DAIRY EXTENSION AND EDUCATIONAL PROGRAMS IN KANSAS

by

MUSTAFA BEDAWI BASHIER

B. V. Sc., University of Khartoum
Sudan 1961

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements of the degree

MASTER OF SCIENCE

Department of Dairy and Poultry Science

KANSAS STATE UNIVERSITY

Manhattan, Kansas

1968

Approved by:

Earl L. Carmon
Major Professor

TABLE OF CONTENTS

INTRODUCTION

The objective of this study was to summarize general concepts which can be applied to improve dairy production and to serve as a guide for the production of milk safe for human consumption in the Republic of the Sudan. In view of the technical and extension aspects of the developmental programs in the Ministry of Animal Resources of the Republic of the Sudan and due to the expected general acceptance of the dairy industry, the writer was granted a scholarship by the Sudanese Government and the United States Agency for International Development to study some of the features of dairying and related programs in the State of Kansas.

This report is a result of personal contact and orientation with respect to programs related to the dairy industry in the State of Kansas. Moreover, the report does not confine itself to a single phase of dairying in the state but involves many programs designed to enhance production of milk suitable for human consumption in an economical manner.

The organizations consulted ranged from agencies involved in production programs such as the Kansas Artificial Breeding Service Unit, Dairy Herd Improvement Associations, and the processing and marketing organization of The Southwest Milk Producers Cooperative in Wichita, Kansas. In addition, tours and consultation provided orientation with respect to the functions and the physical facilities of regulatory establishments, such as the State Board of Agriculture, State Board of Health, State-Federal Cooperative Laboratory for regulation of brucellosis and tuberculosis and the Wichita Board of Health.

The observations obtained while visiting and studying these agencies and establishments culminated in a feeling that dairying in America,

generally, and the State of Kansas particularly, is the most advanced in the world as indicated by the outstanding herds, the quality and variety of the dairy products, the automated facilities in barns and plants and the advanced methods for distribution of products (9).

Such a satisfactory status, particularly with respect to individual cow production, was demonstrated by the national average of 7268 pounds of milk per cow per lactation in 1965 (17, 21). This was the result of a continual increase from an average annual per cow production of 4000 pounds in 1924, 5000 pounds in 1947, 6000 pounds in 1956 and 7000 pounds in 1960. The nation's progressive herds, representing 19.1 percent of the milk cows which were in the dairy herd improvement associations produce an average of 11,976 pounds of milk per cow per year (8, 21). The difference between the 7268 pound average for all cows and the 11,976 pound average for the cows in the progressive herds probably reflected the use of advanced breeding practices, disease control, and desirable feeding and management (17, 29). That is to say, the interaction between these factors had resulted in the specialized dairy farm.

The gradual and consistent improvement in average production came as a result of the gradual development and acceptance of a number of programs. Most of the programs developed were evolved through the efforts of the previously enumerated agencies and establishments and so these programs are referred to in this report as Production, Health and Regulatory Programs. It was apparent that in order to implement these programs, the teaching and information role of the extension service was essential to their acceptance and utilization.

The primary production programs studied were artificial insemination and the Dairy Herd Improvement Associations. In fact these programs are

complementary in function. Furthermore, they require a significant amount of the effort and time of the extension workers (3, 12). The goal of the production programs is the improvement of dairy herd production through the culling of mediocre individuals and the selection of desirable foundation animals, particularly proven sires (3, 12). Consideration is given to both the animal's own performance and its contribution to the genetic make-up of the succeeding generation (2, 4, 13, 29). Specifically, artificial insemination deals with the extended use of superior sires. Artificial insemination, compared to natural service, vastly increases the effect on the genetic constitution of future generations. The Dairy Herd Improvement Association provides an economical method for obtaining information that can be used to improve the production efficiency of the herd. Records of production, feed cost and income enable the dairyman to cull the least profitable cows, to feed the rest according to their production requirements, and to select the most suitable animals for foundation animals. Moreover, both programs have educational features that stimulate greater interest in better livestock breeding and management practices. There is lack of pride in accomplishment when poor production and low income over feed costs from mediocre and inefficient animals prevail. Furthermore, dairy extension specialists and county agents have found that the introduction of artificial insemination reflected an increased interest in other features of dairy management such as the methods of raising calves and the feeding and care of dry cows (19).

For acceptable fulfillment and utilization of these programs considerable technical help was rendered by the land grant university which in Kansas is Kansas State University. The university has encouraged and nurtured dairy cattle breeding through research and dairy extension activities.

Moreover, the Kansas Artificial Breeding Service Unit is an auxiliary function of the university. It has been said that no other single program has had so profound an influence on dairy cattle improvement as the use of artificial insemination (19). Although a gain of 1-2% per year in the average yield of herds during the period of artificial insemination utilization was not spectacular, this steady progress over a period of years has significantly enhanced the economy of dairy operations (11, 24, 29). To maintain the genetic basis when surplus milk is produced, compensation should be made by reducing the number of cows and not by relaxed selection (11).

Also the university through the dairy extension specialists supervises and promotes the Dairy Herd Improvement Association program. Although the function of the dairy herd improvement associations is testing and record keeping, which is actually done by trained supervisors (3, 4, 12), the extension specialist assumes the role of a teacher who motivates the dairymen to use the information the program provides and to develop leadership essential to dairy herd improvement association groups. In addition the dairy specialists train and assist the supervisors to maintain a high standard in performance of their duty. Additional participation by the extension specialists involves the artificial insemination program by providing production record summaries for use in sire evaluation and selection. They also help the artificial breeding program by explaining to the dairymen the need for improved breeding through artificial insemination as a practical source of superior sires.

The role of the private corporation such as The Southwest Milk Producers Association involves the processing and marketing of the producer's milk. It would be expected that this organization would only affect this economic feature of dairying; but, the field workers of the association give considerable assistance to the producer in solving current production problems as

they arise.

Health and regulatory programs function through agencies for controlling and protecting herds and consumers from zoonotic diseases. They aid in the establishment and enforcement of regulations that affect the health of the herds from which milk is marketed. In addition, they regulate the quality of the milk at the producer's farm and the milk products at the plant. In this manner the health and regulatory programs affect the dairy industry indirectly by the impact they have on dairy sanitation.

In the Republic of the Sudan there are no programs similar to the programs described as functioning in Kansas. Furthermore, the existence of the specialized dairy farm is a rarity. Although milk and milk products contribute a significant part of the diet of the Sudanese, milk for sale is a by-product of peasant or subsistence producers (25, 27). These producers aim to satisfy their own requirement before offering any production for sale. Moreover the quality of this milk never reaches satisfactory levels.

Despite this picture considerable demand does exist, and much effort is being made in the development of programs by the Ministry of Animal Resources to provide for an adequate supply of quality milk to satisfy urban areas. Most of these developmental programs focus on the creation of medium-sized specialized demonstration dairy farms with good producing cows, well managed, and incorporating health practices that insure that the milk reaches the consumer in satisfactory condition.

Due to the absence of improvement programs in the Sudan and due to the increase in planned projects for dairy industry this study was designed to investigate the feasibility of the above briefly described programs and to visualize the role each has had in paving the way for the promotion of dairying in Kansas. Moreover, it is hoped that this study will help to

upgrade dairy production and serve as a guide for the production of quality milk for consumers in the Sudan.

Production Program

In this report production programs are defined as those directed toward the improvement of dairy production. Primarily these programs include artificial insemination and the Dairy Herd Improvement Association programs. Artificial insemination may improve the producing capacity of future dairy cows genetically when superior sires are extensively used. The effectiveness of sire selection is sustained by good record keeping and reliable production testing. Moreover these factors are essential for establishing the productive capacity of the individual animal. Good record keeping and reliable production testing are provided concurrently by the Dairy Herd Improvement Association program. Thus artificial insemination and Dairy Herd Improvement Association programs play complementary roles in the improvement of dairy production through breeding and selection.

Artificial insemination is the deposition of male spermatozoa in the female genitalia by instrument rather than by natural service (19). The technique of artificial insemination has been used in many species, but economic and managerial conditions have made it most feasible in dairy cattle.

Historically, artificial insemination is not a recent innovation but was used crudely as early as 1322 by the Arabs to breed equines (6, 14, 19). In 1780 Spallanzani used the technique in an investigation of reproductive function to breed dogs (6, 14). By the beginning of the twentieth century the Russian scientist, Ivanoff, introduced the technique to cattle, sheep and horses (4, 6, 14). By 1950 artificial insemination had spread to nearly every country in the world. In 1962 it was widely used as much as 100 percent

in Denmark, 95 percent in Japan, 75 percent in Holland, 55 percent in England, 45 percent in Western Germany and 40 percent for both the United States and France (6). In 1949 Polge and Parkes established a landmark in the field of artificial insemination by their discovery of a practical method for long time preservation of semen by storage at temperatures of -79°C using solid carbon dioxide (14). In 1952 Polge and Rowson secured satisfactory conception rates using bull sperm extended with egg yolk-sodium citrate and equilibriated with glycerol for several hours before freezing with liquid nitrogen (14). The discovery of the protective properties of glycerol on the sperm cell, and the use of liquid nitrogen enabled storage and the shipping of ampouled semen to become a standard practice among many countries (14, 23). This was an advantage to countries where acclimatization of imported sires was impractical due to general environmental hazards (28).

In the United States the artificial insemination program started in 1938 (14, 19). By 1958, nearly seven million cows were bred artificially by the 71 breeding organizations existing at that time (14). This was 30 percent of the dairy cow numbers (14). By 1962 more than 50% of registrations of purebred dairy cattle were for artificially conceived calves. The general acceptance of the program stood as evidence of its several advantages compared to natural service. Of these advantages the most fundamental was that artificial insemination made sires of proved inheritance for milk and butter fat production available to all dairymen within the area served. Prior to artificial insemination, only the better dairymen benefited by the use of good sires. In natural service a bull can only breed from fifty to sixty cows in a year but through artificial insemination from 30,000 to 50,000 cows can easily be bred by one bull (14).

Thus, if the methods of selection employed were competent to determine the few male individuals that would transmit the best genetic material for production traits, then this genetic material could be perpetuated effectively through artificial insemination (23). It is evident that the higher the intensity of selection, the greater the genetic response expected (2, 13). The genetic response through artificial insemination was not spectacular as it was proved to be 1-2 percent per year in the average yield of the herds (11). Also a high degree of the accuracy of selection could only be achieved by increasing the total number of offspring measured or tested. Also the rapid increase in the use of artificial insemination has precipitated very keen competition for the exceptionally desirable sires available. This has led to an expression of concern that the decrease in the number of bulls in proportion to the number of cows, might result in inbreeding and a general deterioration of vigor (10). So, in order to avoid such a situation it will become increasingly important to conduct progeny testing and plan the mating combination (10). Furthermore the accuracy in methods of evaluating data for proving bulls has been improved and thus more reliable because artificial insemination which involves many herds with considerable variation in the environment minimized the bias due to a single environment (19, 24). Thus in sampling a young sire it is suggested that at least 7,000 cows be bred for the evaluation of the progeny (24). Although the national average of cows per young sire in artificial breeding is 2,000 cows, breeding 7,000 to a young sire could improve the rate of genetic gain. Moreover, improvement during the last decade in artificial breeding procedures, particularly extenders, preciseness of extension, and freeze processings make it possible to inseminate more cows to young sires (23). These improvements have also led to the need for fewer sires as prime semen producers. Because fewer

sires would be required as semen producers, greater intensity in the selection of sires would be possible. Reducing the number of sires for production and simultaneously increasing the intensity of selection among young sires is a realistic compromise between economy and genetic gain. In regard to sampling young sires for evaluation, if ten young sires are sampled and only one is kept, this will only give a maximum rate of improvement of 0.2% higher than over the mean annual yield of 1 to 2% when five sires are sampled (11, 24). In practical application of a sire evaluation program, young sires are sampled at the age of twelve to twenty-four months of age. Pending their full proving, which occurs at ages ranging from three to four years, the semen from these young sires is collected and frozen. The removal of these sires from the service after adequate sampling is essential for the effectiveness of the sire evaluation program.

Artificial insemination has reduced the cost of breeding for the small dairy farm. The average cost of artificial insemination is less than the cost of maintaining individual herd sires. Sires used by artificial insemination studs are expensive to buy and to maintain but due to large numbers of services, the cost is low, the national average being five to seven dollars per first serviced cow (5). In addition to the foregoing, artificial insemination is safer and usually genetically superior to conditions where natural service was used (15, 17, 19). An indirect advantage of artificial insemination was improved reproductive health of the herd through the care and the attention given to the sires (15, 19, 23). This is true because semen, under most conditions, originates from sources under technically competent supervision and responsible management. Also the semen is used by well trained insemination technicians in a responsible sanitary manner (15). Moreover, in the procedures of semen processing the semen is treated with antibiotics

which would control transmission of brucellosis, vibriosis, leptospirosis and other non-specific ailments by bacterial inhibition (15, 23). An additional value of artificial insemination results from the visits of trained technicians. This provides an avenue of communication for technical information which results in improved breeding performance. Due to business and regulatory procedures in artificial insemination, breeding records are maintained. These records are of great assistance to the veterinary practitioners for early diagnosis of breeding problems. Generally, breeding records are the prerequisite for sound breeding efficiency. Also they are used by the dairy extension men when they present production records for the sire evaluation program because these records enable progeny identification which is essential to obtaining progeny data for evaluation of young sires. So, it could be said that artificial insemination program includes an educational feature for the dairyman. This educational feature is desirable in view of the goal of the program by broadening the dairyman's knowledge and acceptance of new ideas.

With respect to disadvantages, artificial insemination restricts the farmer's choice in the semen present at the time the cow is reported in heat. Also in applying artificial insemination the skill and knowledge of the inseminator should be constantly challenged if high conception rates are to be expected. The inseminator should manage his time so that he inseminates cows observed in heat in the morning, the afternoon of the same day. Those cows observed in the afternoon can be inseminated the next morning. Therefore, it is recommended that cows be checked twice daily for estrus and reported as "a.m. or p.m. cows" (6). This arrangement will approach the optimum time for insemination which is at the end of estrus (7). The detection of heat and its accurate reporting is the primary

challenge that the program imposes on the dairyman.

In the state of Kansas the local organization for artificial insemination is the Kansas Artificial Breeding Service Unit. It is a self supporting, non-profit auxiliary function of Kansas State University. Due to this relationship and organizational structure, the unit enjoys the counsel of the dairy cattle geneticist and reproductive physiologists whose assistance is invaluable to the unit's overall maintenance of an efficient and dynamic program. The unit's stud now maintains semen for all major dairy and beef breeds. Its main functions are collection and processing of semen for organizational use. In addition, the stud collects and processes semen from privately owned bulls. After ampuling, the semen is returned to the owner who uses it or hires an inseminator for his own herd. Moreover, the stud trains and supervises technicians in procedures for proper field handling of semen and insemination techniques that insure sanitary insemination coupled with acceptable reproductive efficiency. Reproductive efficiency is a measure of effectiveness of the bull and it is usually stated as percent non-returns to first service especially in the artificial breeding industry. Due to the problems of pregnancy diagnosis it is not feasible to calculate the breeding efficiency of a bull on the basis of services per conception (5). It has been customary to establish breeding fees on a first service basis. Ordinarily a cow would be inseminated as many as three times if necessary to obtain conception for an initial fee of five to seven dollars. A reproductively normal cow would usually conceive with three or fewer services. When an average of less than 1.8 services were required per actual conception, the breeding record was considered satisfactory (17). If the owner desires to inseminate a cow more than three times an extra fee was charged for each additional insemination. Upon completion of the insemination

the technician furnishes a triplicate breeding receipt which contains all pertinent information in regard to date, identification of cow and service sire. The original copy is retained by the owner, the inseminator keeps one copy and sends the third copy to the central office of the artificial breeding parent organization. This receipt besides being an official document needed for registration of purebred cows, is also a financial record referred to in case of repeat breeders (5, 17). It is used to compute the comparative breeding efficiency by bulls, breeds, inseminators and overall.

It is worthy to discuss here the relation between artificial breeding and the Purebred Dairy Cattle Association. The Purebred Dairy Cattle Association is an organization composed of representatives of the five major breed registry associations (17). With the introduction of artificial insemination and its adoption in the breeding of purebred cattle, the Purebred Dairy Cattle Association imposed record and identification requirements for the registration of calves dropped as a result of artificial insemination (17). This action seemed necessary since there was great chance for error in maintaining integrity of pedigree in regard to sire. Because of the number of bulls available and the use of different sires for repeat services more opportunity for error existed. There are requirements that govern the use of semen whether used within the herd or between the herds or by an association, such as the Kansas Artificial Breeding Service Unit. Also the Purebred Dairy Cattle Association requires the stud to keep a record of all semen collections and shipments. All bulls in service at an approved stud must be blood typed. This provides a method of checking and possibility of sire identification in case of contested parenthood and spot checks for accuracy of parentage. In the case of frozen semen, the organization freezing the semen must report this to the respective breed registry

association. Also the semen producing unit must maintain an inventory record of frozen semen. This record of semen must be available for inspection. On the death or sale of a bull the Purebred Dairy Cattle Association requires an inventory report of semen on hand. So, the primary objective of the requirements set up by the Purebred Dairy Cattle Association is to insure the accurate identification of the progeny and thus it adds to the purity of the respective breeds as a whole and accuracy of pedigree as well.

The second production program referred to earlier is the Dairy Herd Improvement Association Program. This is a national production testing program made possible by the cooperation of the Extension Service (3, 12). The program is non-competitive and dedicated to the education of the dairyman (3, 4, 12, 18, 19). Since the beginning of the Dairy Herd Improvement Association's work in 1906 it has been considered as a basic dairy demonstration at the county, state and national level. Despite its modest beginning, by 1964 the Dairy Herd Improvement Association had grown to include a total of 2,822,522 cows in 67,664 herds located in the fifty states and Puerto Rico (12). Recently, in 1966, the number of cows enrolled had risen to 3,300,000 cows. This was 19.1 percent of the national dairy cow numbers (18, 21).

The main advantages the program renders to participating dairymen include accurate records of identification, production, feed costs and income over feed cost, for each cow in the herd rather than on a selected few. These records provide the owner knowledge of his herd as a whole and as individuals. Feed records enable the calculation of feed cost for the individual cow and for the herd. Thus the dairyman can identify the cow returning the most income over feed cost and more important identification of cows returning little or no income over feed costs. Record keeping was also

essential to profitable herd performance because it enables the farmer to feed according to production. Moreover, sound breeding emphasizes the need for culling and selection of both cows and bulls. Therefore, production testing is a prerequisite to sound breeding, feeding and management.

It is evident that individual cow production is the result of interaction between heredity and environment. For the sake of selection and its accuracy it was important that the records reflect as precisely as possible the cows genetic potential for milk and fat production (18). Records alone do not adequately disclose the breeding value of the cows as a number of environmental factors might influence the cow's performance during any single lactation (9). The following are some important factors which affect the total production: length of lactation, number of times milked daily, age at freshening, length of preceding dry period and the season of freshening (9, 19). These factors should be taken into consideration for proper evaluation of the records and their effective usage for selection of bulls and cows. The Dairy Herd Improvement Association has adopted the 305-day lactation record (15, 19). This has provided for a calf each year with a six-to-eight week dry period. Frequently lactations vary from the ideal 305 day period usually caused by the length of the current or the preceding calving interval (9). The effect of varying length of current calving intervals is practically eliminated if the first 200 days of any lactation rather than the 305 record is used (9). However, variation in the preceding calving interval exerts greater influence because it affects maximum daily yield more than persistency (9). In order to use partial records or records of varying duration on a uniform basis it was necessary to convert all records to a 305-day basis by the use of established factors (20). There are, also, similar factors for age and are designed to convert the lactation

to a mature equivalent, because the production ability of young cows is influenced not only by the body development but also by the development of the mammary gland, which does not attain maximum development in the first lactation but in the third or fourth lactation depending on breed (9). Therefore, it was possible to convert most records to a 305-day mature equivalent basis which is standard. Differences due to the number of milking i.e., 2X or 3X were eliminated by limiting the 305-day, mature equivalent to twice daily milking. It is customary to designate the standard lactation as a "305-day, 2X mature equivalent". Individual lactation records, after being properly standardized, form the basis for bull proving and sire evaluation on a nation-wide basis. The sire evaluation program is based on the production differences between the daughters and their contemporary herdmates.

The testing supervisor is trained to give general information on feeding and care of calves and heifers as well as cows. He is a valuable source of information for the dairymen in regard to other practices and labor saving devices. By means of the annual meeting of the association, the dairymen are made aware of the need for business management in dairy farming and informed of current research findings which enhance the efficiency of their dairy operations. It is evident that the Dairy Herd Improvement Associations program is important as a service to the dairyman, as an agricultural extension demonstration project as well as a source of information for sire evaluation and research studies. The program operates under the supervision of state extension dairy specialists and county agricultural agents in cooperation with the Federal Extension Service and the Dairy Cattle Research Branch of the U. S. Department of Agriculture.

In Kansas the Associations were open for all dairymen, but sometimes membership may be limited by the supervisory capacity available. Each

Association was an organization of dairymen that elect a board to run the business. The board hires a trained supervisor to accomplish the production testing, the record keeping and to communicate with members in regard to observations and information leading to improved management and production. He is responsible for adherence to the regulations for the standard Dairy Herd Improvement Association's record keeping and testing plan which is also acceptable to the United States Department of Agriculture for sire evaluation and for academic and research purposes. He weighs and samples the milk of each cow on the testing day followed by the Babcock test for butterfat content. The weighing and sampling of each cow milked may be at any two successive milkings. The data the supervisor collects on the day of testing are reported as the basis for computing the production for the corresponding testing period. The data from the entire state are sent to the Extension Division, Iowa State University where they are centrally computer processed.

In addition to the standard Dairy Herd Improvement Association record keeping plan mentioned above there are two other non-official plans. These are the Owner Sample Plan and the Weigh-a-Day-a-Month Plan. In the former the herd owner records the milk weights and collects samples for each cow in his herd. The samples may be tested for butterfat at a private laboratory or by the supervisor when he visits the farm. Again the data can be processed centrally but the resulting production records are not used for official sire evaluation or research projects. This plan can be effective for many dairymen in evaluating their herd productivity for culling and selection processes.

The Weigh-a-Day-a-Month Plan is useful but as in the case of owner sampler, is not official. It is, in fact, meant to supplement both the

Standard Dairy Herd Improvement Association and the owner samplers plans. It is usually handled through the county agent's office or the computing center. Here again, the dairyman weighs the milk once every month. This weight plus fat test, as obtained from routine milk plant tests and feeding practices, are forwarded to either the county agent's office or a computing center. The calculated records are suitable only as a management tool for the dairyman. Moreover, the plan costs less than either of the previously discussed plans. It was evident that the majority of herds visited in Kansas are enrolled in the standard dairy herd improvement plan. Nation-wide the standard plan has the greatest enrollment. It is reported to involve two million cows in 1966. (8). The other two plans have a combined enrollment of 1,300,000 cows (8).

In addition to the Dairy Herd Improvement Association's plans, production records come from Herd Improvement Registry, Dairy Herd Registry and Advanced Registry Associations. The Herd Improvement Registry is a continuous herd test of all registered cows of the particular breed. The breed association reports lactation records for either a 305 or 365 day basis. If the record indicates production beyond the 365 days, this is credited to the lifetime performance of the individual cow. The lactation records of the Dairy Herd Improvement Associations are also accepted by the breed association as official records. In the Advanced Registry only selected registered cows are tested. In this type of testing special treatment and feeding are given to the cow in order to give excellant records. This Advanced Registry is called Registry of Merit in the Jersey breed whereas it is named as the Record of Production in the Brown Swiss.

As a conclusion to this section it is vividly clear that the production programs have provided an effective means for the promotion and progress of

dairying. Artificial insemination was recognized because it permitted many farmers to have the benefit of desirable sires. Today millions of dairy cows are mated to sires of known transmitting ability. This emphasizes the importance of artificial breeding as a means of mass improvement. Moreover, through artificial insemination small herds have breeding advantages equal to the large herds.

With reference to the Dairy Herd Improvement Associations program, it is as essential as the artificial breeding to the progress of dairying. In fact, this program is the means of providing the production records, vital for sire evaluation and testing. Again these records are invaluable for making decisions about selection and culling. It is realized that both selection and culling are of utmost importance for the disclosure of the genetic merit disseminated effectively by artificial insemination. Therefore these programs are complementary and it is fruitless to implement one program without the other.

Health and Regulatory Programs

Public health is of vital concern to the dairy industry because milk and milk products furnish an excellent medium for growth of bacteria and can be a vector for disease transmission to humans. So it is essential in milk production to maintain conditions that will result in a product with low bacterial count, free from visible dirt, pathogenic organisms, and is produced in clean attractive premises (1, 22, 25, 27). Production of milk and milk products fit for human consumption is subject to a number of regulations and sanitary laws (25, 27). These regulations pertain to the health of the producing cows, to the sanitary conditions on the dairy farm and to the dairy plants where milk is processed before it reaches the consumer. Moreover, the ultimate use of the milk may affect applicable regulations.

That is, milk used as fluid milk is designated as Grade "A" milk and the standards governing its production are more strict than those necessary for manufacturing milk (27). In Kansas, three organizations collectively shoulder the responsibility of enforcing health and sanitation regulations. These organizations are the federal, state and the specific city governments.

In regard to herd health, the regulations demand that all milk must come from herds which are located in a modified accredited tuberculosis free area (27). If the herd happens to be in an area which fails to maintain an accredited status they are required to run an annual tuberculin test for each animal in the herd (27). The tuberculin test must be done by accredited veterinarians and the certificate noting the results of the test must be sent to the proper local and state health authorities. The certificates must include the date of the injection of the tuberculin, the date of reading the test and the result of the interpretation of the test. Positive reactors are sent to slaughter under federal health authority inspection.

In the case of brucellosis, milk is only accepted from herds under brucellosis eradication program where reactors to the brucellosis agglutination test are slaughtered and all calves between six and eight months of age are vaccinated with Brucella abortus Strain 19. Generally, calfhood vaccination gives good protection but the immunity is gradually reduced until the second or third calving when the susceptibility of the animal is restored. Again most of the herds producing Grade "A" and manufactured milk are participating in a ring test program which is required four times a year. The ring test is a screening test for the detection of infection in dairy herds. It is simple and sensitive because it can detect the presence of brucella antibodies in pooled samples of milk of forty non-infected cows with only one infected animal (25). The milk samples for the ring test are

collected from the bulk tank by sanitarians and sent to the Federal-State Cooperative Laboratory to be tested for brucella antibodies. In the event of a suspicious or positive reaction to the ring test, individual blood tests are performed on all animals in the herd. All reactors disclosed by the blood agglutination test are immediately removed from the milking herd. The milk from these cows should not be used for human consumption. A certificate which enables identification of each cow signed by the veterinarian and the director of the laboratory running the test is sent to the State Board of Health. The record of the milk ring test shows only the date and the result of the test.

As brucellosis is a serious zoonosis, the local health authority is required to suspend the farm's license for sale or production of milk for human consumption after a thirty day warning if the cows are not tested. Also suspension and withdrawal from the market follows failure of the dairyman to retest his herd after the lapse of thirteen months from the last blood test or thirty days from the expiration of the official ring test.

Also under the heading of milk unfit for human consumption is milk from mastitic or indurated udders. Such milk evinces such abnormalities as high leucocyte counts, decreased sugar content and increased amount of chloride (16). Also the pH changes from a normal of 6.5 to as high as 7.4 in extreme cases of mastitis. Mastitis can be detected by direct diagnostic tests and indirect or barn tests such as the California Mastitis Test. In addition to the foregoing, milk which contains penicillin or other antibiotics is not acceptable. The common sources of antibiotics in milk are either from milk included from cows after mastitis treatment or purposely added by producers to check bacterial growth. One effect of antibiotics in

milk is the inhibition of starters in the manufacture of cheese which causes economic loss. Of greater significance, fluid milk must not show antibiotic residues because some consumers may be fatally allergic to them. So it is required that milk from antibiotic treated mastitic cows must be withheld from the market for three days (25).

The standard plate count for wholesome raw milk must not exceed 200,000 colonies per milliliter for Grade "A" (25, 27). This limit was reduced to 100,000 colonies per milliliter in the 1965 milk ordinance. High bacterial count of raw milk may not be due to the presence of visible dirt from the cow but may also be due to unsanitized utensils or due to bacterial growth following deficient cooling. It is generally assumed that appreciable quantities of visible dirt is accompanied by numerous bacteria of a particularly undesirable type because of fecal origin and because of the changes they cause in milk. So the regulations encourage thorough cleaning and sufficient clipping of the udder and flank to minimize a sediment.

The regulations for Grade "A" milk producing farms are numerous. Briefly, for a consistently good product, a properly constructed stable and milk house are necessary. Moreover, production of high quality milk requires scrupulous cleaning and a willingness of the producers to adhere to the provisions of the milk ordinance (25, 27).

To see that the producers comply with sanitary regulations, dairy farms are inspected monthly by sanitarians. These sanitarians are either from the State Board of Health or from the specific city's public health department. During the inspection, visual as well as organoleptic examinations of the pipeline, rubber ware and other dairy equipment are effected. Any deviations from the regulations are marked against the farm on the inspection

sheet. Also milk samples are collected and sent to the State Board of Health Laboratory for bacteriological examination which is either the standard plate or the oval tube method. In addition, tests for the presence of coliform bacteria are conducted. The raw milk coliform plate count should not exceed ten colonies per milliliter. Also the disc assay test is performed to detect antibiotic and other inhibiting agents. The results of these tests, coupled with the sanitarian's inspection, determine what procedure the health authority will follow with the producing farms, i.e., warning or degrading, dependent on general conditions of the farm facilities on inspection day.

In the State Board of Agriculture's Laboratory, similar tests are conducted on raw milk from the producer's farm. Again the milk is tested for adulteration by the milk cryoscope. This is an instrument designed to determine the freezing point of liquids. Milk has a constant and lower freezing point than that of water. It is normally $31.0^{\circ}F$ ($\pm 0.55^{\circ}C$) (22). Since the freezing point is among the highly stable physical properties of milk, its variations from the normal are used to detect adulteration of milk. Also in this laboratory, tests for the presence of pesticides are performed. The test for pesticides is not conducted routinely but in cooperation with investigatory procedures initiated by a federal agency, such as the Food and Drug Administration.

In regard to the dairy plant, samples of pasteurized milk are tested by the standard plate and coliform counts and phosphatase test which indicates improper pasteurization. The standards for the plate count is 30,000 colonies per milliliter and for coliform not exceeding one colony per 100 milliliter (25, 27). Detection of coliform in samples of pasteurized milk indicates either improper pasteurization or post pasteurization contamination or both.

In addition to milk samples, swabs of utensils and rinse samples are forwarded for examination. Swabs and rinse sample testings are used to determine the effectiveness of sanitation and cleaning (25). Swabs are acceptable when the nature of the equipment does not permit the satisfactory use of the rinse method (25). The swabs are taken from an area of eight square inches by thorough and slow rubbing of five different sites. The maximum plate standard for swab contact method is 12.5 colonies per square inch (25, 27). The plate standard for the rinse method must not exceed 10,000 colonies per ten quart of equipment capacity. For a twenty quart capacity equipment satisfactory plate standard is 20,000 colonies and so on for larger containers (25, 27). For bottles, colony estimates are 1000 colonies for one quart bottles and proportionately less for smaller containers.

Organizations, such as the Southwest Milk Producers Cooperative, conduct quality control tests in addition to their primary function of processing and marketing milk. In their laboratory, bacteriological tests are run on samples collected by the truck drivers. These tests are not obligatory, but the cooperative can detect poor sanitation and the association's fieldmen and the producer can work together to investigate and solve the problem before sanitary degradation ensues. This is, in fact, a benefit the cooperative renders to its members. Moreover, most major dairy plants have their own laboratory in which quality control examinations are run by federal appointed bacteriologists.

Most of the programs discussed in the foregoing rely in one form or another on the dairy extension specialists whose primary function is education (3). Specifically within the area of production programs, the Dairy Herd Improvement Association's program is supervised by the extension dairy

specialists. In this case the dairy specialist assumes an instructional role in explaining the basic principles of the program to the participating dairymen. Also he motivates and encourages leadership in the Dairy Herd Improvement Association's group. In addition, he inspires dairymen to use records the program makes available as tools to improve the individual and overall dairy economy. Also his impartial zeal usually results in participation in production testing in one of its three plans.

The role of the dairy specialists in regard to artificial breeding is indirect because the artificial breeding organization is offering a service and product to sell. This would involve a direct engagement in active promotion of competitive breeding organizations, an activity the extension service must avoid (3). So the extension specialist has best served the artificial insemination program by providing production record summaries for use by artificial insemination in sire selection and evaluation. Again artificial insemination benefits from the teaching of the specialist wherein insemination is the logical source of superior semen and improved breeding.

In regard to the health and regulatory program the role of dairy extension specialists is essential for general acceptance. It is found that programs such as mastitis control and the correction of nutritional deficiency are accepted when the specialists discuss them in depth at dairymen's meetings. Also in those meetings the specialists explain the benefits of adhering to sanitary regulations and thus avoid economic losses. In fact extension workers are the essential promoters for programs related to dairying in all its aspects.

SUMMARY AND CONCLUSION

Programs at the producer's level such as the production, health and regulatory programs previously discussed in relation to Kansas do not exist

in the Sudan. But in view of the technical and extension aspects of the developmental plans in the Ministry of Animal Resources there, it is becoming mandatory to adopt similar programs modified for conditions in the Sudan.

In regard to production programs, artificial insemination service, with its numerous advantages, can be most helpful to the dairy industry generally, because of its impact on genetic ability for milk production. Genetic improvement will come most rapidly through the selection of superior sires, and their extensive perpetuation artificially. To the peasant producer, as those in the Sudan, this will mean improvement of his breedingstock without the necessity of purchasing expensive bulls. Artificial insemination also would allow a producer to keep an extra cow instead of a bull. This feature would increase the farmer's total production by a considerable fraction in the Sudan as he only keeps a small number of cows. Moreover, these small producers would probably give more attention to the feeding and general management of the herd due to pride in artificially conceived progeny and access to time and facilities formerly needed for a bull. In fact this would initiate an evolution of the peasant producers into small specialized dairy producers. This evolutionary trend would benefit communities of small stockowners such as mixed farmers on small holdings along the Nile.

In the last decade the government initiated cooperative projects where intensive husbandry with herds as large as 2,000 cattle are concentrated for urban milk supply and serve as demonstration units. These projects would benefit from the adoption of the artificial insemination program because their location near big cities will not impose a communication and transportation problem. Moreover the large concentration of cows within these localized projects would justify the initial expense of the breeding operation and eventually reduce breeding costs. Both freshly extended or

frozen semen could be utilized efficiently. Obviously little would be gained and much harm may be done if the sires used are not proved and known to be superior or if their progeny are inferior in type. Actually, access to proven sires will be a major limiting factor to the usefulness of artificial insemination in the Sudan. This problem is nearly eliminated in Kansas because of the national production testing program, which enables accurate selection of individual animals according to their performance. Moreover, the data the program provides are effectively used for sire evaluation and selection on a nationwide basis. Therefore, in Kansas, sires which are used artificially, possess high production transmitting ability. Such an important program as production testing must run concurrently with artificial insemination in the Sudan. But because of the lack of the trained personnel essential for production testing, collection of data and its processing, it will not be practical to generalize this testing program for the whole country immediately. Localized programs located in such a way as to cover cooperative societies of dairymen where there are concentrations of dairy cattle in the Sudan would be a practical beginning. If the data from these localized areas were centrally processed for selection of the sire, this might minimize individual locality environmental bias. This concept would approach results in sire selection now being realized in Kansas.

If the evolution of the peasant producers into small specialized dairy producers is to proceed rapidly, it is essential for the Sudanese authorities to provide them with organized marketing facilities, and efficient advisory and auxiliary services related to dairying. As indicated earlier in the introduction of this report, milk and its products are an appealing part of the Sudanese diet. Therefore, a market exists. But there is an increasing demand for wholesome and high quality dairy products. This is only achieved

by adhering to sound and well founded sanitary and regulatory programs. The impact of these programs on dairy improvement is indirect and focused on the economical aspects of dairying. Universally, fluid milk which returns the biggest income to dairy farms, is most affected by the sanitary and regulatory laws. This is well known in the Sudan but the regulations governing the sale of fluid milk are not as widely enforced and appreciated as they are in Kansas. With respect to health programs pertaining to the herd, only government dairy farms try to maintain reasonable standards. On these farms, brucellosis blood testing and removal of reactors from the producing herd and calfhood vaccination is practiced. In regard to tuberculosis, periodical but not annual, tuberculin testing is conducted at some stations. Moreover, these government farms are not the sole producers of milk; a majority of market milk comes from the peasant producers whose herds are neither tested nor inspected. The sanitary conditions of the farms from which fluid milk comes is grossly inadequate. No specific requirements are needed there in order for the farm to be permitted to sell milk for human consumption. Also, there is no sanitary inspection or quality testing of milk from the producer's farm. The only establishment where strict sanitary regulations are applied, as they are in Kansas, is the single dairy processing plant in the country.

In conclusion it seems obvious that the progress and improvement of the dairy industry in Kansas has been a gradual result of the adoption of a number of programs. These programs involved some of the areas vital to the growth of the dairy industry. The production programs, for example, dealt with the genetic improvement of dairy cattle through the selection of exceptional sires and their extensive perpetuation through the implementation of artificial breeding. The adoption of this program has resulted in mass improvement manifested in the ever increasing numbers of cows

artificially inseminated each year. Data for accurate culling and selection are effectively provided by the Dairy Herd Improvement Association program. This is a national program for production testing and effective record keeping. Production records made available by this program are as essential for sire evaluation programs as they are for culling and selection. Artificial insemination and the Dairy Herd Improvement Associations complement each other for effective dairy management.

The impact of the health and regulatory programs on the dairy industry is indirect and primarily affects the economic aspect of the industry. These programs regulate the facilities and procedures under which milk is produced for human consumption.

All these programs depend, in one form or another, on the instructional role of the extension service for adequate adoption and implementation.

With regard to the situation in the Sudanese Republic, it is important now that similar programs modified for conditions in the Sudan should be adopted. The adoption of dairy improvement programs in the Sudan seems inevitable following the technical and developmental plans now launched for the promotion and improvement of the dairy industry.

ACKNOWLEDGEMENT

The author wishes to express his deepest appreciation to Dr. E. L. Farmer, his major professor, for his guidance and assistance in the preparation of this report. Grateful acknowledgement is warmly extended to Dr. C. L. Norton, Head of the Department of Dairy and Poultry Science, to Dr. G. B. Marion and to Dr. K. A. Huston for reviewing the report. Also sincere acknowledgement is extended to Mr. E. R. Bonewitz and to Mr. D. Z. McCormick for their help in arranging the tours and the consultations with the different establishments and agencies in Kansas.

Special thanks are extended to Mrs. R. Morton, staff members and graduate students of the Department of Dairy and Poultry Science for their cooperation in making his stay in the United States really fruitful and a pleasant experience.

REFERENCES

(1) Coletti, Anthony. Handbook for Dairymen. Iowa State Univ. Press. Ames 1963. pp 153-214.

(2) Falconer, D. S. Introduction to Quantitative Genetics. The Ranold Press Company. New York 1961. pp 26-207.

(3) Federal Extension Service. A Handbook for Extension Workers. Agriculture Handbook No. 248.

(4) Gilmore, L. O. Dairy Cattle Breeding. Lippincott Comp. New York 1952. pp 371-397.

(5) Ibid., pp 524-539.

(6) Hafez, E. S. E. Reproduction in Farm Animals. Lea and Febiger Philadelphia 1962. pp 114-161.

(7) Hall, J. G., Bratton, Ceil, and Stone, E. J. Estrus and Estrous Cycles Ovulation Time, Time of Services and Fertility of Dairy Cattle of Louisiana. J. Dairy Sci., 42. 1-6:1086. 1959.

(8) Hoard's Dairyman. 6:725. 1966.

(9) Johansson, I. Genetic Aspects of Cattle Breeding. Univ. of Illinois Press. Urbana. 1961. pp 136-148.

(10) Ibid., p 205.

(11) Ibid., pp 245-253.

(12) King, G. J. and Miller, R. H. National Cooperative Dairy Herd Improvement Program. Agricultural Handbook No. 278 U.S.D.A.

(13) Lush, J. L. Animal Breeding Plans. Iowa State College Press. Ames 1949. pp 120-205.

(14) Perry, E. J. The Artificial Insemination of Farm Animals. Rutgers University Press. New Brunswick 1960. pp 3-10.

(15) Ibid., pp 315-382.

(16) Petersen, W. E. Dairy Science Principles and Practices. J. B. Lippincott Company. Chicago 1950. pp 388-431.

(17) Reaves, P. M. and Henderson, H. O. Dairy Cattle Feeding and Management. John Wiley and Sons Inc., Sydney 1963. pp 291-305.

(18) Ibid., pp 335-343.

(19) Rice, V. A., Andrews, F. N., Warnick, E. J., and Legates, J. E. Breeding and Improvement of Farm Animals. McGraw-Hill Book Company Inc., London 1957. pp 160-180.

(20) Ibid., pp 400-412.

(21) United States Department of Agriculture Letters Agricultural Research Services at U.S.D.A. 1965. Vol. 41, 505.

(22) Roadhouse, C. L., and Hendersen, J. L. The Market Milk Industry. McGraw-Hill Book Company Inc., London 1950. pp 56-220.

(23) Salisbury, S. W., and Vandemark, N. L. Physiology of Reproduction and Artificial Insemination. W. H. Freeman and Company. San Francisco 1961. pp 1-17.

(24) Specht, L. W., and McGilliard, L. D. Rates of Improvement by Progeny Testing in Dairy Herds of Various Sizes. J. Dairy Sci., 43:63. 1960.

(25) Standard and Methods Examination of Dairy Products Microscopical and Chemical. American Public Health Association Inc., 1960. pp 47-282.

(26) Tothill, J. D. Agriculture In The Sudan. London-Oxford Univ. Oxford 1948. pp 662-667.

(27) U. S. Department of Health and Education and Welfare. Grade "A" Pasteurized Milk Ordinance. 1965. U.S.A. Government Printing Office 1965.

(28) Williamson, G., and Payne, W. J. A. An Introduction To Animal Husbandry In The Tropic. pp 131-162.

(29) Wing, J. M. Dairy Cattle Management Principles and Applications. Reinhold Publishing Corporation. New York 1963. pp 216-229.

DAIRY EXTENSION AND EDUCATIONAL PROGRAMS IN KANSAS

by

MUSTAFA BEDAWI BASHIER

B. V. Sc., University of Khartoum
Sudan, 1961

AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements of the degree

MASTER OF SCIENCE

Department of Dairy and Poultry Science

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1966

The objective of this study was to summarize general concepts needed for the improvement of the dairy production and to serve as a guide for the production of milk safe for human consumption in the Republic of the Sudan. This study was made in conjunction with the technical and extension aspects of the developmental programs in the Ministry of Animal Resources in the Sudan. The need for this study is evidenced by the general acceptance to dairy products by the Sudanese populace.

The study does not confine itself to one phase of dairying in the state of Kansas but it involves a number of programs. These programs are generally described as production, health and regulatory programs. The production programs include artificial breeding and the Dairy Herd Improvement Associations. These programs are complementary with a goal of improving the producing ability of dairy cattle through improved breeding, feeding and management and the application of accurate selection and culling procedures. Artificial breeding can improve the producing ability of future generations through the use of sires proven superior for milk and fat production. This technique provides for mass improvement because of the extended use of proved sires. Application of accurate selection and culling procedures follow the availability and interpretation of good production records.

The required production records are provided by the Dairy Herd Improvement Association program. The data the program provides are essential for sire evaluation and selection.

The health and regulatory programs provide the laws and regulations necessary for controlling and protecting the herds from which milk is produced and the consumers from zoonotic diseases. This protection is accomplished through laws pertaining to the herd health as well as the

quality of the milk at the producer's farm and milk products at the plant.

The fulfillment of these programs requires the educational and instructional role of the extension service. In Kansas, in regard to the Dairy Herd Improvement Association's program, the dairy extension specialist assists the dairymen to use the information the program provides and to develop the leadership essential to dairy herd improvement groups. The specialist also promotes the artificial breeding program by explaining to the dairymen the need for improved genetic potential for high levels of production. Also he provides production records summaries for use in sire evaluation and selection.

In regard to the situation in the Sudan, it is important that similar programs modified for conditions in the Sudan should be adopted following the technical and developmental plans now launched for the promotion and the improvement of the dairy industry.