W

Special Report 27 (3)

Infertility of Cattle

East Polk, Pennington, and Red Lake Counties of Minnesota-1967

Part I. REPORT OF AN INVESTIGATION OF INFERTILITY OF CATTLE

by R. Zemjanis, D.V.M., Ph.D., Department of Veterinary Obstetrics and Gynecology, College of Veterinary Medicine University of Minnesota

and

by R.A. Wescott, D.V.M. Minnesota State Livestock Sanitary Board St. Paul, Minnesota

Part. II. SURVEY OF FEEDING PRACTICES IN DAIRY HERDS REPLYING TO QUESTIONNAIRES

by B.J. Conlin, Ph.D., Extension Dairyman, Department of Animal Science Institute of Agriculture and Agricultural Extension Service University of Minnesota

Agricultural Extension Service (2)
University of Minnesota, St. Paul 55101
(1)

Summary

1. Several farmers in East Polk, Pennington, and Red Lake Counties complained of cattle breeding difficulties to county extension agents, local veterinarians, and state legislators in early 1967.

2. An investigation was requested to determine the extent and the nature of the problem. Survey questionnaires were mailed to 1,568 cattle owners in these counties. Of the 420 returns 225 came from dairy farmers. Eighty-nine, or approximately 40 percent of the dairymen, reported cattle infertility problems. Failure to conceive and difficulties in observing estrus were the most frequent complaints. Those replying to the survey reported an increase in breeding difficulties during the last 3 years.

3. A field investigation was conducted in 36 dairy herds totaling 931 cows. Reproductive histories were obtained, genital examinations were made on all females, and sampling and testing for certain infectious diseases were accomplished.

4. The field investigation revealed severe infertility in the investigated herds. Postservice anestrus occurred in 45.4 percent of the serviced animals with 17.6 percent requiring 4 or more services to conceive. During the 12 months of the investigation only 65.4 percent of the serviced cows conceived.

5. A conservative estimate of the production days lost in these herds from delayed conception resulting from postservice anestrus and repeat-breeding alone is 29,900 days. Each lost production day is calculated at $2.50. Total loss from these two forms of infertility exceeds $74,750 for the 12 months. The average loss per serviced cow exceeds $100. As staggering as these figures are, they do not include losses caused by other forms of infertility or those caused by premature culling and disposal of animals. Nor do they take into account revenue losses caused by the decreased calf crop. In addition, the total loss involving the 34.6 percent of the serviced cows which failed to conceive during the 12 months is not included.

6. To eliminate and prevent losses, a clear understanding of the causes is needed. Because of the limited scope of this investigation we could not determine all of the causes of infertility, particularly the role of infectious and nutritional factors.

7. Information supplied by the survey questionnaire and DHIA records indicates that many cows in this area received diets deficient in energy, protein, phosphorus, and vitamins A and D.

8. Research has shown that reproductive efficiency will be reduced if cows do not receive diets containing sufficient nutrients to supply their needs for growth, body maintenance, and milk production. Dietary requirements for these body functions are well established for most nutrients, but the cow's exact dietary needs for reproduction have not been firmly established.

9. Dry hay and pasture supply a greater portion of the nutrients to dairy cows in Polk, Pennington, and Red Lake Counties than to cows in other areas of the state. Good growing and harvesting practices are critical for the production of quality forage crops.

10. The infertility problem described in this report is not unique for the area. The entire cattle population of the State of Minnesota is affected to a varying degree. A conservative estimate of the loss, caused by infertility, to the dairy industry of Minnesota exceeds 100 million dollars annually.

Recommendations

1. CONTINUED RESEARCH NEEDED. We recommend that state support be provided for a comprehensive investigation of causes of bovine infertility in Minnesota. Because of the complex nature of infertility, the investigation must be adequately supported by long range microbiological and pathological laboratory research.

More research is required to define the exact dietary need of each nutrient for reproduction relative to the non-reproductive functions.

2. EDUCATIONAL PROGRAMS IN HERD HEALTH MANAGEMENT NEEDED. As a result of the three-county investigation we recommend that the Department of Obstetrics and Gynecology, of the College of Veterinary Medicine; the Department of Animal Science of the Institute of Agriculture; and the Agricultural Extension Service cooperate in placing more emphasis on existing educational programs in the northwest area of the state and in developing new educational programs for all areas of the state.

More use should be made of the intensive educational offerings of the Agricultural Extension Service. Programs of particular importance which have been offered since 1963 include the following: the Dairy Seminar Series, the Dairy Herd Improvement Program, Dairy Reproduction Schools, and the Animal Fertility Workshop. There has been only limited participation in this three-county area.

The importance of teamwork between the veterinarian and livestock producers in establishing complete herd health programs should be emphasized and producers should have an opportunity for further education in herd health management. Educational programs in herd health management should be initiated in this three-county area and by the Agricultural Extension Service and later expanded to include all areas of the state.

Part I Report of an Investigation of Infertility of Cattle in East Polk, Pennington, and Red Lake Counties of Minnesota-1967

by R. Zemjanis and R.A. Wescott

Breeding difficulties in their cattle were reported to county extension agents, local veterinarians, and state legislators by several farmers in East Polk, Pennington, and Red Lake Counties in January and February of 1967. Local legislators requested help from the Livestock Sanitary Board, which in turn requested the Department of Veterinary Obstetrics and Gynecology of the College of Veterinary Medicine to investigate the problem.

Funds for the investigation were provided by the Minnesota Livestock Sanitary Board. The financial support and cooperation received from the Livestock Sanitary Board and the Agricultural Extension Service of the University of Minnesota is greatly appreciated. The cooperation and assistance of the county agents of these three counties, local veterinarians, personnel of the artificial insemination organizations serving the area, and the cattle owners was most gratifying.

Table 1. Questionnaires returned by herd owners classified by type of herd and with or without infertility complaint

Type of herd	Infertility complaint	No infertility complaint	Total
Dairy	89	136	225
Beef	4	108	112
Mixed	5	54	59
No cattle	--	--	24
Total	98	298	420

A. Infertility Survey

Because of the many complaints the first step was to determine the extent and the nature of the problem in the involved area. A questionnaire was distributed to all farmers owning cattle in East Polk, Pennington, and Red Lake Counties. Of the 1, 568 questionnaires sent, 420 were returned. A tally of returned questionnaires is presented in table 1.

Table 2 shows that the majority of returned questionnaires as well as complaints of infertility were from East Polk County.

Table 2. Classification of the returned questionnaires by county and type of herd

	Dairy cattle		Beef cattle		Mixed	
County	Infertility complaint	No complaint	Infertility complaint	No complaint	Infertility complaint	No complaint
East Polk	57	75	1	40	1	30
Pennington	18	46	3	50	2	17
Red Lake	14	15	0	18	2	7
Total	89	136	4	108	5	54

The returned questionnaires included incidence of retained placental membranes, abnormal discharge from the reproductive tract, abortions, and repeat-breeding (table 3).

When dairy herds alone were considered the questionnaires indicated that certain forms of infertility have increased during the last 3 years (table 4).

Table 3. Incidence of certain forms of infertility reported in returned questionnaires

Item		Dairy herds	Beef herds
Total calvings	Number	2766	865
Retained membranes	Number	144	40
	percent	5.2	4.6
Preservice discharge	Number	104	15*
	percent	3.8	1.7
Postservice discharge	Number	69	3*
	percent	2.4	0.3
Repeat breeding	Number	498	5
	percent	18	0.6
Abortions	Number	50	14*
	percent	1.8	1.6

* Incomplete records

Table 4. Incidence of reported forms of infertility in dairy herds regardless of breeding practice, 1964, 1965, and 1966

		Year		
Item		1964	1965	1966
Total calvings	Number	2368	2465	2766
Retained membranes	Number	129	205	144
	percent	5.4	8.3	5.2
Preservice discharge	Number	39	51	104
	percent	1.6	2.1	3.8
Postservice discharge	Number	12	19	69
	percent	.51	.77	2.5
Repeat breeding	Number	251	246	498
	percent	10.6	9.9	18.0
Abortions	Number	27	44	40
	percent	1.1	1.8	1.4

As expected, most of the dairy farms reported artificial insemination as the main type of breeding practice, while natural breeding was used predominantly in the beef herds from which questionaires were returned.

The incidence of complaints of infertility in the questionnaires varied with the breeding practice employed. The incidence of complaints from dairy herds using exclusively artificial insemination, natural breeding only, and both methods respectively are presented in table 5. Corresponding information concerning beef herds is presented in table 6.

Table 5. Distribution of reported forms of infertility in dairy herds according to type of breeding

		Type of breeding		
Item		A.I.	Natural	Both
Total calvings	Number	1409	204	1153
Retained membranes	Number	60	12	72
	percent	4.3	5.8	6.2
Preservice discharge	Number	54	11	39
	percent	3.8	5.4	3.4
Postservice discharge	Number	43	8	18
	percent	3.1	3.9	1.6
Repeat breeding	Number	293	31	174
	percent	20.7	15.2	15.1
Abortions	Number	13	6	21
	percent	0.9	2.9	1.8

Table 6. Distribution of reported forms of infertility in beef herds according to the type of breeding

		Type of breeding		
Item		A.I.	Natural	Both
Total calvings	Number	5	741	119
Retained membranes	Number	1	39	0
	percent	20	5.3	0
Preservice discharge	Number	1	15	0
	percent	20	2.0	0
Postservice discharge	Number	0	2	0
	percent	0	.27	0
Repeat breeding	Number	4	28	2
	percent	80	3.8	1.7
Abortions	Number	1	12	1
	percent	20	1.6	.84

Data based on survey type information have generally recognized limitations. Certain conclusions, however, can be made on the basis of the information provided by the returned questionnaires. These can be summarized as follows:

1. Cattle infertility is quite extensive in the three-county area.

2. Infertility seems to occur more frequently in dairy cattle.

3. Considering the dairy herds alone most complaints originated from farms employing artificial insemination.

4. The main form of infertility reported was failure to conceive or "repeat-breeding." In addition many of the farmers complained of difficulties in observing estrus.

B. Field Investigation

Field investigation, which included obtaining reproductive history of the herds, genital examination of all the females in the herd as well as sampling and testing for certain infectious diseases was conducted in 36 dairy herds. The number of herds was restricted to 36 because of limited manpower and support available. The herds were selected on the basis of the information gained through the questionnaires. All the selected herds were dairy herds. Most complaints came from herds using artificial insemination (table 7).

Table 7. Incidence of returned questionnaires complaining of infertility from dairy herds classified according to the breeding practices

Breeding practice	Total questionnaires returned	Questionnaires returned with complaints of infertility: Number	Percent
A.I. (A) *	45	26	57.7
A.I. (A) + natural	30	14	46.9
A.I. (B) *	41	18	43.9
A.I. (B) + natural	35	18	52.8
A.I. (C) *	4	2	50.0
A.I. (C) + natural	4	1	25.0
Only natural breeding	60	10	16.6
Total	219	89	40.6

* A, B, and C refer to artificial insemination organizations employed in the herds returning questionnaires.

Most complaints came from East Polk, the county with the largest number of dairy herds in the three counties. Therefore, more herds were selected for the investigation from East Polk County. Distribution by county of the investigated herds is presented in table 8.

Table 8. Classification of investigated herds according to location and type of breeding

County	Total herds investigated	Number of herds bred by: A.I.	A.I. + natural	Natural
East Polk	25	16	8	1
Pennington	5	4	1	-
Red Lake	6	3	2	1

The findings of the genital examination were correlated with the available reproductive history. Reproductive performance in the investigated cattle population is summarized in table 9.

Table 9. Reproductive performance of the investigated cattle population

Total herds examined	36
Total animals examined	931
Total first services recorded	714
Total first service conceptions	236
Percent first service conceptions	33.0
Number of services per conception	3.1
Percent post service anestrus	45.4
Percent "repeat-breeders"	17.6
Percent genital abnormalities	16.0

Data from table 9 indicate that:

1. The first service conception rate is about 20 percent lower than the average reported (51.4 percent) for larger normal cattle populations.

2. The 3.1 services per conception, exceeds by 1.3 the number of services generally recognized as acceptable.

3. The incidence of postservice anestrus is extremely high. This category includes serviced cows which return in heat 6 weeks or more after service. Also included are serviced cows which were not observed in heat after breeding but were not pregnant upon pregnancy examination.

4. The incidence of "repeat-breeders," cows or heifers requiring more than three services per conception, is also extremely high. Table 10 gives the conception rates from first through tenth services

Table 10. Conception rates from first through tenth services

Service number	Total serviced	Total conceived	Percent conceived
1	714	236	33.0
2	410	110	26.8
3	250	73	29.2
4	138	22	15.9
5	77	18	23.4
6	32	6	18.8
7	10	-	0
8	4	-	0
9	3	2	66.7
10	1	-	0
All services		467	65.4

Recorded abortions in the investigated herds were negligible. Major forms of infertility in the investigated herds are shown in table 11. Incidence of encountered genital abnormalities is given in table 12.

Table 11. Incidence of certain forms of infertility in the investigated herds

Form of infertility	Number cases	Percent
Preservice anestrus*	70	9.8
Postservice anestrus	314	45.4
Irregular returns to heat	30	4.2
Repeat-breeding	126	17.6

* The available calving records were incomplete

Table 12. Incidence of certain genital abnormalities in the investigated herds

Abnormality	Number examined	Number cases	Percent
Atrophy of ovaries	931	49	5.3
Cystic ovaries	931	59	6.3
Metritis	931	24	2.6
Cervicitis	931	4	.43
Perisalpingitis	931	12	1.3

Data in tables 9, 10, 11, and 12 indicate that an infertility problem indeed exists in the area. The data also indicate that the problem is very serious and quite extensive.

C. Laboratory Examination

Cervical and uterine mucus samples were collected from 104 cows selected on the basis of the reproductive history and clinical examination. Each sample was submitted for bacteriological, parasitological and virological examination. Specific infectious agents were not found. In addition, 39 blood samples were examined serologically. Antibodies of specific significance were not found in these samples.

D. Discussion

Whenever a complaint of infertility originates from a closed area it is logical to suspect a common cause or causes affecting all involved animals and herds. When free mating is permitted the cause is generally found either in the female or the male--in this case in cows or bulls.

Domestication with hand breeding and particularly with the advent of artificial insemination has further complicated the problem by introducing procedures in animal breeding for which human beings are responsible. When hand breeding is practiced the herdsman or the owner determines the timing of service and therefore influences the success of the mating.

The success of artificial insemination depends greatly on proper timing of service, which in turn depends upon observation of heat. The inseminator handles the semen and performs the insemination. These steps are therefore exposed to human errors. The time of day when the inseminator arrives on the farm also affects the timing of the service.

Considering the cows and heifers as a group the data obtained in this investigation do not suggest a common cause intrinsic to the females. A specific common infectious agent was not demonstrated in the 104 samples examined in the laboratory. Because of the restricted scope of the investigation each selected animal could be sampled only once and a followup examination was not possible. The value and the reliability of one single laboratory test is obviously limited. The laboratory findings do suggest that infection was responsible for reproductive failures of individual cows or heifers. The genital abnormalities found in the examined cattle (table 12) also do not explain the high incidence of the reproductive failures.

To evaluate the role of the bulls as the cause of the problem it was necessary to test the fertility of each bull used. Table 13 presents data concerning the bulls used by each artificial insemination organization. The large number of the bulls used eliminates the possibility that low fertility or infected bulls are responsible for the infertility problem in the area. This is further supported by the relatively good fertility of the 29 bulls of organization B. The small number of herds serviced by organization C and by natural breeding alone does not permit any comparison.

Table 13. Total bulls used, total of first services per bull and first service conception rate for each breeding practice

Breeding practice	Total bulls used	Total first services	First services per bull used	First service conception
A. I. (A)	95	417	4.3	21.3
A. I. (B)	29	146	5.0	47.0
A. I. (C)*	5	7	1.4	28.5
Natural breedings only	4	18	4.5	83.3

* One herd only

A, B, and C refer to the artificial insemination organizations employed in the investigated herds.

Since the conception rate was lowest in the population serviced by artificial inseminator "A," further comparison of breeding efficiency and incidence of major forms of infertility on the basis of breeding practices were needed. This comparison is presented in table 14.

Table 14. Reproductive efficiency in investigated herds according to the type of breeding

Breeding practice	Total herds	Total animals examined	First service conception percent	Service per conception	Postservice anestrus percent	Repeat breeding percent
A. I. (A) *	18	503	18.5	4.6	61.4	29.7
A. I. (A) + natural	4	93	36.4	3.8	30.2	17.0
A. I. (B) *	7	192	53.7	2.1	21.0	5.8
A. I. (B) + natural	4	86	47.1	1.7	28.6	0
Natural	2	39	87.5	1.3	0	0
A. I. (C) *	1	18	25.0	3.5	25.0	0

*A, B, and C refer to the artificial insemination organizations employed in the investigated herds.

Fertility was lowest in the herds serviced by the artificial insemination organization A. Also, post-service anestrus and repeat breeding, the two most important forms of infertility, were highest in these herds. Fertility was slightly higher in the herds using organization A combined with natural breeding.

First service conception rate in the cattle inseminated with semen from organization B was considerably higher than those serviced by organization A. It did not, however, reach the level generally recognized as acceptable. Organization C was used in only one herd and only two herds bred exclusively by natural breeding were investigated. The fertility in these herds was very good.

The small number of herds and cattle examined does not permit a valid comparison of breeding efficiency between artificial insemination and natural breeding as practiced in these herds selected for investigation. It is obvious, however, that when natural breeding was used along with artificial insemination higher conception rates resulted regardless of the artificial insemination organization employed. Many of the returned questionnaires reported that fertility in the herds was low while artificial insemination was used, and that it improved when natural breeding was started.

Since the lowest fertility occurred in cattle served by organization A one might get the impression that they are responsible for the problem. But, this may not be true. Table 7 indicates that the percent of farmers complaining of infertility is about the same regardless of whether organization A or B is providing the insemination service. And, among the herds included in this investigation, twice as many were serviced by organization A than by organization B. In addition, selection of herds for investigation was influenced by the insistence of the complainants and by the recommendations of one of the insemination technicians of organization A; therefore, unbiased comparison of organizations A and B are impossible.

The fact remains that the fertility in the inseminated herds was very low. The high number of bulls used practically eliminates poor quality semen as a cause for the low fertility. The role of the inseminator remains unknown since the investigation did not evaluate the proficiency of individual inseminators.

Successful artificial insemination depends on proper timing of service. Adequate observation of heat in turn is essential for proper timing of insemination. The low fertility and more so the high incidence of postservice anestrus strongly suggest that inadequate observation of heat might be one of the major causes of the reproductive failures in the herds that were investigated.

E. Conclusions

1. Cattle infertility is extensive and serious in the herds investigated. Judging from the questionnaires, cattle infertility is a problem in many dairy herds in East Polk, Pennington, and Red Lake Counties.

2. The economic loss caused by infertility in the investigated herds is enormous. A conservative estimate of the production days lost in these herds from delayed conception resulting from postservice anestrus and repeat-breeding alone is 29,900 days. Each production day lost is calculated at $2.50. Total loss from these two forms of infertility exceeds $74,750 for the 12 months. The average loss per serviced cow exceeds $100. As staggering as these figures are, they do not include the losses caused by other forms of infertility or those caused by premature culling and the decreased calf crop resulting from infertility. In addition, the total loss involving the 34.6 percent of the serviced cows which failed to conceive during the 12 months is not included.

3. Limitations of this investigation did not permit determination of the actual causes of the problem.

4. The role of infectious agents could not be adequately studied.

5. The influence of nutrition could not be determined because of the limited scope of this investigation.

6. The data obtained by correlating clinical findings indicate that failure to recognize estrus contributes to the infertility problem in the herds investigated.

7. The data also suggest that insemination techniques and practices should be evaluated.

8. The seriousness and the extent of the infertility problem as revealed by this investigation demands a further, more comprehensive investigation.

F. Recommendations

Exact recommendations to eliminate and prevent a problem as complex as infertility are not possible unless the exact causes are known. The limited data obtained in this investigation impose restrictions upon the recommendations concerned with the existing problem. However, even with the limited data possible from this study, there are two major recommendations which should be made:

1. CONTINUED RESEARCH IS NEEDED. Cattle infertility, like any other disease, requires a clear understanding of the causes before losses can be reduced or eliminated. Such knowledge of infertility requires comprehensive, long range microbiological and pathological laboratory research followed with complete herd investigations. The infertility problem as described in this report is not unique for the area reported. The entire cattle population of Minnesota is affected to a varying degree.

It is, therefore, recommended that state support be provided for the required investigation. The cattle industry is one of the most important industries in this state. Such a tremendous loss from infertility, should not be permitted to continue without some serious attempt to curb this loss. State funds for agricultural research should be increased to adequately support studies on bovine infertility.

2. EDUCATIONAL PROGRAMS IN HERD HEALTH MANAGEMENT NEEDED. As a direct result of this study, it is further recommended that the Department of Obstetrics and Gynecology, of the College of Veterinary Medicine; the Department of Animal Science, of the Institute of Agriculture; and the Agricultural Extension Service, cooperate in placing more emphasis upon existing educational programs and in developing new programs in the northwestern area of the state. The importance of teamwork between veterinarians and livestock producers in establishing complete Herd Health Programs should be emphasized. Producers should also have an opportunity for further education and training in Herd Health Management to include the following:

a. Observation of estrus should be improved.

b. Practical ways to assure proper timing of service should be developed between farmers and artificial insemination personnel.

c. Sound breeding practices should be employed when deciding which cows and heifers to breed and when. Breeding too soon after calving results in poor fertility. Cows and heifers with obvious genital infections should not be bred.

d. The success of modern agriculture depends upon good record keeping. Adequate records are essential to any breeding program.

Management, as well as field personnel, should be notified of major infertility problems in areas serviced by artificial insemination organizations. The organizations are anxious to correct any inadequacies involving techniques and practices of their personnel. Several of the insemination technicians in the area are devoting only part-time to insemination. The other occupations might affect the proficiency of the individual inseminators, particularly as far as timing of service is concerned.

Part II Survey of Nutritional Factors in Dairy Herds Replying to Questionnaires and from DHIA Records

by B.J. Conlin

Exact dietary needs for animal reproduction are not clearly established. Research has shown that no nutrients are needed for reproduction that are not also required for growth, milk production, and body maintenance. However, research studies indicate that reproductive efficiency will be reduced if cows do not receive enough of the required nutrients for the non-reproductive functions.

Some reproductive problems associated with faulty nutrition include delayed heat in heifers, irregular heat periods, abortions, calving difficulties, weak or dead calves at birth, and abnormal calves.

Caution must be used when interpreting results from data collected by a mailed questionnaire. Results can be biased by a nonrepresentative sample of people replying, misunderstanding of questions, or incomplete information available to provide answers in adequate detail. The influence of these possible sources of bias is not known. Because of these potential problems in interpretation, the data supplied by the questionnaire were supplemented with DHIA records from herds on test in the three-county area.

Not all questions on the returned questionnaire were answered in enough detail to be included in each of the categories summarized. However, using the information supplied by the 225 dairymen replying to the questionnaire a general assessment of the kinds, amounts, and quality of feeds reported in their dairy rations was made.

A summary of the DHIA supervisors' monthly reports for the three counties indicates that of the cows removed from DHIA herds, 20.2 percent in 1966 and 20.6 percent in the first 9 months of 1967 were sold as nonbreeders. The comparable state average figure for 1966 was 15.0 percent. Of the total cows tested in these three counties in 1966, 3.9 percent left herds as nonbreeders whereas in the state 4.3 percent left for this reason.

Sources of Feed Nutrients in Dairy Rations

A summary of all DHIA herds for the state, each of the three counties, and the dairymen on DHIA replying to the questionnaire is shown in Table I.

DHIA dairymen in the three-county area feed from 800 to 1,100 pounds less concentrate per cow annually than the average Minnesota DHIA herd. (table I) The average hay and silage consumption in DHIA herds in the three-county area is about the same as for all DHIA cows in the state. Dairymen in Pennington County, however, use on the average much less silage than either Red Lake or Polk County dairymen, or than the average Minnesota DHIA dairyman. Cows also spend from 12 to 39 more days on pasture in this three-county area than the average Minnesota DHIA cows.

These differences indicate that hay, silage, and pasture supply a greater portion of the nutrients fed cows in the three-county area than on a statewide basis. Concentrates supply a much smaller portion of the total diets of cows in this area as contrasted to the state.

Ingredients and Amounts of Concentrates Fed

Concentrates are an important source of energy, proteins, and some minerals in dairy rations. Their relative importance to the cow's total diet depends on the quality and quantity of hay, silage, and pasture provided relative to the cow's needs for growth, production, maintenance, and reproduction. The distribution of concentrates fed throughout the lactation can also be important for maintaining profitable production over the entire lactation period.

Replies to the questionnaire indicated that oats was the primary component of the concentrate rations fed. About equal numbers were using barley and corn cob meal with very few using wheat or shelled corn.

Many grain rations consisted entirely of ground oats or contained proportionately small amounts of high energy or protein supplements. While oats are a relatively good source of energy and protein, they will not supply an adequate amount to meet the cow's needs where the quality of hay and silage fed is only average or below.

Average amounts of concentrates reported fed daily per cow ranged from none to 30 pounds. (table II) If we could assume the forage part of the ration would be adequate to supply all the cow's needs for all her functions except production, then the 30 pound feeding level for the ration reported (77 therms per 100 pounds) would supply enough energy to support a herd of cows producing 72 pounds of 3.5 percent milk daily. Cows in herds receiving no concentrates would only have the nutrients in the hay and silage that were not needed for body maintenance, growth, and reproduction available to produce milk.

The average amount of concentrates reported as fed per day was 12.6 pounds per cow. (table II) This daily level of concentrate feeding is at the annual rate of 4,600 pounds per year. DHIA reports for the 19 tested herds replying indicate the annual rate of concentrate feeding to be only 3,900 pounds per cow. (table I) There was probably a tendency for dairymen to report the amount fed in peak lactation, or possibly the amount fed to the highest producing cows in the herd. This may have been influenced by more cows being near the peak of their lactation at the time of the survey. In fact, the general level of concentrate feeding in all herds is probably below the 3,900 pound annual average reported on the DHIA herds. (table I) DHIA reports for 1966 show only 79 percent of the dairymen in the three-county area fed grain rations to dry cows as compared to 89 percent for the state average.

Hay and Silage

Dairymen in the three-county area rely more heavily on forage crops as a source of energy and protein than the average dairyman in the state.

The quantity fed is not any greater than throughout the state, but hay, silage, and pasture make up a larger portion of the total diet because the level of concentrate is lower. (table I) The energy and protein content of concentrates fed is also lower because less high energy and protein feeds are used in the concentrate mixtures being fed. Therefore, the quality of the forage crops is relatively more important to dairymen in this area than in other areas of the state. Quality of forage crops can vary greatly as to net energy and protein content. Some factors that have a major influence on the quality of hay, hay silage, and pasture are the state of maturity when harvested (calendar date), variety, weather conditions at the time of harvest, and moisture content at time ensiled. Variations in weather conditions during the growing season and soil fertility levels can also be important to both the quality and quantity of hay and corn crops.

Dairymen replying to the questionnaire indicated that all were feeding dry hay and only 57 percent were using some silage (table III) in their rations. Most of the dairymen (98 percent) were using some alfalfa, but, in addition, 41 percent indicated they were using timothy or brome grass and 29 percent reported using other varieties such as Reed Canary grass, June grass, red clover, and others (table IV). Only 16 percent of the dairymen reported harvesting their hay crop before June 10, or 1/10 bloom or before; 28 percent harvested the first crop of hay after the first of July. (table IV) More than 30 percent of the dairymen reported that the hay they were feeding smelled musty or contained some mold. (table IV) Presence of certain molds has been shown to reduce reproductive efficiency in swine but there is a lack of information available for cattle. Many dairymen replied that their hay was coarse and/or brown and discolored.

Level of hay feeding is represented in table III which shows more than 50 percent are feeding hay free choice and about 50 percent feeding an average of 29 pounds per cow per day, which ranged from 4 to 60 pounds. It is unlikely that cows will consume more than 40 pounds of dry hay daily, even if it were of superior quality and she received nothing but hay. Because of the large amount of hay being fed that is of mediocre quality as indicated by variety, cutting dates, and mold, dairymen probably tended to report the amount offered the cow and did not account for the amount the cow didn't eat and was thrown out. Leftovers would be larger for mediocre quality hay than for superior quality hay.

Few dairymen who were feeding corn silage reported it to contain high amounts of corn grain. Most indicated their corn silage to contain medium to small amounts of corn grain. Most silage was reported to contain a medium amount of moisture.

From the DHIA reports for tested herds in this three-county area, cows are on pasture longer than cows in average DHIA herds across the state (table I). No indications were made relative to quality of pasture used.

Mineral Supplements (table V)

Soils in Polk, Pennington, and Red Lake Counties are severely deficient in phosphorus. The phosphorus content of home grown feeds will be influenced by the amount available in the soil, and the type and variety of feed grown, especially in a dry crop season. Because of the low soil phosphorus levels and since the major ration ingredients used do not contain large amounts of phosphorus, it is of particular importance that the cow's needs be met in some other way. Supplementation in the grain ration and/or free choice dicalcium-phosphate or bonemeal are usually the lowest cost ways to insure that the cow's needs are met. Only 2.8 percent of 210 dairymen reported they were using dicalcium-phosphate or bonemeal both in the grain ration and free choice. An additional 35 percent indicated they were using these sources of phosphorus or calcium in either the grain ration or free choice. Twenty-six percent reported using a commercial mineral supplement. Some of the brand names reported were examined for phosphorus content and were found to contain subpar levels. The remaining 39 percent did not indicate that they were feeding any phosphorus-calcium supplement.

Most of the dairymen (80 percent) were using trace mineralized salt either free choice, mixed in the grain ration, or both. However, the remainder used either plain salt or did not indicate any supplementation of salt. The use of trace mineralized salt, one percent in the grain ration and also free choice, is recommended.

Vitamins (table VI)

Vitamins A and D have both been associated with reproductive abnormalities. Sun-cured hay and sunlight are two natural sources of vitamin D. Good green forage and corn are good sources of vitamin A.

Supplementation of vitamins A and D are important during the winter if mediocre quality forage is fed, only limited amounts of corn are fed, and/or cows are not exposed to much direct sunlight. Of the 210 dairymen replying only 31.4 percent indicated they were supplementing their dairy rations with both vitamins A and D; 59 percent did not indicate that they were using either vitamin A or D supplements.

Summary and Recommendations

1. Energy and protein feeding levels are probably below recommended levels in most of the dairy herds surveyed. High levels can increase production and improve the general nutritional levels of the animals. Increased energy and protein levels can be obtained in the following ways:

a. Higher levels of concentrate feeding according to production.

b. Use of more high energy and protein ingredients in the grain rations so that the proper balance is obtained for the quality and quantity of forages fed.

c. More extensive use of alfalfa and other legumes for hay crops.

d. Quality (energy and protein content) of hay crops can be improved by harvesting at an earlier stage of maturity 1/10 bloom or before.

e. Recommended fertilization rates should be followed to insure maximum potential yield of energy and protein per acre. This is especially important for the forage crops grown.

2. Phosphorus feeding levels are below recommended amounts in most herds. This is particularly critical because of the phosphorus deficiency that exists in the soils of this area. Phosphorus levels can be increased by:

a. More extensive use of phosphorus rich supplements in the ration and free choice is recommended because of low levels of soil phosphorus. Dicalcium-phosphate and bone-meal are usually the lowest cost sources of phosphorus.

b. Fertilizing soils at recommended levels for the crops grown.

c. More extensive use of soybean meal or other high protein feeds in the grain ration and higher levels of concentrate feeding.

3. Some herds are probably not receiving ample vitamins A and D to meet their needs in the winter feeding period. Vitamins A and D can be increased by:

a. Improving methods of harvesting forage.

b. Supplementing with commercial vitamin A and D supplements mixed in the grain ration.

4. More participation in the intensive educational offerings provided by the Animal Science Department and the Agricultural Extension Service would be helpful.

Table III. Hay and silage feeding practices in herds replying

	Hay	Silage
Total herds	179	179
Free choice	53 percent	11 percent
Limited feeding	47 percent (29 pounds per cow per day average)	46 percent (29 pounds per cow per day average)
None	0	43 percent

Table I. Comparative summary of annual production and energy sources of DHIA herds in 1966

	State	East Polk	Pennington	Red Lake	DHIA members replied to questionnaires
Number herds	3,057	26	24	19	19
Cows/herd	33	30	29	29	30
Pounds fat	446	427	415	398	431
Percent days in milk	85	84	85	84	84
Pounds concentrate	4,700	3,900	3,600	3,700	3,900
Percent net-energy concentrates	46	41	38	37	38
Pounds of succulents	10,800	10,600	5,200	12,400	11,400
Percent net-energy succulents	20	21	10	24	23
Pounds dry roughage	4,600	4,500	6,000	5,100	4,500
Percent net-energy roughage	24	26	35	27	27
Pasture days	81	93	120	95	118

Table II. Range and mean daily consumption of concentrates and the net energy and digestible protein supplied

	Concentrates	Net energy		Protein	
	Average pounds per cow per day	Therms per 100 pounds	Therms per cow per day	Percent Digestible protein	Pounds digestible protein day
143 herds	12.6	68.4	8.62	9.9	1.25
High herd	30.0	77.0	23.10	14.5	2.72
Low herd	-	-	-	-	-

Table IV. Factors influencing hay quality as reported by dairymen

FREQUENCY OF HAY VARIETIES USED			
Total herds 216	Alfalfa 97.7 percent	Timothy-Brome 41.2 percent	Other 28.7 percent
CUTTING DATE			
Total herds 171	Early (prior June 12) 15.8 percent	Medium 73.1 percent	Late (after July 1) 28.1 percent
INCIDENCE MOLD IN HAY FED			
Total herds 156	None 71 percent	Musty 10.8 percent	Moldy 21.2 percent

Table V. Frequency (percent of dairymen) using mineral supplements as reported by 210 dairymen

How fed	Trace mineral salt	Calcium phosphate mineral
	percent	
Grain ration and free choice	8.1	2.8
Only free choice	38.1	11.3
Only in grain ration	32.4	23.5
Plain salt	23.8	
Commercial mineral		26.3
None	4.8	39.0

Table VI. Percent dairymen using vitamin supplements from 210 dairy herds

	Percent herd using
Vitamin A and D supplement	31.4
Vitamin A only	8.6
Vitamin D only	.9
None	59.0

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U. S. Department of Agriculture. Roland H. Abraham, Acting Director of Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55101. 3M--1/68