 square feet per animal and 18 inches of feeder space. Group growing calves according to age or size for best results and easier management.

The area should be planned so that the minimum hand labor is required. All manure can be moved by machine if pen partitions are hinged so they can be swung out of the way when the tractor loader is used. When silage is fed to these young cattle, some access to the regular silage bunk can be provided so that the young cattle and dry cows are fed mechanically. A concrete alley along at least one side of the pen permits the use of a cart to carry baled hay, grain and bedding. Free stalls can be used for youngstock, especially when free stalls are used for the older cattle. When free stalls are used, youngstock must be grouped into sizes which fit the free stalls.

The following are suggested sizes:

Age	Size
2-4 months	2′ x 4′
4-8 months	2′6″ x 5′
8-14 months	3′ x 5′6″
14-20 months	3′6″ x 6′6″

Make the free stall partitions high enough so the animal cannot get his head over the partition and turn around. The height would vary from 3 feet for small animals to 4 feet for mature animals.

Free stalls significantly reduce the amount of bedding used. With proper planning and access to mechanical feeding, the required labor for replacement animals is very small.

MATERNITY PENS

One maternity pen for each 8 to 12 milking cows is recommended for smaller herds. When herds get larger than 60 cows, one maternity pen for 20 cows is recommended. These pens should be well protected from cold winds, rain and snow, but need not be heated. When a cow is ready to freshen she should be isolated in the stall with clean bedding. Cows often freshen on the coldest days of the year. For this reason it is convenient to have one or two maternity pens in the warm calf barn. These pens can alternate as grouping pens for older calves after they leave the individual stalls, but before they are put outside into colder conditions. Maternity pens should contain about 100 to 110 square feet. Neither dimension should be less than 9 feet to allow cows room to turn around.

A floor plan for a calf and youngstock building is shown on the back cover. The complete plan can be obtained from the County Agricultural Agent's office or from the Agricultural Engineering Extension Service, Michigan State University, East Lansing, Michigan 48823.

Appendix Table 1. Daily nutrient allowances for growing dairy heifers

Body wt.	Daily gain	Dry feed	Total protein	Digestible protein	TDN	NE	Ca	P	Carotene	Vit. A 1000 IU	Vit. D 1000 IU
lb	lb	lb	lb	lb	lb	Mcal	g	g	mg	IU	IU
Large Breeds											
80	0.4	1.0	0.22	0.20	1.0	1.2	4	4	4	2.0	240
100	0.6	1.3	0.30	0.25	1.3	1.6	7	6	4	2.1	300
150	1.6	4.2	0.66	0.50	3.0	2.2	12	10	6	3.2	450
200	1.6	5.8	0.74	0.52	4.0	2.8	13	10	8	4.2	600
400	1.6	10.6	1.00	0.66	6.8	5.4	13	12	16	8.3	1200
600	1.6	15.0	1.30	0.80	9.0	7.3	13	12	24	12.5	1800
800	1.6	18.6	1.60	0.90	11.2	9.1	13	12	32	15.0	2400
1000	1.5	21.1	2.00	1.10	11.8	11.1	12	12	40	20.0	3000
1200	0.9	19.3	2.00	1.10	10.9	11.9	12	12	48	22.2	3600
1400	0.3	20.0	1.90	1.00	10.0	10.6	12	12	56	26.0	4200
Small Breeds											
40	0.2	0.7	0.15	0.13	0.7	0.7	2	2	3	0.8	
60	0.3	0.9	0.21	0.19	0.9	1.2	3	3	3	1.0	
80	0.6	1.7	0.31	0.25	1.4	1.4	4	3	4	1.5	
100	1.1	2.5	0.40	0.33	1.9	1.8	7	4	6	2.0	
200	1.2	5.1	0.70	0.44	3.3	3.1	10	8	10	4.0	
400	1.4	9.5	1.00	0.60	7.4	5.8	15	12	20	8.0	
600	1.5	14.8	1.00	0.70	8.5	7.4	20	20	30	13.0	
800	1.0	17.2	1.30	0.70	8.8	8.6	20	20	40	17.0	
1000	0.3	16.0	1.30	0.70	8.0	8.0	18	19	50	20.0	

Appendix Table 2. Daily nutrient allowances for growing dairy bulls (40 to 400 lbs. — Use tables for growing heifers)

Body wt.	Daily gain	Dry feed	Total protein	Digestible protein	TDN	NE	Ca	P	Carotene	Vit. A 1000 IU	Vit. D[a] 1000 IU
lb	lb	lb	lb	lb	lb	Mcal	g	g	mg	IU	IU
400	2.2	12.8	1.3	0.94	7.7	6.7	14	13	22	9	1320
550	2.2	14.7	1.4	0.96	8.8	8.7	15	14	27	11	1650
660	2.2	17.6	1.5	1.00	10.5	10.2	17	15	32	13	1980
880	2.0	21.1	1.8	1.20	12.8	12.8	17	16	43	17	2640
1100	1.8	22.9	2.0	1.27	13.6	14.6	18	17	53	22	3300
1320	1.5	24.6	2.1	1.35	14.3	15.6	18	17	63	26	3960
1540	1.3	26.4	2.3	1.43	15.4	16.9	19	18	74	30	4620
1760	1.1	29.3	2.4	1.52	16.5	16.5	21	20	85	34	5280
1980		29.9	2.5	1.56	17.6	16.6	22	20	95	38	5940
2200		31.9	2.6	1.63	18.7	18.4	23	22	106	43	6600

[a] Vitamin D requirements for cattle weighing over 400 lbs are not known; the estimates are based on requirements for younger cattle. Adapted from NRC Pub. 1349, 1966, Nutrient Requirements of Dairy Cattle.

Appendix Table 3. Minimum nutrient content of ration dry matter for dairy cattle

	Lactating cows		Dry cows and growing heifers	
	Min.	Max.	Min.	Max.
TDN, %	60–70		50	
Digestible Energy, Mcal/lb	1.2–1.4		0.8–1.0	
Net Energy, Mcal/lb	0.6–0.7		0.5–0.7	
Crude protein, %	14.0		10.0	
Digestible protein, %	10.5		6.0	
Crude fiber, %	15.0		15.0	
Calcium, %	0.3–0.4		0.33	
Phosphorus, %	0.30		0.26	
Potassium, %	0.70		0.70	
Magnesium, %	0.15		0.15	
Sodium, %	0.11		0.11	
Chlorine, %	0.18		0.18	
Salt, %	0.45		0.30	
Sulfur, %	0.20		0.20	
Iodine, ppm	0.60		0.60	
Manganese, ppm	20.0		20.0	
Copper, ppm	6.0	<100	6.0	<100
Cobalt, ppm	0.1	< 10	0.1	< 10
Zinc, ppm	25.0	<500	25.0	<500
Iron, ppm	100.0		100.0	
Selenium, ppm	0.1	< 5	0.1	< 5
Flourine, ppm	—	< 40	—	< 40
Molybdenum, ppm	—	< 6	—	< 6
Carotene, ppm	8.0		8.0	
Vitamin A, IU/lb	1500.0		1500.0	
Vitamin D, IU/lb	140.0		140.0	
Vitamin E, IU/lb	3–5		3–5	

Appendix Table 4. Feed requirements of growing dairy heifers according to their size and rate of gain (From Formula, TDN = 0.102W^{-6} (1 + 0.567G)

Body wt.	Average daily gain									
	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
lb										
100	1.98	2.17	**2.35**[j]	2.53	**2.72**[h]	2.90	3.08	3.27	3.45	3.63
150	2.53	2.76	3.00	**3.23**[j]	3.46	**3.70**[h]	3.93	4.17	4.40	4.63
200	3.01	3.28	3.56	3.84	**4.12**[j]	4.39	**4.67**[h]	4.95	5.23	5.51
300	3.83	4.19	4.54	4.90	**5.25**[j]	5.61	**5.96**[h]	6.31	6.67	7.02
400	4.56	4.98	5.40	**5.82**[j]	6.24	6.66	**7.08**[h]	7.50	7.93	8.35
500	5.21	5.69	6.17	**6.65**[j]	7.13	**7.62**[h]	8.10	8.58	9.06	9.54
600	5.81	6.35	6.89	**7.42**[j]	7.96	**8.50**[h]	9.03	9.57	10.11	10.65
700	6.37	6.96	**7.55**[j]	8.14	8.73	**9.32**[h]	9.91	10.50	11.09	11.68
800	6.91	**7.54**[j]	8.18	8.82	**9.46**[h]	10.10	10.74	11.37	12.01	12.65
900	**7.41**[j]	8.10	8.78	9.47	**10.15**[h]	10.84	11.52	12.21	12.89	13.58
1000	7.90	8.63	9.36	**10.09**[h]	10.82	11.55	12.27	13.00	13.73	14.46
1100	8.36	9.13	**9.91**[h]	10.68	11.45	12.22	13.00	13.77	14.54	15.32
1200	8.81	**9.62**[h]	10.44	11.25	12.06	12.88	13.69	14.51	15.32	16.14

(j) Rate of growth outlined for Jerseys will give 490 lb body weight at 14 mo. of age and 774 lb at 24 mo.

(h) Rate of growth outlined for Holsteins will give 700 lb body weight at 14 mo. of age and 1064 lb at 24 mo. E. W. Swanson, Journal of Dairy Science 54:217, 1971.